M–GATOR™ Utility Vehicle

TECHNICAL MANUAL

John Deere
Worldwide Commercial and Consumer Equipment Division

TM1804 (9Feb00)

Litho in U.S.A

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
- Specifications
- Component Location
- System Schematic
- Theory of Operation
- Troubleshooting Chart
- 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

Engine

Electrical

Power Train

Steering

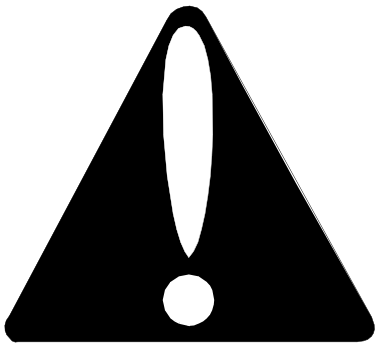
Brakes

Miscellaneous

M

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

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.

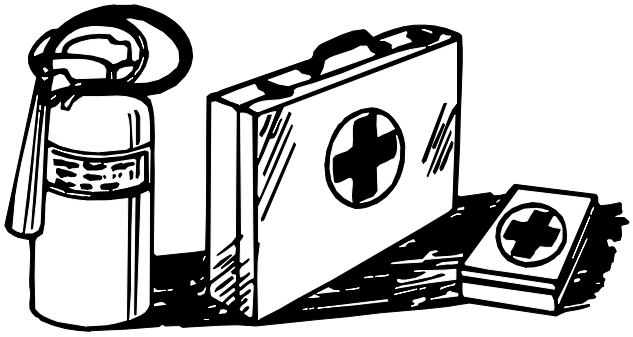
DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

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.

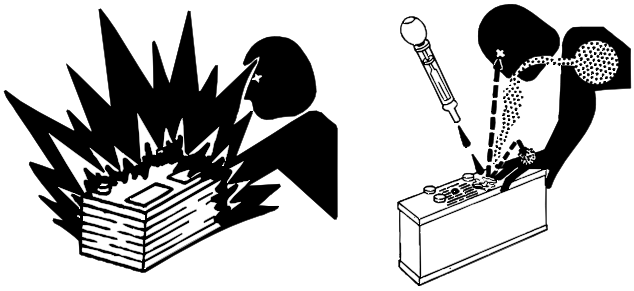
Do not store oily rags; they can ignite and burn spontaneously.

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:**

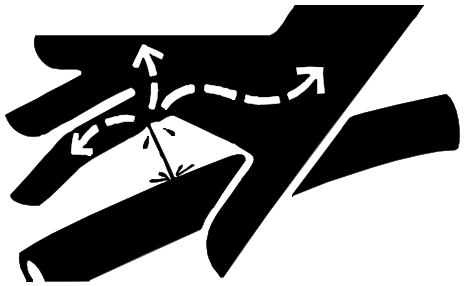
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10 – 15 minutes.
4. Get medical attention immediately.

- **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.

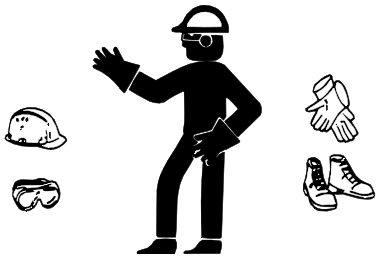
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

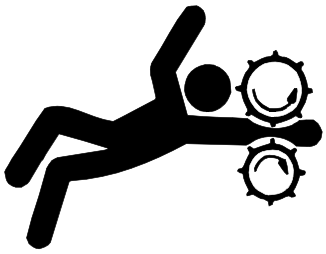


Wear close fitting clothing and safety equipment appropriate to the job.

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



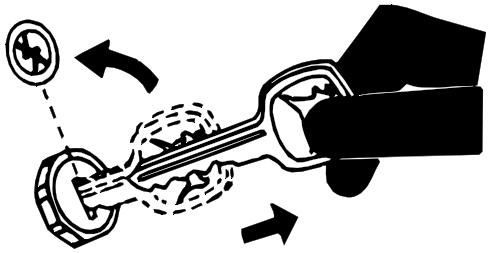
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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.

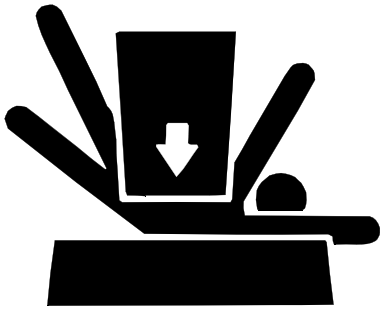
Park Machine Safely



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.

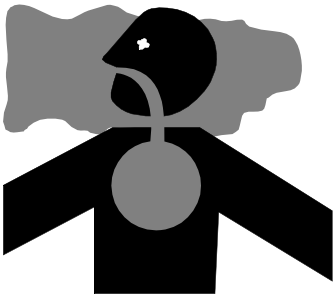
Using High Pressure Washers

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

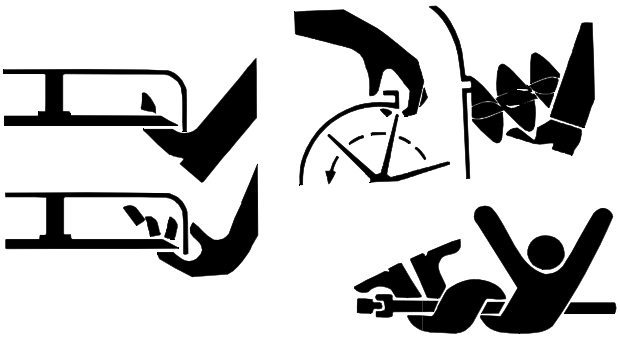
Explosive separation of a tire and rim parts can cause serious injury or death.

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



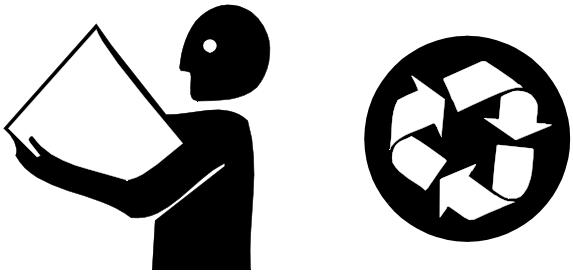
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

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.

CONTENTS

Page

GENERAL VEHICLE SPECIFICATIONS[1]

ENGINE:

Make	Yanmar
Model	3TN66C-JUV
Type	4-cycle diesel
Cylinders	3
Valves	Overhead valves
Displacement	(658 cm^3) 40.2 cu. in.
Power (SAE J1940)	(13.4 kW) 18 hp
Maximum torque	28.9 lb-ft @ 2700 rpm
Lubrication	Full pressure
Slow Idle Speed (no load)	1000 ± 50 rpm
Fast Idle Speed (no load)	3550 ± 25 rpm
Cooling System	Liquid
Air Cleaner	Dry replaceable dual element w/ remote intake
Battery Cold Cranking	340 cold cranking amps

ELECTRICAL:

System	12 VDC
Ignition	Direct inject diesel
Headlights	37.5 watt halogen
Battery	32 amp/hr
Alternator	40 amp regulated

FUEL SYSTEM:

Fuel Type	Diesel
Fuel Tank Capacity	20 L (5.3 U.S. gal)
Fuel Consumption (Approximately)	0.961 L/hr (0.25 U.S. gal/hr)

TRANSMISSION:

Type	Continuous variable
Differential Lock	Standard; hand operated
Ground Speed	0–25 km/h (0–15.5 mph)
Drive Chain	No. 50 industrial roller chain
Transaxle	Fully enclosed; oil bath
Gear Selection	Forward, neutral, reverse
Overall Reduction Ratio	
Low	70.8 : 1
High	14.3 : 1
Brakes	Wet disk in transaxle

STEERING:

Type . . . . . Rack and pinion Ackerman-type

GROUND PRESSURE (maximum):

With 200 lb Operator . . . . . 0.49 kg cm^2 (6.9 psi)

Fully Loaded Vehicle . . . . . 0.51 kg cm^2 (7.3 psi)

DIMENSIONS:

Length (with bumper) . . . . . 2810 mm (110.63 in.)

Width (overall with heavy duty tires) . . . . . 1545 mm (60.83 in.)

Front Tread Centers. . . . . 1270 mm (50.0 in.)

Rear Tread Centers . . . . . 1220 mm (48.0 in.)

Height (overall with heavy duty tires). . . . . 1107 mm (43.6 in.)

Wheelbase (front/rear) . . . . . 2006 mm (79.0 in.)

Weight (includes fuel/fluids) . . . . . .645 kg (1422 lbs)

Turn Clearance Circle . . . . . 7.6 m (24.8 ft)

GROUND CLEARANCE:

Under Transaxle . . . . . 170 mm (6.7 in.)

Under Foot Platform . . . . . 215 mm (8.5 in.)

CAPACITIES:

Payload Capacity (total)[2]. . . . . 636 kg (1400 lb)

Towing Capacity . . . . . 636 kg (1400 lb)

Seating Capacity 2

CARGO BOX:

Material . . . . . .16 gauge roll formed steel

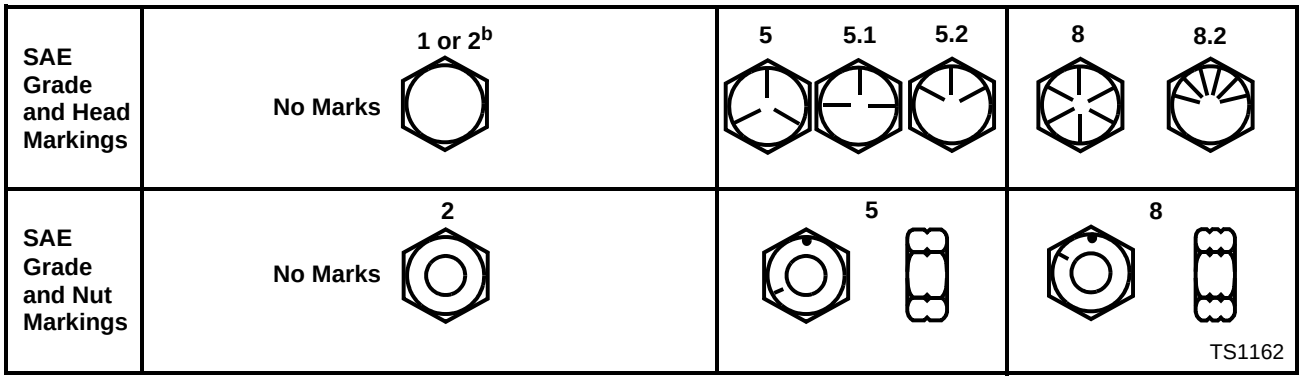
Capacity

Volume . . . . . 0.32 m^3 (11.2 cu-ft)

Weight . . . . . 454 kg (1000 lb)

1. Specifications and design subject to change without notice.
2. Includes 200 lb. operator, 200 lb. passenger and maximum box capacity.

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.

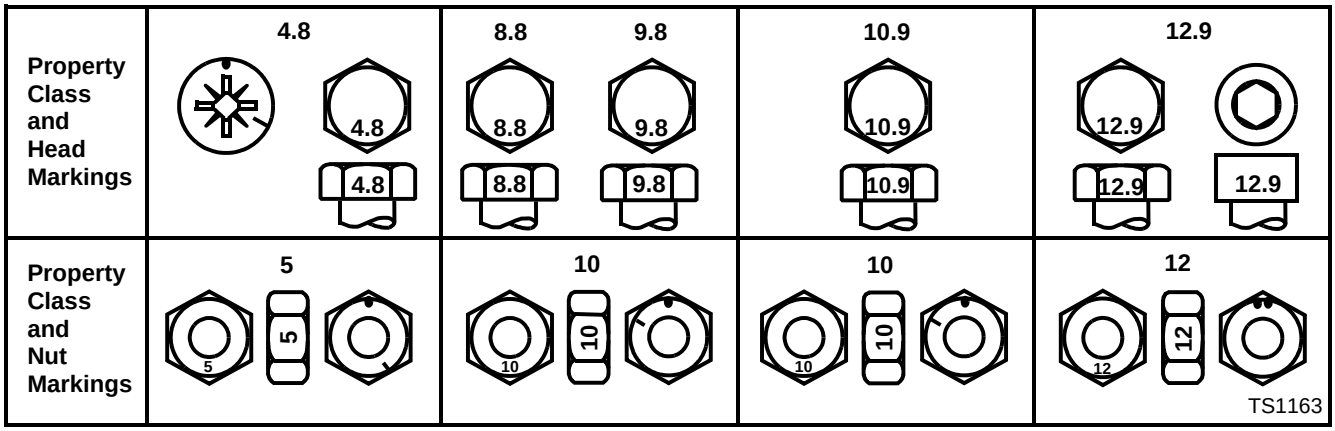
Tighten toothed or serrated-type lock nuts to the full torque value.

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.

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

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Reference: JDS—G200.

DIESEL FUEL SPECIFICATIONS

DIESEL FUEL

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.

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%**.

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

WARNING

<u>California Proposition 65 Warning:</u> 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.

DIESEL FUEL 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.

DIESEL FUEL 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

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:**

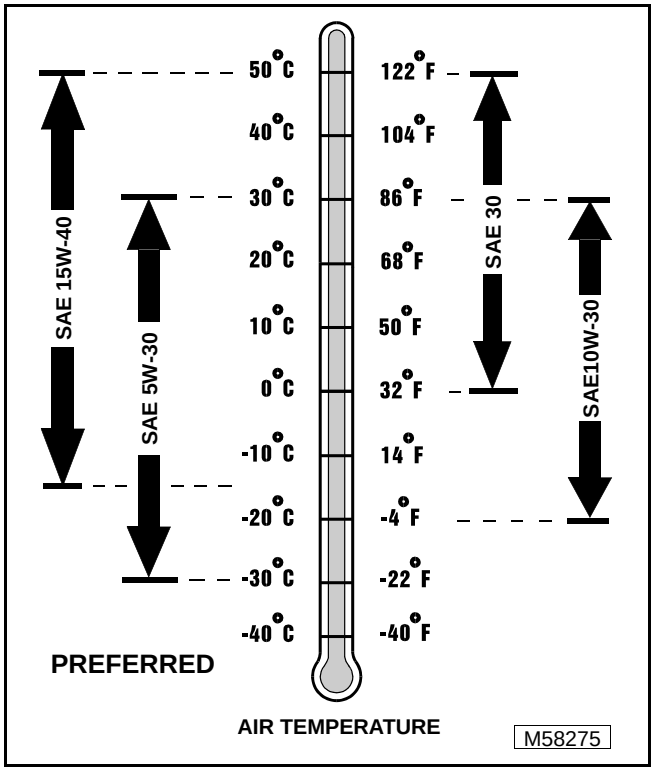
- **PLUS–50®—SAE 15W-40;**
- **UNI–GARD™—SAE 15W-40;**
- **TORQ–GARD SUPREME®—SAE 5W-30**.
- **UNI–GARD™—SAE 5W-30.**

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

- **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%.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

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.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil filter for your customers:

- Module DX,FILT in JDS–G135;
- Section 540, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lawn & Grounds Care Tune-Up Guide PI672.

BREAK–IN ENGINE OIL

IMPORTANT: ONLY use this specified break-in oil in rebuilt or remanufactured engines for the first 100 hours (maximum) of operation. 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.

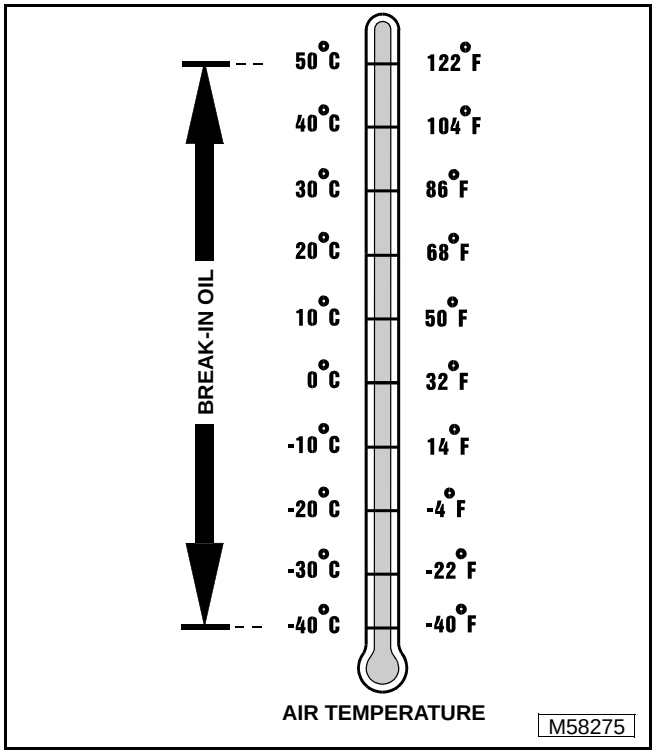
John Deere BREAK–IN ENGINE OIL is also

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.
- CCMC Specification D4 or higher.

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



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL4 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL

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

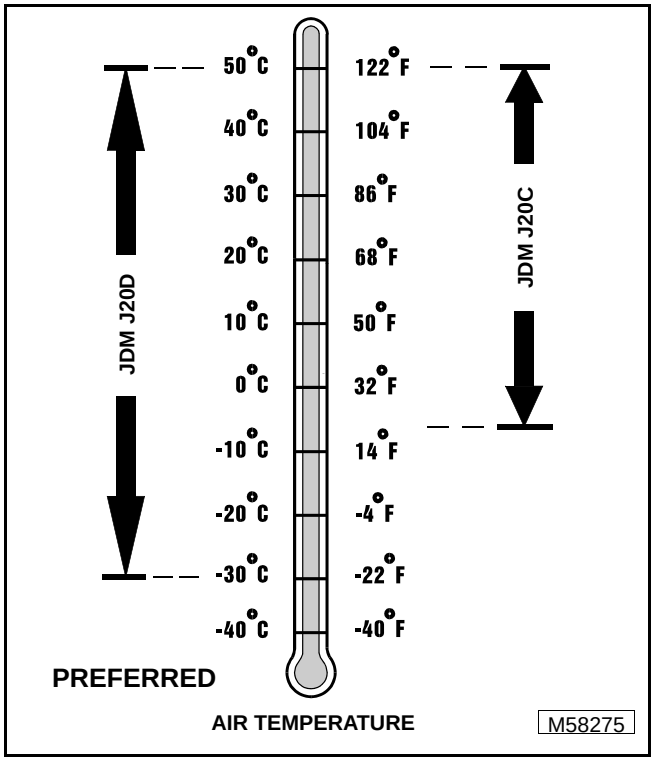
IMPORTANT: Mixing of HY–GARD® and LOW VISCOSITY HY–GARD® oils is permitted. DO NOT mix any other oils in this transmission. DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission.

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

- **HY–GARD®—JDM J20C**.

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

- John Deere Standard JDM J20C;
- John Deere Standard JDM D.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ANTI in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

CHASSIS GREASE

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 greases are **PREFERRED**:

- **MOLY HIGH-TEMPERATURE EP GREASE®—JDM J25C, NLGI Grade 2;**
- **HIGH-TEMPERATURE EP GREASE®—JDM J13E4, NLGI Grade 2.**
- **GREASE–GARD™—JDM J25C, NLGI Grade 2.**

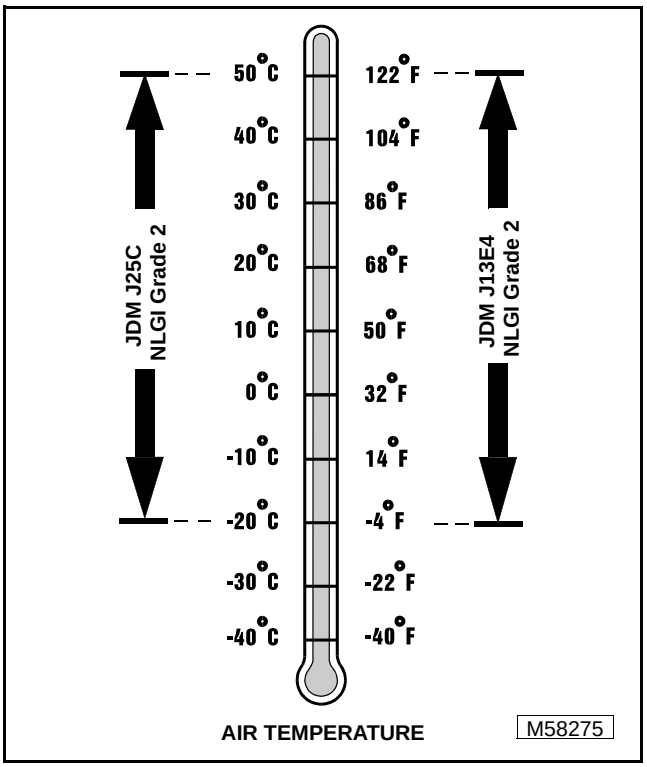
Other greases may be used if above preferred John Deere greases are not available, provided they meet one of the following specifications:

- **John Deere Standard JDM J25C, NLGI Grade 2;**
- **John Deere Standard JDM J13E4, NLGI Grade 2.**

IMPORTANT: If minimum air temperature should fall below -20 °C (-4 °F), the grease must be heated to at least five degrees above the lower limit before start-up or components may be damaged.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- **Module DX,GREA1 in JDS–G135;**
- **Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;**
- **the Lubrication Sales Manual PI7032.**



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 temperature limits and service or lubricant change intervals should be maintained as shown in the operator's manual, unless otherwise stated on lubricant label.

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.

COOLANT

The engine cooling system when filled with a proper dilution mixture of antifreeze and deionized or distilled water provides year-round protection against corrosion, cylinder or liner pitting, and winter freeze protection down to –37 °C (–34 °F).

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

- **PRE-DILUTED DIESEL ENGINE ANTIFREEZE/ SUMMER COOLANT™ (TY16036).**
- **COOL–GARD COOLANT CONCENTRATE™.**

This coolant satisfies specifications for “Automobile and Light Duty Engine Service” and is safe for use in John Deere Lawn and Grounds Care/Golf and Turf Division equipment, including aluminum block gasoline engines and cooling systems.

The above preferred pre-diluted antifreeze provides:

- **adequate heat transfer**
- **corrosion-resistant chemicals for the cooling system**
- **compatibility with cooling system hose and seal material**
- **protection during extreme cold and extreme hot weather operations**
- **chemically pure water for better service life**
- **compliance with ASTM D4656 (JDM H24C2) specifications**

If above preferred pre-diluted coolant is not available, the following John Deere concentrate is **recommended**:

- **DIESEL ENGINE ANTIFREEZE/SUMMER COOLANT CONCENTRATE™ (TY16034).**

If either of above recommended engine coolants are available use any Automobile and Light Duty Engine Service **ethylene glycol base coolant**, meeting the following specification:

- **ASTM D3306 (JDM H24C1).**

Read container label completely before using and follow instructions as stated.

IMPORTANT: To prevent engine damage, DO NOT use pure antifreeze or less than a 50% antifreeze mixture in the cooling system. DO NOT mix or add any additives/conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality—clean, clear, potable water (low in chloride and hardness–Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is ideal to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Table 1: Water Quality

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Max.	170 ppm (10 grns/gal)
Chloride (as Cl), Max.	40 ppm (2.5 grns/gal)
Sulfate (as SO_4), Max.	100 ppm (5.8 grns/gal)

Mix 50 percent antifreeze concentrate with 50 percent distilled or deionized water. This mixture and the pre-diluted mixture (TY16036) will protect the cooling system down to –37 °C (–34 °F) and up to 108 °C (226 °F).

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

COOLANT DRAIN INTERVAL

When using **John Deere Pre-Diluted (TY16036)** Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every **36 months or 3,000 hours** of operation, whichever comes first.

When using **John Deere Concentrate (TY16034)** Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every **24 months or 2,000 hours** of operation, whichever comes first.

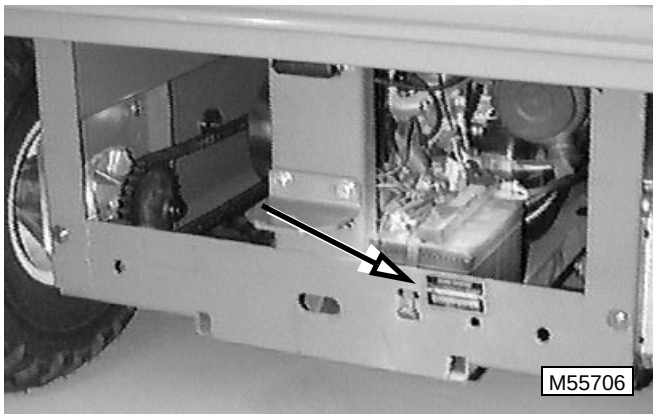
If above John Deere Automobile and Light Duty Engine Service coolants **are not** being used; drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

PRODUCT IDENTIFICATION LOCATIONS

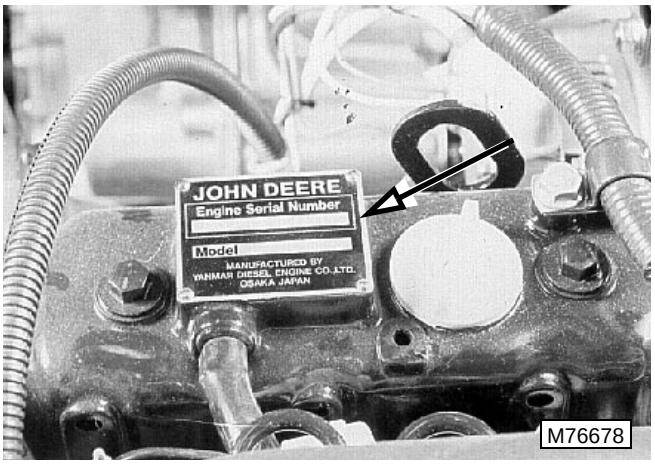
When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the product identification number, and the component product identification numbers.

The location of the product identification numbers and component product identification numbers are shown.

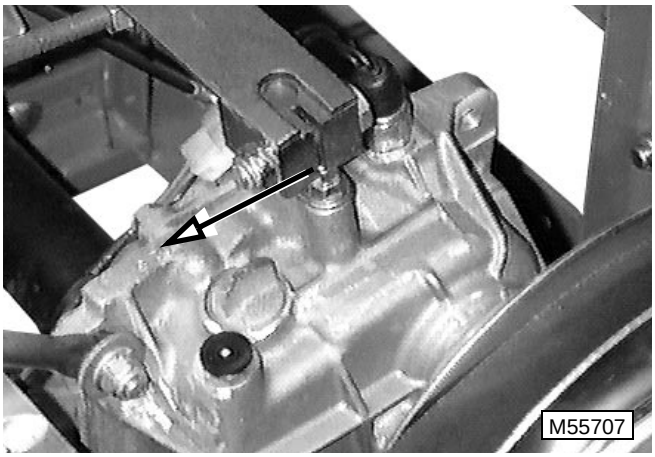
PRODUCT IDENTIFICATION NUMBER



ENGINE PRODUCT IDENTIFICATION NUMBER



TRANSMISSION PRODUCT IDENTIFICATION NUMBER



CONTENTS

SPECIFICATIONS

Make	Yanmar
Model	3TN66C-JUV
Type	Vertical, 4-cycle Diesel
Output Power	13.42 kW (18 HP)
Cylinders	3
Bore	66 mm (2.6 in.)
Stroke	64.2 mm (2.53 in.)
Displacement	0.658 L (40.2 cu. in.)
Firing Order	1—3—2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect Injection Type
Compression Ratio	22.4 to 1
Oil Capacity	Approximately 2.0 L (2.1 qt)
Cooling	Liquid
Capacity	4.5 L (4.8 qt)
Governor	Centrifugal
Slow Idle (no-load)	1000 ± 50 rpm
High Idle (no-load)	3550 ± 25 rpm
Rated RPM	3150

REPAIR SPECIFICATIONS

Rocker Arm Cover:

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

Rocker Arm Assembly:

Mounting Cap Screw and Nut Torque	26 N•m (226 lb-in.)
Rocker Arm Shaft OD	
Standard	9.97 - 9.99 mm (0.3925 - 0.3933 in.)
Wear Limit	9.95 mm (0.3920 in.)
Rocker Arm and Shaft Support ID's	
Clearance	0.14 mm (0.005 in.)
Standard	10.00 - 10.02 mm (0.3937 - 0.3945 in.)
Wear Limit	10.09 mm (0.3972 in.)
Push Rod Length (Standard)	114 - 115 mm (4.488 - 4.528 in.)
Push Rod Bend Wear Limit	0.08 mm (0.003 in.)

Cylinder Head:

Mounting Cap Screw Torque	
First	11 N•m (97 lb-in.)
Second	22 N•m (195 lb-in.)
Final	34 N•m (25 lb-ft)
Piston-to-Cylinder Head Clearance	0.59 - 0.74 mm (0.023 - 0.029 in.)
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.)

Intake and Exhaust Valves:

Intake Valve Seat Width
- Standard . . . . . 1.15 mm (0.045 in.)
- Wear Limit . . . . . 1.65 mm (0.065 in.)

Exhaust Valve Seat Width
- Standard . . . . . 41 mm (0.056 in.)
- Wear Limit . . . . . 1.91 mm (0.075 in.)

Valve Seat Surface Angles
- Exhaust Valve . . . . . 45°
- Intake Valve . . . . . 30°
- Lower Seat Surface . . . . . 70°
- Upper Seat Surface . . . . . 15°

Valve Faces
- Minimum Margin . . . . . 0.51 mm (0.020 in.)
- Exhaust Angle . . . . . 45°
- Intake Angle . . . . . 30°

Valve Stem OD
- Distance A . . . . . 20 mm (0.787 in.)
- Distance B . . . . . 40 mm (1.575 in.)

Intake Valve
- Standard . . . . . 5.46 - 5.48 mm (0.2149 - 0.2157 in.)
- Wear Limit . . . . . 5.40 mm (0.2126 in.)

Exhaust Valve
- Standard . . . . . 5.44 - 5.46 mm (0.2142 - 0.2149 in.)
- Wear Limit . . . . . 5.40 mm (0.2126 in.)

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

Valve Lift . . . . . 7.5 mm (0.300 in.)

Valve Guides:

Valve Guide ID
- 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 . . . . . 0.80 mm (0.032 in.)

Exhaust Manifold:

Mounting Cap Screw and Nut Torque . . . . . 11 N•m (97 lb-in.)

Intake Manifold:

Mounting Cap Screw Torque . . . . . 11 N•m (97 lb-in.)

Connecting Rod Bearing ID:

Clearance . . . . . 0.16 mm (0.006 in.)
Standard . . . . . 36 - 36.042 mm (1.417 - 1.419 in.)
Wear Limit . . . . . 37.07 mm (1.459 in.)
Piston and Connecting Rod Cap Screw Torque . . . . . 23 N•m (203 lb-in.)

Piston Ring Groove Clearance:

First Compression Ring
- Standard . . . . . 0.065 - 0.100 mm (0.0026 - 0.0039 in.)
- Wear Limit . . . . . 0.20 mm (0.0079 in.)

Second Compression Ring
- Standard . . . . . 0.030 - 0.065 mm (0.0012 - 0.0026 in.)
- Wear Limit . . . . . 0.20 mm (0.0079 in.)

Oil Ring
- Standard . . . . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)
- Wear Limit . . . . . 0.20 mm (0.0079 in.)

Piston End Ring Gap:

First Compression Ring and Oil Ring . . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)
Second Compression Ring . . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)
Wear Limit . . . . . 1.50 mm (0.059 in.)

Piston Pin:

Pin OD
- Standard . . . . . 19.991 - 20.00 mm (0.787 - 0.788 in.)
- Wear Limit . . . . . 19.975 mm (0.786 in.)

Bore ID
- Clearance . . . . . 0.045 mm (0.0018 in.)
- Standard . . . . . 20.00 - 20.008 mm (0.787 - 0.788 in.)
- Wear Limit . . . . . 20.02 mm (0.788 in.)

Bushing ID
- Clearance . . . . . 0.110 mm (0.0043 in.)
- Standard . . . . . 20.025 - 20.038 mm (0.788 - 0.789 in.)
- Wear Limit . . . . . 20.10 mm (0.781 in.)

Piston OD:

Distance A . . . . . 5 mm (0.197 in.)

Standard Size Piston
- Standard . . . . . 65.927 - 65.957 mm (2.596 - 2.597 in.)
- Wear Limit . . . . . 65.85 mm (2.593 in.)

0.25 mm (0.010 in.) Oversize Piston
- Standard . . . . . 66.18 - 66.21 mm (2.606 - 2.607 in.)
- Wear Limit . . . . . 66.10 mm (2.602 in.)

0.50 mm (0.020 in.) Oversize Piston
- Standard . . . . . 66.43 - 66.46 mm (2.615 - 2.616 in.)
- Wear Limit . . . . . 66.35 mm (2.612 in.)

Cylinder Bore ID:

Standard Size Bore
- Clearance . . . . . 0.25 mm (0.010 in.)
- Standard . . . . . 66.00 - 66.03 mm (2.599 - 2.600 in.)
- Wear Limit . . . . . 66.20 mm (2.606 in.)

0.25 mm (0.010 in.) Oversize Bore
- Standard . . . . . 66.25 - 66.28 mm (2.609 - 2.610 in.)
- Wear Limit . . . . . 66.45 mm (2.616 in.)

0.50 mm (0.020 in.) Oversize Bore
- Standard . . . . . 66.50 - 66.53 mm (2.619 - 2.620 in.)
- Wear Limit . . . . . 66.70 mm (2.626 in.)

Deglazing . . . . . 30 - 40° cross-hatch pattern
Reboring . . . . . 30 - 40° cross-hatch pattern

Crankshaft Rear Oil Seal:

Seal Case-to-Block Cap Screw Torque . . . . . 11 N•m (96 lb-in.)
Oil Pan-to-Seal Case Cap Screw Torque . . . . . 9 N•m (78 lb-in.)

Crankshaft and Main Bearings:

Main Bearing Cap Screw Torque . . . . . 54 N•m (40 lb-ft)
Crankshaft Maximum Bend . . . . . 0.02 mm (0.0007 in.)
Connecting Rod Journal OD
Standard . . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)
Wear Limit . . . . . 35.92 mm (1.414 in.)
Main Bearing Journal OD
Standard . . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)
Wear Limit . . . . . 39.92 mm (1.572 in.)
Main Bearing ID
Clearance . . . . . 0.15 mm (0.0059 in.)
Standard . . . . . 40.00 - 40.042 mm (1.575 - 1.577 in.)
Wear Limit . . . . . 40.07 mm (1.578 in.)

Stub Shaft:

Stub Shaft-to-Flywheel Cap Screw Torque . . . . . 59 N•m (44 lb-ft)

Flywheel:

Maximum Distortion . . . . . 0.02 mm (0.0008 in.)
Flywheel Mounting Cap Screw Torque . . . . . 83 N•m (61 lb-ft)
Engine Back Plate Mounting Cap Screw Torque . . . . . 49 N•m (36 lb-ft)

Camshaft:

Mounting Cap Screw Torque . . . . . 11 N•m (96 lb-in.)
Camshaft Side Gap
Standard . . . . . 0.05 - 0.15 mm (0.0020 - 0.0060 in.)
Wear Limit . . . . . 0.40 mm (0.016 in.)
Maximum Camshaft Bend . . . . . 0.02 mm (0.001 in.)
Lobe Height
Standard . . . . . 29.97 - 30.03 mm (1.180 - 1.182 in.)
Wear Limit . . . . . 29.75 mm (1.171 in.)
Journal OD
Gear Housing and Flywheel Ends
Standard . . . . . 35.94 - 35.96 mm (1.4150 - 1.4157 in.)
Wear Limit . . . . . 35.85 mm (1.4114 in.)
Intermediate
Standard . . . . . 35.91 - 35.94 mm (1.4138 - 1.4150 in.)
Wear Limit . . . . . 35.85 mm (1.4114 in.)
Bushing ID
Clearance . . . . . 0.18 mm (0.007 in.)
Standard . . . . . 36.00 - 36.065 mm (1.417 - 1.420 in.)
Wear Limit . . . . . 36.10 mm (1.421 in.)
Bore ID
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:

OD
- Standard . . . . . 17.950 - 17.968 mm (0.7067 - 0.7074 in.)
- Wear Limit . . . . . 17.93 mm (0.706 in.)

Bore ID
- Clearance . . . . . 0.032 - 0.068 mm (0.0013 - 0.0027 in.)
- Standard . . . . . 18.00 - 18.018 mm (0.7087 - 0.7094 in.)
- Wear Limit . . . . . 18.05 mm (0.711 in.)

Timing Gear Cover:

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

Idler Gear:

Shaft OD
- Standard . . . . . 19.959 - 19.980 mm (0.786 - 0.787 in.)
- Wear Limit . . . . . 19.93 mm (0.785 in.)

Bushing ID
- Clearance . . . . . 0.15 mm (0.0059 in.)
- Standard . . . . . 20.00 - 20.021 mm (0.787 - 0.788 in.)
- Wear Limit . . . . . 20.08 mm (0.791 in.)

Timing Gear Housing Cap Screw 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 Cap Screw 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 Cap Screw Torque . . . . . 25 N•m (18 lb-ft)
Rotor Shaft OD-to-Backing Plate ID Clearance
- Standard . . . . . 0.015 - 0.048 mm (0.0006 - 0.0035 in.)
- Wear Limit . . . . . 0.20 mm (0.0078 in.)

Rotor Recess Wear Limit . . . . . 0.25 mm (0.010 in.)
Outer Rotor-to-Pump Body Clearance
- Standard . . . . . 0.03 - 0.09 mm (0.0011 - 0.0035 in.)
- Wear Limit . . . . . 0.13 mm (0.0057 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)

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 OD (Minimum) . . . . . 7.90 mm (0.311 in.)
Governor Shaft Bore ID
- Wear Limit . . . . . 8.15 mm (0.321 in.)
- Clearance . . . . . 0.18 mm (0.007 in.)

Sleeve ID (Maximum) . . . . . 8.20 mm (0.323 in.)
Injection Pump Camshaft OD
- 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 . . . . . 40 N•m (30 lb-ft)
Nozzle Torque . . . . . 50 N•m (37 lb-ft)
Separator Plate Nozzle Contact Surface Maximum Wear . . . . . 0.10 mm (0.0039 in.)

Starting Motor - 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 - Nipondenso 40 Amp:

Flywheel Assembly-to-Coil Plate Assembly Nut Torque . . . . . 27 N•m (20 lb-ft)

Checks, Tests and Adjustments:

Valve Clearance . . . . . 20 mm (0.008 in.)
Connecting Rod Side Play
- Standard Clearance . . . . . 0.20 - 0.40 mm (0.0079 - 0.0157 in.)
- Wear Limit . . . . . 0.55 mm (0.0217 in.)

Connecting Rod Bearing Clearance
- Standard Clearance . . . . . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)
- Wear Limit . . . . . 0.15 mm (0.0059 in.)

Crankshaft End Play
- Standard Clearance . . . . . 0.090 - 0.271 mm (0.004 - 0.011 in.)
- Wear Limit . . . . . 0.33 mm (0.0129 in.)

Crankshaft Main Bearing Clearance
- Main Bearing Cap Screw Torque . . . . . 54 N•m (40 lb-ft)
- Standard Clearance . . . . . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)
- Wear Limit . . . . . 0.15 mm (0.0059 in.)

Valve Lift (Intake and Exhaust) . . . . . 7.5 mm (0.300 in.)
Camshaft End Play
- Standard Clearance . . . . . 0.05 - 0.20 mm (0.0020 - 0.0079 in.)
- Wear Limit . . . . . 0.40 mm (0.016 in.)

Timing Gear Backlash

Standard Backlash
All Except Crankshaft Gear-to-Oil Pump Gear . . . . . 0.04 - 0.12 mm (0.0016 - 0.0047 in.)
Crankshaft Gear-to-Oil Pump Gear . . . . . 0.11 - 0.19 mm (0.0043 - 0.0075 in.)
Wear Limit . . . . . 0.20 mm (0.0079 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 (On Engine):

Continuity . . . . . 109° ± 1° C (228° ± 2° F)

Radiator Core Temperature Switch (Operates Fan Motor):

Continuity (Closes) . . . . . 67 - 75° C (153 - 167° F)
No Continuity (Opens) . . . . . 57 - 63° C (135 - 145° F)

Starter No-Load Amp Draw/RPM:

Maximum Starter Amperage . . . . . 60 Amps at 7000 rpm
Minimum Starter RPM 7000

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 . . . . . 42 N•m (31 lb-ft)

Water Pump/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 . . . . . 83 - 96 kPa (12 - 14 psi)
Cylinder Compression Pressure
Compression Pressure . . . . . 2448 kPa (355 psi)
Maximum Difference Between Cylinders. . . . . 490 kPa (71 psi)
Engine Idle Speed
Fast Idle. . . . . 3550 ± 25 rpm
Slow Idle . . . . . 1000 ± 50 rpm
Engine Oil Pressure . . . . . 294 - 392 kPa (43 - 57 psi)
Air Intake System Holding Pressure . . . . . 34 - 69 kPa (5 - 10 psi)

SPECIAL OR REQUIRED TOOLS

Tool	Purpose
JTO5719 Digital Tachometer or, JTO Digital Pulse Tachometer	Used to set slow idle engine rpm and check fast idle rpm
D01109AA Diesel Fuel Injection Nozzle Tester D01110AA Adapter Set 23622 Straight Adapter	Used for fuel injection nozzle test
JDF13 Nozzle Cleaning Kit	Used to clean fuel injection nozzles
JDG356 Fuel Pump Pressure Test Kit	Used for fuel transfer pump pressure test
JTO1682 Compression Gauge Assembly JDG472 Adaptor	Used for cylinder compression check
JDG529 Belt Tension Gauge or, JDST28 Belt Tension Gauge	Used to adjust the water pump/alternator drive belt tension
JDG472 Adaptor	Used for radiator bubble test
DO5104ST Cooling System Pressure Pump JDG692 Radiator Pressure Test Kit Adapters	Used for cooling system pressure test
JTO3017 Hose Assembly JTO5577 Pressure Gauge (100 psi) JTO3349 Connector	Used for engine oil pressure test
JDG813-1 Clutch Removal Tool	Used to remove clutch from flywheel
JDG1175-2 Center Distance Gauge	Used to determine isolator spacers for engine mount
PLASTIGAGE®	Used for clearance measurements
Dial Indicator	Used for valve lift check

OTHER MATERIALS

Number	Name	Use
TY15130 LOCTITE® No. 395	John Deere Form-In-Place Gasket	Seals crankcase extension housing, rear oil seal case and flywheel housing to engine block. Seals oil pan to timing gear housing and engine block.

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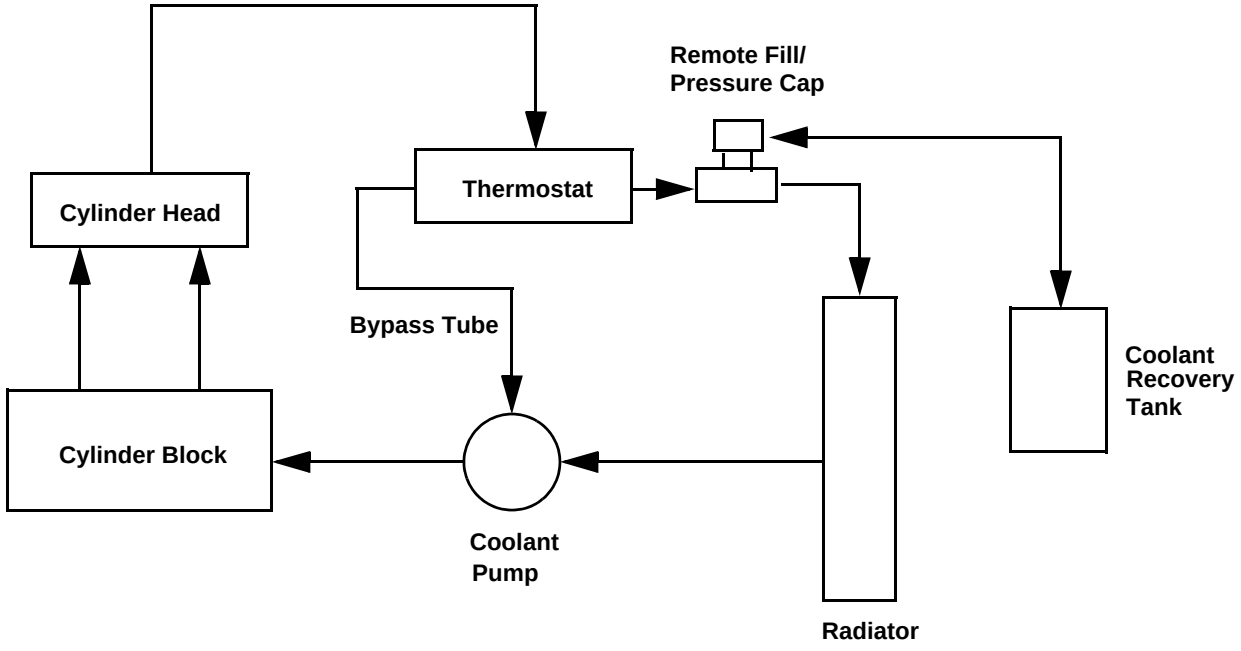
LOCTITE® is a registered trademark of the Loctite Corp.

THEORY OF OPERATION

COOLING SYSTEM



Function:

The cooling system allows the engine to rise to full operating temperature when engine is started cold. Once engine reaches operating temperature, coolant is circulated from the hot engine to the radiator to prevent engine overheating. The cooling system is pressurized, which raises the boiling point of the coolant and allows coolant to carry away more heat from the engine.

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, **85° C (184° F)**, warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

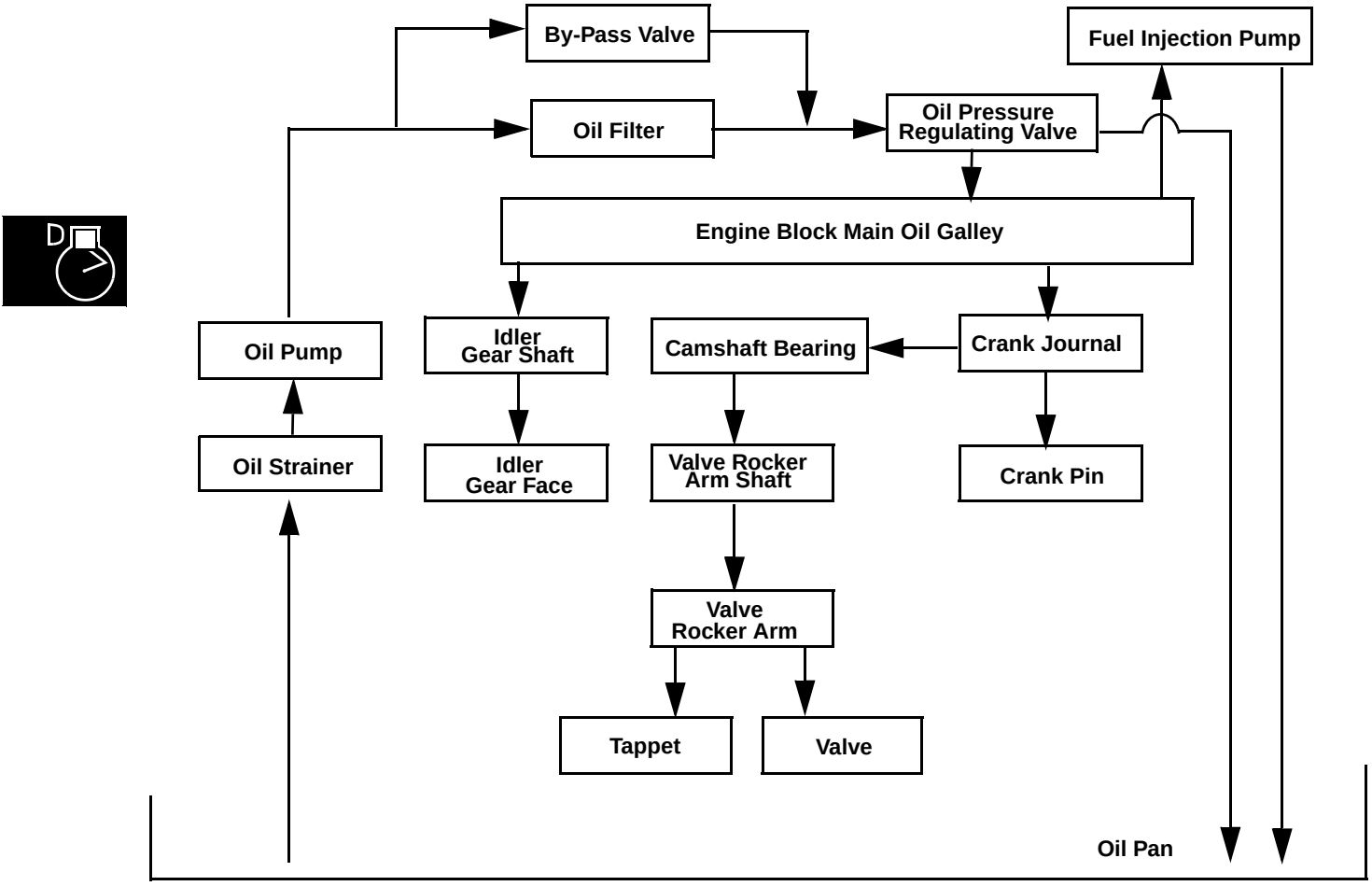
When coolant system pressure exceeds **90 kPa (13 psi)**, a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

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 switch informs the operator of the engine coolant temperature and warns of a high temperature condition by lighting a lamp when the coolant temperature reaches approximately **109°±1°C (228°±2°F)**.

The radiator is equipped with a core temperature sensor which will activate an electric cooling fan mounted on the inside of the radiator. Air is pulled by the fan through a grate under the right passenger seat, through a removable debris guard, through the radiator and fan, and out to the engine compartment.

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 route lubricating oil directly from the main oil galley through external oil lines 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.

AIR SYSTEM OPERATION

Function:

The air intake system filters air needed for combustion.

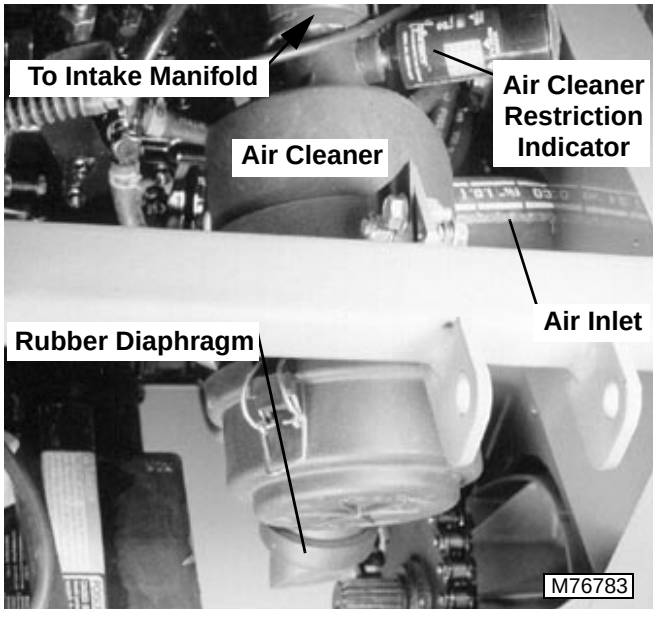
Theory of Operation:

Air enters the air cleaner inlet and is directed into the side of a shield. This starts a high-speed centrifugal motion of air which continues around the element until it reaches the far end of the air cleaner housing, to an unloader valve.

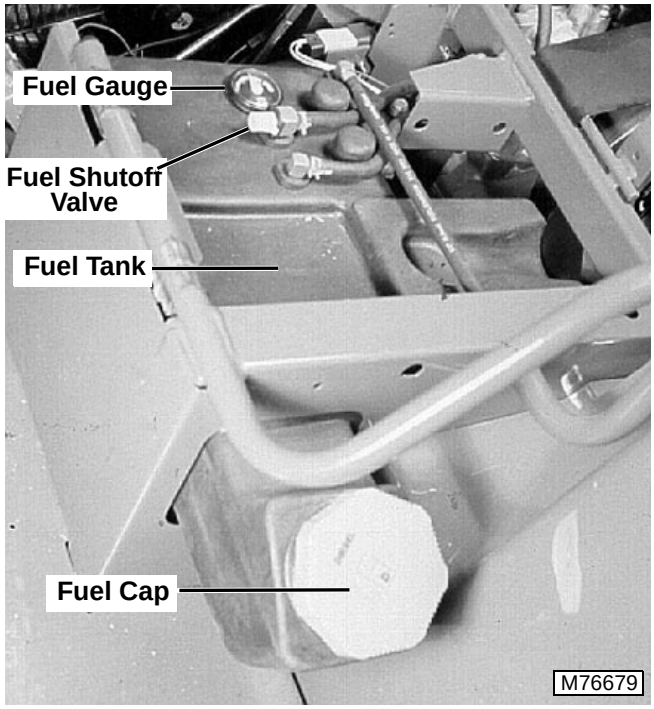
Most of the dust is separated from the air by centrifugal force that causes heavy dust particles to enter the opening at the top of the unloader valve. The remaining air enters the filter element. The filter element filters the air before entering the intake manifold.

The dirt that is deposited in the unloader valve is removed by the rubber diaphragm at the base of the air cleaner. When the engine is running, a pulsing action is created in the intake system by each intake stroke of the engine. This pulsing action causes the rubber diaphragm to open and close, thus emptying the unloader valve. The operator can squeeze the valve to let the large particles out.

The difference in pressure between the intake manifold and air cleaner is monitored by the Air Cleaner Restriction Indicator. As the air cleaner becomes clogged, and intake manifold increases, the restriction indicator piston is pulled down against spring tension, and is calibrated to show when it's time to change air cleaner.



FUEL SYSTEM OPERATION



Function:

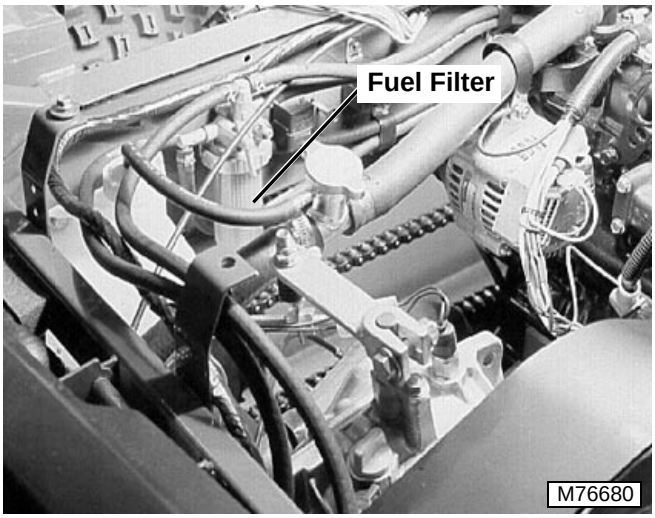
Fuel system supplies fuel to injection nozzles.

Theory of Operation:

The engine driven mechanical fuel transfer pump draws fuel from the vented fuel tank, through the fuel tank shutoff valve, through the fuel supply line (D), to the transfer pump (on the back of the engine). Pressurized fuel is then sent from the fuel transfer pump to the glass bowl fuel filter/water separator mounted on the right side of the frame, then on to the fuel injection pump. After the injection pump galley is full, excess fuel is returned, along with excess leak-off fuel from the injectors, through the return line (B) to the fuel tank.

If the unit ever runs out of fuel, there is a priming lever on the side of the mechanical fuel transfer pump, which allows fuel to be manually pumped from the tank to the injector pump/governor assembly if air has entered the fuel system. (See Checks, Tests and Adjustments)

The engine speed is controlled by the throttle pedal and mechanical linkage. The linkage is connected to the injection pump/governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key ON), the engine can be started. When the key 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 inside whenever injection is not taking place.

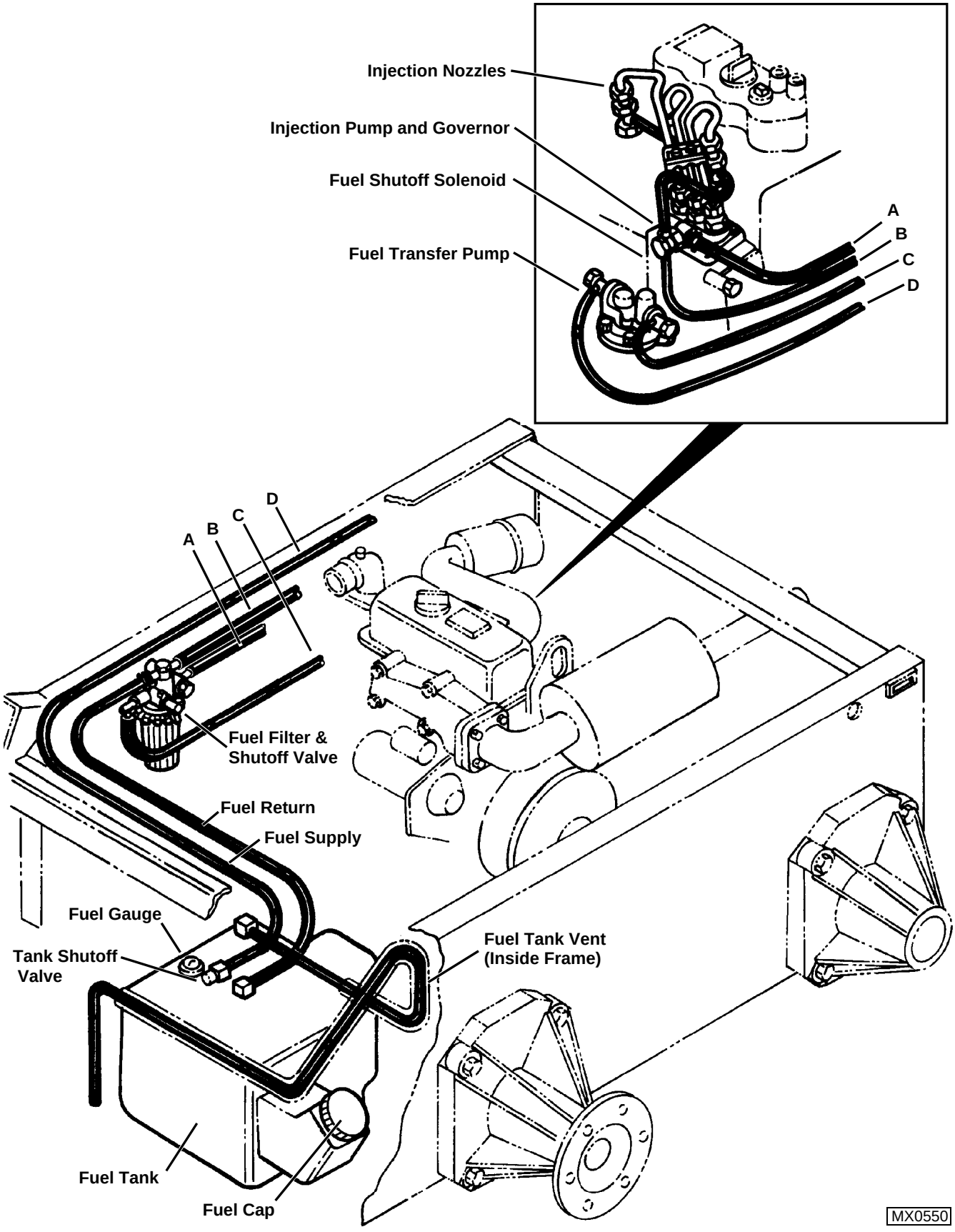
A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

A float-type fuel level sensor mounted on the top of the tank informs the operator of the fuel level.

The fuel shutoff solenoid stops the flow of fuel inside the fuel injector pump by forcing the governor rack linkage to a no fuel position, causing the fuel injector pump to stop suppling fuel to the injectors.

The fuel shutoff solenoid has two coils inside; one pull-in and one hold-in coil. The hold-in coil is energized whenever the key switch is in the on or start position. The pull-in coil is energized only when in the start position and oil pressure switch closed.

FUEL SYSTEM OPERATION



NOTES:

TROUBLESHOOTING

TROUBLESHOOTING CHART

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DIAGNOSIS

Conditions:

- Machine parked on level surface.
- Park brake engaged.
- Key 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 “L” and “H” 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. Coolant tank and radiator - 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. Radiator screen free of debris. Hoses not cracked or leaking, clamps and radiator cap tight. Water pump/alternator belt tight, not glazed or cracked. Fan blades not damaged or warped.	Add proper coolant mix. Drain and flush system. Check for source of contamination. Clean or replace. Pressure test radiator and cap. Replace and adjust belt tension. Replace fan.
3. Fuel tank, pump, lines, filter, filter shutoff valve - Fuel System Check	Fuel level correct, not contaminated, correct grade of fuel, no water or debris in filter bowl/water separator. Fuel tank and filter shutoff valves both in “ON” position. Fuel hoses not cracked or leaking. Fuel hose clamps tight. Fuel tank does not have vacuum.	Drain and clean fuel tank. Add fresh fuel. Replace filters. Move to “ON” position. Replace. Replace or tighten. Replace fuel tank vent hose.
4. Air filter and air intake - Air Intake System Check	Air filter hose not cracked, clamps tight. Element not plugged. Air filter housing sealed, no dirt tracking inside filter element. Air filter restriction indicator not leaking	Replace and tighten clamps. Replace element or housing. Replace indicator
5. Fuel shutoff solenoid. (Key in RUN position.)	Fuel shutoff solenoid must pull in and stay in. Listen for clicking as key is cycled	If solenoid will not pull in and hold in, see Fuel Shutoff Solenoid Circuit Diagnosis in ELECTRICAL section.
6. Engine Coolant Temperature Light (Key in RUN position.)	Indicator light should come on up to 30 seconds depending on air temperature.	See Indicator Light Diagnosis in 6x4 ELECTRICAL section.
7. Fuel filter/water separator.	Fuel level visible in filter bowl. Fuel bowl not full of water. Fuel present at injector pump inlet hose	Pump lever on side of fuel transfer pump to prime pump and fuel bowl. Drain water from bowl. Replace fuel filter. Recheck. Test fuel pump.
8. Throttle cable and pedal stop.	Cable not binding and pedal stop adjusted correctly.	Repair, replace or adjust cable.
9. Intake and exhaust valves	Valve clearance within specification (engine cold). Valves not sticking.	Adjust valves. (See *Tests & Adjustments* in this section.) Check valve guides and stems.

10. Fuel is reaching injectors.	Crack fuel injection lines at injectors. Crank engine. (Be sure fuel shutoff solenoid has pulled in.). Fuel leaks out.	No fuel present: Check both fuel shutoff valves are open, fuel level, inspect filter/ separator element. Test fuel pump.
11. Injectors are working properly	Injector spray pattern is normal and cracking pressure is within specifications.	Check spray pattern and cracking pressure. (See *Tests and Adjustments* in this section.) Replace injectors.
12. Engine compression tested at fuel injector ports.	Cylinder compression within specification. Pressure difference between cylinders within specification.	Perform cylinder compression test. (See *Tests and Adjustments* in this section.)
13. Flywheel and starting motor	Minimum cranking rpm within specification.	See Starter Amp Draw Test in *Electrical* section.
14. Injection pump timing inspection (Key ON, Engine OFF)	Timing should be correct. (Remove pump as the **LAST** possible solution.)	Have injection pump static timing adjustment performed by a qualified Service Repair Shop. (See *Tests and Adjustments* in this section.)
15. Injection pump slow idle speed (Engine running)	Engine runs at **1000 ± 50 rpm**.	See Slow Idle Adjustment in this section.
16. Injection pump fast idle speed (Engine running)	Engine runs at **3550 ± 25 rpm**.	See Fast Idle Speed Adjustment in this section.
17. Governor	Engine runs smooth throughout rpm range with low smoke and good power	Have governor torque capsule adjusted by a certified CARB/EPA service center.
18. Oil pressure sender port	Oil pressure in specification.	Test engine oil pressure. (See *Tests and Adjustments* in this section.)
19. Thermostat	Opening temperature within specification.	Perform thermostat opening test. (See *Tests and Adjustments* in this section.)
20. Muffler	Not restricted.	Replace muffler.

TESTS AND ADJUSTMENTS

CYLINDER COMPRESSION TEST

Reason:

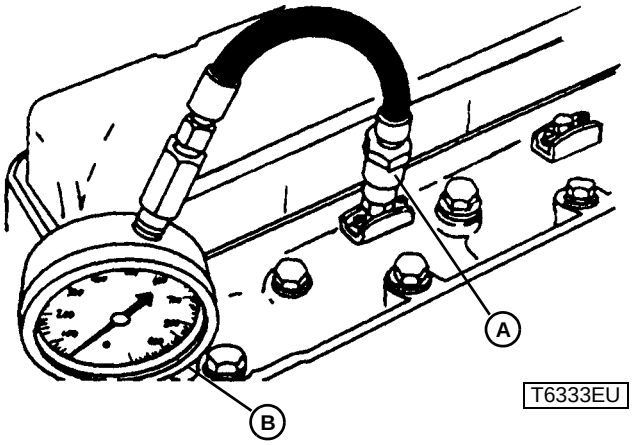
To determine the condition of the pistons, rings, cylinder walls and valves.

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.



3. Install heat protector from end of injector and install on JDG472 adapter (A).
4. Install JT01682 Compression Gauge Assembly (B) and JDG472 Adapter in injection port.
5. Disconnect fuel shutoff solenoid electrical connector on top of engine.

IMPORTANT: DO NOT overheat starting motor during test.

6. Crank engine for three seconds with starting motor.
7. Record pressure reading for each cylinder.

Specifications:

Compression Pressure . . . . . 2448 kPa (355 psi)
Maximum difference
between cylinders . . . . . 490 kPa (71 psi)
Minimum cranking speed . . . . . 250 rpm

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

Results:

- If pressure reading is below specification, squirt 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.

THROTTLE CABLE ADJUSTMENT

Reason:

To ensure that throttle pedal and cable adjustment is allowing throttle lever on governor to reach full high idle and slow idle positions, and that enough slack is in throttle cable to prevent unnecessary wear.

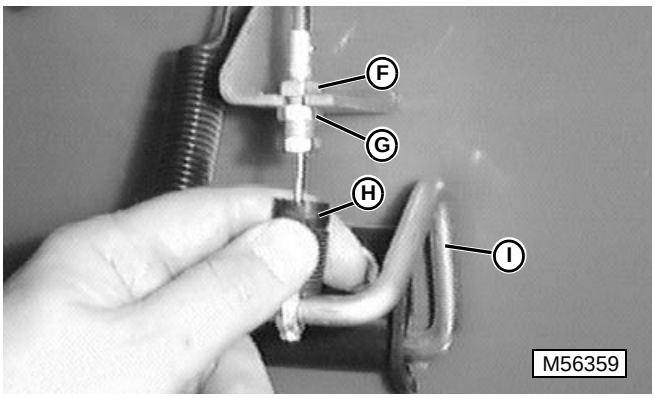
Equipment:

- Two 1/2” Open End Wrenches

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Loosen jam nut on cable end at engine and turn adjuster until an equal amount of threads are showing on front and rear of cable ferrule. Tighten jam nut.

IMPORTANT: DO NOT move engine throttle control arm by hand, this will kink the wire cable and damage it. Use throttle pedal only.



3. Check that throttle pedal rod is resting against front panel at (I).
4. Pull rubber boot (H) down.
5. Loosen jam nut (F).
6. Turn adjusting nut (G) until there is enough slack in cable so that when throttle pedal is depressed there is a **2 mm gap** between pedal rod and front panel at (I) before throttle lever arm on governor begins to move.
7. Tighten jam nut (F).
8. With throttle pedal released, throttle lever arm on governor should be resting against slow idle stop screw.

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 or JT07270 Digital Pulse Tachometer.

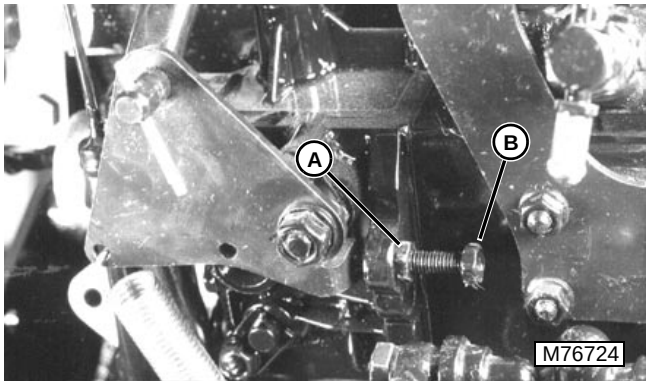
Procedure:

1. Start engine and run for 5 minutes.
2. Visually check that injection pump throttle lever is against slow idle stop screw. If not against slow idle stop screw, adjust throttle cable (see *Throttle Cable Adjustment* in this section).
3. Use JT05719 Hand Held Digital Tachometer or JT07270 Digital Pulse Tachometer to check engine speed at flywheel.

Specifications:

Slow Idle Speed . . . . . 1000 ± 50 rpm

:



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

FAST IDLE ADJUSTMENT

ATTENTION!

Fast idle is adjusted to comply with EPA emissions requirements by the engine manufacturer. Fast idle can only be adjusted by an EPA authorized diesel service center. Tampering with the fast idle adjustment by unauthorized personnel will void the engine warranty and result in fines.

Reason:

To verify proper fast idle speed setting. This checks that the engine is running at proper rpm's for peak performance.

Equipment:

- JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer

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 needed.

2. Start engine and run for 5 minutes to obtain normal operating temperature.
3. Move throttle lever to fast idle position.
4. Use JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.

Specifications:

Fast Idle Speed. . . . . 3550 ± 25 rpm

Results:

- If fast idle speed does not meet specifications, adjust throttle cable as needed. See "THROTTLE CABLE ADJUSTMENT" on page 21.
- If engine still does not meet fast idle speed specifications, have injection pump inspected by an EPA authorized diesel service (ADS) center.

VALVE CLEARANCE, CHECK AND ADJUSTMENT

Reason:

To be sure valves are fully opening at the correct time, but not remaining open too long or wearing valve train unnecessarily.

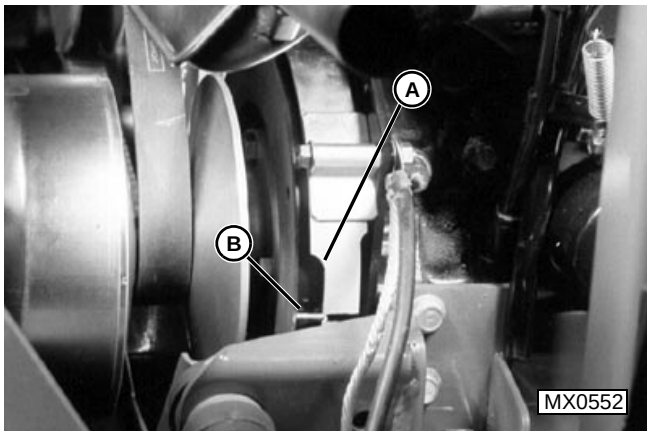
Equipment:

- Feeler Gauge
- Open End Wrench
- Flat Blade Screwdriver

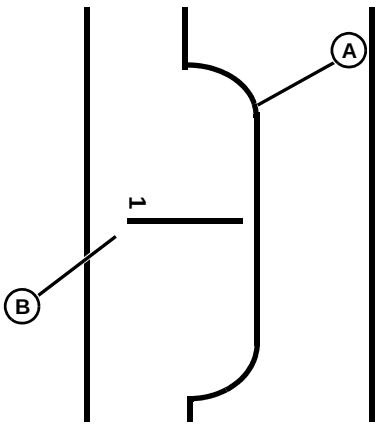
Procedure:

1. Remove rocker arm cover.

NOTE: "Top Dead Center (TDC)" is when the piston is at it's highest point of travel in the cylinder on either the compression or exhaust stroke. No. 1 cylinder is the closest to the flywheel.



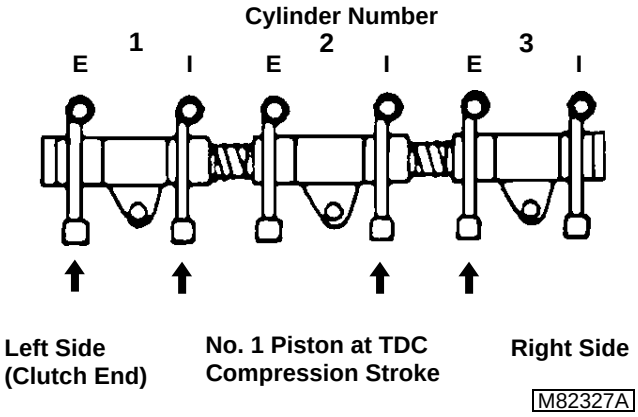
2. Locate the notched out area (A) on the flywheel guard near left rear engine mount isolator bracket.



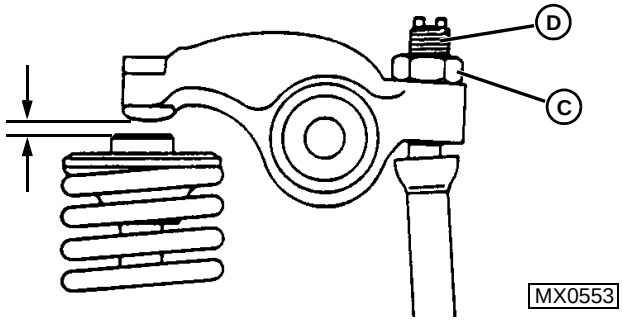
3. Rotate flywheel counterclockwise (turn towards front of vehicle) until No. 1 cylinder TDC mark (B) on flywheel is visible in notch of flywheel guard.

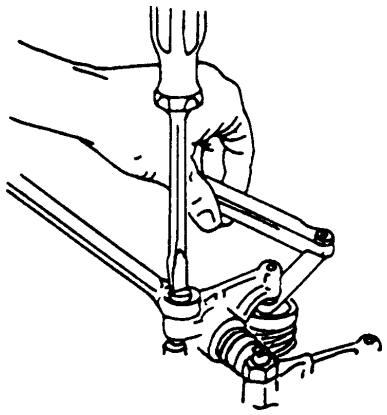
NOTE: There are two marks on flywheel for each cylinder, approximately 30 mm (1.2 in.) apart. The mark with the cylinder number stamped next to it is the mark for finding TDC for that cylinder.

4. Try to move intake and exhaust rocker arms and/or push rods for No. 1 cylinder:
   - If rocker arm and push rod are loose, the piston is at TDC on the compression stroke and you may proceed to step 5.
   - If rocker arms and/or push rods are not loose, rotate flywheel one revolution (360°), and recheck rocker arm and push rods.



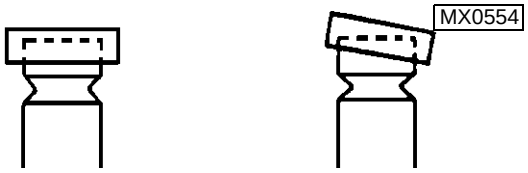
5. Measure and adjust valve clearance only on the four valves indicated above with black arrows while No. 1 piston is at TDC on compression stroke.





T6105BF

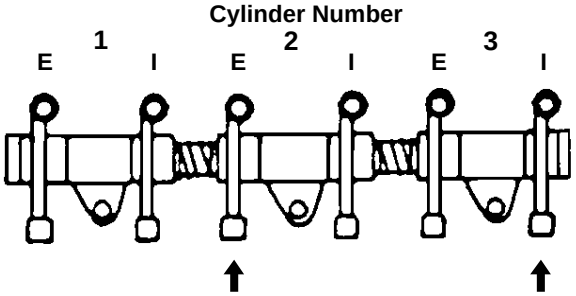
6. To adjust valves, loosen lock nut (C) and turn adjusting screw (D) until **0.20 mm (0.008 in.)** feeler gauge can be inserted between rocker arm and valve cap. Hold adjusting screw while tightening lock nut.
7. Recheck valve clearance after tightening lock nut.



MX0554

Normal **Not Normal**

8. Check that valve cap on end of valve stem remained seated on valve and inside valve spring retainer.
9. Turn crankshaft pulley one revolution (360°). This puts the piston in No. 1 cylinder at TDC on the exhaust stroke.



M82327A

10. Measure and adjust valve clearance on the last two valves (black arrows) with No. 1 piston at TDC of exhaust stroke.

VALVE LIFT CHECK

Reason:

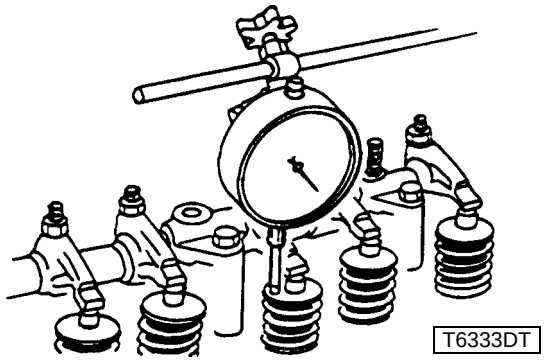
To test for excessive wear on camshaft lobes, cam followers, bent push rods, worn rocker arms, or worn valve stems.

Equipment:

- Dial Indicator

Procedure:

1. Adjust valve clearance. See “VALVE CLEARANCE, CHECK AND ADJUSTMENT” on page 23.
2. Remove rocker arm cover. See “ROCKER ARM COVER REMOVAL AND INSTALLATION” on page 36.



T6333DT

3. Fasten dial indicator to engine and position indicator tip on valve retainer. Valve must be fully closed and rocker arm must move freely.
4. Zero the dial indicator.
5. Rotate crankshaft towards front of vehicle while observing dial indicator as valve is moved to the full open (down) position. Valve lift (intake and exhaust) should be **7.5 mm (0.300 in.)**.
6. Repeat for each valve.

Results:

- If valve lift is less than specification, remove and inspect camshaft, camshaft followers, push rods, and/or rocker arms for wear or damage.

FUEL INJECTION NOZZLE TEST

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.

Reason:

To determine opening pressure, leakage, chatter and spray pattern of the fuel injection nozzle.

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:

Fuel Injection Nozzle 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. Leakage time should be 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.

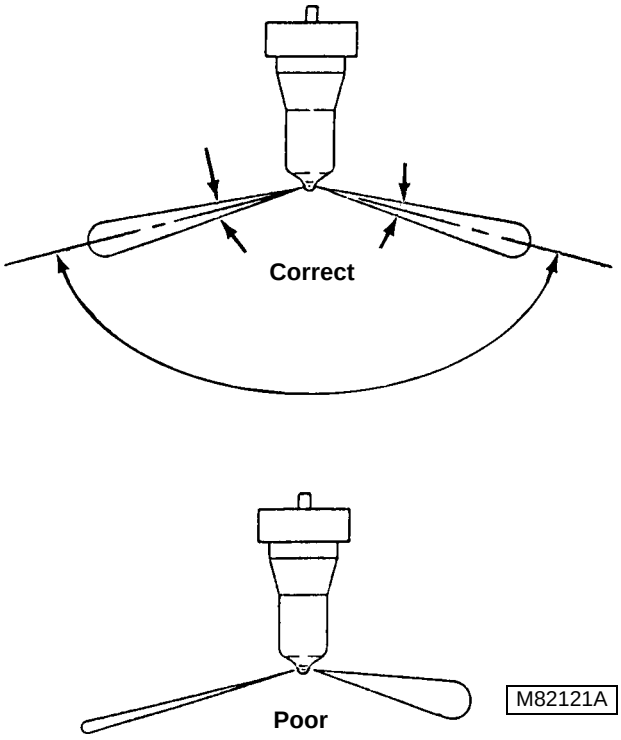
1. Pressurize nozzle to **11722 ± 480 kPa (1700 ± 70 psi)**.
2. Listen for “chatter” sound and watch spray pattern.

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. See “Repair:” on page 72. 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. See *Fuel Injection Nozzle* Repair section. Replace nozzle assembly if necessary.

FUEL INJECTION PUMP STATIC TIMING ADJUSTMENT

Reason:

To make sure that injection pump timing is set so fuel is delivered to the injector nozzles and combustion cylinders at the correct time of combustion cycle.

Equipment:

- End Wrenches

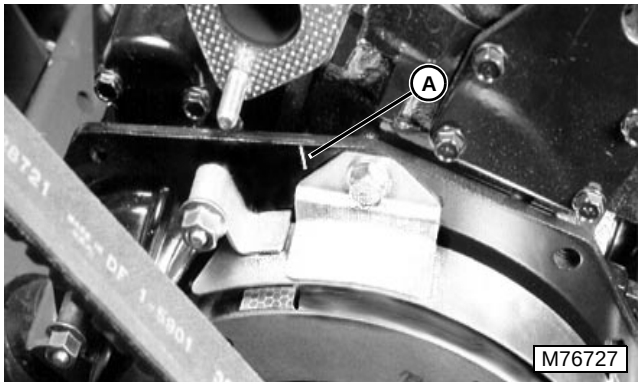
Procedure:

ATTENTION!

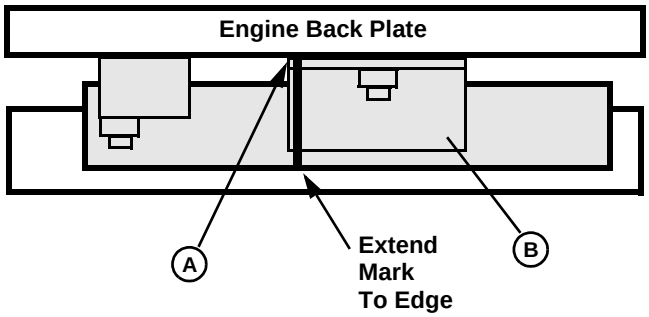
DO NOT attempt to adjust the fuel injection timing unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

IMPORTANT: Injection pump timing will remain correct unless a major engine failure occurs. Once timing is set, it will normally not change during the life of the engine, unless it was tampered with. Check and adjust timing only as the last option. Check fuel, fuel supply system, injectors, air intake system and cylinder compression before continuing.

1. Park vehicle on level surface, lock park brake, transmission in neutral, stop engine, key switch in OFF position.
2. Remove cargo box to allow access to fuel injection pump.
3. Remove muffler from exhaust manifold. See “MUFFLER REMOVAL AND INSTALLATION” on page 36.
4. Remove air cleaner assembly.

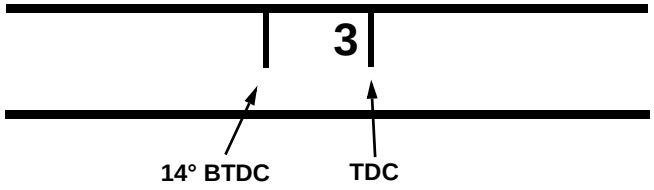


5. Locate the index mark (A) stamped into the engine back plate.

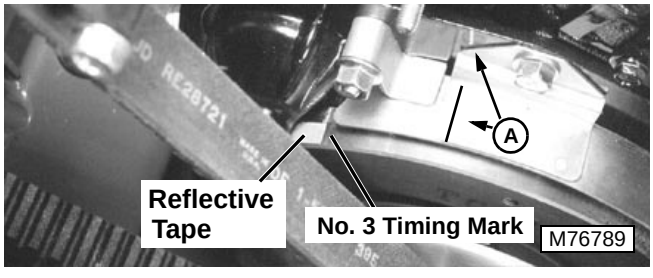


View From Top Of Flywheel

6. Extend the index mark from it's location on the engine back plate to the outside edge of the flywheel guard (B) using a square or similar tool.



7. Rotate flywheel until the No. 3 timing mark is located. (The marks are not visible except where flywheel guard is notched on rear of engine, and between starting motor and guard.) There are two marks side-by-side. One is stamped with the number 3 and is top-dead-center (TDC) for cylinder No.3. The other mark is 14° before top-dead-center (BTDC) and is the mark to be used to set the timing of the injection pump.
   - Use the No. 3 timing mark to set timing of No. 1 cylinder.



8. Attach reflective tape to flywheel with edge of tape aligned with 14° before top dead center (BTDC) mark. Place tape so it can be seen on flywheel as it passes extended index mark (A) on flywheel guard.

NOTE: Reflective tape is not needed using JT07270 Digital Pulse Tachometer.

9. Alternatively, timing mark can be scribed into flywheel in line with 14° BTDC mark so it can be seen as it passes under index mark on guard.

Timing Fuel Injection Pump:

10. The timing procedure must be performed with the fuel shutoff solenoid pulled in and holding open so a steady supply of fuel may be available to the injection pump. The key switch must be left ON during test to hold-in fuel solenoid. To pull solenoid in, the key switch must be momentary turned to the START position and an audible click heard from governor housing. DO NOT start engine during test.
11. Turn crankshaft (by hand) until the No. 3 cylinder 14° BTDC timing mark is about 1 inch to the rear of the index mark on the flywheel guard.

NOTE: The crankshaft turns counterclockwise (as viewed from the transmission drive belt/clutch end). The number one cylinder is closest to the drive belt/clutch on the left side of the vehicle.

12. Remove the number one fuel injection line from the injector pump to injector.
13. Use manual pump lever located on fuel transfer pump to keep a continuous supply of fuel to injection pump while performing timing procedure.
14. While fuel transfer pump lever is being pumped, slowly turn flywheel counterclockwise until timing mark on flywheel approaches index mark on flywheel guard. Watch fuel level in fitting on top of injection pump where No. 1 injector line was removed. At exact moment when fuel level begins to rise in fitting, flywheel timing mark should be lined up with index mark on flywheel guard.

NOTE: If the fuel level does not change, the number one piston may be on TDC of the exhaust stroke instead of compression stroke. Turn flywheel one revolution and repeat Steps 8 & 9. Check that fuel shutoff solenoid is pulled in and battery is up to full charge.

15. Turn key switch OFF.

Specifications:

Injection Pump Timing . . . . . 14° BTDC
Engine Crankshaft Position . . . . . No.1 Cylinder
Distance Outer Surface Of Flywheel Travels Per 1° Of Rotation . . . . . 2.62 mm (0.100 in.)
Timing Change per 0.1 mm Shim Thickness. . . . . 2°

Results:

- **If Timing Is Not According To Specifications:**
  - Remove injection pump and shims.
  - Increase shim pack thickness to retard injector timing, decrease thickness to advance timing.
  - Install injection pump and tighten nuts to **20 N•m (180 lb-in.)**
  - Recheck timing.
- **If Engine Performance Is Poor:**
  - Check air cleaners, fuel filter, fuel supply, injectors 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 an Authorized Diesel Service (ADS) Center. When reinstalling injection pump, use same thickness of shim pack removed. If shim pack thickness is unknown or new pump is installed, replace with **0.8 mm (0.031 in.)** shim pack thickness.
- **If Timing Is Ok:**
  - Install number one injection line.
  - Install muffler, air cleaner assembly, and cargo box.

WATER PUMP/ALTERNATOR DRIVE BELT ADJUSTMENT

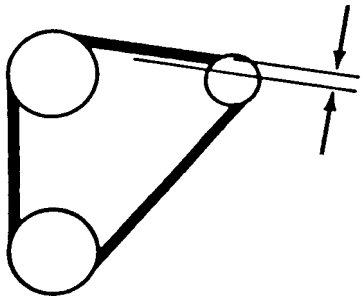
Reason:

To keep proper tension on belt to drive water pump and alternator. To prevent shortened belt and bearing life.

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:



M54014

1. Remove belt cover.
2. Check belt tension between water pump and alternator using Belt Tension Gauge and a straight edge.

Specifications:

Applied Force . . . . . 98 N (22 lb-force)
Deflection . . . . . 10 - 15 mm (0.4 - 0.6 in.)

Results:

- **If deflection is not within specifications:**
  - Loosen top and bottom alternator mounting cap screws/nuts.
  - Apply force only to right side of alternator housing (near the belt) until tension is correct.
  - Tighten alternator mounting hardware.
  - Replace belt cover.

THERMOSTAT TEST

Reason:

To determine opening temperature of thermostat.

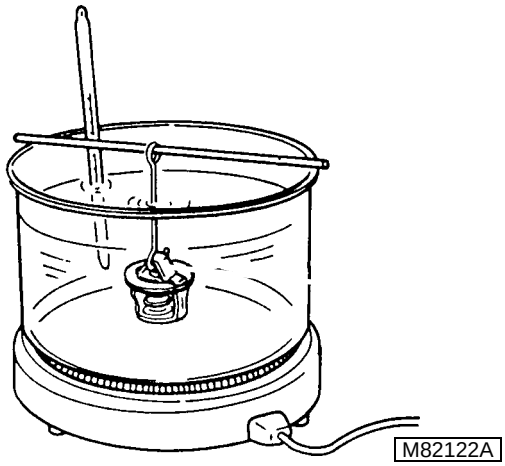
Equipment:

- 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.
- Install thermostat in block with air bleed screw at 12 o'clock (top) position.

RADIATOR BUBBLE TEST

Reason:

To determine if compression pressure is leaking from combustion cylinder into water jacket of cylinder block.

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. Do not exceed rated pressure of hoses and tools being used. Do not exceed 355 psi pressure cylinder pressure.
- Check for bubbles in coolant 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

Reason:

To inspect cooling system for leaks.

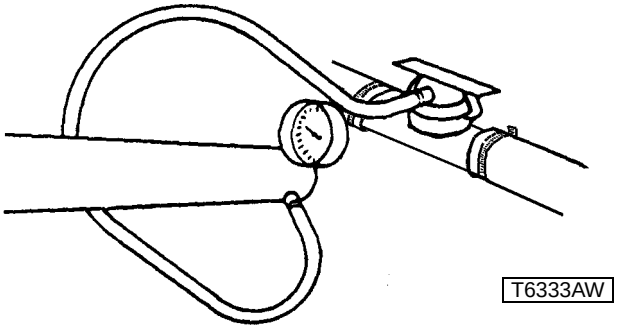
Equipment:

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

Procedure:

CAUTION

Coolant may be above boiling temperature and under pressure in cooling system. DO NOT remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system.


T6333AW

1. Check cooling system is cool and squeeze top radiator hose to check system pressure has dropped.
2. Remove cap. Top off coolant if low. Attach cooling system pressure pump to hose.
3. Pressurize system with tester to **15 psi**.
4. Check for leaks throughout cooling system.

Specifications:

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

Results:

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

RADIATOR CAP PRESSURE TEST

Reason:

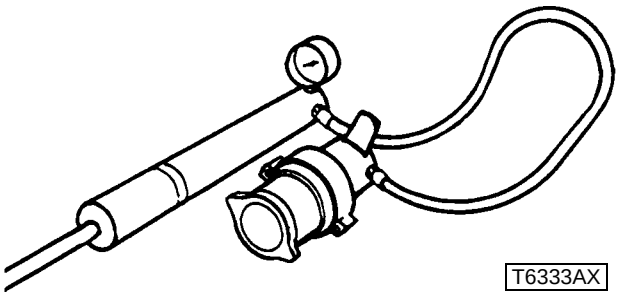
To test radiator cap spring and seal for correct opening pressure range.

Equipment:

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

Procedure:

1. Install radiator cap on appropriate adapter
2. Attach adapter to D05104ST pressure pump.
3. Apply pressure. Pressure valve in cap should open according to specifications.


T6333AX

Specifications:

Valve Opening Pressure . . . 83 - 96 kPa (12 - 14 psi)
Results:

- If cap leaks, relieve pressure and re-tighten cap. Test again. Replace cap if pressure is not within specification.

ENGINE OIL PRESSURE TEST

Reason:

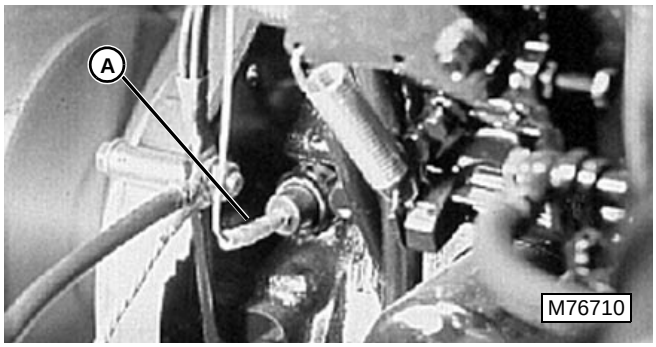
To determine if engine bearings or lubrication system components are worn.

Equipment:

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

Procedure:

1. Park vehicle in neutral, engine OFF, and park brake ON.



2. Remove wire to oil pressure switch.
3. Unscrew oil pressure switch (A) from block.
4. Install JT03349 Connector into block.
5. Connect Hose Assembly and Pressure Gauge.

IMPORTANT: Stop running engine if no oil pressure present.

6. Start engine. If pressure reading is below 69 kPa (10 psi), **STOP ENGINE**.
7. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.

Specifications:

Fast Idle Speed. . . . . 3550 ± 25 rpm
Engine Oil Pressure. . . . . 343 ± 49 kPa (50 ± 7 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 *Lubrication System* in this section.)
- If oil pressure does not increase, see “Engine Has Low Oil Pressure” in *Diagnosis* group.

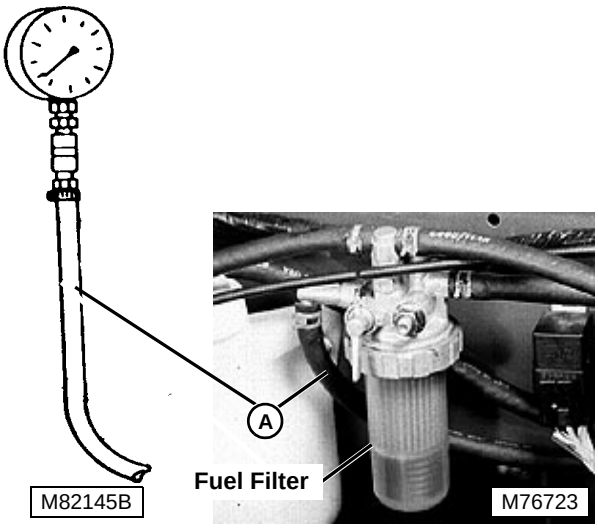
FUEL TRANSFER PUMP PRESSURE TEST

Reason:

To determine transfer pump operating pressure.

Equipment:

- JDG356 Fuel Pump Pressure Test Kit



Procedure:

1. Disconnect transfer pump-to-filter hose (A).
2. Install hose coupler on gauge to transfer pump hose.
3. Use manual pump lever located on fuel transfer pump to pressurize test gauge.

Specifications:

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

Results:

- If pressure is below specification, replace fuel transfer pump.

FUEL DRAIN BACK TEST

Reason:

Determines if air is entering the fuel system at connections, allowing fuel to siphon back to tank.

Procedure:

1. Disconnect fuel supply line and return line at fuel tank.
2. Drain all fuel from the system, including fuel transfer pump, injection pump and filters.
3. Plug end of fuel return hose.
4. Pressurize fuel system at fuel supply line, to a maximum pressure of **103 kPa (15 psi)**.
5. 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.

FUEL SYSTEM BLEEDING

The diesel engine incorporates a self bleeding fuel system. Manually bleeding the fuel system is usually not necessary after opening the fuel system. A primer lever is provided on the fuel transfer pump to fill the fuel bowl should the system be completely drained and will not self-prime.

AIR INTAKE SYSTEM LEAKAGE TEST

Reason:

To check for leaks in air intake system which allow unfiltered air to bypass air cleaner.

Equipment:

- Air Pressure Regulator

Procedure:

1. Connect air pressure regulator to manifold using hose and fitting from air cleaner.
2. Remove air cleaner cover and primary filter element.

M82124

3. Put large plastic bag into and over end of primary filter element. Install primary filter element and cover.

NOTE: Do not start engine with plastic bag in air cleaner.

4. Pressurize the air intake system between **34 - 69 kPa (5 - 10 psi)**. If air intake system cannot be pressurized, turn engine slightly to close valves.
5. 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.

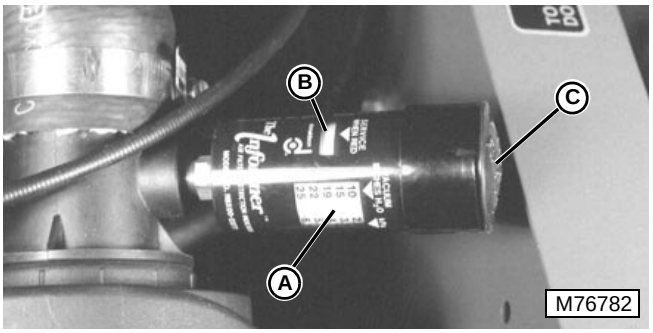
AIR FILTER/AIR RESTRICTION INDICATOR TESTS

Reason:

Check operation of indicator and check air intake system for leaks, restrictions, or obstructions.

Procedure (Normal Operation):

1. Park machine on level surface, shift transmission to NEUTRAL, and LOCK park brake.
2. Run engine at FAST idle.



M76782

3. Check air restriction indicator yellow marker (A).
4. Press reset button (C) and recheck.
5. Stop engine.

Specifications:

- Normal maximum vacuum **2.5 kPa (10 in. H_2O)** vacuum (with clean filters)**.**

*NOTE: Normal vacuum is between **2.5 – 6.25 kPa (10 – 25 in. H2O)**, and indicates a partially dirty air filter. DO NOT change air filter under this condition.*

Results:

If vacuum is **6.25 kPa** (**25 in. H_2O) or higher**:

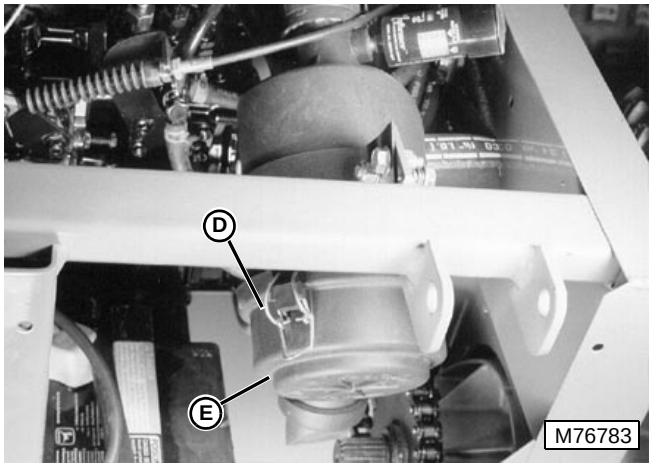
- replace primary filter
- reset air restrictor (C)

If vacuum is still greater than **6.25 kPa** (**25 in. H_2O)**:

- replace secondary filter

Procedure (Simulated Excess Restriction)

1. Unsnap spring clips (D) and remove filter cover (E) from filter housing.

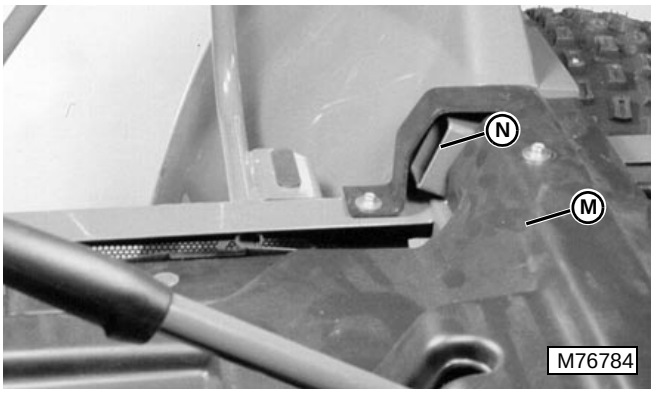


2. Remove large secondary filter and set aside.
3. Remove smaller primary filter and keep nearby the air filter housing.
4. Set park brake and start and run engine at SLOW idle.
5. Turn primary filter so closed rubber end is inserted first into the air filter housing (opposite normal installation).
6. Watch air restriction indicator yellow marker (A) and (B). It should move into the red area — **4.75 kPa (19 in. H_2O) vacuum.**
7. Remove primary filter and STOP engine.
8. Push indicator reset button (C), indicator should drop to bottom of scale.

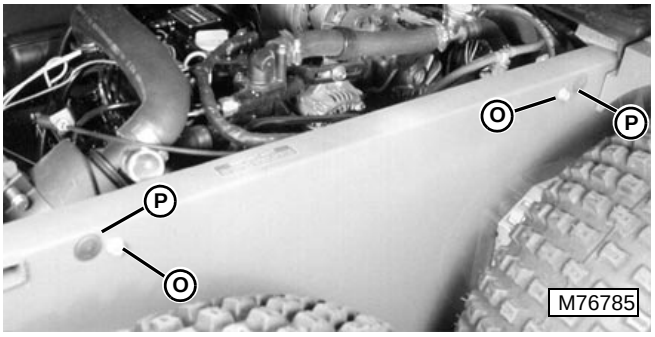
Results:

If yellow marker DID NOT move or moved very little, check for:

- loose or damaged hose clamps
- air leaks in air filter to intake manifold hose
- air leaks where air filter seals primary filter
- air leaks in intake manifold
- air leaks at indicator mounting threads
- cracked indicator housing or diaphragm.

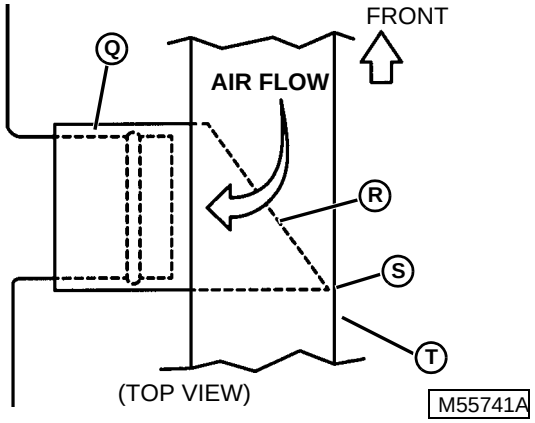


9. While air filter assembly is disconnected, remove seats and plastic shroud (M) to check frame air intake channel (N) for debris or obstructions.



10. Be sure shipping cap screws (O) and black plugs (P) are installed in frame.

NOTE: Use compressed air to remove dust and debris from inside channel. Always remove air cleaner-to-frame hose and cover air inlet to air cleaner before using compressed air to blow channel clear.



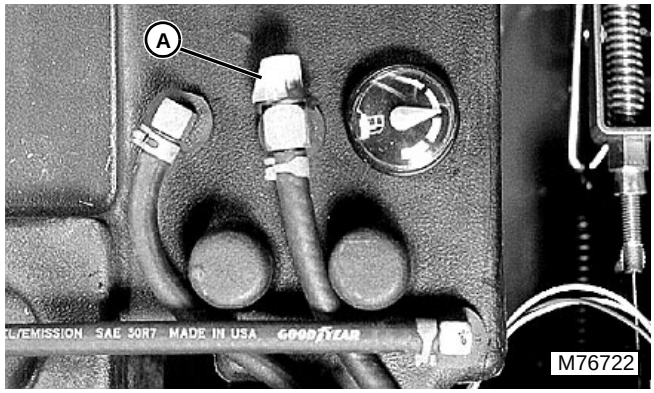
11. Install frame hose (Q) so angled edge (R) faces to front of machine and tip (S) just touches inside edge of frame (T) without being bent.

REPAIR

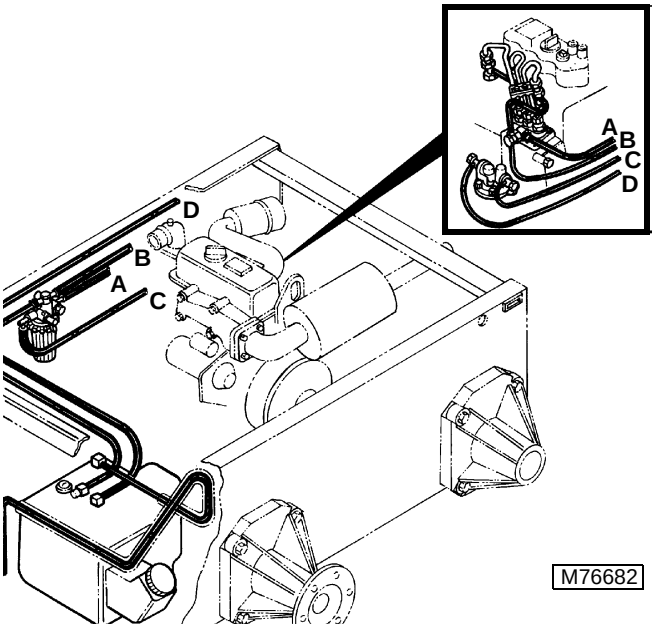
ENGINE REMOVAL AND INSTALLATION

Removal:

1. Disconnect battery negative (–) cable.
2. Disconnect battery positive (+) cable.
3. Remove cargo box.
4. Remove air cleaner assembly.
5. Remove drive belt.
6. Drain cooling system, lower block, and hose.
7. Remove coolant hose clamps and remove radiator hoses.
8. Shut off fuel valve at tank (A).



9. Mark and remove fuel lines.



10. Mark and remove wiring harness connections.

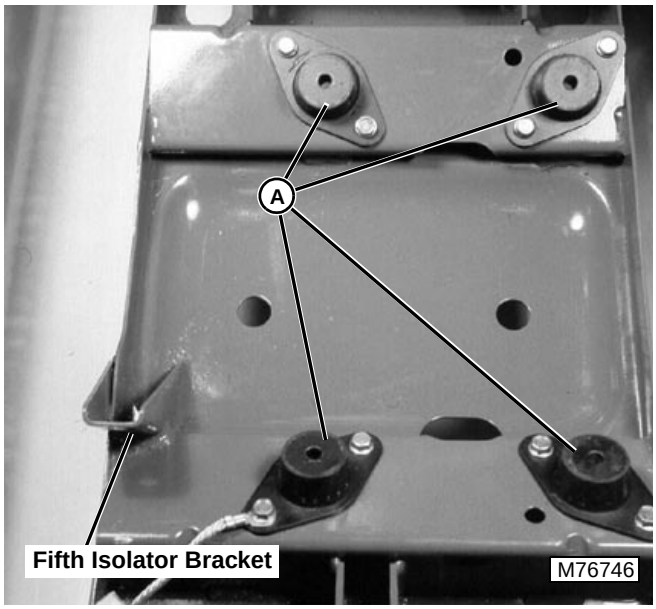
11. Remove grounding wire lead cap screw, remove battery negative cable and ground wire lead.
12. Remove throttle cable.
13. Remove mounting cap screws and lock nuts from motor mounts.
14. Remove engine with safe lifting device and lifting straps.
15. Remove drive clutch.

Installation:

Installation is done in reverse order of removal.

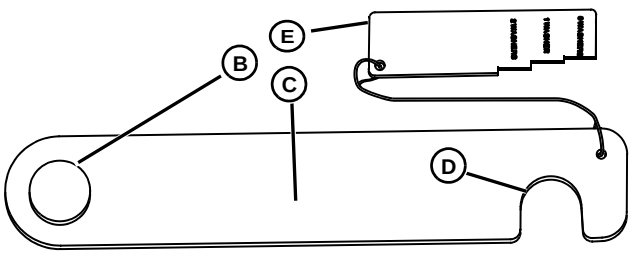
1. Place engine in frame, loosely install four main mounting cap screws through main isolators and engine mounting brackets.
2. Lift engine **5 - 10 mm (0.2 - 0.4 in.)** to release strain on isolators.
3. Lower engine fully onto isolators (A). Tighten four main mounting cap screws to **50 N•m (37 lb-ft)**

.

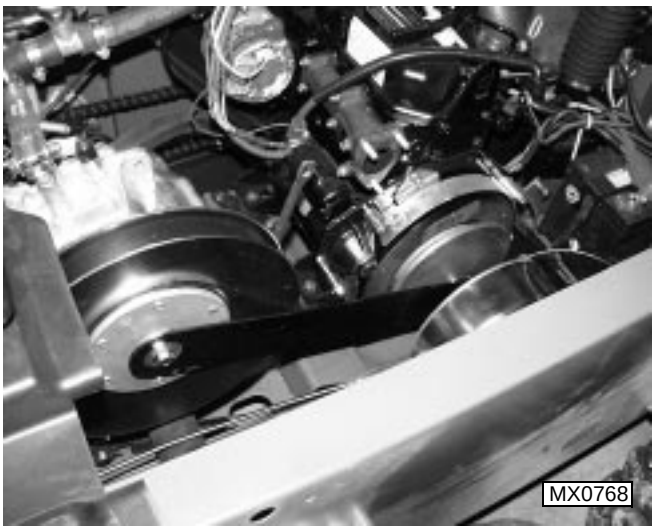


4. Inspect spacer(s) removed with fifth isolator parts. If spacers removed are good proceed to Step 8. If spacer(s) are damaged or missing:

.

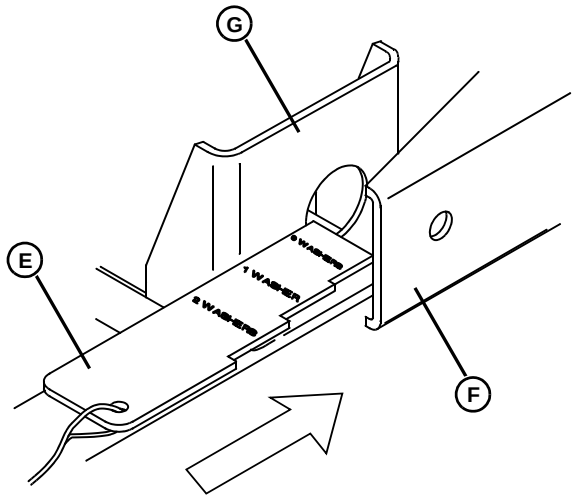


5. Place the closed end (B) of clutch center distance gauge (C) over the end of the secondary clutch. Position the open end (D) over the center shaft of the primary clutch.

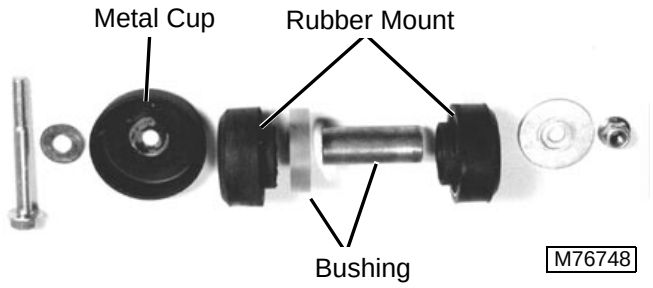


- Make sure closed end is seated completely over bushing end at secondary clutch.

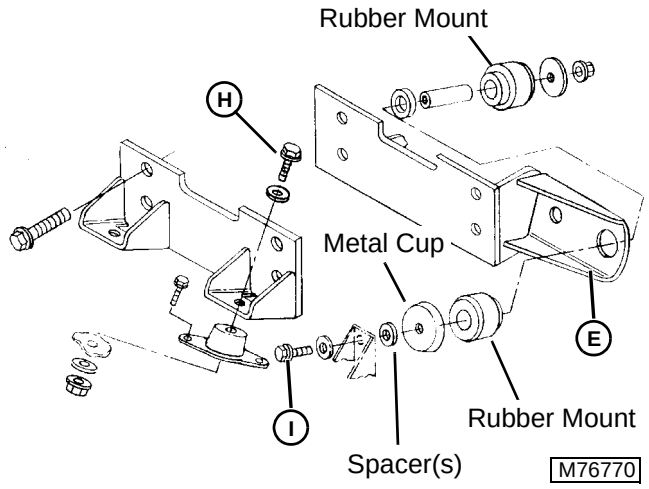
NOTE: The engine may need to be pushed toward the driven clutch to allow the gauge to drop onto the drive clutch shaft.



6. Insert snubber step gauge (E) into opening between front surface of engine isolator bracket (F) and the rear surface of the frame bracket (G).
   - Identify which step on gauge is inserted into opening to determine the number of spacer washers to install.
7. Remove gauges from machine.



8. Install fifth isolator parts in order shown.
   - Assemble bushings and rubber mounts onto frame bracket. The spacer(s), metal cup and one rubber mounting are installed between the frame mounting bracket and engine mounting bracket. Install correct number spacer(s) as determined using snubber gauge.
   - Install fifth isolation mounting cap screw and nut. Tighten fifth isolation mounting cap screw (I) to **37±7 N•m (27±5 lb-ft)**



9. Connect all electrical wires.
10. Connect coolant hoses and fill cooling system. See "COOLANT FILLING" on page 68.
11. If drained, fill engine with proper oil. Refer to Specifications section. Engine oil capacity is approximately **2.0 L (2.1 qt)**.
12. Install air cleaner assembly.
13. Install drive belt onto primary clutch. Install belt to secondary clutch by rotating belt and clutch slowly until belt slides onto clutch.
14. Prime fuel system by pumping lever on fuel transfer pump until fuel filter bowl is full.
15. Adjust throttle cable. See "THROTTLE CABLE ADJUSTMENT" on page 21.
16. Connect battery positive (+) cable and then negative (–) cable.
17. Install cargo box.

MUFFLER REMOVAL AND INSTALLATION

Removal:

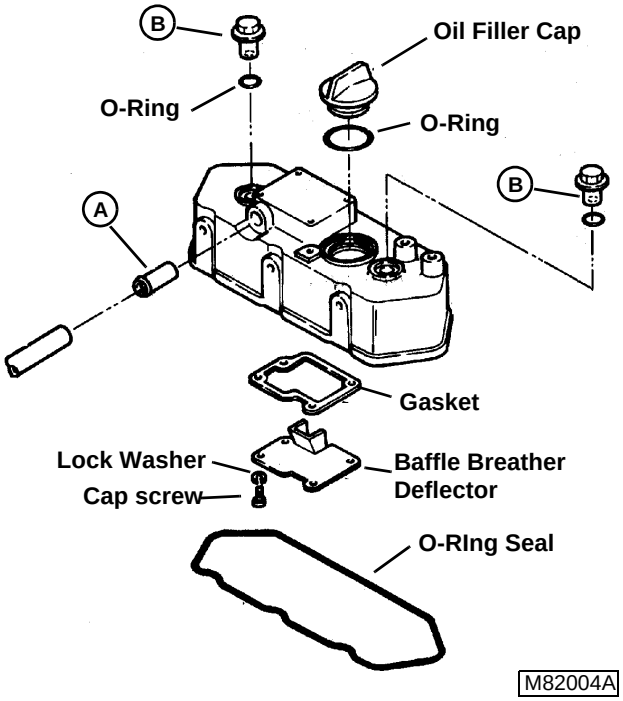
1. Allow muffler to cool, or wear protective gloves before working on muffler.
2. Remove three nuts and lock washers holding muffler flange to exhaust manifold.
3. Remove cap screw holding muffler to cylinder block and remove muffler.
4. Inspect studs on exhaust manifold. Replace if worn.

Installation:

- Clean sealing surfaces of muffler flange and exhaust manifold and replace gasket before installation.
- Tighten mounting nuts to **28 N•m (240 lb-in.)**.

ROCKER ARM COVER REMOVAL AND INSTALLATION

Removal:



1. Remove crankcase breather tube from breather fitting (A) on rocker cover.
2. Remove two special nuts (B) securing cover to cylinder head.
3. Remove rocker cover.

NOTE: If cover has not been removed recently, it may be necessary to lightly tap side of cover with soft faced hammer.

4. Inspect O-ring seals for wear or damage. Replace if necessary.
5. Disassemble breather baffle and clean all parts thoroughly.

Installation:

Installation is done in the reverse order of removal.

- Tighten nuts (B) to **18 N•m (160 lb-in.)**.

ROCKER ARM

Removal:

1. Remove rocker arm cover. See “ROCKER ARM COVER REMOVAL AND INSTALLATION” on page 36.
2. Remove two M8 rocker arm mounting nuts (end arm supports) and one M8 cap screw (center support).
3. Pull rocker arm assembly straight up off of mounting studs on cylinder head.
4. Inspect all parts for wear. See “Inspection:” on page 37.

Installation:

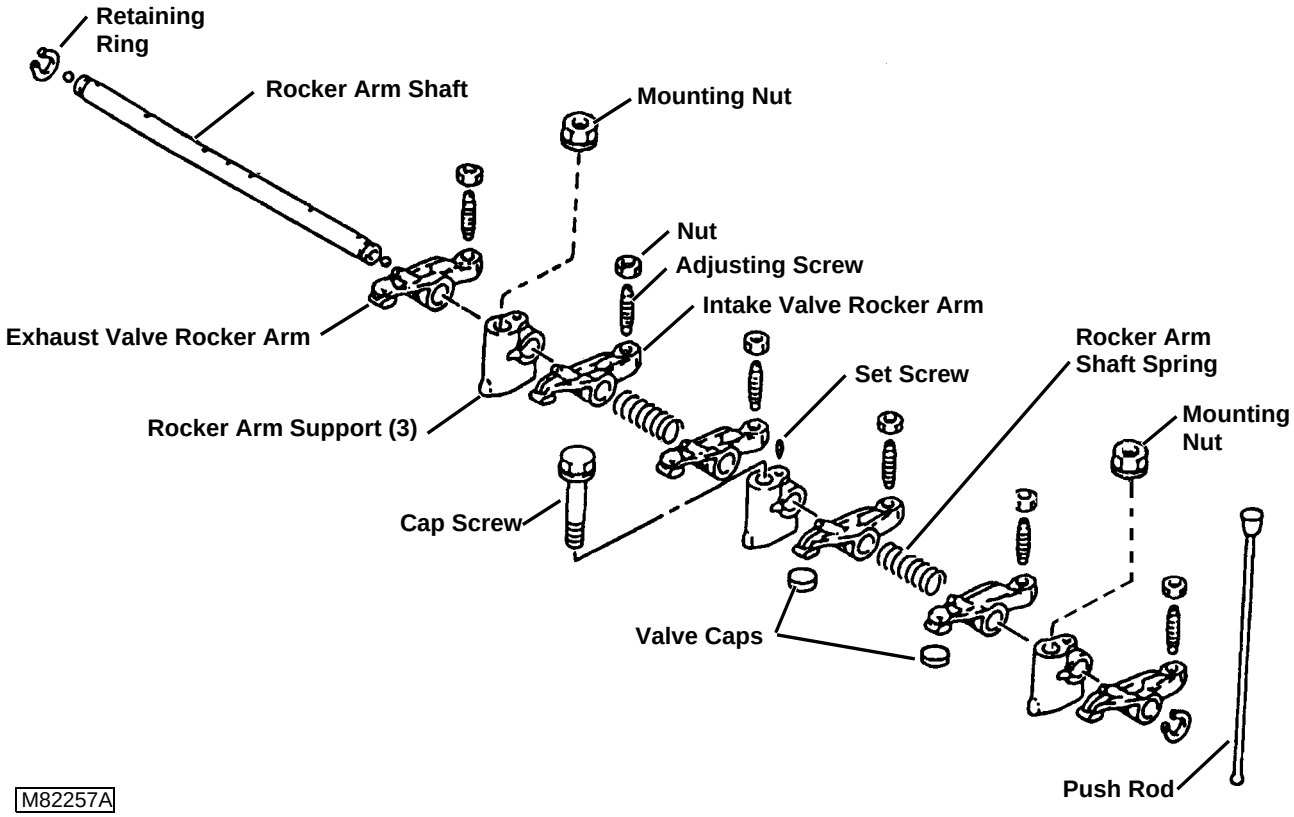
1. Be sure valve caps are in place on end of valve stems before installing rocker arms
2. Align rocker arm supports with studs on cylinder head. Align rockers with valve stems.
3. Install push rods in block and align into rocker arms.
4. Install mounting nuts on rocker arm supports and evenly tighten nuts to pull rocker assembly to head. Tighten mounting nuts and cap screw to **26 N•m (226 lb-in.)**.
5. Adjust valve clearance. See “VALVE CLEARANCE, CHECK AND ADJUSTMENT” on page 23.
6. Install rocker arm cover. See “ROCKER ARM COVER REMOVAL AND INSTALLATION” on page 36.

Inspection:

1. Remove rocker arm cover and rocker arm.
2. Mark all parts before tear-down to aid assembly.
3. Remove end retaining rings and slide components off of rocker shaft.
4. Remove set screw from center support. Remove rocker shaft from center support.

Measure Outer Diameter Of Rocker Arm Shaft:

M35262



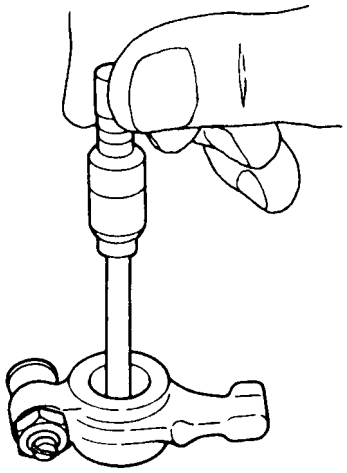
M82257A

Rocker Arm Shaft OD:

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

Replace rocker arm shaft if diameter is less than wear limit.

Measure Inside Diameter Of Rocker Arms & Supports:

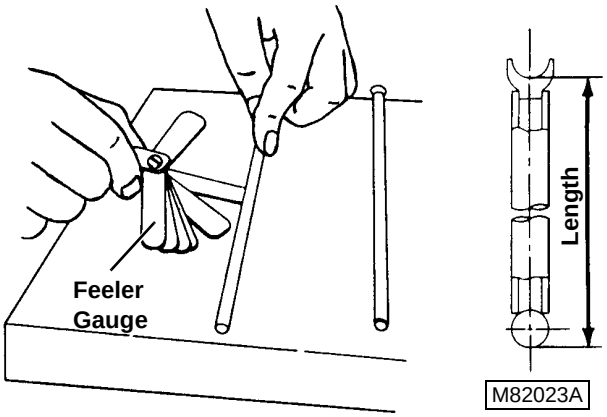

M82022A

Rocker Arm and Shaft Support ID's:

Standard . . . . . 10.00 - 10.02 mm (0.394 - 0.395 in.)
Wear Limit. . . . . 10.09 mm (0.397 in.)
Clearance . . . . . 0.14 mm (0.005 in.)
Replace rocker arms or supports if ID is more than wear limit.

If shaft and support/arm clearance (support/arm ID minus shaft OD) exceed wear limit, replace all parts.

Measure Push Rod Length & Straightness:



M82023A

Push Rod Length:

Standard . . . . . 114 - 115 mm (4.488 - 4.528 in.)

Push Rod Bend:

Wear Limit. . . . . 0.08 mm (0.003 in.)
Replace push rod if not within specifications.

- Check the surface of the adjusting screw that contacts the push rod for wear, replace push rod or adjusting screw if worn.
- Check the rocker arm to valve stem cap contact surface for wear. Replace rocker arm if worn.

Rocker Arm Assembly:

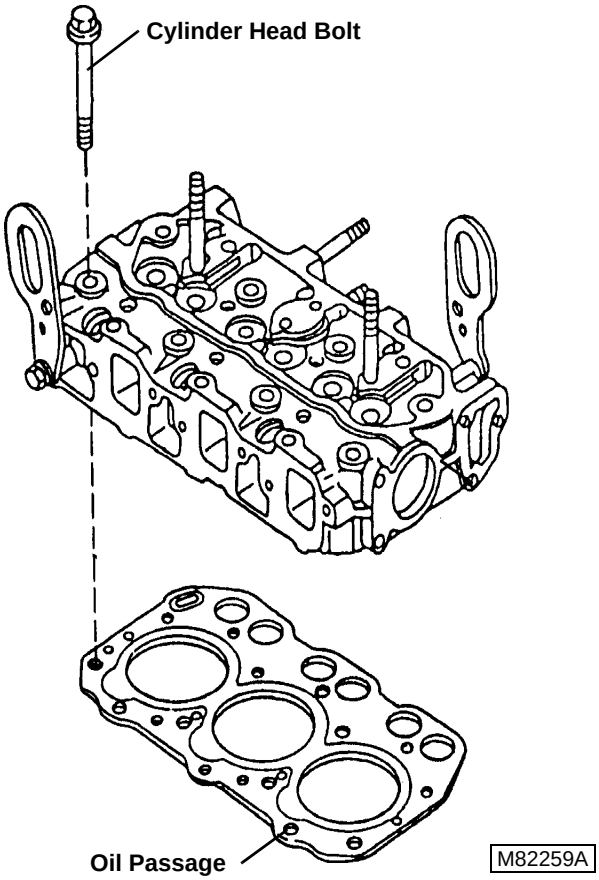
1. Clean all parts of varnish and oil.
2. Assemble rocker shaft into center support, aligning set screw hole in support with hole in rocker shaft.
3. Be sure rocker arms are installed in same order as removed.

CYLINDER HEAD REMOVAL AND INSTALLATION

Removal:

NOTE: Cylinder head may be removed with engine installed in vehicle chassis. Engine removal will allow easier access to cylinder head.

1. Park machine on level surface, transmission in NEUTRAL, park brake ON, engine OFF.
2. Disconnect negative battery cable from battery.
3. Remove cargo box from chassis.
4. Remove air cleaner.
5. Remove engine if needed (see note above). See "ENGINE REMOVAL AND INSTALLATION" on page 34.
6. Remove muffler, rocker arm cover, rocker arm assembly, push rods and valve caps.
7. Drain cooling system, cylinder block, and hoses.
8. Remove water pump.
9. Shut off fuel valve at tank and fuel filter.
10. Remove fuel injector lines from injection pump to nozzles.
11. Remove fuel injection nozzles from cylinder head.
12. Remove glow plug wires and glow plugs from cylinder head.
13. Remove electrical leads to coolant temperature switch, fuel shutoff solenoid, engine ground, oil pressure switch, battery positive cable, and any alternator leads across top of cylinder head.
14. Loosen and remove cylinder head bolts.



15. Using lift brackets and hoist, pull head straight up from block.
16. Remove exhaust and intake manifolds. See “INTAKE MANIFOLD REMOVAL AND INSTALLATION” on page 39.
17. Disassemble and inspect cylinder head and valves. See “CYLINDER HEAD RECONDITION” on page 40.

Installation:

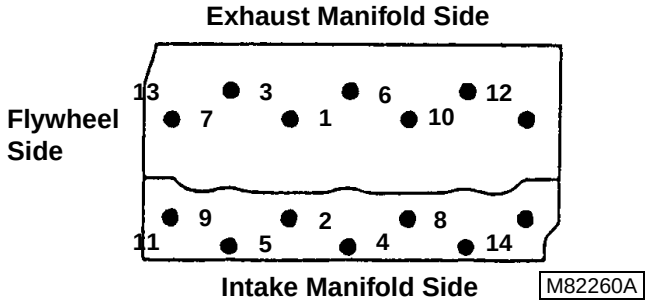
1. Clean top of cylinder block and check for flatness.
2. Place new cylinder head gasket on block with oil passage lined up with oil port in block.

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

3. Set cylinder head on gasket.

NOTE: Dip cylinder head bolt in clean oil before installing.

4. Install all cylinder head bolts and start all threads before tightening any one bolt.



5. Tighten cylinder head bolts in the sequence shown, in three stages of gradually-increasing torque.

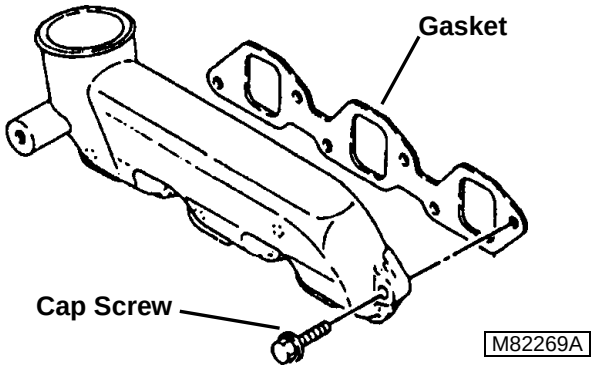
Torque Sequence Specifications:

First . . . . . 11 N•m (97 lb-in.)
Second . . . . . 22 N•m (195 lb-in.)
Final . . . . . 34 N•m (25 lb-ft)

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

INTAKE MANIFOLD REMOVAL AND INSTALLATION

Removal:



1. Remove cylinder head. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 38.
2. Remove four M6 x 20 intake manifold mounting cap screws.
3. Remove gasket and clean mating surfaces. Check flange for flatness with straight edge.

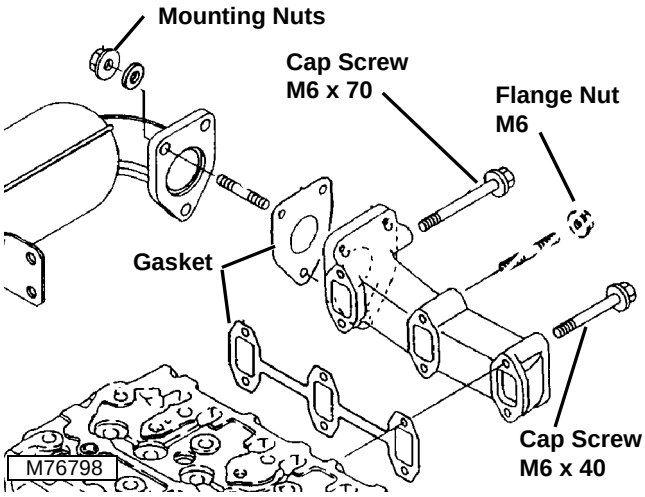
Installation:

- Install new gasket.
- Tighten mounting cap screws to **11 N•m (97 lb-in.)**.
- Tighten muffler mounting nuts to **28 N•m (240 lb-in.)**.

EXHAUST MANIFOLD REMOVAL AND INSTALLATION

Removal:

1. Remove muffler and gasket. See “MUFFLER REMOVAL AND INSTALLATION” on page 36.
2. Remove four cap screws and two flange nuts holding manifold to cylinder head.



Installation:

- Tighten all cap screws to **11 N•m (97 lb-in.)**
- Tighten muffler mounting nuts to **28 N•m (240 lb-in.)**

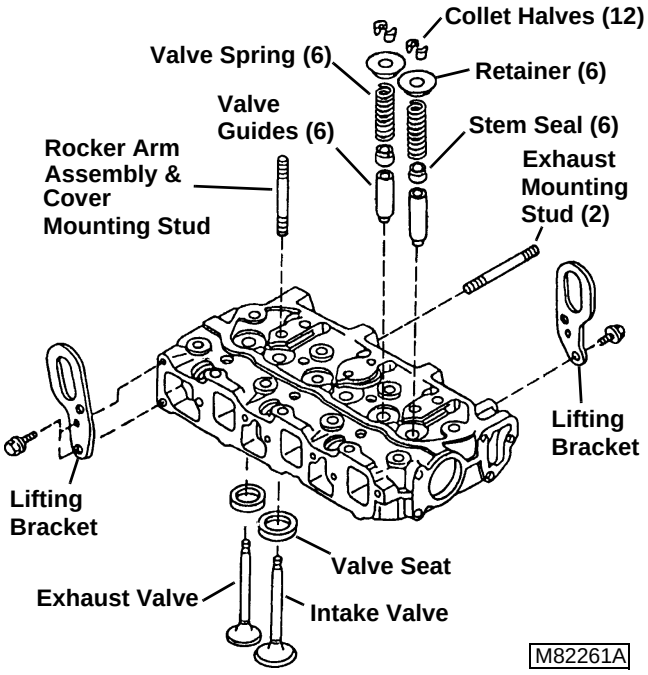
CYLINDER HEAD RECONDITION

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).

- JDE138 Valve Spring Compressor
- JDE504 Valve Guide Driver

Disassembly:



1. Compress valve springs using JDE138 valve spring compressor

NOTE: It may be necessary to tap on valve spring retainer while initially operating compressor to break retainer free from valve stem.

2. Remove collet halves from retainer.
3. Slowly release compressor and valve spring.
4. Remove valve spring, stem seal, and valve from head.
5. Valve guides and seats are press fit. Remove guides only if replacement is necessary.
6. Inspect all parts for wear or damage. Clean all carbon deposits and measure all parts for proper clearances.

Assembly:

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

1. Apply clean engine oil on intake and exhaust valve stems during assembly.
2. Install springs with smaller pitch end or paint mark toward cylinder head.

NOTE: If new valves are installed, measure valve recession. See “Valve Recession Specifications:” on page 42.

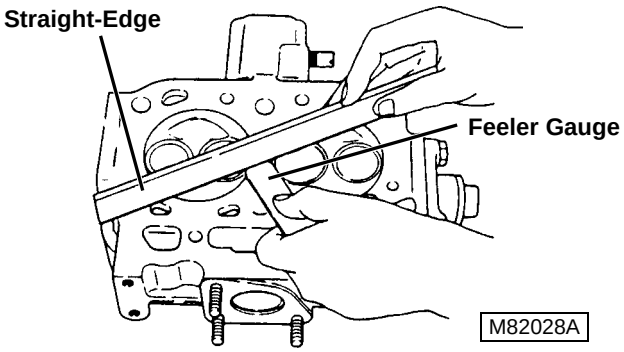
3. Use valve spring compressor to compress spring and retainer, and install collet as removed.
4. After each valve has been assembled, tap on top of valve stem with a plastic hammer to seat retainer.

Inspection/Replacement:

Before inspection, thoroughly clean all components of carbon or dirt.

Cylinder Head:

- Measure cylinder head flatness. Place a straight-edge along each of the four sides and each diagonal. Measure clearance between straight edge and combustion surface with a feeler gauge.



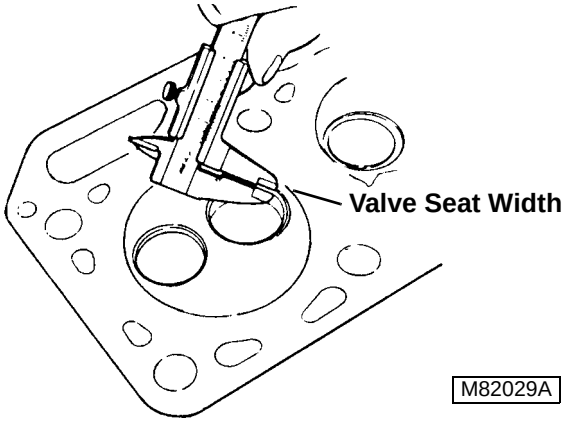
Cylinder Head Distortion:

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

If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat; but do not remove more than **0.20 mm (0.008 in.)**.

If Cylinder Head Was Resurfaced:

- Measure piston-to-cylinder head clearance. See “PISTON-TO-CYLINDER HEAD CLEARANCE” on page 55.
- Measure valve recession. See procedure in this group.
- Measure valve seat width. See procedure in this group.

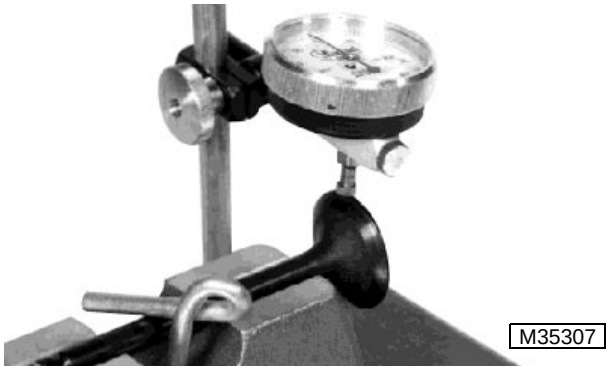


Valve Seat Width Specifications:

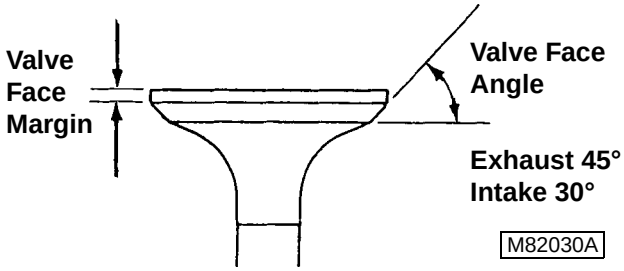
Intake Valve
Standard . . . . . 1.15 mm (0.045 in.)
Wear Limit. . . . . 1.65 mm (0.065 in.)
Exhaust Valve
Standard . . . . . 1.41 mm (0.056 in.)
Wear Limit. . . . . 1.91 mm (0.075 in.)

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

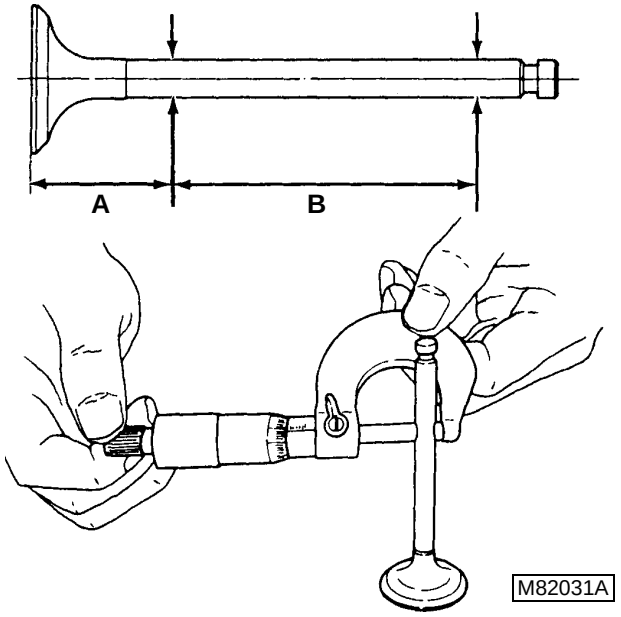
Intake and Exhaust Valves:



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



• 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.

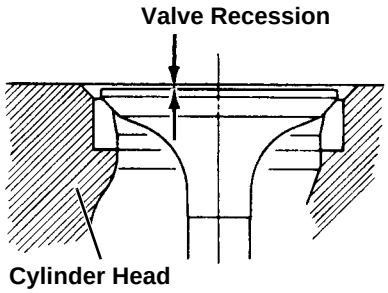


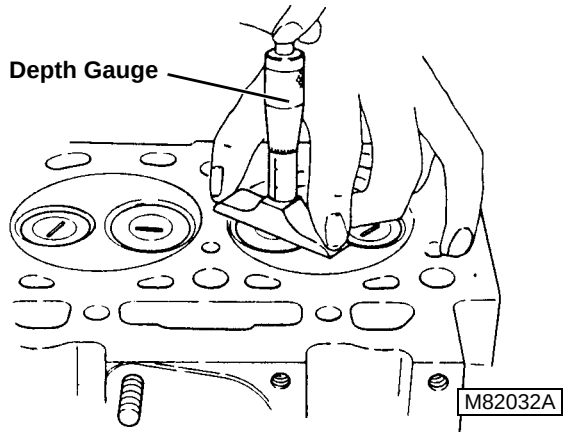
2. Measure valve stem diameter at two locations shown. Replace valve if measurement is less than wear limit.

Valve Stem Specifications:

Valve Stem OD Measurement Locations
Location Distance A. . . . . 20 mm (0.787 in.)
Location Distance B. . . . . 40 mm (1.575 in.)

Intake Valve Stem OD . . . . . .
Standard . . . . 5.46 - 5.48 mm (0.2149 - 0.2157 in.)
Wear Limit. . . . . 5.40 mm (0.2126 in.)
Exhaust Valve Stem OD
Standard . . . . 5.44 - 5.46 mm (0.2142 - 0.2149 in.)
Wear Limit. . . . . 5.40 mm (0.2126 in.)





3. Measure valve recession using a depth gauge. Replace valve or cylinder head if measurement exceeds specifications.

Valve Recession Specifications:

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

Valve Guides:

1. Clean valve guides using a valve guide brush.
2. Measure valve guide inside diameter.

Valve Guide ID:

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

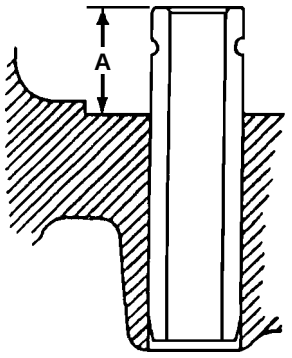
- If diameter exceeds wear limit, knurl or replace guide.
- If diameter is less than wear limit, determine guide-to-stem clearance (guide diameter minus stem diameter).
- If clearance exceeds **0.15 mm (0.006 in.)** but is less than **0.20 mm (0.008 in.)**, knurl valve guides using a 5.50 mm Valve Guide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

Valve Guide Replacement:

- Use JDG504 Valve Guide Driver.

Intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none.

1. Install valve guides with tapered ends down. Push valve guides down until top of valve guides are set to distance (A) from top of cylinder head.

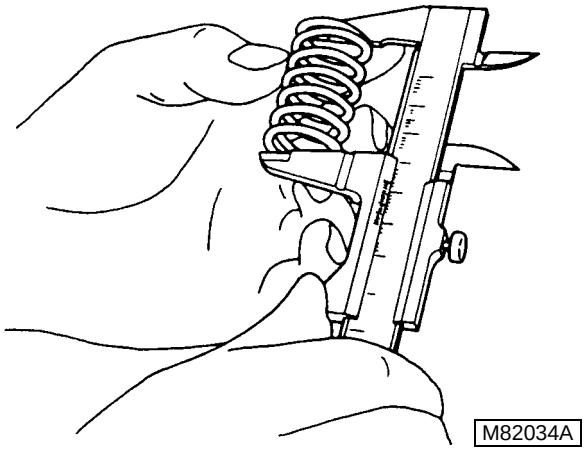


Valve Guide Height "A": . . . . . 7 mm (0.276 in.)

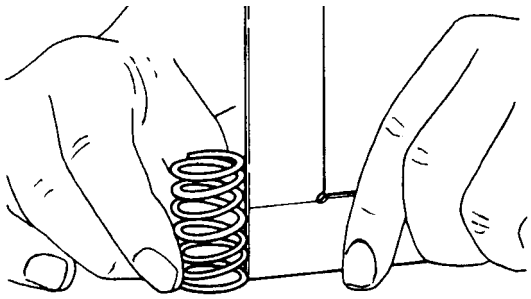
2. Ream inside diameter of valve guides using 5.50 mm Valve Guide Reamer

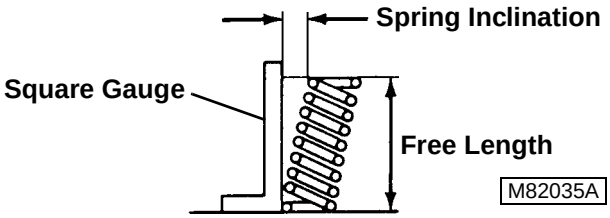
Valve Springs:

1. Measure spring free length. Replace spring if measurement exceeds specification.



2. Measure spring inclination. Replace spring if measurement exceeds specification.





Spring Specifications:

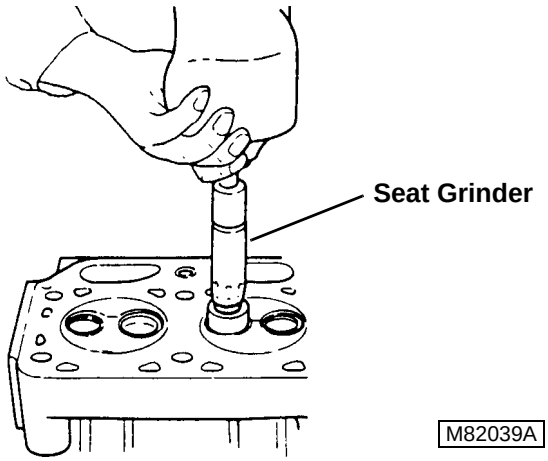
Spring Free Length . . . . . 28 mm (1.102 in.)
Maximum Spring Inclination . . . 0.80 mm (0.032 in.)

Valve Seat Grinding:

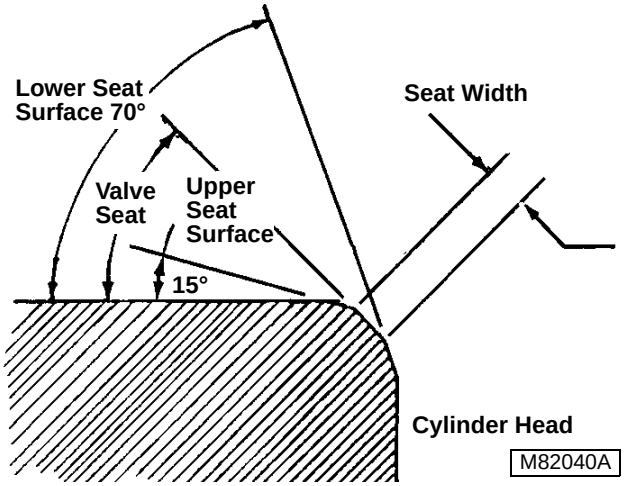
IMPORTANT: Valve seats should never be cut. Cutting a valve seat can damage its sealing surface, which may result in leaks or valve/seat failure. Valve seats should be ground and lapped.

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.

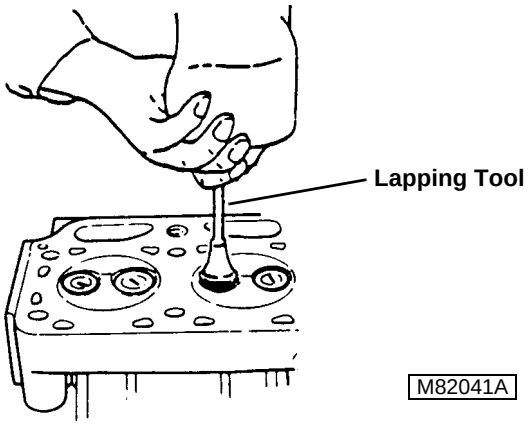


3. If seat is too wide after grinding, grind lower seat surface using a 70° seat grinder until seat width is close to specifications.
4. Grind upper seat surface using a 15° seat grinder until seat width is narrowed to specifications.
5. If valve seats are ground, measure valve recession and check contact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

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

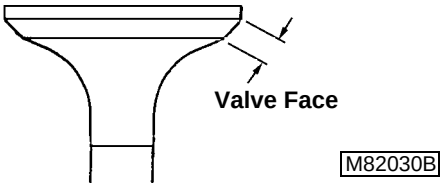
Valve Lapping:

NOTE: Use a rubber type lapping tool for valves without a lapping tool groove slit.



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.



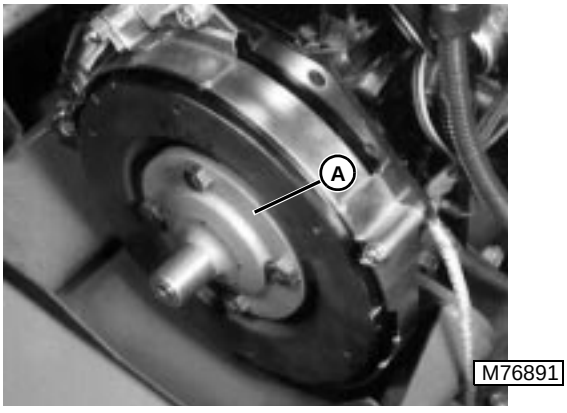
2. Turn valve to lap valve to seat.
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center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

CRANKSHAFT REAR OIL SEAL

NOTE: The crankshaft rear oil seal (on left side of vehicle) may be replaced with engine in chassis.

Engine In Chassis:

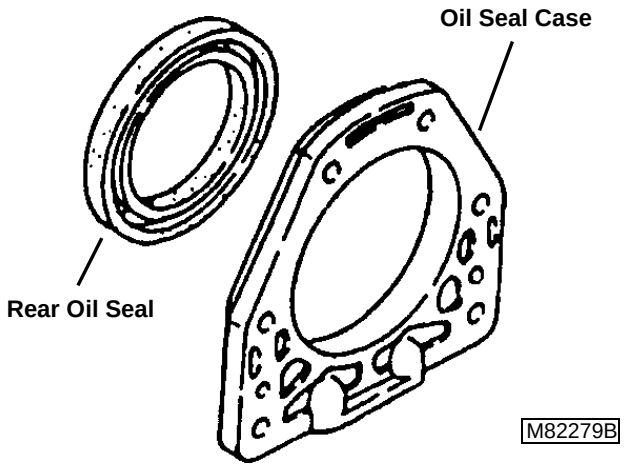
1. Remove muffler from exhaust manifold.
2. Remove drive belt from front transaxle pulley and engine clutch.
3. Remove left rear axle chain master link and pull chain from axle sprocket. Set chain out of way of engine clutch.
4. Remove plastic plug from left side of engine drive clutch.
5. Remove clutch retaining cap screw and remove clutch with JDG813-1 clutch removal tool.



6. Remove four cap screws holding clutch stub shaft (A) to flywheel. Remove stub shaft.
7. Remove five cap screws holding flywheel to crankshaft.

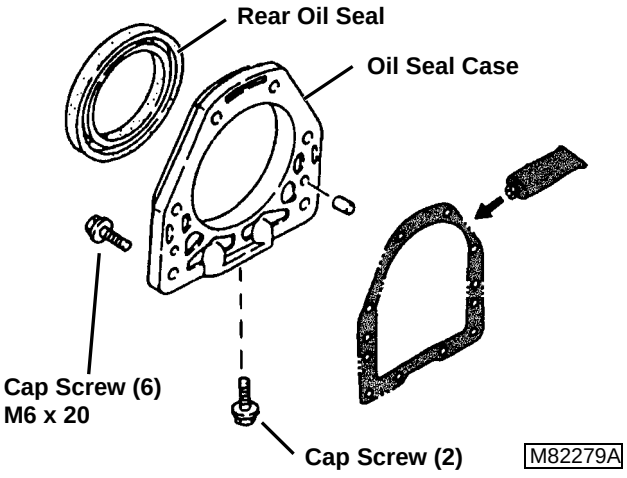
8. Remove flywheel from alignment pin on crankshaft.
9. Carefully pry oil seal from oil seal case.
10. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

NOTE: If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) farther into oil seal case.



Rear Oil Seal Case:

NOTE: It is not necessary to remove oil seal case to remove oil seal.



11. Remove oil seat case-to-block cap screws, and two oil pan-to-seal case cap screws.
12. Pry oil seal case from block and oil pan.
13. Clean all old gasket material from seal case and oil pan.
14. Install seal case with form-in-place gasket sealer on mating surfaces to block and to oil pan. Tighten cap screws to specification.
15. Install new oil seal after oil seal case is installed.
16. Install flywheel and tighten five cap screws to specification.
17. Install clutch stub shaft to flywheel and tighten four cap screws to specification.
18. Install clutch on stub shaft and tighten clutch mounting bolt to specification.
19. Replace clutch dust cap and drive chain master link.

Torque Specifications:

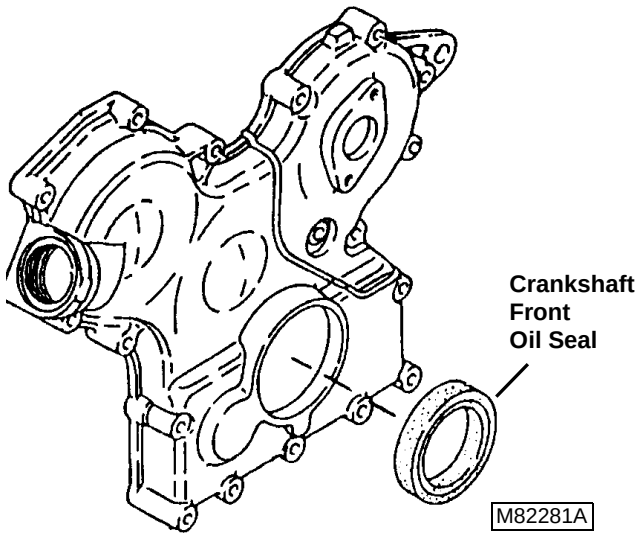
Seal Case-to-Block Cap Screws . . 11 N•m (96 lb-in.)
Flywheel Cap Screws. . . . . 83 N•m (61 lb-ft)
Stub Shaft-to-Flywheel Cap Screws59 N•m (44 lb-ft)
Clutch Mounting Bolts. . . . . 55 N•m (40 lb-ft)

CRANKSHAFT FRONT OIL SEAL

NOTE: The crankshaft front oil seal (on RH side) may be replaced with engine in chassis.

Engine In Chassis:

1. Remove alternator/water pump belt guard from front of engine.
2. Loosen alternator mounts and remove belt.
3. Remove right rear axle chain master link and remove chain from axle shaft sprocket. Set chain out of the way of crankshaft pulley.
4. Remove crankshaft pulley mounting bolt and washer.
5. Using a puller and two 7 x 40 mm cap screws installed into tapped holes on crankshaft pulley, remove crankshaft pulley from crankshaft.

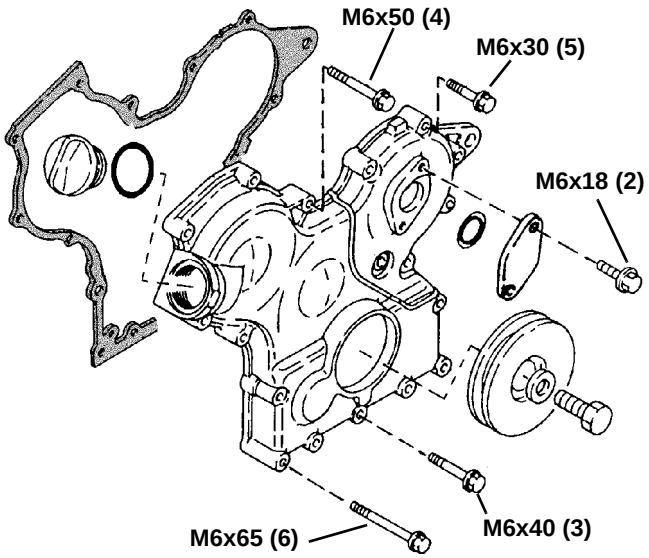


6. Carefully pry oil seal from timing cover.
7. Install new oil seal using a driver set. Install seal with lip toward engine. Install seal flush with surface of cover.
8. Coat lip of seal with clean engine oil.
9. Install crankshaft pulley on crankshaft, lining up pin on crankshaft timing gear with hole in crankshaft pulley. Tighten cap screw to **88 N•m (65 lb-ft).**
10. Install alternator/water pump belt, belt cover, and drive chain as removed.

TIMING GEAR COVER

Removal/Installation

1. Remove battery negative (–) cable.
2. Remove alternator/water pump belt cover.
3. Loosen alternator mounting screws and remove alternator/water pump belt.



4. Remove crankshaft pulley mounting bolt and washer.
5. Using a puller and two 7 x 40 mm cap screws installed into tapped holes on crankshaft pulley, remove crankshaft pulley from crankshaft.

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

6. Remove mounting cap screws and timing gear cover.
7. Clean all old gasket material from timing cover and timing cover housing on block.
8. Apply John Deere Form-In-Place Gasket Sealer to timing cover prior to installation
9. Tighten all cover mounting cap screws to **9 N•m (78 lb-in.)**
10. Install crankshaft pulley and tighten cap screw to **88 N•m (65 lb-in.)**
11. Adjust alternator drive belt tension. See “WATER PUMP/ALTERNATOR DRIVE BELT ADJUSTMENT” on page 28.

CAMSHAFT END PLAY CHECK

Reason:

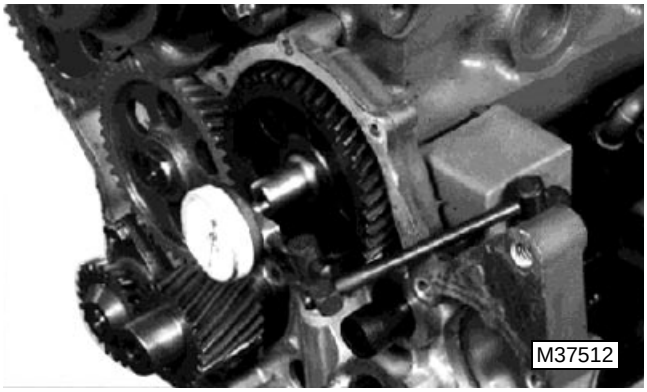
To determine proper side clearance between camshaft gear end journal and thrust plate.

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.



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.

Clearance Specifications:

Standard . . . . . 0.05 - 0.20 mm (0.002 - 0.008 in.)
Wear Limit . . . . . 0.40 mm (0.016 in.)

Results:

- If end play exceeds specification, remove camshaft and replace thrust plate. See “CAMSHAFT” on page 49.

TIMING GEAR BACKLASH CHECK

Reason:

To check for wear between meshing gears, resulting in excessive noise and poor engine performance.

Equipment:

- Dial Indicator

Procedure:

1. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.
2. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.

Specifications:

Standard Backlash For All Gears (Except Crankshaft Gear-to-Oil Pump Gear):

Standard . . . . . 0.04-0.12 mm (0.002-0.005 in.)
Crankshaft Gear-to-Oil Pump Gear . . . . . 0.11-0.19 mm (0.004-0.0075 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)

Results:

- If backlash exceeds specifications, replace meshing gears as a set:

Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear and/or Idler Gear, Fuel Injection Pump Gear.

IDLER GEAR

Removal:

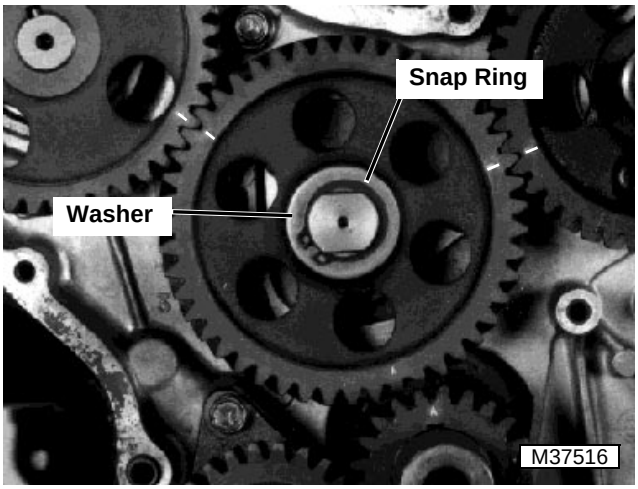
1. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.
2. Check backlash of timing gears. See “TIMING GEAR BACKLASH CHECK” on page 47.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump (No. 3) is at TDC on compression stroke.
(No. 1 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 *Inspection/Replacement* procedures.)

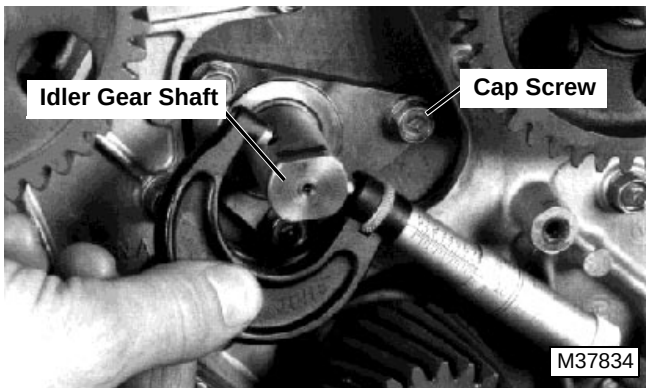
Installation:

Installation is done in the reverse order of removal.



Inspection/Replacement:

1. Inspect gear for chipped or broken teeth. Replace if necessary.
2. Measure idler gear shaft diameter.



Idler Gear Shaft OD:

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

- If shaft diameter is less than wear limit, replace idler gear shaft.

3. Measure idler gear bushing diameter.


M35492

Idler Gear Bushing ID:

Standard . . . . . 20.00 - 20.021 mm (0.787 - 0.788in.)
Wear Limit. . . . . 20.08 mm (0.791 in.)
Clearance . . . . . 0.15 mm (0.0059 in.)

- If bushing diameter exceeds wear limit, replace bushing.

To replace bushing:

- Replace bushing using a driver set.
- Align oil holes in bushing and idler gear. Install bushing flush with surface of idler gear.
- If bushing clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft or both.

CAM FOLLOWERS

Removal:

1. Remove cylinder head. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 38.

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 from cylinder block with magnetic pick-up tool.
4. Inspect all parts for wear or damage. (See *Inspection* procedures.)

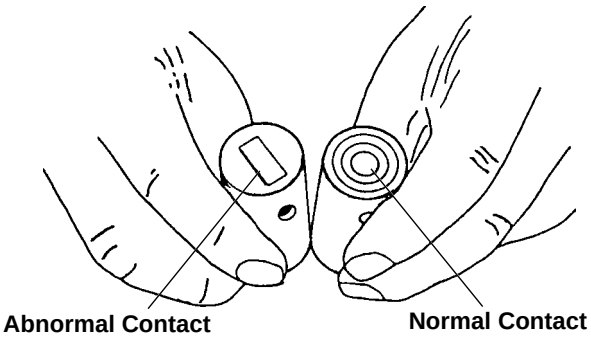
Installation:

Installation is done in the reverse order of removal.

1. Apply clean engine oil on all parts during installation.
2. Install cam followers after camshaft is installed.

Inspection:

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



M82293A

2. Measure cam follower diameter.


M35268

Cam Follower OD Specifications:

Standard . . . . . 17.95 - 17.97 mm (0.707 – 0.708 in.)
Wear Limit. . . . . 17.93 mm (0.706 in.)

- If stem diameter is less than wear limit, replace cam follower.

3. Measure cam follower bore diameter in cylinder block.

Cam Follower Bore ID Specifications:

Standard . 18.000 – 18.018 mm (0.7087 – 0.7094 in.)
Wear Limit. . . . . 18.05 mm (0.711 in.)
Clearance . . 0.032 – 0.068 mm (0.0013 – 0.0027 in.)

- If cam follower bore diameter exceeds wear limit, replace cylinder block.
- If bore clearance (bore ID minus follower stem OD) exceeds specification, replace cam follower, cylinder block or both.

CAMSHAFT

Removal:

1. Remove rocker arm assembly and push rods. See “ROCKER ARM” on page 37.
2. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.
3. Check camshaft end play. See “CAMSHAFT END PLAY CHECK” on page 46.
4. Check backlash of timing gears. See “TIMING GEAR BACKLASH CHECK” on page 47.

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

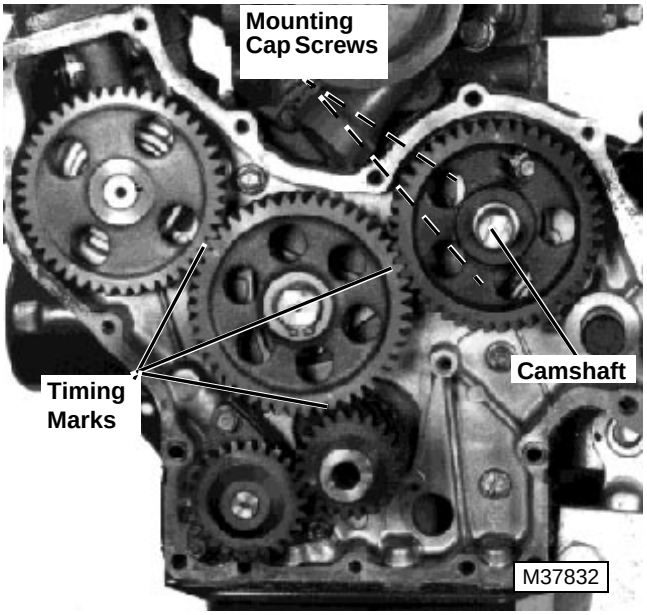
5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

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 cap screws holding camshaft mounting flange to block (through holes in camshaft gear).
8. Inspect all parts for wear or damage. (See *Inspection/Replacement* procedures.)



Installation:

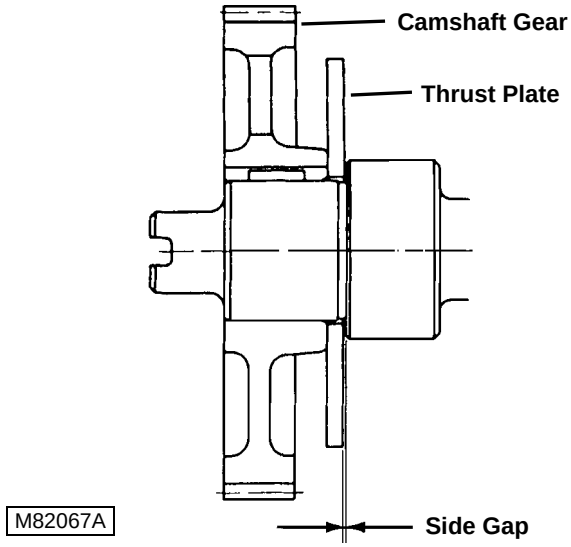
- Apply clean engine oil on all parts during installation.

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

1. Rotate crankshaft to align timing marks.
2. Install camshaft.
3. Install and tighten mounting cap screws to **11 N•m (96 lb-in.)**.
4. Install timing gear cover. See “TIMING GEAR COVER” on page 46.
5. Install push rods and rocker arm assembly. See “ROCKER ARM” on page 37.

Inspection/Replacement:

1. Check camshaft side gap using a feeler gauge.



Camshaft Side Gap:

Standard . . . . . 0.05 - 0.15 mm (0.0020 - 0.0060 in.)
Wear Limit . . . . . 0.40 mm (0.016 in.)

- If side gap is at wear limit, remove gear and replace thrust plate.

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

To Remove/Replace Gear:

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

⚠ CAUTION

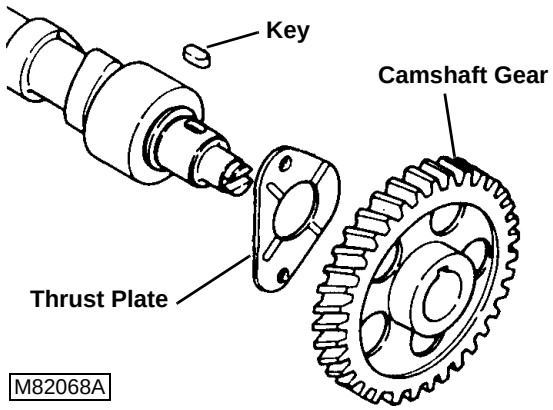
DO NOT heat oil over 182° C (360° F). Oil fumes or oil can ignite above 193° C (380° F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

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

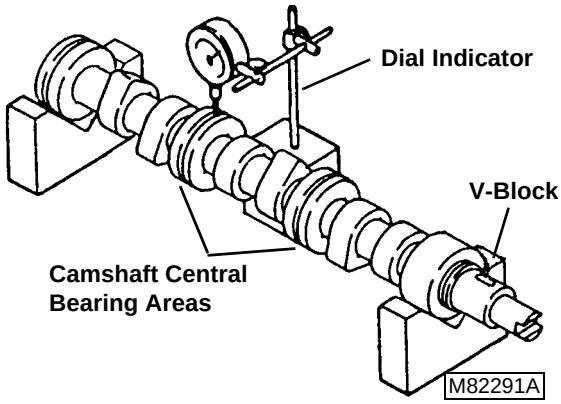
IMPORTANT: Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

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

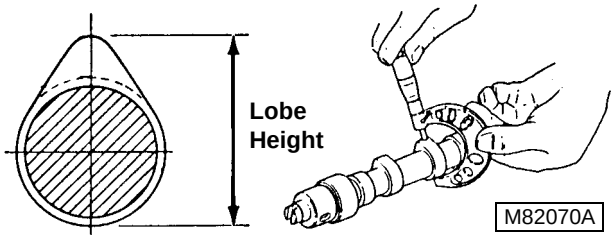
NOTE: Thrust plate must spin freely on camshaft.



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



6. Measure camshaft lobe height.

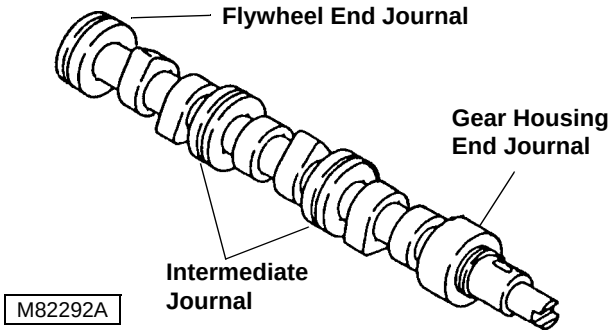


Lobe Height Specifications:

Standard . . . . . 29.97 - 30.03 mm (1.180 - 1.182 in.)
Wear Limit. . . . . 29.75 mm (1.171 in.)

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

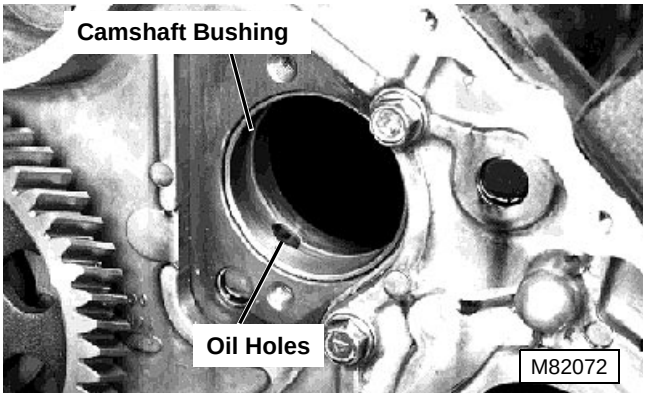
7. Measure camshaft end and intermediate journal diameters.



Camshaft Journal OD Specifications:

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 Journal OD
Standard . . . . 35.91 - 35.94 mm (1.414 - 1.415 in.)
Wear Limit. . . . . 35.85 mm (1.411 in.)

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



8. Measure camshaft bushing diameter at gear housing end.

Camshaft Bushing ID Specifications:

Standard . . . . . 36.00 - 36.065 mm (1.417 - 1.420 in.)
Wear Limit. . . . . 36.10 mm (1.421 in.)
Clearance . . . . . 0.18 mm (0.007 in.)

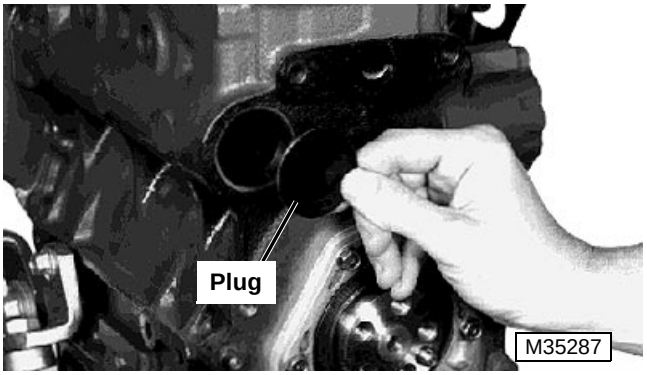
- If bushing diameter exceeds wear limit, replace bushing.
- If bushing clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft or both.

To Replace Bushing:

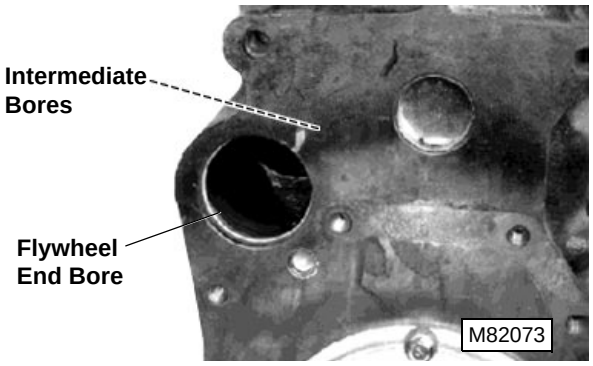
1. Remove and replace bushing using a bushing driver. Be careful not to push bushing inside of engine. Align oil holes in new bushing and cylinder block.

NOTE: Engine back plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

2. Measure intermediate and flywheel end camshaft bore diameters using the following procedures:
   - Remove engine back plate.
   - Remove plug using a long wooden dowel. Insert wooden dowel through gear housing side.



- Measure intermediate and flywheel end camshaft bore diameters.



Camshaft Bore ID Specifications:

Standard . . . . . 36.00 - 36.025 mm (1.417 - 1.418 in.)
Wear Limit. . . . . 36.10 mm (1.421 in.)
Clearance . . . . . 0.18 mm (0.007 in.)

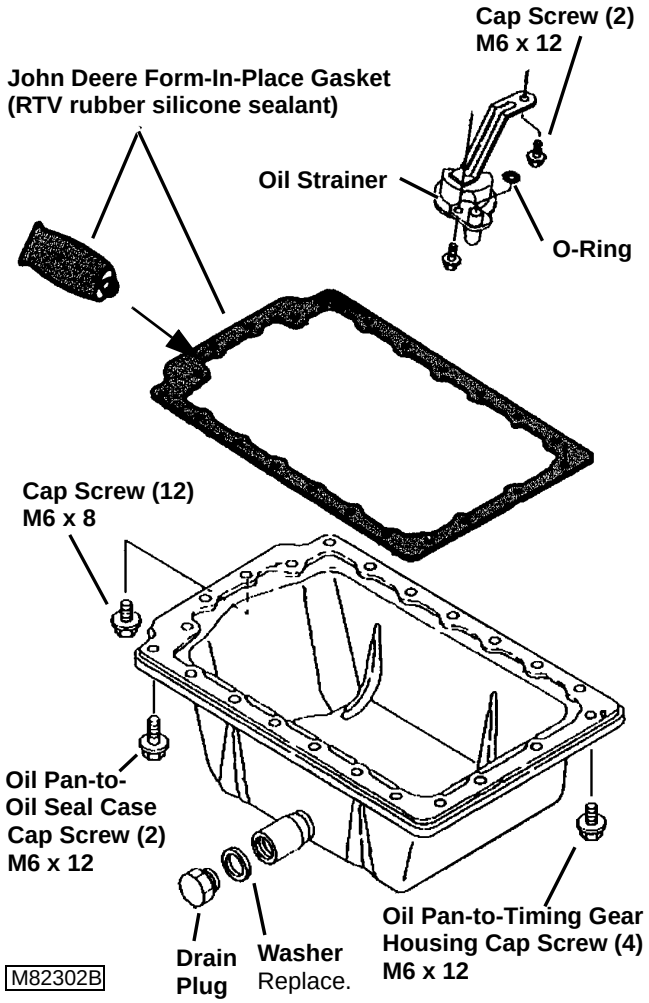
- If bore diameter exceeds wear limit, replace cylinder block.
- If bore clearance (bore ID minus camshaft journal OD) exceeds specification, replace camshaft, cylinder block or both.

3. Apply John Deere Form-In Place Gasket, or an equivalent, on outer edge of plug. Install plug until it bottoms in bore.
4. Install engine back plate.

OIL PAN AND STRAINER

Removal:

1. Drain engine oil.
2. Remove cap screws securing oil pan. Remove oil pan and remove old gasket material.
3. Remove cap screws securing oil strainer. Remove oil strainer.



Installation:

1. Install oil strainer with new O-ring.
2. Tighten cap screws to **11 N•m (96 lb-in.)**.
3. Cover oil pan mounting flange with a thin layer of sealant.
4. Install oil pan and tighten cap screws to specification.

Oil Pan Torque Specifications:

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

5. Install drain plug with new washer.
6. Fill crankcase with oil.
   - Crankcase oil capacity is **2.0 L (2.1 qt)**.
   - Fill engine with proper engine oil. (See *Specifications* section.)

CONNECTING ROD SIDE PLAY CHECK

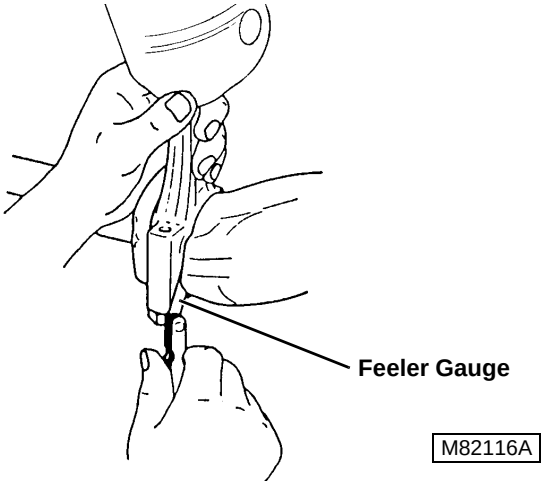
Reason:

To determine proper side clearance between crankshaft and connecting rod.

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.)
Wear Limit . . . . . 0.55 mm (0.022 in.)

Results:

- If side play exceeds wear limit, replace connecting rod and connecting rod cap.

CRANKSHAFT END PLAY CHECK

Reason:

To determine proper side clearance between crankshaft and engine block.

Equipment:

- Dial Indicator

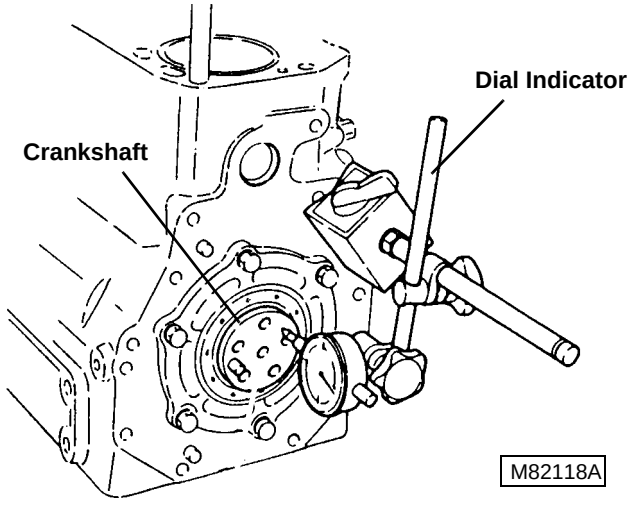
Procedure:

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.



Clearance Specifications:

Standard . . . . . 0.090 - 0.271 mm (0.004 - 0.011 in.)
Wear Limit. . . . . 0.33 mm (0.0129 in.)

Results:

If end play exceeds wear limit, replace thrust bearings.

CONNECTING ROD BEARING CLEARANCE CHECK

Reason:

To measure oil clearance between connecting rod bearing and crankshaft journal.

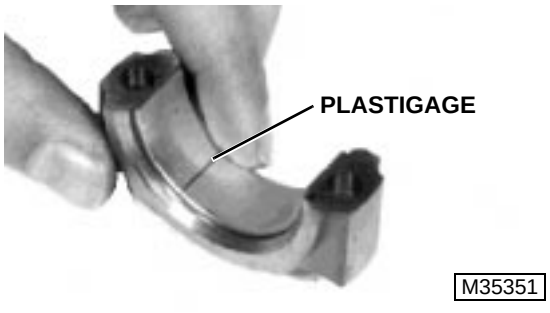
Equipment:

- PLASTIGAGE®

Procedure:

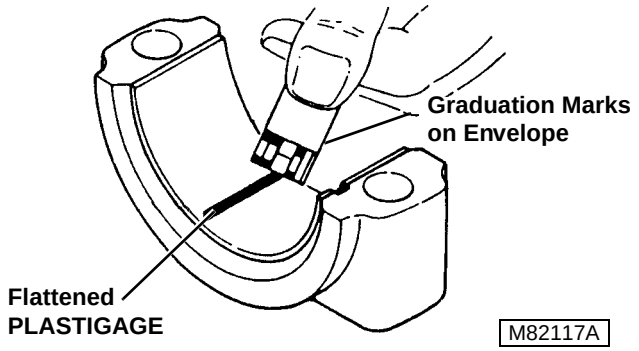
IMPORTANT: Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

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 (0.25 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.
5. Install connecting rod end cap and original cap screws. Tighten cap screws to **23 N•m (203 lb-in.)**.
6. Remove cap screws 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®.

Clearance Specifications:

Standard . . . . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)
Wear Limit. . . . . 0.15 mm (0.0059 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

CRANKSHAFT MAIN BEARING CLEARANCE CHECK

Reason:

To measure oil clearance between main bearing and crankshaft journal.

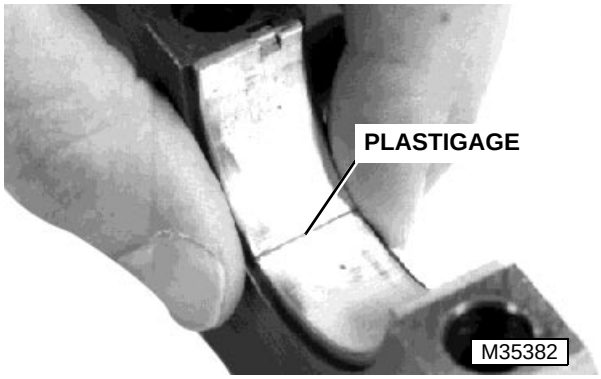
Equipment:

- PLASTIGAGE®

Procedure:

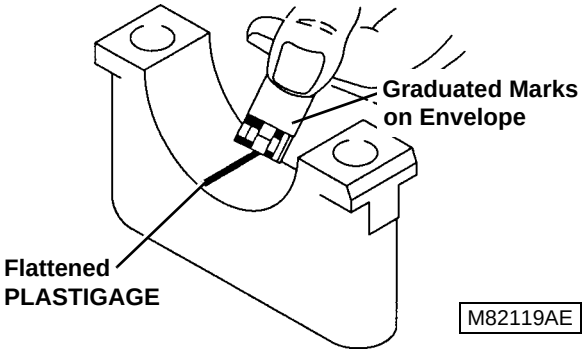
IMPORTANT: Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

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



3. Place 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 cap screws. Tighten cap screws to **54 N•m (40 lb-ft).**
5. Remove cap screws and main bearing cap.

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



6. Use the graduated 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®.

Specifications:

Standard
Clearance . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)
Wear Limit. . . . . 0.15 mm (0.0059 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

PISTON-TO-CYLINDER HEAD CLEARANCE

1. Place small pieces of solder in three positions on the flat part of the piston head.
2. Install cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence to specified torque. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 38.
3. Slowly turn crankshaft one complete revolution.
4. Remove cylinder head and gasket.
5. Measure thickness of flattened pieces of solder. Calculate average thickness of solder pieces to obtain piston-to-cylinder head clearance specification.

Piston-to-Cylinder Head Specification:

Clearance . . . . . 0.59 - 0.74 mm (0.023 - 0.029 in.)

- If clearance is less than specifications, replace cylinder head.

CONNECTING ROD REPAIR

Removal:

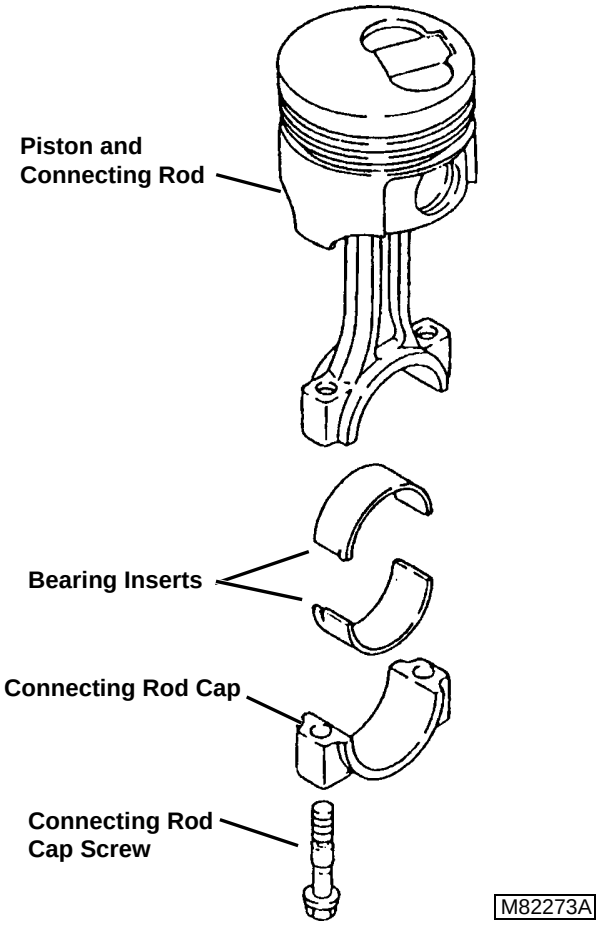
1. Remove oil pan and strainer tube. See “OIL PAN AND STRAINER” on page 52.
2. Remove cylinder head. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 38.
3. Check cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.
4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.
5. Measure connecting rod side play. See “CONNECTING ROD SIDE PLAY CHECK” on page 52.
6. Measure connecting rod bearing clearance. See “CONNECTING ROD BEARING CLEARANCE CHECK” on page 53.

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

7. Remove two cap screws, 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 *Disassembly* and *Inspection/ Replacement* procedures.)



Installation:

Installation is done in reverse order of removal.

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

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. If new piston rings were installed, deglaze cylinder bore. See “Deglazing:” on page 61.
2. Install piston and connecting rod into the cylinder from which it was removed, with alignment mark on connecting rod and/or with piston size mark on top of piston toward fuel injection pump.
3. Install bearing inserts on connecting rod and rod cap, aligning tangs with grooves.

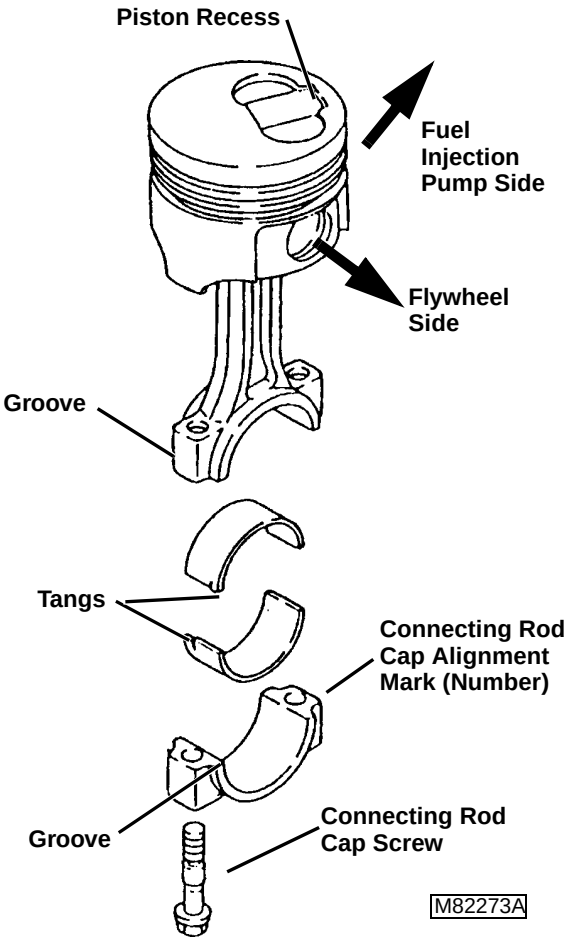
IMPORTANT: Connecting rod caps must be installed on the same connecting rods they were removed from.

4. Match the connecting rods to caps using alignment marks. Install caps.
5. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws and tighten to specifications.

Torque Specification:

Connecting Rod Cap Screw . . . . 23 N•m (203 lb-in.)

- If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod cap and connecting rod.



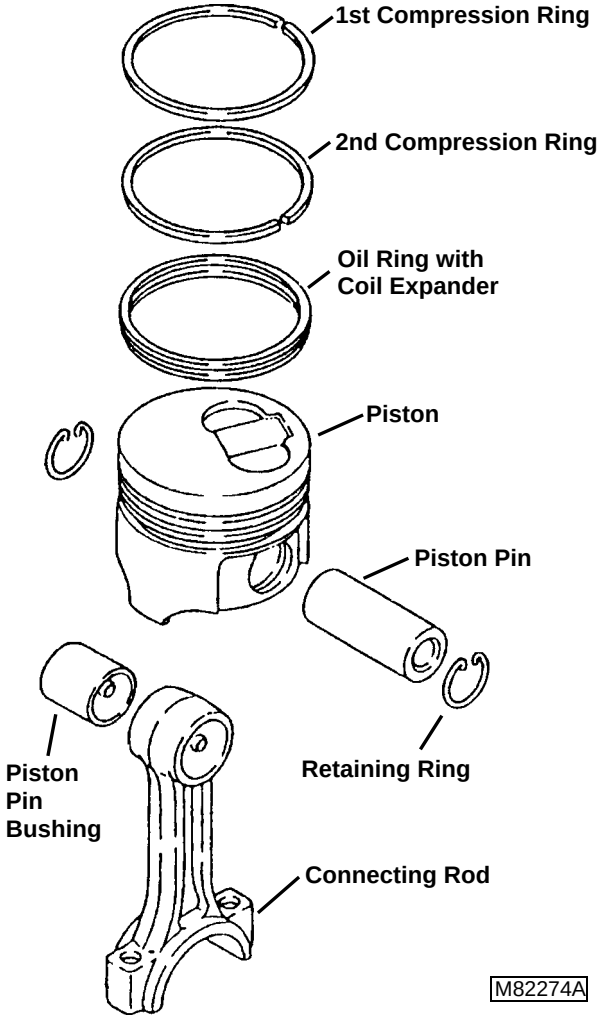
6. Install cylinder head. See "CYLINDER HEAD REMOVAL AND INSTALLATION" on page 38.
7. Install oil pan and strainer tube.

PISTONS

Disassembly:

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

- Put a mark on each piston and connecting rod to aid in assembly.
- Piston pin bushing is press fit in connecting rod. Remove bushing only if replacement is necessary. (See *Inspection/Replacement* procedures.)
- Inspect all parts for wear or damage. Replace as necessary.

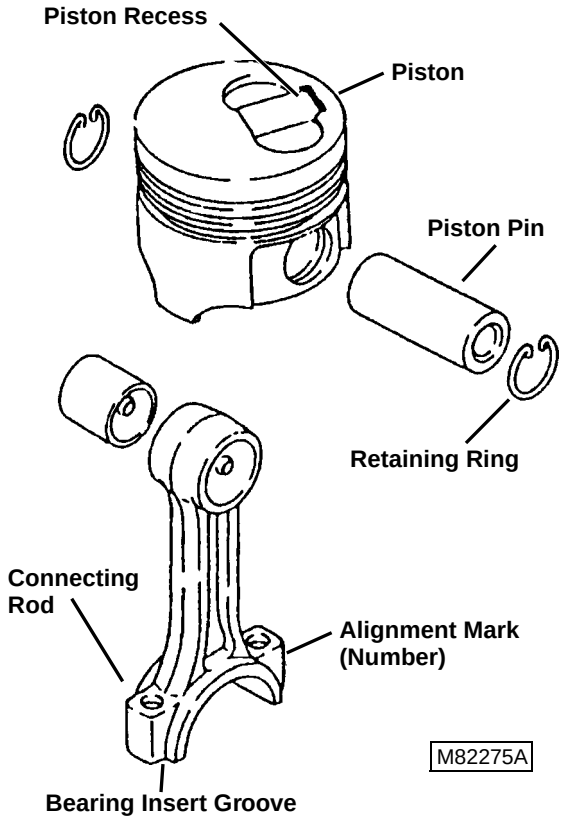


Assembly:

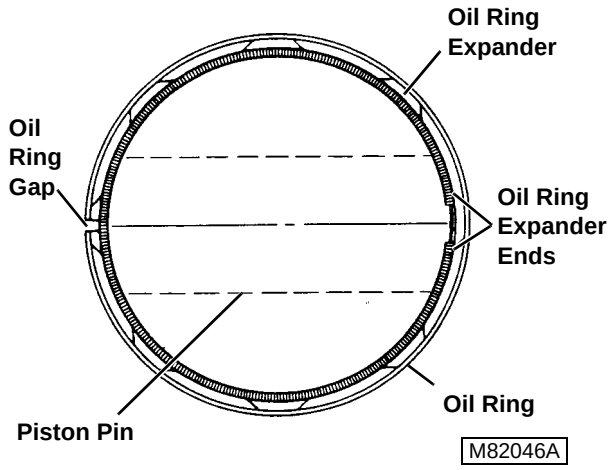
1. Apply clean engine oil to all parts during assembly.

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

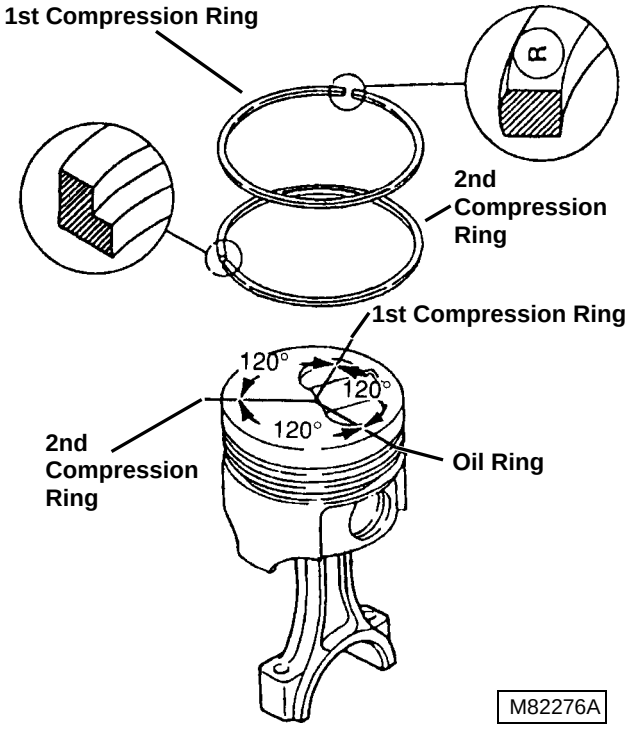
2. Assemble piston to connecting rod with piston size mark on same side as connecting rod “punched” alignment mark. If a new connecting rod is used, assemble piston to connecting rod with piston size mark opposite connecting rod bearing insert groove.



3. Install piston pin and retaining/snap rings.
4. Install oil ring expander in bottom ring groove of piston with ends above either end of piston pin.
5. Install oil ring over expander with ring gap opposite (180^{o}) of expander ends.



6. Install second compression ring, with small diameter of taper toward top of piston, in middle groove. Turn ring until gap is 120^{o} away from oil ring gap.



7. Install first compression ring (chrome plated), with manufacturer's mark “R”, “T” or “RN” (near ring gap) toward top of piston, in top groove. Turn ring until gap is 120^{o} away from second ring gap.

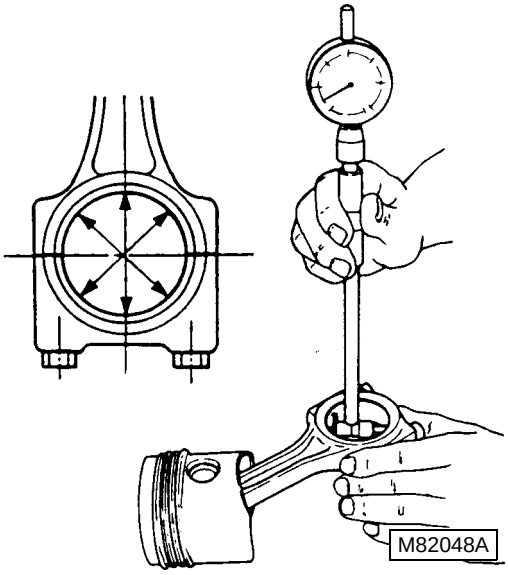
Inspection/Replacement:

1. Inspect all parts for wear or damage. Replace as necessary.
2. Measure crankshaft connecting rod journal diameter. (See *Crankshaft, Main Bearings and Flywheel* in this section.)
3. Install connecting rod cap and bearing inserts on connecting rod. Install old connecting rod cap screws and tighten to specification.

Torque Specification:

Connecting Rod Cap Screw . . . . 23 N•m (203 lb-in.)

4. Measure connecting rod bearing diameter.



Connecting Rod Bearing ID:

Standard . . . . . .36 - 36.042 mm (1.417 - 1.419 in.)
Wear Limit. . . . . 37.07 mm (1.459 in.)
Clearance . . . . . 0.16 mm (0.006 in.)

- If bearing diameter exceeds wear limit, replace bearing inserts.
- If bearing clearance (bearing ID minus crankshaft journal OD) exceeds specification, grind crankshaft connecting rod journals and install undersized bearing inserts, or replace bearing inserts and crankshaft.

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

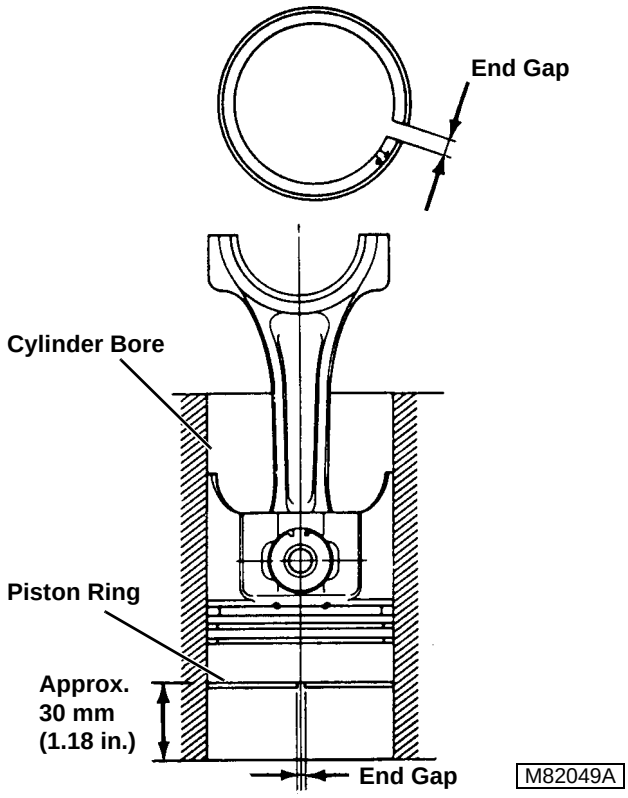
Piston Ring Groove Clearance:

First Compression Ring
Standard . . 0.065 - 0.100 mm (0.0026 - 0.0039 in.)
Wear Limit. . . . . 0.20 mm (0.0079 in.)
Second Compression Ring
Standard . . 0.030 - 0.065 mm (0.0012 - 0.0026 in.)
Wear Limit. . . . . 0.20 mm (0.0079 in.)

Oil Ring
Standard . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)

- If clearance exceeds maximum limit, replace rings or piston.

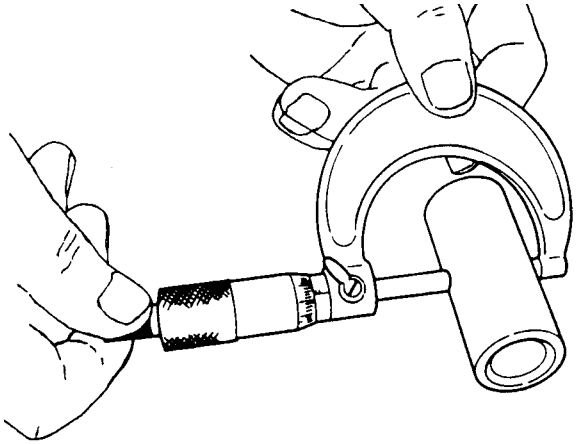
6. Measure piston ring end gap. Push ring into cylinder bore, using a piston, until ring is approximately **30 mm (1.18 in.)** from bottom of cylinder bore.



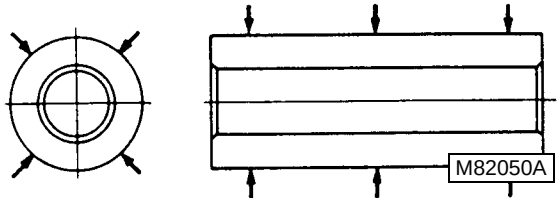
Standard Piston Ring End Gap:

First Compression Ring and Oil Ring
. . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)
Second Compression Ring
. . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)
Wear Limit. . . . . 1.50 mm (0.0591 in.)

- If end gap exceeds wear limit, replace rings.



Measuring Position



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

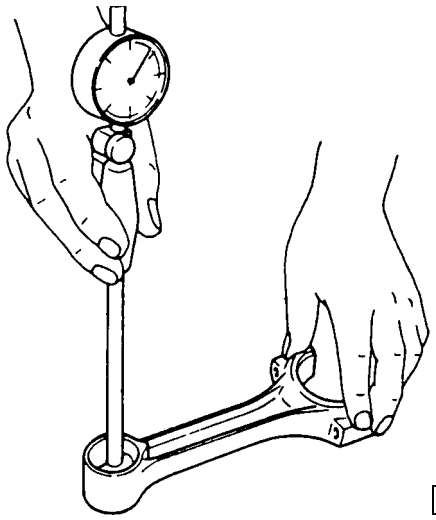
Piston Pin OD Diameter Specifications:
Standard . . . 19.991 - 20.00 mm (0.787 - 0.788 in.)
Wear Limit . . . . . 19.975 mm (0.786 in.)

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

8. Measure piston pin bore diameter in piston.

Piston Pin Bore ID Specifications:
Standard . . . 20.00 - 20.008 mm (0.787 - 0.788 in.)
Wear Limit . . . . . 20.02 mm (0.788 in.)
Clearance . . . . . 0.045 mm (0.0018 in.)

- If piston pin bore exceeds wear limit, replace piston.
- If bore clearance (bore ID minus pin OD) exceeds specification, replace piston, piston pin or both.



9. Measure piston pin bushing diameter in connecting rod.

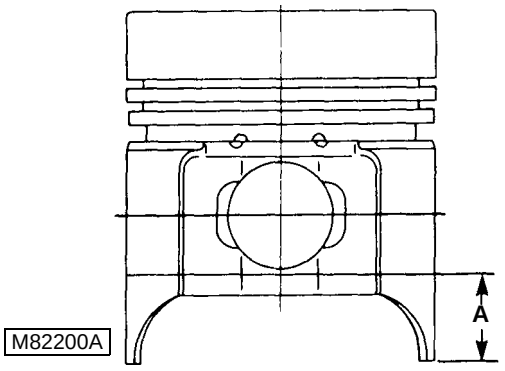
Piston Pin Bushing ID Specifications:
Standard . . 20.025 - 20.038 mm (0.788 - 0.789 in.)
Wear Limit . . . . . 20.10 mm (0.781 in.)
Clearance . . . . . 0.11 (0.0043 in.)

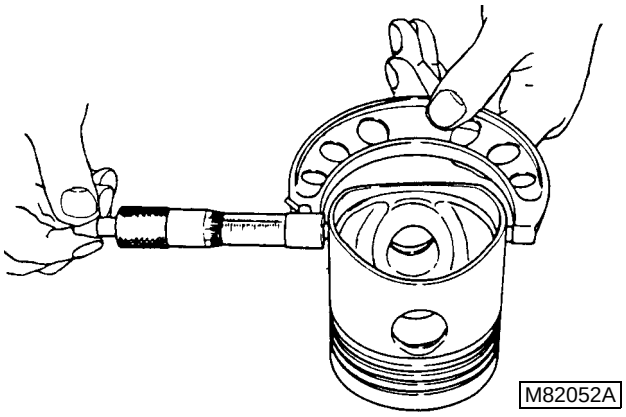
- If bushing diameter exceeds wear limit, replace bushing.
- If bushing clearance (bushing ID minus pin OD) exceeds specification, replace bushing, piston pin or both.

NOTE: 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.

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

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.) and 0.50 mm (0.020 in.) oversize.





Specifications:

Piston OD Distance A) . . . . . 5 mm (0.197 in.)
Standard Size Piston
Standard . . 65.927 - 65.957 mm (2.596 - 2.597 in.)
Wear Limit . . . . . 65.85 mm (2.593 in.)
Oversize Piston – 0.25 mm (0.010 in.)
Standard . . . . 66.18 - 66.21 mm (2.606 - 2.607 in.)
Wear Limit . . . . . 66.10 mm (2.602 in.)
Oversize Piston – 0.50 mm (0.020 in.)
Standard . . . . 66.43 - 66.46 mm (2.615 - 2.616 in.)
Wear Limit . . . . . 66.35 mm (2.612 in.)

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

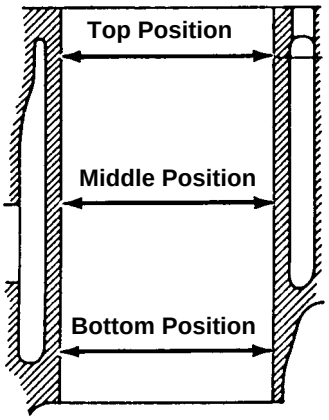
11. Measure cylinder bore diameter. (See procedure in this group.)

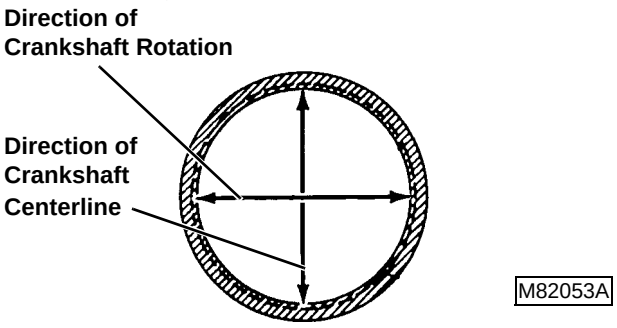
CYLINDER BORE

Inspection:

1. 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.





Cylinder Bore ID Specifications:

Standard Size Bore
Standard . . . . 66.00 - 66.03 mm (2.599 - 2.600 in.)
Wear Limit . . . . . 66.20 mm (2.606 in.)
Piston to Cylinder Clearance . . 0.25 mm (0.010 in.)
Cylinder Roundness . . . . . 0.25 mm (0.010 in.)
Wear Limit . . . . . 0.03 mm
First Oversize Bore
Standard . . . . 66.25 - 66.28 mm (2.609 - 2.610 in.)
Wear Limit . . . . . 66.45 mm (2.616 in.)
Second Oversize Bore
Standard . . . . 66.50 - 66.53 mm (2.619 - 2.620 in.)
Wear Limit . . . . . 66.70 mm (2.626 in.)

- If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. (See *Reboring* procedure.)
- If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available

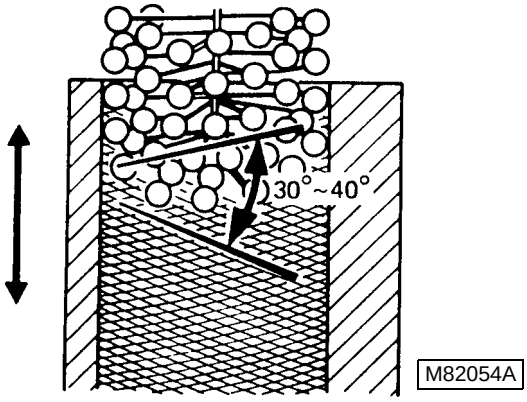
in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) oversize.

- If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.

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.

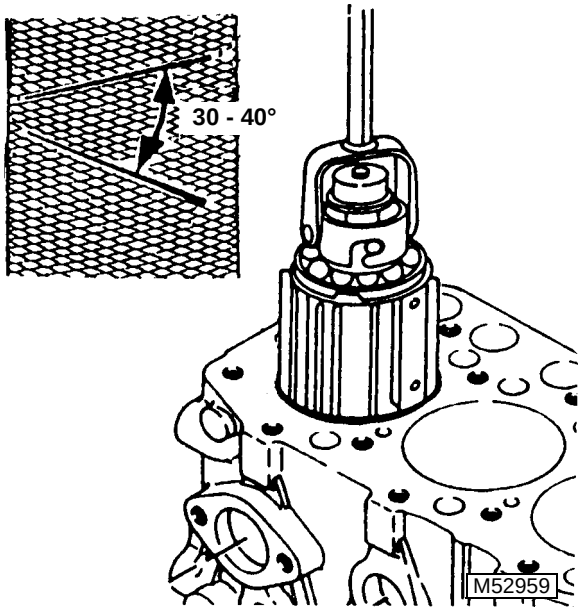
Reboring:

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.) and 0.50 mm (0.020 in.) oversize. (See this group for cylinder bore I D specifications.)

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° 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. (See *Inspection* procedures.)

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 AND MAIN BEARINGS

Removal:

1. Check crankshaft end play. See “CRANKSHAFT END PLAY CHECK” on page 53.
2. Remove flywheel. See “FLYWHEEL” on page 64.
3. Remove rear oil seal case. See “CRANKSHAFT REAR OIL SEAL” on page 44.
4. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.
5. Check crankshaft bearing clearance. See “CRANKSHAFT MAIN BEARING CLEARANCE CHECK” on page 54.

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.

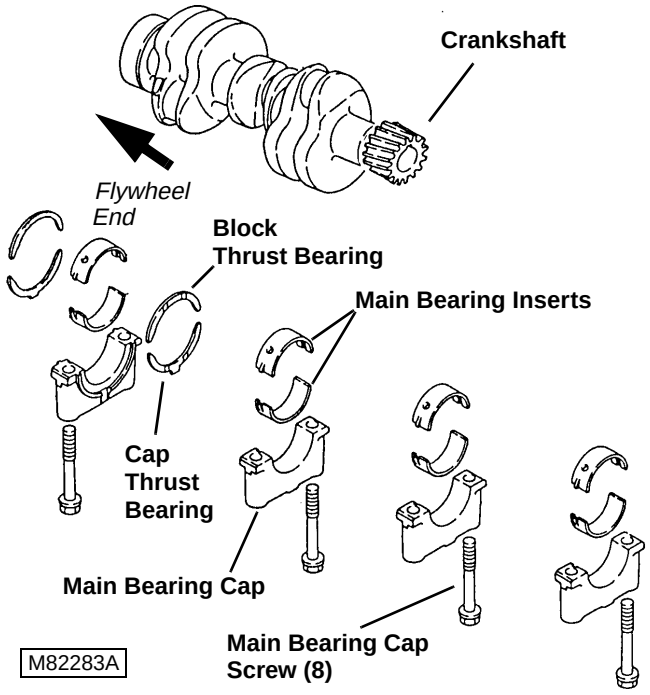
6. Remove connecting rod cap screws and end caps.
7. Push pistons and connecting rods away from crankshaft.

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

8. Remove main bearing cap screws, 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 *Inspection/Replacement* procedure.)

Installation:

1. Apply clean engine oil on all parts during installation.
2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.



3. Install block thrust bearings with oil grooves facing away from engine block.

NOTE: Main bearing caps have “raised arrows” that are stamped with numbers. Both correspond to their location on the engine block. The number “1” main bearing bore is at flywheel end. Install bearing caps beginning with number 1, then 2, etc. The main bearing cap at gear train end does not have a number. Also install bearing caps with the “arrow” toward the flywheel end.

4. Install crankshaft.
5. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
6. Install cap thrust bearings, with oil grooves facing away from cap, in the number “1” main bearing cap.
7. 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 cap screws.

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. DO NOT tighten to specifications.
9. Using a soft-faced hammer, tap the front end of the crankshaft then the rear end of the crankshaft to align the thrust bearings.
10. Tighten main bearing cap screws 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.

Torque Specification:

Main Bearing Cap Screws . . . . . 88 N•m (65 lb-ft)

Inspection/Replacement:

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

To replace gear:

- Remove gear from crankshaft 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.

- Heat gear to approximately 150°C (300°F). Install gear with timing mark "A" toward press table. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.

2. 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 (0.0008 in.)**, replace crankshaft.
3. 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 OD Specifications:

Standard . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)
Wear Limit. . . . . 35.92 mm (1.414 in.)

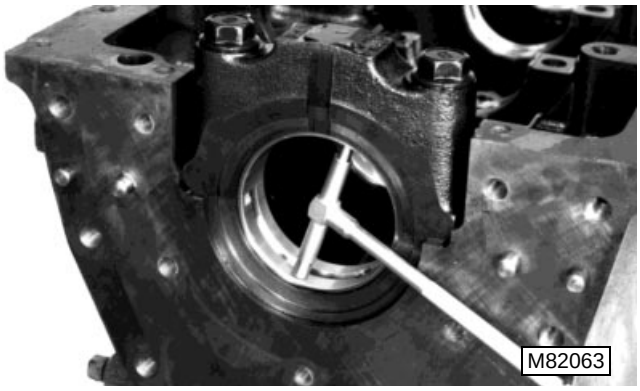
Main Bearing Journal OD Specifications:

Standard . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)
Wear Limit. . . . . 39.92 mm (1.572 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.

4. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to a minimum of **54 N•m (40 lb-ft)** to compress main bearing for measurement.
5. Measure main bearing diameter.



Main Bearing ID Specifications:

Standard . . . . 40.000 - 40.042 mm (1.575 - 1.577 in.)
Wear Limit. . . . . 40.07 mm (1.578 in.)
Clearance . . . . . 0.15 mm (0.0059 in.)

- If bearing diameter exceeds wear limit, replace bearing inserts.
- If bearing clearance (bearing ID minus crankshaft main bearing journal OD) exceeds specification, replace bearing inserts and crankshaft or have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.

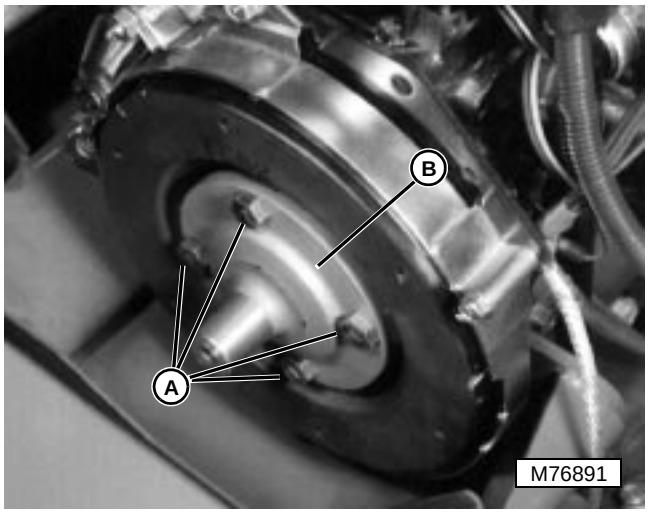
Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

6. Clean and inspect oil passages in main bearing journals, connecting rod journals and main bearing bores in cylinder block.
7. Inspect crankshaft for cracks or damage. Replace if necessary.

FLYWHEEL

Removal:

1. Remove engine drive clutch. See GEAR POWER TRAIN SECTION.



1. Remove flywheel guard.
2. Remove four cap screws (A) securing engine drive clutch stub shaft (B) to flywheel hub.
3. Remove five flywheel mounting cap screws from flywheel to crankshaft.
4. Pull flywheel from crankshaft alignment pin.

IMPORTANT: Never reuse flywheel mounting cap screws. Always install new.

5. Inspect flywheel ring gear teeth for wear or chips. Replace flywheel if worn.

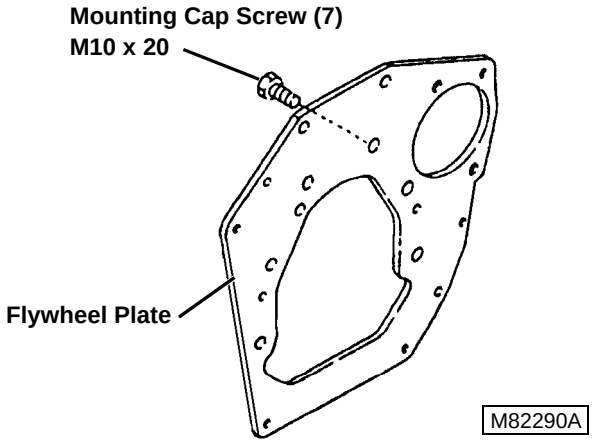
Installation:

1. Align flywheel on spring pin and install five **new** flywheel mounting cap screws (see note above). Tighten cap screws to **83 N•m (61 lb-ft).**
2. Install stub shaft to flywheel hub and tighten four mounting cap screws to **59 N•m (44 lb-ft).**
3. Install flywheel guard.

FLYWHEEL PLATE

Removal:

1. Remove clutch from crankshaft.
2. Remove flywheel guard.
3. Remove flywheel. See “FLYWHEEL” on page 64.
4. Remove starting motor.



5. Remove seven mounting cap screws and flywheel plate.

Installation:

Installation is done in reverse order of removal.

- Tighten mounting cap screws to **49 N•m (36 lb-ft)**.

TIMING GEAR HOUSING

Removal:

1. Remove engine. See “ENGINE REMOVAL AND INSTALLATION” on page 34.
2. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.
3. Remove fuel injector lines from engine. See “FUEL INJECTION NOZZLE” on page 71.
4. Remove engine camshaft. See “CAMSHAFT” on page 49.
5. Remove water pump. See “WATER PUMP” on page 68.
6. Remove oil dipstick tube.
7. Remove oil pan. See “OIL PAN AND STRAINER” on page 52.
8. Remove timing gear housing mounting cap screws and remove housing from cylinder block.
9. Replace O-rings.

Installation:

Installation is done in the reverse order of removal.

- Apply low strength thread lock to studs before installing into timing gear housing.
- Replace O-rings.
- Tighten timing gear housing mounting cap screws to **11 N•m (96 lb-in.)**.

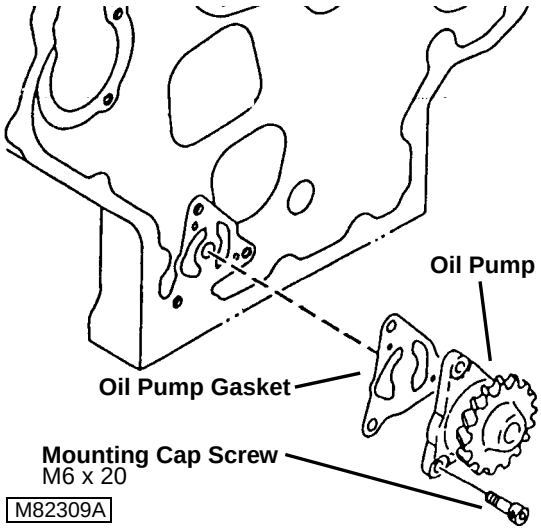
OIL PUMP

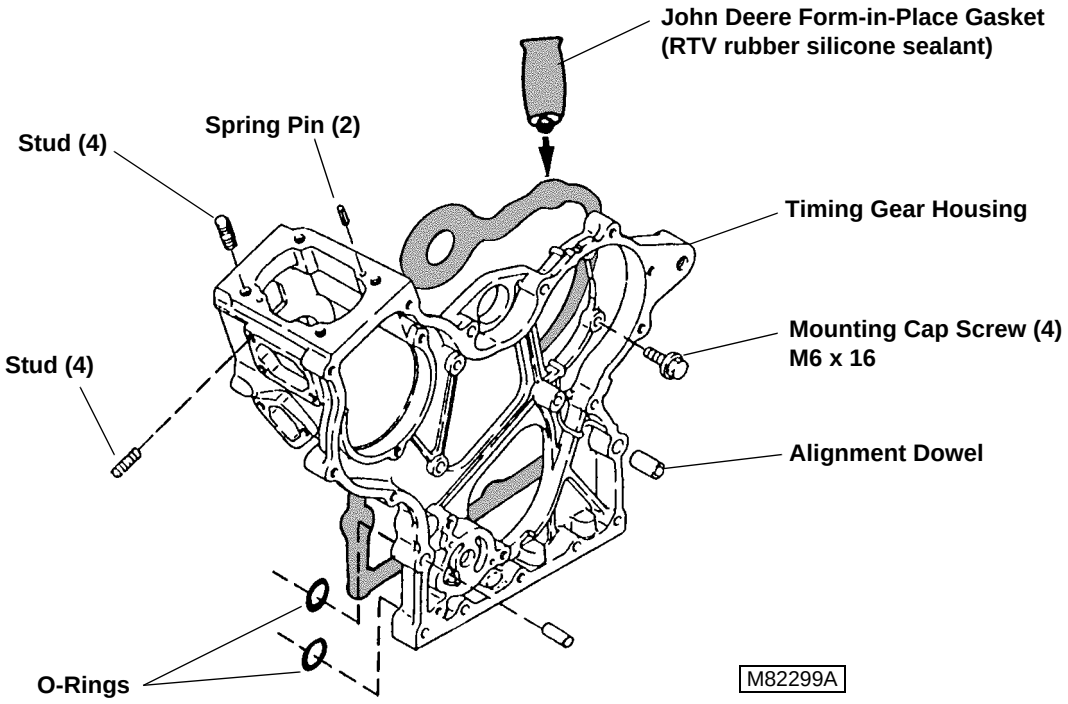
Removal/Installation

1. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.
2. Check oil pump gear backlash. Replace entire oil pump assembly if backlash is more than **0.25 mm (0.010 in.)**.
3. Remove three mounting cap screws, oil pump and gasket.
4. Inspect all parts for wear or damage. See Disassembly/Assembly procedures.

Installation:

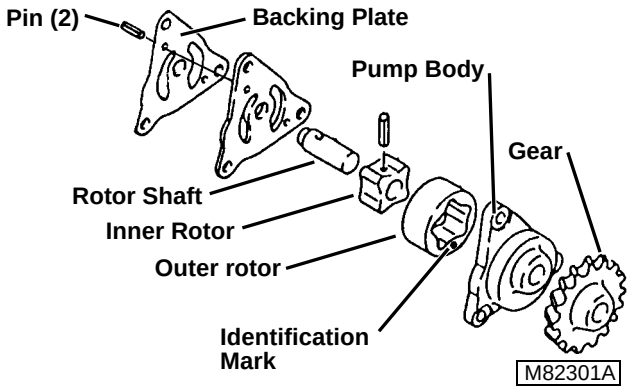
- Tighten mounting cap screw to **25 N•m (18 lb-ft).**





Disassembly/Assembly:

1. Remove gear using a knife edge puller and a press. Gear is press fit on rotor shaft.
2. Inspect parts for wear or damage. (See *Inspection* procedures.)
3. Coat all parts with clean engine oil.
4. Install outer rotor with identification mark facing toward rotor shaft assembly.

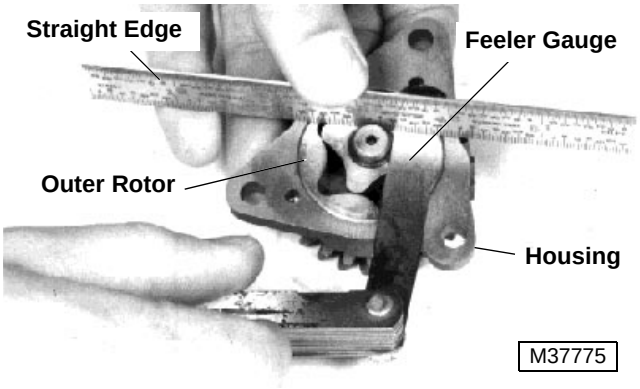


Inspection:

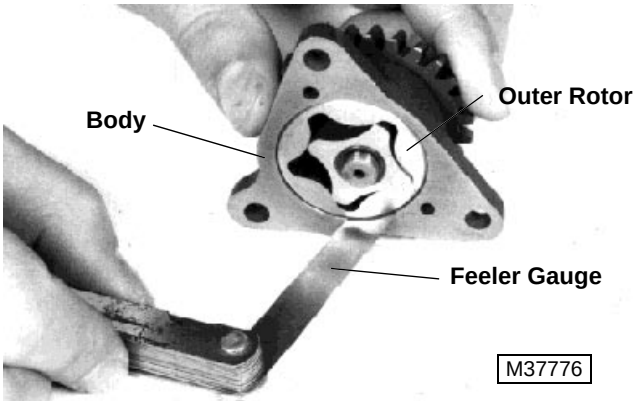
1. Check rotor shaft outer diameter and the shaft hole diameter in backing plate. If clearance is more than wear limit, replace entire assembly.

Rotor Shaft and Plate Clearance:

Standard . . . . . 0.015 - 0.048 mm (0.001 - 0.004 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)



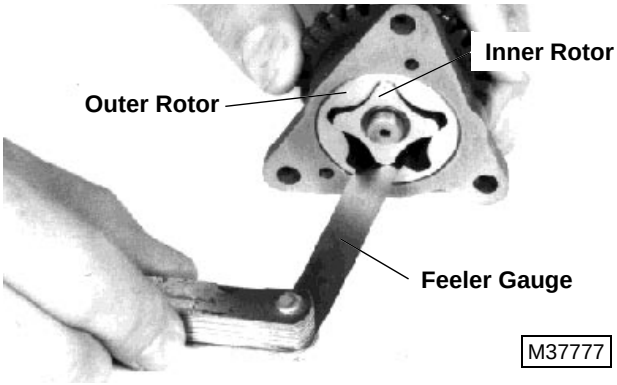
2. Check rotor recess. If rotors are below face of pump housing more than **0.25 mm (0.01 in.)**, replace rotor assembly.



3. Check outer rotor-to-pump body clearance. If clearance is more than wear limit, replace entire assembly.

Outer Rotor-to-Pump Body Clearance:

Standard . . . . . 0.03 - 0.09 mm (0.0011 - 0.0035 in.)
Wear Limit. . . . . 0.13 mm (0.0051 in.)



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

OIL PRESSURE REGULATING VALVE

Removal:

1. Remove oil filter and O-ring.
2. Remove retaining nut and valve assembly.
3. If adjusting pressure only, remove cap and add shims. Each **1 mm (0.039 in.)** of shim thickness increases oil pressure **13.8 kPa (2.0 psi)**.

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

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

Spring Specifications:

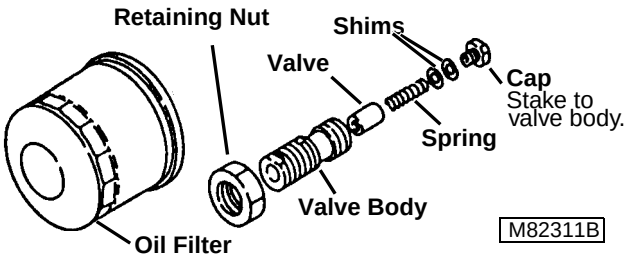
Free
Length . . . . .21.90 mm - 24.50 mm (0.860 - 0.960 in.)

Compressed
Length . . . . .14.70 mm (.580 in.)@12 N (2.7 lb-force)

Installation:

Installation is done in the reverse order of removal.

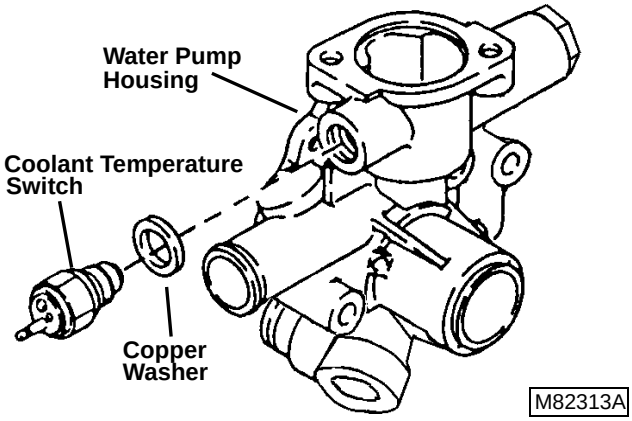
- Tighten retaining nut to 30 N•m (22 lb-ft).



COOLANT TEMPERATURE SWITCH

Replacement:

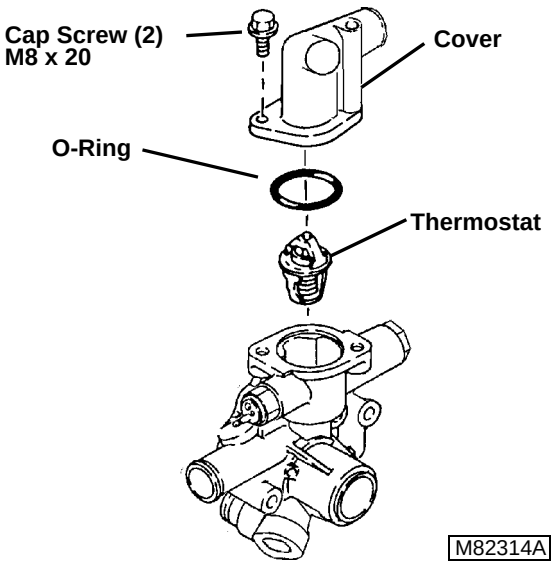
1. Open engine drain valve to drain coolant level to below coolant sensor level.
2. Disconnect wiring lead.
3. Remove sensor and washer.
4. Test sensor. (See ELECTRICAL SECTION.)
5. Installation is done in reverse order of removal.
   - Replace copper washer.



THERMOSTAT

Removal:

1. Open engine drain valve to drain coolant level to below thermostat level.
2. Disconnect upper radiator hose from thermostat housing.
3. Remove two cap screws holding thermostat cover to water pump.
4. Test thermostat. See “THERMOSTAT TEST” on page 29.



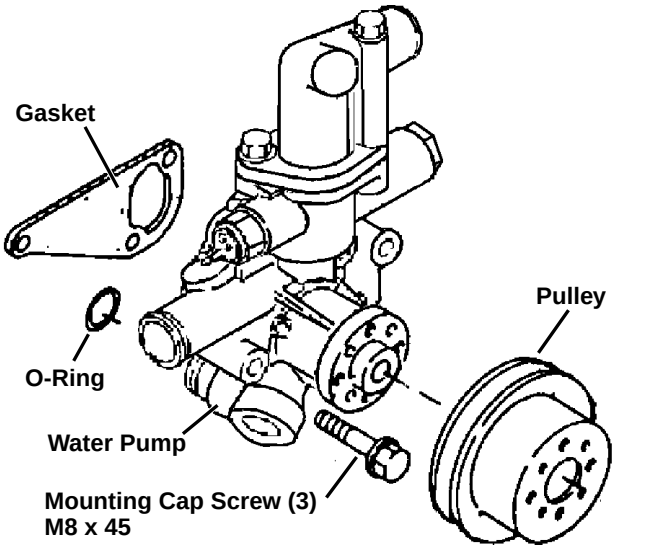
Installation:

- Replace O-ring when installing thermostat.
- Tighten cap screws securing cover to **26 N•m (230 lb-in.)**.

WATER PUMP

Removal:

1. Remove engine belt guard.
2. Open engine drain valve to drain coolant from cylinder block.
3. Disconnect coolant temperature switch lead.
4. Disconnect upper and lower radiator hoses.
5. Remove water pump/alternator drive belt.



6. Remove four pulley cap screws and pulley.
7. Remove three pump mounting cap screws, pump and gasket.
8. Inspect all parts for wear or damage.
9. Clean cylinder block mating surfaces of all old gasket material.

Installation:

Installation is done in the reverse order of removal.

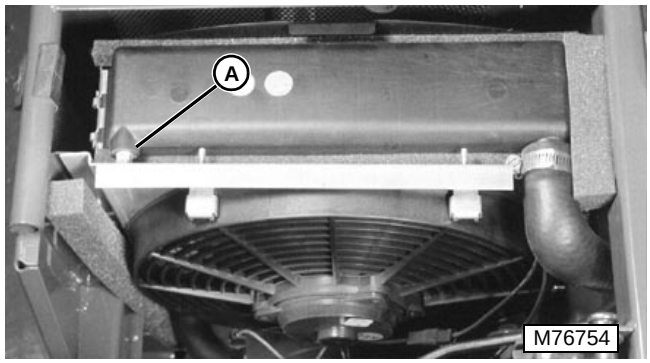
1. Install new gasket and O-ring.
2. Tighten mounting cap screws to **26 N•m (226 lb-in.)**.
3. Install coolant temperature switch. See "COOLANT TEMPERATURE SWITCH" on page 67.
4. Install thermostat. See "THERMOSTAT" on page 67.
5. Adjust water pump/alternator drive belt tension. See "WATER PUMP/ALTERNATOR DRIVE BELT ADJUSTMENT" on page 28.
6. Install engine belt cover.

COOLANT FILLING

NOTE: Capacity of cooling system is approximately 4.5 L (4.8 qt).

Fill Procedure with Coolant in Engine Block

1. Ensure engine is cool.
2. Remove upper radiator bleed screw.



3. Fill system with coolant through remote fill until coolant comes out bleed screw hole (A).
4. Install bleed screw.

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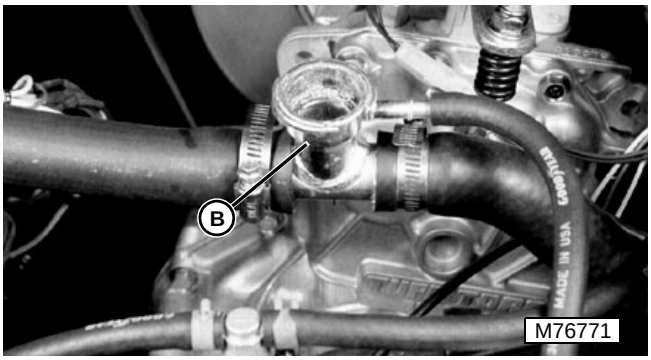
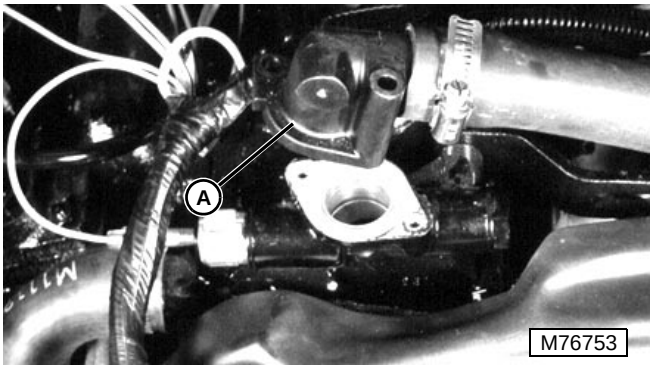


5. Continue filling through remote fill (B) until full.

Fill Procedure without Coolant in Engine Block

1. Remove thermostat housing (A) and thermostat.



2. Fill engine block until full.
3. Install thermostat and thermostat housing.
4. Tighten thermostat housing cap screws to **9 N•m (78 lb-in)**.
5. Remove upper radiator bleed screw.
6. Fill system with coolant through remote fill (B) until coolant comes out bleed screw hole.

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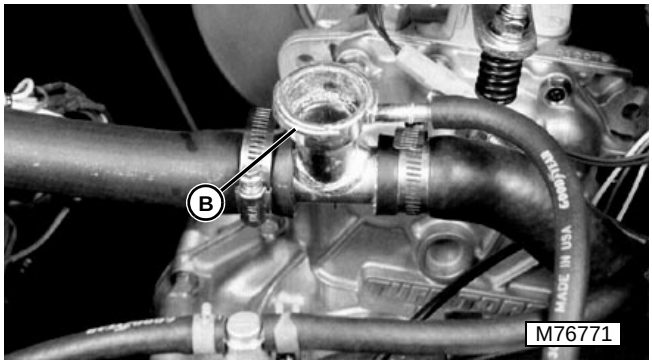
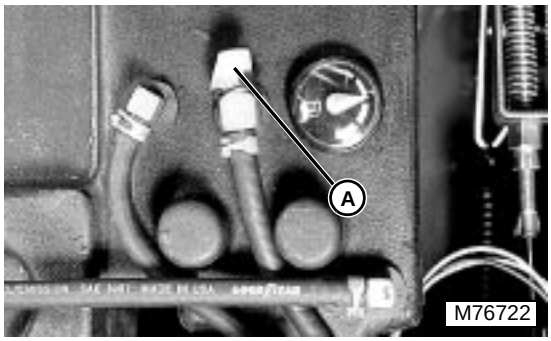


7. Install bleed screw.
8. Continue filling through remote fill (B) until full.

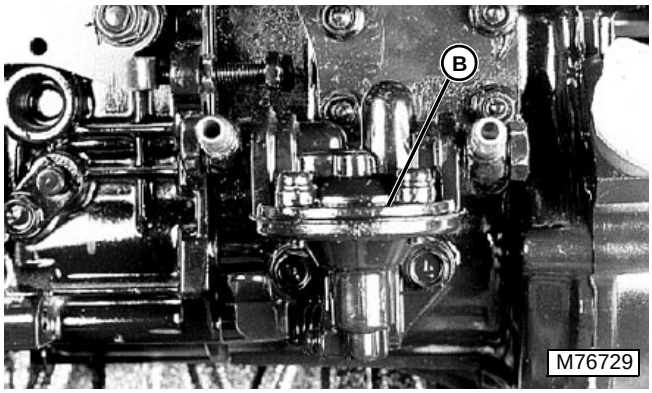
FUEL TRANSFER PUMP

CAUTION

Fuel tank shutoff valve must be closed before disconnecting fuel lines.

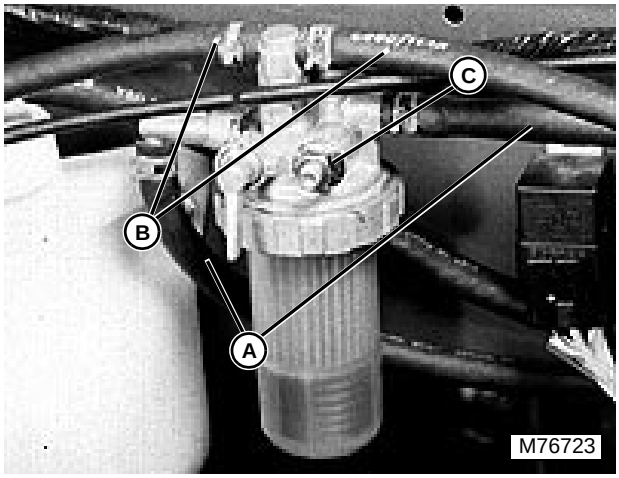


1. Close fuel shutoff valve (A) at tank and at filter.



2. Remove inlet and outlet hose clamps at fuel transfer pump (B) and disconnect hoses.
3. Disconnect two cap screws securing fuel pump assembly to frame.
4. Remove all old gasket material from mating surfaces before installation.
5. Installation is done in the reverse order of removal.

FUEL FILTER



1. Remove two fuel lines (A) from fuel filter assembly.
2. Remove two fuel return lines (B) from fuel filter assembly.
3. Remove nut (C) securing filter assembly to mounting stud.
4. Slide fuel filter off of mounting stud.

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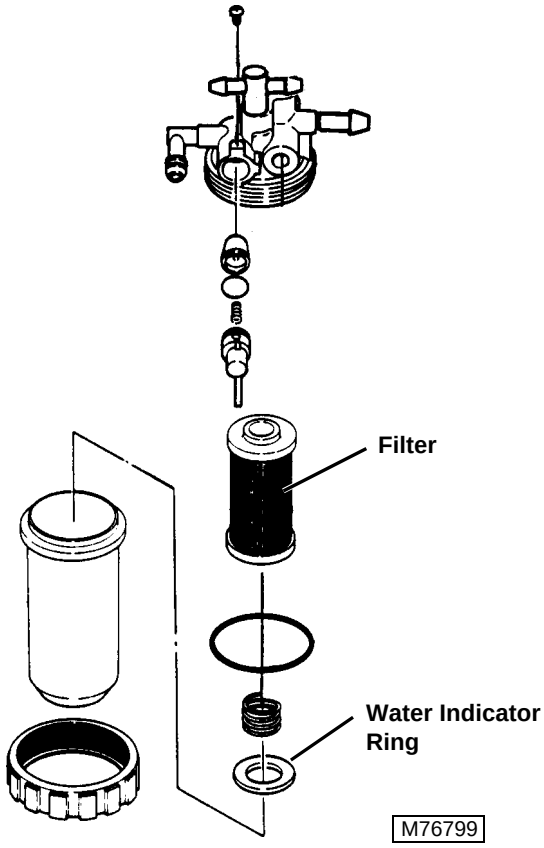
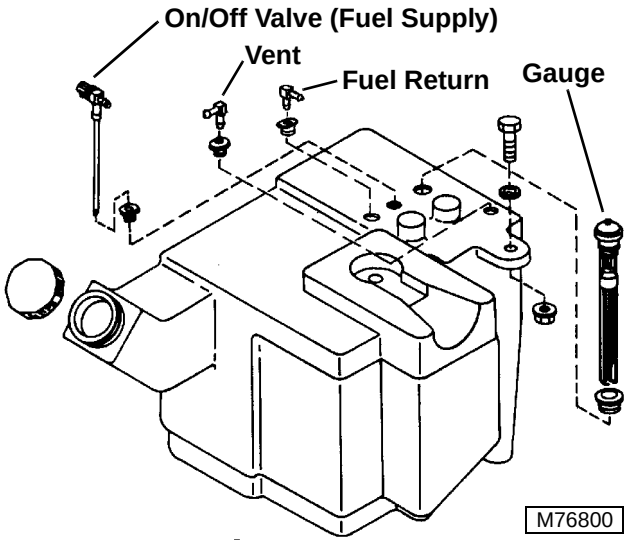


Installation:

Installation is done in the reverse order of removal.

FUEL TANK COMPONENTS



FUEL INJECTION NOZZLE

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.

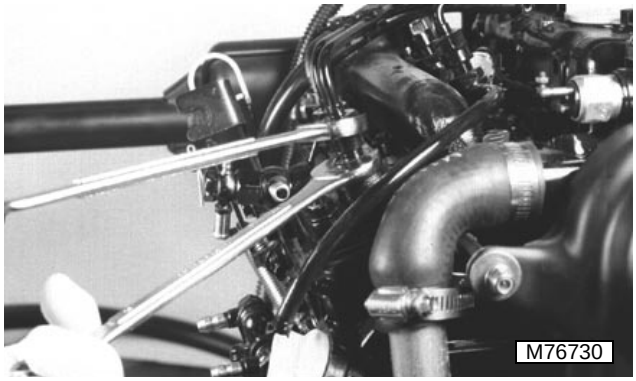
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgable source. Such information is available from the Deere & Company Medical Department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

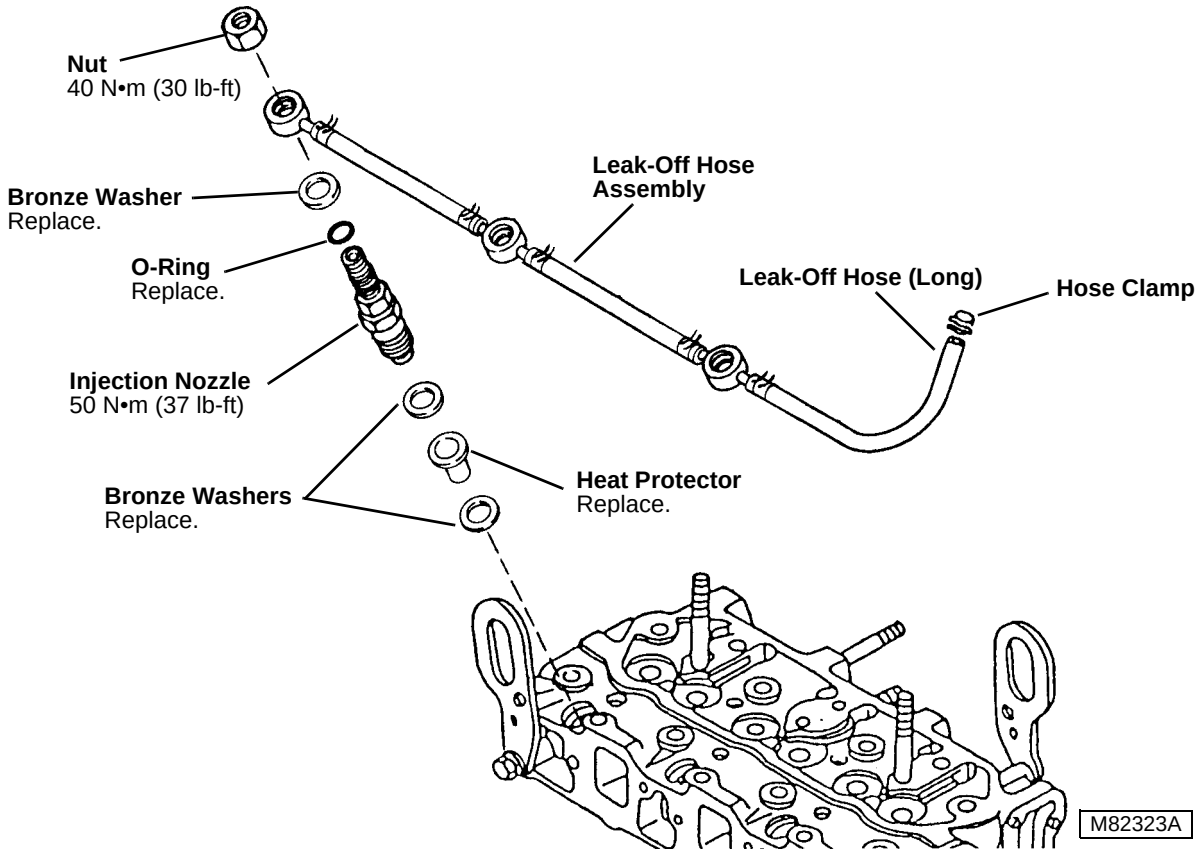
1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

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. Always use a backup wrench when removing lines.



2. Loosen fuel line connectors at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to



prevent delivery valves from turning.

3. Loosen fuel line clamp, and remove fuel 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 *Tests and Adjustment* section.

Installation:

Installation is done in reverse order of removal.

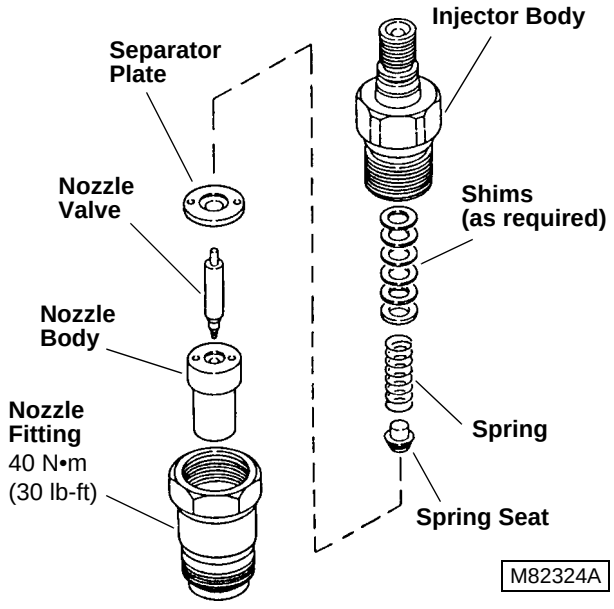
- Tighten injection nozzle to **50 N•m (37 lb-ft)**.
- Tighten leak-off hose nuts to **40 N•m (30 lb-ft)**.

Repair:

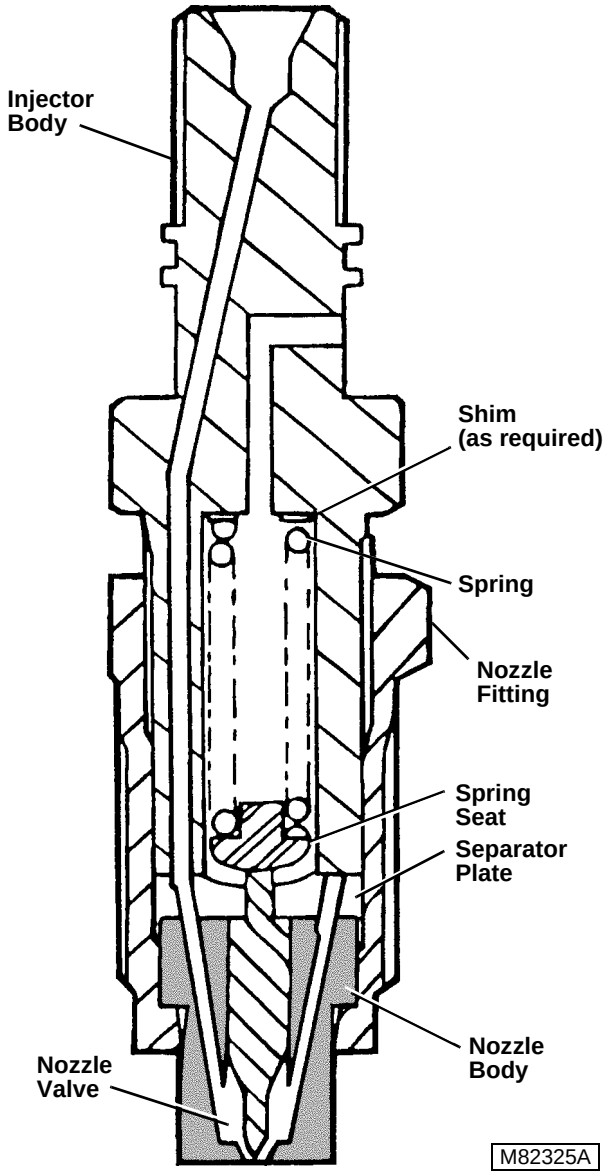
NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

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 “Cleaning and Inspection:” on page 72.
- After assembly is complete, test injection nozzle. See *Test and Adjustment* section.



INJECTION NOZZLE CROSS SECTION



Cleaning and Inspection:

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

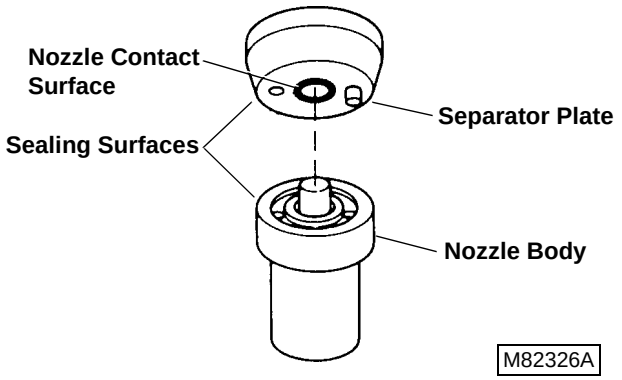
1. Remove anticorrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

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

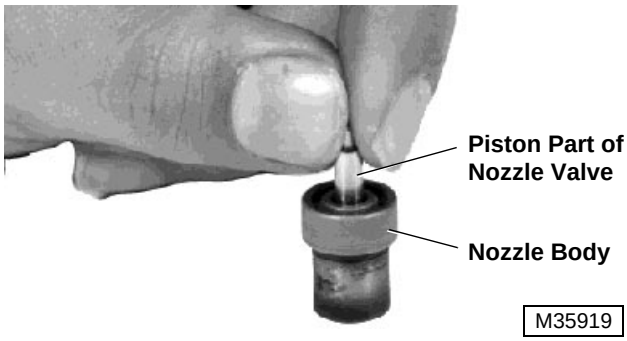
2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with

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 (0.0039 in.)**, replace nozzle assembly.



6. 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.
7. 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.

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.

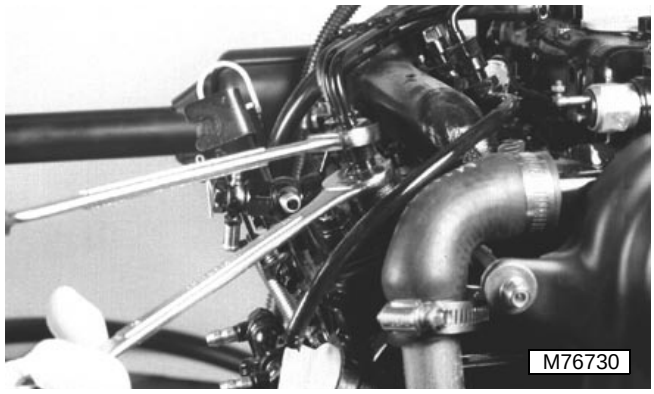
ATTENTION!

DO NOT attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

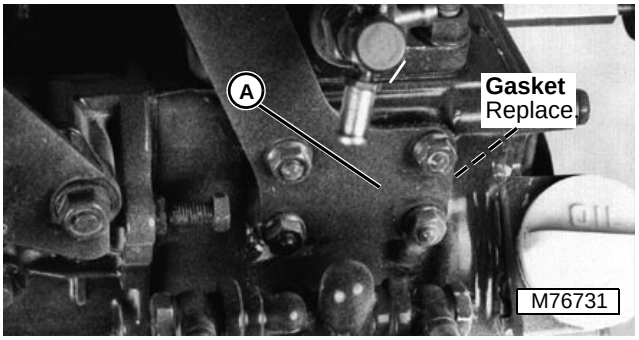
IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

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

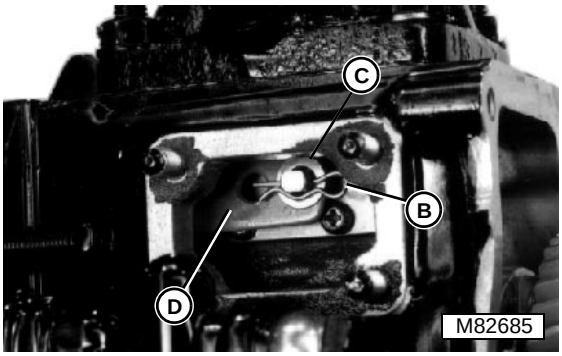
IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.



2. Disconnect injector/bypass fuel line.
3. Remove hose from air cleaner to intake manifold.
4. Loosen fuel line connectors at fuel injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to keep delivery valves from loosening.
5. Loosen line clamp and remove fuel injection lines.
6. Disconnect hoses from fuel injection pump.
7. Disconnect leak-off hoses from injectors.



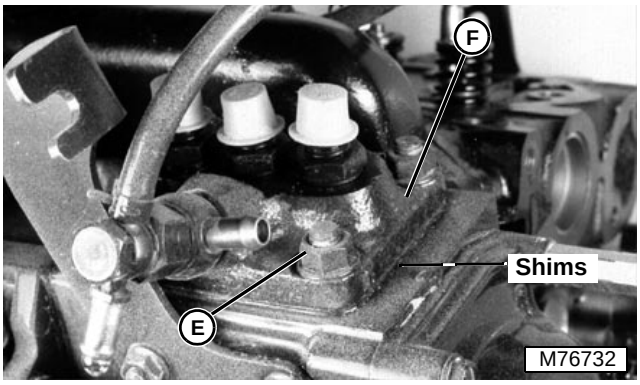
8. Remove four nuts, governor linkage cover (A) and gasket.



NOTE: Washer may be fixed to linkage. Do not drop pin during removal.

9. Remove pin (B) and washer (C) if equipped. Disconnect governor linkage (D).

IMPORTANT: If injection pump is being removed to be serviced or replaced, the same thickness of new shims must be installed when pump is assembled. New shims must be used with protective seal coating.



10. Remove four nuts (E) to remove fuel injection pump (F) and shims.

Installation:

Installation is done in the reverse order of removal.

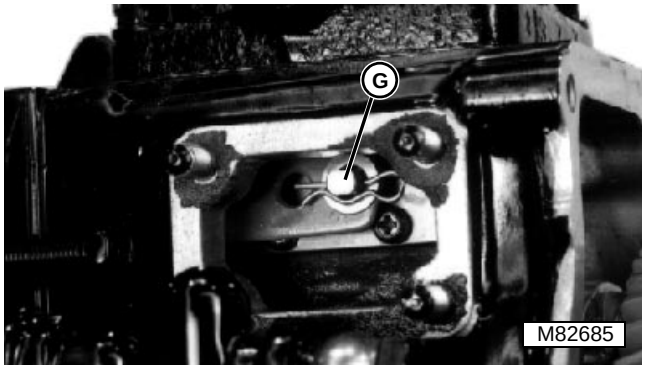
ATTENTION!

DO NOT attempt to adjust the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

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

NOTE: Do not drop pin or washer during installation.

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

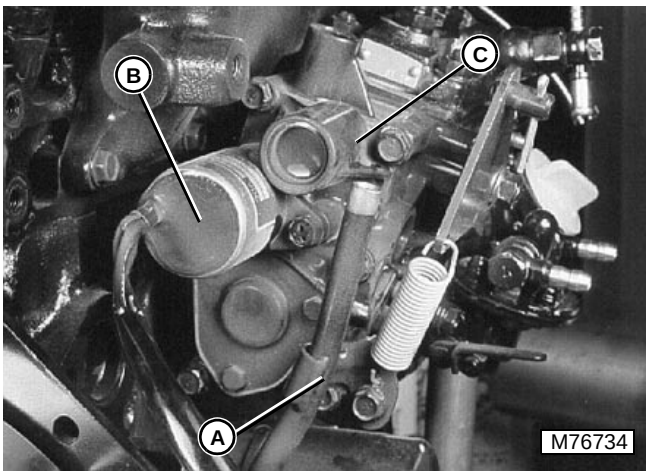


- When connecting governor linkage to injection pump rack (G), attach link to rack at hole closest to injection pump gear.
- Bleed the fuel system.
- If new injection pump is being installed, check and adjust injection pump timing. See *Injection Pump Timing*.
- Tighten injection body nuts to **20 N•m (180 lb-in.)**.
- Tighten injection nozzle to **50 N•m (37 lb-ft)**.
- Tighten leak-off hose nuts to **40 N•m (30 lb-ft)**.

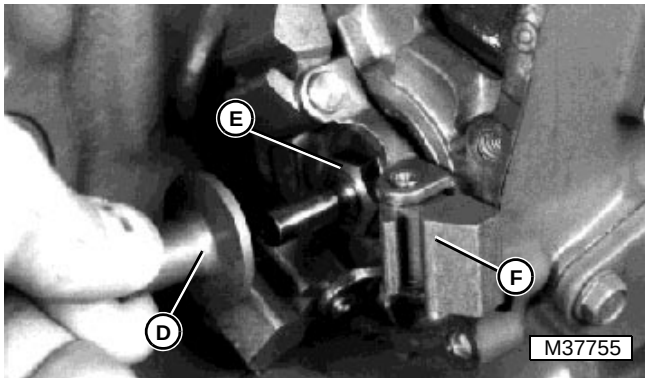
FUEL INJECTION PUMP CAMSHAFT

Removal:

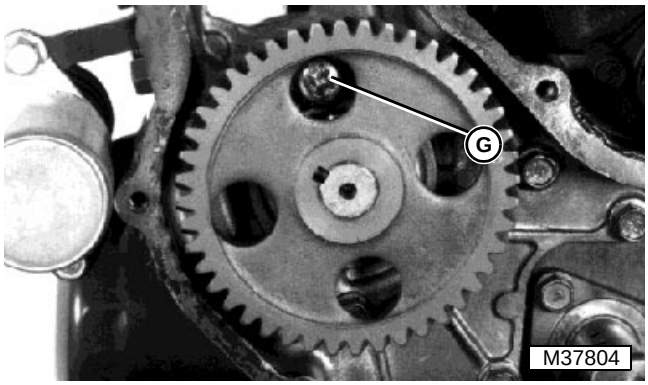
1. Remove timing gear cover. See “TIMING GEAR COVER” on page 46.
2. Remove fuel injection pump. See “FUEL INJECTION PUMP” on page 73.
3. Remove fuel pump.



4. Remove throttle return spring and oil dipstick tube (A).
5. Disconnect and remove fuel shutoff solenoid (B).
6. Remove five cap screws attaching governor assembly (C) to timing gear housing.
7. Remove governor assembly.



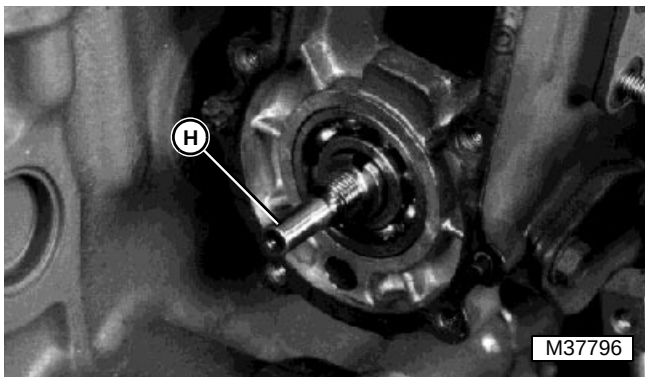
8. Remove sleeve (D), nut (E) and governor weights (F) from end of injection pump camshaft.



9. Remove bearing retaining screw (G).

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 (H) with plastic hammer to remove from housing.

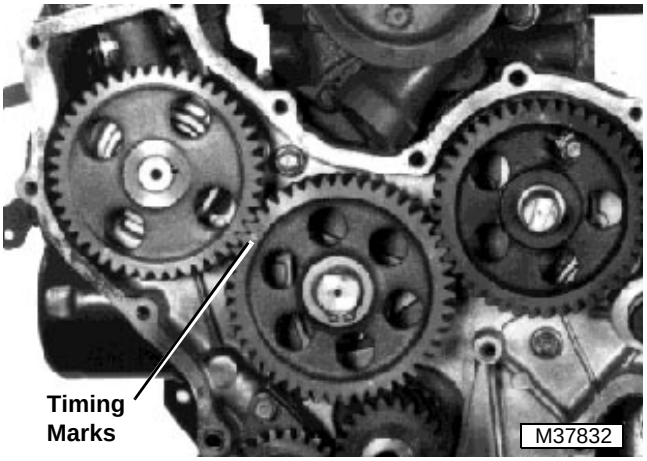


11. Disassemble and inspect all parts for wear or damage. (See Fuel Injection Pump Camshaft Inspection.)

Installation:

Installation is done in reverse order of removal.

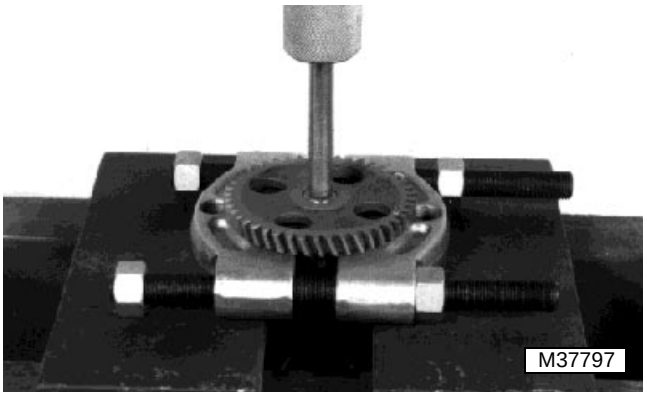
- After installing camshaft assembly into housing, tap on end of camshaft gear with a plastic hammer to seat bearings in bores.
- Tighten bearing retainer screw (G) to **20 N•m (180 lb-in.)**.
- Align timing marks on injection pump gear and idler gear when installing camshaft.



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.)

Assembly:

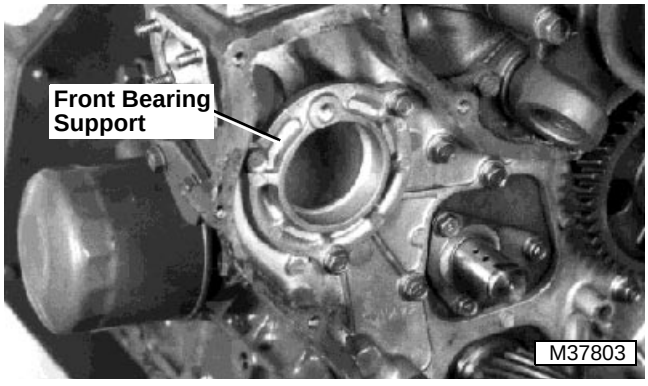
NOTE: Install large bearing on gear end.

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

1. Install bearings on ends of camshaft using a 3/4 inch 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.

Inspection:

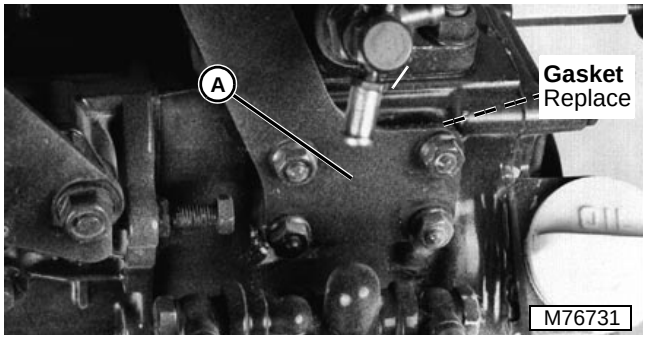
1. Measure height of each camshaft lobe. Replace camshaft if lobe height is less than **30.90 mm (1.217 in.)**.



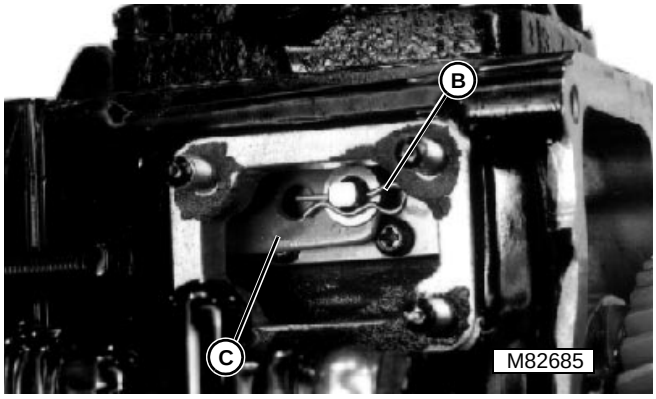
2. Inspect camshaft bearing supports in timing gear housing. Check for cracks, damage or indications that bearings have spun in support.
   - If rear bearing bore is damaged, replace timing gear housing.
   - If front bearing bore is damaged, remove three cap screws and replace support.
3. Inspect all parts for wear or damage. Replace as necessary.

FUEL CONTROL AND GOVERNOR LINKAGE

Removal:



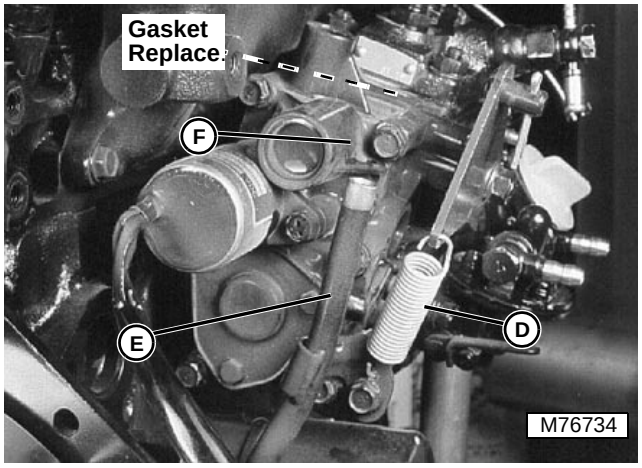
1. Disconnect and remove fuel shutoff solenoid.
2. Remove four nuts, governor linkage cover (A) and gasket. Discard old gasket.



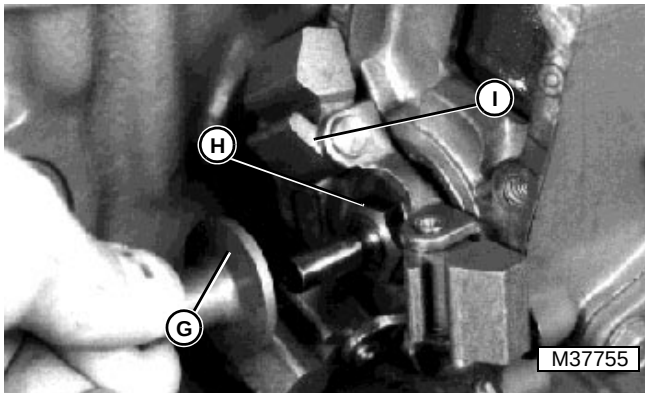
3. Remove muffler.
4. Remove valve cover breather hose.

NOTE: Washer may be fixed to linkage. Do not drop pin during removal.

5. Remove pin (B) and washer to disconnect governor linkage (C).



6. Remove throttle return spring (D) and dipstick tube (E).
7. Remove five cap screws attaching fuel linkage housing (F).
8. Remove linkage housing and gasket.



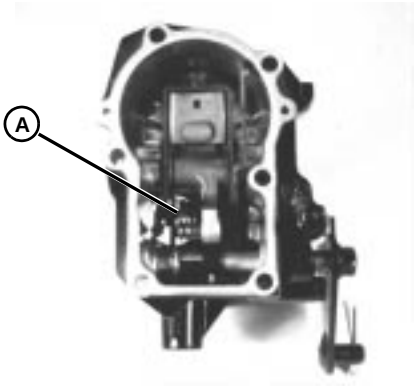
9. Remove sleeve (G).
10. Remove nut (H) and governor weights (I).
11. Disassemble and inspect all parts for wear or damage. See *Fuel Control and Governor Linkage Inspection*.

Installation:

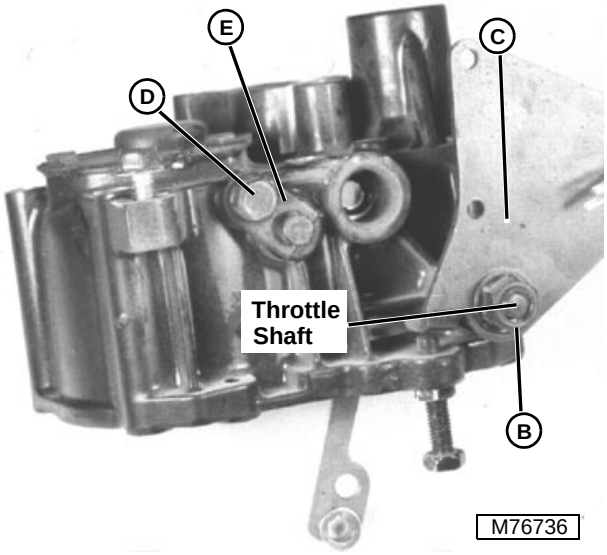
Installation is done in the reverse order of removal.

- Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.
- Check and adjust slow idle settings. See “SLOW IDLE ADJUSTMENT” on page 22.

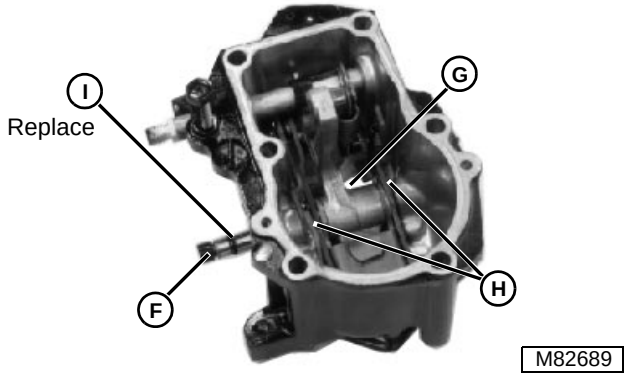
Disassembly:



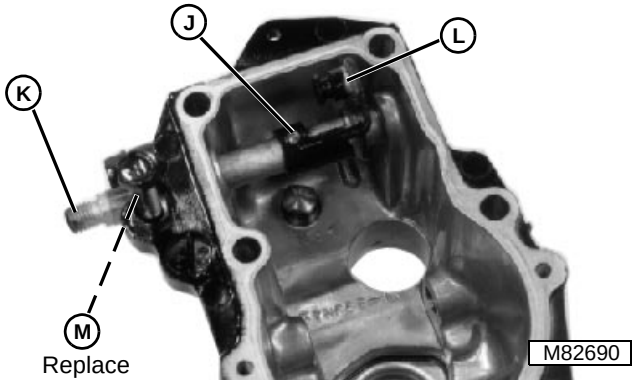
1. Remove spring (A).



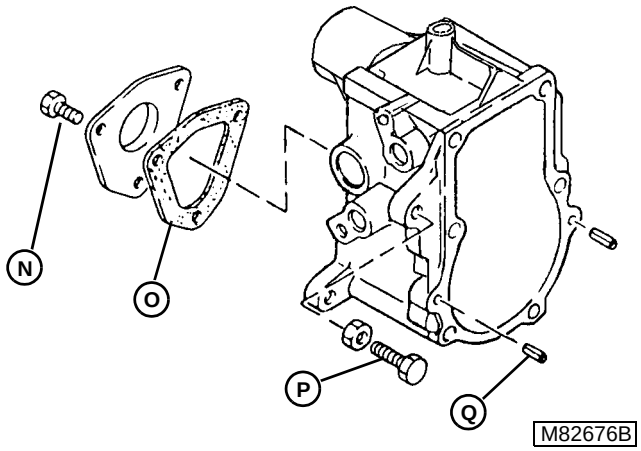
2. Remove nut (B) and throttle lever plate (C).
3. Remove cap screw and throttle shaft retaining plate.
4. Remove cap screw (D) and governor shaft retaining plate (E).



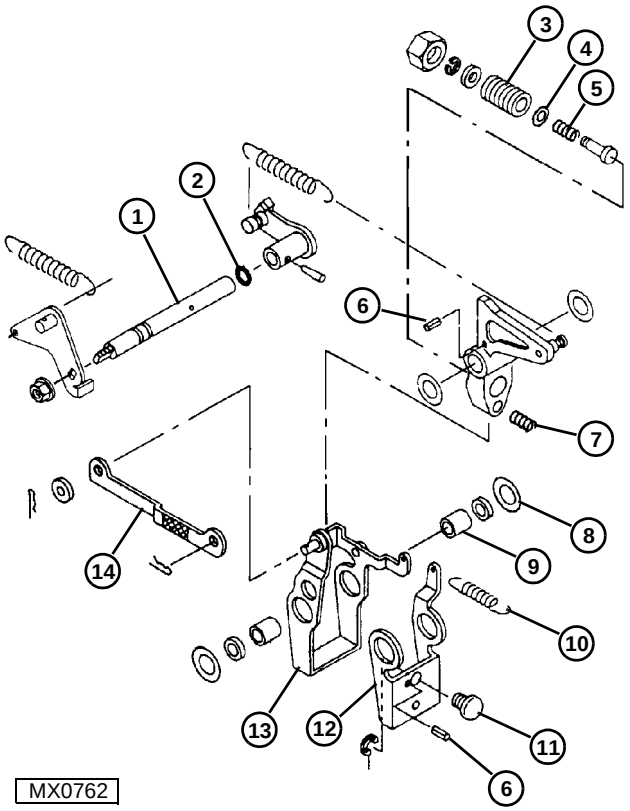
5. Remove governor shaft (F), governor linkage assembly (G), shims (H) and O-ring (I).



6. Rotate throttle shaft assembly as shown.
7. Remove tapered pin (J) from tapered hole using a punch.
8. Remove throttle shaft (K), shaft lever (L) and O-ring (M).



N. Cap Screw (3 used)
O. Gasket (replace)
P. Slow Idle Stop
Q. Spring Pin (2 used)



MX0762

1. Throttle Shaft	8. Shim
2. O-ring	9. Bushing
3. Adjuster Stud	10. Spring
4. Shim(s) (as required)	11. Pin
5. Spring	12. Governor Lever
6. Spring Pin	13. Bracket
7. Spring	14. Governor Link

15. Disassemble governor linkage assembly.
16. Inspect all parts for wear or damage. Replace as necessary.

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.
- Slow idle adjustments are made after engine has been installed in the machine. (Refer to Slow Idle Adjustment.)

Inspection:

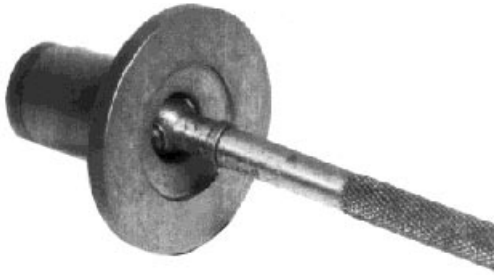

M37763

1. Measure governor shaft diameter. If OD is less than specification, replace governor shaft.
2. Measure governor shaft bore diameter in governor linkage.

Governor Shaft Specifications:

Shaft OD (Wear Limit) . . . . . 8.01 mm (0.315 in.)
Bore ID (Wear Limit). . . . . 8.50 mm (0.335 in.)
Clearance . . . . . 0.09 mm (0.004 in.)

- If shaft bore exceeds wear limit, replace governor linkage.
- If bore clearance (bore ID minus shaft OD) exceeds specification, replace governor shaft, governor linkage or both.


M37756

3. Measure inside diameter of sleeve. If ID is more than specification, replace sleeve.

Specification:

Sleeve ID (Maximum) . . . . . 9.00 mm (0.354 in.)

4. Measure injection pump camshaft diameter.

Injection Pump Camshaft OD:

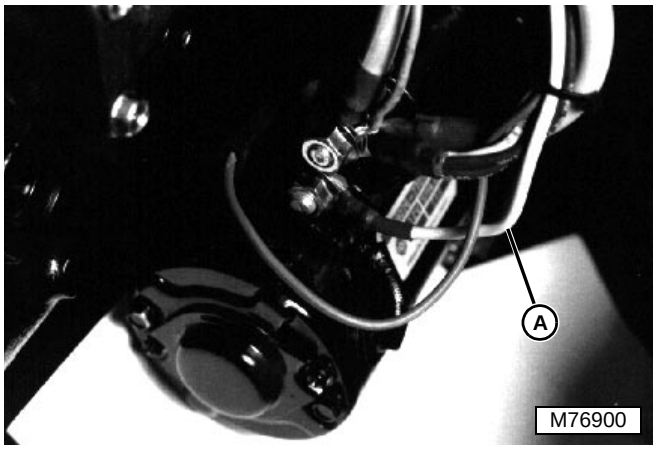
Wear Limit. . . . . 7.90 mm (0.311 in.)
Clearance . . . . . 0.15 mm (0.006 in.)

- If camshaft diameter is less than wear limit, replace injection pump camshaft.
- If clearance (sleeve ID minus camshaft OD) exceeds specification, replace sleeve, injection pump camshaft or both.

STARTING MOTOR

Removal:

1. Park vehicle on level surface, engine OFF, park brake ON, cargo box UP.
2. Disconnect negative battery cable.



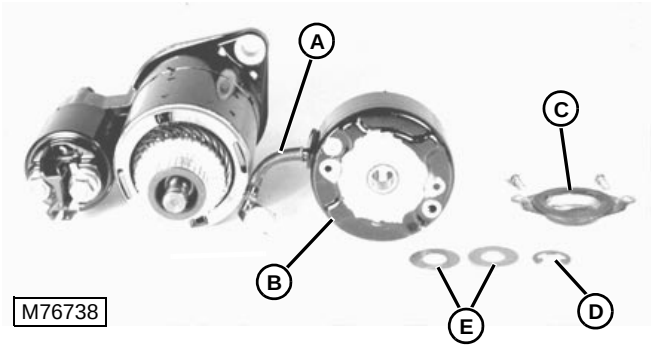
3. Mark and remove all wires to starting motor. Note that white wire (A) is connected to lower starting motor stud.
4. Remove two mounting nuts holding starting motor to frame, and pull starting motor off of studs and out of engine compartment.

Installation:

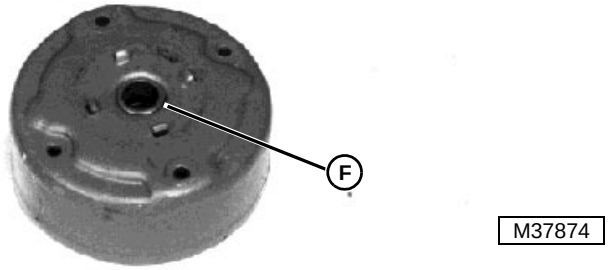
1. Install starting motor on studs as removed and tighten mounting bolts to **28 N•m (20 lb-ft)**.
2. Install all wires as removed, note that white wire is connected to lower starting motor stud.
3. Reconnect negative battery lead to battery.

STARTING MOTOR REPAIR

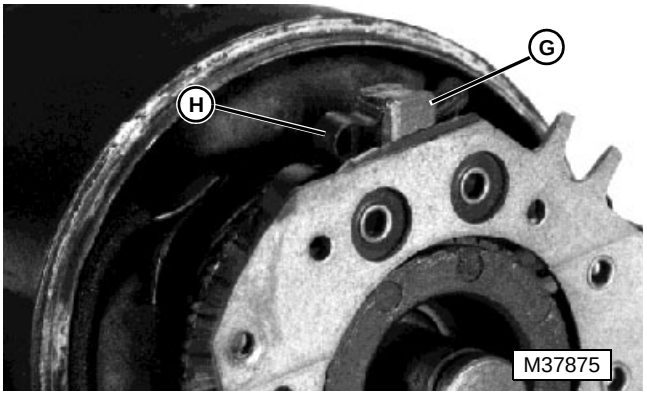
Disassembly and Inspection:



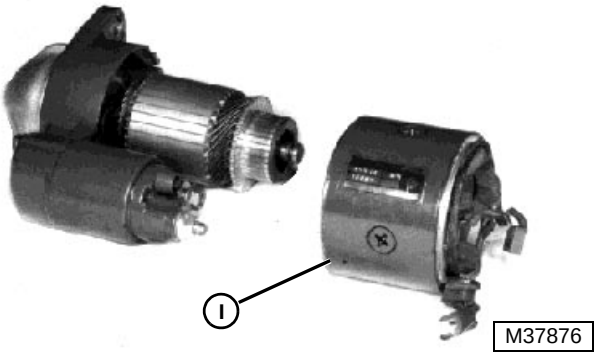
1. Disconnect field lead (A).
2. Remove two cap screws and two screws from rear cover (B).
3. Pry off cap (C).
4. Remove E-clip (D), shims (E) and rear cover .
5. Inspect rear cover bushing for wear or damage.
   - To replace rear cover bushing:
     Remove bushing using a blind-hole puller set.
     Install new bushing until it bottoms in cover bore using a driver set.



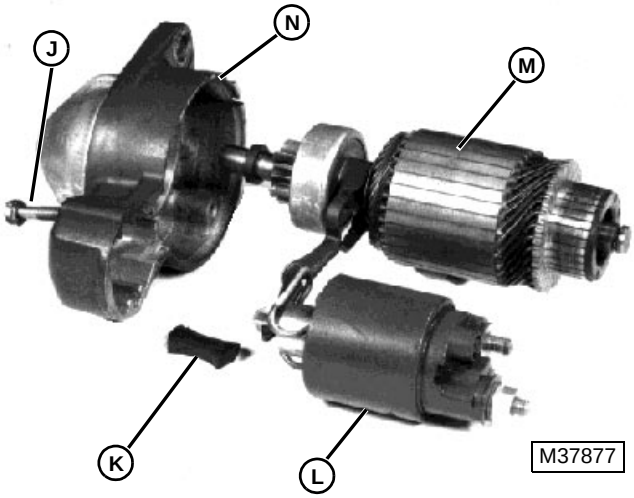
6. Ream bushing (F) to **12.50 - 12.53 mm (0.492 - 0.493 in.)**



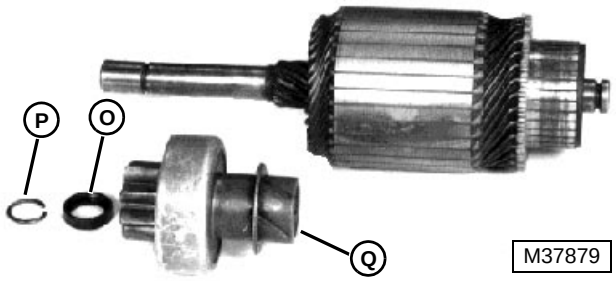
7. Remove field coil brushes (G) from brush holder.
8. Pry brush springs (H) away and pull negative brushes up enough to allow spring to hold brush in place.
9. Remove brush holder.



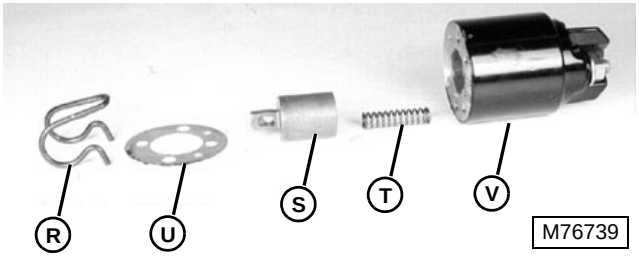
10. Remove field coil housing (I) from armature/ solenoid assembly.



11. Remove two cap screws (J).
12. Remove dust cover (K).
13. Remove solenoid (L) and armature assembly (M) from end frame (N).
14. Inspect end frame bushing for wear or damage. Replace if necessary.



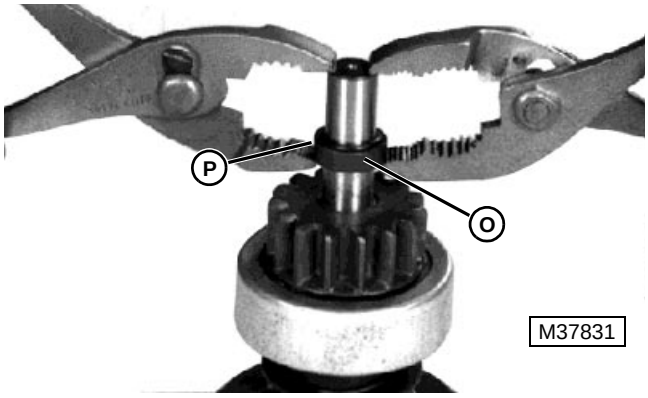
15. Slide pinion stopper (O) away from retaining wire (P) using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly (Q) from armature shaft.
16. Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.



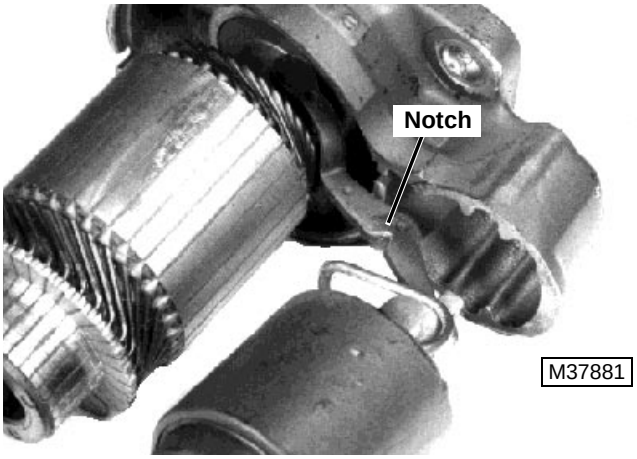
17. Remove clutch fork pivot (R), plunger (S), spring (T) and shim(s) (U) from solenoid (V).
18. Inspect all parts for wear or damage. Replace as necessary.
19. Inspect and test brushes, holder, field coil and armature. See *Starting Motor Component Testing* procedures.

Assembly:

Assembly is done in the reverse order of disassembly.



• After installing clutch assembly, pinion stopper (O) and retaining wire (P) on armature shaft, use two pliers to press pinion stopper over retaining wire.



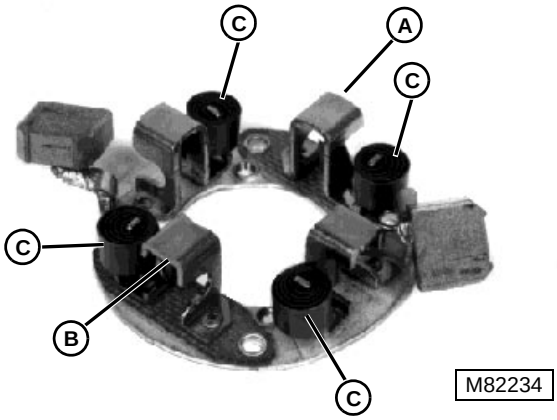
• When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.

IMPORTANT: When installing rear cover, be sure field coil brush wires do not touch cover. Turn brush holder slightly to take up slack in brush wires. Press wires inward to clear rear cover.

Starting Motor Component Testing:

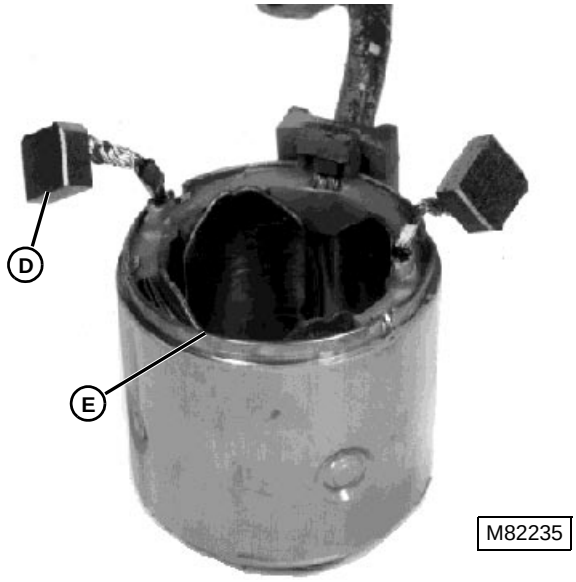
1. Measure holder and field coil brush lengths. Minimum brush length is **7.70 mm (0.303 in.)**. Replace brush holder or field coil if brush length is below minimum.

NOTE: Test brush holder using an ohmmeter or test light.



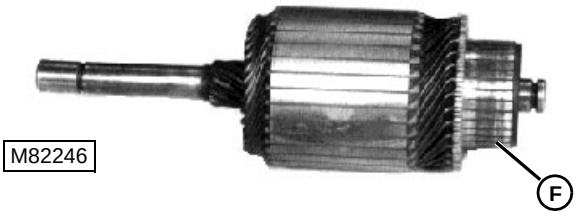
2. Test brush holder:
   Touch one probe of tester to negative brush holder (A) and other probe to field brush holder (B). If there is continuity, replace the brush holder.
3. Inspect springs (C) for wear or damage. Replace if necessary.

NOTE: Test field coil using an ohmmeter or test light.



4. Test for grounded field winding:
   Touch one probe of tester to field coil brush (D) and other probe to field coil housing (E). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.
5. Test for open field coil:
   Touch one probe of tester to each field coil brush. If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

IMPORTANT: Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.



6. Inspect armature. Look for signs of dragging against pole shoes.
7. Inspect commutator (F). 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.

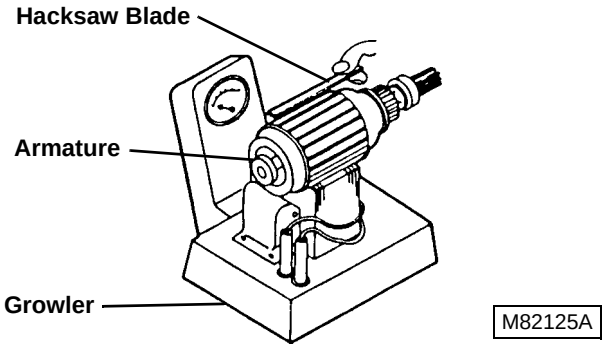
NOTE: Test armature windings using an ohmmeter or test light.

8. 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.

9. 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.



10. 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.

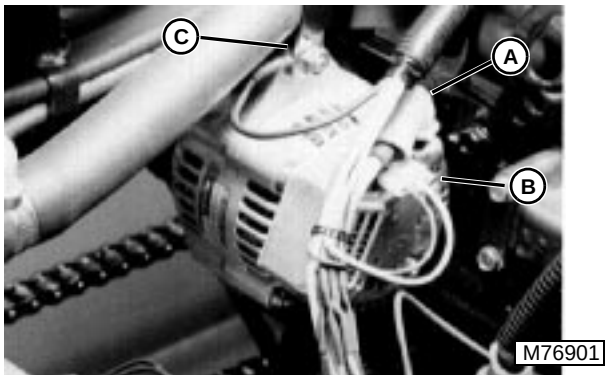
NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

11. 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.

ALTERNATOR

Removal:

1. Park vehicle on level surface, park brake ON, engine OFF, cargo box RAISED.
2. Disconnect negative (–) battery cable from battery.
3. Remove alternator/water pump belt cover from front of engine by removing three nuts and washers from front of cover.



4. Lift red plastic protective cover from positive (red) lead (A) from battery. Remove nut and washer and remove lead from alternator stud.
5. Remove indicator lamp connector (B) and ground wire (C) from alternator and move wiring harness to the side
6. Loosen alternator mounting bolts and remove belt from drive pulley.
7. Remove mounting bolts. Pull alternator from frame.

Installation:

Installation in reverse of removal.

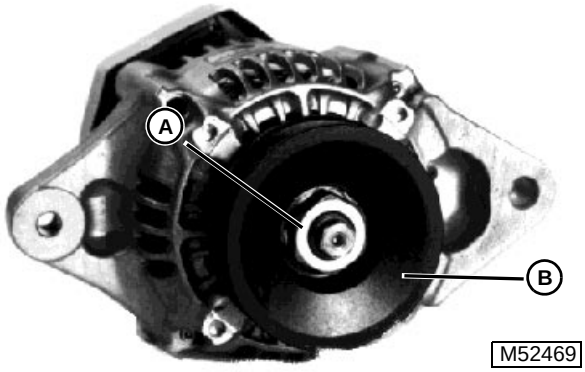
- Tension drive belt. See “WATER PUMP/ ALTERNATOR DRIVE BELT ADJUSTMENT” on page 28.

Repair:

Equipment:

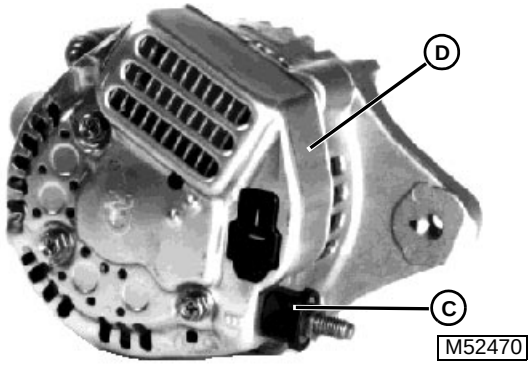
- Volt-Ohm-Amp Meter
- 13 Ton Bearing Puller Set

Disassembly:

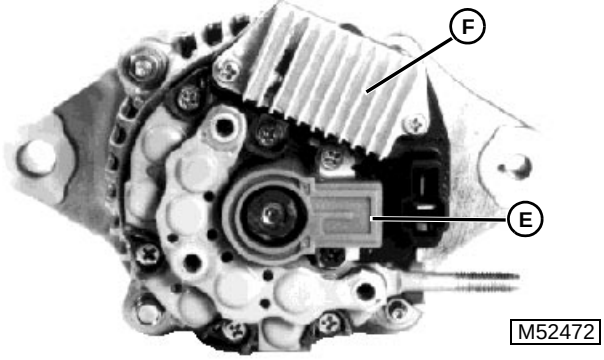


1. Clamp sheave in a soft jaw vise and remove sheave

nut (A).
2. Use puller to remove sheave (B).



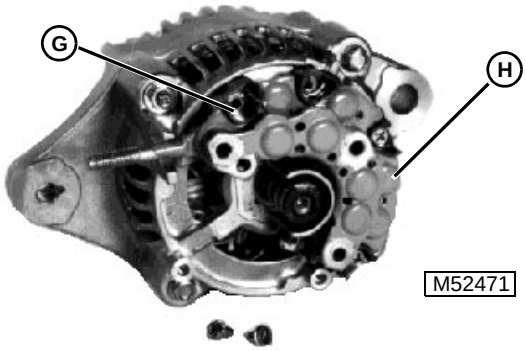
3. Remove insulator (C).
4. Remove cover (D).



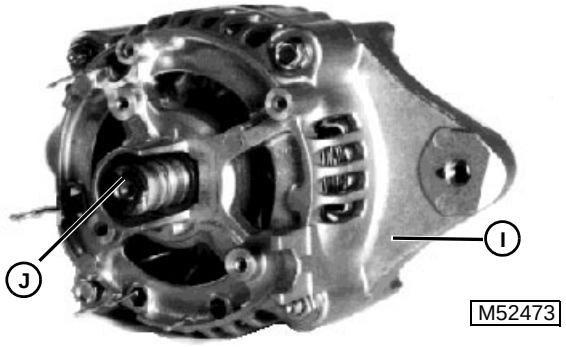
5. Remove brush holder and cover (E).

NOTE: Remember location of short screw on regulator tab.

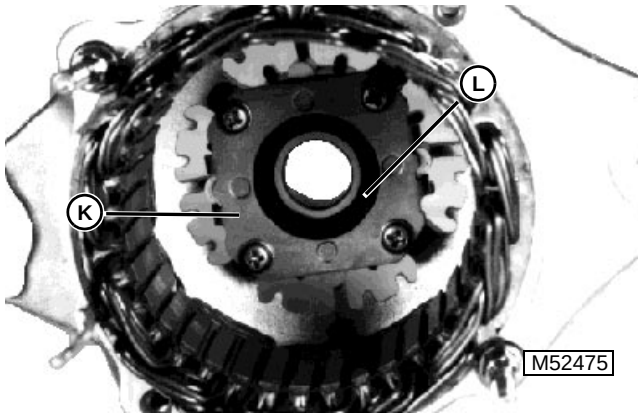
6. Remove regulator (F).



7. Remove screw and straighten wire leads (G).
8. Remove rectifier (H).

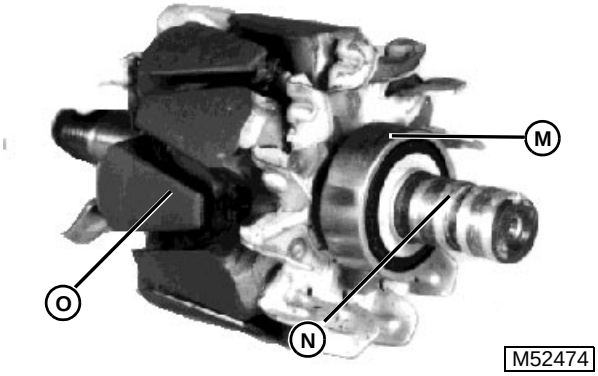


9. Remove rear case assembly (I).
10. Press rotor shaft (J) from rear case.



11. Remove retainer plate (K).
12. Press bearing (L) from case.

Inspection:



1. Inspect bearing (M) for smooth rotation. Replace if necessary.
2. Inspect slip rings (N) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish rings.
3. Measure outer diameter of slip rings (N). Replace

rotor if less than specification.

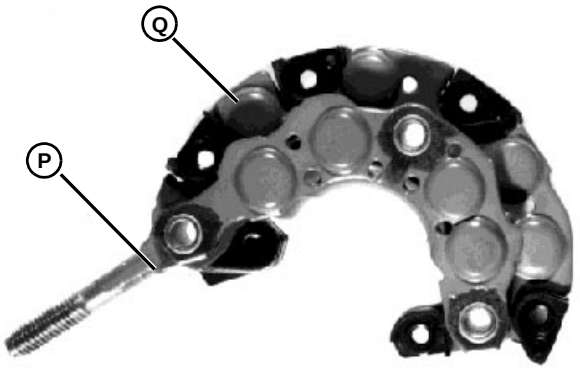
Specification:

Slip Ring Diameter (Minimum) . . 14.0 mm (0.55 in.)

4. Check continuity between slip rings (N) using ohmmeter or continuity tester. Replace rotor assembly if there is no continuity.
5. Check continuity between slip rings and rotor core (O). Replace rotor assembly if there is continuity.

NOTE: Use an ohmmeter that is sensitive to 0 - 1 ohm.

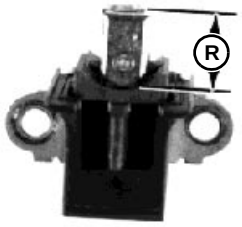
6. Inspect stator for defective insulation, discoloration, or burned odor.
7. Check for continuity between each stator lead and body. Replace stator if there is continuity.



M52477

NOTE: Set ohmmeter to the K ohm range.

8. Check continuity between lead (P) and each diode lead (Q). Reverse ohmmeter leads and recheck. There should be continuity in one direction, but not the other. Replace diodes or rectifier plate if bad.



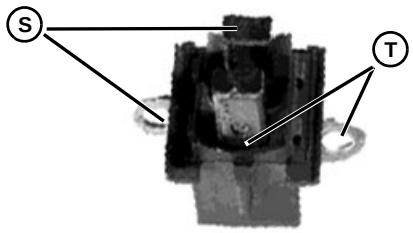
M52478

9. Measure length of brush protruding from holder. Dimension (R) should be within specification. Replace brushes if worn below minimum.

Brush Length Specifications:

Exposed Brush Length:

Minimum . . . . . 4.5 mm (0.17 in.)
Maximum. . . . . 10.5 mm (0.41 in.)



M52479

10. Check continuity between brush and terminal (S). Check continuity between brush and terminal (T). There should be continuity only at these points.

Assembly:

1. Press new bearing (L) into case.
2. Install retainer plate (K).

NOTE: Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.

3. Press rotor shaft (J) into rear case.
4. Install rear case assembly (I).
5. Install rectifier (H).
6. Install screws through loop formed in wire leads (G).

IMPORTANT: Check that short screw is installed in regulator tab. Longer screw will contact frame and will cause damage to the charging system.

7. Install regulator (F).
8. Install brush holder (E).
9. Install regulator cover (D).
10. Install insulator (C) and nut.
11. Install sheave (B).
12. Clamp sheave in soft jaw vise. Install sheave nut (A) and tighten to **69 N•m (51 lb-ft)**.


D

CONTENTS

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

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.

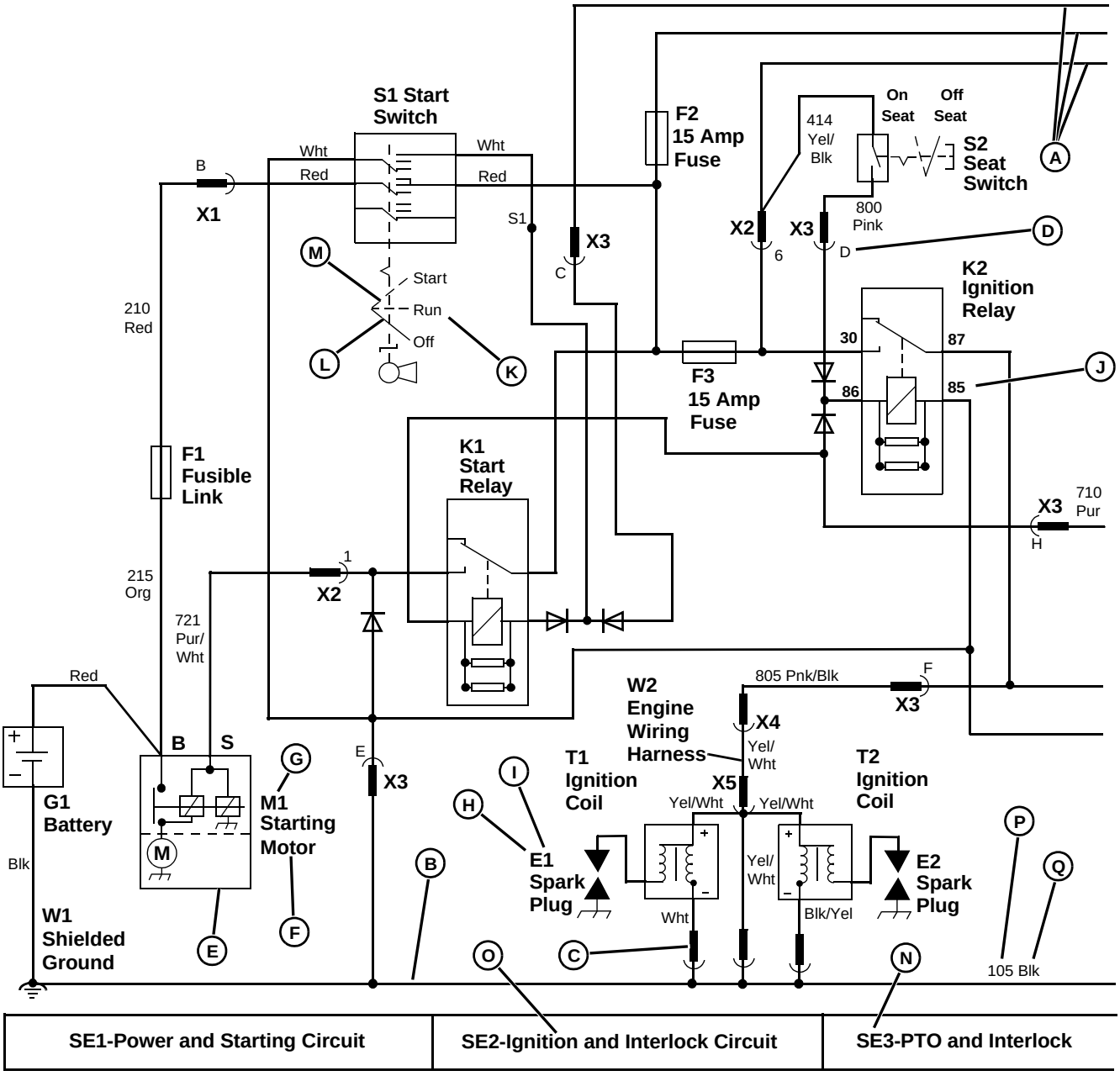
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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.

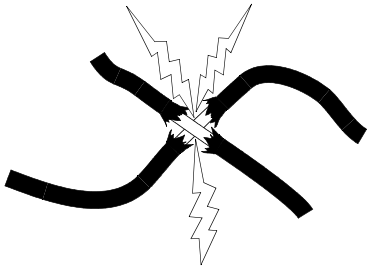


COMMON CIRCUIT TESTS

Shorted Circuit:

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

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



M85600 mif

High Resistance or Open Circuit:

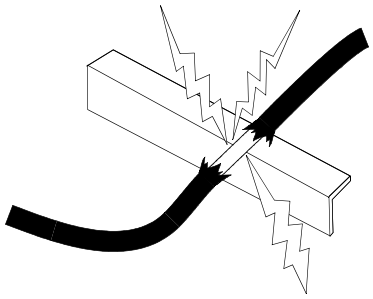
High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

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

M85601 mif

Grounded Circuit:

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



M85602 mif

CONDUCTORS FOR 12 VOLT CIRCUITS

STRANDED CONDUCTORS FOR 12 VOLT CIRCUITS						
SAE WIRE SIZE (GAUGE)	20	18	16	14	12	10
METRIC WIRE SIZE (MM)	0.5	0.8	1.0	2.0	3.0	5.0
TYPICAL STRANDING	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
MINIMUM CONDUCTOR AREA IN CIRCULAR MILS	1072	1537	2336	3702	5833	9343

SPECIFICATIONS

Battery:

Voltage 12
BCI group U-1
CCA rating (Amps at 0^{o}) 340
Reserve capacity (minutes). 38
Specific gravity . . . . . .1.225 or above
Electrolyte required fill (Approx.) . . . . . 1.9 L (2.0 qt)
Load test (minimum.) . . . . . 340 amp for 15 seconds

Starting Motor:

Type. . . . . Solenoid Shift
Amp draw (on vehicle). . . . . 60 amps (max.)
No-load amp draw (free running) . . . . . .50 amps (max.) at 6000 rpm

Alternator:

Rating . . . . . .40 amps
Regulated amperage:
1000 RPM (engine cold) . . . . . .23 amps
1000 RPM (engine hot) . . . . . .16 amps
3300 RPM (engine cold) . . . . . .51 amps
3300 RPM (engine hot) . . . . . .42 amps
Unregulated amperage . . . . . 40 amps (min.)
Regulated voltage . . . . . .12.2 - 14.8 VDC

Fuel Shutoff Solenoid:

Pull-in voltage . . . . . .6.8 VDC
Hold voltage . . . . . 3.0 VDC

Glow Plug:

Resistance . . . . . 0.3 - 0.5 ohms

Engine Coolant Temperature Switch (Control Panel Light):

. . . . . From off to on at 109° ± 1° C (228° ± 2°F)
. . . . . .ON: Continuity

Radiator Core Temperature Switch (Fan Control):

Closes (Continuity) . . . . . .67 - 75° C (153 - 167° F)
Opens (Infinity) . . . . . .57 - 63° C (135 - 145° F)

Lighting:

Headlights (halogen). . . . . .37.5 Watts

Neutral Start Switch:

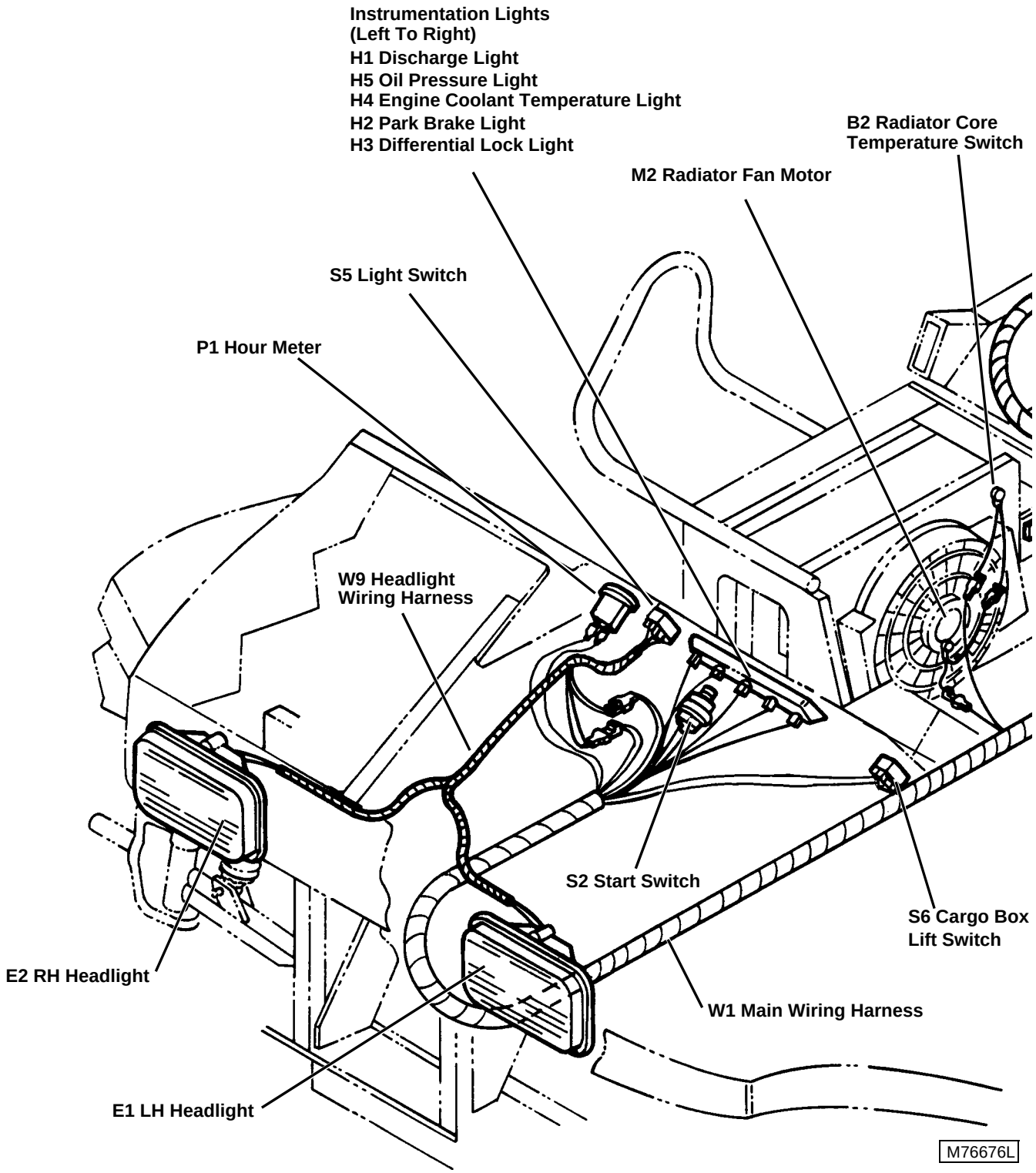
Neutral (depressed) . . . . . Continuity
In gear (released) . . . . . .No Continuity

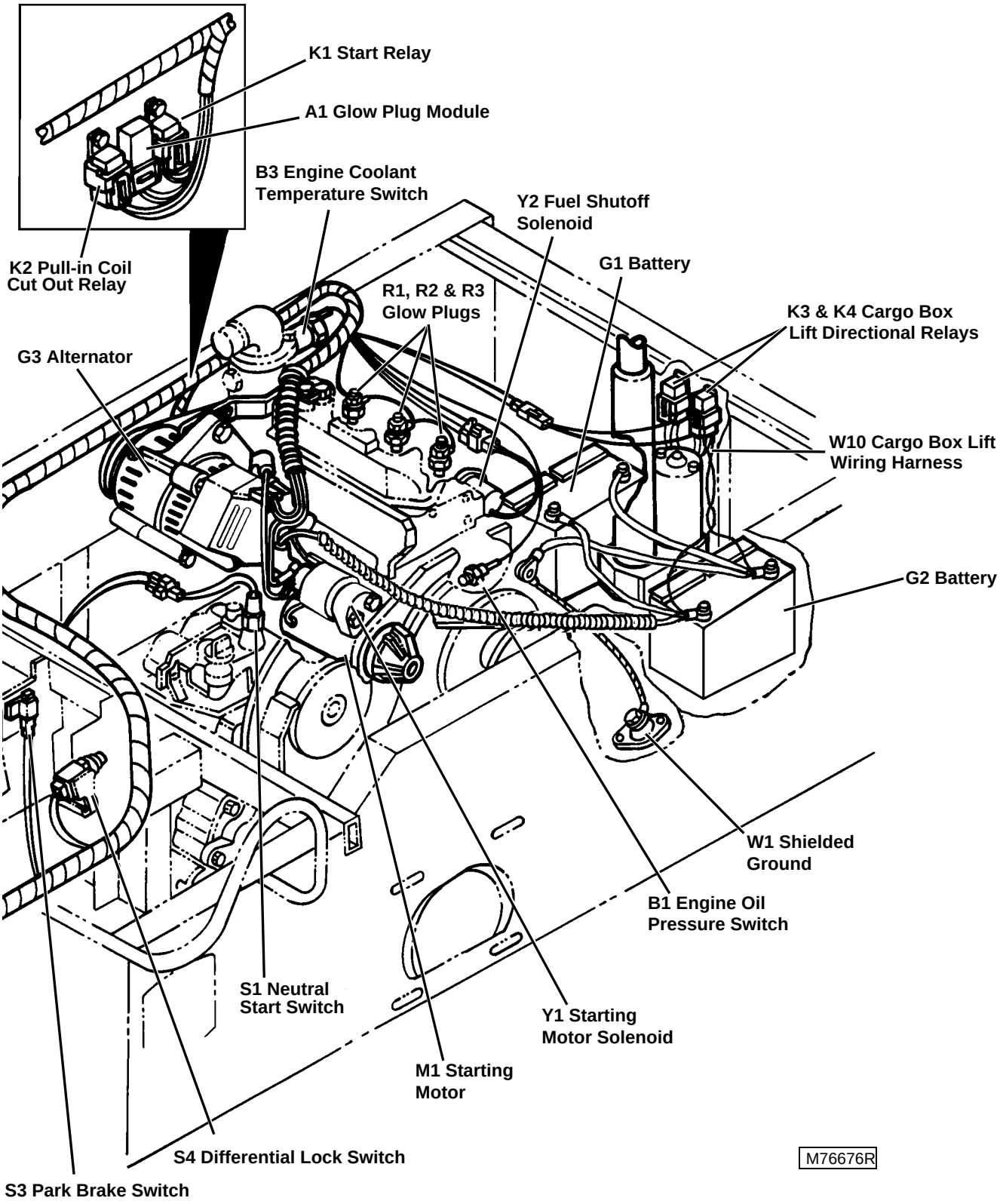
CARGO BOX LIFT SPECIFICATIONS

Electrical Input	12 VDC
Lift Capacity	400 Kg (880 lbs) min.
Lift Rate	0.5 in/sec
Stroke Length	130 mm (5.12 in.)
Current Draw	28 amps @ 12 VDC - Full Load
Duty Cycle	25% on time at rated load per cycle
Motor Protection	Automatic reset thermal overload in windings
Overload Protection	Ball Detent Overload Clutch
Temperature Range	-40° to 66° C (-40° F to 150° F)
Drive	Ball Bearing Screw
Connector	Packard Series 56
Lead Wires	14 gauge
Mounting	Clevis mounting only
Restraining Torque	17 N•m (150 lb-in.)
End Play	1.14 mm (0.045 in.) max.
Static Load	1818 Kg (4000 lbs)

Duty cycle means that for an actuator operating continuously for 10 seconds, it must cool for 30 seconds.

COMPONENT LOCATION




K1 Start Relay
A1 Glow Plug Module
B3 Engine Coolant Temperature Switch
Y2 Fuel Shutoff Solenoid
G1 Battery
K2 Pull-in Coil Cut Out Relay
R1, R2 & R3 Glow Plugs
K3 & K4 Cargo Box Lift Directional Relays
G3 Alternator
W10 Cargo Box Lift Wiring Harness
G2 Battery
W1 Shielded Ground
B1 Engine Oil Pressure Switch
S1 Neutral Start Switch
Y1 Starting Motor Solenoid
M1 Starting Motor
S4 Differential Lock Switch
S3 Park Brake Switch
M76676R

TROUBLESHOOTING

Problem or Symptom / Check or Solution	Starter cranking problems	Engine cranks but will not start	Engine will not shut off	Improper component operating with switch	Engine oil light problem	Battery goes dead, discharges or overcharges	Discharge light problem	Engine coolant temperature light problem	Cooling fan problems	Instrument lights problems	Headlight problem
See power circuit diagnosis	●										
See cranking circuit diagnosis	●										
Check ground circuit	●	●									
Test battery and battery connections	●										
See glow plug/fuel supply diagnosis		●	●								
See charging circuit diagnosis						●	●				
See instrumentation circuits					●			●	●	●	
See lighting and horn circuit diagnosis											
Check for shorted circuit			●	●							
See headlight circuit											●

TROUBLESHOOTING – CARGO BOX LIFT SYSTEM

Problem or Symptom / Check or Solution	Lift does not operate	Lift will not extend or raise cargo box	Lift will not retract to lower cargo box	Lift stops in mid-stroke	Lift will not hold position	Lift is slow	Fast thumping noise	Switch operates in wrong direction
Lift not receiving power; check connection and fusible links at starter. See Lift circuit diagnosis.	●	●	●					
Thermal overload cut-out; let cool.		●		●				
Stripped nut or gears; check for excessive shock loads.		●						
Excessive loaded; reduce load.	●	●				●	●	
Clutch Worn; replace clutch.		●					●	
Brake worn seized or broken; replace brake.		●	●	●	●			
Fusible link burnt; replace.	●							
Low voltage.				●		●		
Faulty Switch. See switch test.	●							
Actuator binding; check distribution of load, cargo box and lift pivot points for binding and wear.		●	●	●				
Cylinder at end of stroke or clutch slipping.							●	
Wire location switched at lift control switch outlet terminals or in lift motor connector.								●

ELECTRICAL SCHEMATIC AND WIRING HARNESS LEGEND

A1—Glow Plug Module (SE4, W1)

B1—Engine Oil Pressure Switch (SE5, W1)

B2—Radiator Core Temperature Switch (SE5, W1)

B3—Engine Coolant Temperature Switch (SE6, W1)

E1—LH Headlight (SE7, W9)

E2—RH Headlight (SE7, W9)

E3—LH Rear Marker Light (SE8, W11) (opt.)

E4—LH Front Marker Light (SE8, W11) (opt.)

E5—RH Rear Marker Light (SE8, W11) (opt.)

E6—RH Front Marker Light (SE8, W11) (opt.)

F1—Fusible Link (SE1, W1)

F2—Fusible Link (SE1, W1)

F3—Fusible Link (SE1, W1)

F4—Fusible Link (SE1, W1)

F5—Fusible Link (SE1, W1)

G1—Battery (SE1, W1)

G2—Battery (SE1, W1)

G3—Alternator (SE2, W1)

H1—Discharge Light (SE5, W1)

H2—Park Brake Light (SE6, W1)

H3—Differential Lock Light (SE6, W1)

H4—Engine Coolant Temperature Light (SE6, W1)

H5—Engine Oil Pressure Light (SE6, W1)

K1—Start Relay (SE2, W1)

K2—Pull-in Coil Cut Out Relay (SE4, W1)

K3—Cargo Box Raise Relay (SE8, W10)

K4—Cargo Box Lower Relay (SE8, W10)

M1—Starting Motor (SE1, W1)

M2—Radiator Fan Motor (SE5, W1)

M3—Cargo Box Lift Motor (SE7, W10)

P1—Hour Meter (SE6, W1)

R1—Glow Plug (SE3, W7)

R2—Glow Plug (SE3, W7)

R3—Glow Plug (SE3, W7)

S1—Neutral Start Switch (SE2, W1)

S2—Start Switch (SE3, W1)

S3—Park Brake Switch (SE6, W1)

S4—Differential Lock Switch (SE6, W1)

S5—Light Switch (SE6, W1)

S6—Cargo Box Lift Switch (SE7, W1)

S7—Blackout Light Switch (SE7, W1) (opt.)

V1—Diode (SE4, W1)

W1—Shielded Ground (SE1, W1)

Y1—Starting Motor Solenoid (SE1, W1)

Y2—Fuel Shutoff Solenoid (SE4, W1)

CONNECTORS:

X1—W1 Main Wiring Harness to W8 Engine Wiring Harness (SE4, W1)

X2—W1 Main Wiring Harness to B2 Radiator Core Temperature Switch (SE5, W1)

X3—M2 Radiator Fan Motor to W1 Main Wiring Harness (SE5, W1)

X4—M2 Radiator Fan Motor to B2 Radiator Core Temperature Switch (SE5, W1)

X5—W1 Main Wiring Harness to W9 Headlight Wiring Harness (SE6, W1)

X5A—W9 Headlight Wiring Harness to W11 Blackout Light Kit Wiring Harness (SE6, W1) (opt.)

X6—W1 Main Wiring Harness to W9 Headlight Wiring Harness (SE6, W1)

X6A—W9 Headlight Wiring Harness to W11 Blackout Light Kit Wiring Harness (SE6, W1) (opt.)

X7—W10 Cargo Box Lift Wiring Harness to M3 Cargo Box Lift Motor (SE7, W10)

X8—W1 Main Wiring Harness to W10 Cargo Box Lift Wiring Harness (SE8, W1)

WIRING HARNESSES:

W1—Main Wiring Harness

W2—Engine Wiring Harness (Battery Jumper)

W3—Engine Wiring Harness (Battery Jumper)

W4—Engine Wiring Harness (Ground)

W5—Engine Wiring Harness (Ground)

W6—Engine Wiring Harness (Alternator)

W7—Engine Wiring Harness (Glow Plugs)

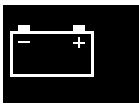
W8—Engine Wiring Harness (Fuel Shut Off)

W9—Headlight Wiring Harness

W10—Cargo Box Lift Wiring Harness

W11—Blackout Light Kit Wiring Harness (opt.)

ELECTRICAL SCHEMATIC



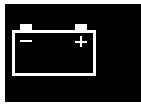
REPLACE WITH FOLD-OUT FILE 4-13_2PG.FM

W1 MAIN WIRING HARNESS

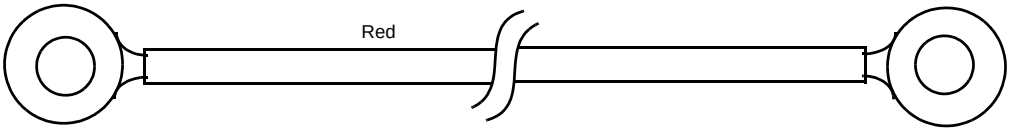
REPLACE WITH FOLD-OUT FILE 4-13_2PG.FM

W1 WIRE COLOR CODES

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	Splice #2, A1
105	1.0	Blk	X6, K1
110	0.5	Blk	H3, X6
120	0.5	Blk	H2, H3
125	0.5	Blk	W1, Splice #2
130	3.0	Blk	G3, Splice #2
135	3.0	Blk	Splice #2, X2
145	1.0	Blk	K1, A1
150	3.0	Blk	Splice #2, X1
170	0.8	Blk	H2, P1
200	2.0	Red	F1, S2
201	0.8	Fuselink, F1	Splice #1, 200 Red
205	5.0	Red	Y1, G3
210	3.0	Red/Blk	F4, X4
211	1.0	Fuselink, F4	Splice #1, 210 Red/Blk
215	2.0	Red	F2, K1
216	0.8	Fuselink, F2	Splice #1, 215 Red
220	3.0	Red	F5, A1
221	1.0	Fuselink, F5	Splice #1, 220 Red
230	2.0	Red	S2, S2
240	5.0	Red	Y1, Splice #1
300	0.8	Org/Wht	H4, B3
301	0.5	Org/Wht	H4, A1
400	2.0	Yel/Red	S2, Splice #3
402	0.8	Yel	X5, H4
403	0.8	Yel	H4, H5
404	0.5	Yel	H5, H1
410	1.0	Yel/Red	X5, Splice #3
415	1.0	Yel/Red	Splice #3, S6
420	0.8	Yel	Splice #3, S4
423	0.8	Yel	S4, S3
425	1.0	Yel	Splice #3, G3
430	0.8	Yel	A1, S3
435	0.8	Yel	A1, X1
439	1.0	Fuselink, F3	Splice #1, 440 Wht
440	3.0	Wht	F3, K2
441	3.0	Wht	X1, K2
450	0.8	Yel	Splice #3, P1
600	0.5	Brn	G3, H1
620	0.5	Tan	H5, V1
621	0.8	Tan	V1, B1
625	0.5	Diode	K2, 620 Tan and 621 Tan
630	0.8	Gry/Blk	S3, H2
640	0.5	Grn	S4, H3
670	1.0	Yel/Wht	X8, S6
675	1.0	Yel/Blk	X8, S6
700	2.0	Pur	K1, Y1
706	0.8	Pur	S1, K1
710	0.8	Pur/Blk	S2, S1
711	0.8	Pur	S1, K2
920	3.0	Red/Wht	A1; R1, R2 & R3



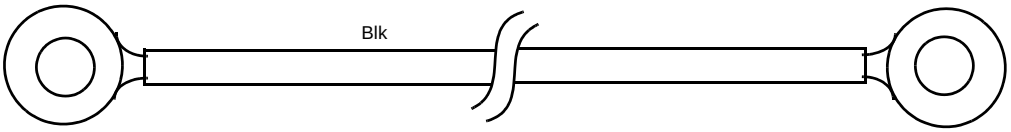
W2 ENGINE WIRING HARNESS



To G1 Battery Pos. (+) Terminal

To G2 Battery Pos. (+) Terminal

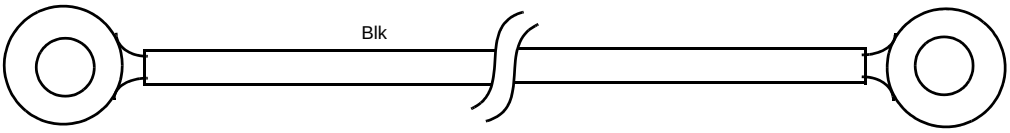
W3 ENGINE WIRING HARNESS



To G1 Battery (-) Terminal

To G2 Battery (-) Terminal

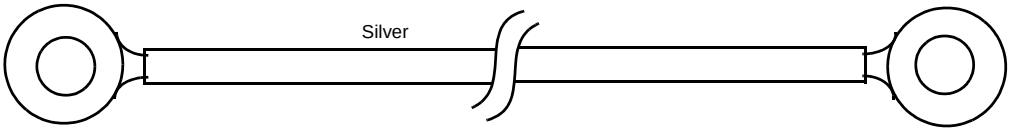
W4 ENGINE WIRING HARNESS



To G2 Battery (-) Terminal

To Engine Block

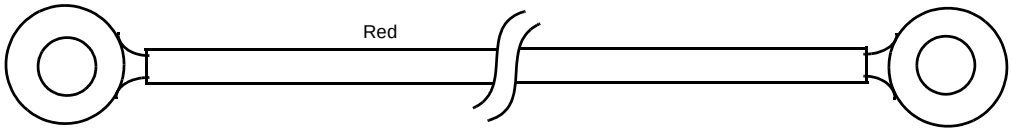
W5 ENGINE WIRING HARNESS



To Engine Block

To Chassis

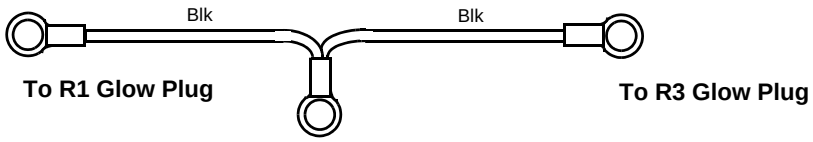
W6 ENGINE WIRING HARNESS



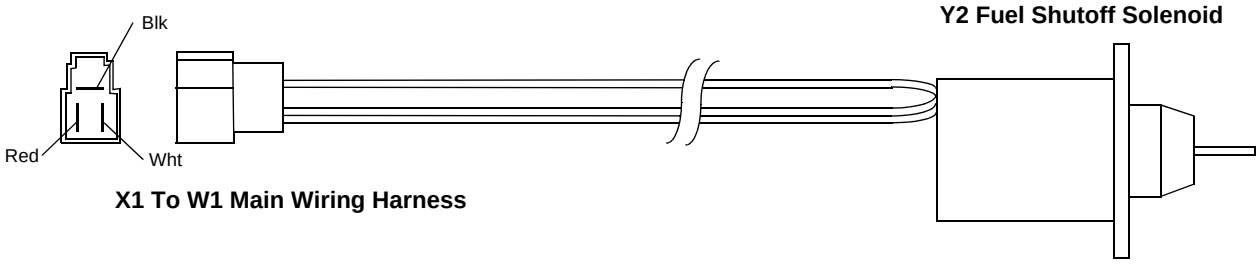
To G2 Battery Pos (+) Terminal

To Y1 Starting Motor Solenoid Terminal

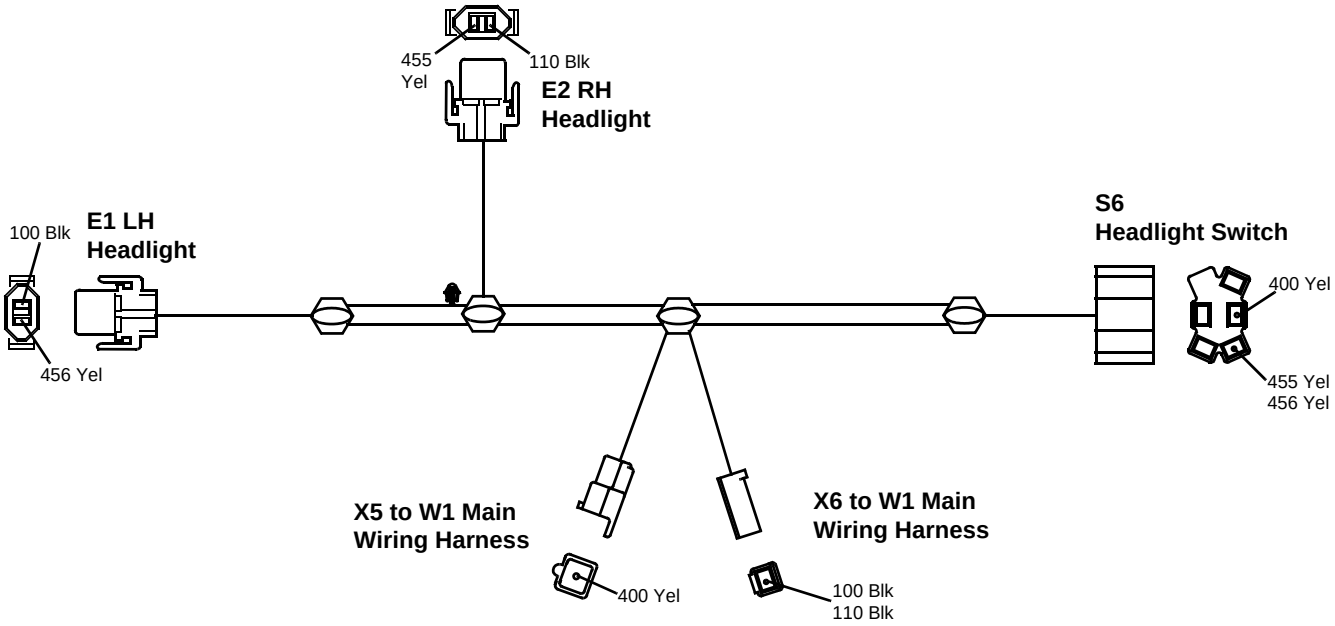
W7 ENGINE WIRING HARNESS



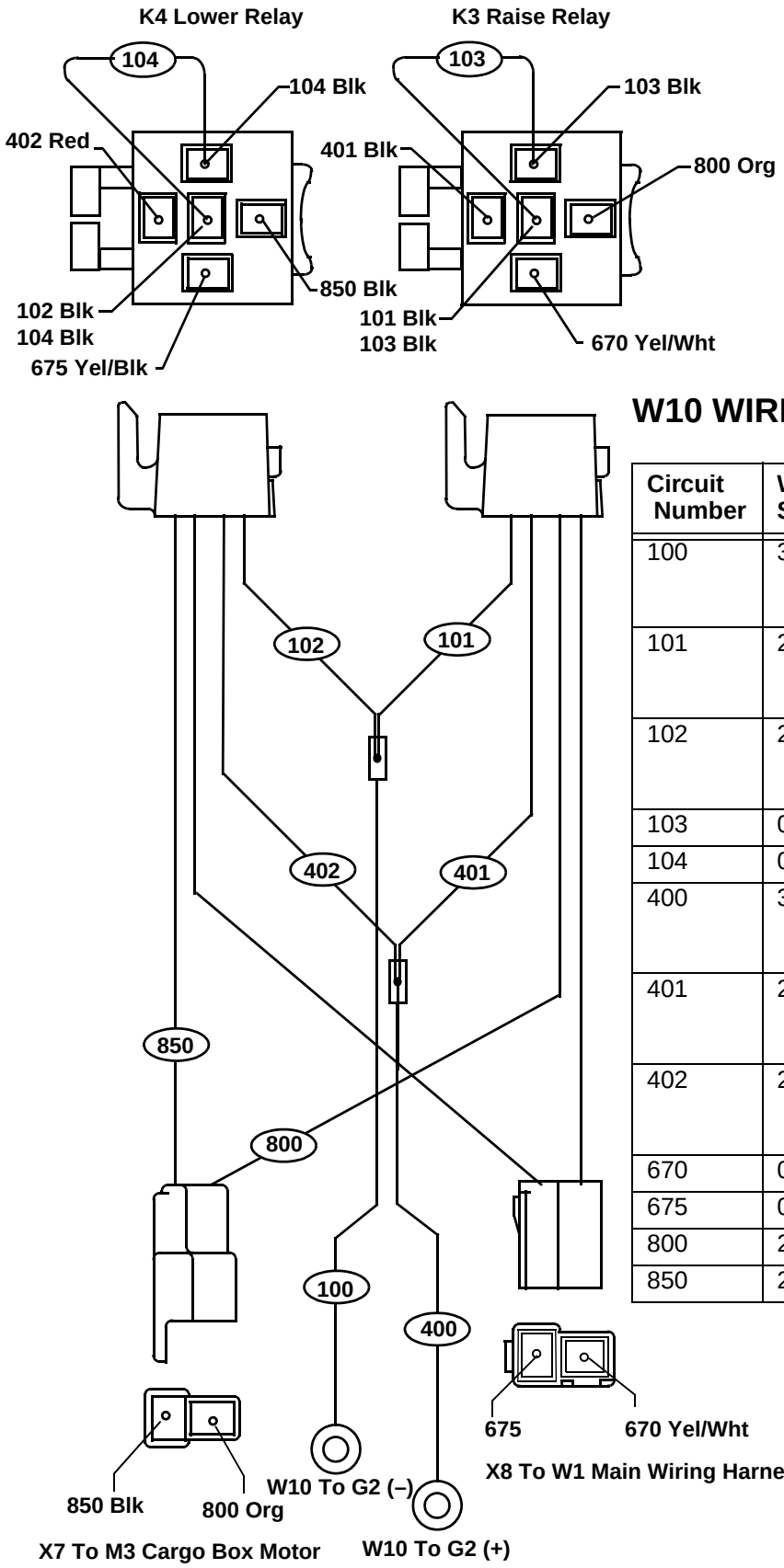
W8 ENGINE WIRING HARNESS



W9 HEADLIGHT WIRING HARNESS



W10 CARGO BOX LIFT WIRING HARNESS

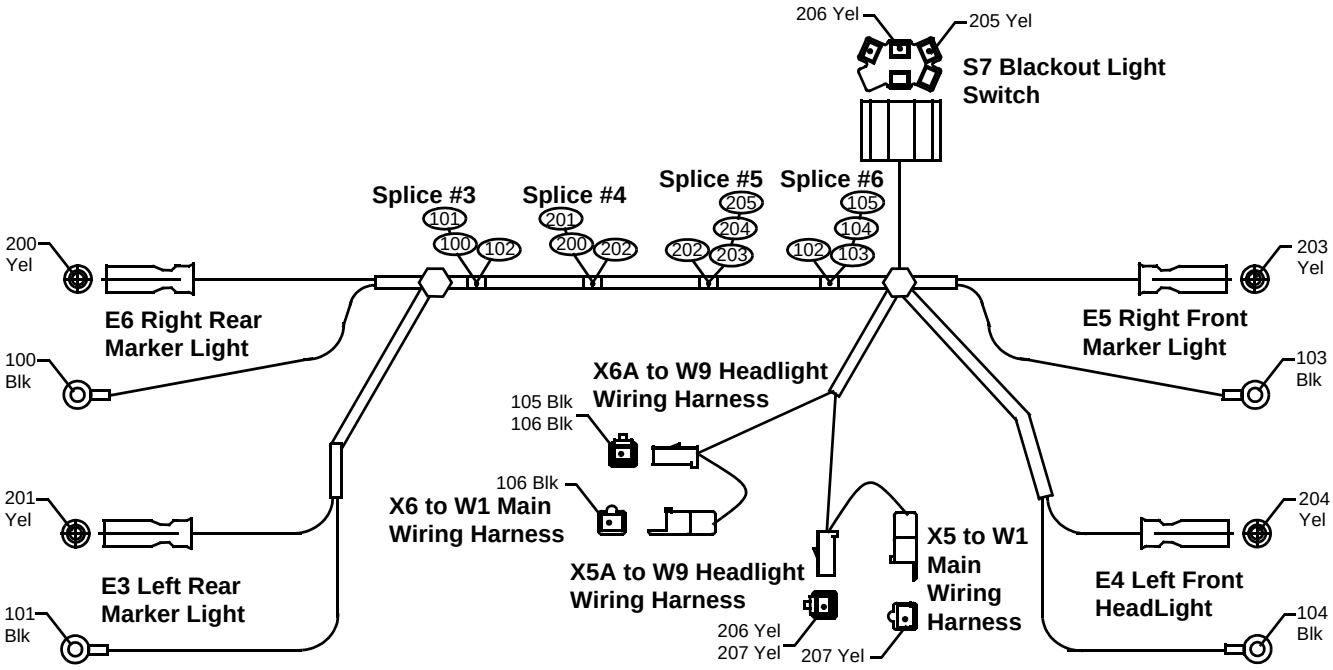


W10 WIRE COLOR CODES

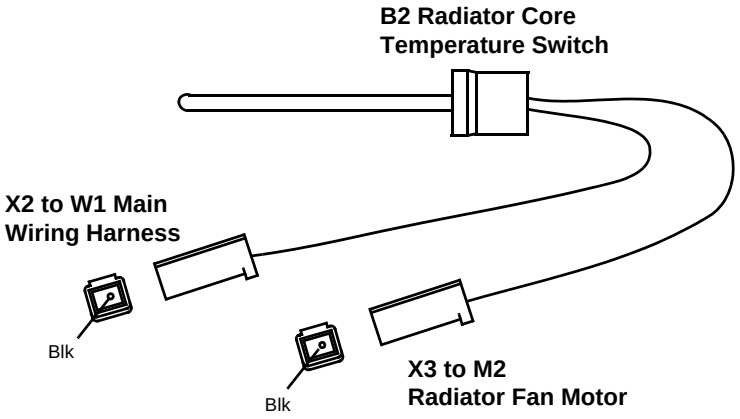
Circuit Number	Wire Size	Color	Termination Points
100	3.0	Blk	101 Blk and 102 Blk solder connection, G2 (–)
101	2.0	Blk	K3, 102 Blk and 100 Blk solder connection
102	2.0	Blk	K4, 101 Blk and 100 Blk solder connection
103	0.8	Blk	K3, K3
104	0.8	Blk	K4, K4
400	3.0	Red	G2 (+), 401 Red and 402 Red solder connection
401	2.0	Blk	400 Red and 402 Red solder connection, K3
402	2.0	Red	400 Red and 401 Red solder connection, K4
670	0.8	Yel/Wht	X8, K3
675	0.8	Yel/Blk	X8, K4
800	2.0	Org	K3, X7
850	2.0	Blk	K4, X7

M56348

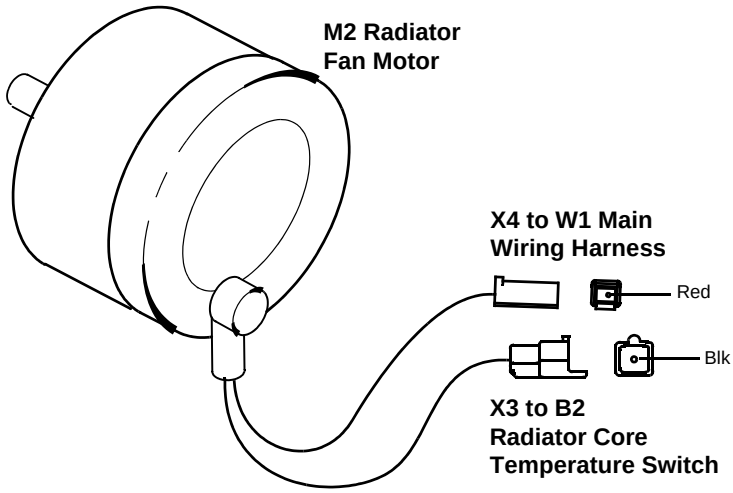
W11 BLACKOUT LIGHT KIT WIRING HARNESS (opt.)



B2 RADIATOR CORE TEMPERATURE SWITCH WIRING



M2 RADIATOR FAN MOTOR WIRING



THEORY AND DIAGNOSIS

POWER CIRCUIT OPERATION AND SCHEMATIC

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the start switch “OFF”:

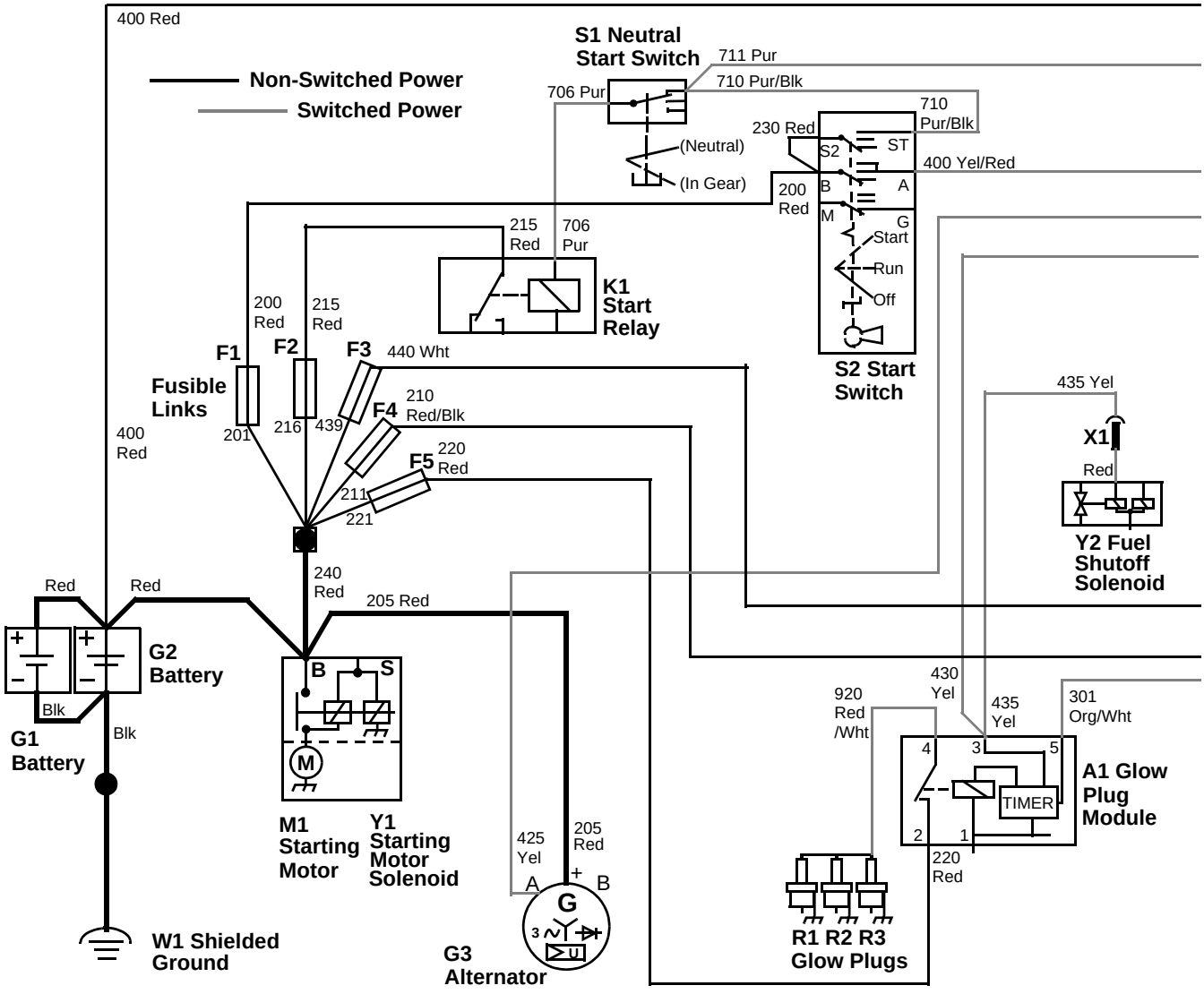
- G1 & G2 Battery Positive Terminals
- “B” Terminal of Starting Motor Solenoid
- G3 Alternator Positive Terminal
- K3 Cargo Box Raise Relay
- K4 Cargo Box Lower Relay
- “B” & "S2" Terminal of S2 Start Switch
- K1 Start Relay
- K2 Pull-in Coil Cut Out Relay
- A1 Glow Plug Module
- M2 Radiator Fan Motor

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor tie point connections must be good for the vehicle electrical system to work properly.

The ground cable connections is equally important as the positive cable. Proper starter operation depends on these cables and connections to carry the high current for its operation.

The connections between the starting motor solenoid and start switch, start relay, cut out relay, glow plug module and radiator fan motor are each fused by a fusible link. This is a short piece of wire that is designed to fail if current load is too high or a short occurs. It protects the wiring harness from damage.



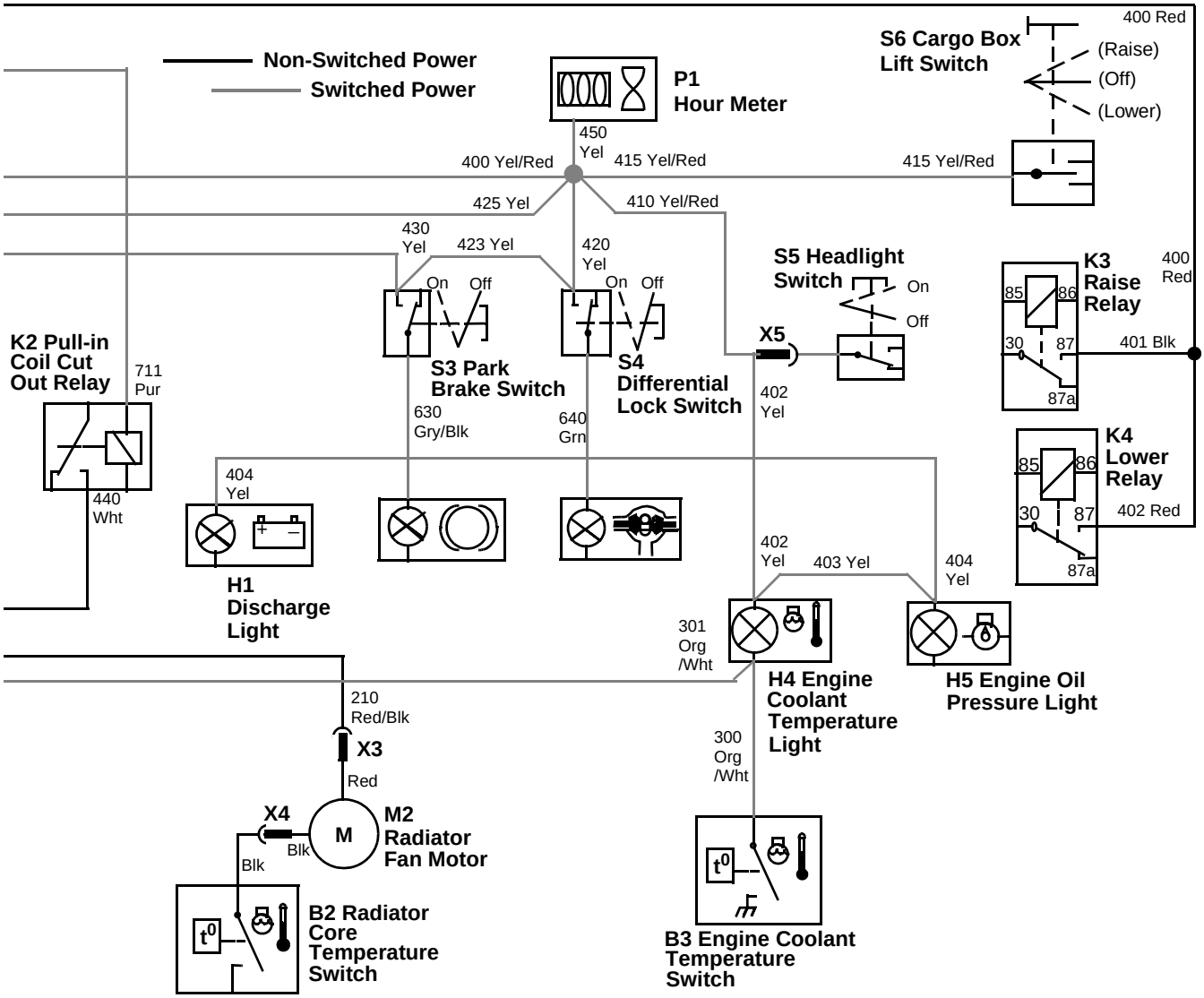
The charge wire running between the alternator and starting motor is unprotected.

Switched Power:

Voltage must be present at the following components with the start switch in the “ON or RUN” position:

- “A “ and “S1” Terminals of S2 Start Switch
- S1 Neutral Start Switch
- K1 Start Relay
- K2 Pull-in Coil Cut out relay
- P1 Hour Meter
- S6 Cargo Box Lift Switch
- G3 Alternator
- S5 Headlight Switch
- H4 Engine Coolant Temperature Light
- H5 Engine Oil Pressure Light
- H1 Discharge Light
- S4 Differential Lock Switch
- S3 Park Brake Switch
- A1 Glow Plug Module
- Y2 Fuel Shutoff Solenoid

These circuits are controlled by the start switch and are protected by the fusible link.



POWER CIRCUIT DIAGNOSIS

Test Conditions:

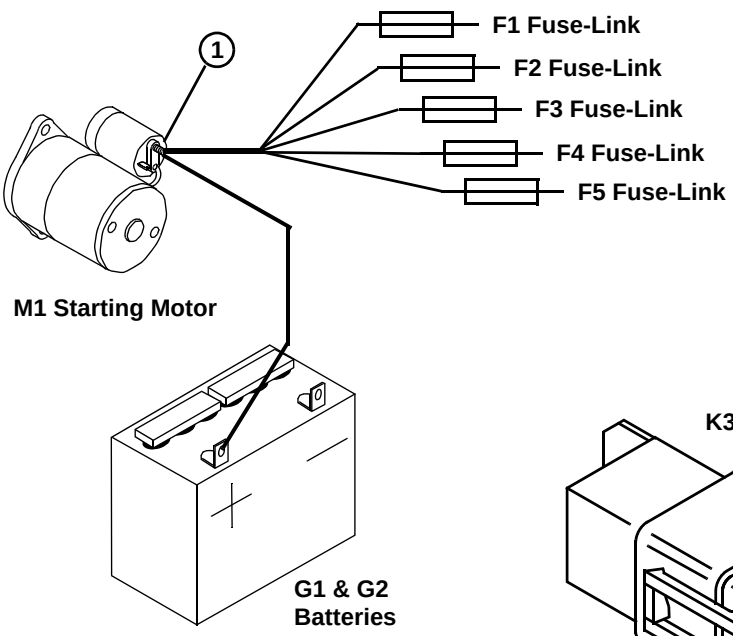
- Start switch in OFF position

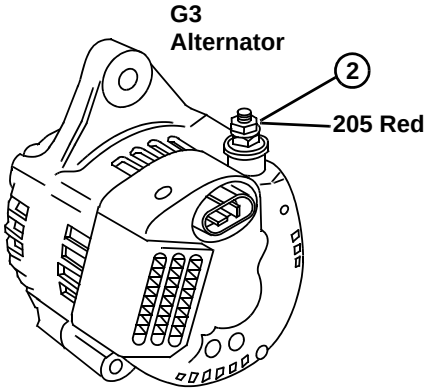
Test/Check Point	Normal	If Not Normal
1. Starting motor solenoid battery (B) terminal	Battery voltage	Check battery cables and test battery. See Battery Tests.
2. Alternator	Battery voltage	Check 205 Red wire and connections.
3. Raise and Lower relays	Battery voltage	Check 400 Red wire and connections.
4. Start switch	Battery voltage	Check 200 Red wire and connections. Replace F1 fusible link.
5. Start relay	Battery voltage	Check 215 Red wire. Replace F2 fusible link.
6. Pull-in Coil Cut Out Relay	Battery voltage	Check 440 Wht wire. Replace F3 fusible link.
7. Glow plug module	Battery voltage	Check 220 Red wire. Replace F5 fusible link.
8. Radiator fan motor	Battery voltage	Check 210 Red wire. Replace F4 fusible link.

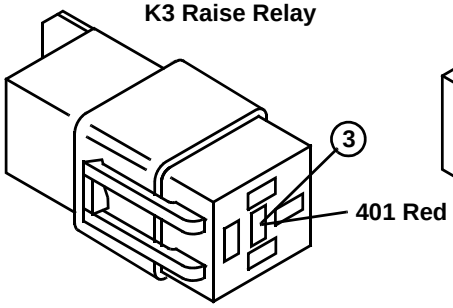
Test Conditions:

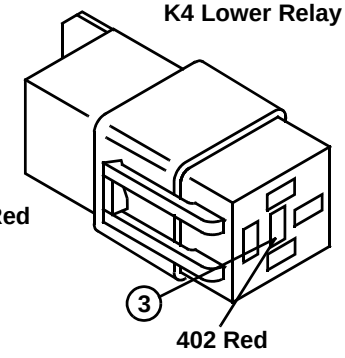
- Start switch in RUN position

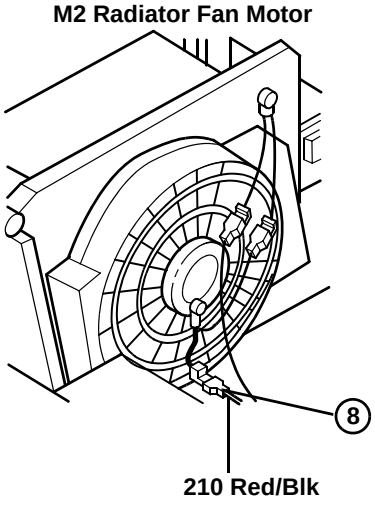
9. Start switch	Battery voltage	Replace start switch.
10. Neutral Start Switch	Battery voltage	Check 710 Pur/Blk wire and connections.
11. Start Relay	Battery voltage	Check 706 Pur wire and connections. If OK, replace neutral start switch.
12. Pull-in Coil Cut out relay	Battery voltage	Check 711 Pur wire and connections.

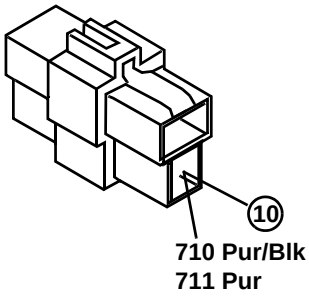

1
F1 Fuse-Link
F2 Fuse-Link
F3 Fuse-Link
F4 Fuse-Link
F5 Fuse-Link
M1 Starting Motor
G1 & G2
Batteries

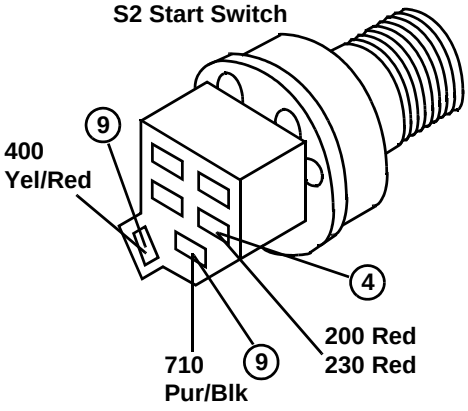

G3
Alternator
2
205 Red

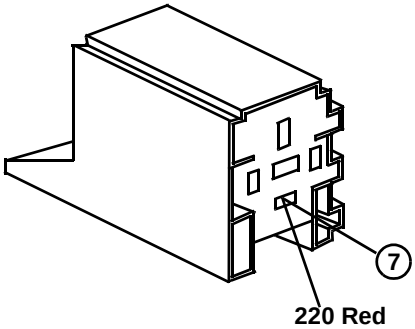

K3 Raise Relay
3
401 Red

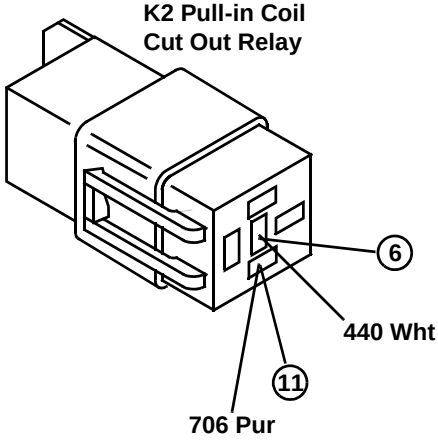

K4 Lower Relay
3
402 Red

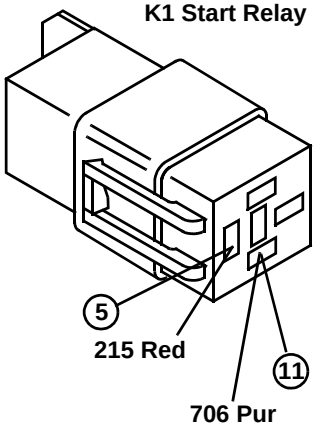

M2 Radiator Fan Motor
8
210 Red/Blk


S1 Neutral Start Switch
10
710 Pur/Blk
711 Pur


S2 Start Switch
9
400
Yel/Red
4
200 Red
230 Red
710
Pur/Blk
9


A1 Glow Plug Module
7
220 Red


K2 Pull-in Coil
Cut Out Relay
6
440 Wht
11
706 Pur


K1 Start Relay
5
215 Red
11
706 Pur

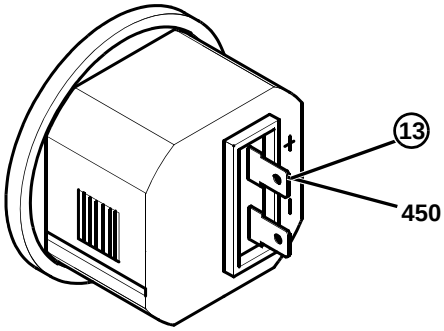
POWER CIRCUIT DIAGNOSIS (Continued)

Test Conditions:

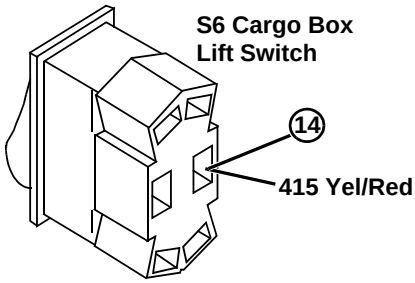
- Start switch in RUN position.

Test/Check Point	Normal	If Not Normal
13. Hour Meter	Battery voltage	Check 400 Yel/Red and 450 Yel wire and connections.
14. Cargo Box Lift Switch	Battery voltage	Check 415 Yel/Red wire and connections.
15. Alternator	Battery voltage	Check 425 Yel wire and connections.
16. Headlight Switch	Battery voltage	Check 410 Yel/Red wire and connections.
17. Engine Coolant Temperature Light	Battery voltage	Check 402 Yel wire and connections.
18. Engine Oil Pressure Light	Battery voltage	Check 403 Yel wire and connections.
19. Discharge Light	Battery voltage	Check 404 Yel wire and connections.
20. Differential Lock Switch	Battery voltage	Check 420 Yel wire and connections.
21. Park Brake Switch	Battery voltage	Check 423 Yel wire and connections.
22. Glow Plug Module	Battery voltage	Check 430 Yel wire and connections.
23. Fuel Shutoff Solenoid	Battery voltage	Check 435 Yel wire and connections.

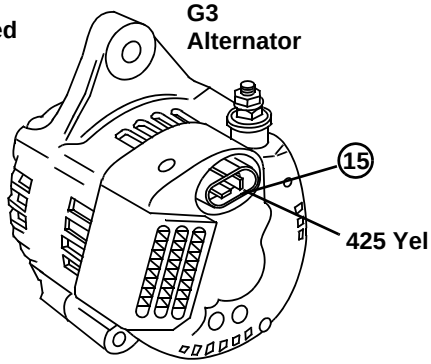
P1 Hour Meter



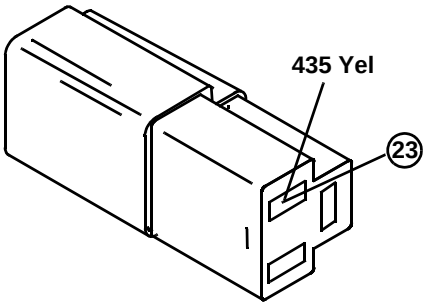
S6 Cargo Box Lift Switch



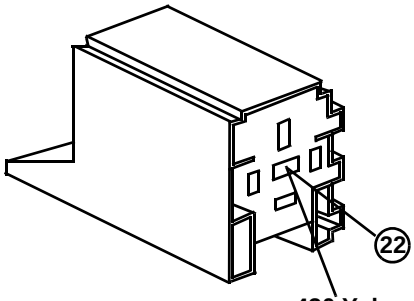
G3 Alternator



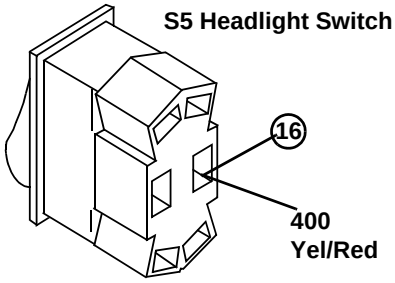
Y2 Fuel Shutoff Solenoid



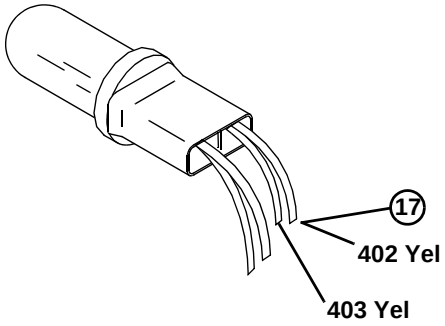
A1 Glow Plug Module



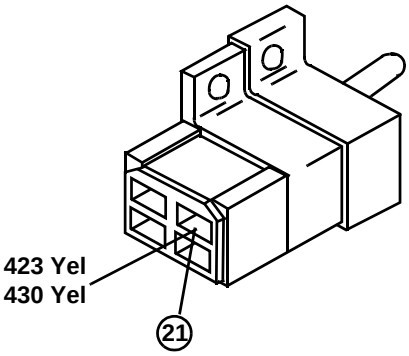
S5 Headlight Switch



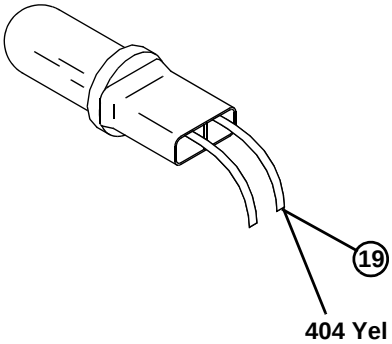
H4 Engine Coolant Temperature Light



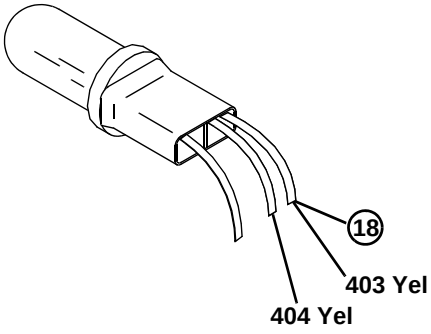
S3 Park Brake Switch



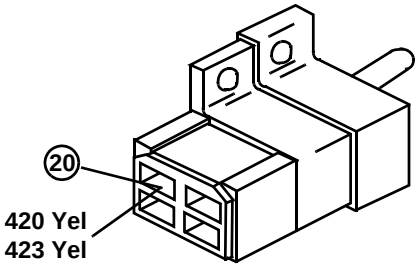
H1 Discharge Light



H5 Engine Oil Pressure Light



S4 Differential Lock Switch



CRANKING CIRCUIT OPERATION

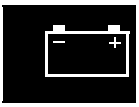
Function:

To energize the starting motor solenoid and engage the starting motor to crank the engine.

Operating Conditions:

- Start switch in START position
- Transmission in neutral

Theory of Operation:



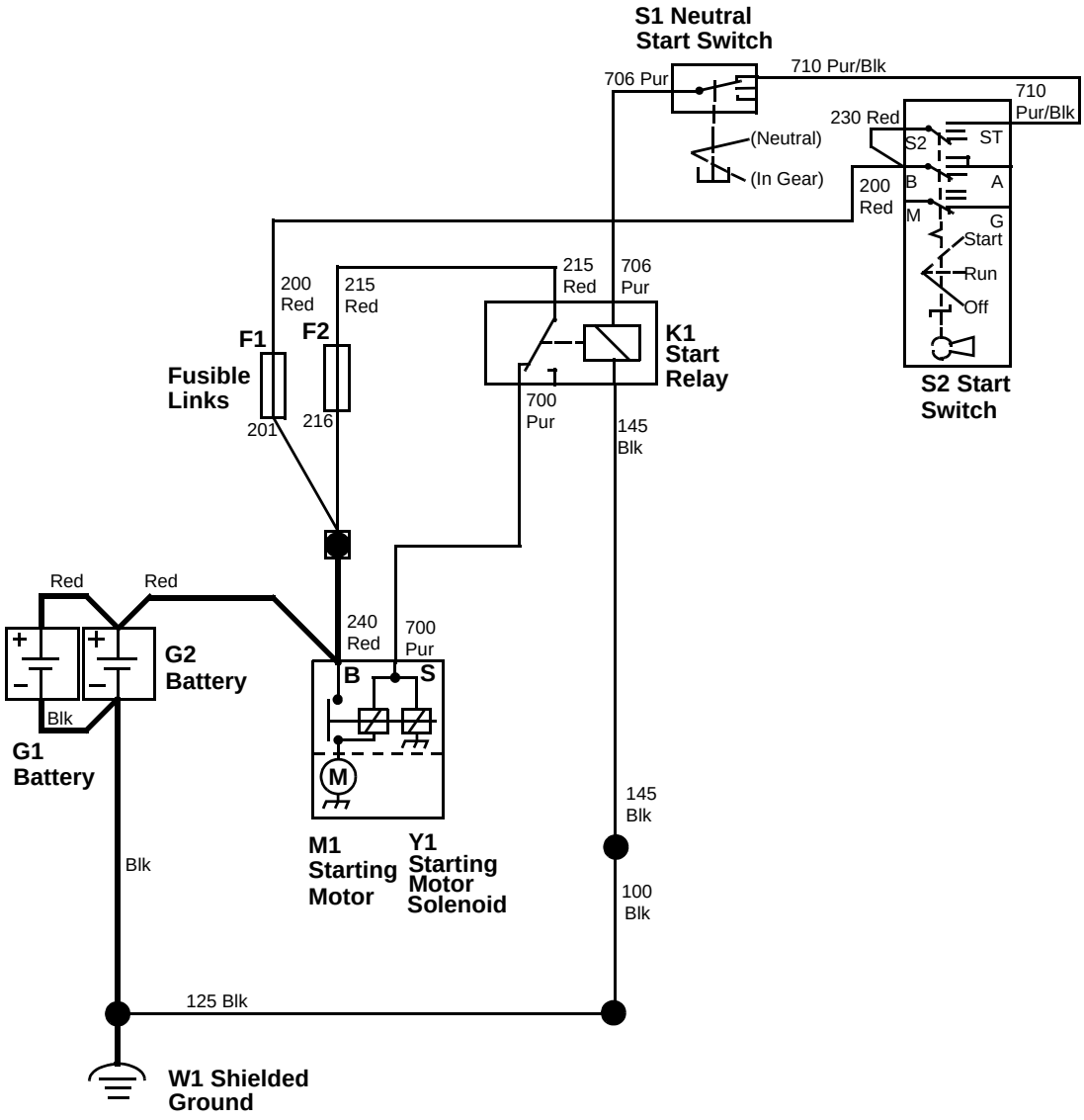
Current from the power circuit (200 Red) flows through the F1 fusible link to the start switch, and is connected from the B terminal of the start switch to the S2 terminal of the start switch through circuit 230 Red.

When in the start position the start switch allows current to flow to the neutral start switch (710 Pur/Blk). With the transmission in neutral, current flows to the K1 start relay coil allowing the start relay to activate.

When activated, the start relay contacts pass current from the battery, and the F2 fusible link to energize the Y1 starting motor solenoid (215 Red, 700 Pur).

With the starting motor solenoid activated, high current from the battery passes through the battery cable and solenoid contacts, and energizes the starting motor.

CRANKING CIRCUIT SCHEMATIC

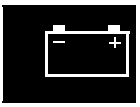


CRANKING CIRCUIT DIAGNOSIS

Test Conditions:

- Transmission in neutral and brake set
- Start switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Start switch	Battery voltage	Check 200 and 230 Red wires and F1 fusible link. See “POWER CIRCUIT DIAGNOSIS” on page 22.
2. Start relay	Battery voltage	Check 215 Red wire and F2 fusible link. See “POWER CIRCUIT DIAGNOSIS” on page 22.

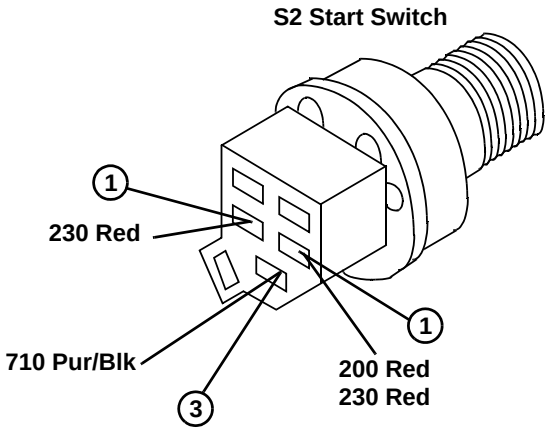


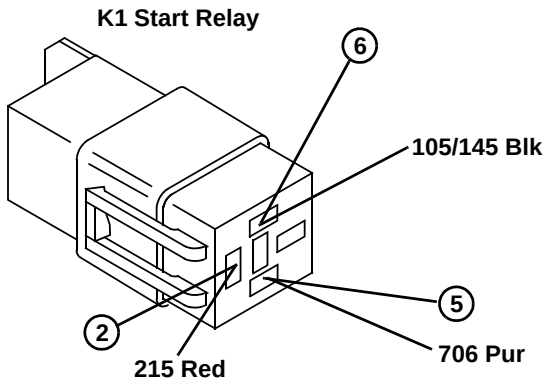
Test Conditions:

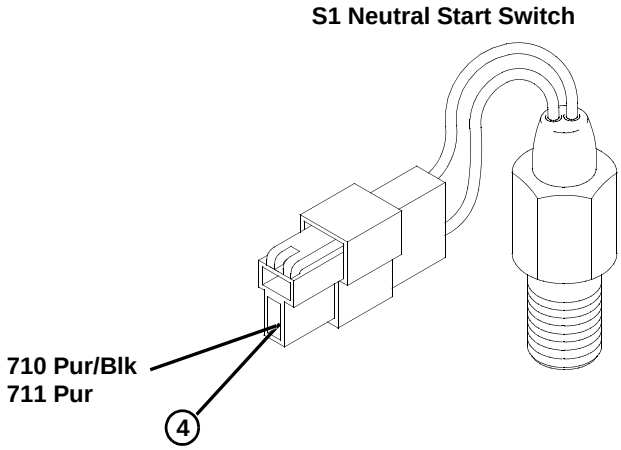
- Transmission in neutral and brake set
- Start switch in START position while performing each test.

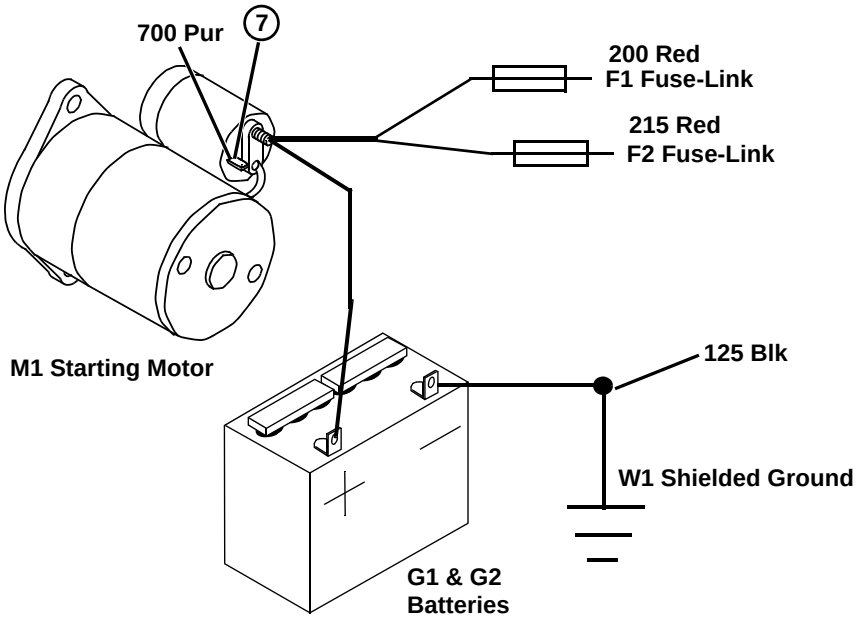
NOTE: Engine will turn over during this test. Allow time for starter to cool between each test.

3. Start switch	Battery voltage	Replace start switch.
4. Neutral start switch connector	Battery voltage	Check 710 Pur/Blk wire and connections.
5. Start relay	Battery voltage	Check 706 Pur wire and connections. If OK, replace the neutral start switch.
6. Start relay	Continuity to ground	Check 145, 100 and 125 Blk wires and connections. If OK, test relay. See “RELAY TEST” on page 66.
7. Starting motor solenoid	Battery voltage	Check 700 Pur wire and connections. If OK, test relay. See “RELAY TEST” on page 66. If relay tests OK, test starting motor solenoid. See “STARTING MOTOR SOLENOID TEST” on page 66.


S2 Start Switch
1
230 Red
710 Pur/Blk
3
1
200 Red
230 Red


K1 Start Relay
6
105/145 Blk
5
2
215 Red
706 Pur


S1 Neutral Start Switch
710 Pur/Blk
711 Pur
4


700 Pur
7
200 Red
F1 Fuse-Link
215 Red
F2 Fuse-Link
M1 Starting Motor
125 Blk
W1 Shielded Ground
G1 & G2
Batteries

GLOW PLUG/FUEL SUPPLY CIRCUIT OPERATION

Function:

To control the injection of diesel fuel and provide and an added source of heat for combustion.

Operating Conditions:

- Start switch must be in the START or RUN position.

Theory of Operation:

The ignition system is designed to inject diesel fuel into the precombustion chamber and piston cylinder where heat from compression ignites the fuel and air mixture. When starting a cold engine, compression pressure may not provide enough heat to ignite the fuel when injected into a cold precombustion chamber. An electronically operated glow plug is installed into the precombustion chamber to provide added heat to ignite the fuel as it is injected. The glow plugs are energized during starting, and also may be preheated by turning the start switch to the RUN position for up to 30 seconds before turning the start switch to the start position.

In the START position current flows from the start switch to the start relay which in turn energizes the starting motor. The differential lock, park brake, pull-in coil cut out relay, fuel shutoff solenoid and glow plug module are all provided current by the start switch in both the RUN and START position.

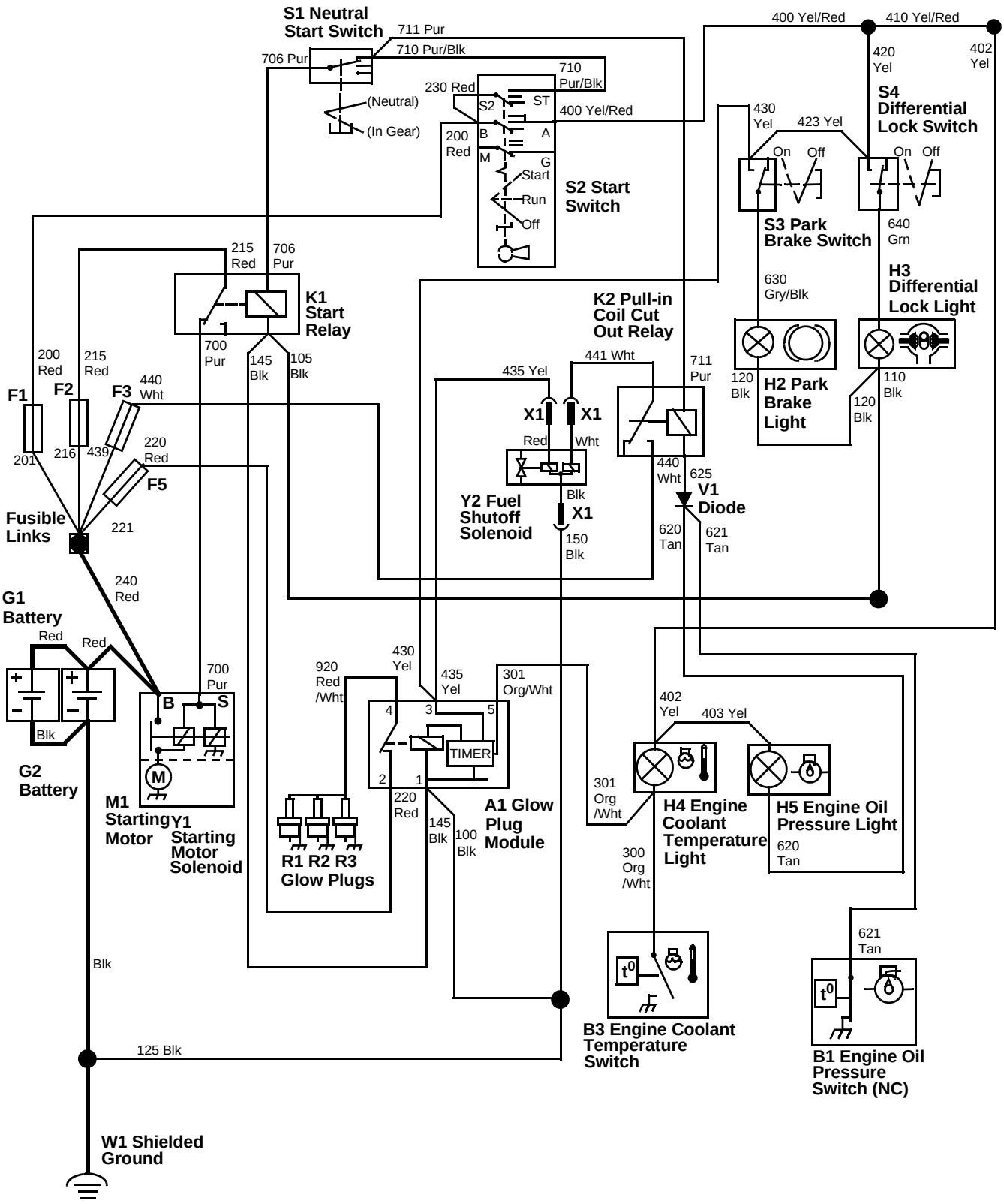
When the start switch is turned to the START position the starting motor turns the engine over. Before oil pressure opens the engine oil pressure switch (normally closed), the closed engine oil pressure switch provides a ground path for the pull-in coil cut out relay. While this ground is provided, the pull-in coil energizes, closing cut out relay contacts which allow current flow from the starting motor to energize the fuel shutoff solenoid.

Diesel fuel is provided to the engine when the fuel shutoff solenoid is energized. The fuel shutoff solenoid is initially pulled in when current from the starting motor energizes it. After oil pressure opens the oil pressure switch and de-energizes the pull-in coil, the fuel shutoff solenoid is held in the energized state by current provided through the start switch in the RUN position.

The glow plugs heat when current is provided through the glow plug module. The glow plug module provides current to the glow plugs through relay contacts controlled by a timer.

The timer is started by turning the start switch to either the RUN or START position. The length of time the timer stays on is a function of ambient air temperature and ranges from approximately 10 to 30 seconds. The colder the temperature, the longer the timer stays on. Stopping the electronic timer de-energizes the glow plugs.

GLOW PLUG/FUEL SUPPLY CIRCUIT SCHEMATIC



GLOW PLUG/FUEL SUPPLY CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Start Switch	Battery voltage	Check 200 Red wire and F1 fusible link.
2. Pull-in Coil Cut out relay	Battery voltage	Check 440 Wht wire and F3 fusible link.
3. Glow Plug Module	Battery voltage	Check 220 Red wire and F5 fusible link.
4. Park Brake light	Continuity to ground	Check 120, 110, 105, 145, 100, and 125 Blk wires and connections.
5. Fuel shutoff solenoid	Continuity to ground	Check 150 and 125 Blk wires and connections.
6. Engine Oil Pressure Light	Continuity to ground	Check 620 and 621 Tan wires and connections.
7. Diode	Continuity in one direction only	Replace diode.

Test Conditions:

- Start switch in RUN position

8. Start switch	Battery voltage	Replace start switch.
9. Fuel shutoff solenoid	Battery voltage	Check 435, 430, 423, 420 Yel and 400 Yel/Red wires and connections.
10. Engine Coolant Temperature Light	Battery voltage	Check 402 Yel and 410 and 400 Yel/Red wires and connections.

Test Conditions:

- Start switch in RUN position. (Turn start switch to the OFF position while setting up for each test listed below. Then turn the start switch to the RUN position and perform each test within 10 - 30 seconds.

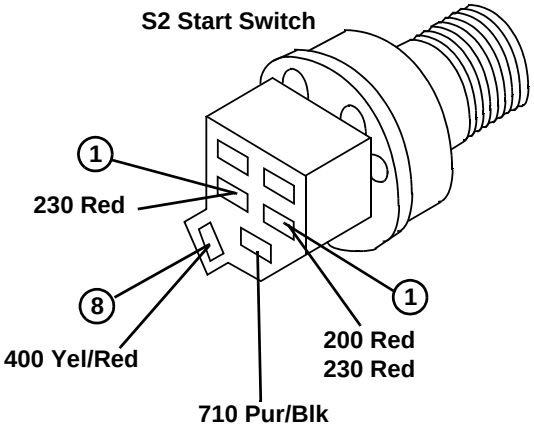
11. Engine Coolant Temperature Switch	Low voltage raising to battery voltage after a few seconds.	Check 300 and 301 Org/Wht wire and connections and the engine coolant temperature light. If OK, replace glow plug module.
12. Glow plugs	Battery voltage for up to 30 seconds	Check 920 Red/Wht wire and connections. If OK, replace glow plug module.

Test Conditions:

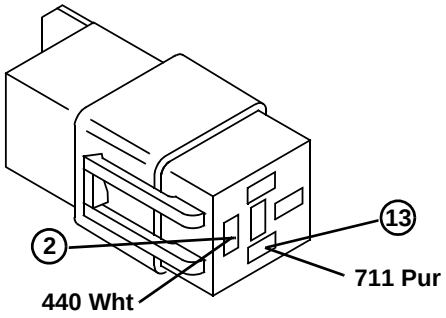
- K1 Start Relay unplugged from W1 Main wiring harness to prevent engine from turning over and starting.
- Start switch in START position during each test.

13. Pull-in Coil Cut Out Relay	Battery voltage	Check 711 Pur and 710 Pur/Blk wires and connections. If OK, replace start switch.
14. Fuel shutoff solenoid	Battery voltage	Check 441 Wht wire and connections. If OK, replace pull-in coil cut out relay
15. Fuel shutoff solenoid	Audible click	Replace fuel shutoff solenoid

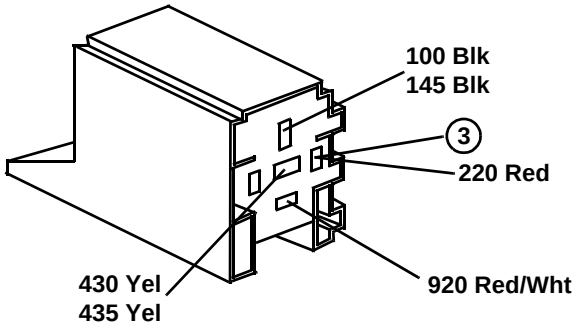
S2 Start Switch



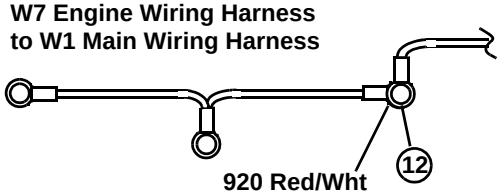
K2 Pull-in Coil Cut Out Relay



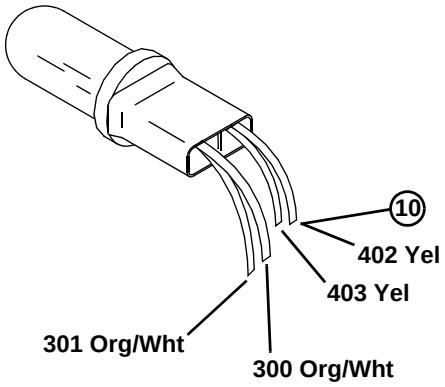
A1 Glow Plug Module



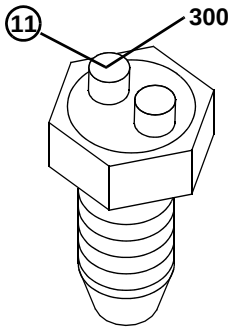
W7 Engine Wiring Harness
to W1 Main Wiring Harness



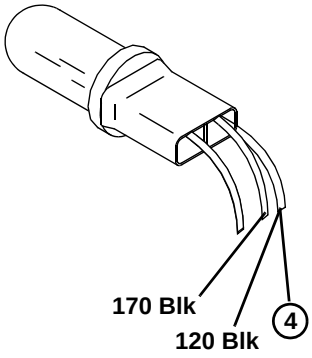
H4 Engine Coolant Temperature Light



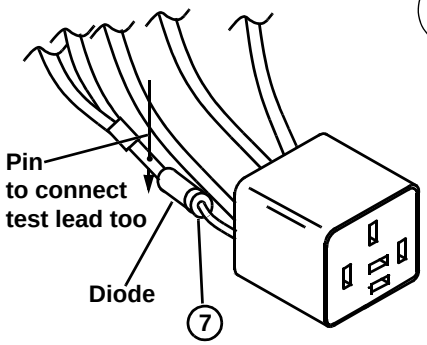
B3 Engine Coolant
Temperature Switch



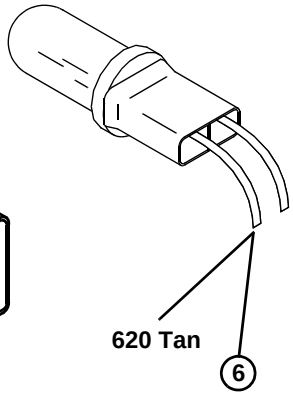
H2 Park Brake Light



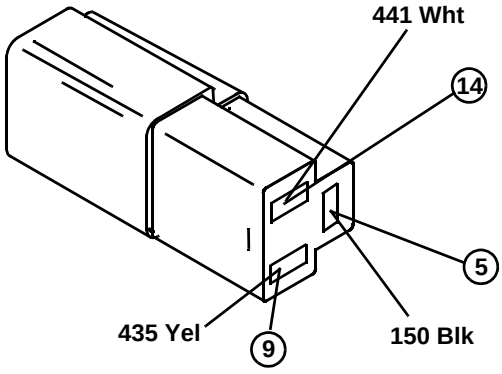
V1 Diode



H5 Engine Oil Pressure Light



Y2 Fuel Shutoff Solenoid



CHARGING CIRCUIT OPERATION

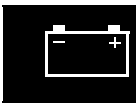
FUNCTION:

To maintain battery voltage between 12.4 and 13.2 volts.

OPERATING CONDITIONS:

The start switch must be in the RUN position with the engine running for the charging system to operate.

SYSTEM OPERATION:



The charging system is a permanent magnet and stator design alternator (G3). Charging output is controlled by a regulator/rectifier built into the alternator. The status of the charge rate is indicated by the H1 discharge light.

With the start switch in the RUN position, battery sensing circuit current flows from battery positive terminal to starter terminal, fusible link F1 (200 Red), start switch, and to regulator/rectifier (425 Yel). The battery sensing circuit allows the voltage regulator/ rectifier to monitor battery voltage.

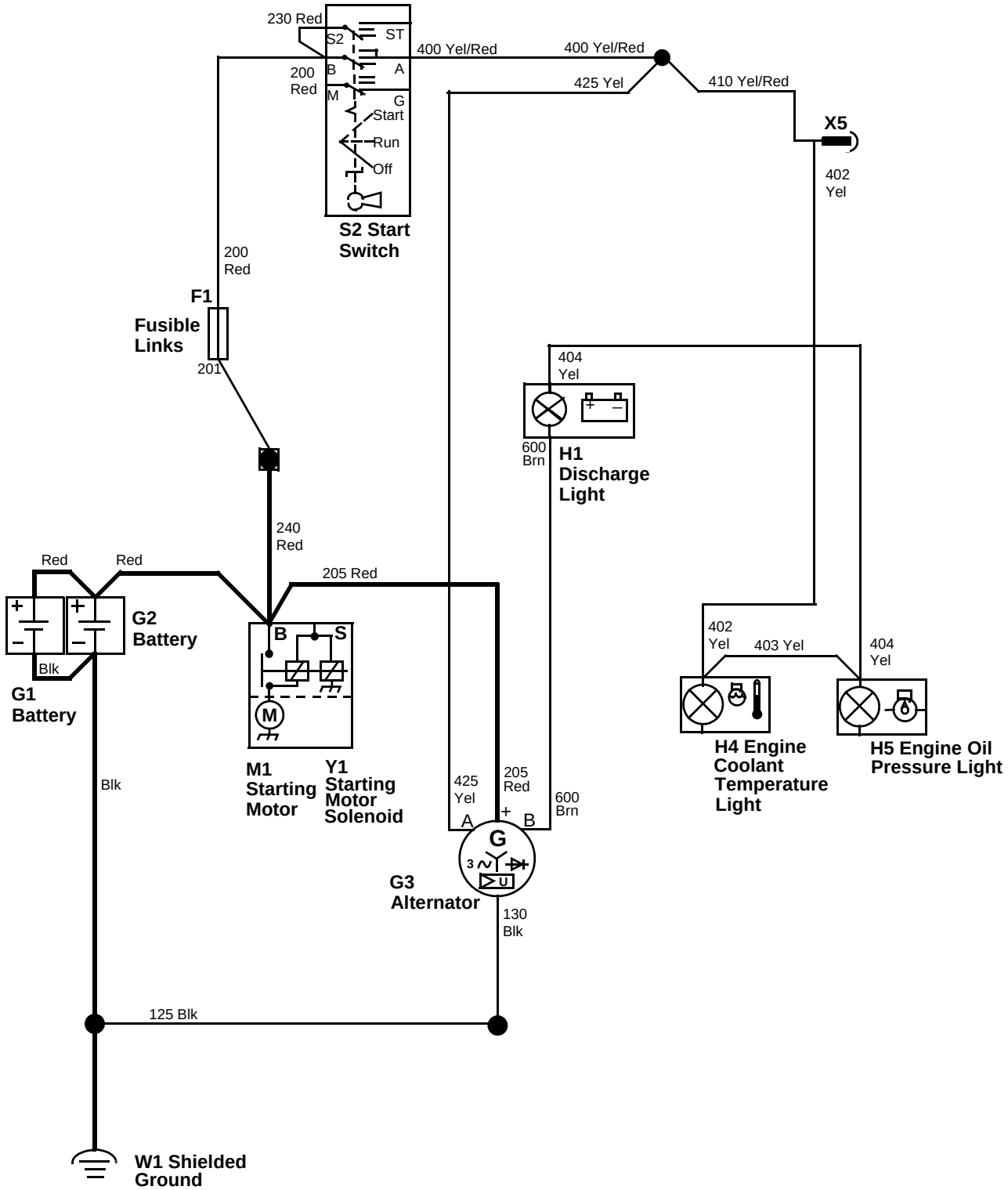
A rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit (205 Red). When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

If the stator output current falls below the system usage or is insufficient to maintain a preset voltage, the voltage regulator/rectifier provides a current path (600 Brn) to turn on the discharge light.

The ground circuit (130 and 125 Blk) provides a path to ground for the voltage regulator/rectifier.

CHARGING CIRCUIT SCHEMATIC



CHARGING CIRCUIT DIAGNOSIS

Test Conditions:

- Park brake set
- Transmission in neutral
- Engine and start switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	Battery voltage (11.8 - 13.2 volts)	Test battery. See “BATTERY TEST” on page 60.
2. Starting motor solenoid battery (B) terminal	Battery voltage	Test battery and starter cable connections.
3. Alternator (+) terminal)	Battery voltage	Check 205 Red wire and connections. See Power Circuit Diagnosis.

Test Conditions:

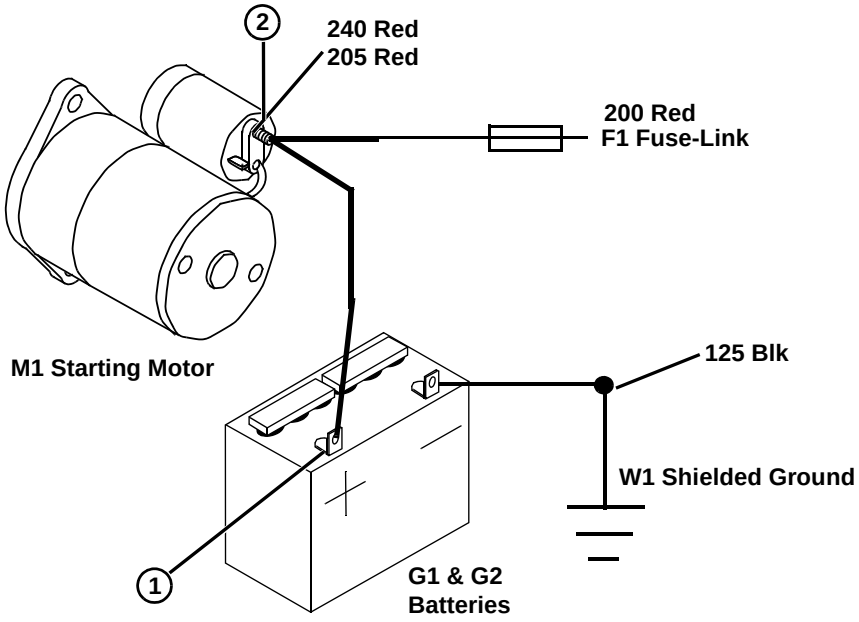
- Engine OFF
- Start Switch in RUN position

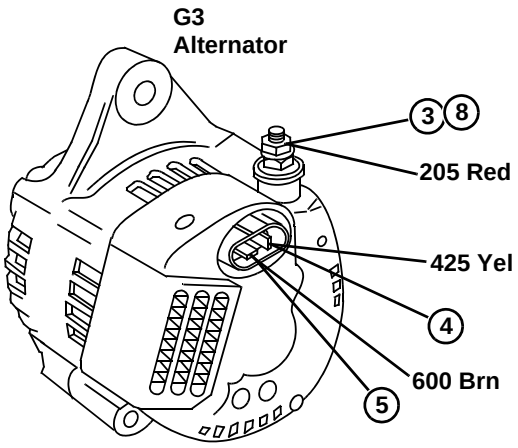
4. Alternator (A terminal)	Battery voltage	Check 425 Yel wire and connections. See Power Circuit Diagnosis. Check F1 fusible link and start switch.
5. Alternator (B terminal)	Greater than 0 volts - less than 0.2 volts	Greater the 0.2 volts: Test voltage regulator/ rectifier ground circuit.
6. Discharge light (404 Yel wire)	Battery voltage	Check 402, 403 and 404 Yel wires and connections
7. Discharge light (600 Brn wire)	Greater than 0 volts - less than 0.2 volts	0 volts: Replace bulb Greater than 0.2 volts: Check all connection and ground wires for open or poor connection.

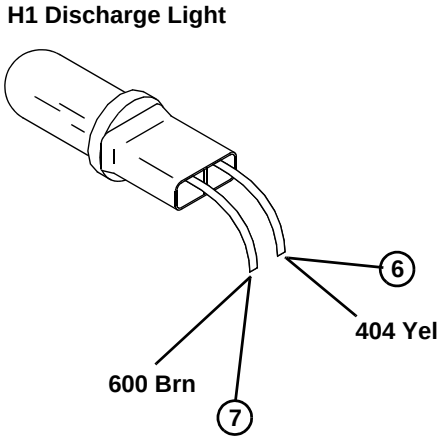
Test Conditions:

- Engine running

8. Alternator	Minimum 40 Amps at 12.2 to 13.8 volts	See Amperage Output Test. Replace voltage regulator/rectifier.
9. Battery	Voltage above normal battery voltage.	Check for excessive load on electrical system.


2
240 Red
205 Red
200 Red
F1 Fuse-Link
M1 Starting Motor
125 Blk
W1 Shielded Ground
1
G1 & G2
Batteries


G3
Alternator
3
8
205 Red
425 Yel
4
600 Brn
5


H1 Discharge Light
6
404 Yel
600 Brn
7

INDICATOR LIGHTS CIRCUIT OPERATION

Function:

ENGINE DISCHARGE LIGHT

Inform the operator of a low charge rate by illuminating a warning light.

ENGINE OIL PRESSURE LIGHT

To alert operator of low engine oil pressure by illuminating a warning light.

ENGINE COOLANT TEMPERATURE LIGHT

Dual function to inform operator of critical engine and coolant operating temperature by illuminating a warning light, and inform operator of glow plug operation.

PARK BRAKE LIGHT

Inform the operator that the parking brake is ON by illuminating a warning light.

DIFFERENTIAL LOCK LIGHT

Inform the operator that the differential Lock is ON by illuminating a warning light.

Operating Condition:

The start switch must be in RUN position.

Theory of Operation:

ENGINE DISCHARGE LIGHT

With the engine off and start switch in RUN position, the voltage regulator built into the alternator provides a voltage difference across the discharge light allowing the light to go on.

When the engine is started and running the light should go out when the voltage across the regulator equalizes and allows too low of a current flow to illuminate the light.

OIL PRESSURE LIGHT

With the engine off and start switch in RUN position, oil pressure will be below **28 kPa (4 psi)**. The oil pressure switch will be closed, completing the circuit path to ground and illuminating the light. This will inform the operator that the light is functioning.

When the engine is started and running the light should go out when the oil pressure is adequate to open the B1 engine oil pressure switch.

ENGINE COOLANT TEMPERATURE LIGHT

When the start switch is in the start position, the ground circuit is allowed to pass through the glow plug module ground. This will turn on the light for a few seconds depending on air temperature. When the glow plug control times out, the light will go out. If the engine temperature reaches **109°C ±1°C (228°F ±2°F)** the switch contacts will close, providing a path to ground through the engine block which turns on the engine coolant temperature light.

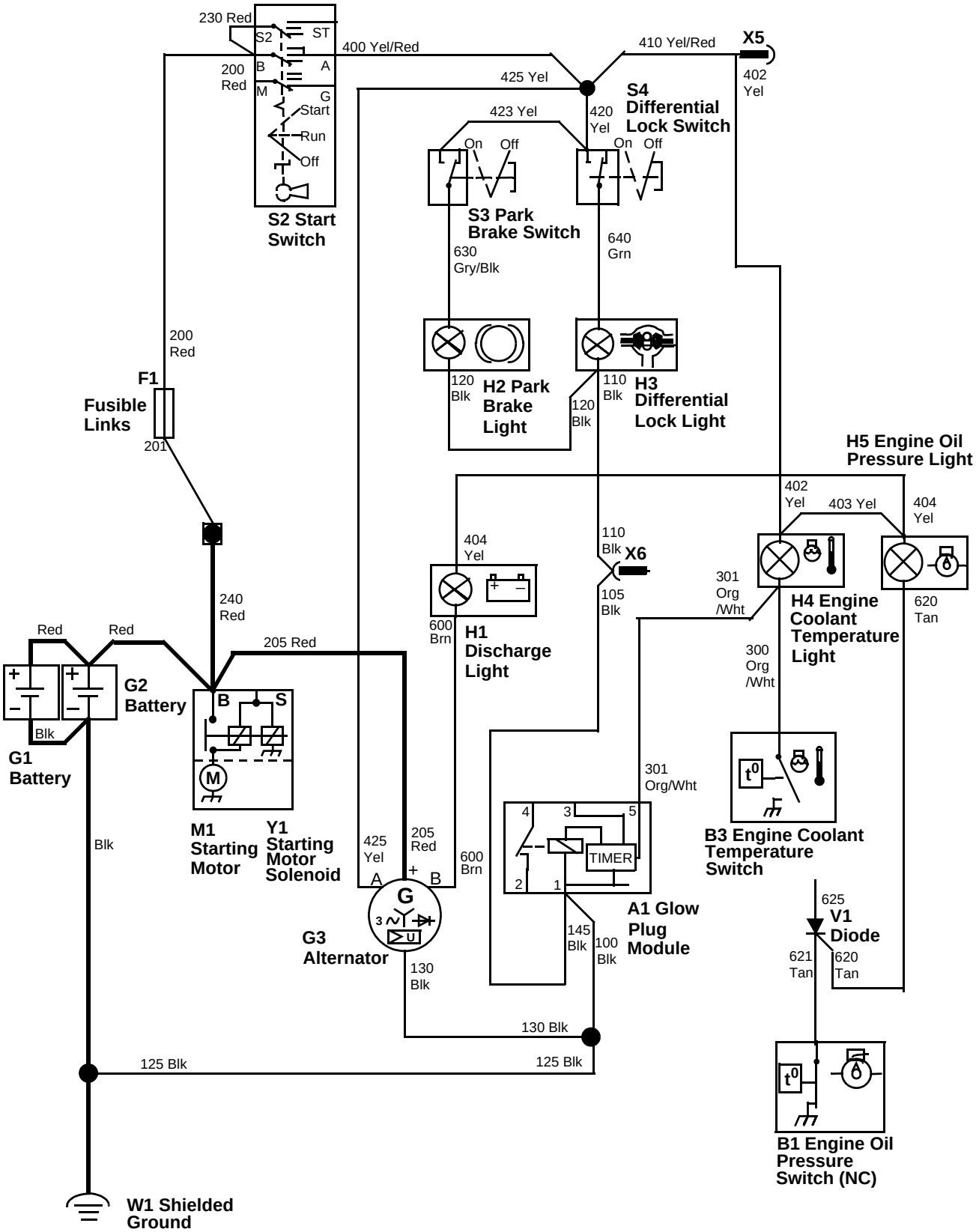
PARK BRAKE LIGHT

When the park brake is set the switch is released (closes), allowing current to flow to the warning light. When the park brake is released the park brake switch is opened and the light goes out.

DIFFERENTIAL LOCK LIGHT

When the differential lock lever is moved to engage the differential lock, the differential lock switch is depressed (closed), allowing current flow to the differential lock light. When the differential is released, the switch is released (open), and the light goes out.

INDICATOR LIGHTS CIRCUIT SCHEMATIC

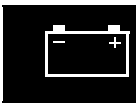


INDICATOR LIGHTS CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch in OFF position
- Differential lock engaged
- Park brake set

Test/Check Point	Normal	If Not Normal
1. Park Brake light	Continuity to ground	Check 120, 110, 105, 145, 100, and 125 Blk wires and connections.
2. Engine oil pressure light	Continuity to ground	Check 620 and 621 Tan wires and connections. Check engine ground. If engine ground OK, replace oil pressure switch.

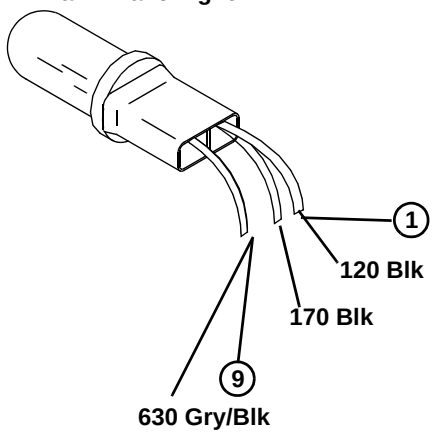


Test Conditions:

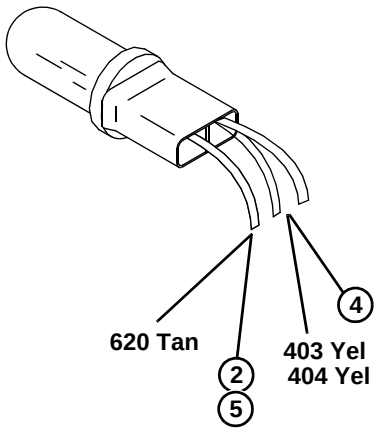
- Start switch in RUN position, engine OFF
- Differential lock engaged
- Park brake set

3. Discharge light	Battery voltage (light should be ON)	Check 404, 403 and 402 Yel wires and connections. See Power Circuit Diagnosis. If OK, replace light bulb.
4. Engine oil pressure light	Battery voltage (light should be ON)	Check 402 and 403 Yel wires and connections. See Power Circuit Diagnosis.
5. Engine oil pressure light	Continuity to ground (light should be ON)	Check 620 and 621 Tan wires and connections. If OK, replace light bulb.
6. Engine coolant temperature light	Battery voltage (light should be on for 3 to 30 seconds after turning start switch to RUN position)	Check 402 Yel wire. See Power Circuit Diagnosis. Replace engine coolant temperature light.
7. Engine coolant temperature switch	Battery voltage after 10 seconds. Sensor open lower than 109°C ±1°C (228°F ±2°F)	Check 300 Org/Wht wire and connections. See Power Circuit Diagnosis. Replace engine coolant temperature switch.
8. Engine coolant temperature switch	Battery voltage after 10 seconds. Switch open lower than 109°C ±1°C (228°F ±2°F)	Disconnect 300 Org/Wht wire at engine coolant temperature switch. Check 301 Org/Wht wire and connections. Replace glow plug module.
9. Park brake light	Battery voltage (light should be ON)	Check 630 Gry/Blk wire and connections. See Power Circuit Diagnosis. Adjust or replace park brake switch.
10. Park brake switch	Battery voltage	Check 420 and 423 Yel wires. Adjust or replace park brake switch.
11. Differential lock light	Battery voltage	Check 640 Grn wire and connections. Check differential lock switch. See Power Circuit Diagnosis.
12. Differential lock switch	Battery voltage	Check 420 Yel wires. Adjust or replace differential lock switch.

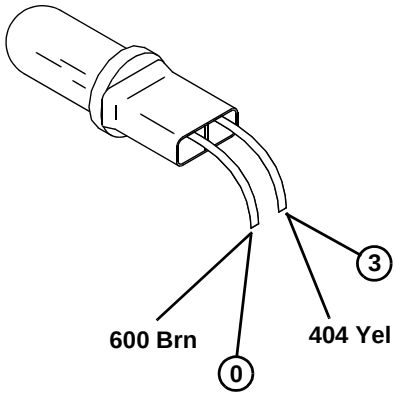
H2 Park Brake Light



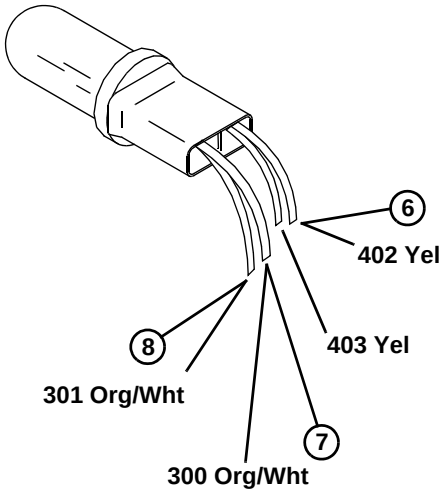
H5 Engine Oil Pressure Light



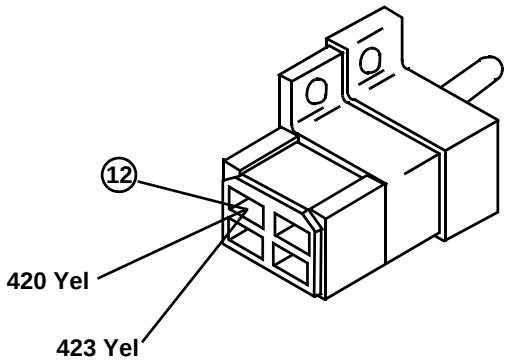
H1 Discharge Light



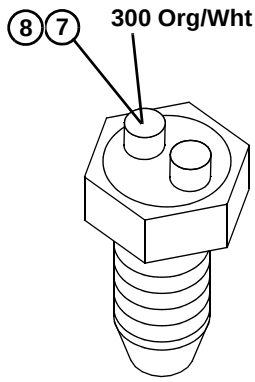
H4 Engine Coolant Temperature Light



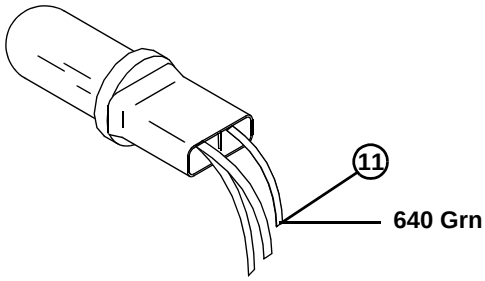
S4 Differential Lock Switch



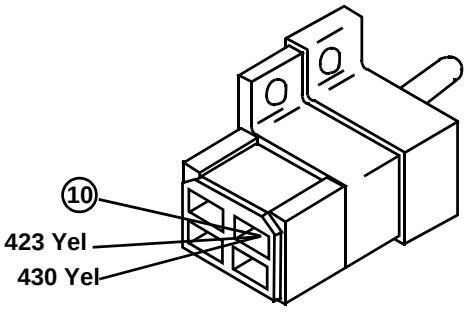
B3 Engine Coolant Temperature Switch



H3 Differential Lock Light



S3 Park Brake Switch



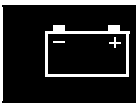
RADIATOR FAN MOTOR CIRCUIT OPERATION

Function:

To provide a means of moving air across the radiator core to dissipating the heat from the engine coolant.

Operating Conditions:

With the batteries connected, the radiator fan motor operates when the radiator core temperature switch closes. The radiator core temperature switch closes when the coolant heats to **86°-93°C (186°-200°F) raising the** outer radiator core temperature to **68°-74°C (153°-167°F)**.



*NOTE: The outer radiator core temperature is approximately **20°C (36°F)** lower than engine coolant temperature.*

The fan motor will stop when the coolant temperature drops to **77°-84°C (170°-184°F)**, the outer radiator core temperature cools to **57°-63°C (135°-145°F),** and the radiator core temperature switch opens. The radiator fan motor circuit is connected directly to the battery and does not depend upon the start switch position.

Theory of Operation:

Operates when the radiator core temperature switch closes when coolant heats the outer radiator core to **68°-74°C (153°-167°F)**. The radiator core temperature switch monitors outer radiator core temperature, not engine coolant temperature.

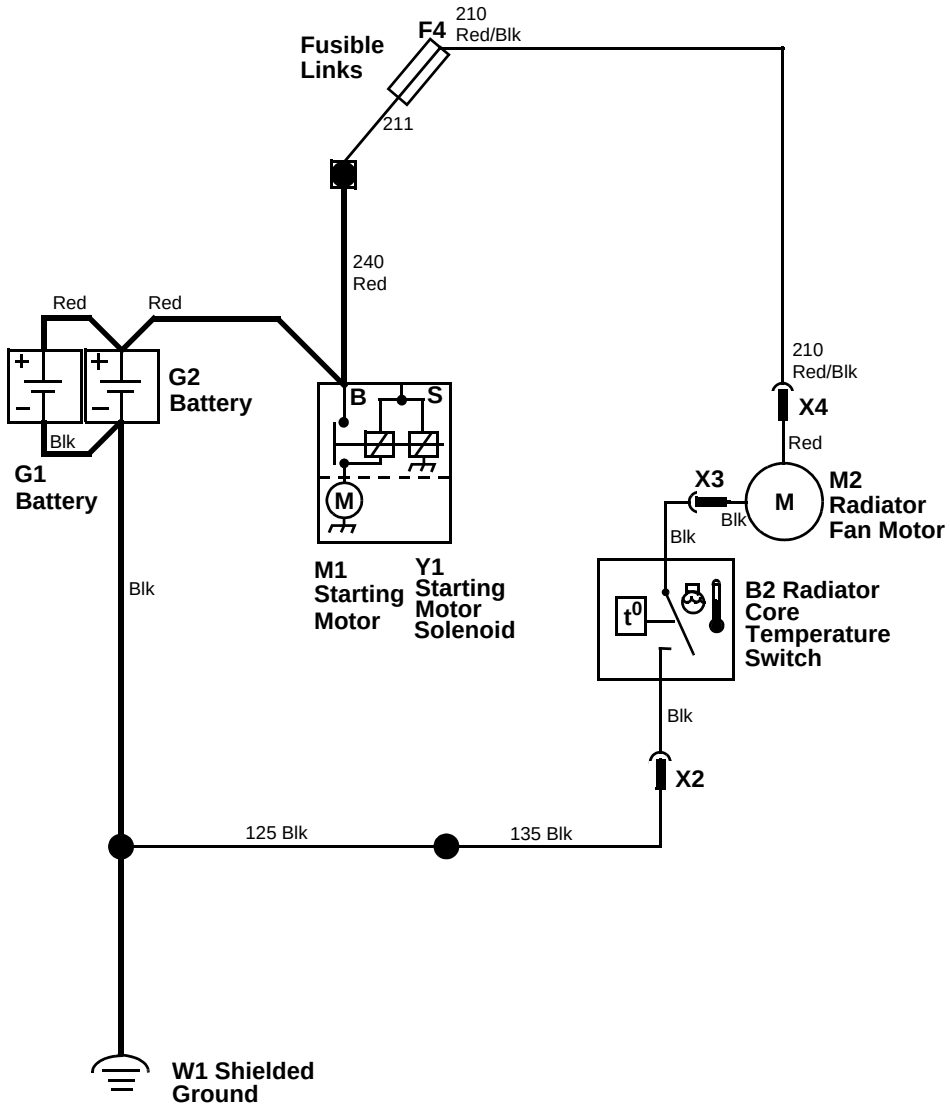
Fan motor may run after engine is shutoff. Fan motor will stop when outer radiator core temperature cools to **57°-63°C (135°-145°F)** and radiator core temperature switch opens.

The radiator fan motor is connected to the battery terminal of the starting motor solenoid and is protected by the F4 fusible link. The 210 Red/Blk wire connects to the radiator fan motor at the X3 connector.

The X4 connector links the fan motor to the radiator core temperature switch. The radiator core temperature switch is a normally open switch that closes when the temperature around the switch reaches **68°-74°C (153°-167°F)**.

With the core temperature switch closed a ground path is provided through the switch, the X2 connector and the 135 and 125 Blk wires.

RADIATOR FAN MOTOR CIRCUIT SCHEMATIC

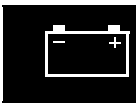


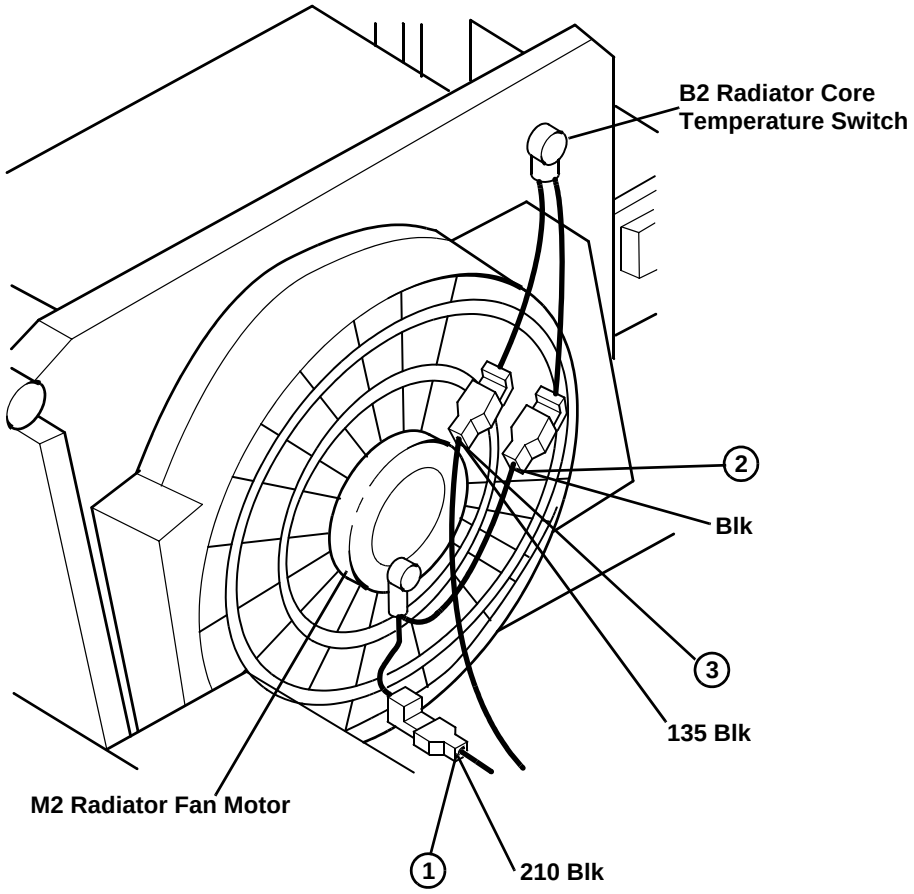
RADIATOR FAN MOTOR CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch in OFF position, engine cool.

Test/Check Point	Normal	If Not Normal
1. Radiator fan motor	Battery voltage	See Power Circuit Diagnosis. Check 210 Red/ Blk wire, F4 fuse link and connections.
2. Radiator core temperature switch	Battery voltage	Check fan motor and core temperature switch Blk wires and connections.
3. Radiator core temperature switch	Continuity to ground	Check X2 connector, 135 and 125 Blk wires and connections.




B2 Radiator Core
Temperature Switch
2
Blk
3
135 Blk
M2 Radiator Fan Motor
1
210 Blk

HEADLIGHTS AND BLACKOUT LIGHTS KIT CIRCUIT OPERATION

Function:

HEADLIGHTS

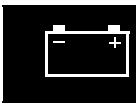
Provide power to illuminate the headlights.

BLACKOUT LIGHTS

Provide power to illuminate the front and rear marker lights.

Operating Conditions:

HEADLIGHTS



The start switch in the RUN position and the headlight switch ON.

BLACKOUT LIGHTS

The start switch in the RUN position and the blackout light switch ON.

Theory of Operation:

HEADLIGHTS

With the start switch in the RUN position, power is supplied to the headlight switch S5 via the 400 and 410 Yel/Red wires to the X5 connector to the 400 Yel/Red wire and the S5 headlight switch. With the headlight switch in the ON position, power is supplied to the 455 Yel/Wht wire and the LH headlight and the 456 Yel/Wht wire and the RH headlight. The 100 and 110 Blk wires provide the ground from the headlights to the X6 connector. From the X6 connector the ground path is provided by the 105, 145, 100 and 125 Blk wires.

BLACKOUT LIGHTS

With the start switch in the RUN position, power is supplied to the blackout light switch S7 via the 400 and 410 Yel/Red wires to the X5 connector to the 207 and 206 Yel wires and the S7 blackout light switch. With the blackout light switch in the ON position, power is supplied to the 205, 204, 203, 202, 201 and 200 Yel wires.

The 204 Yel wire supplies voltage to the right front marker light.

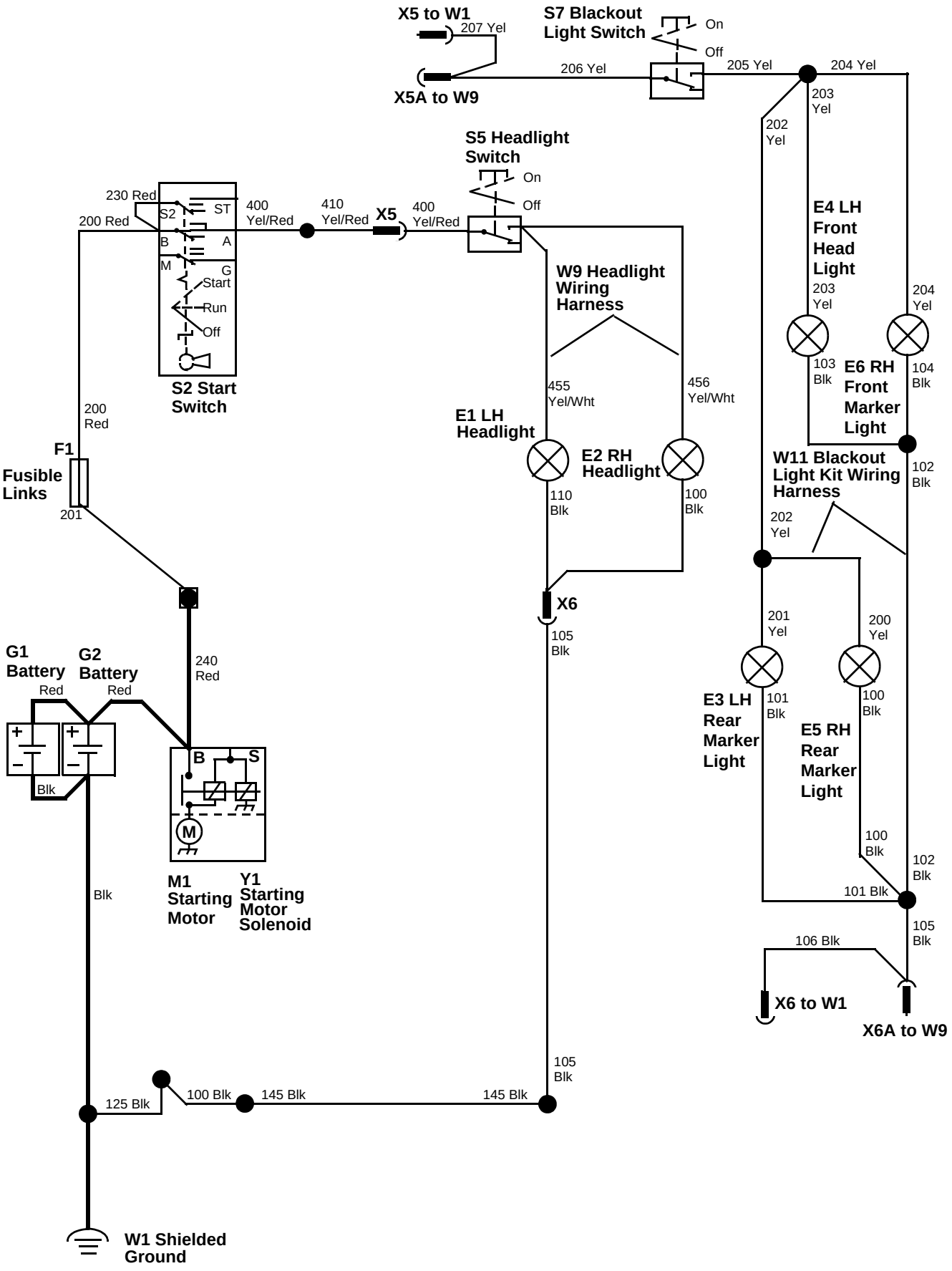
The 203 Yel wire supplies voltage to the left front headlight.

The 201 Yel wire supplies voltage to the left rear marker light.

The 200 Yel wire supplies voltage to the right rear marker light.

The 100, 101, 102, 103, 104, 105 and 106 Blk wires of the W11 wiring harness provide the ground from the marker lights to the X6 connector. From the X6 connector the ground path is provided by the 105, 145, 100 and 125 Blk wires of the W1 wiring harness.

HEADLIGHTS AND BLACKOUT LIGHTS KIT CIRCUIT SCHEMATIC



HEADLIGHTS AND BLACKOUT LIGHTS KIT CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch must be in the RUN position
- Headlight switch ON
- Blackout light switch OFF

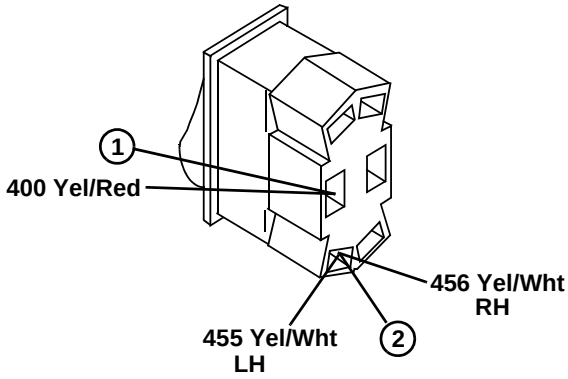
Test/Check Point	Normal	If Not Normal
1. Headlight switch	Battery voltage	See Power Circuit Diagnosis. Check connection at X5 headlight wiring harness power connector.
2. Headlight switch	Battery voltage	Replace headlight switch.
3. LH headlight	Battery voltage	Check 455 Yel/Wht wire and connections.
4. LH headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X6), 105/145/100/125 Blk wires and connections to W1 shielded ground.
5. RH headlight	Battery voltage	Check 456 Yel/Wht wire and connections.
6. RH headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X6), 105/145/100/125 Blk wires and connections to W1 shielded ground.

Test Conditions:

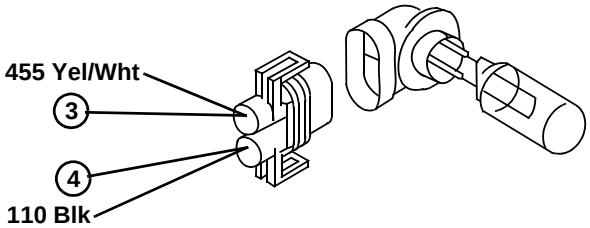
- Start switch must be in the RUN position
- Headlight switch OFF
- Blackout light switch ON

7. Blackout light switch	Battery voltage	Check connection at X5 connector.
8. Blackout light switch	Battery voltage	Replace blackout light switch.
9. LH rear marker light	Battery voltage	Check 201 Yel wire and connections.
10. RH rear marker light	Battery voltage	Check 200 Yel wire and connections.
11. LH front headlight	Battery voltage	Check 203 Yel wire and connections.
12. RH front marker light	Battery voltage	Check 204 Yel wire and connections.
13. Marker light	Greater than 0 volts - less than 0.2 volts	0 volts: Replace marker light. Greater than 0.2 volts: Check ground circuit connection at X6 connector, 105/145/100/125 Blk wires and connections to W1 shielded ground.

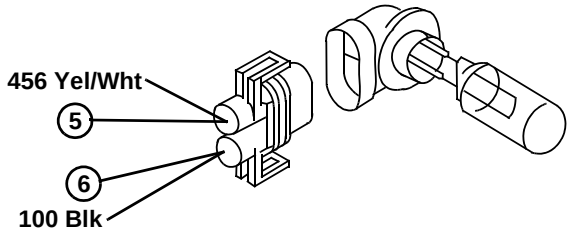
S5 Light Switch



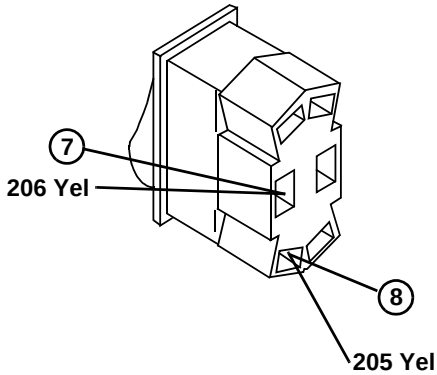
E1 LH Headlight



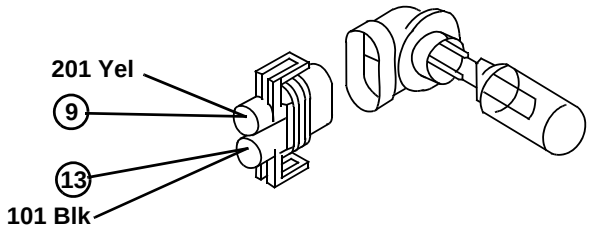
E2 RH Headlight



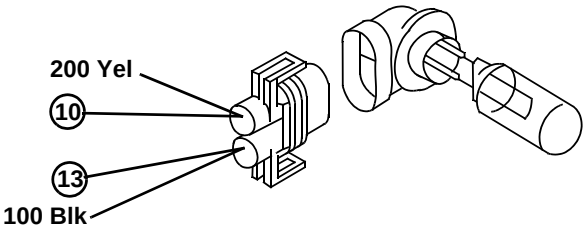
S7 Blackout Light Switch



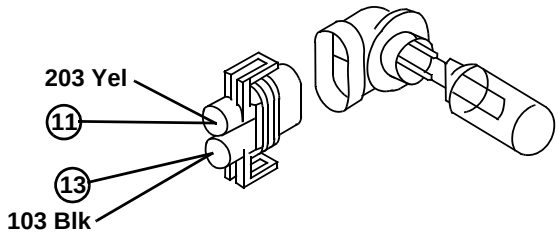
E3 Left Rear Marker Light



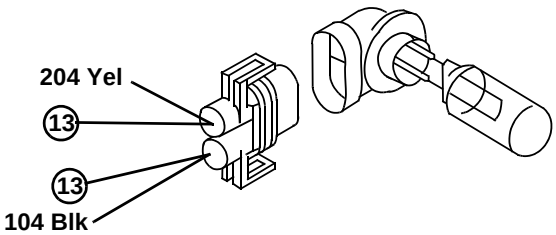
E5 Right Rear Marker Light



E4 Left Front Headlight



E6 Right Front Marker Light



HOUR METER CIRCUIT OPERATION

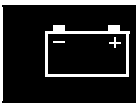
Function:

To record the number of hours the start switch is in the RUN position.

Operating Conditions:

- Start switch in RUN position.

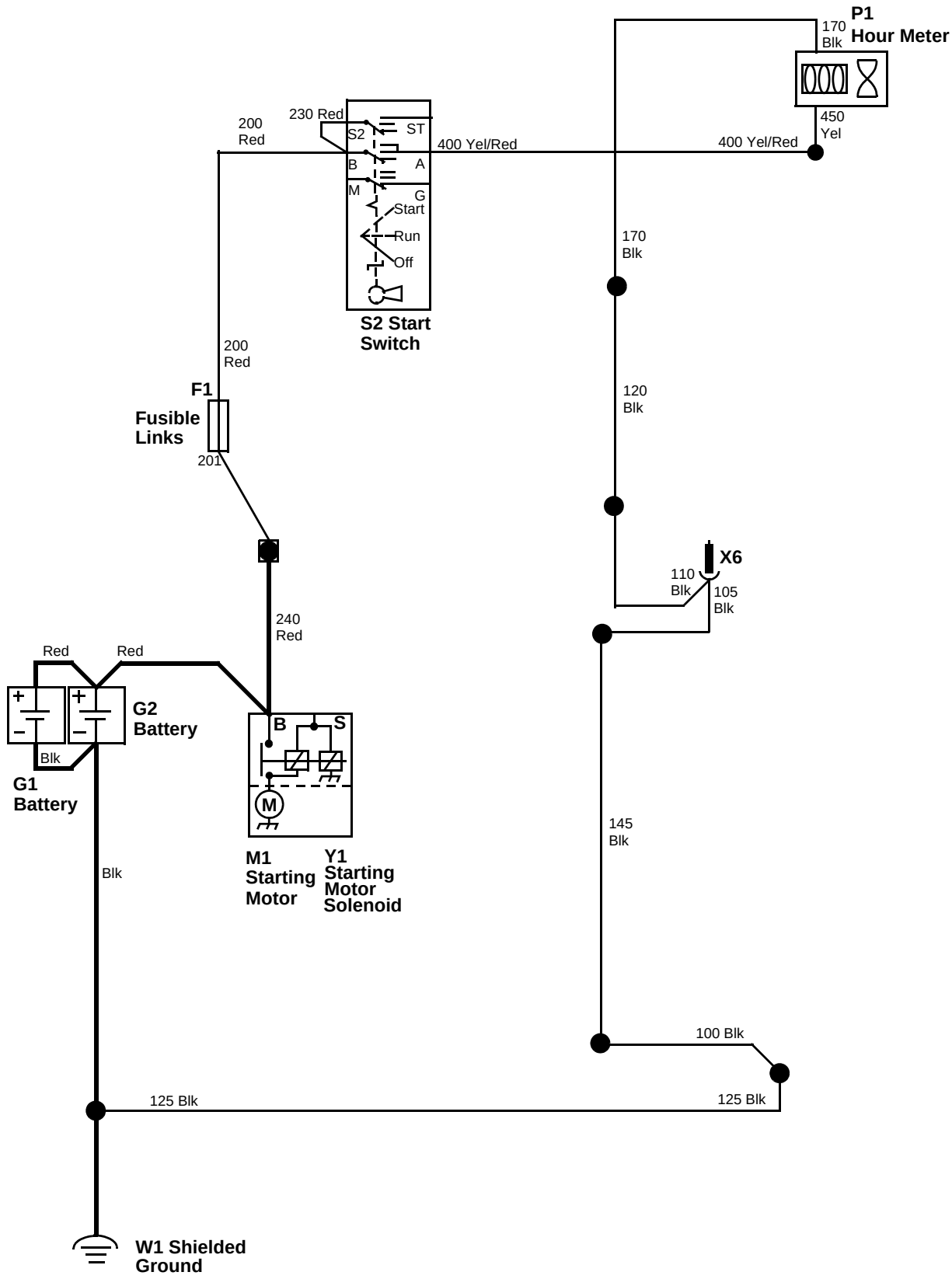
Theory of Operation:



The power circuit provides current to the start switch (S1) and protects the hour meter circuit with a fusible link (F1). Current flows from the battery (G1) positive (+) terminal to the fusible link and start switch. With the start switch in the RUN position, current flows to the 400 Yel/Red and 450 Yel wires to the (P1) hour meter.

The ground circuit 170, 120, 110, 105, 145, 100 and 125 Blk wires provides a path to frame ground for the hour meter.

HOUR METER CIRCUIT SCHEMATIC

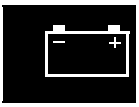


HOUR METER CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch in OFF position.
- Park brake set.

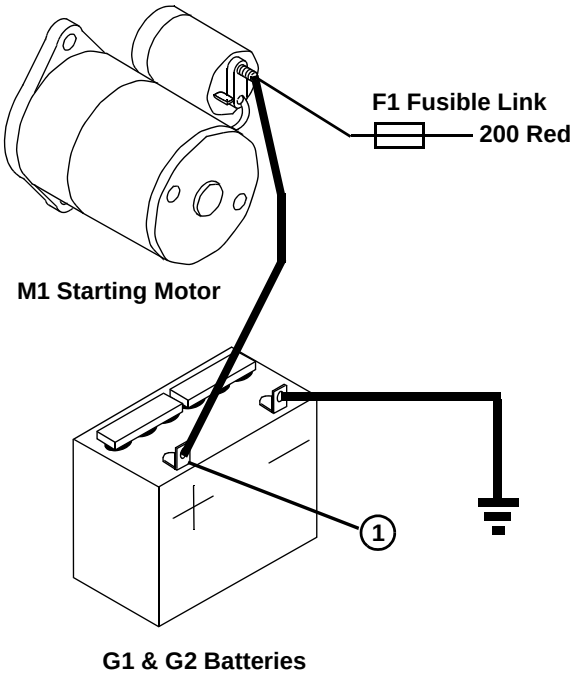
Test/Check Point	Normal	If Not Normal
1. Battery positive post	Battery voltage (11.8 - 13.3 volts)	Check and clean battery cable connections. Test battery.
2. Start switch “B” terminal	Battery voltage	Check 240 Red wire, F1 fusible link and 200 Red and connections.

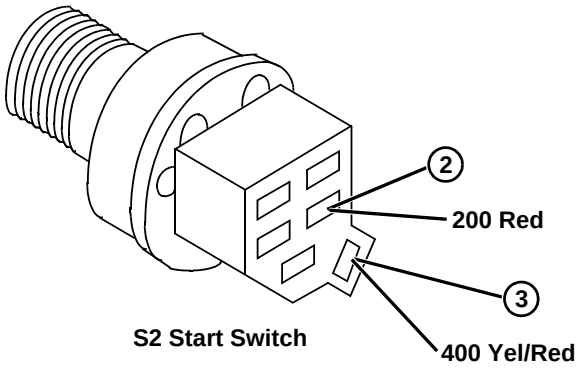


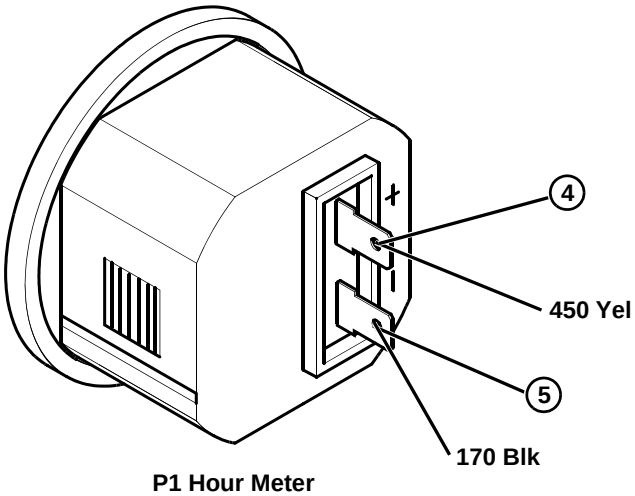
Test Conditions:

- Turn start switch in RUN position

3. Start switch “A” terminal	Battery voltage	Replace start switch.
4. Hour meter (positive terminal)	Battery voltage	Check 400 Yel/Red and 450 Yel wire and connections.
5. Hour meter (negative terminal)	Disconnect hour meter connector. Measure resistance of ground circuit for less than 0.3 ohm resistance.	Check 170, 120, 110, 105, 145, 100 and 125 Blk wires and connections. If OK, replace hour meter.


F1 Fusible Link
200 Red
M1 Starting Motor
1
G1 & G2 Batteries


2
200 Red
3
400 Yel/Red
S2 Start Switch


4
450 Yel
5
170 Blk
P1 Hour Meter

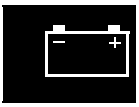
CARGO BOX LIFT SYSTEM CIRCUIT OPERATION

Function:

Controls the direction of current through the actuator motor, raising and lowering the cargo box.

Theory of Operation:

The primary controlling circuit passes through the start switch and cargo box lift switch. The cargo box lift switch is a three position self-centering switch. The start switch must be in the RUN position for the system to operate. When the cargo box lift switch is held to the raised or lower position, it energizes the appropriate directional relay.

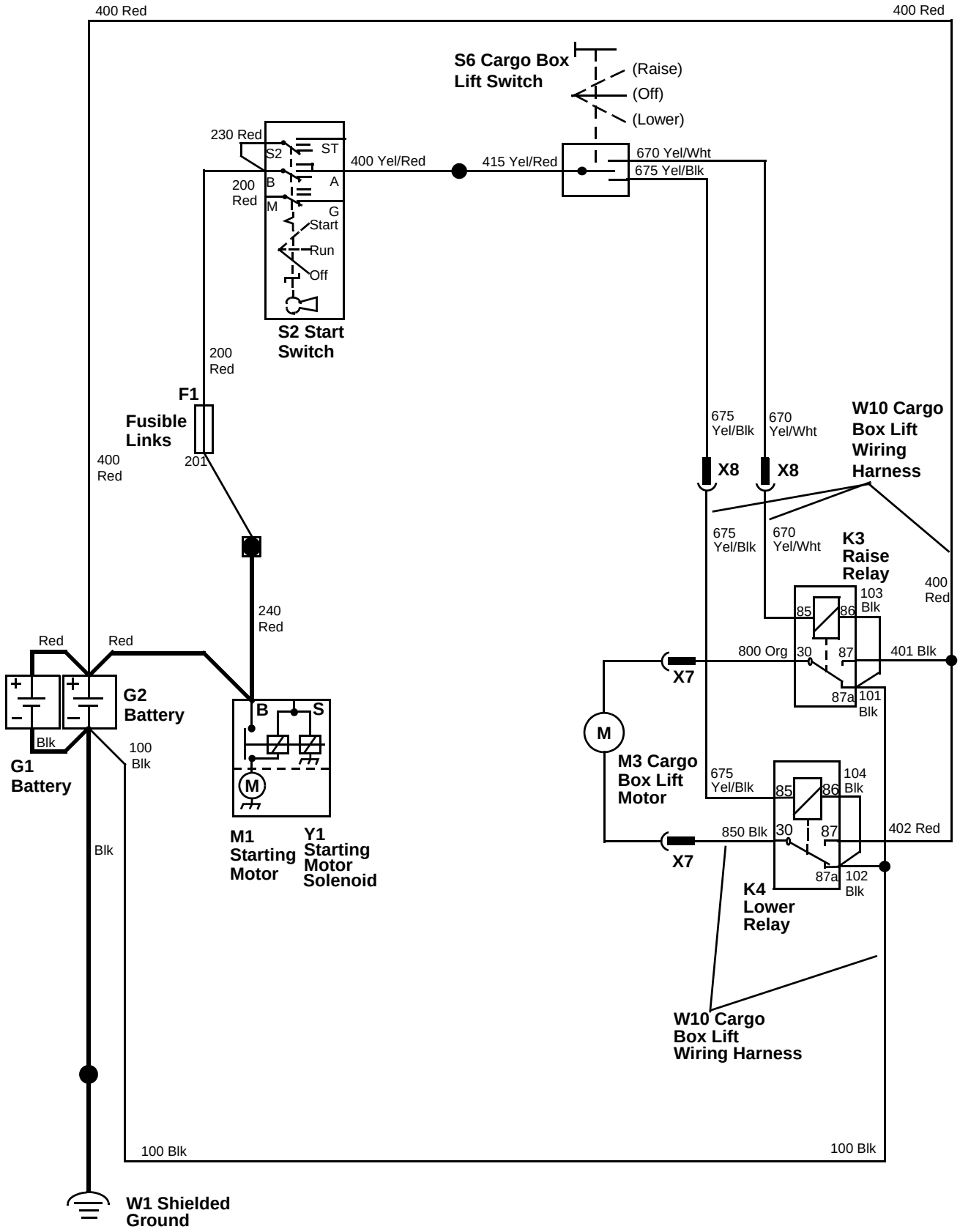


The control circuit is protected by the F1 fusible link. When the control circuit energizes a directional relay, the relay allows high current from the battery to flow to the motor.

The motor is a linear actuator. It is a screw type actuator. It consist of a electric motor, gear train, drive screw and ram. The motor turns the drive screw that extends and retracts the ram from the ram tube. The direction in which the motor turns is determined by which way current flows through it. The motor circuit is connected directly to the battery positive terminal. Current flow is controlled by the cargo box lift switch and directional control relays.

The motor ground circuit grounds through the other non-operating relay to the battery negative bolt.

CARGO BOX LIFT SYSTEM CIRCUIT SCHEMATIC



CARGO BOX LIFT SYSTEM CIRCUIT DIAGNOSIS

Test Conditions:

- Start switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Battery positive post	Battery voltage (11.8 - 13.3 volts)	Check and clean battery cable connections. Test battery.
2. Terminal 87 of both control relays	Battery voltage	Check 400 Red wire and connections. Also check for short to ground. Perform Raise Motor Amperage Draw Test.
3. Start switch “B” terminal	Battery voltage	Check 240 Red, F1 fusible link and 200 Red wires and connections.

Test Conditions:

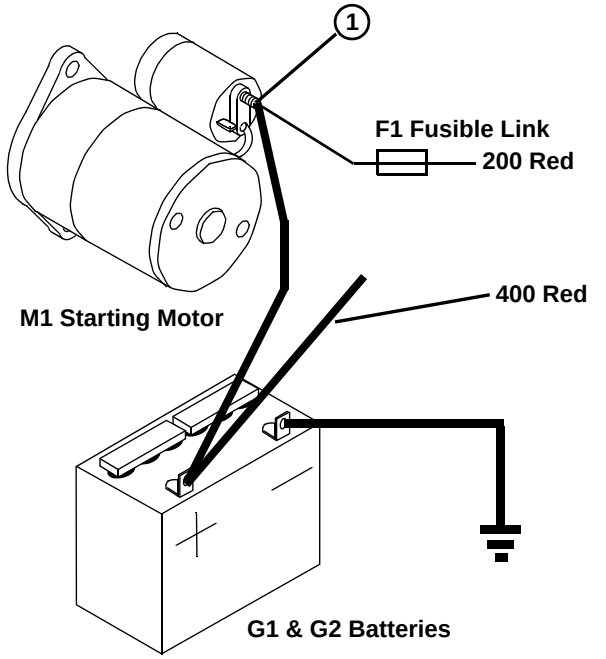
- Turn start switch in RUN position

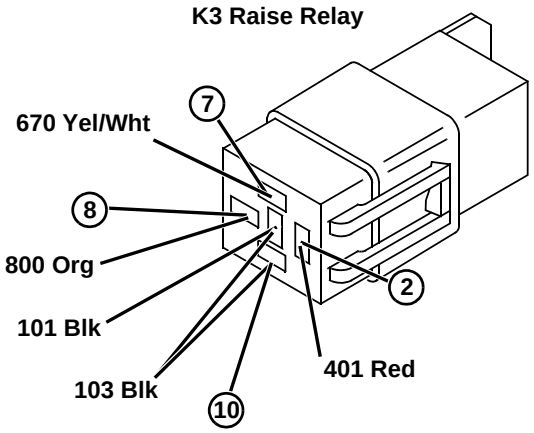
4. Start switch “A” terminal	Battery voltage	Replace start switch.
5. Cargo box lift switch	Battery voltage	Check 400 and 415 Yel/Red wires and connections.

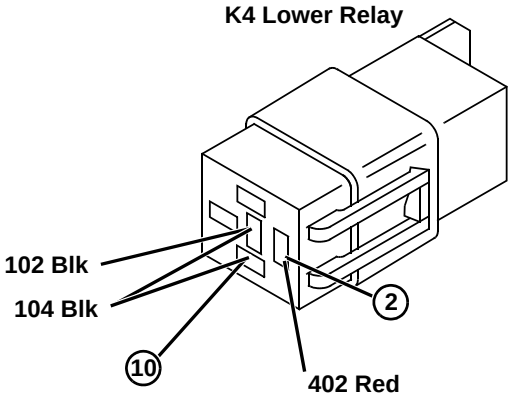
Test Conditions:

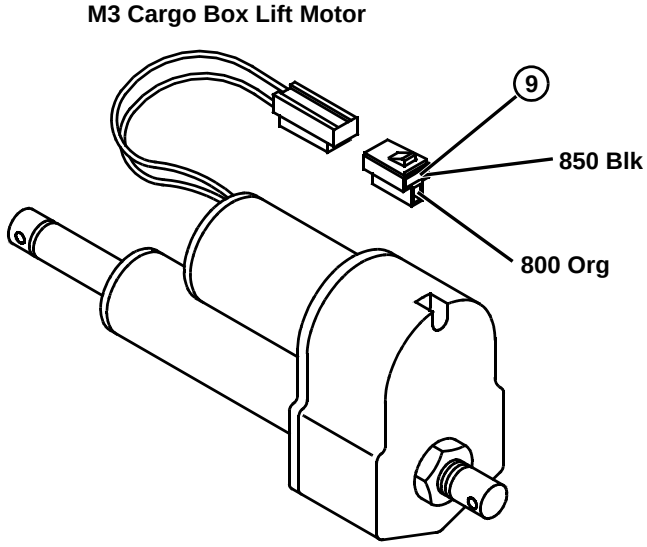
- Depress cargo box motor control switch to raise position. Hold in position for the following test.

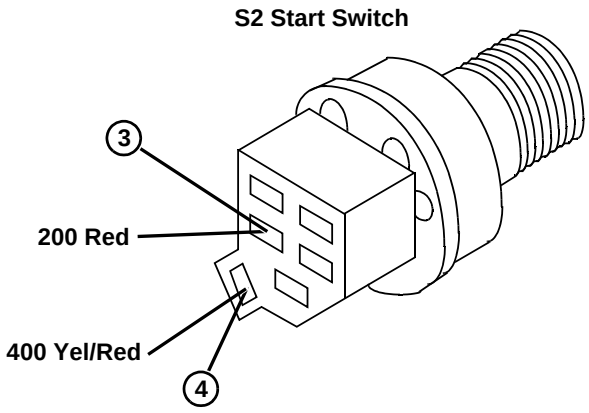
6. Cargo box lift switch Yel/Wht wire	Battery voltage	Replace cargo box control switch
NOTE: If no voltage, test with switch in lower position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.		
7. Raise relay terminal 85	Battery voltage	Check 670 Yel/Wht wire and connections.
8. Raise relay terminal 30	Battery voltage	Replace relay.
9. Motor connector	Battery voltage	Check connections and continuity of 800 Org wire between connector and relay.
10. Motor connector (ground side)	Greater than 0 volts - less than 0.2 volts OR: Disconnect motor connector and measure resistance of ground circuit for less than 1 ohm resistance	Check connections at lower relay and continuity through 30 and 87a. Replace relay. Check ground wires 100, 101, 102, 103 and 104 Blk connections and continuity. Check battery ground cable connections.

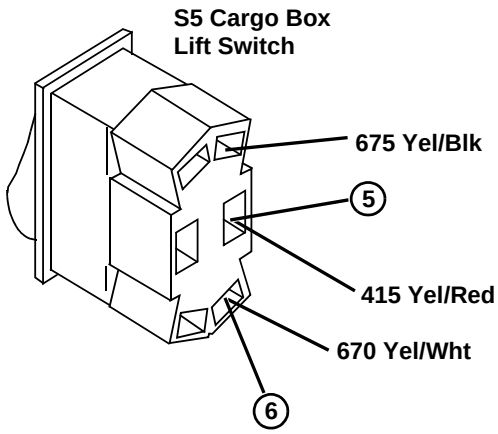

1
F1 Fusible Link
200 Red
400 Red
M1 Starting Motor
G1 & G2 Batteries


K3 Raise Relay
670 Yel/Wht
7
8
800 Org
101 Blk
103 Blk
10
2
401 Red


K4 Lower Relay
102 Blk
104 Blk
10
2
402 Red


M3 Cargo Box Lift Motor
9
850 Blk
800 Org


S2 Start Switch
3
200 Red
400 Yel/Red
4


S5 Cargo Box
Lift Switch
675 Yel/Blk
5
415 Yel/Red
670 Yel/Wht
6

CARGO BOX LIFT SYSTEM CIRCUIT DIAGNOSIS (Continued)

Test Conditions:

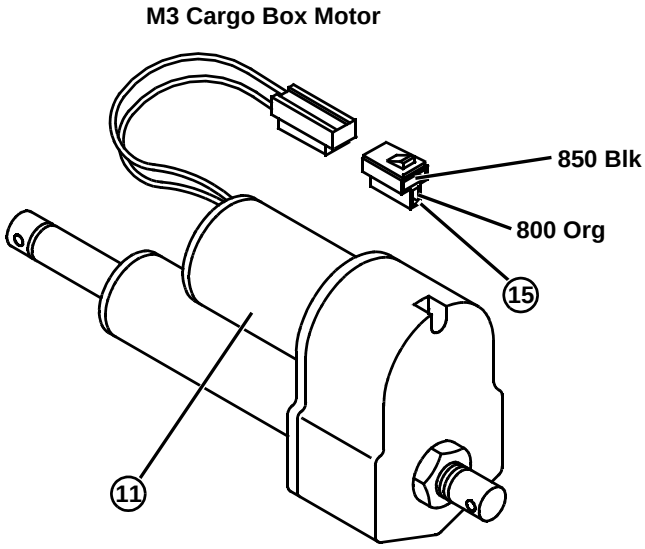
- Depress cargo box motor control switch to raise position. Hold in position for the following test.

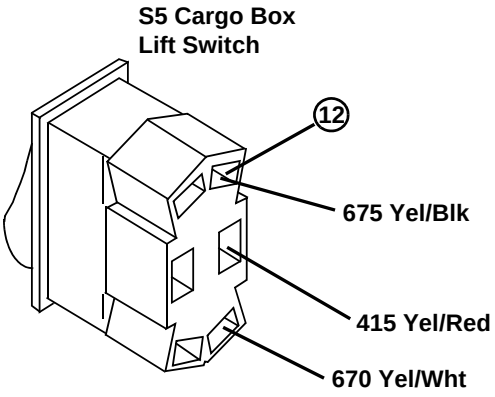
Test/Check Point	Normal	If Not Normal
11. Actuator motor	Operates and raises maximum load and holds set position	Motor operates slow. Perform Motor Amperage Draw Test. Will not hold position. See Actuator Clutch Repair. Repair or replace motor.

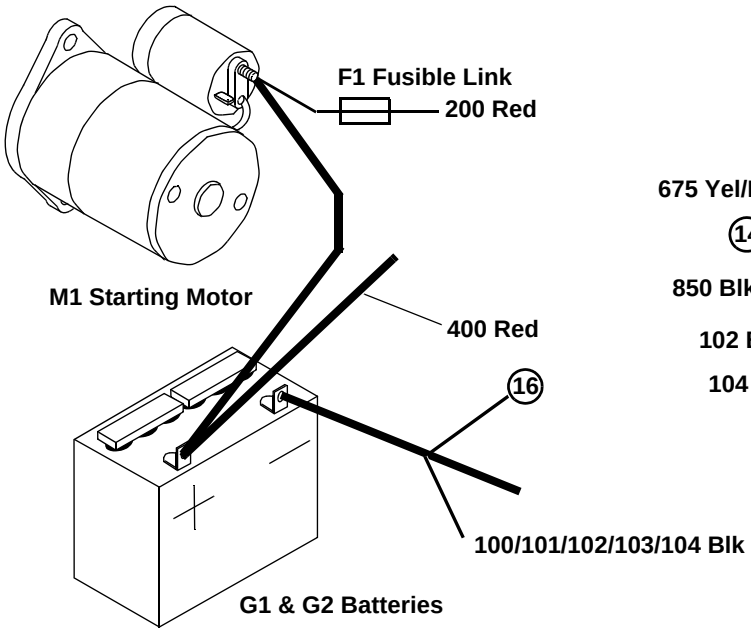
Test Conditions:

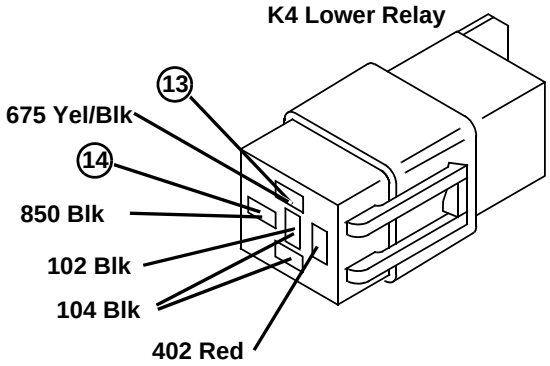
- Depress and hold cargo box control switch to lower position.

12. Cargo box lift switch Yel/Blk wire	Battery voltage	Replace cargo box control switch.
NOTE: If no voltage, test with switch in raised position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.		
13. Lower relay terminal 85	Battery voltage	Check 675 Yel/Blk wire and connections.
14. Lower relay terminal 30	Battery voltage	Replace relay.
15. Cargo box motor connector	Battery voltage	Check connections and continuity of 850 Blk wire between motor and relay.
16. Cargo box motor connector (ground side).	Greater than 0 volts - less than 0.2 volts	Check connections at raise relay and continuity through 30 and 87a. Replace relay. Check 100, 101, 102, 103 and 104 Blk ground wire connections and continuity.


M3 Cargo Box Motor
850 Blk
800 Org
15
11


S5 Cargo Box
Lift Switch
12
675 Yel/Blk
415 Yel/Red
670 Yel/Wht


F1 Fusible Link
200 Red
M1 Starting Motor
400 Red
16
100/101/102/103/104 Blk
G1 & G2 Batteries


K4 Lower Relay
13
675 Yel/Blk
14
850 Blk
102 Blk
104 Blk
402 Red

TESTS AND ADJUSTMENTS

BATTERY TEST

Reason:

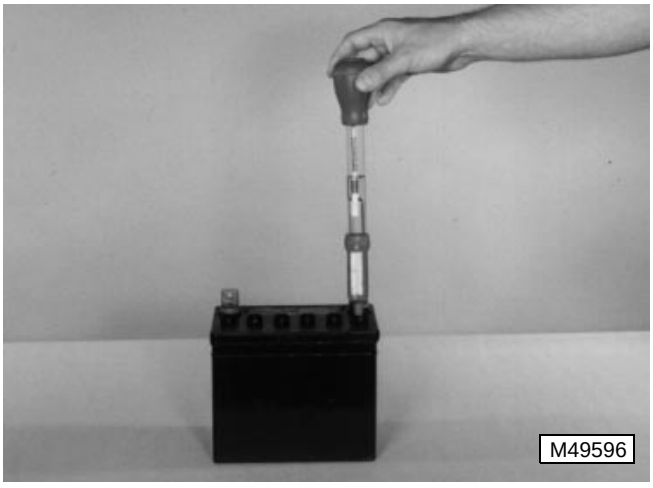
To check condition of battery and determine battery voltage.

Equipment:

- Hydrometer
- Voltmeter or JTO5685 Battery Tester

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.
6. Inspect battery terminals and case for breakage or cracks.
7. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water was added, charge battery for 20 minutes at 10 amps.
8. Remove surface charge by placing a small load on the battery for 15 seconds.


M49596

9. Use an hydrometer to check for a **minimum specific gravity of 1.225 with less than 50 point variation in each cell.**

Results:

- if all cells less than 1.175, charge battery at 10 amp rate, See “CHARGE BATTERY” on page 60.
- If all cells less than 1.225 with less than 50 point variation, charge battery at 10 amp rate, See “CHARGE BATTERY” on page 60.
- If all cells more than 1.225 with less than 50 point variation, load test battery, See “BATTERY LOAD TEST” on page 61.
- If more than 50 point variation, replace battery.

10. Use a voltmeter or JTO5685 Battery Tester to check for a **minimum battery voltage of 12.4 volts.**

Results:

- If battery voltage less than 12.4 VDC, charge battery See “CHARGE BATTERY” on page 60.
- If battery voltage more than 12.4 VDC, test specific gravity.

11. Install battery.

CHARGE BATTERY

Reason:

To increase battery charge after battery has been discharged.

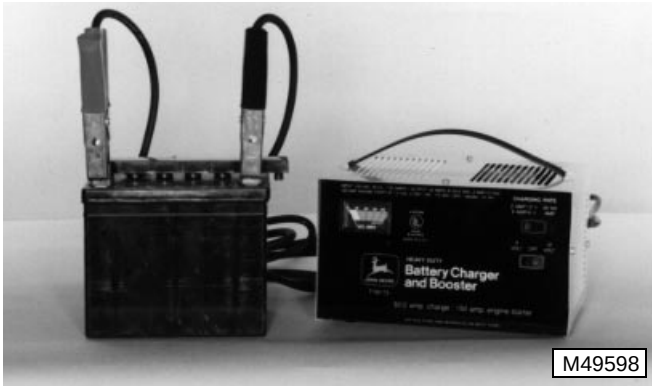
Equipment:

- Battery charger (variable rate))

Procedure:

NOTE: See BATTERY TEST in this group before charging battery.

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.



M49598

6. Connect variable rate charger to battery.

NOTE: Maximum charge time at boost setting is 10 minutes. Allow additional 5 minutes for each 10 degrees below 70 degrees F.

7. Start charger at SLOW rate. Increase charge rate ONE setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10 amp charge rate. Use boost setting as necessary.
8. Check if battery is accepting a 10 amp charge after 10 minutes at boost setting.

Results:

- If battery WILL NOT accept 10 amp charge after 10 minutes at boost setting, replace battery.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did NOT need water, go to Steps 10 and 11.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, but battery DID need water or all cells were BELOW 1.175, go to Steps 9 and 10.

9. Set charger at 15-25 amps.

IMPORTANT: Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

10. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Results:

- If MORE THAN 50 point variation between cells, replace battery.
- If LESS THAN 50 point variation between cells, go to Steps 11 and 12.

NOTE: If battery was discharged at slow or unknown rate, charge at 10-15 amps for 6-12 hours. (Maintenance-free battery: 12-24 hours.) If battery was discharged at fast rate, charge at 20-25 amps for 2-4 hours. (Maintenance-free battery: 4-8 hours.)

11. Continue to charge battery until specific gravity is **1.230-1.265 points.**
12. Load test battery. See “BATTERY LOAD TEST” on page 61.
13. Install battery.

BATTERY LOAD TEST

Reason:

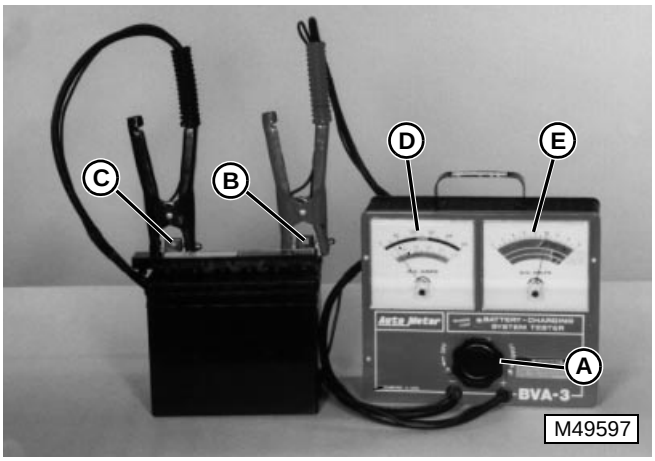
To check condition of battery under load.

Equipment:

- JTO5685 Battery Tester

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.



6. Turn load knob (A) counterclockwise to OFF position.
7. Connect tester positive cable (red) to battery positive (+) terminal (B).
8. Connect tester negative cable (black) to battery negative (-) terminal (C).
9. Turn load knob (A) of tester clockwise (in) until amperage reading (D) is equal to:
   - cold cranking amperage rating of battery (use blue scale).
   —or—
   - three times ampere hour rating (use black scale).
10. Hold for 15 seconds and turn load knob (A) of tester counterclockwise (out) into OFF position.
11. Repeat Steps 9 and 10 above and read condition of battery at DC Volts scale (E).

Results:

- If battery DOES NOT pass test and has NOT been charged, charge battery and retest. See “CHARGE BATTERY” on page 60.
- If battery DOES NOT pass the test and HAS BEEN charged, replace the battery.

ELECTRICAL SYSTEM AMPERAGE DRAW TESTS

Reason:

To measure amperage draw of electrical components when battery has a discharge problem.

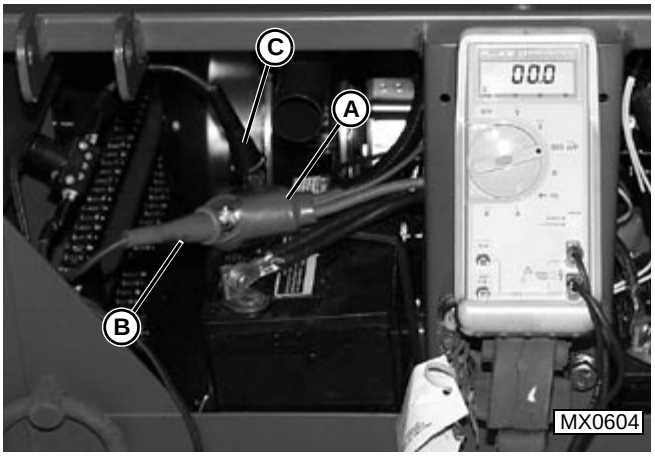
NOTE: The battery will discharge if operating several electrical components at the same time with the engine at low idle.

Equipment:

- Ammeter
- JTO5792 Ammeter Shunt Assembly

Procedure:

1. Turn start switch to off position.



2. Disconnect battery positive cables (A). Connect ammeter shunt red lead (B) to battery positive cables and the black lead (C) to battery positive terminal.
3. Set the Multi-Meter to the 300 mV scale for these tests.
4. Turn start switch to on position.
5. Turn one component ON at a time and measure amperage draw. Several components can be ON to measure total amperage draw to match a specific operating condition that a battery discharge occurs.

The following tables show approximate charging output and component amperage draw.

Alternator Output

RPM	With cold engine	With hot engine
1000	23	16
3300	51	42

Component Amperage Draw:

Item	Amp Draw
Radiator fan motor	10
Differential lock light*	1.4
Headlights*	6.9
Lift motor (Maximum load)*	28
Lift motor (No load)*	7.9
Hour meter*	1.1

*** Tests conducted with start switch ON.**

Results:

- If component amperage draw exceeds alternator output at that engine speed, the battery will discharge. Either reduce amperage draw or do not let engine idle for extended period of time.

UNREGULATED AMPERAGE TEST

Reason:

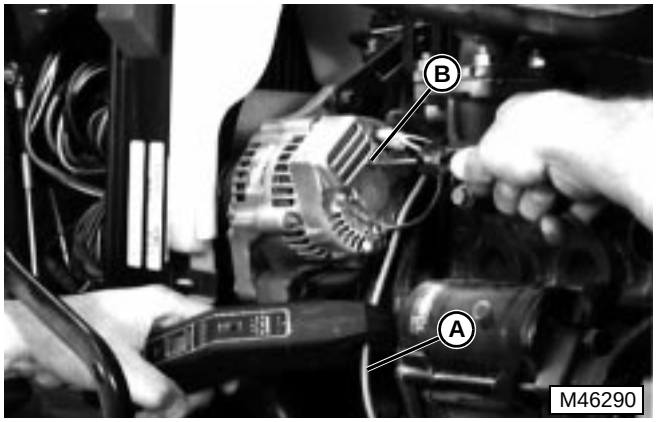
To determine charging output of the alternator stator.

Equipment:

- JTO5712 Current Gun

Connections:

1. Put JTO5712 Current Gun over alternator red wire (A). Set Current Gun for DC current.



Procedure:

IMPORTANT: Perform this test quickly to prevent damage to battery. DO NOT apply full load to battery for more than 10 seconds.

1. Start and run engine at **3300 RPM**.
2. Insert a Phillips screwdriver through hole (B) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.

Specifications:

Minimum unregulated amperage . . . . . 40 amps

Results:

- If reading does not meet specifications, verify voltage at the alternator regulated terminal and good alternator ground. If voltage and ground are OK, replace the alternator.
- If reading meets the specification, replace the regulator. See ALTERNATOR REPAIR in DIESEL ENGINE SECTION.

REGULATED AMPERAGE AND VOLTAGE TESTS

Reason:

To determine regulated voltage (charging) output of voltage regulator/rectifier.

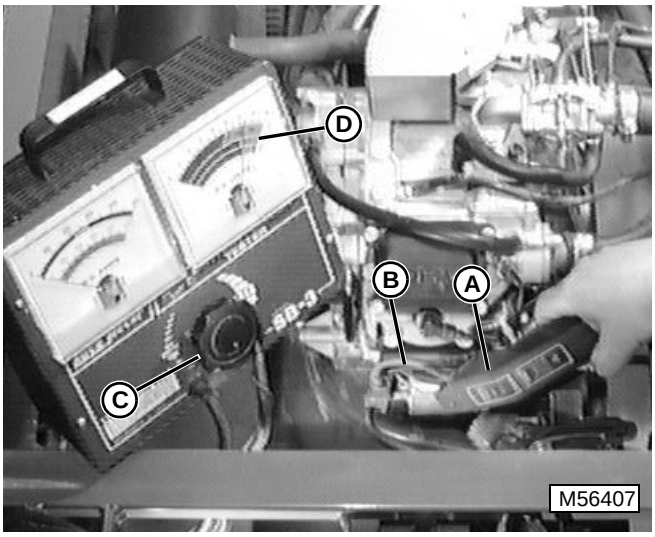
Equipment:

- JTO5712 Current Gun
- JTO5685 Battery Tester

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.

NOTE: Battery must be in good state of charge. See "BATTERY TEST" on page 60.



4. Put JTO5712 Current Gun (A) around positive (red) battery cable (B) going to starting motor so current-flow arrow points towards battery. Set current gun for DC current.

IMPORTANT: Turn load knob (C) fully counterclockwise (out) into OFF position BEFORE making any test connections.

5. 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.

6. Turn load knob (C) clockwise (in) until voltage on tester voltage scale (D) reads **11 volts for 5 seconds only** to partially drain battery.
7. Quickly turn load knob (C) completely counterclockwise (out) into OFF position.
8. Start and run engine at FAST idle. Battery voltage should read between **12.2—14.7 volts DC.**
9. Turn load knob (C) clockwise (in) until voltage on tester voltage scale (D) reads **11 volts** and look at current gun (A) for a “minimum” amperage reading of 40 amps.
10. Quickly turn load knob (C) completely counterclockwise (out) into OFF position.
11. After load test, voltmeter should return to a maximum of 14.7 volts DC.
12. If current gun amp reading is BELOW specification, test for unregulated output. See “UNREGULATED AMPERAGE TEST” on page 62.
13. If unregulated voltage output test meets specifications and you have verified voltage and ground to voltage regulator/rectifier, replace voltage regulator/rectifier.
14. If at anytime voltage increase exceeds 14.7 volts DC, replace voltage regulator/rectifier.

STARTING MOTOR LOADED AMPERAGE DRAW TEST

Reason:

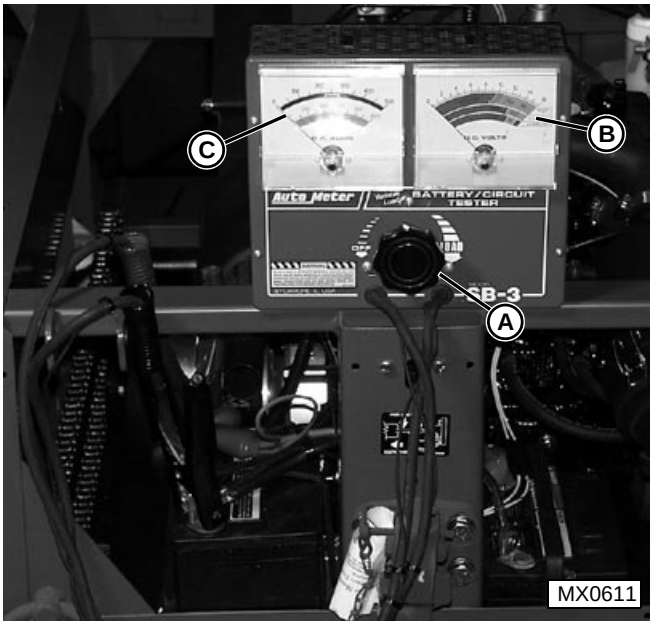
To determine the amperage required to crank the engine and check starting motor operation under load.

Equipment:

- JTO5685 Battery Tester

Procedure:

1. Park machine on flat surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Test system ground connections and battery. See “GROUND CIRCUIT TESTS” on page 72, and “BATTERY LOAD TEST” on page 61.
5. Disconnect fuel shutoff solenoid connector.



IMPORTANT: Turn load knob (A) fully counterclockwise (out) into OFF position before making any test connections.

6. Connect JTO5685 Battery Tester to battery.
7. Crank engine—read and record voltage on DC voltage scale (B) of battery tester.
8. Turn start switch to OFF position.

IMPORTANT: Perform following procedure within 15 seconds to prevent damage to tester and/or machine components.

9. Turn load knob (A) clockwise (in) until DC voltage (B) reads the same as when cranking.
10. Read and record DC amperage (C).
11. Turn load knob (A) completely counterclockwise (out) into OFF position.

Results:

- Maximum starting motor draw on should be **60 amps**.
- If amperage is above specification, perform Starting Motor No-Load Amperage and RPM Test to determine if starting motor is binding or damaged.
- If starting motor is good, check internal engine components for binding, ware, or damage.

STARTING MOTOR NO-LOAD AMPERAGE AND RPM TESTS

Reason:

To determine if starting motor is binding or has excessive amperage draw under no-load.

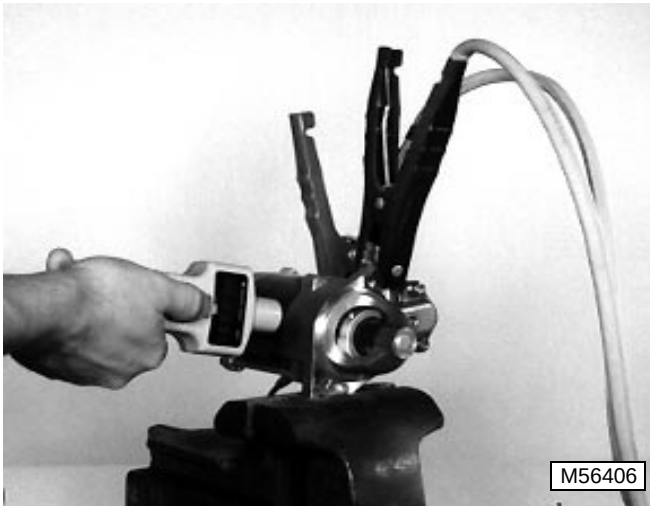
Equipment:

- JTO5712 Current Gun
- JDM71 Vibration Tachometer or JT07270 Digital Pulse Tachometer

Procedure:

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on flat surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Remove starting motor assembly to workbench.
5. Connect jumper cables to battery.



6. Connect negative jumper cable to starting motor body and positive cable (red) to solenoid battery terminal (A).
7. Use reflective tape on starting motor worm gear and JTO5719 Photo Tachometer to measure starting motor rpm's.
8. Put JTO5712 current gun around positive jumper cable (red).

IMPORTANT: Complete this test in 20 seconds or less to prevent starting motor damage.

9. Use jumper wire to briefly connect terminal (A) and solenoid engagement terminal (B).
10. Measure and record starting motor amperage and rpm's.

Results:

- a good starting motor should have **a maximum amperage reading of 50 amps and a minimum rotational reading 6000 rpm.**
- If amperage reading is above 50 amps or starting motor rpm is less than 6000, check for binding or seized bearings, sticky brushes, and dirty or worn commutator.

11. Repair or replace starting motor.

STARTING MOTOR SOLENOID TEST

Reason:

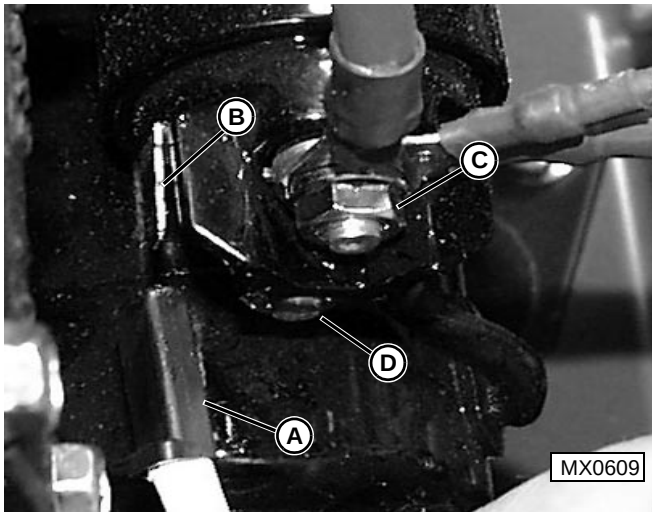
To determine if starting motor solenoid or starting motor is defective.

Equipment:

- Jumper wire.

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Disconnect the X1 connector to the fuel shutoff solenoid.
4. Cargo box RAISED and LOCKED.



5. Disconnect wire (A) from starting motor solenoid terminal (B).
6. Connect jumper wire to positive battery terminal (+) and briefly jump to starting motor solenoid terminal (B).

Results:

- Starting motor runs—solenoid is good, check circuit wiring.
- Starting motor DOES NOT run—go to Step 7.

7. Remove rubber boot(s) from terminals (C and D).
8. Connect jumper wire between starting motor solenoid large terminals (C and D).

Results

- Starting motor runs—replace solenoid.
- Starting motor DOES NOT run—check battery cables, then replace starting motor.

RELAY TEST

Reason:

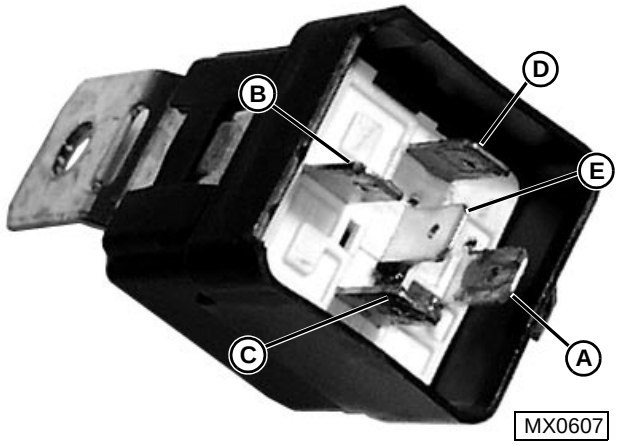
To check relay terminal continuity in the energized and de-energized condition.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Disconnect relay connector from harness.



5. Check continuity.

Results:

- there should be continuity between terminals (A) and (B), and between terminals (C) and (D);
- there should NOT be continuity between terminals (E) and (B).

6. Connect a jumper wire from battery positive (+) terminal to relay terminal (C). Connect a jumper wire from relay terminal (D) to ground (-).

Results:

- there should be continuity between terminals (E) and (B).
- If continuity is NOT correct, replace relay.

NEUTRAL START SWITCH TEST

Reason:

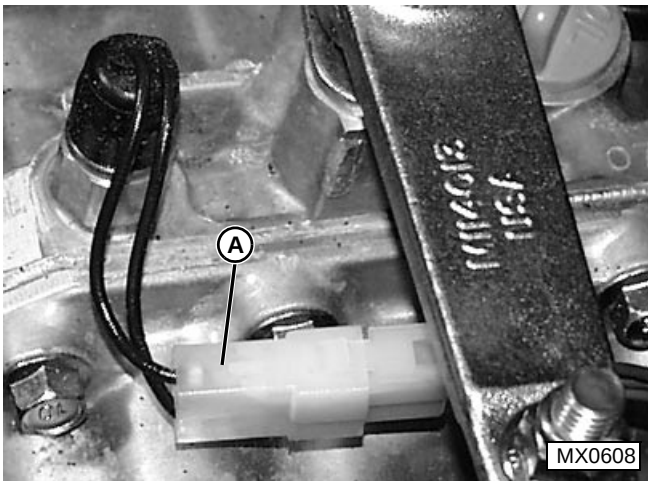
To make sure the neutral start switch terminals have continuity when the gear shift is in neutral position.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



NOTE: When transaxle shift lever is in NEUTRAL the neutral start switch plunger is DEPRESSED.

4. Disconnect neutral start switch from harness and check continuity across neutral start switch terminals (A).

Results:

- There should BE continuity when shift lever is in NEUTRAL position**.**
- If the neutral start switch DOES NOT have continuity with the plunger DEPRESSED (while the gear shift is in NEUTRAL position), replace the switch.

5. Move transaxle shift lever into FORWARD and then REVERSE (this should RELEASE switch plunger) and check continuity across neutral start switch terminals (A).

Results:

- there should NOT BE continuity when shift lever is in FORWARD and REVERSE.
- If the neutral start switch DOES have continuity with the plunger RELEASED (while the gear shift is in either FORWARD or REVERSE position), replace the switch.

PARK BRAKE SWITCH TESTS

Reason:

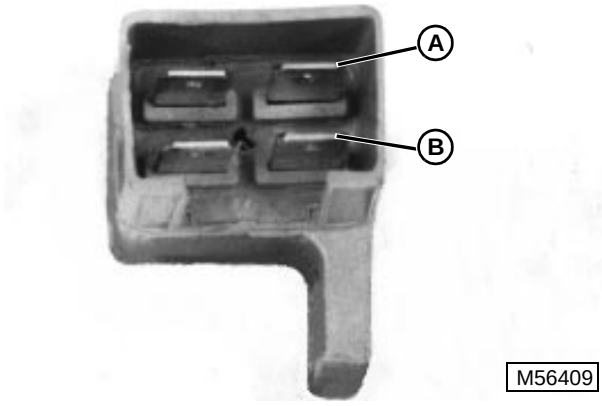
To make sure the park brake switch has continuity when plunger is RELEASED.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats, and operator's station black plastic shroud.
4. Disconnect harness connector from park brake switch.



NOTE: Two of the four terminals ARE NOT used in each of these applications.

5. Check continuity.

Results:

- there should BE continuity between terminals (A and B) when plunger is RELEASED,
- there should NOT BE continuity between terminals (A and B) when plunger is DEPRESSED.
- If continuity is NOT correct, replace switch.

ENGINE OIL PRESSURE SWITCH TEST

Reason:

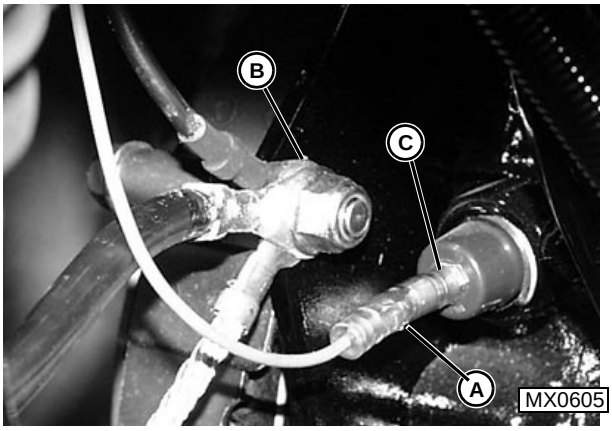
To determine if the oil pressure switch is functioning properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



IMPORTANT: Do not allow wire connector to contact engine or frame because there will be voltage at that point during the test.

4. Disconnect wiring lead (A) from switch.
5. Connect black lead of meter to engine block (B) and red lead of meter to terminal (C) of switch.
6. Set ohmmeter for 1X ohms scale.
7. Read meter.

Results:

- there should be continuity to ground.
- If the switch does NOT have continuity to ground, replace the switch.

NOTE: BE SURE to apply John Deere Pipe Thread Sealant with TEFLON®, or an equivalent to threads of switch anytime it is installed.

8. Start and run engine.
9. Read meter.

Results:

- it should NOT have continuity to ground.
- If the switch DOES have continuity to ground with the engine running, check engine oil pressure. See OIL PRESSURE TEST in ENGINE TESTS AND ADJUSTMENTS SECTION.
- If the oil pressure is to specification, replace the switch. BE SURE to apply John Deere Pipe Thread Sealant with TEFLON®, or an equivalent to threads of switch anytime it is installed.

LIGHT SWITCH TEST

Reason:

To make sure the light switch terminals have continuity when the light switch is **ON**.

Equipment:

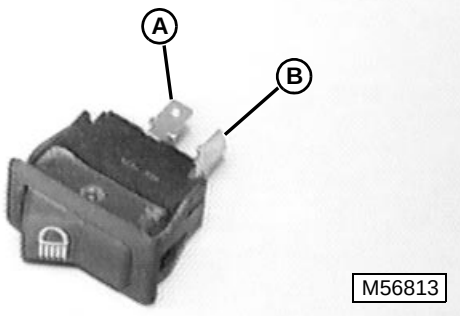
- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.

NOTE: You may want to remove front hood for easy access to dash panel electrical components.

3. Disconnect light switch connector.



4. Move light switch to the ON and then the OFF position. Check continuity between terminals (A and B).

Results:

- Terminals should have continuity with switch ON.
- Terminals should NOT have continuity with switch OFF.
- If continuity is NOT correct, replace light switch.

DIFFERENTIAL LOCK SWITCH TEST

Reason:

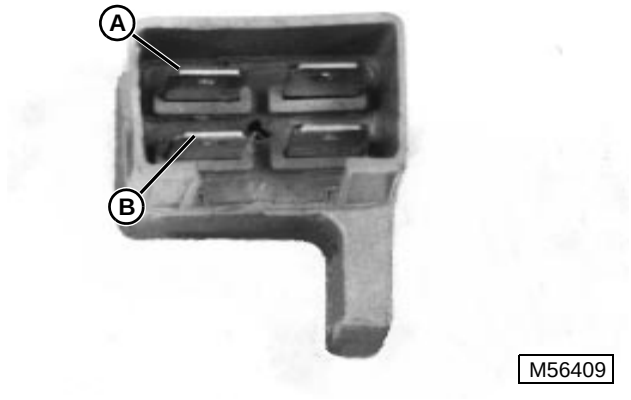
To make sure differential lock switch terminals have continuity when the plunger is DEPRESSED.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats and operator's station black plastic shroud.
4. Disconnect differential lock switch connector.



NOTE: Two of these terminals ARE NOT used in this application.

5. Check continuity.

Results:

- there should NOT BE continuity between terminals (A and B) when plunger is RELEASED,
- there should BE continuity between terminals (A and B) when plunger is DEPRESSED.
- If continuity is NOT correct, replace switch.

START SWITCH TEST

Reason:

To verify start switch functions are operating properly.

Equipment:

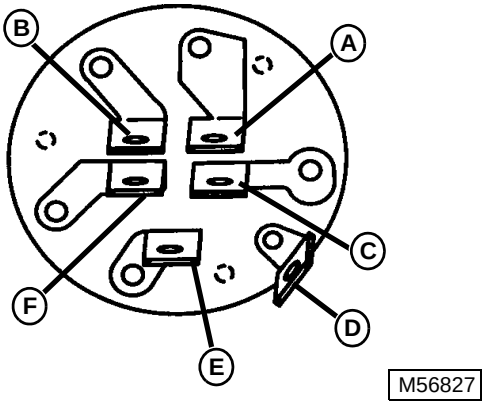
- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.

NOTE: You may want to remove front hood for easy access to dash panel electrical components.

3. Disconnect start switch connector.



4. Use an ohmmeter to test switch continuity in OFF, RUN, and START positions.

NOTE: DO NOT refer to markings stamped on terminals. Identify terminals by art keys ONLY. Terminal combinations other than those listed in chart should NOT have continuity.

Start Switch Continuity:

Switch Position	Terminal Continuity
OFF	A and B
RUN	C and D
START	C and D
	E and F

Results:

- If any continuity is NOT correct, replace switch.

CARGO BOX LIFT SWITCH TEST

Reason:

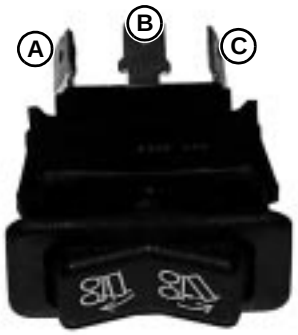
To make sure the cargo box lift switch terminals have continuity in the proper positions.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface with the start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove front hood for access to dash panel electrical components.
4. Disconnect cargo box lift switch connector.



MX0612

5. Check continuity between terminals (A, B and C) with the switch in its normal (static) position.

Results:

- Terminals should NOT have continuity.
- If continuity is NOT correct, replace switch.

6. Press the switch to the RAISE position and check continuity between terminals (A, B and C).

Results:

- Terminals (B and C) should have continuity.
- Terminals (A and B) and (A and C) should NOT have continuity.
- If continuity is NOT correct, replace switch.

7. Press the switch to the LOWER position and check continuity between terminals (A, B and C).

Results:

- Terminals (A and B) should have continuity.
- Terminals (A and C) and (B and C) should NOT have continuity.
- If continuity is NOT correct, replace switch.

FUEL SHUTOFF SOLENOID TEST

Reason:

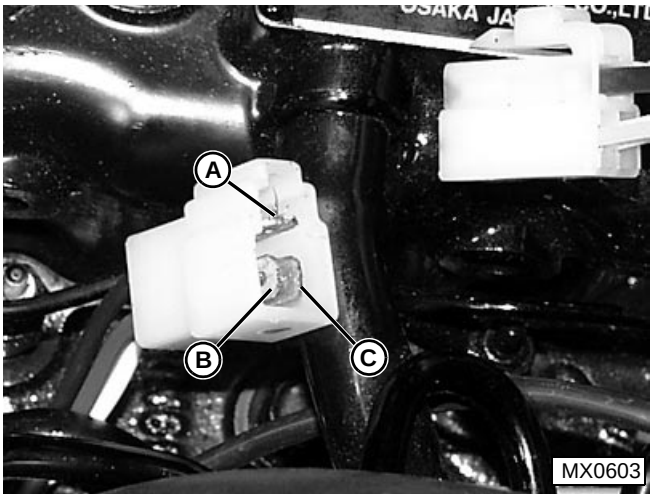
To verify fuel shutoff solenoid is functioning properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Disconnect fuel shutoff solenoid connector.



MX0603

5. Measure and record the resistance across each combination of terminals as listed below.

The red lead position of the VOM is listed across the top and the black lead position of the VOM is listed down the side.

Results:

	Blk Wire (A)	Red Wire (B)	Wht Wire (C)
Blk Wire (A)		12	0.4
Red Wire (B)	12		12.4
Wht Wire (C)	0.4	12.4	

- If continuity is NOT correct, replace fuel shutoff solenoid.

RADIATOR CORE TEMPERATURE SWITCH TEST

Reason:

To verify radiator core temperature/fan motor switch is functioning properly at specified temperatures to turn cooling fan ON and OFF to protect engine from overheating.

Equipment:

- Thermometer
- Glass Container
- Heating Unit
- Ohmmeter

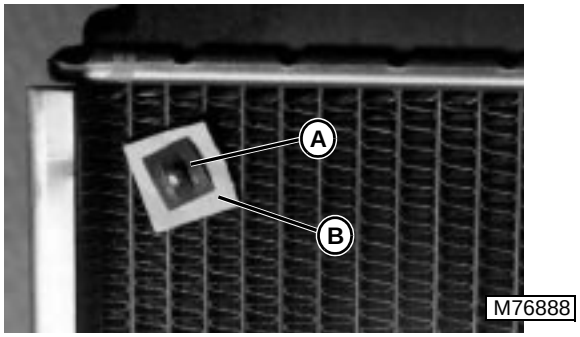
Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Disconnect negative battery cable from battery.

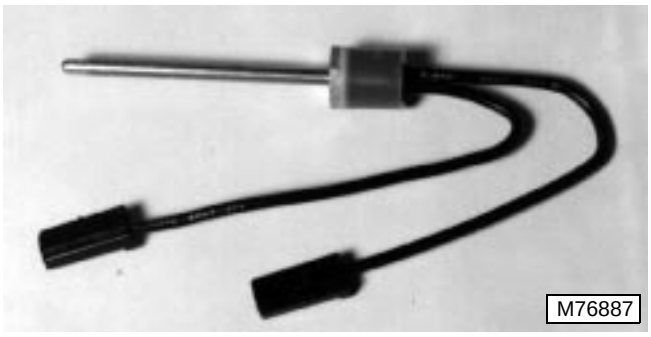
CAUTION

Radiator fan can start at any time, even with start switch in the OFF position. Always disconnect the negative battery cable before doing any electrical repair.

4. Remove seats and operator's station black plastic shroud.
5. Disconnect electrical leads to radiator core temperature/fan motor switch sending unit on top rear inside edge of radiator.
6. Remove screen bolted to frame under passenger's right side grab handle.
7. Remove slide-in screen on right side of radiator.



8. Reaching up into frame where screens were removed, bend tabs of push-on nut (A) and remove nut and protective pad (B) from end of radiator core temperature/fan motor switch.

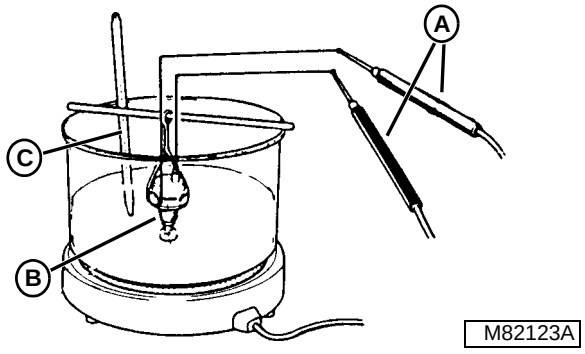


9. Pull radiator core temperature/fan motor switch from left side of radiator.

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 (A), to switch terminals.
2. Suspend switch (B) and a thermometer (C) in a container of water.
3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be **67–75°C (153–145°F)**



Results:

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

Specifications:

- Fan should turn on (switch closes) when temperature reaches **67–75°C (153–167°F).**
- Fan should turn off (switch opens) when temperature reaches **57–63°C (135–145°F)**.
- If switch fails to meet either of these specifications, replace it.

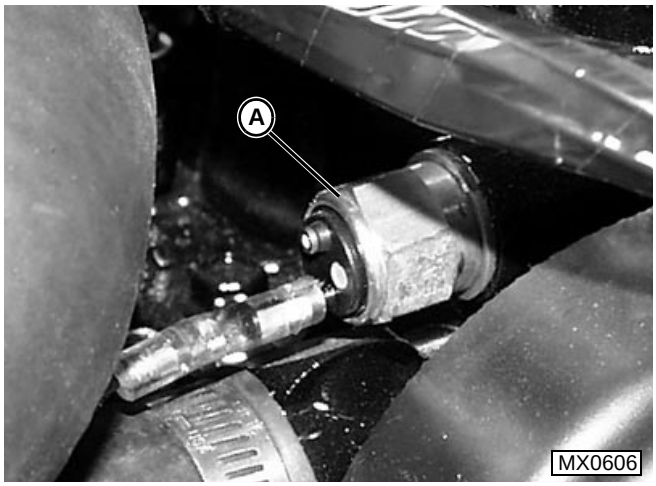
ENGINE COOLANT TEMPERATURE SWITCH TEST

Reason:

To verify coolant temperature switch is functioning properly to warn operator of an overheating engine.

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



4. There is no means to test the coolant temperature switch (A) out of the engine. Check all related components of the cooling system to determine if the switch is functioning properly:
   - check that air intake screen is clean
   - check that radiator trash screen is clean
   - check that radiator core fins are clean
   - check that coolant is properly mixed
   - perform cooling system fill/bleed procedure
   - perform thermostat test
   - check that coolant is flowing adequately through entire system
   - perform all radiator and radiator cap tests
   - check that there are no leaks in cooling system
   - perform radiator core coolant temperature/fan motor switch test.
5. If all above checks and tests prove OK, replace engine coolant temperature switch.

GROUND CIRCUIT TESTS

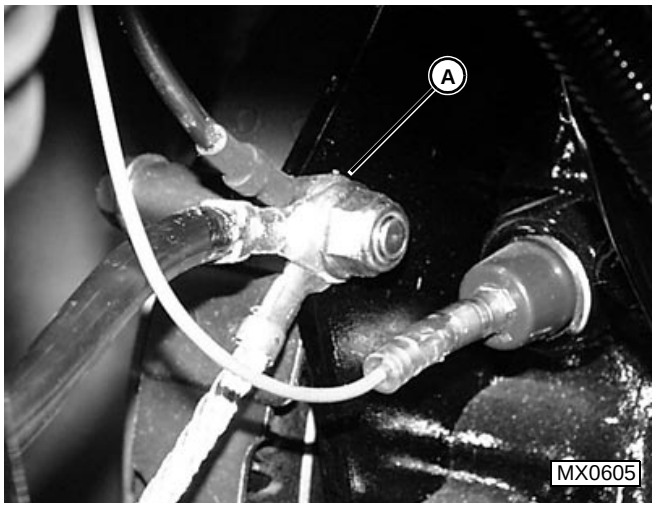
Reason:

To check for opens, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Equipment:

- Ohmmeter or Voltmeter.

The voltmeter method checks ground connections under load.



Procedure:

OHMMETER METHOD:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Connect ohmmeter negative (black) lead to negative terminal of battery. Put meter positive (red) lead on negative terminal of battery and record reading.
5. Put meter red lead on ground terminal of circuit or component (A, B, and/or C) to be tested that is closest to the battery negative terminal. **Resistance reading must be very close to or the same as the battery negative terminal reading. Work backwards from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohms.** The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. **Maximum allowable resistance in the circuit is 0.1 ohms.** Check both sides of connectors closely as disconnecting and connecting may temporarily solve problem.

VOLTMETER METHOD:

1. Park machine on level surface and turn start switch ON.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Connect voltmeter negative (black) lead to negative terminal of battery.
5. Put meter positive (red) lead on ground terminal of circuit or component (A, B, and/or C) to be tested. Be sure the component circuit is activated (key on, switches closed) so voltage will be present at the component. Record voltage. **Voltage must be greater than 0 but less than 1 volt.** Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results:

- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

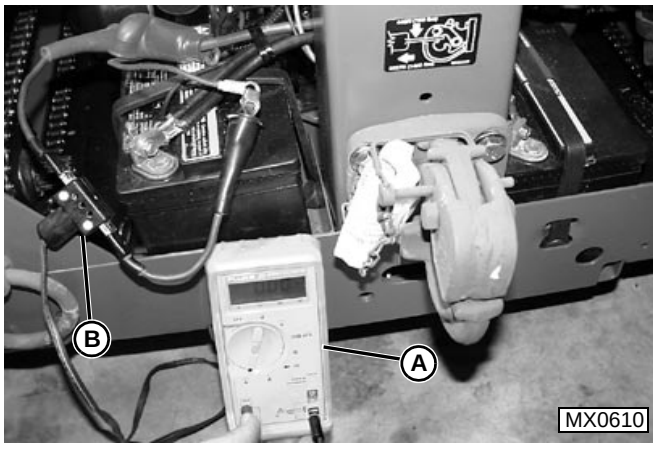
CARGO BOX MOTOR AMPERAGE DRAW TEST

Reason:

To determine the condition of cargo box motor and actuator assembly.

Equipment:

- JTO5791 Multimeter (A)
- JTO5792 Shunt (B)



Procedure:

1. Battery fully charged and start switch in RUN position.
2. Connect shunt in series between battery connection and cargo box motor. (Some jumper wire required).
3. Connect shunt leads to voltmeter.
4. Set meter to the milli-amp scale.
5. Raise box and observe amperage reading
6. Lower box and observe amperage reading.

Maximum Amperage Draw Specifications:

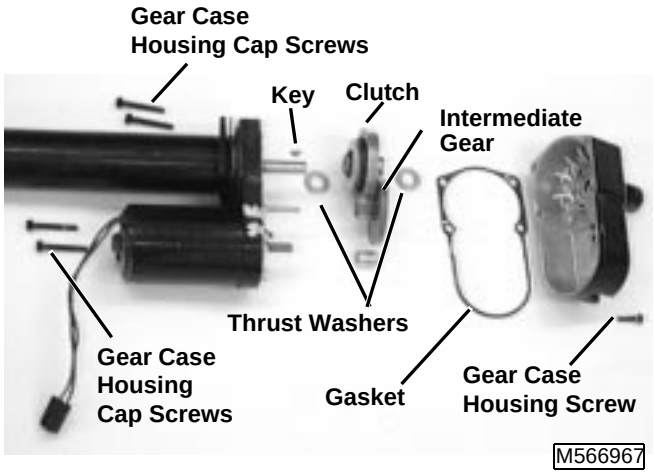
No Load Up . . . . . 3 - 6 Amps
No Load Down . . . . . 3 - 4 Amps
With Clutch Operating . . . . . 4 - 28 Amps
880 lb Load . . . . . 28 Amps

Results:

- If amperage is below specification, cargo box motor is OK, or if unit does not raise, check for stripped gears or worn clutch.
- If amperage is zero, check control circuit or fusible link.
- If control circuit and fusible link are OK, and motor will not run, thermal protector or motor maybe defective. Replace motor.
- If amperage is above specification, check cargo box for binding or gears, worm gear or bearings causing an excessive load.
- Repair or replace cargo box actuator.

CARGO BOX LIFT REPAIR

REPLACE ACTUATOR CLUTCH



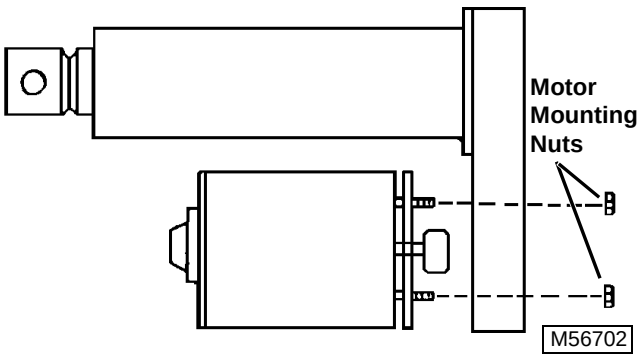
1. Remove gear case housing, intermediate gear, clutch and thrust washers.
2. Install new clutch.
3. Install new gear case housing gasket.
4. Tighten hardware evenly.

Specifications:

Gear Case Housing Cap Screws. . . 8 N•m (70 lb-in.)
Gear Case Housing Screw . . . . . 2.3 N•m (20 lb-in.)

REPLACE MOTOR

IMPORTANT: When replacing motor, note direction that motor gear is installed. Intermediate gear teeth should ride close to the center of motor gear.

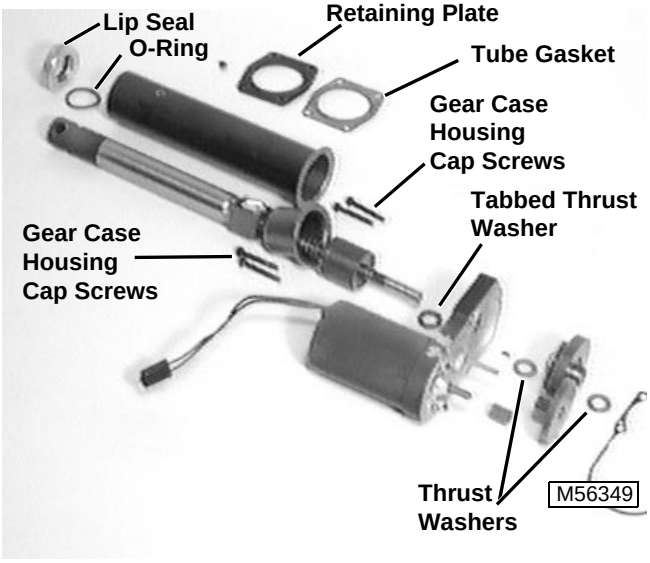


1. Remove gear case housing.
2. Remove nuts from motor.
3. Replace motor and seal.
4. Tighten nuts evenly.

Specifications:

Motor Mounting Nuts . . . . . 8 N•m (70 lb-in.)

COVER TUBE SEAL



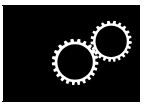
If tube is removed or leaking, replace the upper O-ring and lip seal. Drive seal and O-ring from end of tube with a disk and driver.

1. Install new lip seal and O-ring flush with end of tube.
2. Install new tube retaining gasket.
3. Install tabbed thrust washer and thicker thrust washer.
4. Tighten hardware evenly.

Specifications:

Gear Case Housing Cap Screws. . . 8 N•m (70 lb-in.)
Gear Case Housing Screw . . . . . 2.3 N•m (20 lb-in.)

CONTENTS



SPECIFICATIONS

GENERAL SPECIFICATIONS

- Chain Tension . . . . . 12 - 38 mm (0.5 - 1.5 in.)
- Chain Size . . . . . Number 50
- Chain Length . . . . . 112 Links
- Clutch Engagement Speed . . . . . 1350 - 1600 rpm
- Clutch Disengage Speed . . . . . 1300 rpm
- Drive Belt Width
  - New . . . . . Approximately 30.2 mm (1.19 in.)
  - Minimum . . . . . 27 mm (1.06 in.)
- Secondary Clutch Spring Torsion - Standard Wrap . . . . . 22 - 40 N (5 - 9 lb)
- Transaxle Oil Capacity . . . . . 4.5 L (4.75 qt)

REPAIR SPECIFICATIONS

Transaxle:

Input Shaft

- Washer Thickness (Reverse Drive Gear End)
  - Standard . . . . . 1.45 - 1.55 mm (0.057 - 0.061 in.)
  - Wear Limit . . . . . 1.20 mm (0.047 in.)
- Washer Thickness (Forward Drive Sprocket End)
  - Standard . . . . . 1.52 - 1.68 mm (0.060 - 0.066 in.)
  - Wear Limit . . . . . 1.30 mm (0.051 in.)
- Shift Collar
  - Shift Groove Width . . . . . 6.10 - 16.30 mm (0.634 - 0.642 in.)
  - Shift Groove-to-Block Clearance (Max) . . . . . 2 mm (0.080 in.)
- Spring Free Length . . . . . 29.50 mm (1.161 in.)

Shifter Arm

- Shifter Block Width . . . . . 15.7 - 15.9 mm (0.618 - 0.626 in.)
- Shifter Block-to-Collar Groove Clearance (Max) . . . . . 2 mm (0.080 in.)
- Transaxle Case Thrust Washer Thickness . . . . . 1.12 - 1.28 mm (0.044 - 0.050 in.)

Differential:

- Bevel Gear Washer Thickness
  - Standard . . . . . 1.50 - 1.70 mm (0.059 - 0.067 in.)
  - Wear Limit . . . . . 1.30 mm (0.051 in.)
- Pinion Gear Washer Thickness
  - Standard . . . . . 0.96 - 1.04 mm (0.038 - 0.041 in.)
  - Wear Limit . . . . . 0.70 mm (0.028 in.)
- Differential Lock Collar
  - Groove Width . . . . . 7.10 - 7.30 mm (0.280 - 0.287 in.)
  - Collar Groove-to-Lock Fork Finger Clearance (Max) . . . . . 2 mm (0.080 in.)

Differential Lock:

- Differential Lock Fork
  - Finger Thickness . . . . . 6.70 - 6.90 mm (0.264 - 0.272 in.)
  - Finger-to-Collar Groove Clearance (Max) . . . . . 2 mm (0.080 in.)
- Spring
  - Free Length . . . . . 93.2 mm (3.67 in.)
  - Working Load . . . . . 74 mm at 150 N (2.913 in. at 33.72 lb force)

TORQUE SPECIFICATIONS

Differential Housing Half Cap Screw and Nut . . . . . 27 N•m (20 lb-ft)
Differential Lock Lever Bracket Cap Screw . . . . . 26 N•m (230 lb-in.)
Drain Plug . . . . . 39 N•m (29 lb-ft)
Drive Axle Mounting Nut . . . . . 90 N•m (67 lb-ft)
Engine-to-Frame . . . . . 28 - 42 N•m (20 - 30 lb-ft)
Neutral Start Switch . . . . . 39 N•m (29 lb-ft)
Primary Clutch Mounting Cap Screw . . . . . 40 - 60 N•m (30 - 44 lb-ft)
Primary Clutch Spider . . . . . 135 N•m (100 lb-ft)
Rear Axle Housing Bolts . . . . . 90 - 108 N•m (66 - 80 lb-ft)
Rear Wheel Mounting Cap Screw . . . . . 100 N•m (75 lb-ft)
Secondary Clutch Mounting Cap Screw . . . . . 38 N•m (28 lb-ft)
Shifter Arm Retaining Plate Cap Screw . . . . . 25 N•m (221 lb-in.)
Transaxle-to-Frame . . . . . 155 - 195 N•m (114 - 143 lb-ft)
Transaxle Case Half Cap Screw . . . . . 35 N•m (26 lb-ft)

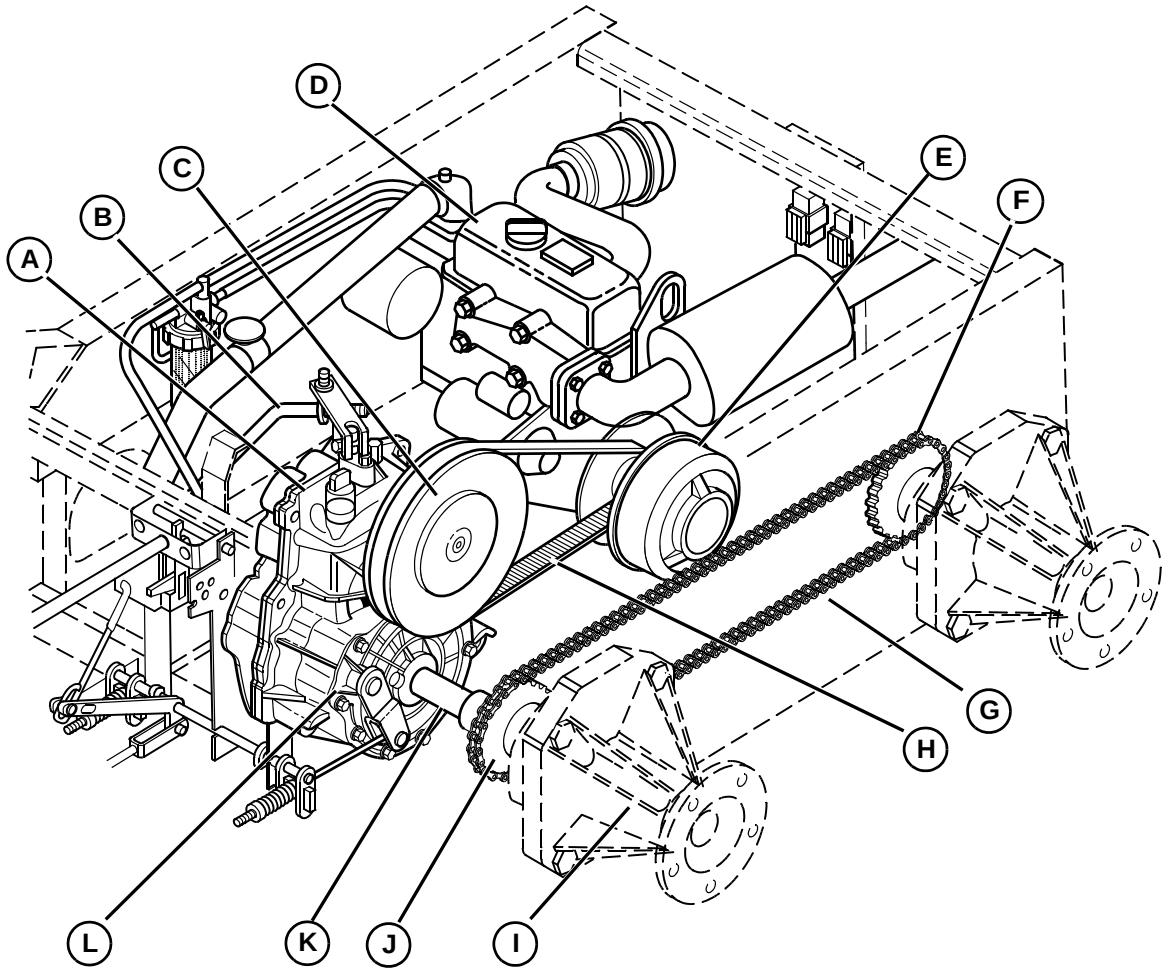
SPECIAL OR ESSENTIAL TOOLS

Number (U.S./Canadian) (Loctite)	**Name**	**Use**
JDG1175	Clutch Center Distance Gauge	Used to space clutches and engine isolator.
JDG813-1	Clutch Removal Tool	Used to remove the clutch from the engine stub shaft.
JDG813-2	Spanner Wrench	Used to remove spider.
JDG813-3	Tapered Holding Tool	Used to remove clutch cover bolts.
JDG1175-2	Center Distance Gauge	Measure and adjust rubber mounts

OTHER MATERIALS

Number (U.S./Canadian) (Loctite)	**Name**	**Use**
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY15139/ TY15443	John Deere Sealant	Seals transaxle case halves.
TY6333	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft.
TY22034	John Deere SuperLube®	Apply to rollers and cam weigh pivots of primary clutch.
TY9370/TY9477 #242	Thread Lock and Sealer (Medium Strength)	Apply to threads of secondary clutch set screw and ramp tabs. Threads of retaining screw.

COMPONENT LOCATION



A. Transaxle
B. Shift Linkage
C. Secondary Clutch
D. Engine
E. Primary Clutch
F. Rear Sprocket and Axle
G. Drive Chain
H. Drive Belt
I. . Axle Housing
J. Front Axle and Sprocket
K. Coupler
L. Internal Wet Brake

THEORY OF OPERATION

CLUTCH OPERATION

Theory of Operation:

The variable clutch system is speed and load sensitive. The primary and secondary clutches work together, automatically up-shifting and down-shifting. This shifting changes the ratio between the clutches, allowing the engine to operate at optimum efficiently, at the peak of its power curve.

The primary clutch (A) is engine speed sensitive, and is mounted on the engine crankshaft. It operates on the principle of centrifugal force. The secondary clutch (B), mounted on the transaxle input shaft, is load sensitive to the rear drive wheels.

Idle Speed:

Primary clutch is spinning with engine crankshaft, but engine speed is not enough to overcome primary spring tension. The primary clutch sheave remains opened wide and does not engage drive belt.

Engagement RPM, Minimum Load, Low Output Speed:

Primary clutch sheaves are moving closer together, just starting to move drive belt. Drive belt is running at the top of secondary clutch. A high ratio between the clutches exist, similar to a low gear, as long as there is minimal load.

High Engine RPM, Light Load, High Output Speed:

As engine speed increases, centrifugal forces of the flyweights (F) force the primary clutch to up-shift, moving the drive belt to outer pulley diameter, overcoming secondary clutch spring (C). Drive belt then is pulled deep in secondary clutch giving a low ratio, similar to a high gear.

High Engine RPM, Increasing Load, Lower Output Speed

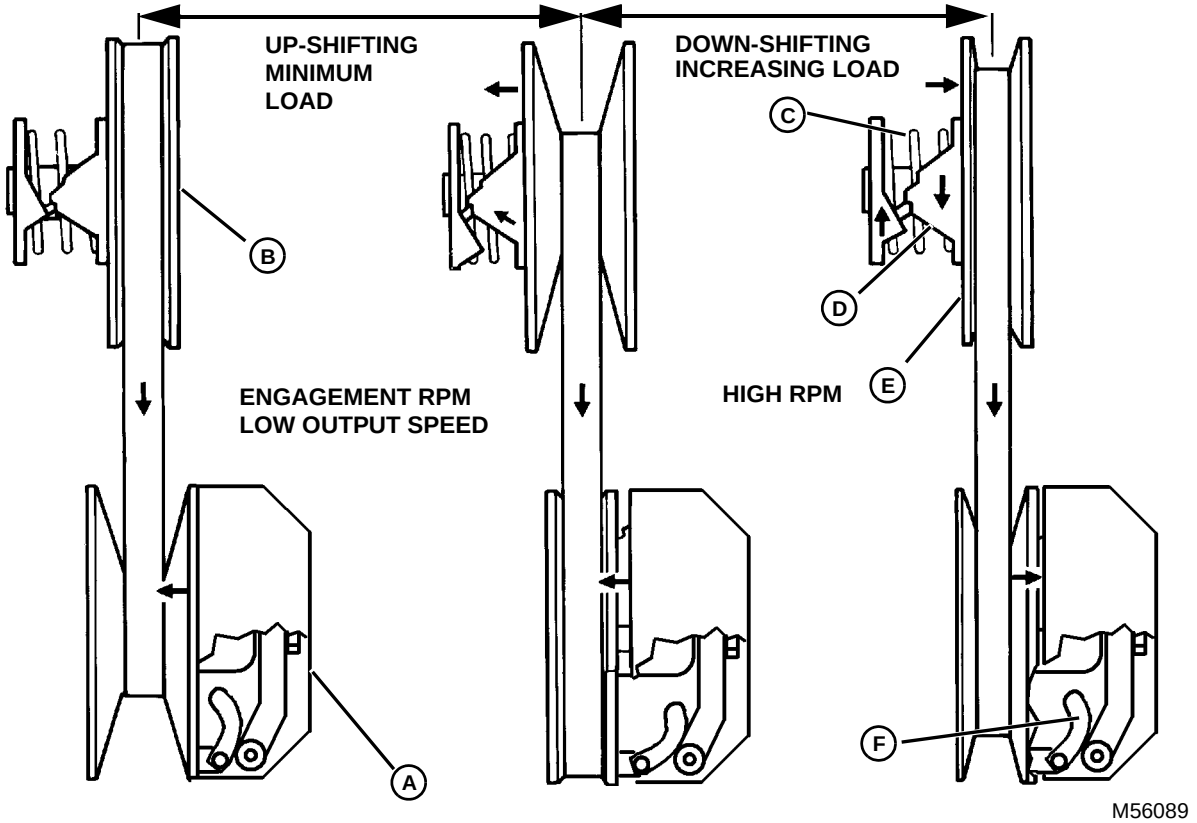
down-shifting occurs as a load is encountered, such as a hill or soft terrain. The stationary side of the secondary clutch resists forward movement of the wheels, at the same time, torque from the drive belt moves the moveable sheave up the ramp (D). The ramp and spring forces the belt to the outside diameter of the secondary clutch, and overcomes centrifugal forces of the primary clutch causing the down-shifting.

TRANSAXLE OPERATION

Function:

The transaxle provides:

- shifting into forward, neutral and reverse.
- differential action between axles for turning
- differential lock, locking axles together for better traction.



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Neutral:

In neutral the shift arm (B) centers the shift collar (P) between the forward drive gear (Q), and reverse drive sprocket (E), so they are not engaged. The input shaft (R) rotates freely, not transferring power to the gear on the reduction shaft (O). The shift fork (C) also depresses the neutral start switch (A) only allowing the engine to be started when the transaxle is in neutral.

Forward Power Flow:

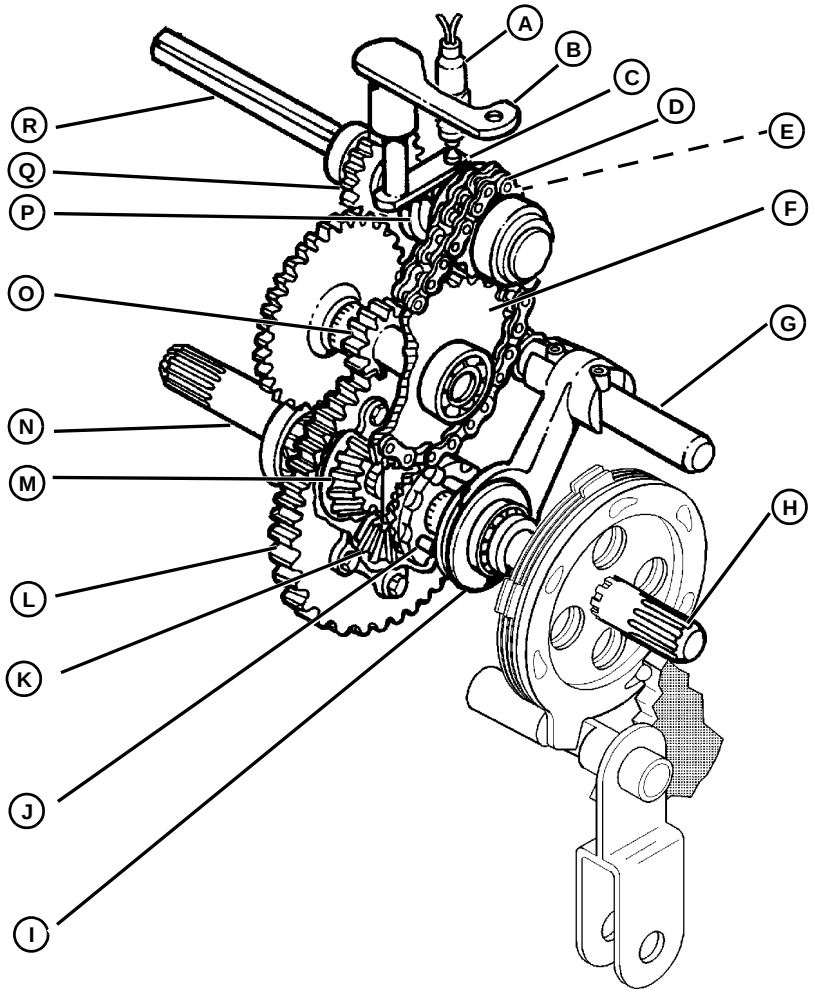
When shifted into the forward position, the shift collar (P) engages the forward drive gear (Q). Power is transmitted through the reduction shaft (O) that is in constant mesh with the differential gear (L). The differential gear (L) and assembly rotate, transferring power through the pinion (K) and side gears (M) to the output shafts (H and N).

Reverse Power Flow:

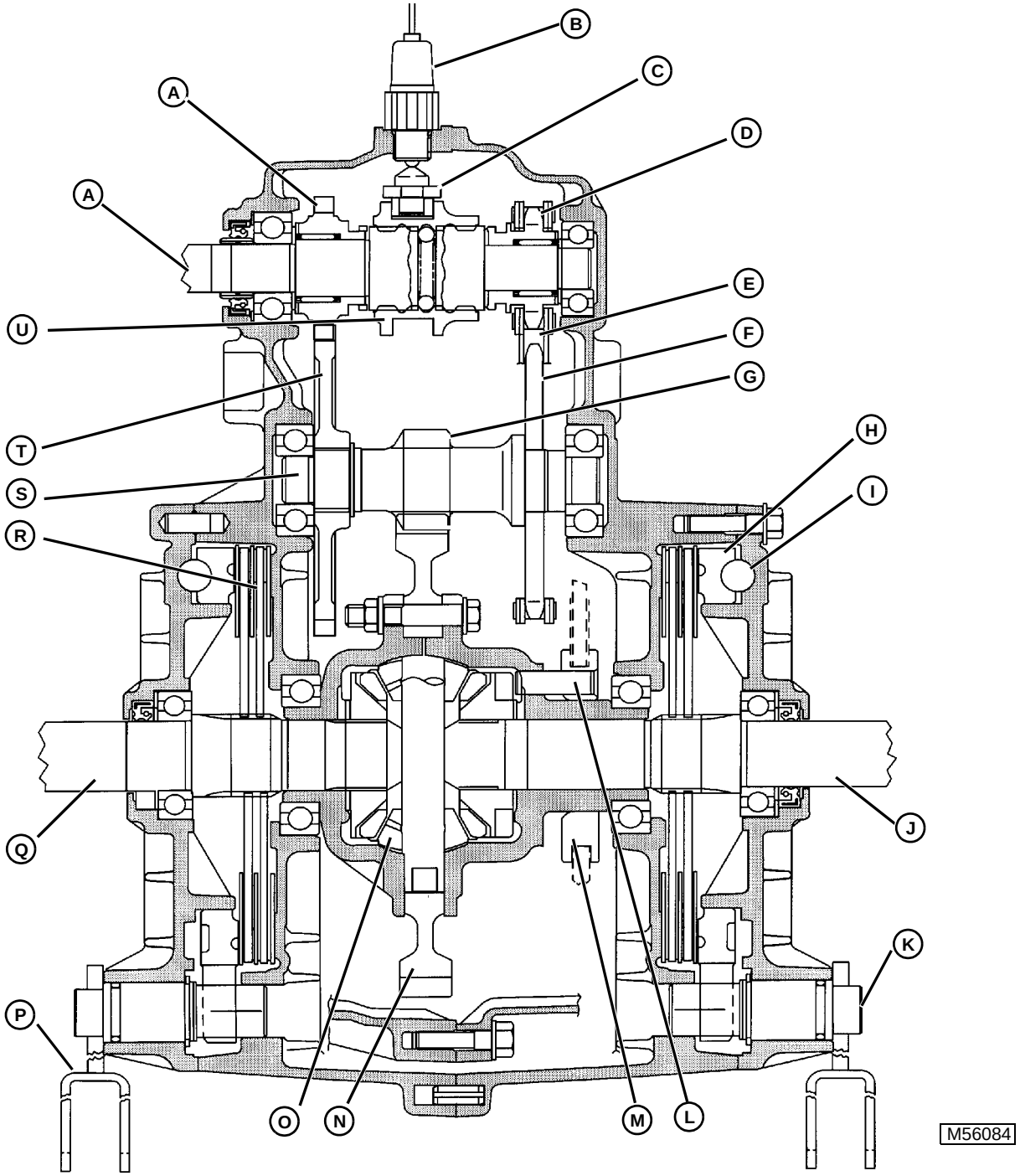
When shifted into reverse, the shift collar (P) engages the reverse drive sprocket (E), that transmits power through the reverse drive chain (D) to the reduction shaft (O). The chain drives the reduction shaft in the opposite direction of the forward gear (Q), rotating the differential gear (L) in the reverse direction. Power is then transferred through the pinion (K) and side gears (M) to the output shafts (H and N).

Differential Lock:

When the differential lock (G) is engaged, the differential lock collar (I) and pins (J) are pushed in, locking the side gears (M) to the differential housing. Power then flows equally out of both output shafts (H and N).



TRANSAXLE COMPONENT LOCATION



M. Forward Drive Gear
N. Neutral Switch
O. Shift Fork
P. Reverse Drive Sprocket
Q. Reverse Drive Chain
R. Reverse Driven Sprocket
S. Reduction Drive Shaft
T. Brake Actuator Plate
U. Ball and Ramp
V. Right Output Shaft
W. Brake Shaft
X. Differential Lock Pin
Y. Differential Lock Collar
Z. Differential Gear
AA. Differential Pinion Gears
AB. Brake Lever
AC. Left Output Shaft
AD. Brake Discs and Plates
AE. Reduction Gear Shaft
AF. Forward Driven Gear
AG. Input Shaft

DIAGNOSIS/TEST POINTS

Test Conditions:

- Engine off. Rear wheels jacked up
- Air pressure equal in all driving tires. All driving tires all close to same radius.

Test/Check Point	Normal	If Not Normal
Drive belt	Drive belt must be in good condition; minimum width 27 mm (1-1/16 in.)	Replace drive belt.
Shift linkage	Transaxle shifts into forward, neutral and reverse	Adjust shift linkage.
	Transaxle stays in gear during operation	Adjust shift linkage.
	Transaxle is driving axles and wheels	Check transaxle internal components.
Axles and brakes	Axles rotate smoothly and quietly; no free play in axles, bearings, or housings	Check axles and housings. Check axle couplers.
	Brakes not dragging	Adjust brakes.
Differential lock	Engages when in a turn or when wheels slip on one side; disengages when lever is released and torque is equalized on axles	Adjust differential lock.
	No ratcheting sound in transaxle	Check internal components.
Drive chain	Slack between 12 mm (0.5 in.) and 38 mm (1.5 in.) during rotation	Adjust drive chain tension.

Test Conditions:

- Engine running at operating temperature and brakes set.
- Transmission in neutral position.
- Ensure engine is at correct slow idle speed. See appropriate engine specifications.

34. Engine primary clutch	Primary clutch disengaged (drive belt not moving)	Repair or replace primary clutch.

Test Conditions:

- Engine running at operating temperature and brakes set.
- Transmission in neutral position.
- Accelerate engine to 1600 rpm.

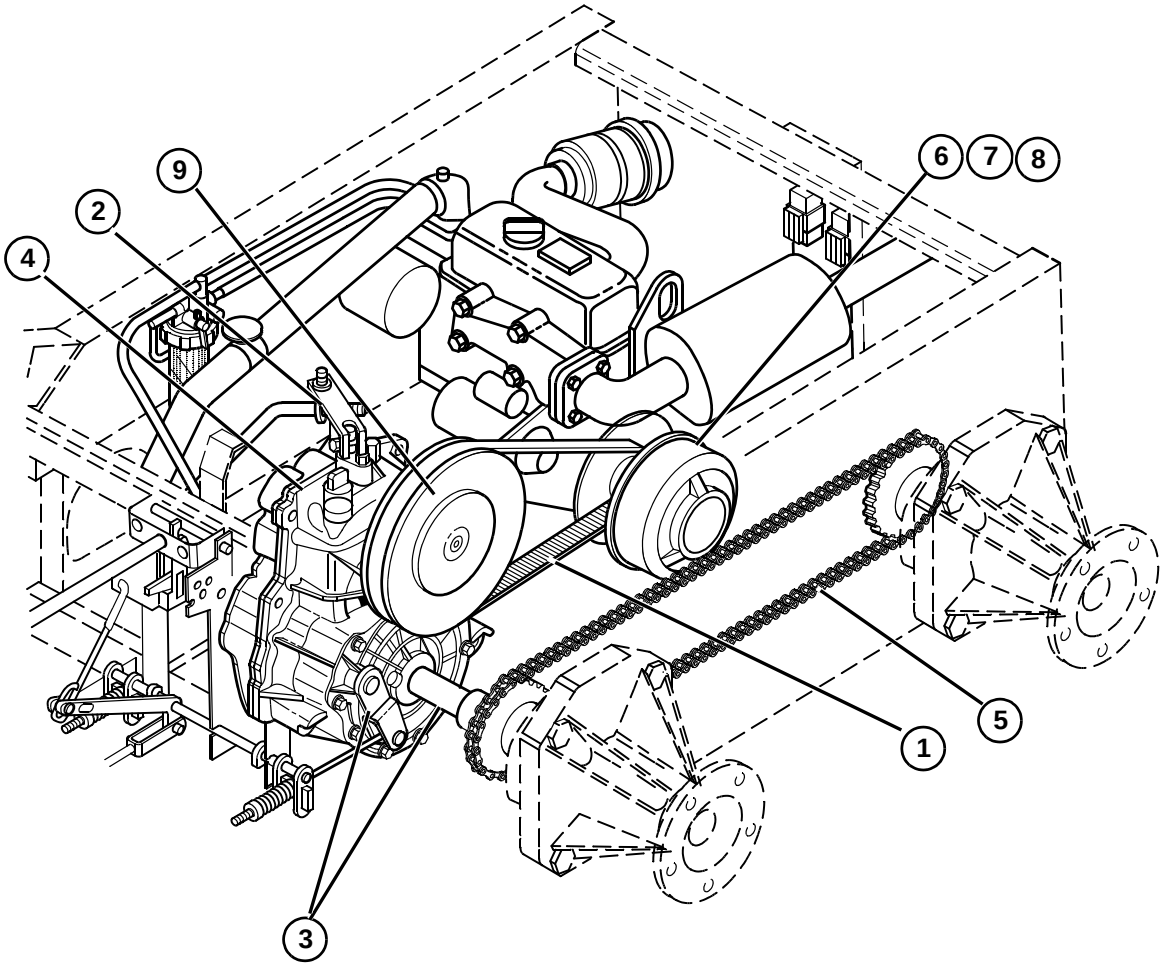
35. Engine primary clutch	Primary clutch must engage drive belt at 1350 - 1600 rpm	Replace drive belt. Repair or replace primary clutch.

Test Conditions:

- Engine running at operating temperature and brakes set.
- Transmission in neutral position.
- Ensure engine is at correct fast idle speed. See appropriate engine specifications.

36. Engine primary clutch	Primary clutch sheave (movable clutch sheave) moves toward stationary sheave	Repair or replace primary clutch.
37. Secondary clutch	Secondary clutch sheaves separate	Repair or replace secondary clutch.

Test/Check Point	Normal	If Not Normal
	Secondary clutch fully up-shifted. Primary clutch sheaves completely closed.(Drive belt will not ride at top of primary clutch).	Repair or replace drive and/or secondary clutches.
Vehicle performance	Top speed 4.5 sec. minimum per 100 ft. Acceleration to 70 ft. in maximum of 5.5 sec.	Check drive train components and engine performance. Check for correct engine mounting location.



TESTS AND ADJUSTMENTS

DRIVE BELT CHECK

Reason:

To check drive belt wear and condition of drive belt.

Procedure:

1. Measure drive belt width. Drive belt must not be less than **27 mm (1-1/16 in.)**
2. Check drive belt condition. Drive belt must not be cracked. Some amount of glazing is normal.

Results:

- If drive belt less than specification, replace.
- If drive belt is within specification, and there is performance complaint, check primary clutch and secondary clutch, and run Power Train Performance Test.

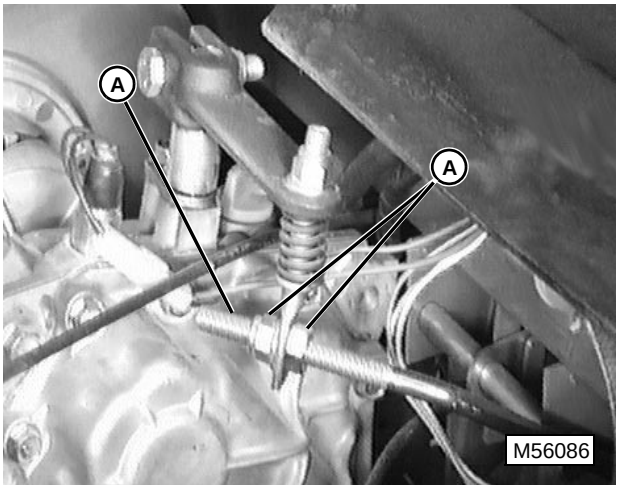
TRANSAXLE SHIFT LINKAGE ADJUSTMENT

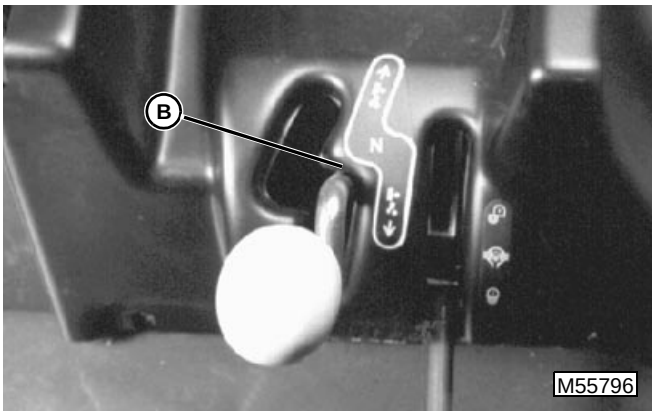
Reason:

- To insure gear shift lever is centered in neutral when transaxle is in neutral
- To insure both forward and reverse gears will be completely engaged
- To help prevent shifter from disengaging from gear during operation

Procedure:

1. Park on level surface and LOCK park brake. Engine OFF, cargo box RAISED. Plastic shroud under operator's seats must be bolted into place.
2. Move shift lever until detent inside transaxle clicks firmly into the center neutral position.





3. With transaxle in neutral detent, adjust shift rod nuts (A) so shift lever (B) is contacting the shift quadrant in neutral slot (C).

NOTE: There should be approximately 15 - 20 threads.

4. Shift into forward and reverse. Shift lever should not contact shift quadrant in the forward or reverse positions. This ensures the shift lever is not preventing the transaxle from fully engaging.

NOTE: Note location of spring. If assembled incorrectly, rod will contact other components.

5. Shift into neutral and check neutral start.
6. Drive machine over rough ground to check adjustments.

DRIVE TRAIN PERFORMANCE TESTS

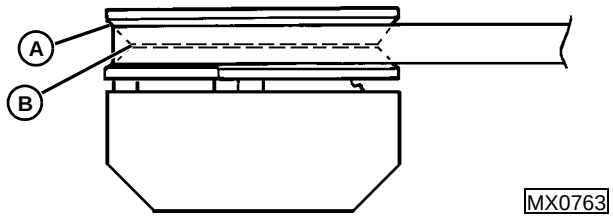
ENGAGEMENT AND FULL UP–SHIFT CHECK

CAUTION

When operating vehicle to observe drive train performance, always operate in an area flat and free of obstacles. Use a passenger to observe power train so you can concentrate on driving safely. Never back vehicle with cargo box raised.

Reason:

To determine if the engine and drive train are operating at peak performance.



Conditions:

- Engine slow and fast idle speed set correctly
- Drive belt width at or above minimum specification
- Engine warmed up

Procedure:

1. Transaxle in neutral and park brake set. Start engine.
2. Slowly increase engine rpm. Observe engine rpm when clutch starts to engage and move drive belt.
3. Accelerate from idle to wide-open-throttle and back to idle several times. Watch drive belt for a smooth transition from bottom to top of primary clutch (A). Watch closely for any hesitation or engine surging. Observe gap between primary clutch movable sheave and stationary sheave. Gap should completely close (B).
4. When approaching idle, watch for a positive disengagement from drive belt.

NOTE: On clutches with some hours of use, system may not disengage as smoothly due to primary clutch spring taking a set and other wear in the drive components.

5. Shut off engine.

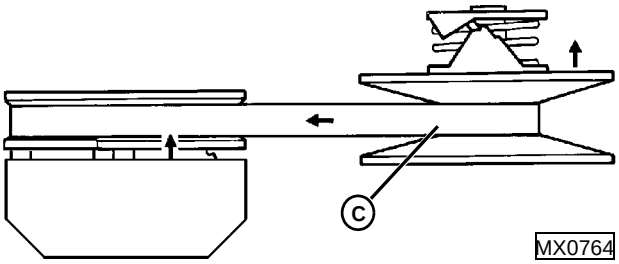
Result:

- Clutch should slowly start to engage and move drive belt between 1350 - 1600 rpm. Drive belt should be riding high in primary clutch and low in secondary clutch (C).
- If clutch has harsh engagement, erratic transition, hesitation, or clutch noise (chirping); perform primary clutch lubrication. Check primary clutch for flyweights binding, pivot pins worn, flat spots on rollers or rollers sticking, and no groove in sheave. Repair or replace primary clutch.
- If engine is surging; check engine and governor performance.
- Smooth engagement and transition (up-shift), primary clutch is good. Go to Drive Train Performance Tests; secondary clutch down-shifting check.

SECONDARY CLUTCH DOWN-SHIFTING CHECK

Reason:

To determine condition of secondary clutch (C) and down-shifting performance.



Conditions:

- Cargo box raised
- Indoor testing - all rear wheels off ground and vehicle supported safely on jack-stands.
- Front wheels chocked
- Differential lock engaged
- Tachometer displaying engine speed

Procedure:

CAUTION

Rear wheels will rotate during test. Keep clear!

1. Start engine.
2. Put transaxle in gear.
3. Operate engine at wide open throttle.

Results:

- Engine and wheel speed should remain at constant

speed. Drive belt should be riding high in primary clutch and low in secondary clutch.

Procedure:

4. Momentarily load power train by slowly applying brake or park brake until down-shift is made.
5. Quickly observe engine speed, then release brake.

Results:

- Clutches should down-shift as load is increased.
- Drive belt should not squeal or slip.
- If engine speed drops below 2400 rpm or clutches are not down-shifting, see Secondary Clutch Spring Torsion Check.
- Check secondary clutch for complete up-shift. Check for load on drive train, such as an engaged brake or failed axle bearings. (See brake adjustment procedure.)

DRIVING CHECK

Conditions:

- Cargo box empty, no passengers.
- Test on hard surface.

Procedure:

1. From a standing start, accelerate through 21.3 meters (70 ft). This should take approximately 4.5-5.5 seconds.
2. Once up to speed, travel time to cover 30.5 meters (100 ft.) should be approximately 4.5 seconds.

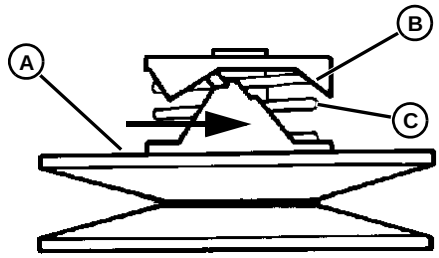
Results:

- If performance is not to specifications, check engine performance; engine rpm, governor, compression and valve clearance.
- Check secondary clutch opens freely, has correct spring tension, and all three ramp shoes are in place and against ramps. Repair secondary clutch.

SECONDARY CLUTCH SPRING TORSION CHECK

Reason:

Verify condition and spring adjustment of secondary clutch.



Conditions:

- Engine OFF and key removed
- Transmission in gear
- Park brake set
- Drive belt removed from secondary clutch

Procedure:

IMPORTANT: Do not damage sheave when clamping vise-grip. Use protective strips of brass or aluminum.

1. Clamp vise grip to movable sheave (A).
2. Using spring scale hooked into jaw of vise-grips, measure the force required to rotate the movable sheave, to where the sheave is almost contacting ramp (B).

Torque Specification for Movement:

With Standard Wrap . . . . . 75.6 N (17 lb)

NOTE: Standard torsion spring installation sets spring tab in hole "2" in moveable sheave half (Standard Wrap). Due to variations in the spring rate of the torsion spring, the spring tab may be factory set in holes "1" or "3".

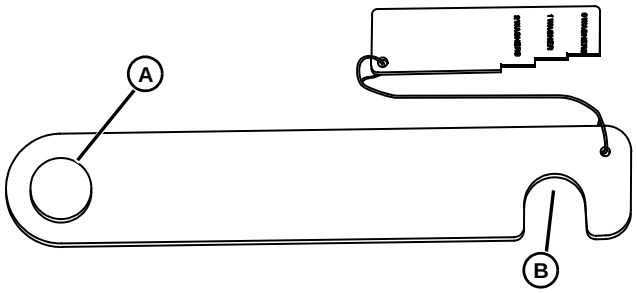
Results:

- Spring force within specification, secondary clutch is OK.
  Check engine rpm and performance.
- Spring force less than specification, up-shift will be faster and engine load greater, reducing engine rpm and response time. Check spring position, set

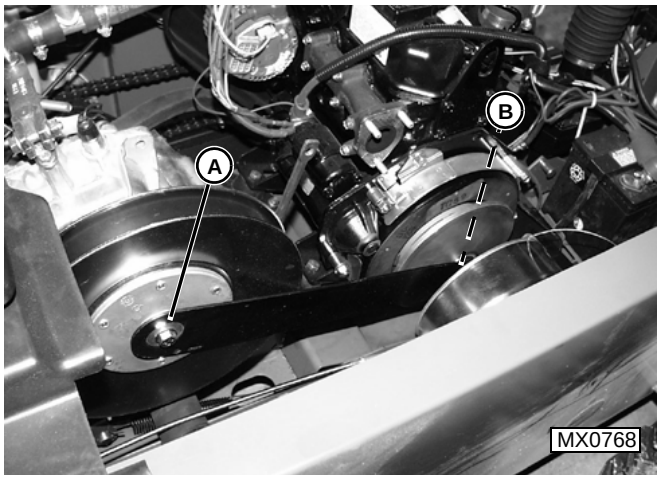
spring tab in next higher number hole. (i.e. move from hole “2” to ”3”) See “SECONDARY CLUTCH” on page 19. Re-check spring force. Replace spring if still not within specifications.

- Spring force higher than specification, up-shift or acceleration will be slower, reducing engine load, increasing engine rpm and response time. Check spring position, set spring tab in next lower number hole. (i.e. move from hole “2” to ”1”) Recheck spring force. Replace spring (C) if still not within specifications.

CLUTCH CENTER DISTANCE CHECK

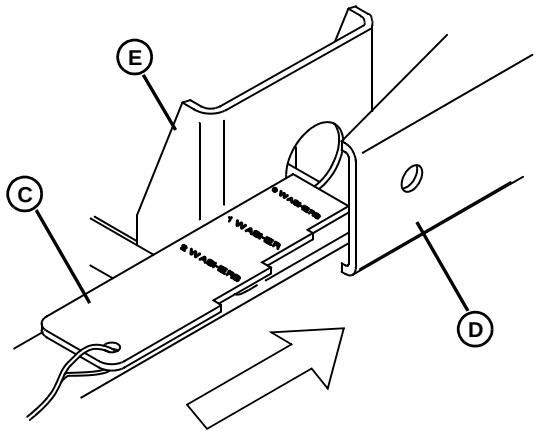


1. Remove fifth isolator.
2. Place the closed end (A) of clutch center distance gauge over the end of the secondary clutch. Position the open end (B) over the center shaft of the primary clutch.

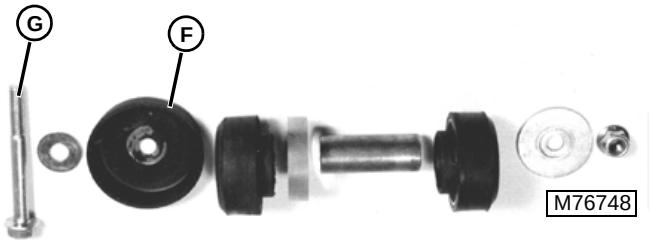


- Make sure closed end is seated completely over bushing end at secondary clutch.

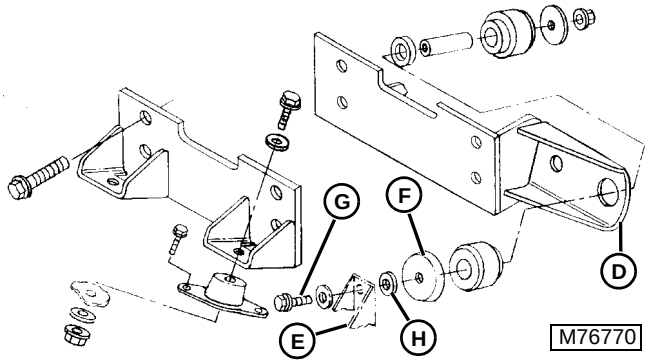
NOTE: It may be necessary to push the engine toward the driven clutch to allow the gauge to drop onto the drive clutch shaft.



3. Insert snubber step gauge (C) into opening between front surface of engine isolator bracket (D) and the rear surface of the frame bracket (E).
   - Identify which step on gauge is inserted into opening to determine the number of spacer washers to install.
4. Remove gauges from machine.



5. Install fifth isolator parts in shown order.
   - Assemble bushings and rubber mounts onto frame bracket. The spacer(s) (H), metal cup (F) and one rubber mounting are installed between the frame bracket (E) and the engine isolator bracket (D). Install correct number of spacer(s) as determined using snubber gauge.
   - Loosely install fifth isolation mounting cap screw and nut.



6. Tighten fifth isolation mounting cap screw (G) to **37 ±7 N•m (27 ±5 lb-ft)**.

DIFFERENTIAL LOCK LINKAGE ADJUSTMENT

Reason:

To insure complete disengagement and engagement of differential lock, and that indicator lamp switch is adjusted properly.

DISENGAGEMENT CHECK:

Conditions:

- Engine OFF
- Park brake OFF
- Cargo box raised
- Differential lock lever in disengaged (UP) position
- Right side wheels jacked up and free to rotate
- Left side of vehicle wheels on ground and chocked

Procedure:

1. By hand, rotate right side drive wheels.

Results:

- Wheels should rotate freely with no clicking sound in transaxle.
- Differential should be disengaged and cable loose.
- Differential lock arm on transaxle should be just touching differential lock shaft.
- If there is noise or wheel will not rotate, loosen differential lock cable at rear adjusting nuts (A), and slacken cable:
  – If differential releases, check cable adjustment.
  – If differential will not release, move differential lock arm on transaxle by hand while trying to rotate tires and check if differential lock shaft is moving freely into and out of transaxle case. If not, repair transaxle.
- If cable is adjusted correctly and lock lever movement will still not disengage transaxle, check that differential lock switch rod linkage is not preventing the cable from going slack when lock lever is raised to disengaged (UP) position.

ENGAGEMENT CHECK:

Conditions:

- Engine OFF
- Park brake OFF
- Cargo box raised
- Differential lock lever in engaged (DOWN) position

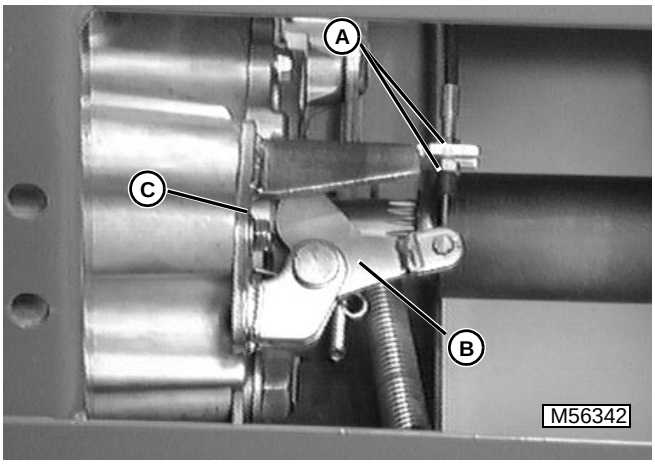
Procedure:

1. Engage differential lock lever at operator's station.
2. Move differential lock arm (B) at transaxle forward by hand and check for free play. Arm should be depressing differential lock shaft completely.

NOTE: If internal differential lock collar pins do not align, differential may not be engaged. Engagement spring should be compressed. Rotate tires until engagement spring pulls differential lock into position.

Results:

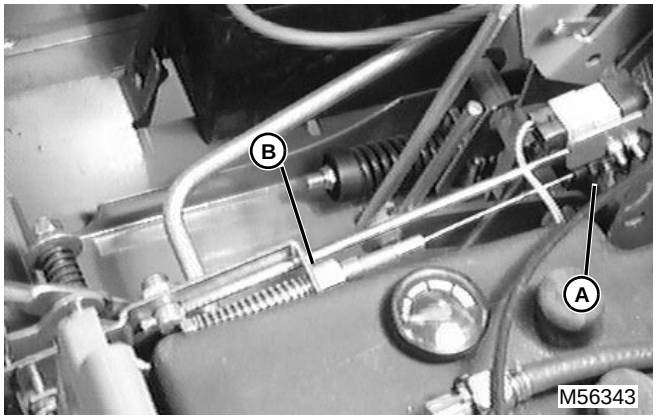
- Differential lock should engage, or engage as tires are rotated. When locked, tires should not rotate. If differential will not lock, adjust cable.
- Differential lock shaft (C) should be bottomed out within transaxle after rotating tires. If not, adjust cable.
- If lock lever will not move to full engaged (DOWN) position, check lock switch actuating rod is not contacting switch before lock lever is going over center, or that secondary brake linkage (Road Homolagated only) is not binding.



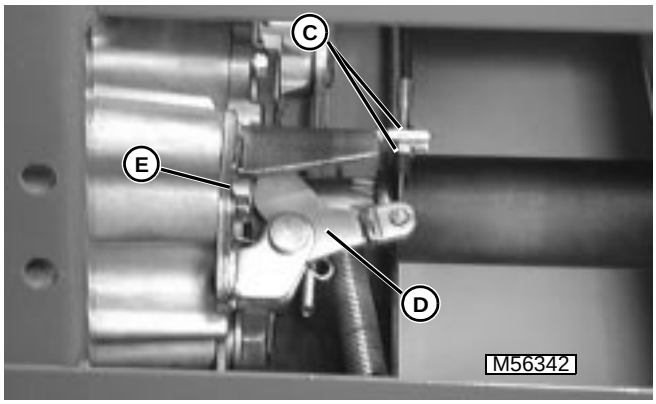
Cable Adjustmtent:

Conditions:

- Park brake must be OFF
- Differential lock lever must be disengaged (UP)
- Transaxle in NEUTRAL



1. Adjust differential lock cable front (A) and rear adjusting nuts (C) so that all cable slack is removed, and there is no gap between bracket and nut at location shown (B).



2. Check that all cable slack is removed and that differential lock arm (D) is just touching differential lock shaft (E).

IMPORTANT: Do not over tighten cable so that differential will not disengage.

Differential Lock Switch Actuating Rod Adjustment:

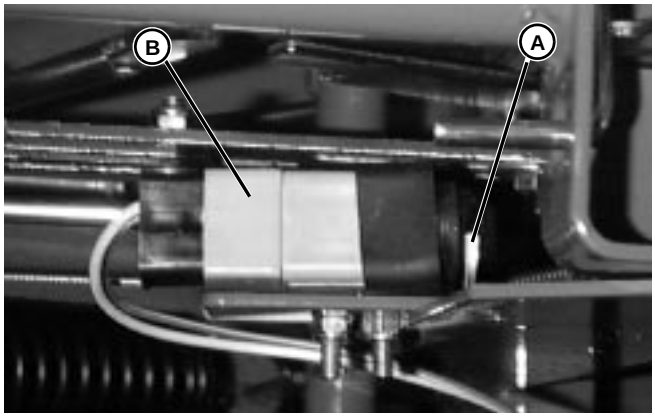
Conditions:

- Engine OFF
- Park brake OFF
- Key switch in ON position

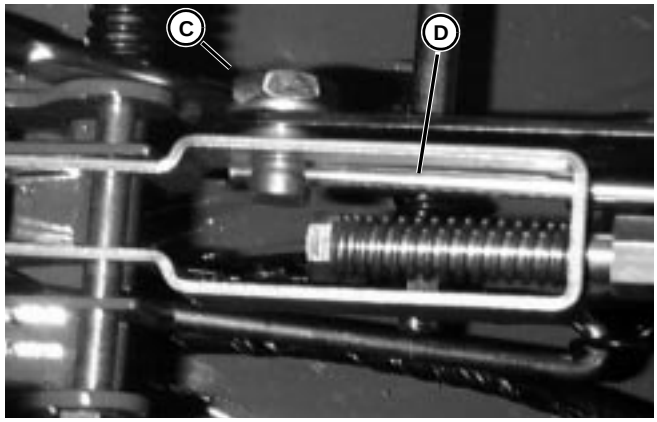
Procedure:

1. Engage differential lock lever (DOWN position). The tab on the end of the differential lock switch actuating rod (A) should move forward, depressing the switch (B) , and lighting indicator lamp on the dashboard.

NOTE: If park brake is ON, differential lock is automatically ENGAGED, and both park brake and differential lock indicator lamps will be ON.

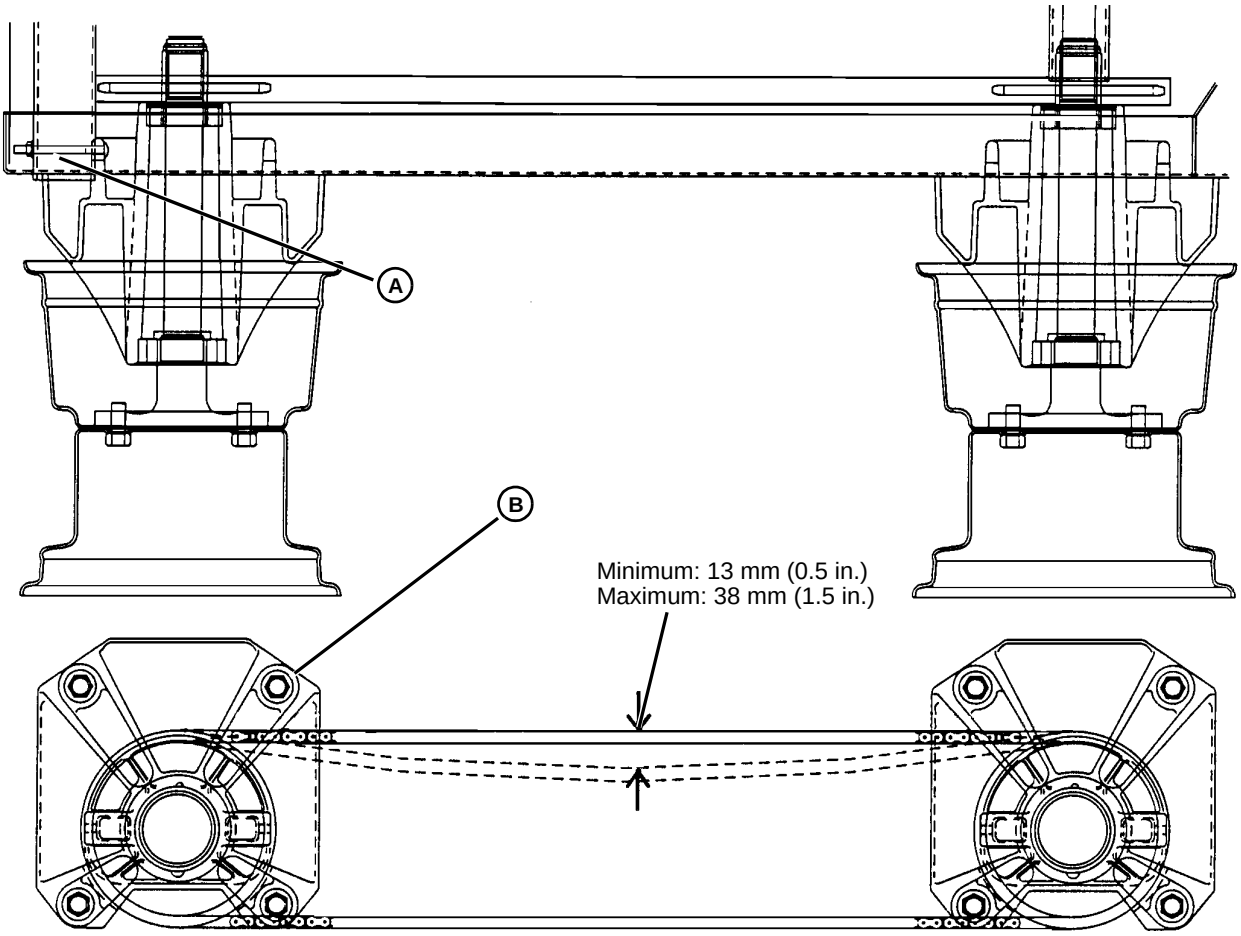


2. Disengage differential lock. Indicator light should go out.



3. To adjust switch rod (D), engage differential lock (DOWN position). Loosen rod nut (C). Position switch rod so it is centered on switch plunger and plunger is depressed, but not bottomed out.
4. Tighten rod nut.

DRIVE CHAIN ADJUSTMENT



Reason:

Proper chain slack prevents excessive wear and backlash problems that could cause chain damage.

Conditions:

- Engine off
- Park brake set
- Box raised
- Jack-up side of vehicle to be adjusted so wheels are off ground and properly supported with jack stands.

Check Chain Slack:

1. Jack up one side so tires are free to rotate. Properly support vehicle with jack stands.
2. With brakes set, attempt to rotate rear wheel forward against resistance of transaxle.
3. Measure chain slack on top run of chain at center point between axles.

Adjust Chain Slack:

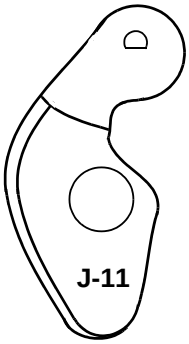
IMPORTANT: Do NOT use adjusting bolt to move axle housing. Damage to axle housing could result.

1. Loosen rear axle housing bolts (B).
2. Move axle housings to obtain chain slack. Slack should be **13 - 38 mm (0.5 - 1.5 in.).**
3. Use adjusting bolt (A) to hold axle in place while tightening axle-to-frame bolts.
4. Torque rear axle bolts and recheck chain slack. Readjust if necessary.

NOTE: If chain is too long, remove one link and replace with half-link.

REPAIR

PRIMARY CLUTCH FLYWEIGHT IDENTIFICATION



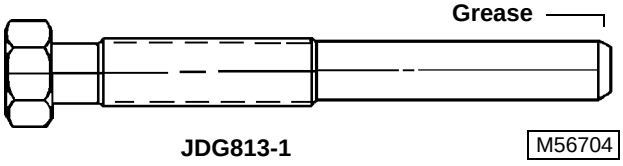
The primary clutches can be identified by a model number, stamped on the face of the flyweights.

PRIMARY CLUTCH

IMPORTANT: Lightly grease end of puller to help prevent puller wear. To prevent clutch thread damage, DO NOT thread bolt in any farther than necessary to remove clutch.

Removal:

1. Remove left rear wheel.
2. Remove black plug between tires on left side of frame.
3. Remove drive belt guard and drive belt.



4. Remove plastic plug from left side of clutch cover.
5. Remove clutch mounting bolt and washers.
6. Use JDG813-1 Clutch Removal Tool. Thread puller into clutch and against crankshaft. Tighten until clutch pops free from crankshaft taper.

NOTE: Check threads in primary clutch. Damage to threads may occur during removal.

Installation:

Installation is done in the reverse order of removal.

- Torque clutch bolt to **40 - 60 N•m (30 - 44 lb-ft).**

Repair:

1. Remove clutch cover bolts. Remove cover. (Cover should pop off; do not pry on cover).
2. Install JDG813-3 Tapered Holding Tool and retain it with a M10 X 1.5 X 150 mm hex-head bolt.

IMPORTANT: Always use spider wrench to remove spider. Unequal pressure on clutch towers could cause stress fractures or break them off. A medium strength thread lock is used on spider threads.

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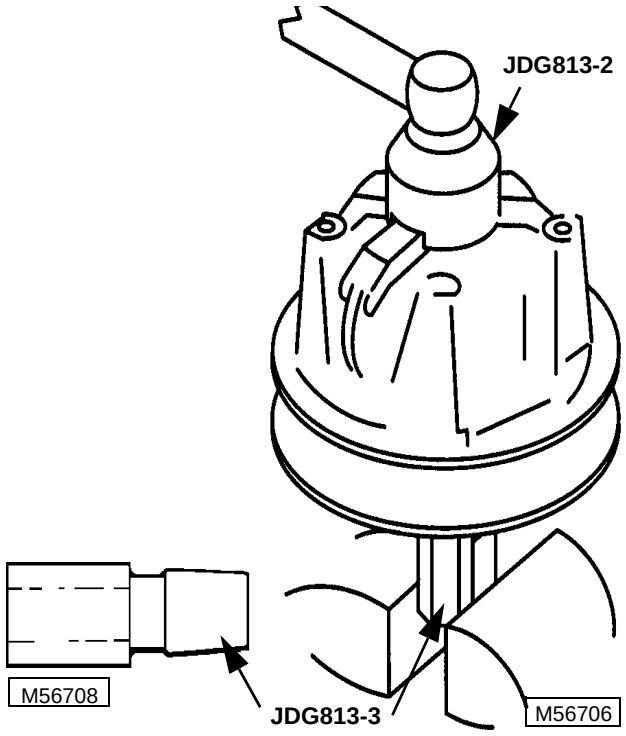


3. Use JDG813-2 Spanner Wrench to remove spider.

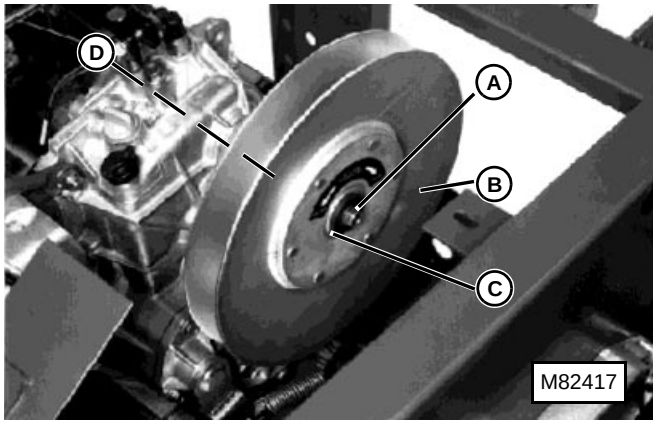
NOTE: Washers and rollers are one piece.

4. Lubricate using TY22034 SuperLube® Spray or equivalent. Lubricate cam weight pivot area. Slide bolts side to side for lubricant to penetrate pivot area. Bolt may need to be removed to lubricate properly. Replace bolt if worn through plating. Check flyweight for binding.
5. Lubricate spider rollers. Check for flat spots or binding.

SECONDARY CLUTCH

Removal:

1. Remove drive belt and muffler.
2. Hold clutch with a strap wrench and remove cap screw (A) and bushing (C).
3. Tap on inside of clutch with a rubber mallet.
4. Remove secondary clutch (B).



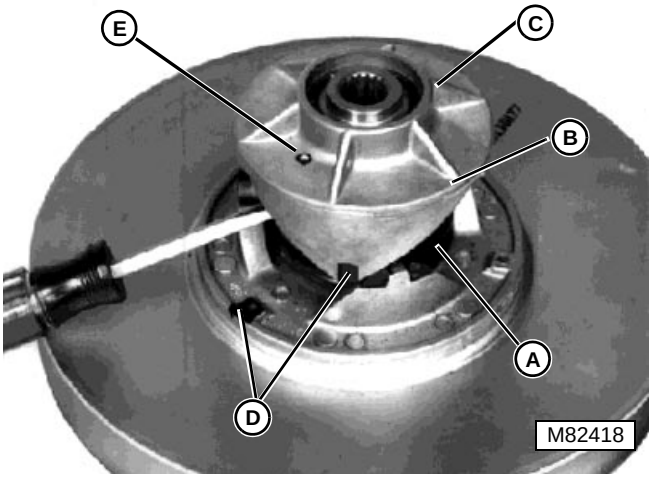
Installation:

Installation is done in the reverse order of removal.

- Apply Moly High Temperature EP Grease, or equivalent, to splines of transaxle input shaft.
- Install new cap screw (A) or apply Thread Lock and Sealer to original cap screw. New cap screw will have thread lock applied. Tighten to **38 N•m (28 lb-ft).**

Disassembly:

1. Release tension on spring (A) by prying spring out of hole in cam (B).
2. Remove set screw (C).
3. Place alignment marks (D) on cam and movable sheave to aid in assembly.



NOTE: Cam is press fit on shaft. Use a three-jaw puller and an impact wrench, at low speed, to remove cam from shaft.

CAUTION

Hold cam securely to prevent sudden spring release.

4. Remove cam using a three-jaw puller and impact wrench.

NOTE: Before removing spring, mark the hole (E) on the sheave that the spring tab is installed in.

5. Remove spring, movable sheave and spacer from shaft.

NOTE: Ramp shoes are mounted with tabs on backside. Tabs are interference fit into holes on face of ramps. Remove shoes only if replacement is necessary.

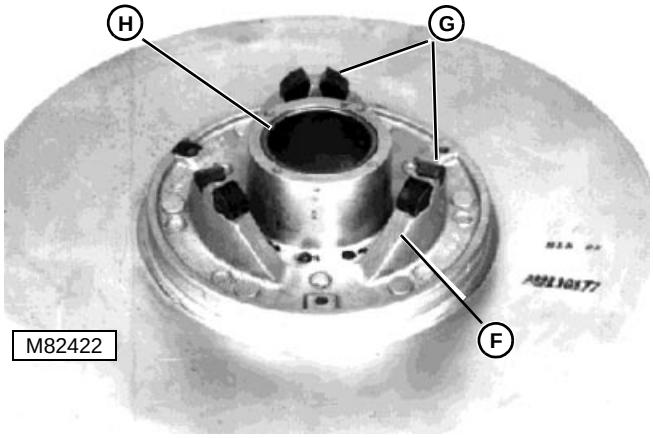
Inspection:

1. Inspect ramp shoes for wear or cracks.

To replace shoes:

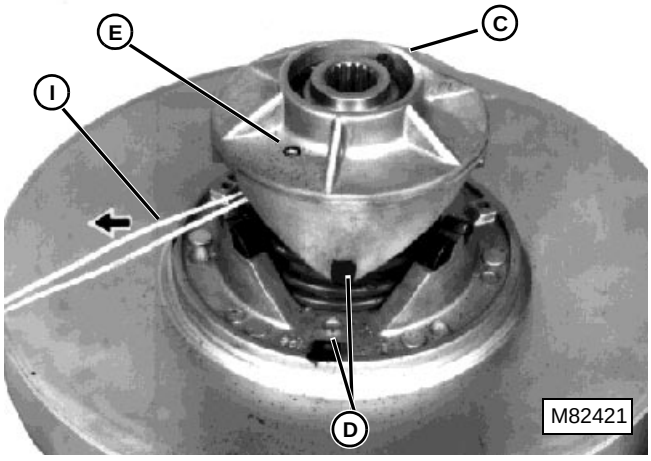
- Apply heat to movable sheave ramp (F) until shoe mounting tabs release from holes in ramp. Pull off shoes (G).
- If shoe mounting tabs break off inside holes in ramp, remove tabs using a drill bit.
- Install ramp shoe tabs into ramp holes. If shoes are too difficult to install, sand tab as necessary. If tabs are loose, apply thread lock and sealer (medium strength) on tabs.

2. Inspect bushing (H) for wear or damage. Replace movable sheave if necessary.



Assembly:

1. Install spacer and movable sheave on fixed sheave.
2. Install spring. Insert spring tab into previously marked hole in movable sheave. Place cam on spring.
3. Align set screw bores and alignment marks (D). Press cam on shaft until it stops.
4. Apply thread lock and sealer (medium strength) to threads of set screw (C) and install.
5. Pry spring away from cam and loop a piece of string (I) around top spring tab. Pull on string until tab seats in hole in cam.

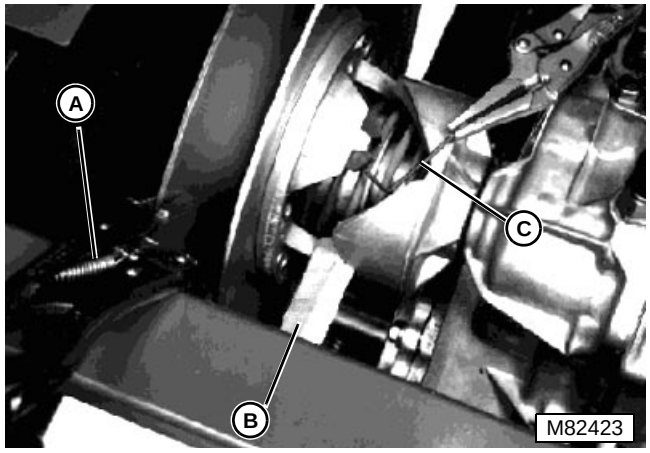


Replace Ramp Shoes (Clutch Mounted On Machine):

1. Remove drive belt.
2. Install locking pliers (A) on outer edge of fixed sheave half. Rotate sheave until pliers contact frame and prevent sheave from turning.
3. Turn moveable sheave until shoes are away from ramps. Install small block of wood (B) between other ramps and shoes to hold sheave half in position.

CAUTION

Prevent burns. Hold allen wrench with locking pliers.



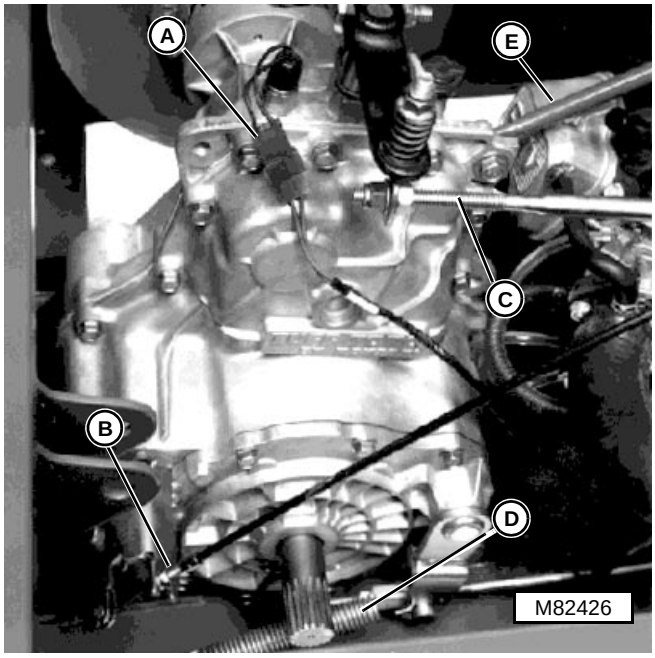
4. Clamp long end of **2 mm (0.078 in.)** allen wrench (C) into locking pliers. Heat short end of allen wrench until red. Insert wrench into center of ramp shoe as plastic melts.
5. Hold wrench in place until plastic hardens.
6. Twist and pull on allen wrench to remove ramp shoe.
7. Install new ramp shoes. Push ramp shoe straight in with a screwdriver by prying against cam.

- If shoe is difficult to install, sand mounting tab as necessary.
- If shoe is loose, apply thread lock and sealer (medium strength) on mounting tabs.

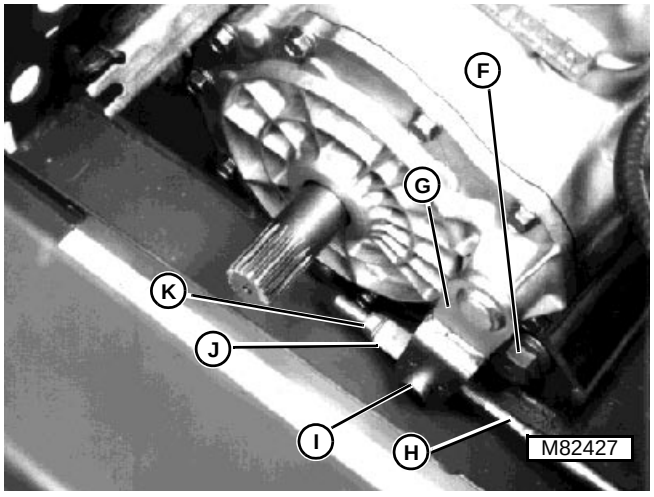
TRANSAXLE

Removal:

1. Remove cargo box, drive belt and drive axles.
2. Drain transaxle. Capacity is **4.5 L (4.75 qt).**



3. Disconnect neutral start switch (A), differential lock cable (B), shift rod (C), and brake return springs (D).



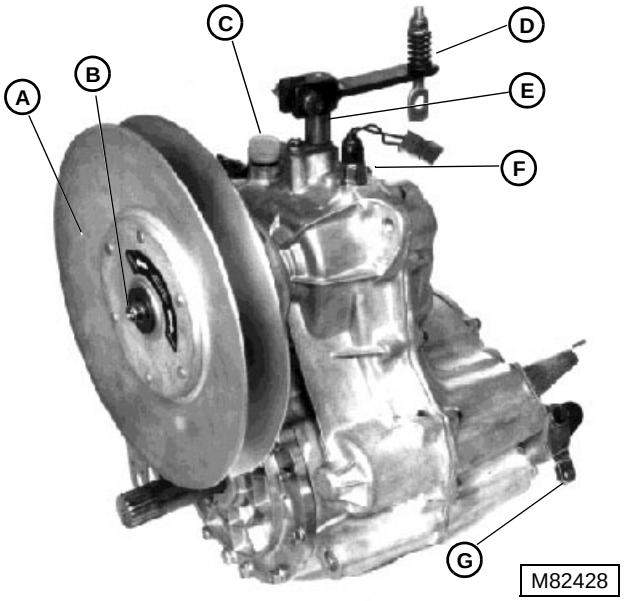
4. Remove lock nut (K) and adjustment nut (J) from brake rods (H) on each side of transaxle. Remove brake rods and cross pins (I) from cam levers (G).
5. Remove support bracket (E), mounting cap screws (F) and washers. Remove transaxle.

Installation:

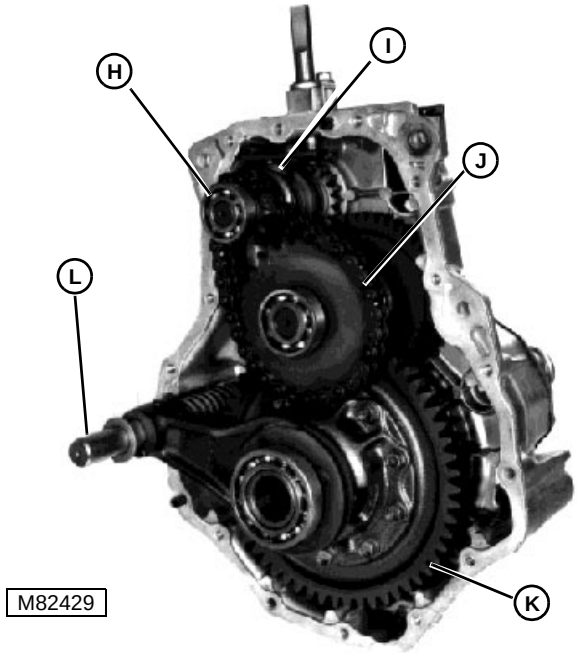
Installation is in the reverse order of removal.

- Adjust brake linkage.
- Adjust shift rod and differential lock cable.
- Fill transaxle with John Deere J20C Hy-Gard.

Disassembly And Inspection:



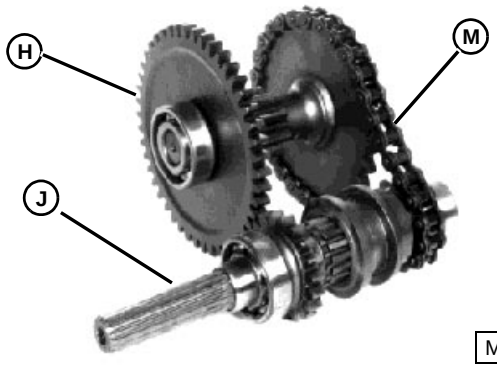
1. Remove secondary clutch (A), thrust washer (if used), neutral start switch (F), O-ring, shift lever (D), spacer (E), and differential lock bracket (G).
2. Remove dipstick (C) and O-ring.
3. Remove 16 cap screws. Tap seam of case with a plastic hammer or pry apart at pry points and separate case halves.



4. Lift input shaft (J) and secondary shaft H) just enough to unseat from bearing bores.

NOTE: Do not to lose shift block (I) when removing input and secondary shaft assembly.

5. Remove differential unit (K) and differential lock shaft (L) together as an assembly.



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6. Remove input shaft (J) and secondary shaft (H) together as an assembly.
7. Remove reverse drive chain (M) from input (H) and secondary shaft assembly (H).
8. Remove sleeve (U), bearing (V), washer (W), needle bearing (X), and forward drive sprocket (Y) from the input shaft (H).

⚠ CAUTION

Balls (S) and spring (T) will shoot from hole in shaft when shift collar is removed.

9. Remove shift collar (N), balls (S) and spring (T), reverse drive gear (O), needle bearing (P), washer (Q), and ball bearing (R) from input shaft (H).
10. Measure thickness of washers (Q and Y), and width of shift groove in shift collar (N).

Input Shaft Specifications:

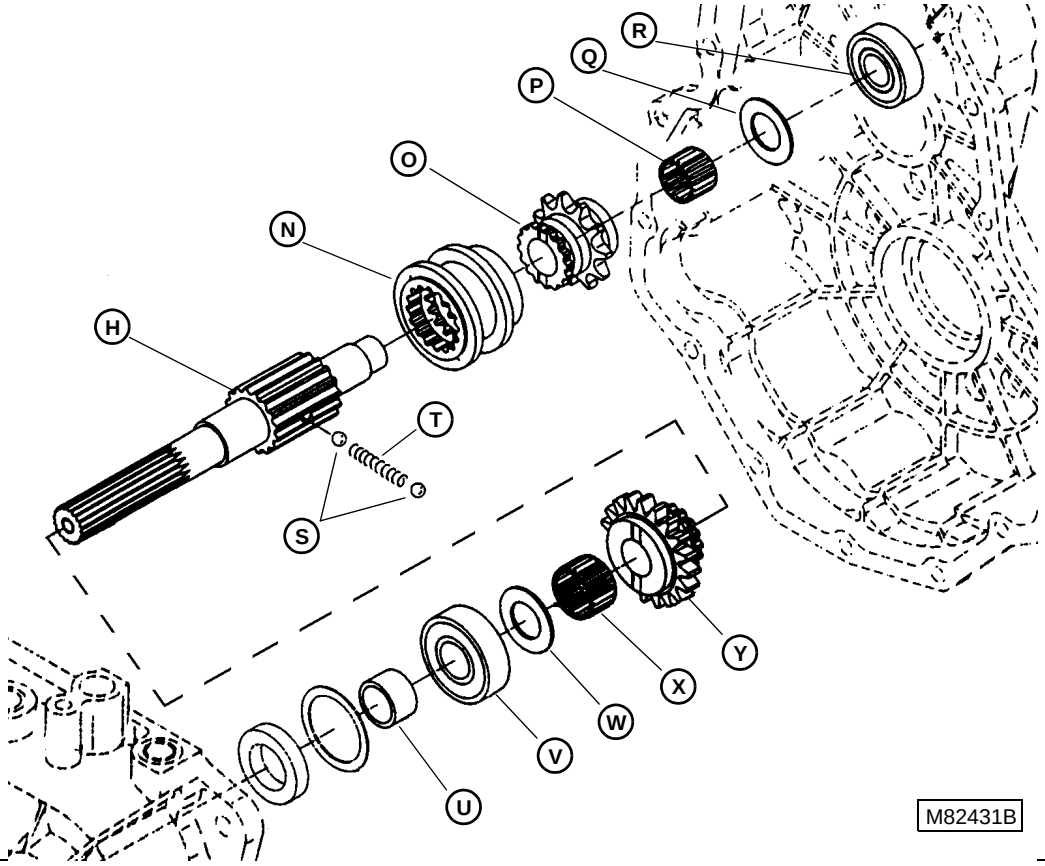
Washer (Q) Thickness
Standard . . . . . 1.45 - 1.55 mm (0.057 - 0.061 in.)
Wear Limit . . . . . 1.20 mm (0.047 in.)

Washer (Y) Thickness
Standard . . . . . 1.52 - 1.68 mm (0.060 - 0.066 in.)
Wear Limit . . . . . 1.30 mm (0.051 in.)

Shift Collar (N):

Shift Groove
Width . . . . . 6.10 - 16.30 mm (0.24 - 0.642 in.)

Shift Groove-to-Block Clearance
(Max) . . . . . .2 mm (0.080 in.)
Spring Free Length . . . . . 29.50 mm (1.161 in.)



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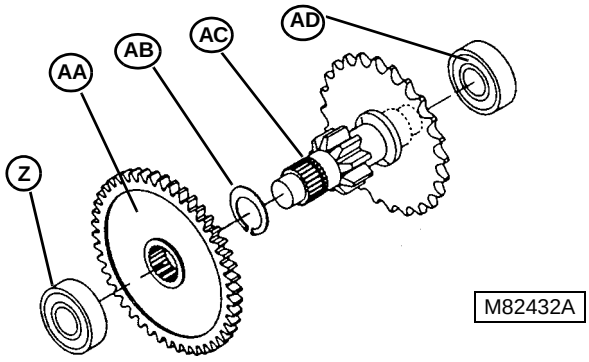
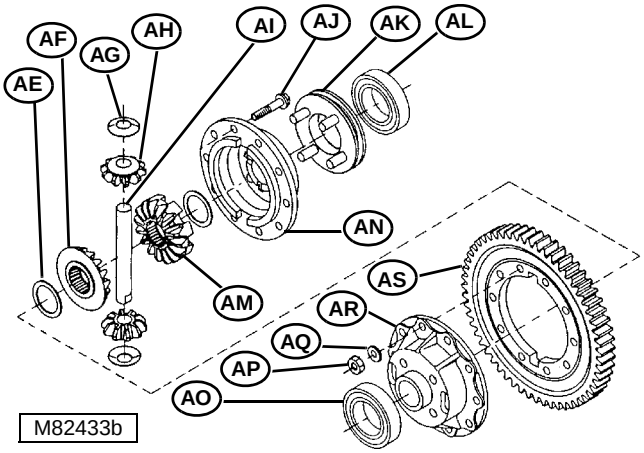


11. Remove the ball bearing (Z), forward driven gear (AA), snap ring (AB), and ball bearing (AD), from secondary shaft (AC). Inspect all parts for wear and damage.

NOTE: Bearings (Z and AD) on the secondary shaft are press fit.



12. Disassemble differential. Remove bevel gear washers (AE), bevel side gear (AF), bevel pinion washers (AG), bevel pinion gears (AH), bevel pinion shaft (AI), and notched bevel gear (AM).
13. Remove bearing (AL) and differential lock collar (AK).
14. Remove nuts (AP), and lock washers (AQ) from 10 cap screws (AJ), and separate the differential housing halves (AN, AR) from final drive gear (AS).
15. Measure thickness of washers and groove width of differential lock collar.

Differential Specifications:

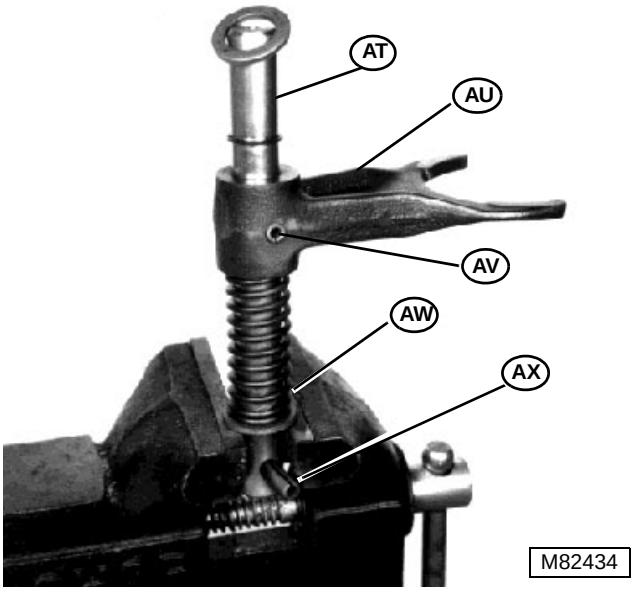
Bevel Side Washer (AE) Thickness:
Standard . . . . . 1.50 - 1.70 mm (0.059 - 0.067 in.)
Wear Limit . . . . . 1.30 mm (0.051 in.)

Pinion Gear Washer (AG) Thickness:
Standard . . . . . 0.96 - 1.04 mm (0.038 - 0.041 in.)
Wear Limit . . . . . 0.70 mm (0.028 in.)

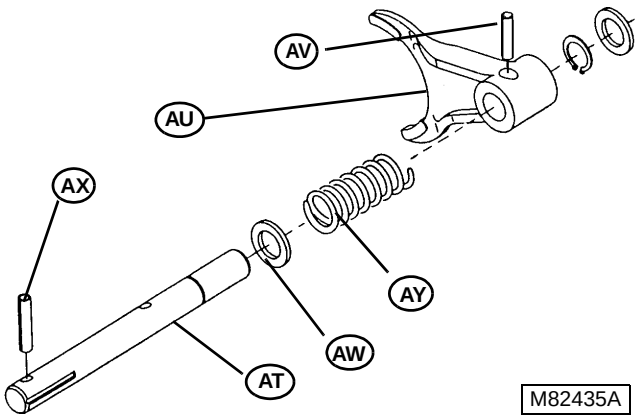
Differential Lock Collar (AK):
Groove Width . . 7.10 - 7.30 mm (0.280 - 0.287 in.)

Collar Groove-to-Lock Fork
Finger Clearance (Max) . . . . . 2 mm (0.080 in.)

16. Disassemble differential lock shaft. Remove washer.



17. Put end of differential lock shaft (AT) in a soft jawed vise as shown. Push down on lock shaft until washer (AW) is away from short spring pin (AX). Tighten vise around shaft.
18. Drive out short spring pin.
19. Hold differential lock fork (AU) and slowly loosen vise. Remove washer and spring.
20. Drive out long spring pin (AV). Remove differential lock fork.
21. Inspect all parts. Measure thickness of lock fork fingers and spring free length and working load.

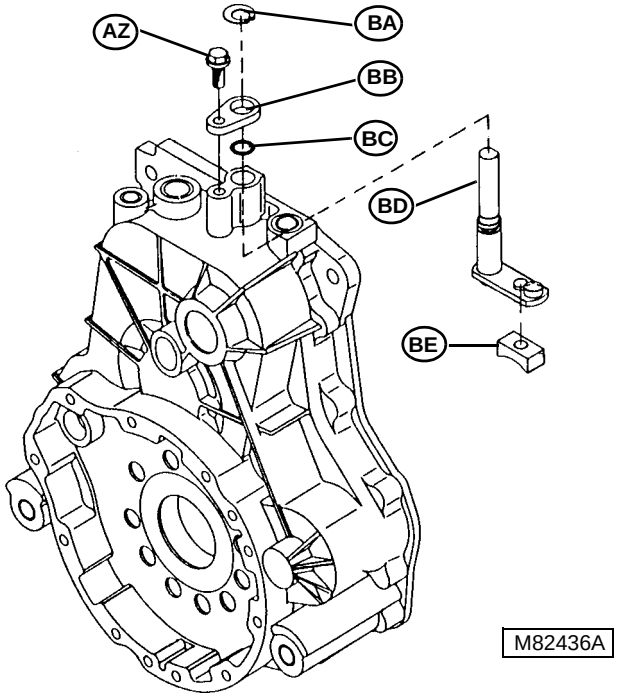


Differential Lock Shaft Specifications:

Differential Lock Fork (AU) Finger
Thickness . . . . . 6.70 - 6.90 mm (0.264 - 0.272 in.)

Finger-to-Collar Groove
Clearance (Max) . . . . . 2 mm (0.080 in.)

Spring (AY)
Free Length. . . . . 93.2 mm (3.669 in.)
Working
Load. 74 mm @ 150 N (2.913 in. @ 33.72 lb force)



22. Remove cap screw (AZ), snap ring (BA) and retaining plate (BB).
23. Remove the shifter arm (BD) and block (BE).
24. Inspect all parts of shifter arm for wear or damage. Replace as necessary.
25. Measure width of shifter block. Replace block if not within specifications.

Shifter Arm (BD) Specifications:

Shifter Block (BE)
Width . . . . . 15.7 - 15.9 mm (0.618 - 0.626)

Block-to-Collar Groove
Clearance (Max) . . . . . 2 mm (0.080 in.)

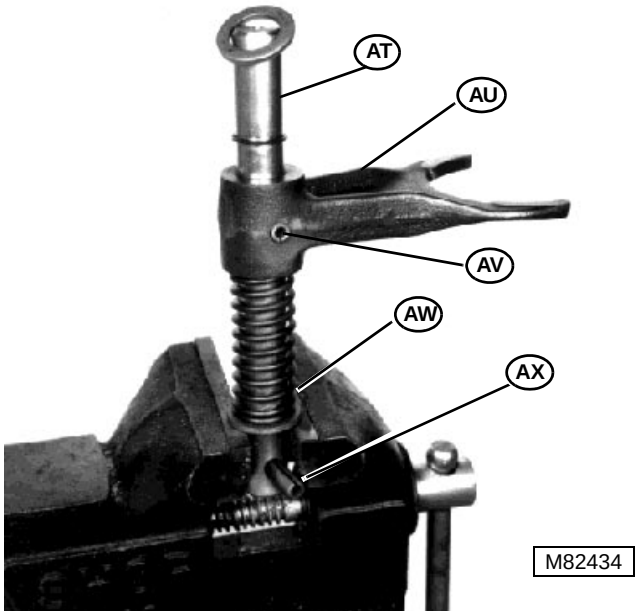
IMPORTANT: Replace all seals and o-rings. Damaged or worn parts will leak.

26. Inspect case halves for cracks or damage.
27. Measure thickness of thrust washer. If thickness is not within **1.12 - 1.28 mm (0.044 - 0.050 in.),** replace washer.

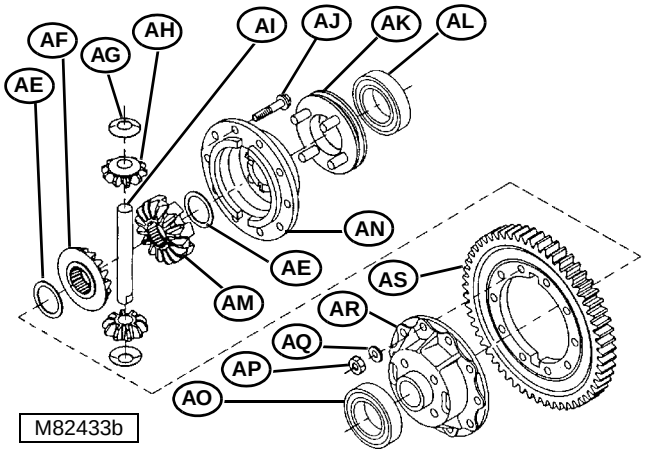
Assembly:

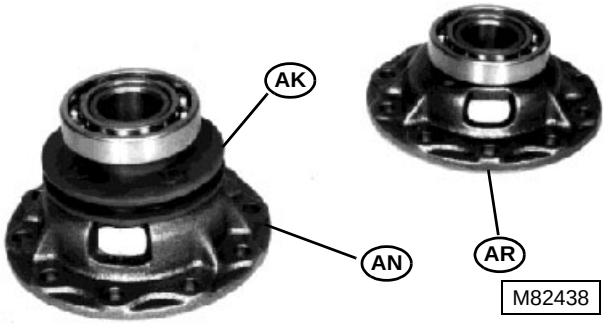
NOTE: Lubricate all internal parts with clean oil during assembly.

1. Apply multipurpose grease to new o-ring and inside lips of seals.
2. Install input shaft seal into case bore until it stops with seal lips facing away from case half.
3. Install differential lock shaft seal until flush with case bore and with seal lips facing toward case half.
4. Apply multipurpose grease on thrust washer to hold in place.
5. Apply multipurpose grease to shifter arm shaft, new o-ring and shifter block to hold in place.

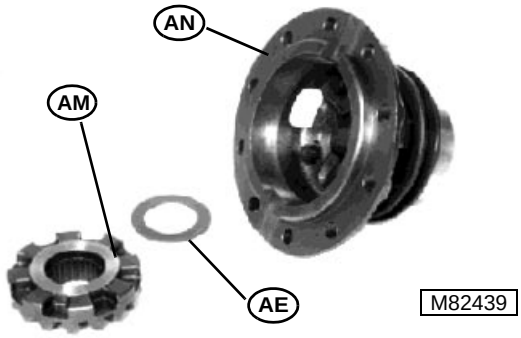


6. Install differential lock fork (AU) on shaft (AT).
7. Drive in long spring pin (AV) with split facing toward long end of shaft.
8. Install spring (AW) and washer.
9. Put end of differential lock shaft in a soft jawed vise as shown. Push down on lock shaft until washer is away from hole in shaft. Tighten vise around shaft.
10. Drive in short spring pin (AX) with split facing washer.
11. Install snap ring and washer.

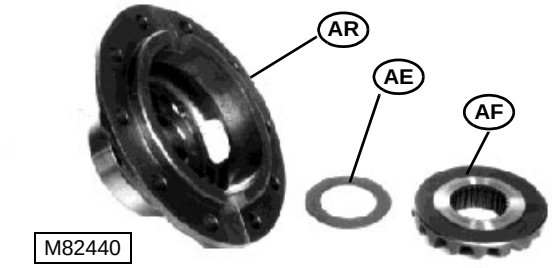




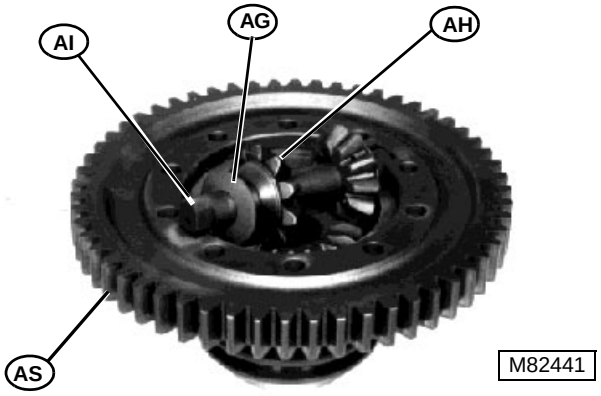
12. Install differential lock collar (AK).
13. Press bearings tight against housing half shoulders (AN, AR).



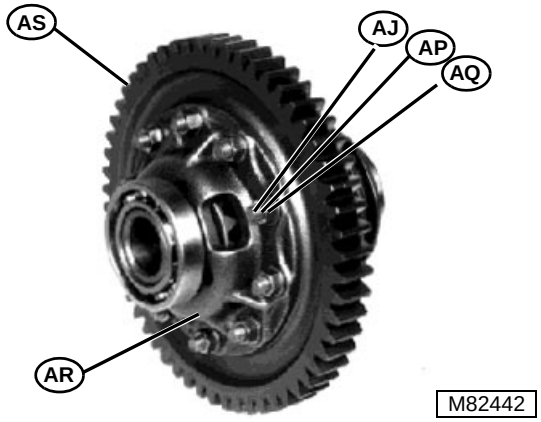
14. Install washer (AE) and notched bevel side gear (AM) into housing half with lock collar (AN).



15. Install washer (AE) and bevel side gear (AF) into other housing half (AR).



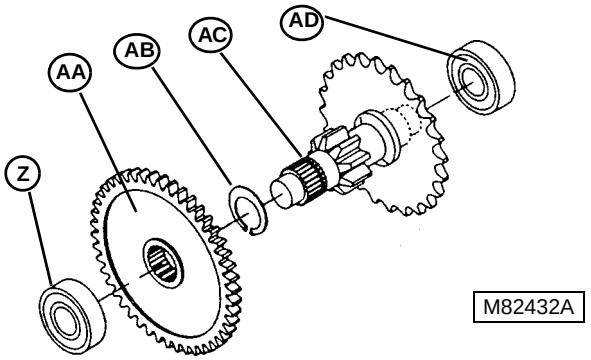
16. Place final drive gear (AS) on differential housing half (AN).
17. Install bevel pinion shaft (AI) with pinion gears (AH) and washers (AG).

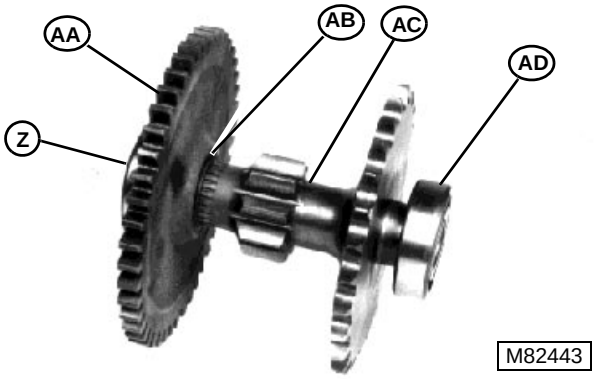


18. Place other differential housing half (AR) on final drive gear (AS).

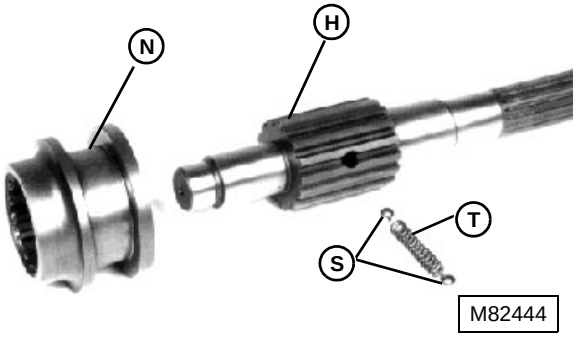
IMPORTANT: Use new cap screws (AJ), lock washers (AQ), and nuts (AP) to secure differential halves. Locking strength of existing hardware is lost when removed. Reuse of existing hardware will result in damage to differential assembly.

19. Install ten new cap screws, washers and nuts. Tighten nuts to **27 N•m (20 lb-ft).**

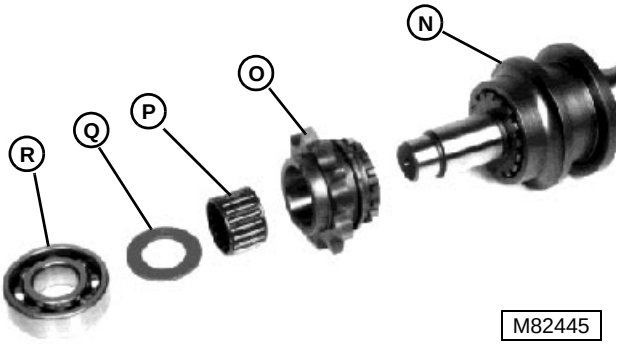




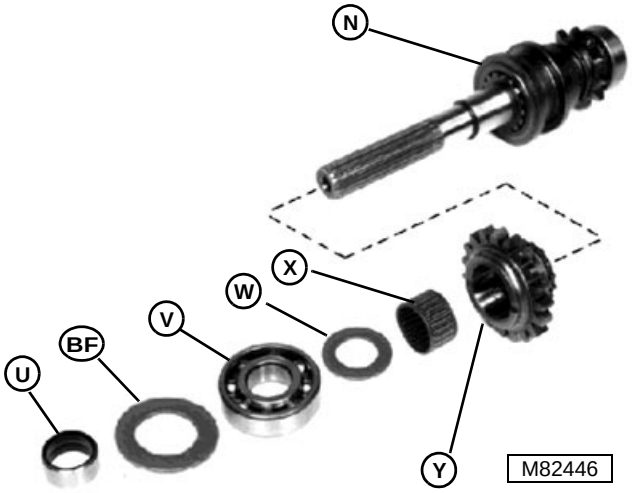
20. Install snap ring (AB) and forward secondary gear (AA) with shoulder facing snap ring.
21. Press bearings (Z, AD) tight against shoulders of secondary shaft (AC).



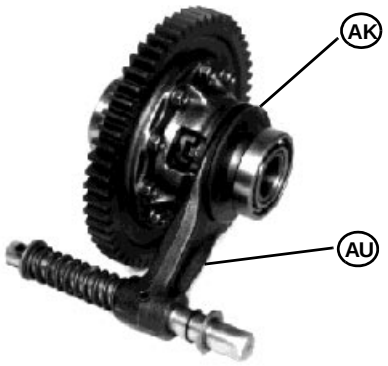
22. Apply multipurpose grease to balls (S) and spring (T).
23. Insert spring and balls into hole in input shaft (H).
24. Install shift collar (N) with shoulder toward short end of input shaft (H). Move shift collar to “neutral” position.



25. Install reverse drive gear (O) onto short end of input shaft with shift splines facing shift collar (N).
26. Install needle bearing (P) inside gear.
27. Install washer (Q) tight against shoulder of shaft.
28. Press bearing (R) tight against washer.

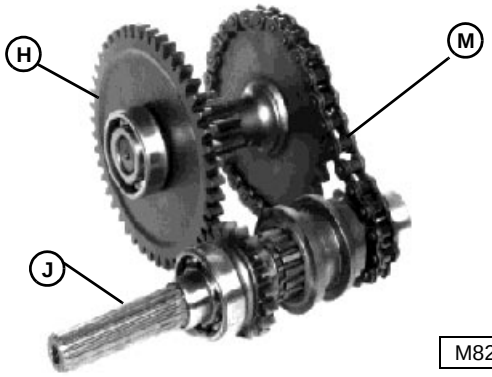


29. Install forward drive sprocket (Y) onto long end of input shaft with shift splines facing shift collar (N).
30. Install needle bearing (X) inside gear.
31. Install ID washer (W) tight against shoulder of shaft.
32. Press bearing (V) tight against washer using a piece of pipe and a press.
33. Install OD washer (BF) tight against bearing.
34. Apply multipurpose grease to inside diameter of sleeve and on input shaft.
35. Press sleeve (U) tight against bearing using a piece of pipe and a press.



M82447

36. Assemble differential lock shaft fork (AU) into differential lock collar (AK).

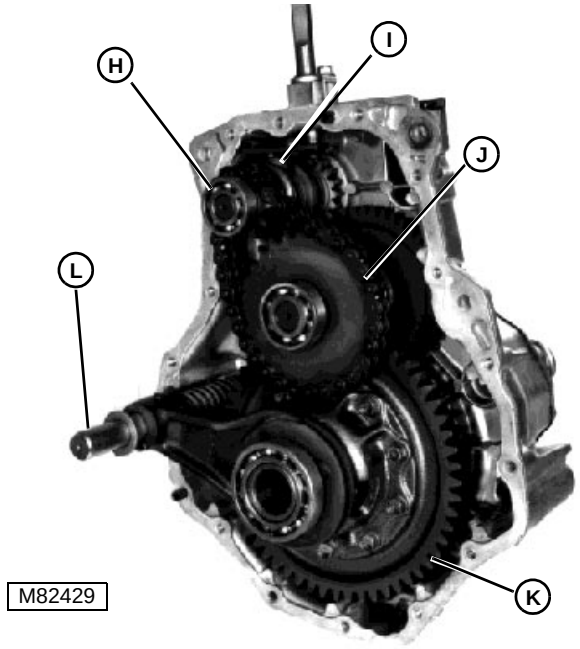


M82430

37. Assemble input shaft (J) and secondary shaft (H) with reverse drive chain (M).

NOTE: Apply multipurpose grease to input and differential lock shafts to avoid damaging seal lips.

38. Apply multipurpose grease to splined end of input shaft.
39. Align shifter block with groove in shift collar and install input shaft and secondary shaft together as an assembly.

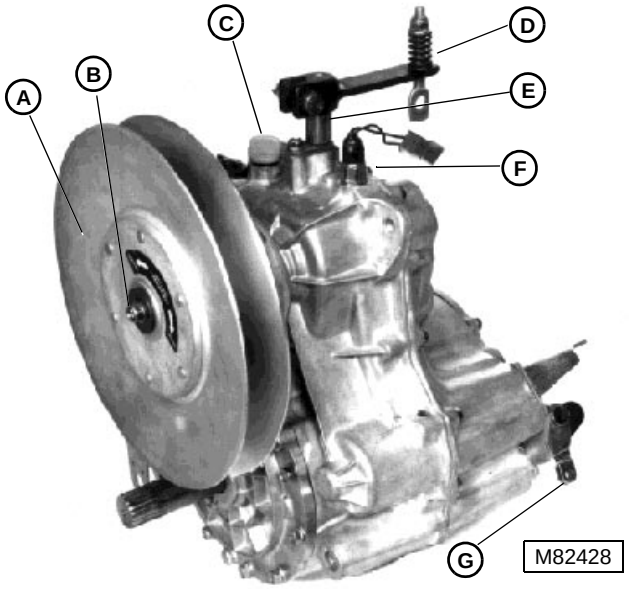


M82429

40. Lift input shaft (H) and secondary shaft (J) to seat into bearing bores, and then install differential (K) and differential lock shaft (L) together as an assembly.
41. Tap on end of shafts and differential with a rubber mallet to seat bearings.
42. Clean mating surfaces of transaxle case halves using Clean and Cure Primer. Apply a coat of John Deere Plastic Gasket, or an equivalent, to case halves.
43. Apply multipurpose grease to end of differential lock shaft.
44. Assemble case halves. Install 16 cap screws and tighten to **35 N•m (26 lb-ft).**

IMPORTANT: Allow sealant to cure at least 30 minutes before filling transaxle with oil.

45. Install:
    - Dipstick and O-ring (C)
    - Spacer (E) and gear shift lever (D). Tighten nut.
    - Neutral start switch (F) and new o-ring. Tighten to **39 N•m (29 lb-ft)**.
    - Differential lock lever bracket (G) and cap screws.
46. Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle input shaft, before installing secondary clutch.

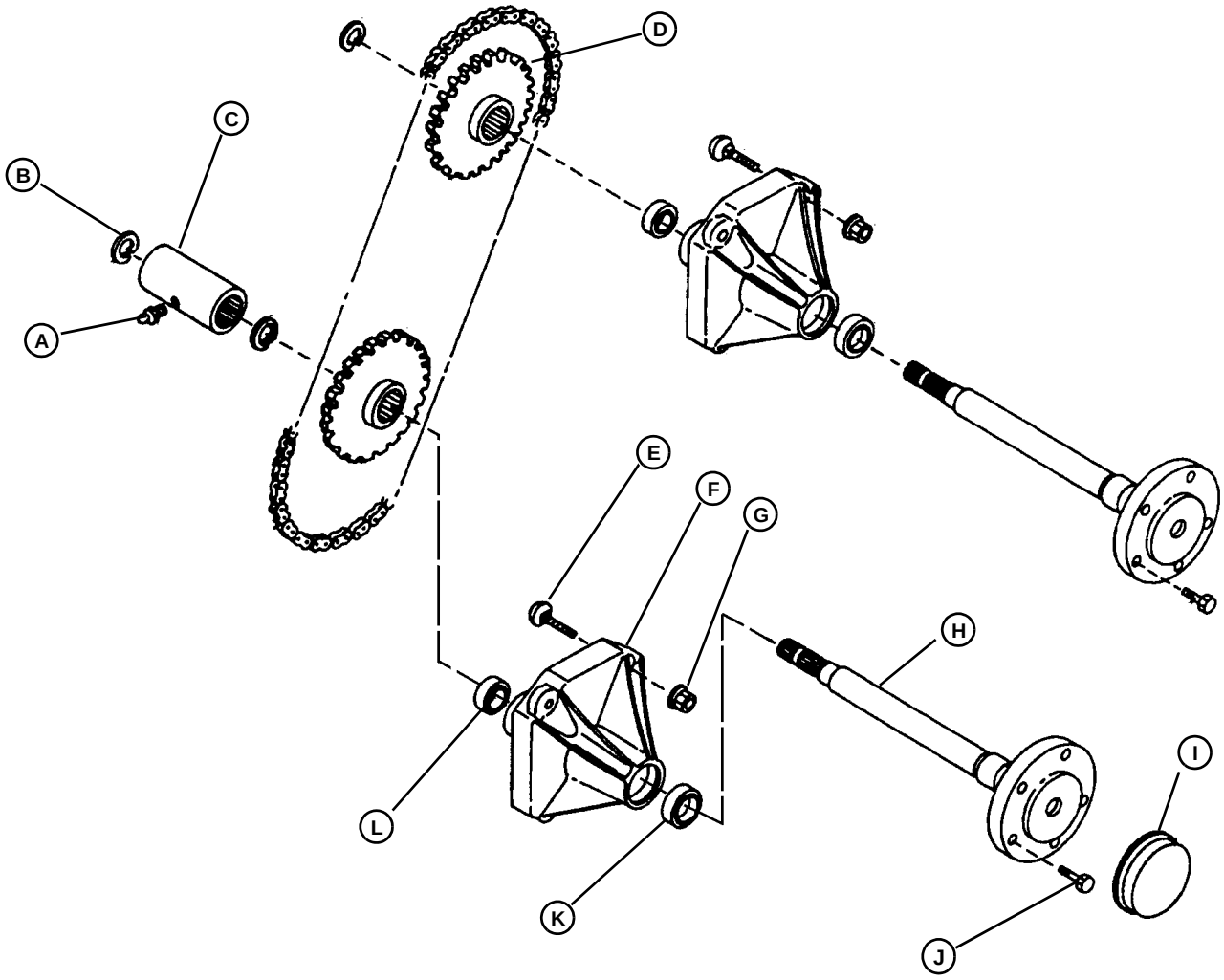


47. Install secondary clutch (A) .

NOTE: Secondary clutch mounting cap screw (B) has left-hand threads. Install new bolt or apply medium strength Thread Lock and Sealer.

48. Install bushing and cap screw (B). Hold clutch with a strap wrench and tighten cap screw to **38 N•m (28 lb-ft).**

DRIVE AXLES - COMPONENT LOCATION



A. Grease Fitting
B. Snap Ring (2 used)
C. Splined Coupler
D. Chain Sprocket
E. Carriage Bolt
F. Axle Housing
G. Flanged Lock Nut (M12)
H. Axle Shaft
I. Cap
J. Wheel Bolt
K. Outer (Large) Bearing
L. Inner (Small) Bearing

DRIVE AXLES

Removal:

1. Lift cargo box and remove master link from drive chain on the axle being serviced. Remove drive chain from chain sprockets (D).
2. Jack frame and remove tire and wheel from axle being serviced.
3. Remove four carriage head bolts (E) and flange nuts (G) holding axle housing (F) to frame. Remove axle and sprocket assembly from vehicle.

Installation:

1. Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle output shaft.
2. Align splines of coupler on front axle with splines of transaxle output shaft.
3. Torque axle housing mounting nuts (G) to **90 N•m (67 lb-ft.)**.
4. Install drive chain around axle sprockets and install master link.
5. Install wheels and tires. Torque wheel mounting cap screws to **100 N•m (75 lb-ft)**.
6. Adjust drive chain tension.

Disassembly :

1. Remove splined coupler (C) from end of axle shaft (H) if coupler remained with shaft when removed.
2. Remove snap ring, washer or spacer, from end of axle shaft.

NOTE: Bearings are press fit on shaft and in housing. Remove bearings only if replacement is necessary. Do not reuse bearings.

3. Remove axle from axle housing (H) using a soft-faced mallet.
4. Inspect bearings (L, K) for wear or damage. Replace if necessary.

To replace large outside bearing (K):

- Remove bearing from axle shaft using a knife-edge puller and a press.
- Install bearing in axle housing using a driver set, only pressing on inside race of bearing.

To replace small bearing (L):

- Replace bearing using a driver set.

Assembly:

Assembly is done in reverse order of disassembly.

- The small bearing may unseat from housing bore during axle installation. Install small bearing into housing bore using a piece of pipe and a hammer. Apply force on inner race of bearing only.
- Apply Moly High Temperature EP Grease, or an equivalent, to splines of axle shaft before installing secondary coupler.

CONTENTS

SPECIFICATIONS

REPAIR SPECIFICATIONS

Lubrication Interval:

Spindle grease fitting and kingpin
- Severe Conditions . . . . . Every 25 hours
- Normal Conditions. . . . . Every 50 hours

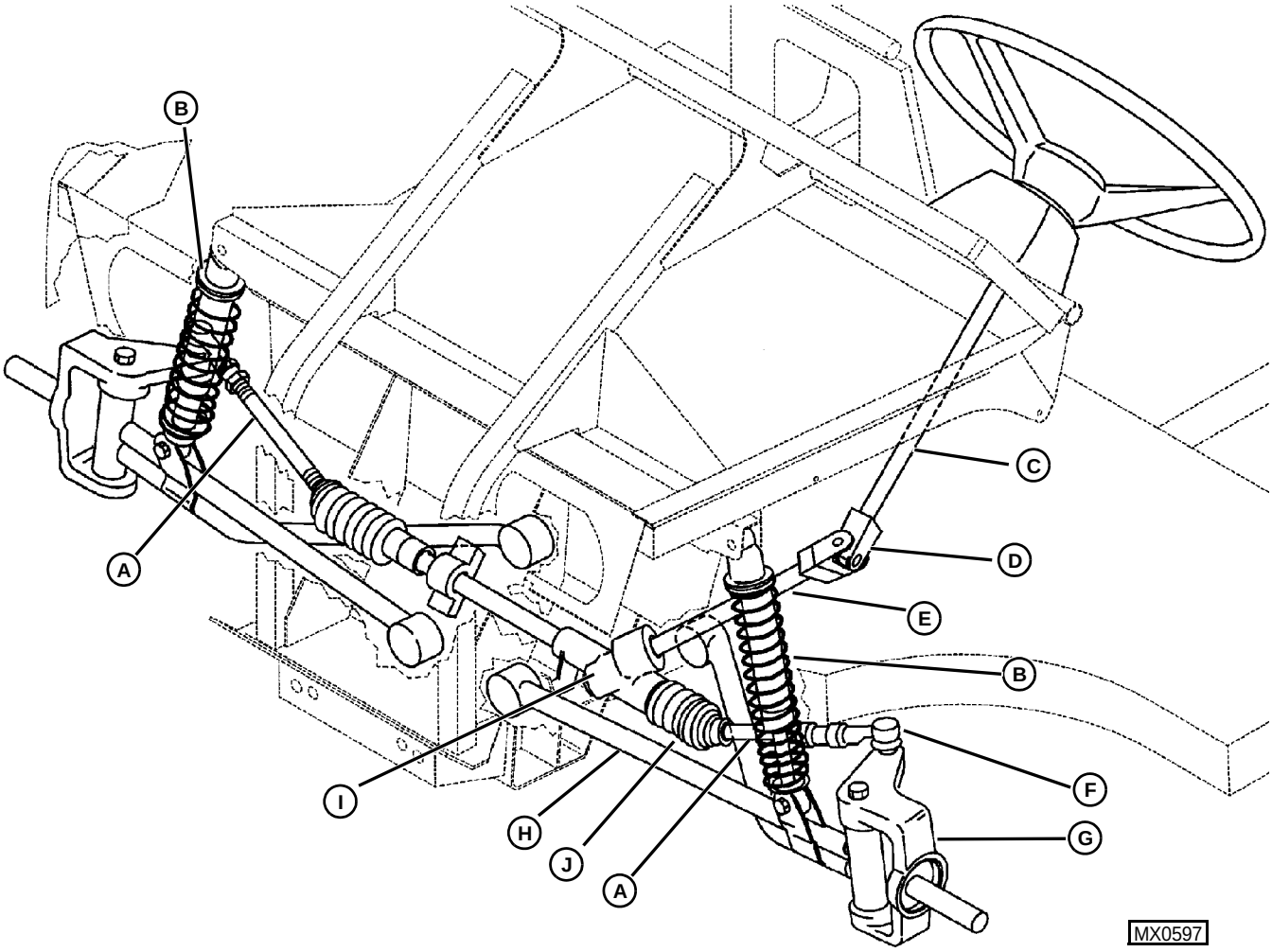
Toe-In Adjustment:

Front-to-rear difference . . . . front dimension is 1 - 7 mm (0.04 ± 0.28 in.) less than rear

TORQUE SPECIFICATIONS

- Shock absorber lock nuts . . . . . 80 N•m (60 lb-ft)
- Spindle assembly lock nuts . . . . . 60 N•m (44 lb-ft)
- A-Arm assembly lock nuts. . . . . 90 N•m (67 lb-ft)
- Rack and pinion assembly lock nuts . . . . . 70 N•m (52 lb-ft)
- Rubber boot assembly tie straps . . . . . Snug Only — boot must not turn with tie rod when tie rod is adjusted
- Front wheel bolts . . . . . 78 - 98 N•m (58 - 72 lb-ft)
- Tie rod
  - Lock nuts . . . . . 50 N•m (37 lb-ft)
  - Jam nuts . . . . . 70 N•m (52 lb-ft)
- Steering shaft U-joint assembly cap screw . . . . . 40 N•m (30 lb-ft)
- Steering wheel nut . . . . . Snug Only

COMPONENT LOCATION



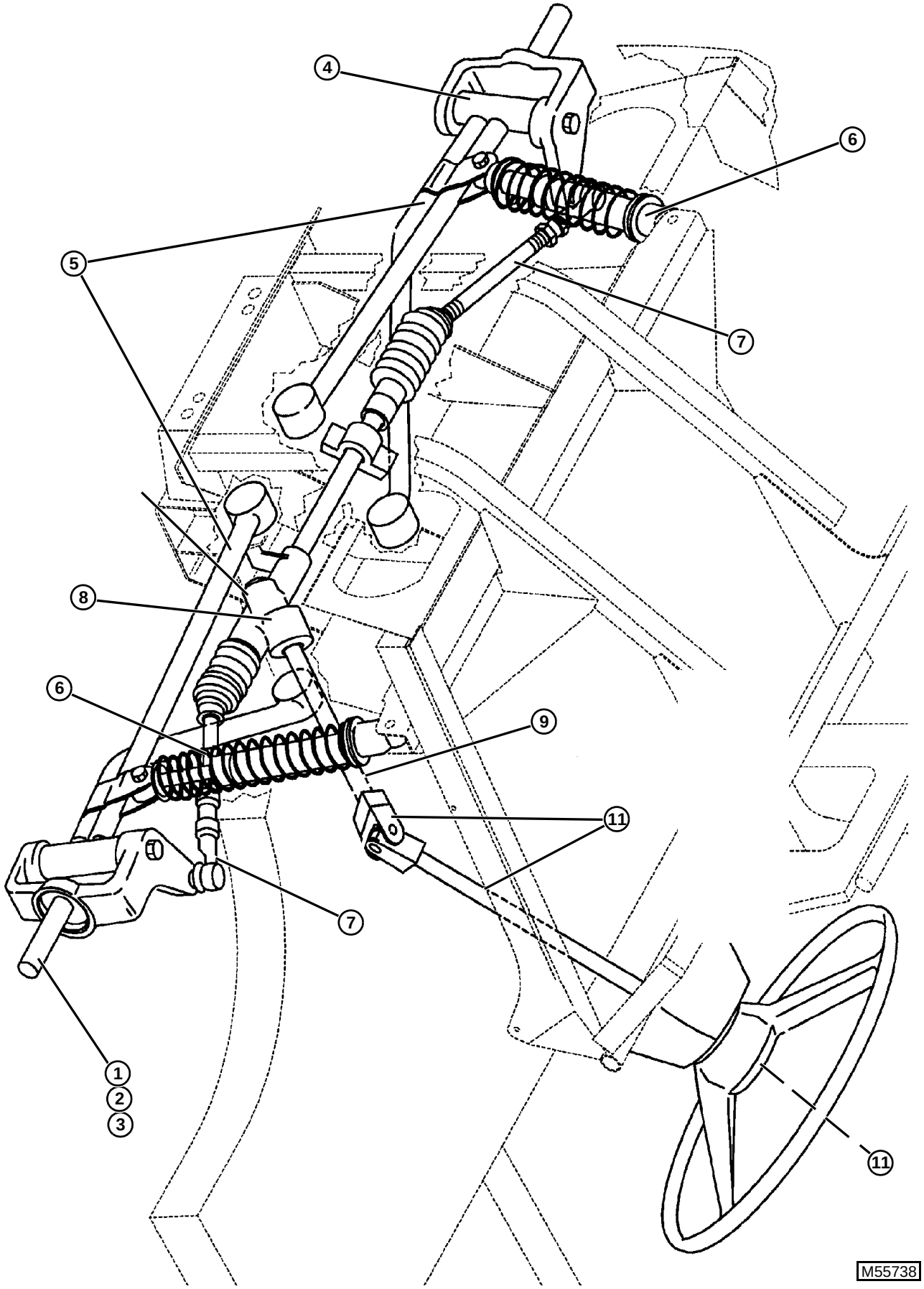
A. Tie Rod
B. Shock Absorber
C. Upper Steering Shaft
D. Steering Shaft U-Joint
E. Lower Steering Shaft
F. Tie Rod End
G. Spindle Assembly
H. A-Arm
I. Rack and Pinion
J. Rubber Boot

TROUBLESHOOTING

Problem or Symptom / Check or Solution	Steering pulls in one direction	Steering wonders	Steering shimmies or vibrates	Wheel bearing noise	Steers hard left or right or both	Steering locks in hard left or right turns	Steering wheel pulls upward	Steering wheel spins freely	Noise during turns or over rough terrain	Front steering suspension weak or unstable
Spindles, king pins, or king pins A-frame bearings worn or not lubricated sufficiently	●	●	●		●	●			●	
Rack and pinion assembly worn or broken	●	●	●		●	●		●	●	
Tie rods bent, loose, or toe-in incorrect	●	●	●		●	●			●	
Steering shaft u-joint worn or cap screw loose		●					●	●	●	
Wheel bearings worn or lost lubricating properties	●	●	●	●	●				●	
Tire size incorrect, out-of-round, or air pressure incorrect	●	●	●		●					
Shock absorbers leaking or springs broken			●						●	●
Steering wheel and/or shaft splines worn or stripped		●			●			●		
Steering wheel nut loose, stripped, or fallen off		●					●	●		
Steering shaft-to-rack and pinion assembly snap ring dislodged or broken	●	●	●		●	●	●	●		
Rubber boots cracked or torn					●	●			●	
A-arm bent, pivot bushings worn or lost lubricating properties	●	●	●						●	●
Shock absorbers mounts bent or hardware worn, loose, or broken	●	●	●						●	●
Shock absorbers installed upside down									●	●

DIAGNOSIS/TEST/CHECK POINTS

Test/Check Point	Normal	If Not Normal
1. Rims	Runout less than 3 mm (0.12 in.) Wheel bolts tight	Replace rims. Tighten to specification.
2. Tires	Runout less than 10 mm (0.4 in.)	Remount or replace tires.
	Tires properly inflated	Inflate tires to proper pressure.
3. Wheel bearings and bushings	Wheels rotate freely without rough spots	Replace rims.
4. Spindle and kingpin assemblies	Assemblies tight and turn smoothly	Tighten assemblies. Replace assemblies.
	King pins properly greased	Grease.
5. A-arm assemblies	Fastened securely	Tighten lock nuts to specification.
	Assemblies not bent	Replace A-arm assemblies.
	Pivot bushing not worn or binding	Replace bushings.
6. Shock absorbers	Installed and tightened properly	Tighten lock nuts to specification.
	Operate smoothly and not leaking	Replace shock absorbers.
7. Tie rods and tie rod ends	Jam nuts tight, tie rod ends tight, and toe-in adjusted properly	Adjust toe-in and tighten jam nuts and lock nuts.
	Tie rods straight, not worn	Replace components as necessary.
8. Rack and pinion assembly	Assembly fastened securely	Tighten assembly.
	Operates from stop-to-stop smoothly with little effort	Replace assembly.
9. Lower steering shaft	Fastened securely to rack and pinion assembly	Fasten securely.
	Straight	Replace shaft.
10. Upper steering shaft and U-joint	U-joint fastened securely	Tighten U-joint cap screw to specification.
	Operates smoothly. Shaft splines good	Replace upper steering shaft and U-joint.
11. Steering wheel and leaping deer emblem	Installed properly, nut snug	Install and tighten properly.
	No cracks or breaks, splines good	Replace components as necessary.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M55738

TOE-IN ADJUSTMENT

Reason:

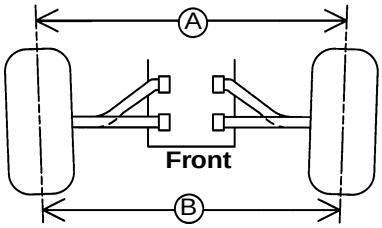
To prevent tire wear and steering wander.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

NOTE: Toe-in cannot be correctly adjusted with:
- wheels off surface
- an uneven surface
- any weight or load on machine.

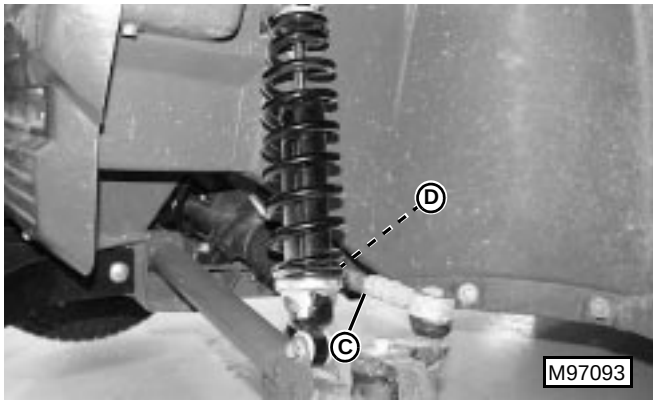
2. Turn steering wheel until front drivers-side tire aligns with drivers-side rear tire(s). Use straight 2 x 4 or piece of angle iron for guide.



Front Toe-In Adjustment
(B) = (A) - 1 - 7 mm (0.04 - 0.28in.)

M55739

3. At hub height and center of tire tread, measure rear distance (A) and front distance (B).
4. At right side tie rod, loosen jam nut (C) and turn tie rod until front distance (B) is **1 - 7 mm (0.04 - 0.28 in.) less** than rear distance (A).
5. Tighten jam nut.



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IMPORTANT: The rubber boot may turn with the tie rod if boot clamp (D) is too tight. DO NOT allow this to happen. Loosen clamp enough to allow the rubber boot to remain stationary.

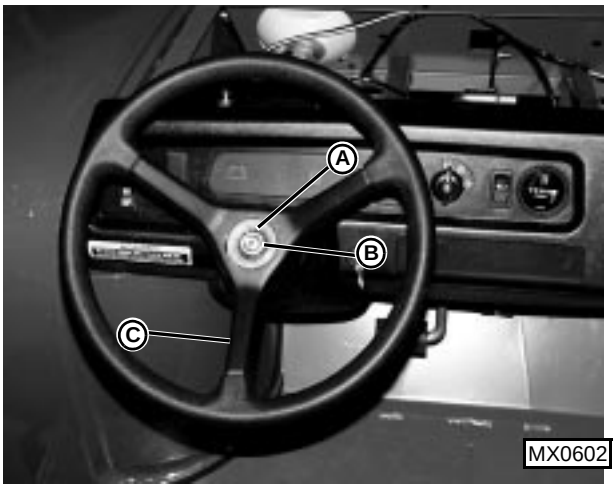
STEERING WHEEL ADJUSTMENT

Reason:

To position steering wheel properly.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Turn steering wheel to right or left steering stop.
3. Turn wheel to other stop while counting number of turns.
4. Turn wheel back $^1/_2$ of total turns counted.



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NOTE: Proper position of steering wheel is as shown with spokes at approximately 2, 6, and 10 o'clock.

5. If wheel is not correct, remove leaping deer emblem, nut (A), and washer.
6. Without moving steering shaft, remove steering wheel and align on splines (B) so bottom spoke (C) points to 6 o'clock.
7. Install washer and nut, tighten until snug only
8. Install leaping deer emblem.

REPAIR

TIE ROD END REPLACEMENT

Removal:

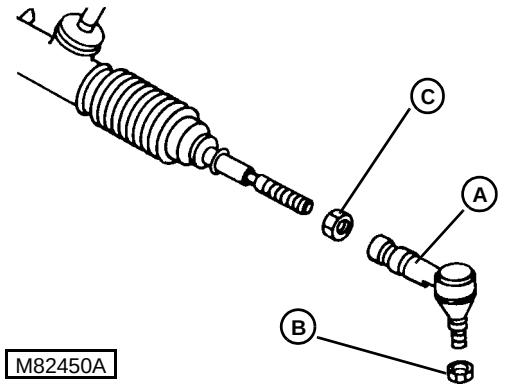
1. Remove front wheel.

NOTE: Tie rod end is a tapered bore fit. Use a ball joint fork or puller to ease removal.

2. Remove tie rod end lock nuts and disconnect tie rod ends from spindles.
3. Remove tie rod end (A).

Installation:

1. Install new tie rod end. Position spindle shaft 90° to machine and turn wheel on other side to straight position.
2. Turn tie rod end until tapered end fits into arm of spindle. Tighten lock nut (B) to **50 N•m (37 lb-ft)**
3. Adjust toe-in.
4. Tighten jam nut (C) to **70 N•m (52 lb-ft).**



M82450A

STEERING WHEEL AND SHAFT

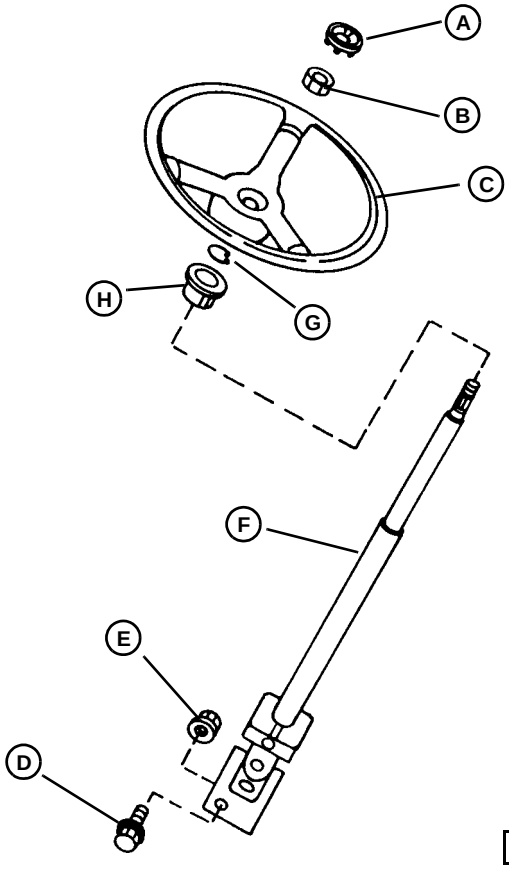
Removal:

1. Remove cap (A), lock nut (B).and steering wheel (C).
2. Remove U-joint cap screw (D) and nut (E).
3. Pull up on steering shaft (F). Remove snap ring (G).
4. Remove shaft (F) and bushing (H).
5. Inspect all parts for wear or damage. Replace as necessary.

Installation:

Installation is done in the reverse order of removal.

- Tighten U-joint cap screw to **40 N•m (30 lb-ft)**.



M82448A

RACK AND PINION ASSEMBLY

Removal:

1. Remove front wheels.
2. Remove U-joint cap screw (A) and nut (B).
3. Pull up on steering wheel to disconnect U-joint from lower steering shaft (J).
4. Remove tie rod end lock nuts (C) and disconnect tie rod ends from spindles.
5. Remove mounting cap screws (D) and lock nuts (E). Loosen the mounting bracket (G) and isolator (H).
6. Remove nine mounting screws and washers from left-hand fender.
7. Remove steering assembly (F) from left-hand side of machine.
8. Inspect all parts for wear or damage. Replace as necessary.

Installation:

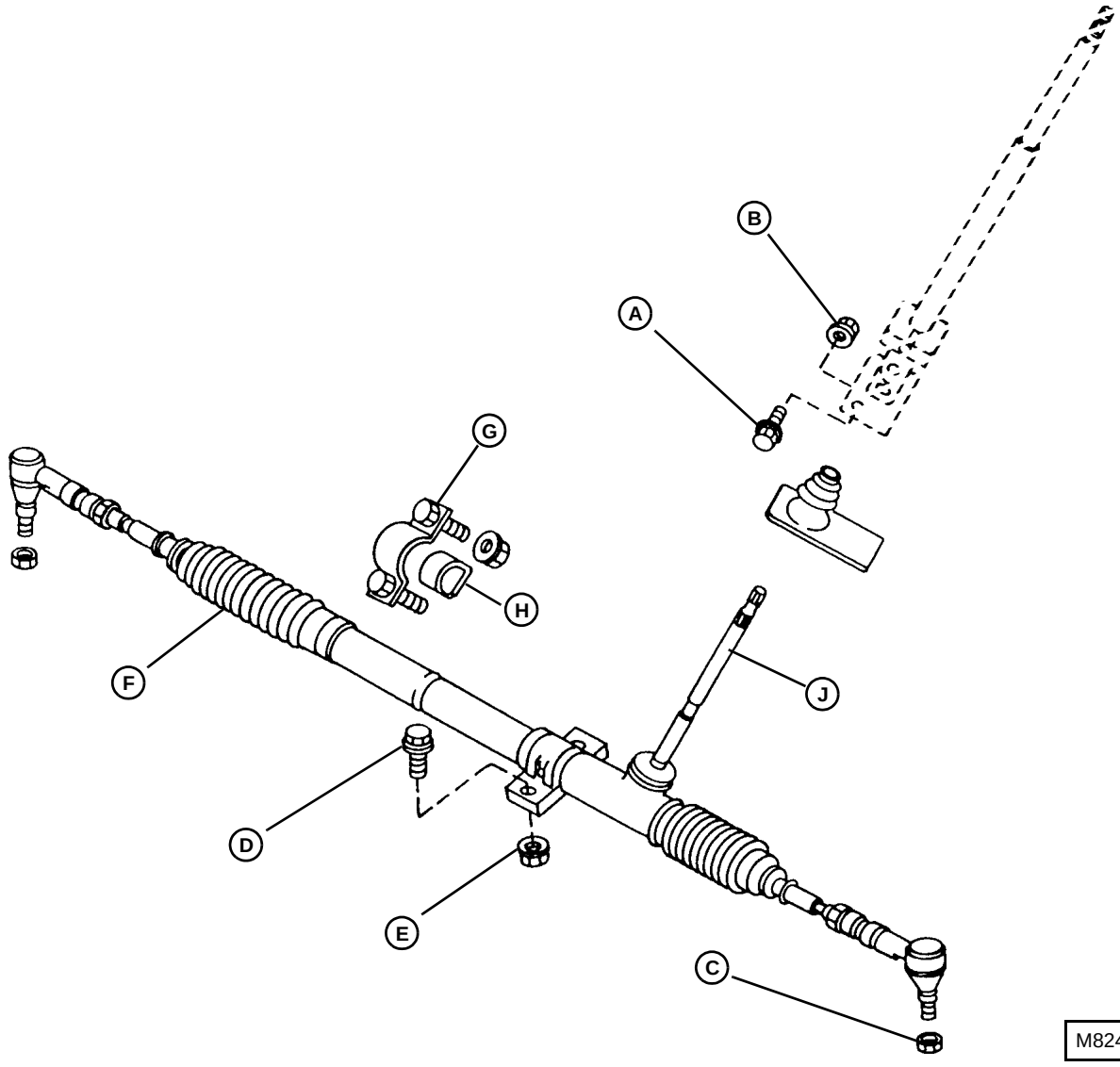
Installation is done in the reverse order of removal.

- Adjust toe-in.

Torque Specifications:

Tie rod end lock nut (C) . . . . . 50 N•m (37 lb-ft)
U-joint cap screw (A) . . . . . 40 N•m (30 lb-ft)
Mounting lock nuts (E) . . . . . 70 N•m (52 lb-ft)

RACK AND PINION COMPONENT LOCATION



SPINDLE SHAFT AND BUSHING

Removal:

1. Remove tire.
2. Disconnect tie rod end from spindle shaft (A).
3. Remove lock nut (B) and cap screw (C).
4. Remove spindle shaft.
5. Replace bushings (E).

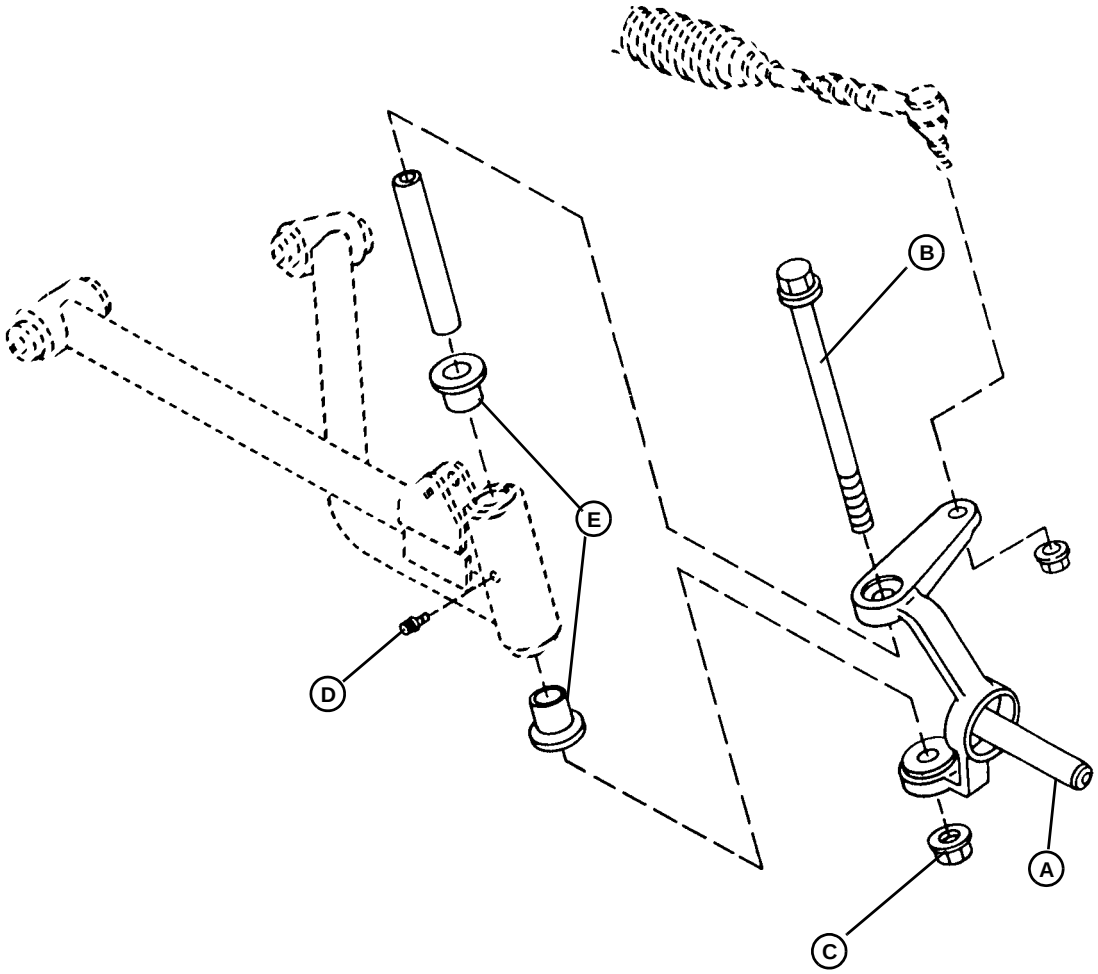
NOTE: Bushings are press fit into the a-arm. Use an inside puller set to remove bushings, and a driver set to install bushings

Installation:

Installation is done in the reverse order of removal.

- Apply multipurpose grease to lubrication fitting (D).
- Tighten lock nut (C) to **60 N•m (46 lb-ft).**

SPINDLE COMPONENT LOCATION



M82451A

CONTENTS

SPECIFICATIONS

Brake Plate Thickness. . . . . .1.44 - 1.60 mm (0.057 - 0.063 in.)
Friction Disk Thickness . . . . . .4.60 - 4.80 mm (0.181 - 0.189 in.)
Thrust Washer Thickness . . . . . .0.92 - 1.08 mm (0.036 - 0.43 in.)
Brake Pedal Freeplay Adjustment (Maximum) . . . . . 4 mm (0.16 in.)

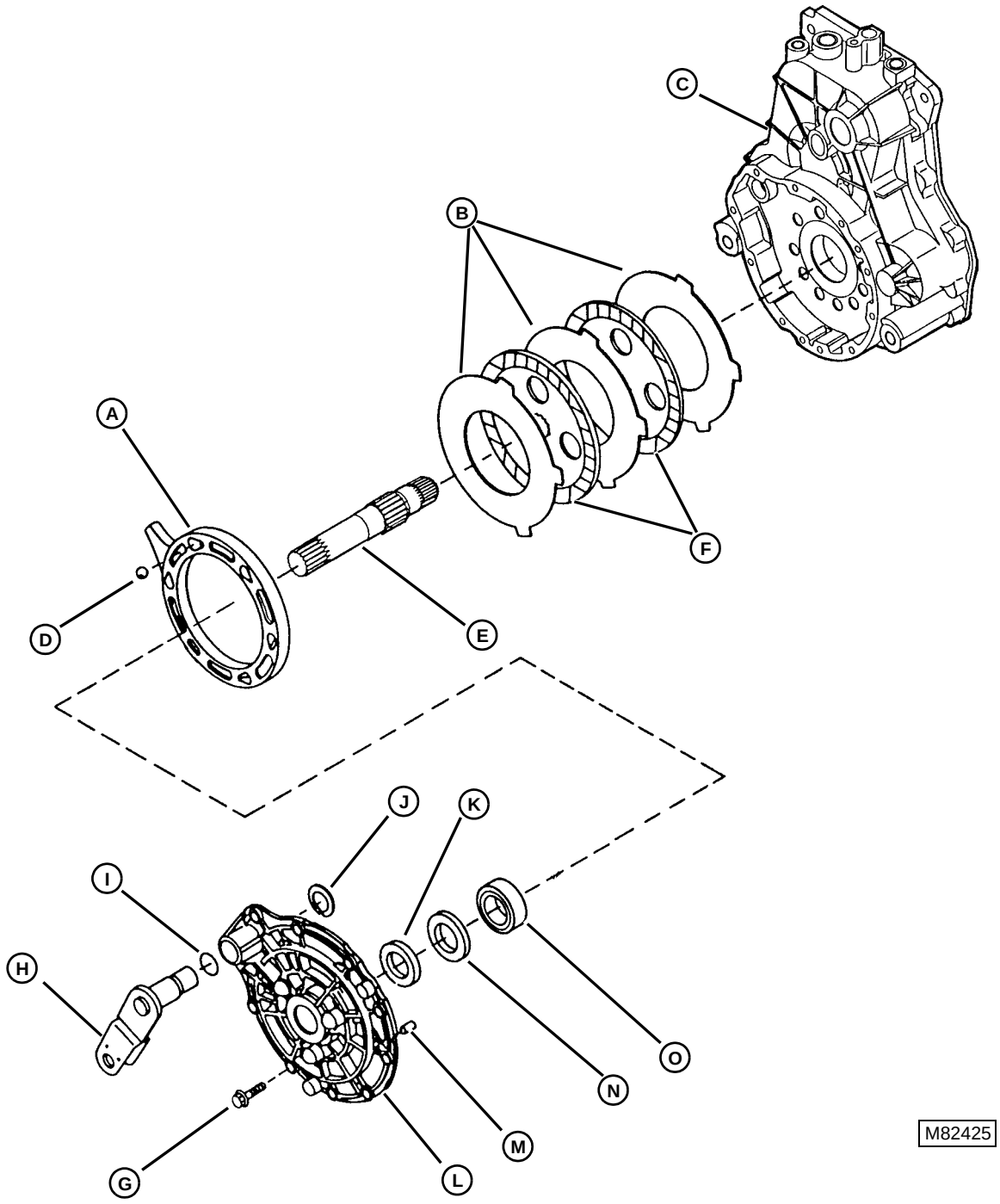
TORQUE SPECIFICATIONS

Driven Clutch Mounting Cap Screw . . . . . 38 N•m (28 lb-ft)
Brake Cover-to-Transaxle Case Cap Screw . . . . . 26 N•m (230 lb-in.)

OTHER MATERIALS

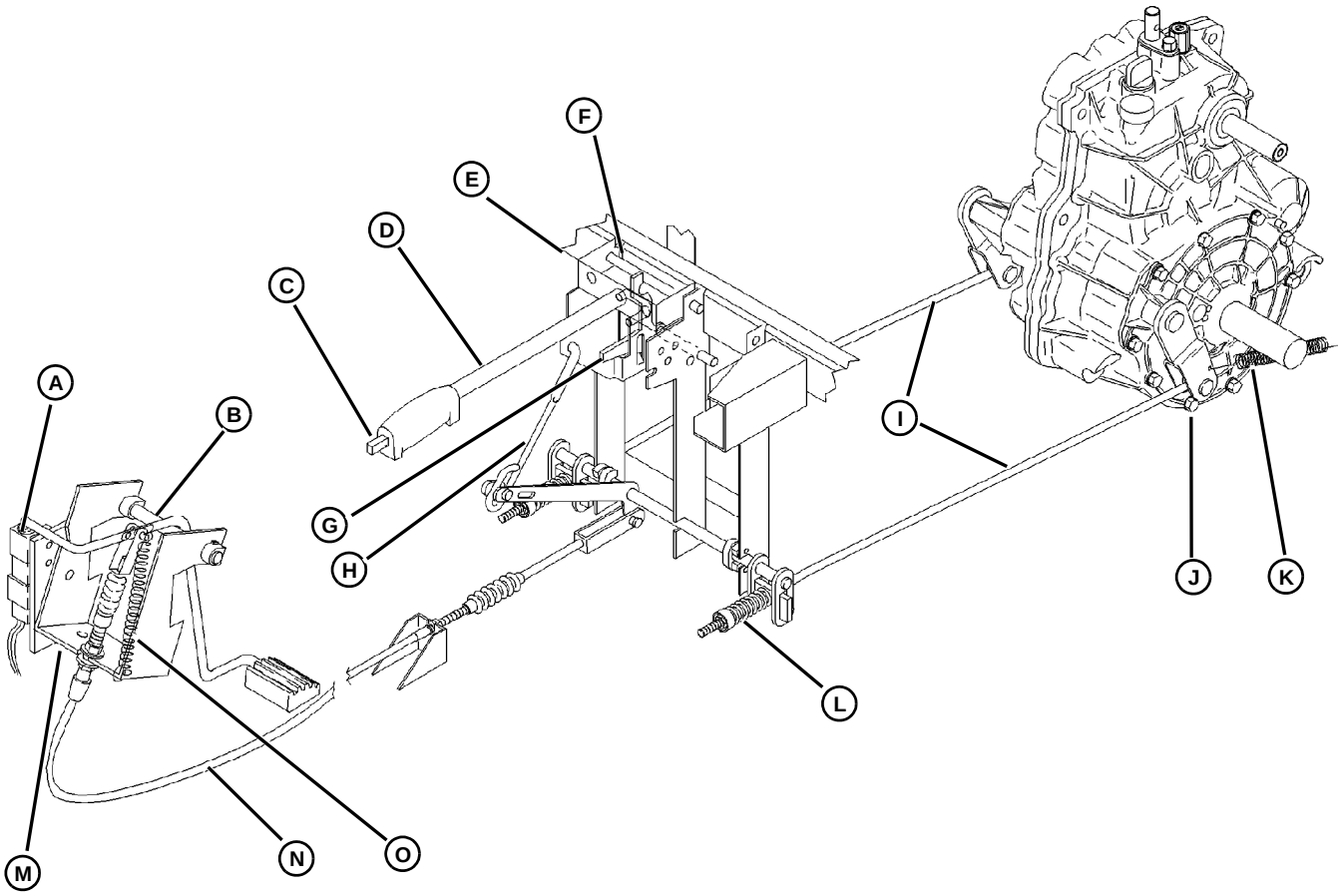
Number	Name	Use
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY15130 or TY15443	John Deere Sealant	Seals brake cover to transaxle case.
TY6333	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft.

COMPONENT LOCATION - BRAKE ASSEMBLY



A. Actuator Ring	B. Brake Plates (3 used)	C. Transaxle Housing (left side)
D. Ball (6 used)	E. Output Shaft (left side)	F. Brake Discs (2 used)
G. Cap Screw (10 used)	H. Brake Arm	I. O-Ring
J. Snap Ring	K. Seal	L. Transaxle Housing Cover
M. Alignment Pin (2 used)	N. Thrust Washer	O. Ball Bearing

COMPONENT LOCATION - BRAKE SYSTEM



A. Brake Pedal Switch
B. Brake Pedal Assembly
C. Park Brake Release Button
D. Park Brake Lever
E. Park Brake Switch
F. Park Brake Release Pawl
G. Park Brake Locking Pawl
H. Park Brake Rod
I. Brake Rods
J. Transaxle Assembly
K. Brake Arm Return Spring
L. Load Spring (1 per side)
M. Brake Pedal Bracket
N. Brake Cable
O. Brake Pedal Return Spring

TROUBLESHOOTING

Problem or Symptom / Check or Solution	Brakes will not engage or show poor response	Brakes binding or brake effort excessive	Brake engagement too aggressive	Brakes will not release	Park brake will not engage	Park brake will not release	Park brake will not hold	Brakes noisy or chattering	Excessive brake wear	Brake pedal travel excessive	Brakes noisy or chattering
Brake pedal bent, binding, or worn.	●	●		●				●	●		
Brake pedal return spring stretched or broken.				●				●	●		
Brake pedal stop plate worn or mis-adjusted.	●	●	●	●				●	●	●	
Brake cable mis-adjusted, stretched, worn, or binding.	●	●	●	●							
Brake linkage freeplay adjustment incorrect.	●	●	●	●	●	●	●		●		
Mid-frame brake springs mis-adjusted, collapsed or broken.	●	●	●	●	●		●	●			
Mid-frame brake arm linkage loose, mis-adjusted, binding, worn, or broken.	●	●		●	●	●	●	●	●	●	
Park brake lever, locking pawl, slotted rod, or park brake arm bent, binding, worn, or broken.					●	●	●				
Mid-frame -to-transaxle brake rods mis-adjusted, loose, or bent.	●	●	●	●	●	●		●	●	●	
Transaxle brake arm return springs stretched or broken.			●	●		●		●	●		
Transaxle brake arm and shaft bent, binding, or worn.	●	●	●	●	●	●	●	●	●	●	
Internal brake plates and discs warped, grooved, or worn.	●	●		●	●	●	●	●	●	●	
Internal actuator ring warped, grooved, missing balls, or worn.	●	●		●	●	●	●	●	●	●	
Change Transaxle oil - use ONLY HY–GARD® J20C											●

THEORY OF OPERATION

Function:

To provide a means of stopping the unit and also prevent movement when not in use.

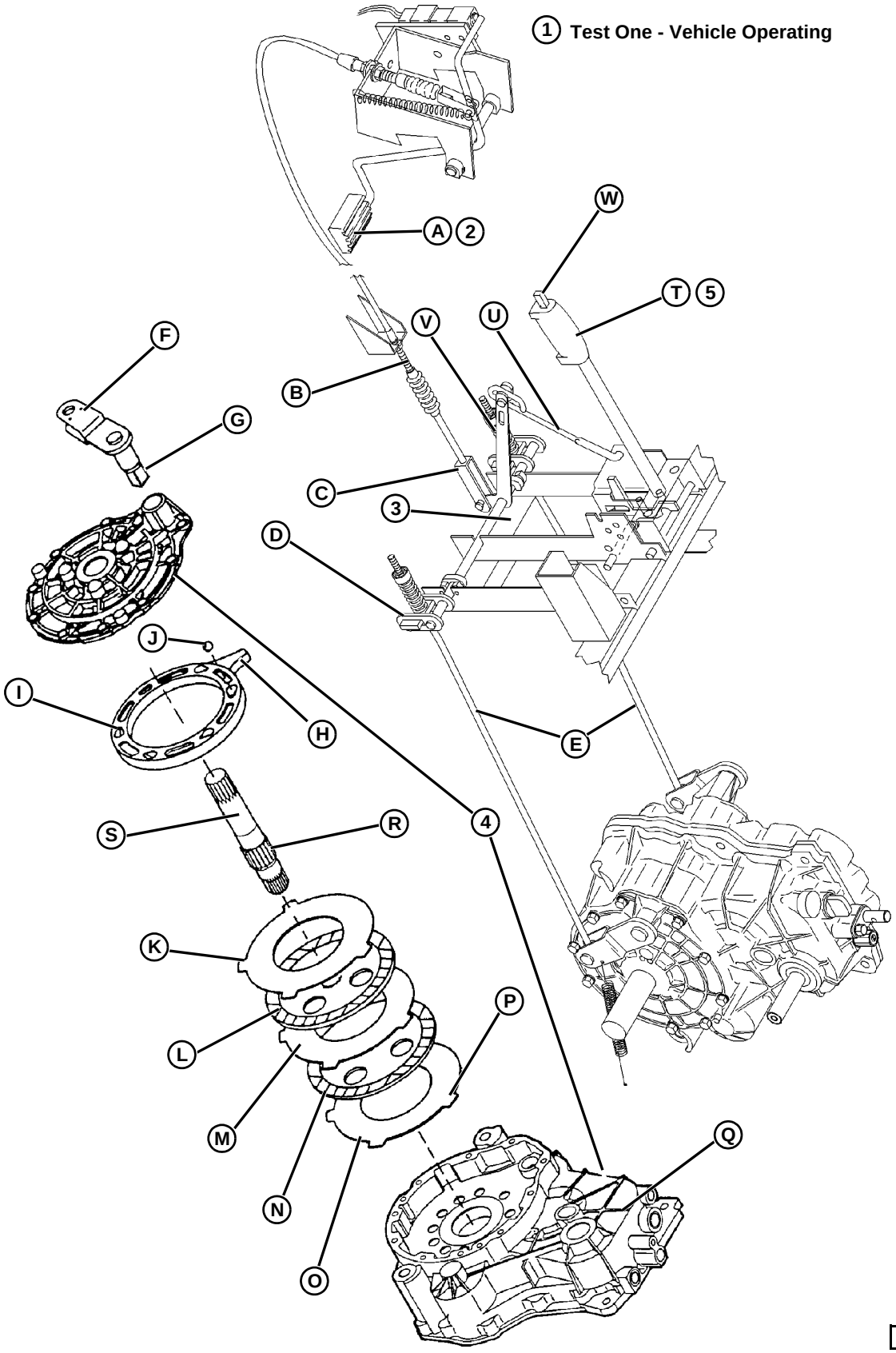
Theory Of Operation:

When the brake pedal (A) is depressed, the brake cable (B) pulls U-bracket (C) and mid-frame brake arms (D) forward. Mid-frame brake arms pull left and right side brake rods (E) which pull transaxle brake arms (F) forward. When transaxle brake arms are pulled forward the flat edge at the internal end of the brake arm shaft (G) pushes against the actuator ring tab (H). This rotates the right-side actuator ring clockwise and the left-side actuator ring counter-clockwise causing the six angled ramps (I) to move against the six captured balls (J). This action forces the actuator ring against the outer brake plate (K), outer brake disc (L), middle brake plate (M), inner brake disc (N), and finally the inner brake plate (O).

The friction between the brake plates and brake discs slows or stops output shaft (S) rotation, which slows or stops the drive wheels. The brake plates are held stationary by four tabs (P) on each of three brake plates which are seated in four transaxle housing grooves (Q). The brake discs are spline engaged to the output shaft's center splines (R).

When the park brake lever (T) is raised into its locked position, the slotted rod (U) pulls the park brake arm (V) up and the mid-frame brake arms (D) forward. From hereon, everything works the same. To release the park brake lever, first raise the lever slightly, then depress the release button (W) and lower lever all-the-way.

SYSTEM OPERATION



DIAGNOSIS/TEST/CHECK POINTS

Test Conditions:

- Engine running at operating temperature - Test 1 only.
- Minimum of 50 feet of open and flat pavement away from any people - Test 1 only.
- Operator in seat.
- Shift lever in forward or reverse - Test 1 only.
- Key switch OFF and shift lever in NEUTRAL - all except Test 1.

Test/Check Point	Normal	If Not Normal
1. Vehicle operating	When brakes applied, machine stops aggressively with rear wheels locking.	Check linkage and brake components for adjustment, binding, wear or damage
	Brake pedal should depress smoothly and with little effort.	Check linkage and brake components for binding, wear or damage.
2. Brake pedal	Components not worn or damaged.	Repair or replace as necessary.
	Hardware not worn or loose.	Repair or replace as necessary.
	Springs not broken or stretched.	Replace as necessary.
3. Mid-frame	Cable not binding, mount and jam nut good.	Repair or replace as necessary.
	Rubber boot and clamps good.	Repair or replace as necessary.
	Load springs not broken or compressed.	Repair or replace as necessary.
4. Transaxle	Linkage adjusted properly and not damaged or worn.	Adjust Repair or replace as necessary.
	Internal components not worn or damaged.	Repair or replace as necessary
5. Park brake	Properly adjusted.	Adjust.
	Linkage not worn or damaged	Repair or replace as necessary.

BRAKE ADJUSTMENTS

Reason:

To ensure service brake linkage and park brake linkage are adjusted properly.

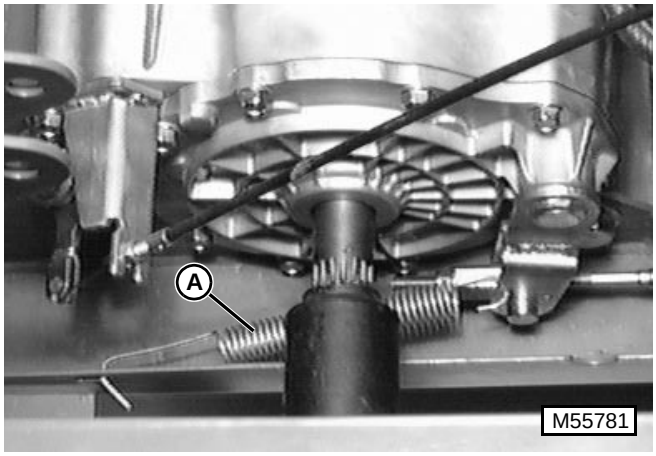
Procedure:

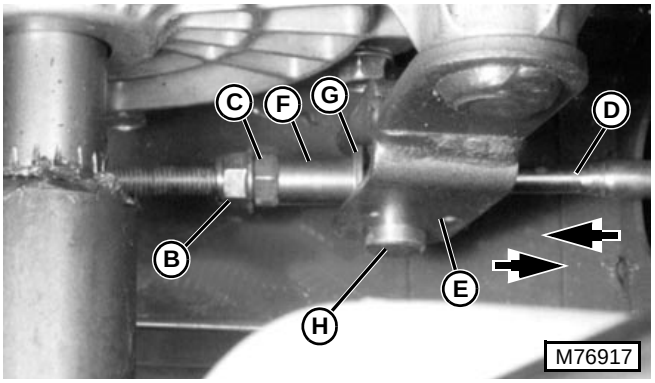
NOTE: If this is a NEW transaxle or you have replaced the brake pack assembly, ONLY perform steps 1-7, 9 and 10. DO NOT perform step 8 because NEW brake parts require a tighter linkage adjustment to account for initial break-in wear.

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake lever in released position, and front wheels BLOCKED.
3. Use jack stands or hoist to raise rear wheels at least **25 mm (1.0 in.)** off ground.

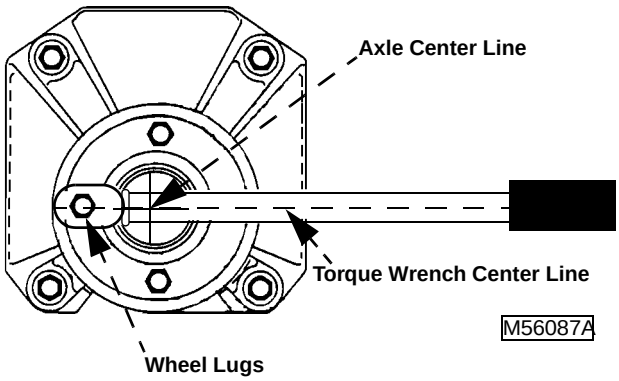
NOTE: If brake cable is being replaced, DO NOT attach cable to brake pedal at this time. Attach cable only at mid-frame mounting and brake arm assembly.

4. Disconnect brake arm return spring (A).





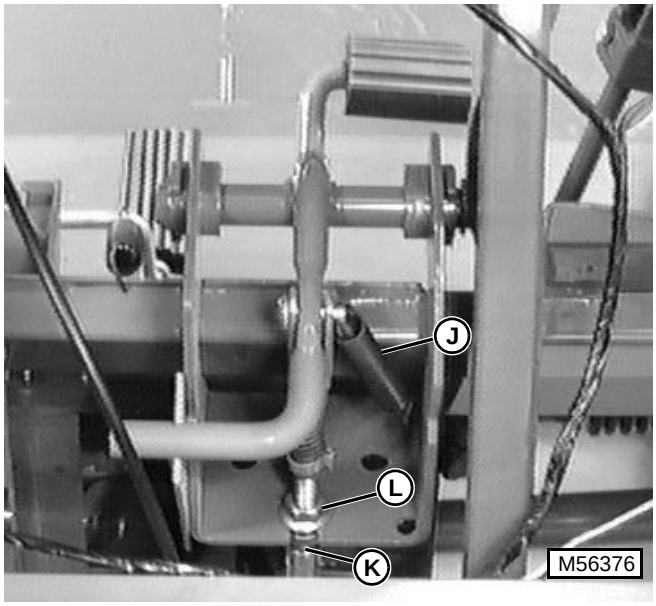
5. Loosen jam nut (B) and coupler nut (C).
6. Hold brake rod (D) to rear and brake arm (E) forward to remove all play.
7. Turn coupler nut (C) forward until it pushes spacer (F) and washer (G) forward until washer just contacts coupler pin (H).
8. Turn coupler nut (C) 3 turns (eighteen flats of nut) away from pin (H).
9. Tighten jam nut (B).
10. Install brake arm return spring (A).
11. Turn rear wheel, it should rotate with a slight drag (considerably higher drag for NEW parts) and provide even braking on both sides. See alternate procedure, step 12 (Except: DO NOT use for NEW parts).
12. Alternate procedure to Step 11. (DO NOT use this step for NEW parts):
    - Turn any lug of rear wheel. Wheel should rotate at less than **20 N•m (15 lb-ft)**, ideally **14 N•m (10 lb-ft)**.



NOTE: When using torque wrench, the torque wrench centerline should intersect the axle flange centerline!

13. After repeating procedure for both sides, check both sides for EVEN braking. If UNEVEN, repeat entire procedure.

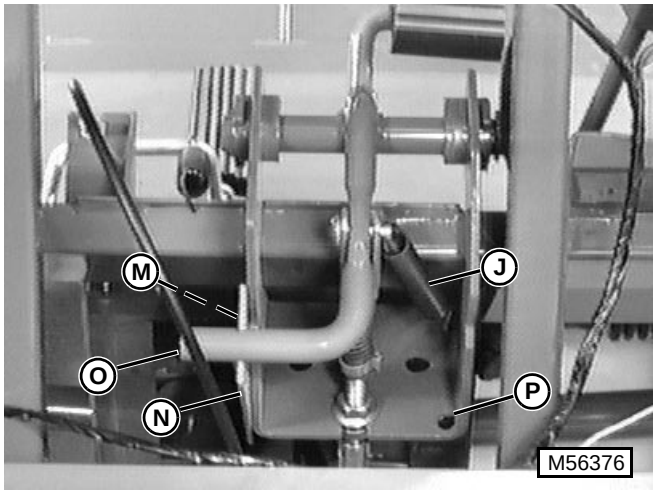
NOTE: This completes the routine portion of brake adjustment procedure. If brake cable has been replaced or foot pedal linkage needs adjustment, complete Steps 14 - 20.



14. Pull park brake lever into LOCKED position.
15. Unhook brake pedal return spring (J).

IMPORTANT: DO NOT allow brake cable to slip out of slot or cable may become kinked. Hold cable in slot by holding cable below lower nut (K) when loosening top nut (L).

16. Adjust brake cable nuts (K) and (L) to provide a **20 mm (0.79 in.)** gap between the bottom of the brake pedal and the floor.
17. Tighten nuts (K) and (L).



NOTE: Brake pedal freeplay is necessary to prevent any preload of brake linkage. If stop plate (N) is adjusted too high, brakes will be preloaded. If stop plate (N) is adjusted too low, return spring (J) pressure, will kink brake cable.

18. Loosen cap screw (M) of stop plate (N). Adjust stop plate up to reduce amount of freeplay in brake pedal. *Apply only enough up force to stop plate to take up freeplay. Do not start actuating brake. Maximum freeplay pedal travel is* ***4 mm (0.16 in.).***
19. Hold stop plate (N) while you tighten cap screw (M).
    - If light and horn kit is installed, stop plate (N) will have a switch fastened to it. Stop plate must be positioned so switch is aligned with bottom of brake pedal rod (O). Be sure brake pedal rod contacts switch plunger (plunger depressed) but does not contact the switch body.
20. Install brake pedal return spring (J) in hole (P).

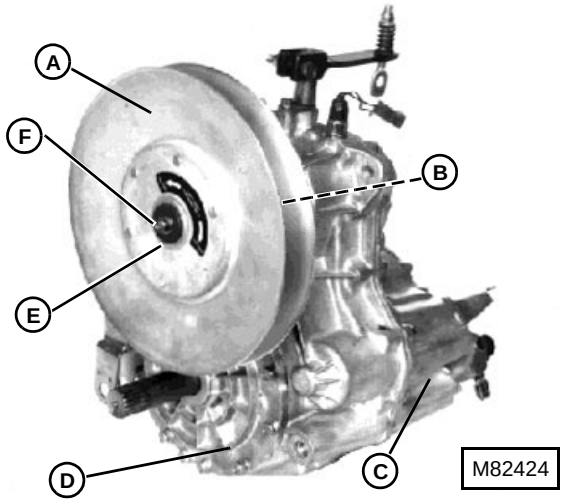
BRAKE

Removal:

1. Remove transaxle assembly (C).

NOTE: Driven clutch must be removed to service left hand brake assembly (D). Mounting cap screw (E) has left-hand threads.

2. Remove driven clutch (A). Hold clutch with a strap wrench and remove left hand thread cap screw (E) and bushing (F).
3. Tap on inside of clutch with a rubber mallet.



NOTE: Balls may fall out when cover is removed.

Bearing is slip fit on output shaft and in cover.

4. Remove brake cover and brake parts.

IMPORTANT: Replace all seals and O-rings.

5. Pry out seal using a screwdriver.
6. Inspect all parts for wear or damage. Installation is done in the reverse order of removal.

- Apply multipurpose grease to lips of new seal. Install seal flush to inside of cover using a driver set.
- Apply petroleum jelly on thrust washer and balls to hold in place during installation.
- Clean mating surfaces of transaxle case and brake cover using Clean and Cure Primer. Apply a coat of John Deere Sealant, or an equivalent, to mating surfaces.
- Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle input shaft before installing driven clutch.

Inspection:

Inspect all parts for wear or damage. Measure thickness of brake plates, friction discs and thrust washer. If not within specifications, replace.

Thickness Specifications:

Brake Plates . . . . . 1.44 - 1.60 mm (0.057 - 0.063 in.)
Friction Discs . . . . 4.60 - 4.80 mm (0.181 - 0.189 in.)
Thrust Washer . . . 0.92 - 1.08 mm (0.036 - 0.043 in.)

Installation:

Installation is done in the reverse order of removal.

CONTENTS

M

TORQUE SPECIFICATIONS

Shock Absorber:

Mounting Lock Nut . . . . . 70 N•m (52 lb-ft)

A-Arm:

Shock Absorber to A-Arm lock nut . . . . . 70 N•m (52 lb-ft)
A-Arm to Frame Lock Nut . . . . . 90 N•m (67 lb-ft)

Wheels:

Front Wheel Mounting Hub Cap Screw . . . . . 78 - 98 N•m (58 - 72 lb-ft)
Rear Wheel Mounting Bolts . . . . . 78 - 98 N•m (58 - 72 lb-ft)
Rear Wheel Mounting Bolts (EMT tires) . . . . . 78 - 98 N•m (58 - 72 lb-ft)

Cargo Box:

Hinge Bolts (side and tail gate) . . . . . 41 - 60 N•m (30 - 44 lb-ft)

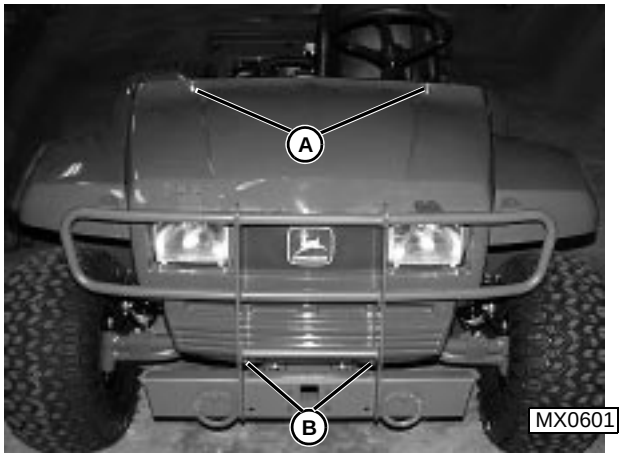
HOOD ADJUSTMENT

Reason:

To position hood so openings for the headlights are centered around headlights.

Procedure:

1. Park machine on level surface, turn key switch OFF, place shift lever in NEUTRAL, and lock park brake.



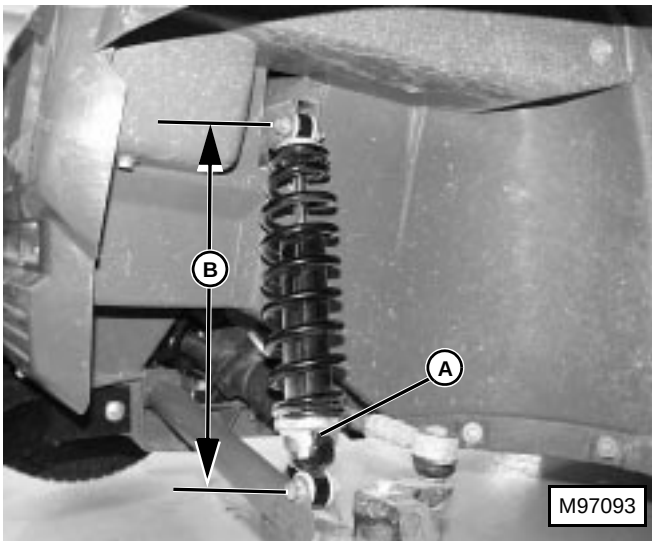
2. Loosen cap screws (A) and (B).

IMPORTANT: Hood MUST NOT touch headlights or vibration may cause headlights to fail.

3. Adjust hood so openings around headlights are equal.
4. Tighten bottom cap screws (B), then tighten top cap screws (A)
5. Make sure hood has not shifted during tightening. Adjust again, if necessary.

SHOCK RIDE HEIGHT AND SPRING PRELOAD ADJUST

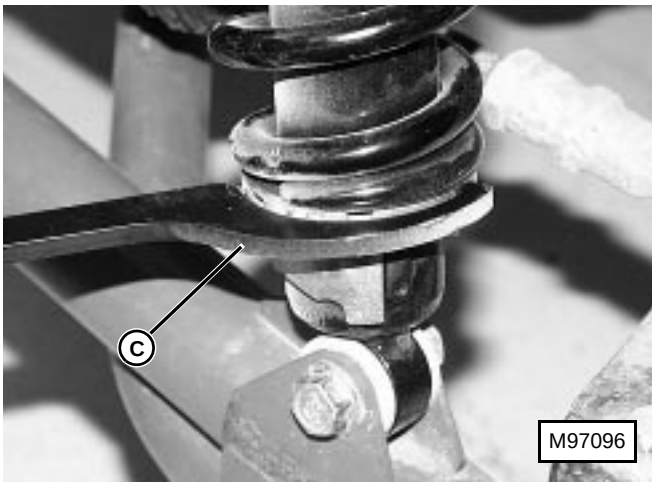
1. Ensure all tires are inflated to **41 kPa (6 psi)**.



2. Measure center of bolt head to center of bolt head (B) on each shock and average the two dimensions.

IMPORTANT: The cam position (A) on each shock needs to be the same to maintain a stable ride.

3. If average dimension is less than **305 mm (12 in.)**, adjust the cam to provide more spring preload. DO NOT exceed **315 mm (12-3/8 in.)**.



4. Use the adjusting wrench (C) to adjust the shock up to 5 levels of adjustment. Each level of the adjustment is approximately **3 mm (1/8 in.)** more spring preload.
5. Drive to allow settling and setting in of the shocks, then check measurements. Adjust if necessary.

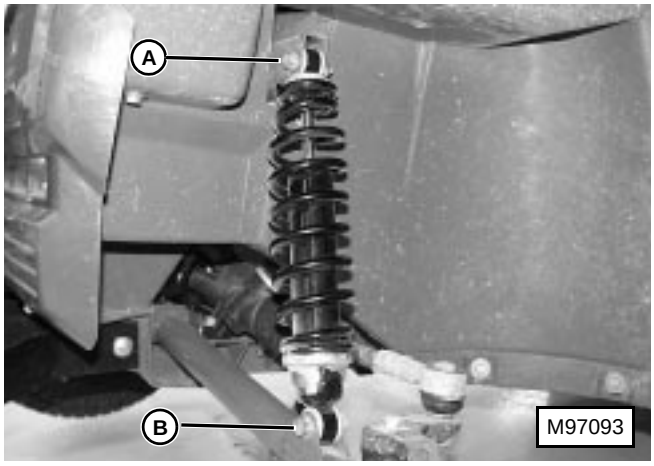
M

REPAIR

SHOCK ABSORBER REPLACEMENT

Removal:

1. Remove front wheel.



2. Remove top and bottom mounting lock nuts and cap screws (A or B).
3. Remove shock absorber(s).

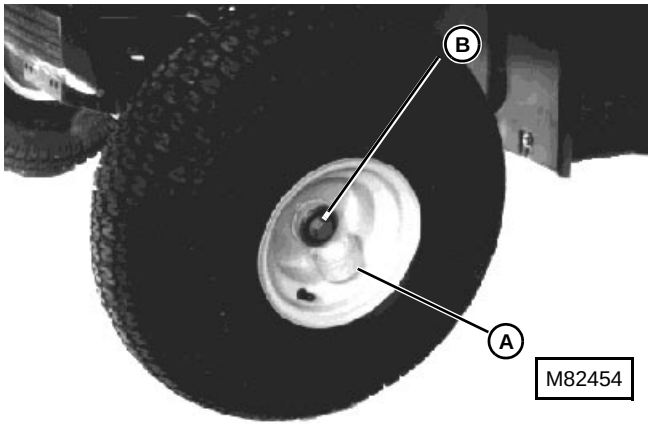
Installation:

1. Install new shocks, leaving in lowest spring preload setting, with rod end up.
2. Tighten mounting lock nuts to **70 N•m (52 lb-ft)**.

FRONT WHEEL REMOVAL AND INSTALLATION

Removal:

1. Raise and support machine.



2. Remove hub cap (A).
3. Remove mounting cap screw (B).
4. Tap on backside of wheel rim with a soft-faced mallet to remove wheel.
5. Inspect and replace bearings, if necessary.

Installation:

Installation is done in the reverse order of removal.

- Apply multipurpose grease to spindle shaft before installing wheel.
- Install front wheels with stems toward outside of machine. Tighten cap screw to 78 - 98 N•m (58 - 72 lb-ft)

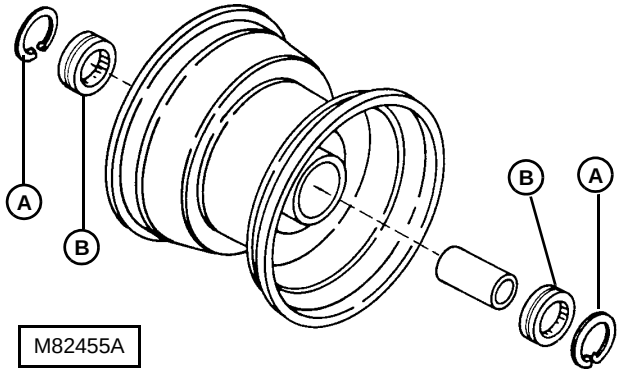
WHEEL BEARING REPLACEMENT

Removal:

1. Remove front wheel.
2. Remove snap ring (A).
3. Remove bearing (B) on one side using an inside puller and slide hammer.

NOTE: Bearings are press fit in wheel rim.

4. Remove snap ring and bearing on opposite end using a driver set.



Installation:

Installation is done in the reverse order of removal.

- Pack inside of rim with multipurpose grease before installing spacer and bearings.

M

A-ARM REMOVAL AND INSTALLATION

Removal:

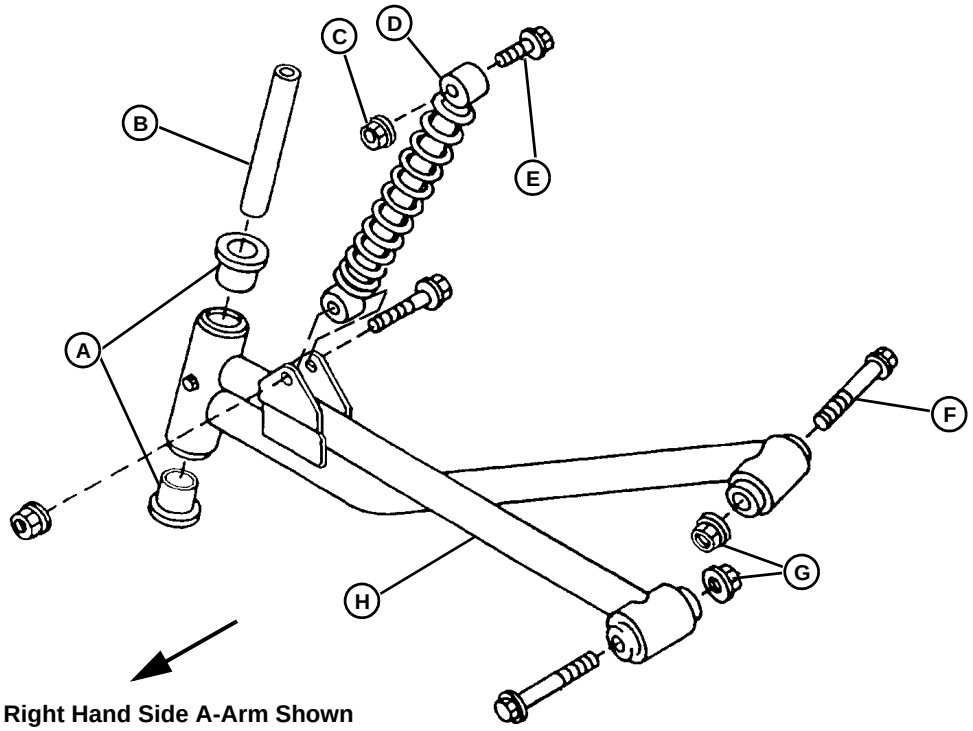
*NOTE: If replacing A-Arm, remove spindle shaft and bushings. (See **STEERING** section.)*

1. Remove front wheel.
2. Remove shock absorber mounting cap screw and lock nut.
3. Remove mounting cap screws, lock nuts and A-Arm.

Installation:

Installation is done in the reverse order of removal.

Shock absorber should be in place to provide proper orientation of A-Arm when tightening mounting hardware.



Right Hand Side A-Arm Shown

M82453A

A. Bushing (2 used)
B. King Pin
C. Lock Nut (2 used)
D. Shock Absorber
E. Cap Screw M10 X 40, Head Marked 10.9 (2 used)
F. Cap Screw M12 X 90 (2 used)
G. Lock Nut (2 used)
H. A-Arm

M

A

B

C

D

E

F

T

V

W