JOHN DEERE

WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Lightweight Fairway Mower
3215, 3215A, 3215B, 3225B, 3235, 3235A and 3235B

TM1534 FEB03

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho in U.S.A.

Manual Description

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:

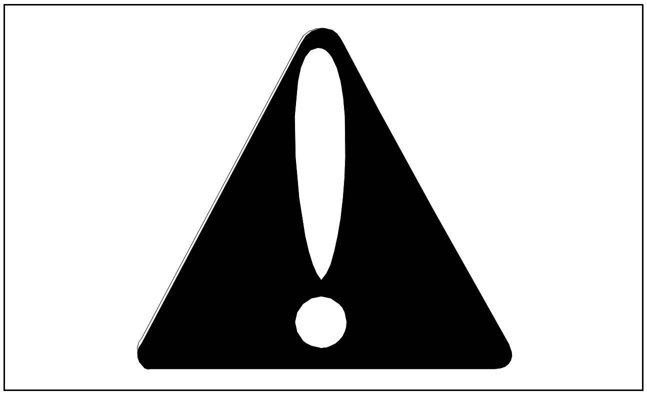
- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

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

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

Recognize Safety Information



MIF

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.

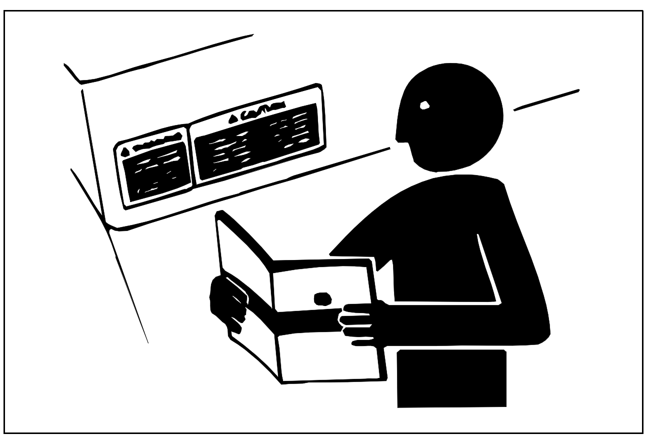
Follow recommended precautions and safe servicing practices.

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

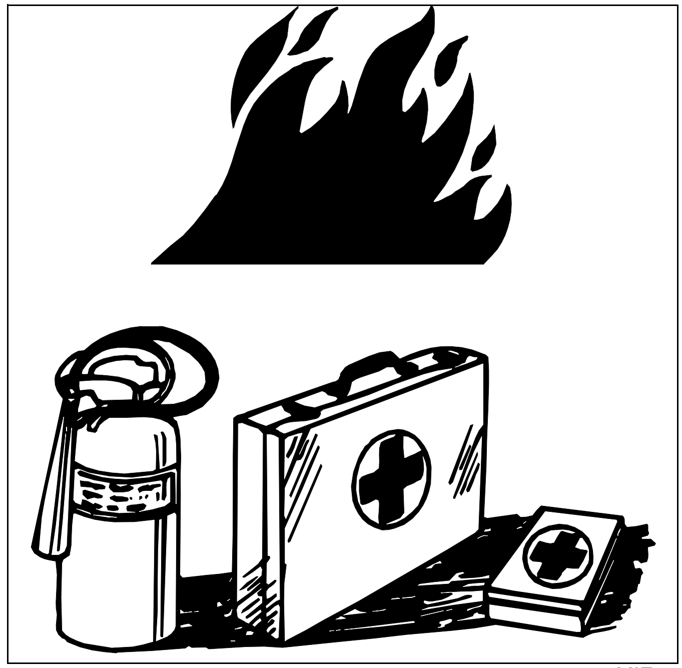


MIF

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



MIF

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.

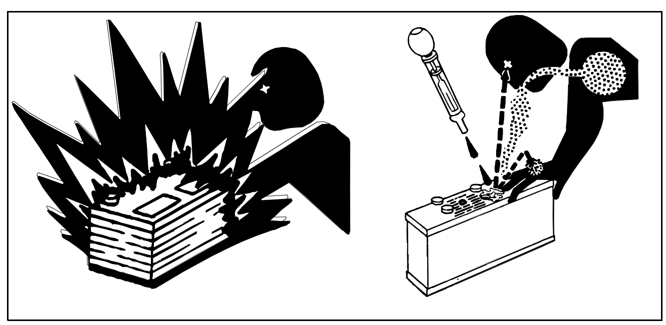
Do not store oily rags; they can ignite and burn spontaneously.

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



MIF

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 voltmeter 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. Using 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

MIF

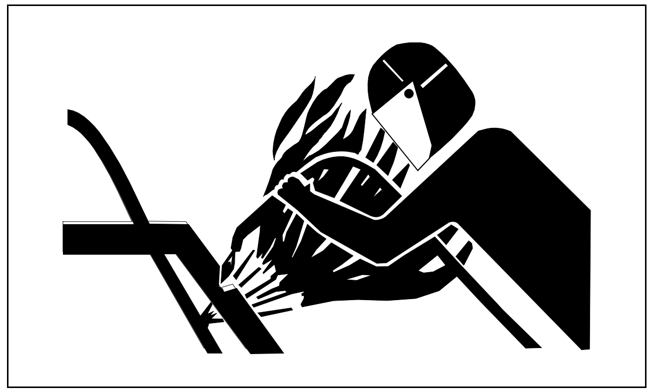
Escaping fluid under pressure can penetrate the skin causing serious injury.

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

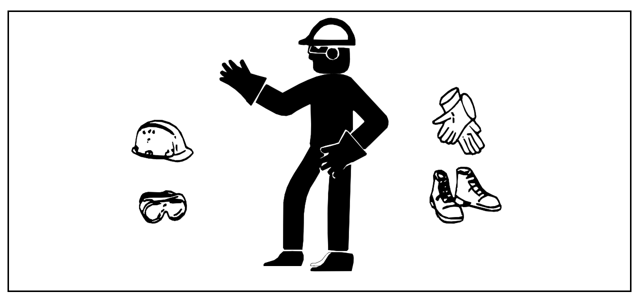


MIF

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



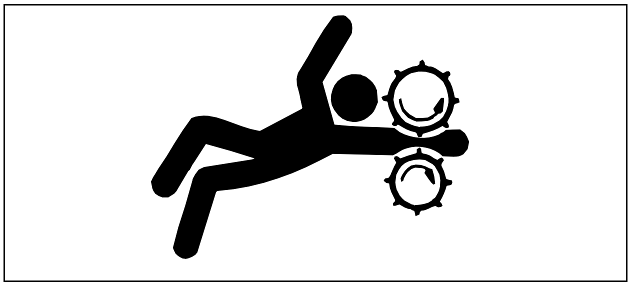
MIF

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



MIF

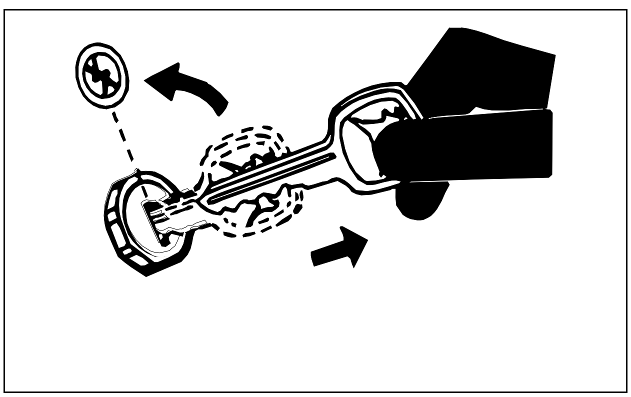
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

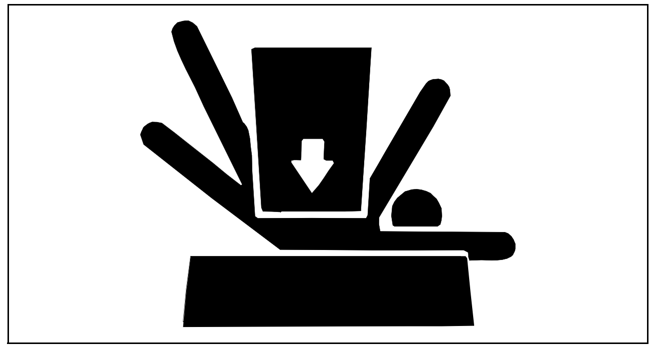


MIF

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



MIF

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.

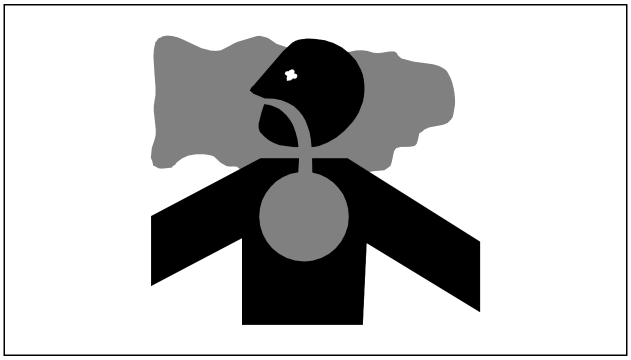
Using High-Pressure Washers

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



MIF

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.

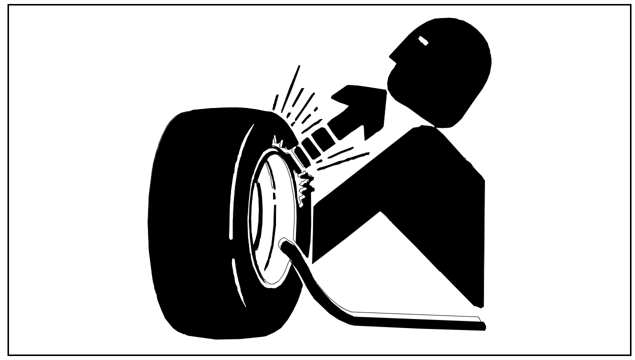
Avoid Harmful Asbestos Dust

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



MIF

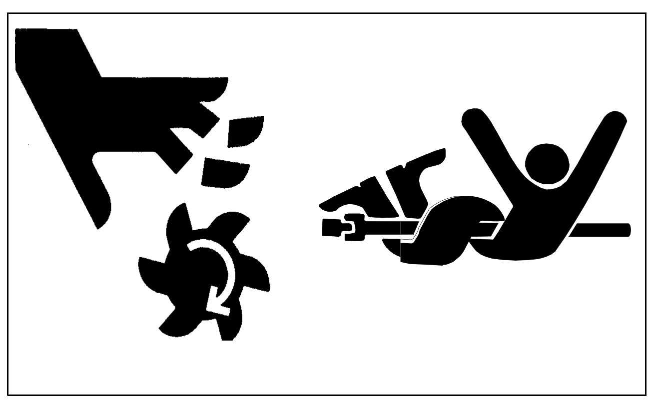
Explosive separation of a tire and rim parts can cause serious injury or death.

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.

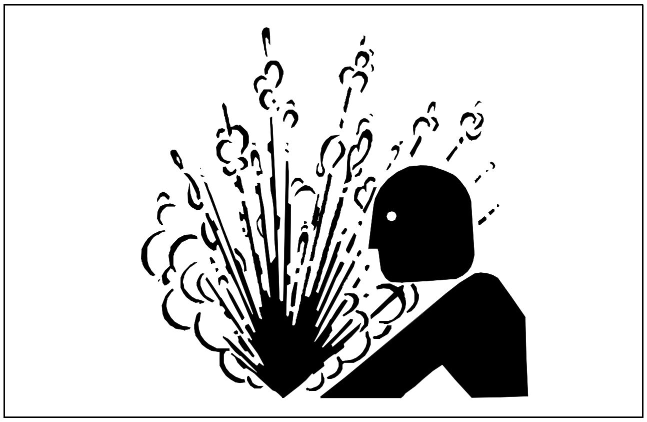
Avoid Injury from Rotating Blades and Drive Shafts



MIF

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

Service Cooling System Safely

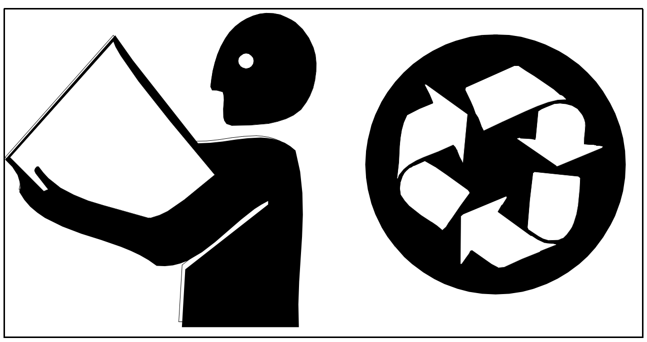


MIF

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 the cap to first stop to relieve the pressure before removing completely.

Handle Chemical Products Safely



MIF

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 includes 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

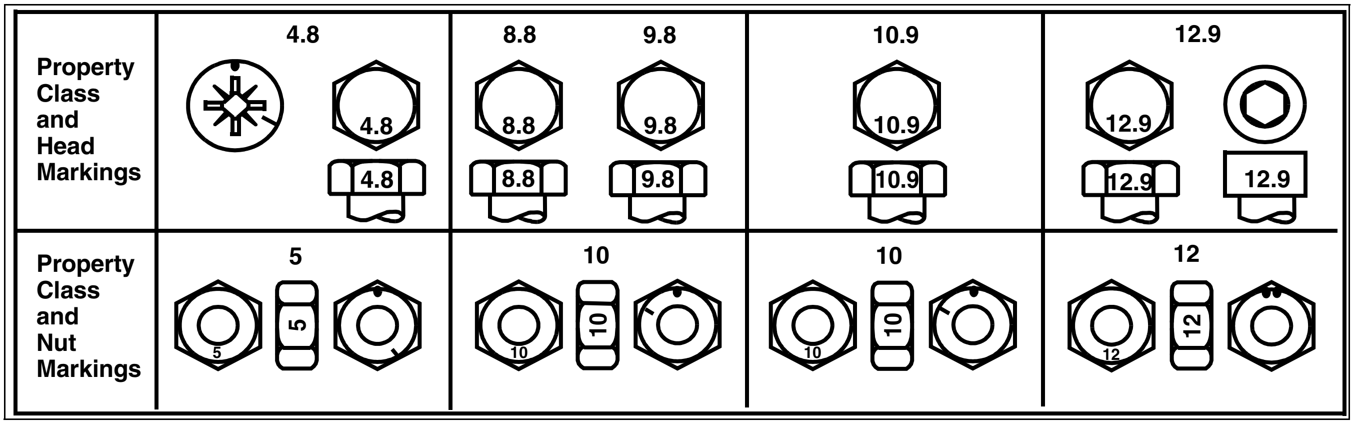
MIF

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

Table of Contents

General Information

Metric Fastener Torque Values



TS1163

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

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

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

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

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

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

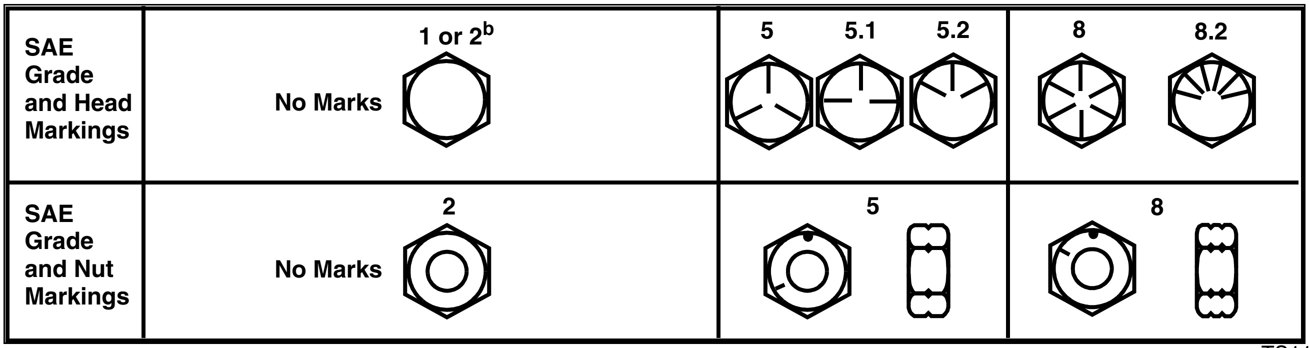
a *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate-Specification JDS117) without any lubrication.*

Reference: JDS-200.

Metric Fastener Torque Values - Grade 7

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

Inch Fastener Torque Values



TS1162

	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 bolt head.

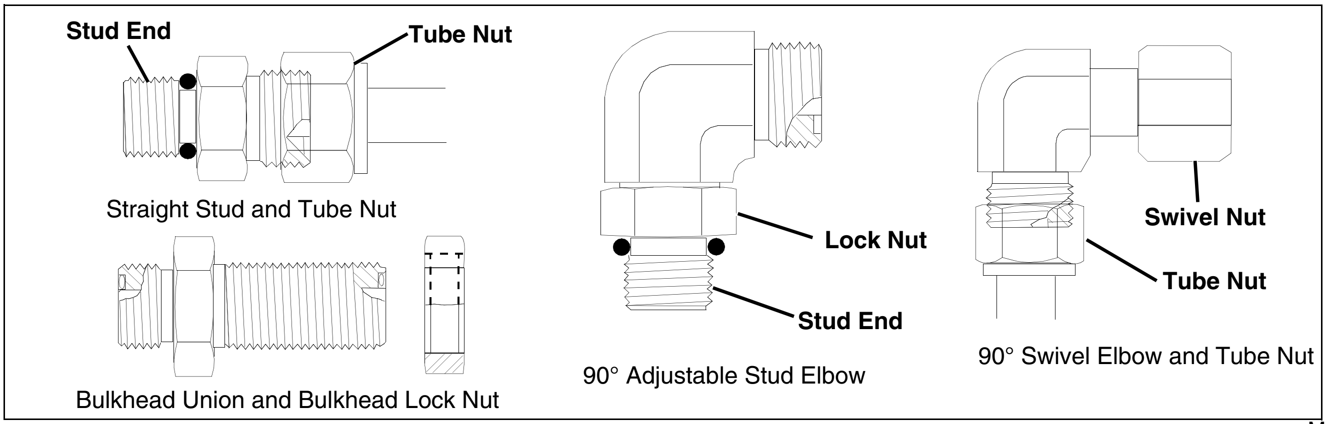
Tighten toothed or serrated-type lock nuts to full torque value.

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.

Face Seal Fittings with Inch Stud Ends Torque



Straight Stud and Tube Nut

Bulkhead Union and Bulkhead Lock Nut

90° Adjustable Stud Elbow

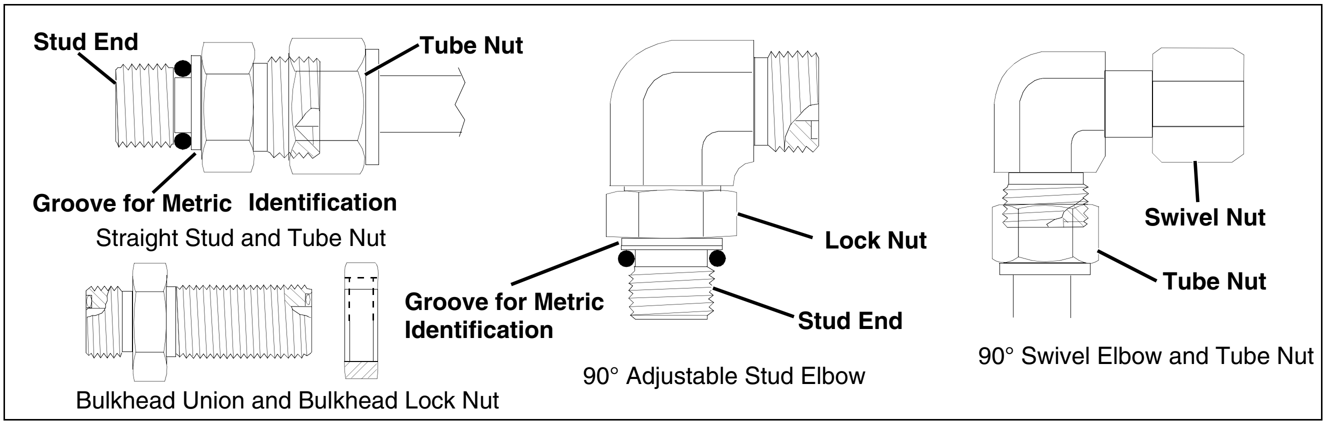
90° Swivel Elbow and Tube Nut

MIF

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

NOTE: Torque tolerance is +15%, -20%.

Face Seal Fittings with Metric Stud Ends Torque

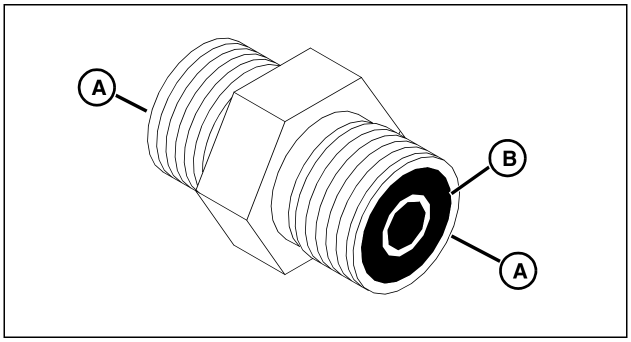


MIF

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

NOTE: Torque tolerance is +15%, -20%.

O-Ring Face Seal Fittings



MIF

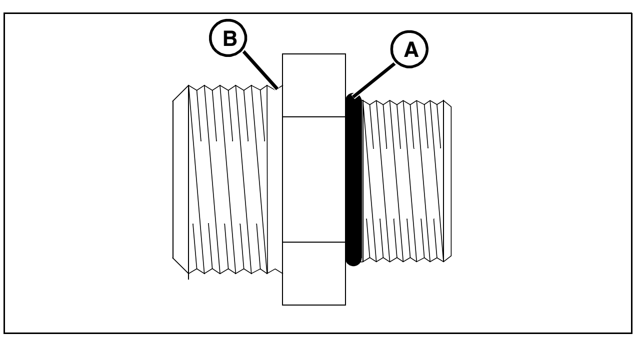
1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.
2. Inspect the O-ring (B). It must be free of damage or defects.
3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

IMPORTANT: Avoid damage! DO NOT allow hoses to twist when tightening fittings. Use two wrenches to tighten hose connections: one to hold the hose, and the other to tighten the swivel fitting.

6. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

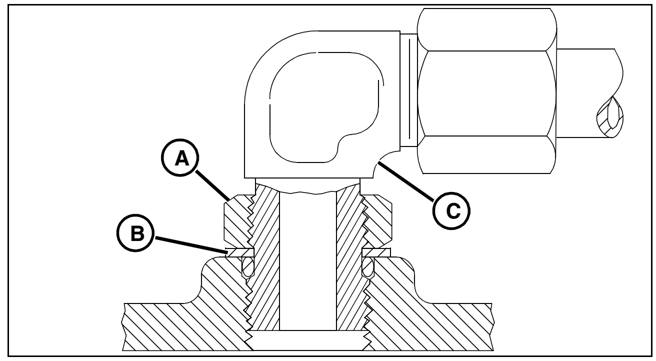
O-Ring Boss Fittings

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



MIF

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



MIF

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

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

1. Torque tolerance is ± 10 percent.

2. To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss, then tighten special nut or straight fitting the number of flats shown.

Diesel Fuel - North America

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 (Min)

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% (Max)

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%.

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

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

Diesel Fuel - Europe

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

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

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

- Cetane Number 40 (Min)

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% (Max)

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.

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: Avoid damage! 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: Avoid damage! 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.

4-Cycle Diesel Engine Oil - North America

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

The following John Deere oils are PREFERRED:

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

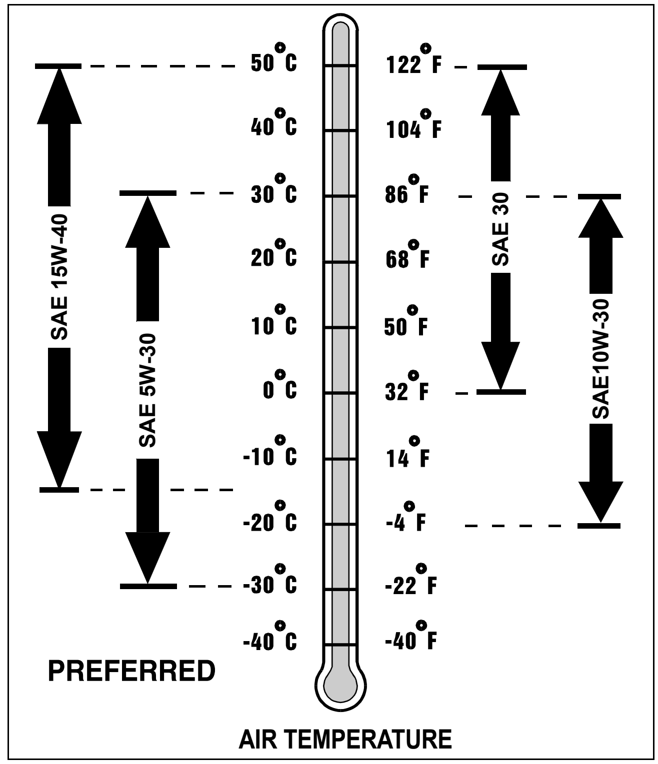
The following John Deere oils are also recommended, based on their specified temperature range:

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

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

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

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



M58275

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.

4-Cycle Diesel Engine Oil - Europe

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

The following John Deere oils are PREFERRED:

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

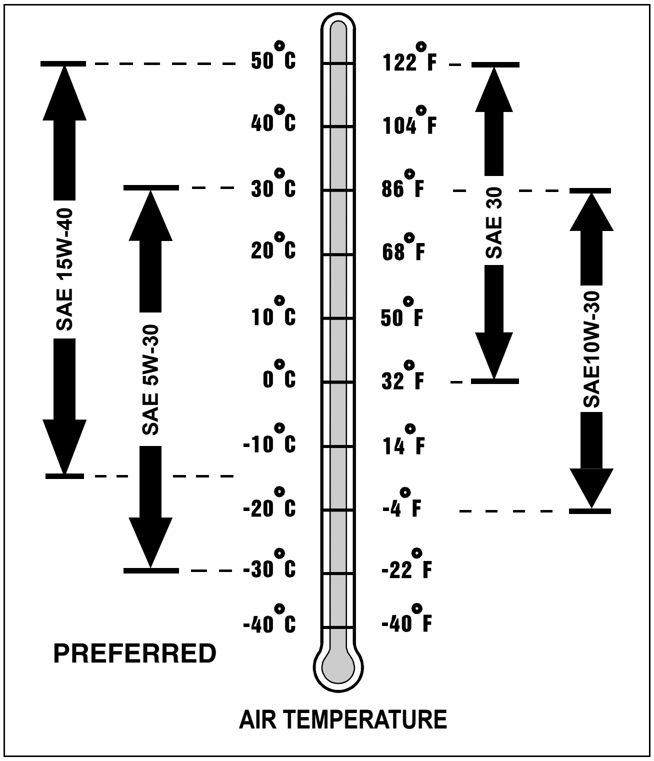
The following John Deere oils are also recommended, based on their specified temperature range:

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

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

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

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



M58275

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.

Break-In Diesel Engine Oil - North America

IMPORTANT: Avoid damage! ONLY use this specified break-in oil in rebuilt or remanufactured engines for the first 100 hours (Max) 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**.

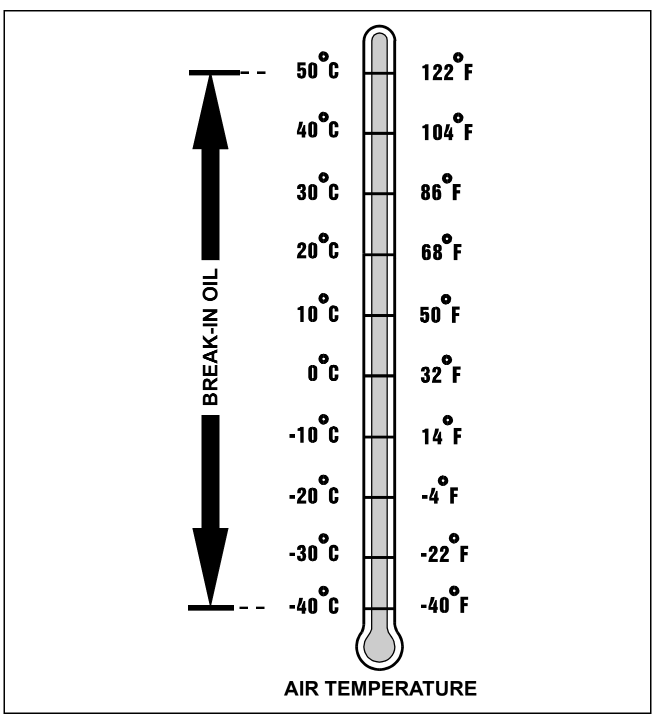
John Deere BREAK-IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions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

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



M58275

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.

Break-In Diesel Engine Oil - Europe

IMPORTANT: Avoid damage! ONLY use this specified break-in oil in rebuilt or remanufactured engines for the first 100 hours (Max) of operation. DO NOT use SAE 14W40 oil or oils meeting CCMC Specification D5 - these oils will not allow rebuilt or remanufactured engines to break in properly.

The following John Deere oil is PREFERRED:

- **BREAK-IN ENGINE OIL**.

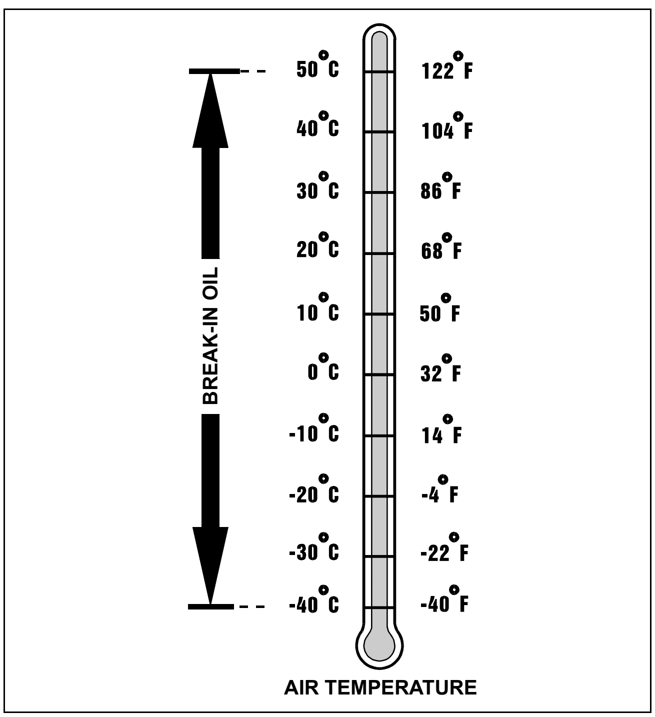
John Deere BREAK-IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions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

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

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

- CCMC Specification D4 or higher.

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



M58275

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.

Hydrostatic Transmission and Hydraulic Oil

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

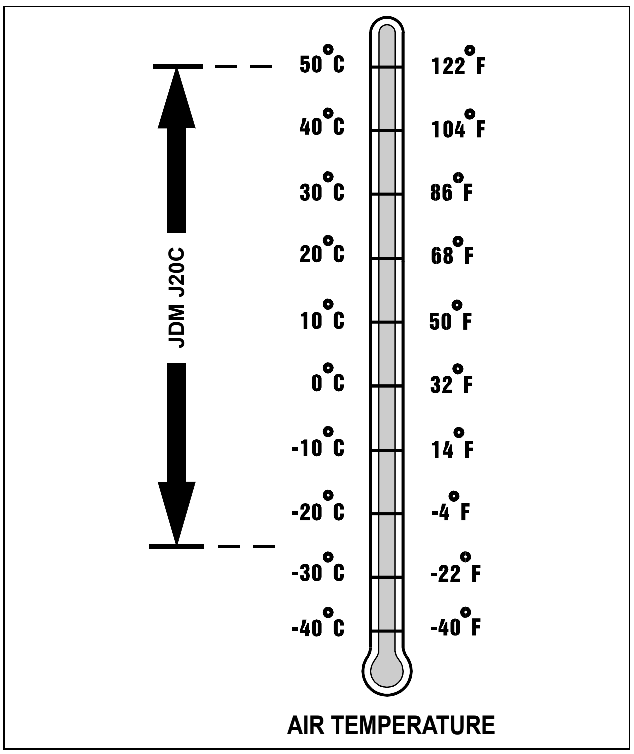
IMPORTANT: Avoid damage! DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission.

The following John Deere transmission and hydraulic oil is PREFERRED:

- **HY-GARD®-JDM J20C**.

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

- John Deere Standard JDM J20C.



M58275

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.

Biodegradable Oil

Application

IMPORTANT: Avoid damage! Biodegradable oils, other than BIO HY-GARD, are not recommended.

When use of a biodegradable lubricant is desired or required, BIO HY-GARD is recommended. BIO HY-GARD may be used under normal mowing conditions.

DO NOT USE biodegradable lubricants in machines for the following operations:

- Any machine used for scalping procedure.
- Any verticut operation in temperatures exceeding 32°C (90°F).

BIO HY-GARD should be used only in cases where the benefits of its use offset the extra initial cost, the increased oil change cost and the potential increasing maintenance costs for hydraulic systems with high temperatures and heavy loads.

- If the natural color of the fluid has become black, it is possible an overheating problem exists. The fluid should be changed.
- If the fluid becomes milky, water contamination may be a problem. Investigate the source of the contamination.
- Take fluid level reading when system is cold.
- Mixing of biodegradable oil and mineral oil will reduce the biodegradability of the lubricant in the machine. Mixing of HY-GARD and BIO HY-GARD will not result in performance deterioration.

Cold Weather Operation

Precautions should be taken if BIO HY-GARD containers or equipment are stored for long periods of time in extremely cold temperatures. Freezing should be expected if BIO HY-GARD is subjected to the following temperatures:

- Stored for six months at -20° to -23°C (-1° to -10°F)
- Stored for seven days at -23° to -26°C (-10° to -15°F)
- Stored for three days at -26° to -29°C (-15° to -20°F)
- Stored for two days at -29° to -35°C (-20° to -30°F)
- Stored for one day at -35°C (-30°F) and below.

IMPORTANT: Avoid damage! Equipment should not be started or any operation attempted until BIO HY-GARD has reached a safe operating viscosity.

If freezing of BIO HY-GARD is suspected, the container or equipment MUST be warmed to at least 0°C (32°F) and maintained for 24-48 hours to ensure the fluid has reached a safe operating viscosity.

Converting from HY-GARD to BIO HY-GARD

Systems being converted from HY-GARD to BIO HY-GARD should follow the procedure listed below to obtain maximum lubricant biodegradability.

1. Park machine on a level surface.
2. Lower cutting units, stop engine, set park brake and remove key from ignition.
3. Drain hydraulic reservoir.
4. Replace hydraulic filter.
5. Fill reservoir with BIO HY-GARD to appropriate level.
6. Start engine and bring to medium idle.
7. Turn steering wheel full stroke several times and cycle cutting units several times.
8. Stop engine and check hydraulic oil level. Add BIO HY-GARD to appropriate level.
9. Operate machine under normal operating conditions for a minimum of two hours.
10. Repeat steps 1-7.
11. Follow recommended maintenance schedules.

Anti-Corrosion Grease

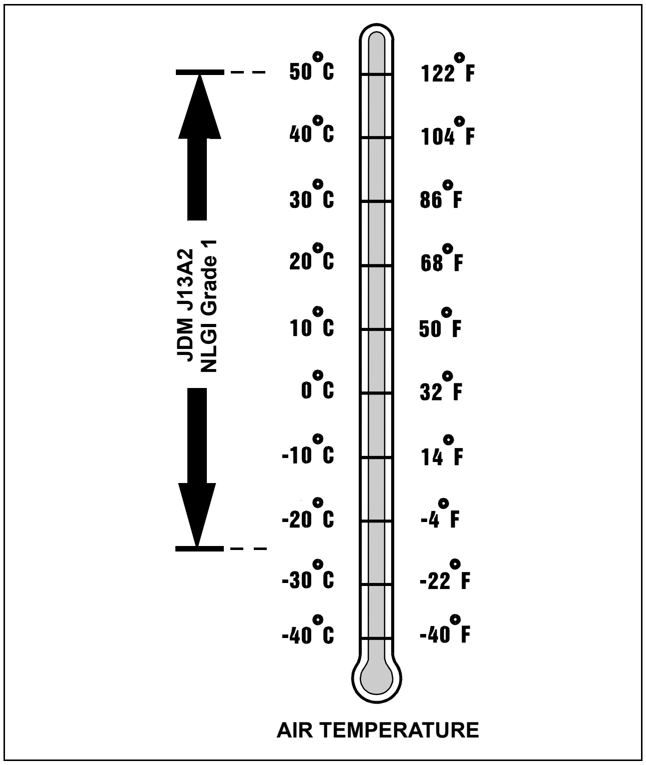
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

The following anti-corrosion grease is PREFERRED:

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

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

- John Deere Standard JDM J13A2, NLGI Grade 1.



M58275

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.
- Lubrication Sales Manual PI7032.

Grease - North America

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

IMPORTANT: Avoid damage! 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.

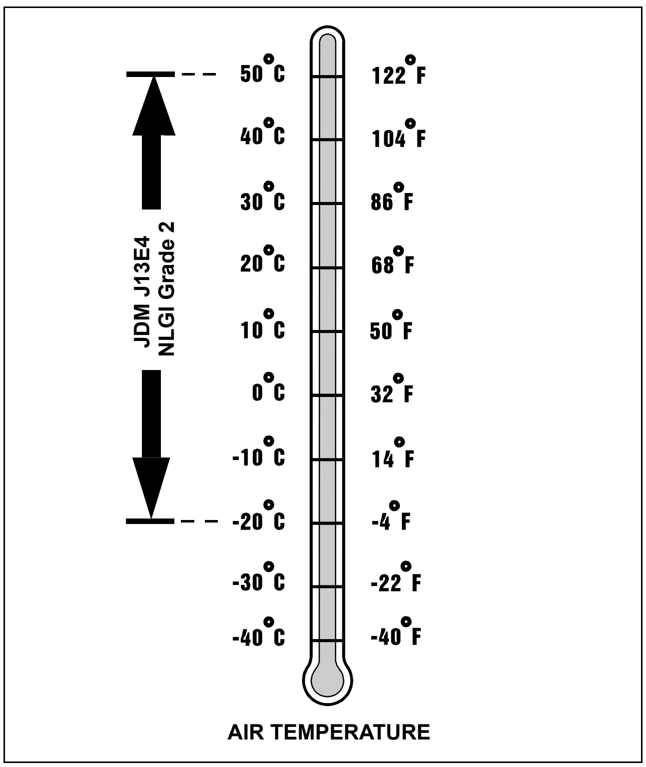
The following John Deere greases are PREFERRED:

- **Multi-Purpose SD Polyurea (TY6341).**
- **Special-Purpose HD Moly (TY6333).**
- **Reel Support Grease-Special Purpose Golf and Turf Cutting Unit Grease (TY25083).**

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

Reel Support Grease Applications:

- Polyurea Grease-NLGI Grade 0.
- Calcium Complex Grease-NLGI Grade 0.
- Lithium Complex Grease-NLGI Grade 0.
- John Deere Standard JDM J13E4, NLGI Grade 2.



M58275

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.
- Lubrication Sales Manual PI7032.

Grease - Europe

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

IMPORTANT: Avoid damage! 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.

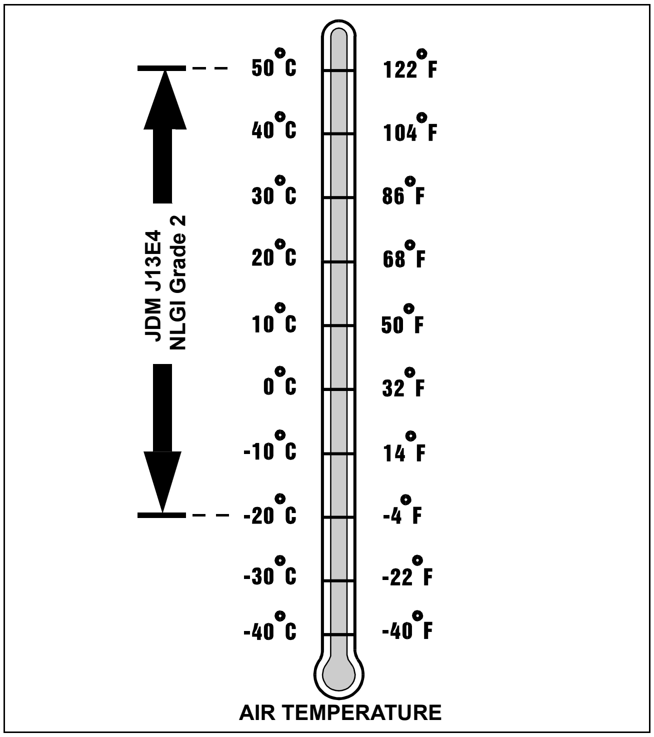
The following John Deere greases are PREFERRED:

- **GREASE-GARD™-JDM J13E4, NLGI Grade 2.**
- **Reel Support Grease-JDM J13E6, NLGI Grade 0.**

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

Reel Support Grease Applications:

- Polyurea Grease-NLGI Grade 0.
- Calcium Complex Grease Grade 0.
- Lithium Complex Grease-NLGI Grade 0.
- John Deere Standard JDM J13E4, NLGI Grade 2.



M58275

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.

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: Avoid damage! Use of alternative lubricants could cause reduced life of the component.

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

Synthetic Lubricants

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

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

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

Lubricant Storage

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

Mixing of Lubricants

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

Oil Filters

IMPORTANT: Avoid damage! 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.

Diesel Engine Coolant - North America

The engine cooling system when filled with a proper dilution mixture of anti-freeze 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 ANTI-FREEZE/ SUMMER COOLANT™ (TY16036)**.

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 anti-freeze 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 ANTI-FREEZE/SUMMER COOLANT CONCENTRATE™ (TY16034).**

If either of above recommended engine coolants are not 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: Avoid damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze 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.

Water Quality	
Property	**Requirements**
Total Solids (Max)	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 anti-freeze concentrate with 50 percent distilled or deionized water. This mixture and the pre-diluted mixture (TY16036) will protect the cooling system down to a temperature of -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 anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Diesel Engine Coolant Drain Interval - North America

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.

Diesel Engine Coolant - Europe

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

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

- **COOL-GARD COOLANT CONCENTRATE™.**

If above preferred coolant is not 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: Avoid damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze 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 best to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Water Quality	
Property	**Requirements**
Total Solids (Max)	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 anti-freeze concentrate with 50 percent distilled or deionized water. This mixture 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 anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Diesel Engine Coolant Drain Interval - Europe

When using John Deere Cool-Gard Coolant Concentrate for Automobile and Light Duty Engine Service, 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 coolant is 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.

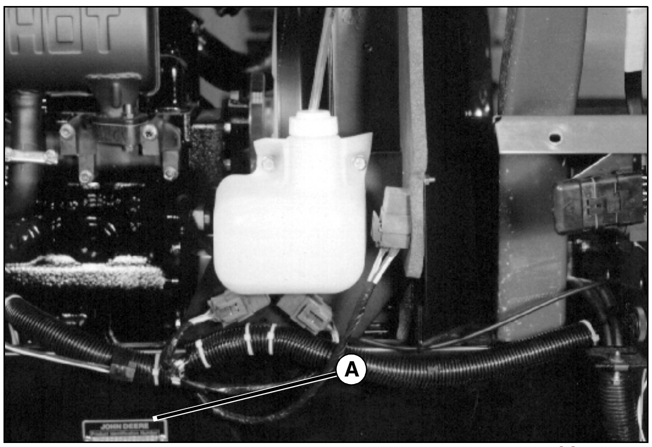
Identification Numbers

Serial Number Location

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

The locations of mower identification number and component serial numbers are shown.

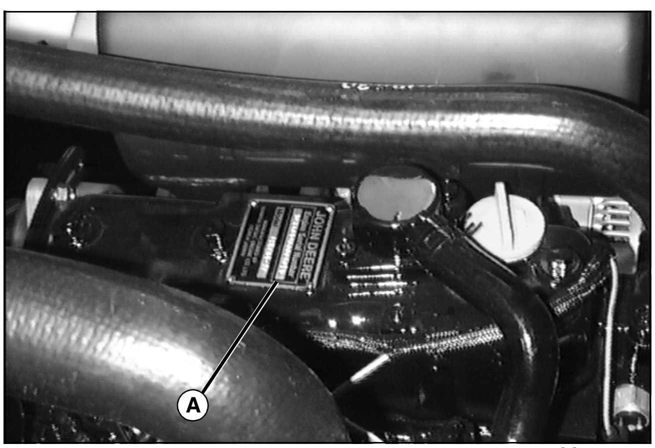
Mower Identification Number



M76476

The mower identification number plate is (A) located on the right-hand frame under the engine compartment.

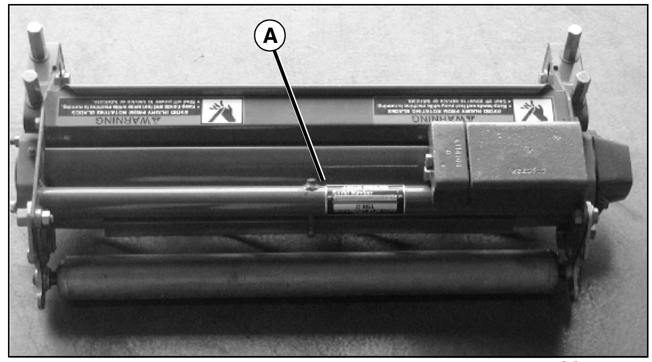
Engine Serial Number



M58797

The engine serial number plate (A) is located on the top of the valve cover.

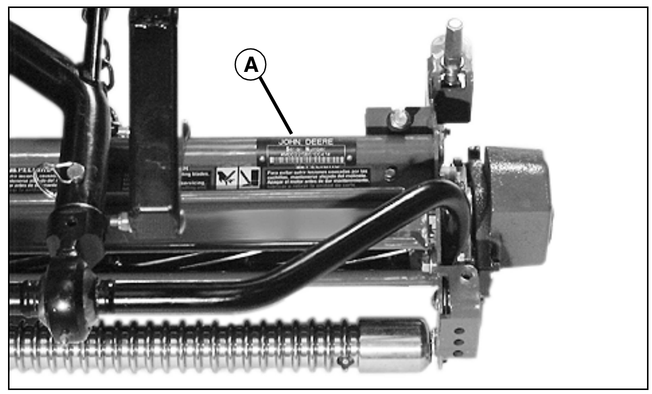
Cutting Unit Serial Numbers



M84563

Picture Note: 22 In. Standard Cutting Unit

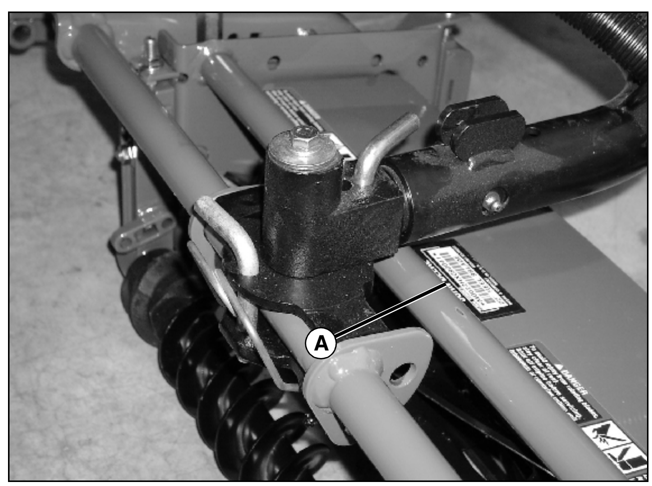
The cutting unit serial number plate (A) is located on top of the cutting unit.



M84563

Picture Note: 2500M Cutting Unit

The cutting unit serial number plate (A) is located on top of the cutting unit.



MX18036

Picture Note: 22” In. Heavy Duty

The cutting unit serial number plate (A) is located on top of the cutting unit.

Table of Contents

Specifications

3TNE78A and 3TNE82A Engines

General Specifications

Make. . . . . Yanmar
Model . . . . 3TNE78A or 3TNE82A
Type . . . . 4-Cycle Diesel
Output Power (3TNE78A). . . . . 19 kW (25 HP)
Output Power (3TNE82A). . . . . 20.2 kW (27 HP)
Cylinders 3
Bore (3TNE78A) . . . . 78 mm (3.07 in.)
Bore (3TNE82A) . . . . 82 mm (3.23 in.)
Stroke (3TNE78A and 3TNE82A). . . . . 84 mm (3.31 in.)
Displacement (3TNE78A). . . . . 1.204 L (73.5 cu. in.)
Displacement (3TNE82A). . . . . 1.33 L (81.2 cu. in.)
Firing Order. 1-3-2
Direction of Rotation . . . . Counterclockwise (Viewed from Flywheel)
Combustion System. . . . . Direct Injection Type
Compression Ratio. 18-1
Cooling . . . . Liquid
Governor . . . . Centrifugal
RPM at Idle . . . . 950 ± 50
RPM at Fast Idle (No-Load) . . . . 3150 ± 25
Rated RPM. 3000
Torque Rise . . . . 20 Percent Minimum

Startability

W/O Block Heater . . . . -17.8°C (0°F)
W/ Block Heater . . . . -28.9°C (-20°F)

Repair Specifications

Alternator

Belt Deflection @ 98 N (22 lb-force) . . . . 10-15 mm (0.4-0.6 in.)
Slip Ring Diameter (Min) . . . . 14 mm (0.55 in.)
Exposed Brush Length (Minimum). . . . . 4.5 mm (0.17 in.)
Exposed Brush Length (Maximum) . . . . 10.5 mm (0.41 in.)

Cam Follower Bore

Bore ID. . . . . 12.000-12.02 mm (0.472-0.473 in.)
Wear Limit . . . . 12.05 mm (0.474 in.)
Clearance . . . . 0.010-0.043 mm (0.0.001-0.002 in.)

Cam Follower Stem

Stem OD . . . . 11.98-11.99 mm (0.471-0.472 in.)
Wear Limit . . . . 11.93 mm (0.470 in.)

Camshaft

Camshaft End Play . . . . 0.05-0.25 mm (0.002-0.010 in.)
Camshaft Bend (Maximum) . . . . 0.02 mm (0.0021 in.)
Camshaft Lobe Height . . . . 38.64-38.77 mm (1.521-1.526 in.)
Wear Limit . . . . 38.40 mm (01.512 in.)

Camshaft Bushings

Camshaft Bushing ID at Gear Housing . . . . 44.990-45.055 mm (1.771-1.774 in.)
Camshaft Bushing ID at Intermediate and Flywheel End . . . . 45.00-45.025 mm (1.772-1.773 in.)
Wear Limit . . . . 45.10 mm (1.776 in.)
Camshaft Bushing-to-Journal Clearance . . . . 0.20 mm (0.008 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journals OD . . . . 44.93-44.95 mm (1.769-1.770 in.)
Intermediate Camshaft Journals . . . . 44.91-44.94 mm (1.768-1.769in.)
Wear Limit . . . . 44.85 mm (1.766 in.)

Connecting Rod Bearing

Bearing ID . . . . 46.00-46.016 mm (1.811-1.812 in.)
Wear Limit . . . . 46.07 mm (1.814 in.)
Bearing Oil Clearance . . . . 0.038-0.090 mm (0.001-0.004 in.)

Crankshaft and Main Bearings

Crankshaft Bend Variation . . . . 0.02 mm (0.001 in.)
Connecting Rod Journal OD . . . . 42.95-42.96 mm (1.6909-1.6913 in.)
Wear Limit . . . . 42.91 mm (1.689 in.)
Main Bearing Journal OD . . . . 46.95-46.96 mm (1.8484-1.8488 in.)
Wear Limit . . . . 46.91 mm (1.847 in.)
Main Bearing Oil Clearance . . . . 0.038-0.090 mm (0.001-0.004 in.)
Wear Limit . . . . 0.25 mm (0.010 in.)

Cylinder Bore (3TNE78A)

Standard Cylinder Bore ID . . . . 78.00-78.03 mm (3.071-3.072 in.)
Wear Limit . . . . 78.20 mm (3.079 in.)
Oversize Cylinder Bore ID . . . . 78.25-78.28 mm (3.081-3.082 in.)
Wear Limit . . . . 78.45 mm (3.089 in.)
Piston-to-Cylinder Bore Clearance . . . . 0.035-0.065 mm (0.001-0.003 in.)
Cylinder Roundness . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . 0.03 mm (0.001 in.)
Cylinder Taper . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . 0.03 mm (0.001 in.)

Cylinder Bore (3TNE82A)

Standard Cylinder Bore ID . . . . . 82.00-82.03 mm (3.228-3.230 in.)
Wear Limit . . . . . 82.20 mm (3.236 in.)
Oversize Cylinder Bore ID . . . . . 82.25-82.28 mm (3.238-3.239 in.)
Wear Limit . . . . . 82.45 mm (3.246 in.)
Piston-to-Cylinder Bore Clearance . . . . . 0.035-0.065 mm (0.001-0.003 in.)
Cylinder Roundness. . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)
Cylinder Taper . . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)

Cylinder Head

Cylinder Head Flatness (Allowable Distortion Without Resurfacing) . . . . . 0.05 mm (0.002 in.)
Cylinder Head Flatness (Resurface Range) . . . . . 0.05-0.15 mm (0.002-0.006 in.)
Cylinder Head Flatness (Maximum Distortion) . . . . . 0.15 mm (0.006 in.)

Flywheel

Flatness . . . . . 0.02 mm (0.001 in.)

Fuel Injection Nozzles

Nozzle Contact Surface . . . . . 0.10 mm (0.004 in.)

Idler Gear

Shaft OD . . . . . 45.950-45.975 mm (1.809-1.810 in.)
Wear Limit . . . . . 45.93 mm (1.808 in.)
Bushing ID. . . . . 46.00-46.025 mm (1.811-1.812 in.)
Wear Limit . . . . . 46.08 mm (1.814 in.)
Shaft and Bushing Clearance . . . . . 0.15 mm (0.006 in.)

Oil Pressure Regulating Valve

Spring Free Length. . . . . 46 mm (1.810 in.)
Spring Compressed Length (at 20.5 N (4.6 lb-force)) . . . . . 27.5 mm (1.080 in.)

Oil Pump

Oil Pump Gear Backlash . . . . . 0.12 mm (0.005 in.)
Rotor Shaft OD-to-Backing Plate ID Clearance . . . . . 0.013-0.043 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.20 mm (0.008 in.)
Rotor Recess . . . . . 0.03-0.09 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)
Outer Rotor-to-Pump Body Clearance . . . . . 0.10-0.16 mm (0.004-0.006 in.)
Wear Limit . . . . . 0.25 mm (0.010 in.)
Inner-to-Outer Rotor Clearance. . . . . 0.05-0.10 mm (0.002-0.004 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)

Piston (3TNE78A)

Standard Piston OD . . . 77.95-77.98 mm (3.069-3.070 in.)
Wear Limit . . . 77.90 mm (3.067 in.)
Oversize Piston OD . . . 78.20-78.23 mm (3.079-3.080 in.)
Wear Limit . . . 78.15 mm (3.077 in.)

Piston (3TNE82A)

Standard Piston OD . . . 81.95-81.98 mm (3.069-3.070 in.)
Wear Limit . . . 81.90 mm (3.067 in.)
Oversize Piston OD . . . 81.20-81.23 mm (3.079-3.080 in.)
Wear Limit . . . 81.15 mm (3.077 in.)

Piston-to-Cylinder Head

Clearance . . . 0.64-0.82 mm (0.025-0.032 in.)

Piston Pin Bore

Piston Pin Bore ID . . . 23.00-23.01 mm (0.9055-0.9060 in.)
Wear Limit . . . 23.02 mm (0.907 in.)
Piston Pin-to-Piston Oil Clearance . . . 0.00-0.02 mm (0.00-0.001 in.)
Wear Limit . . . 0.12 mm (0.005 in.)

Piston Pin Bushing

Piston Pin Bushing ID . . . 23.025-23.038 mm (0.906-0.907 in.)
Wear Limit . . . 23.10 mm (0.909 in.)
Piston Pin-to-Rod Bore Oil Clearance . . . 0.03-0.05 mm (0.001-0.002 in.)
Wear Limit . . . 0.20 mm (0.008 in.)

Piston Pin Diameter

Piston Pin OD . . . 22.99-23.00 mm (0.905-0.906 in.)
Wear Limit . . . 22.90 mm (0.902 in.)

Piston Ring End Gap

Piston Ring End Gap . . . 0.20-0.40 mm (0.008-0.016 in.)
Wear Limit . . . 1.50 mm (0.059 in.)

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance. . . 0.075-0.11 mm (0.003-0.004 in.)
Wear Limit . . . 0.025 mm (0.010 in.)
Second Compression Ring Groove Side Clearance (3TNE78A) . . . 0.035-0.065 mm (0.001-0.003 in.)
Wear Limit . . . 0.025 mm (0.010 in.)
Second Compression Ring Groove Side Clearance (3TNE82A) . . . 0.045-0.080 mm (0.002-0.003 in.)
Wear Limit . . . 0.025 mm (0.010 in.)
Oil Control Ring Groove Side Clearance . . . 0.025-0.060 mm (0.001-0.002 in.)
Wear Limit . . . 0.020 mm (0.008 in.)

Push Rods

Maximum Bend . . . 0.03 mm (0.001 in.)
Length . . . 178.25-178.75 mm (7.018-7.037 in.)

Rocker Arm Shaft

Rocker Arm Shaft OD . . . 15.97-15.98 mm (0.628-0.629 in.)
Rocker Arm Shaft Wear Limit . . . 15.95 mm (0.628 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance . . . 0.02-0.05 mm (0.001-0.002 in.)
Oil Clearance Wear Limit . . . 0.14 mm (0.006 in.)

Rocker Arms and Supports

Rocker Arm and Support ID . . . 16.00-16.02 mm (0.630-0.631 in.)
Rocker Arm and Support Wear Limit . . . 16.09 mm (0.633 in.)

Springs

Valve Spring Free Length . . . 44.4 mm (1.75 in.)
Wear Limit . . . 43.9 mm (1.728 in.)
Spring Inclination . . . 1.10 mm (0.044 in.)

Valve Guides

Valve Guide ID . . . 7.00-7.015 mm (0.2756-0.2762 in.)
Wear Limit . . . 7.08 mm (0.279 in.)
Oil Clearance . . . 0.015-0.075 mm (0.001-0.003 in.)
Valve Guide Projection . . . 12 mm (0.472 in.)

Valve Seats

Intake Valve Seat Width . . . 1.36-1.53 mm (0.054-0.060 in.)
Wear Limit . . . 1.98 mm (0.078 in.)
Exhaust Valve Seat Width . . . 1.66-1.87 mm (0.066-0.074 in.)
Wear Limit . . . 2.27 mm (0.089 in.)

Valve Recession

Valve Recession . . . 0.30-0.50 mm (0.012-0.020 in.)
Wear Limit . . . 1.00 mm (0.039 in.)

Valves

Valve Head (Minimum Thickness) . . . 0.50 mm (0.020 in.)
Intake and Exhaust Valve Stem OD . . . 6.95-6.96 mm (0.2736-0.2740 in.)
Wear Limit . . . 6.90 mm (0.272 in.)

Test and Adjustment Specifications

Camshaft

End Play . . . 0.05-0.25 mm (0.002-0.010 in.)

Connecting Rod

Side Play . . . . . . 0.2-0.4 mm (0.008-0.016 in.)

Connecting Rod-to-Crankshaft Journal Clearance . . . . . . 0.038-0.090 mm (0.001-0.004 in.)

Cooling System

Maximum Pressure . . . . . . 97 kPa (14 psi)

Minimum Pressure (After 15 Seconds) . . . . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Radiator Cap Pressure . . . . . . 88 kPa (12.8 psi)

Temperature Switch (Contact Closing Temperature) . . . . . . 107-113°C (225-235°F)

Crankshaft

End Play . . . . . . 0.09-0.27 mm (0.004-0.011 in.)

Main Bearing-to-Crankshaft Journal Oil Clearance . . . . . . 0.038-0.090 mm (0.001-0.004 in.)

Cylinder Compression pressure

Cylinder Compression Pressure 3TNE78A - at 250 RPM (Standard) . . . . . . 3137 kPa (455 psi)

Cylinder Compression Pressure 3TNE78A - at 250 RPM (Minimum) . . . . . . 2551 kPa (370 psi)

Difference Between Cylinders 3TNE78A - at 250 RPM (Maximum) . . . . . . 296 kPa (43 psi)

Cylinder Compression Pressure 3TNE82A - at 250 RPM (Standard) . . . . . . 3040 kPa (441 psi)

Cylinder Compression Pressure 3TNE82A - at 250 RPM (Minimum) . . . . . . 2455 kPa (356 psi)

Difference Between Cylinders 3TNE82A - at 250 RPM (Maximum) . . . . . . 296 kPa (43 psi)

Fan/Alternator Belt

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

Fuel Injection Nozzles

Opening Pressure . . . . . . 19 600 ± 979 kPa (2845 ± 142 psi)

Oil Pressure

Engine Oil Pressure . . . . . . 345 ± 48 kPa (50 ± 7.0 psi)

Thermostat

Begins to Open . . . . . . 71°C (160°F)

Fully Open . . . . . . 85°C (184°F)

Lift Height . . . . . . 8 mm (0.310 in.)

Timing Gear

Backlash . . . . . . 0.04-0.12 mm (0.001-0.005 in.)

Throttle Lever

Friction . . . . . . 36-53 N (8-12 lb-force)

Valve Adjustment

Clearance . . . . . . 0.15-0.25 mm (0.006-0.010 in.)

Valve Lift

Valve Lift . . . . . . 8.8 mm (0.350 in.)

3TNE84 Engine

General Specifications

Make	Yanmar
Model	3TNE84
Type	4-Cycle Diesel
Output Power	23.2 kW (31.2 HP)
Cylinders	3
Bore	84 mm (3.31 in.)
Stroke	90 mm (3.54 in.)
Displacement	1.496 L (91.3 cu. in.)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Combustion System	Direct Injection Type
Compression Ratio	18-1
Cooling	Liquid
Governor	Centrifugal
RPM at Idle	950 ± 50
RPM at Fast Idle (No-Load)	3150 ± 25
Rated RPM	3000
Torque Rise	20 Percent Minimum

Startability

W/O Block Heater	-17.8°C (0°F)
W/ Block Heater	-28.9°C (-20°F)

Repair Specifications

Alternator

Belt Deflection @ 98 N (22 lb-force)	10-15 mm (0.4-0.6 in.)
Slip Ring Diameter (Min)	14 mm (0.55 in.)
Exposed Brush Length (Minimum)	4.5 mm (0.17 in.)
Exposed Brush Length (Maximum)	10.5 mm (0.41 in.)

Cam Follower Bore

Bore ID	12.00-12.02 mm (0.472-0.473 in.)
Wear Limit	12.05 mm (0.474 in.)
Clearance	0.010-0.043 mm (0.0.001-0.002 in.)

Cam Follower Stem

Stem OD	11.98-11.99 mm (0.471-0.472 in.)
Wear Limit	11.93 mm (0.470 in.)

Camshaft

Camshaft End Play . . . . 0.05-0.25 mm (0.002-0.010 in.)

Camshaft Bend (Maximum) . . . . 0.02 mm (0.0021 in.)

Camshaft Lobe Height . . . . 38.64-38.77 mm (1.521-1.526 in.)

Wear Limit . . . . 38.40 mm (01.512 in.)

Camshaft Bushings

Camshaft Bushing ID at Gear Housing . . . . 44.990-45.055 mm (1.771-1.774 in.)

Camshaft Bushing ID at Intermediate and Flywheel End . . . . 45.00-45.025 mm (1.772-1.773 in.)

Wear Limit . . . . 45.10 mm (1.776 in.)

Camshaft Bushing-to-Journal Clearance . . . . 0.20 mm (0.008 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journals OD . . . . 44.93-44.95 mm (1.769-1.770 in.)

Intermediate Camshaft Journals . . . . 44.91-44.94 mm (1.768-1.769 in.)

Wear Limit . . . . 44.85 mm (1.766 in.)

Connecting Rod Bearing

Bearing ID . . . . 48.00-48.028 mm (1.888-1.891 in.)

Wear Limit . . . . 48.07 mm (1.893 in.)

Bearing Oil Clearance . . . . 0.038-0.074 mm (0.001-0.003 in.)

Crankshaft and Main Bearings

Crankshaft Bend Variation . . . . 0.02 mm (0.001 in.)

Connecting Rod Journal OD . . . . 47.95-47.96 mm (1.8878-1.8882 in.)

Wear Limit . . . . 47.91 mm (1.886 in.)

Main Bearing Journal OD . . . . 53.95-53.96 mm (2.1240-2.1244 in.)

Wear Limit . . . . 53.91 mm (2.122 in.)

Main Bearing Oil Clearance . . . . 0.038-0.074 mm (0.001-0.003 in.)

Wear Limit . . . . 0.15 mm (0.006 in.)

Cylinder Bore

Standard Cylinder Bore ID . . . . 84.00-84.03 mm (3.307-3.308 in.)

Wear Limit . . . . 84.20 mm (3.315 in.)

Oversize Cylinder Bore ID . . . . 84.25-84.28 mm (3.317-3.318 in.)

Wear Limit . . . . 84.45 mm (3.325 in.)

Piston-to-Cylinder Bore Clearance . . . . 0.040-0.070 mm (0.001-0.003 in.)

Cylinder Roundness . . . . 0.00-0.01 mm (0.00-0.0004 in.)

Wear Limit . . . . 0.03 mm (0.001 in.)

Cylinder Taper . . . . 0.00-0.01 mm (0.00-0.0004 in.)

Wear Limit . . . . 0.03 mm (0.001 in.)

ENGINE - DIESEL SPECIFICATIONS

Cylinder Head

Cylinder Head Flatness (Allowable Distortion Without Resurfacing) . . . . 0.05 mm (0.002 in.)

Cylinder Head Flatness (Resurface Range). . . . . 0.05-0.15 mm (0.002-0.006 in.)

Cylinder Head Flatness (Maximum Distortion) . . . . 0.15 mm (0.006 in.)

Flywheel

Flatness. . . . . 0.02 mm (0.001 in.)

Fuel Injection Nozzles

Nozzle Contact Surface . . . . 0.10 mm (0.004 in.)

Idler Gear

Shaft OD . . . . 45.950-45.975 mm (1.809-1.810 in.)

Wear Limit . . . . 45.93 mm (1.808 in.)

Bushing ID. . . . . 46.00-46.025 mm (1.811-1.812 in.)

Wear Limit . . . . 46.08 mm (1.814 in.)

Shaft and Bushing Clearance . . . . 0.15 mm (0.006 in.)

Oil Pressure Regulating Valve

Spring Free Length. . . . . 46 mm (1.810 in.)

Spring Compressed Length (at 20.5 N (4.6 lb-force)) . . . . 27.5 mm (1.080 in.)

Oil Pump

Oil Pump Gear Backlash . . . . 0.12 mm (0.005 in.)

Rotor Shaft OD-to-Backing Plate ID Clearance . . . . 0.013-0.043 mm (0.001-0.002 in.)

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

Rotor Recess . . . . 0.03-0.09 mm (0.001-0.002 in.)

Wear Limit . . . . 0.15 mm (0.006 in.)

Outer Rotor-to-Pump Body Clearance . . . . 0.10-0.16 mm (0.004-0.006 in.)

Wear Limit . . . . 0.25 mm (0.010 in.)

Inner-to-Outer Rotor Clearance. . . . . 0.05-0.10 mm (0.002-0.004 in.)

Wear Limit . . . . 0.15 mm (0.006 in.)

Piston

Standard Piston OD . . . . 83.95-83.98 mm (3.305-3.306 in.)

Wear Limit . . . . 83.90 mm (3.303 in.)

Oversize Piston OD . . . . 84.20-84.23 mm (3.315-3.316 in.)

Wear Limit . . . . 84.10 mm (3.311 in.)

Piston-to-Cylinder Head

Clearance . . . . 0.64-0.82 mm (0.025-0.032 in.)

Piston Pin Bore

Piston Pin Bore ID . . . . 26.00-26.01 mm (1.0236-1.0240 in.)

Wear Limit . . . . 26.02 mm (1.0244 in.)

Piston Pin-to-Piston Oil Clearance . . . . 0.00-0.02 mm (0.00-0.001 in.)

Wear Limit . . . . 0.12 mm (0.005 in.)

Piston Pin Bushing

Piston Pin Bushing ID . . . . 26.025-26.038 mm (1.0246--1.0251 in.)

Wear Limit . . . . 26.10 mm (1.028 in.)

Piston Pin-to-Rod Bore Oil Clearance . . . . 0.03-0.05 mm (0.001-0.002 in.)

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

Piston Pin Diameter

Piston Pin OD . . . . 25.99-26.00 mm (1.023-1.024 in.)

Wear Limit . . . . 25.90 mm (1.020 in.)

Piston Ring End Gap

Piston Ring End Gap . . . . 0.20-0.40 mm (0.008-0.016 in.)

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

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance. . . . . 0.075-0.11 mm (0.003-0.004 in.)

Wear Limit . . . . 0.025 mm (0.010 in.)

Second Compression Ring Groove Side Clearance . . . . 0.045-0.080 mm (0.002-0.003 in.)

Wear Limit . . . . 0.025 mm (0.010 in.)

Oil Control Ring Groove Side Clearance . . . . 0.025-0.060 mm (0.001-0.002 in.)

Wear Limit . . . . 0.020 mm (0.008 in.)

Push Rods

Maximum Bend . . . . 0.03 mm (0.001 in.)

Length . . . . 178.25-178.75 mm (7.018-7.037 in.)

Rocker Arm Shaft

Rocker Arm Shaft OD . . . . 15.97-15.98 mm (0.628-0.629 in.)

Rocker Arm Shaft Wear Limit . . . . 15.95 mm (0.628 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance. . . . . 0.02-0.05 mm (0.001-0.002 in.)

Oil Clearance Wear Limit . . . . 0.14 mm (0.006 in.)

Rocker Arms and Supports

Rocker Arm and Support ID . . . . 16.00-16.02 mm (0.630-0.631 in.)

Rocker Arm and Support Wear Limit . . . . 16.09 mm (0.633 in.)

Springs

Valve Spring Free Length . . . . . 42 mm (1.654 in.)
Wear Limit . . . . . 41.50 mm (1.630 in.)
Spring Inclination . . . . . 1.10 mm (0.044 in.)

Valve Guides

Valve Guide ID. . . . . 8.010-8.025 mm (0.3154-0.3160 in.)
Wear Limit . . . . . 8.10 mm (0.319 in.)
Oil Clearance. . . . . 0.035-0.070 mm (0.001-0.003 in.)
Valve Guide Projection. . . . . 15 mm (0.591 in.)

Valve Seats

Intake Valve Seat Width . . . . . 1.07-1.24 mm (0.042-0.049 in.)
Wear Limit . . . . . 1.74 mm (0.069 in.)
Exhaust Valve Seat Width . . . . . 1.24-1.45 mm (0.049-0.057 in.)
Wear Limit . . . . . 1.94 mm (0.076 in.)

Valve Recession

Valve Recession . . . . . 0.30-0.50 mm (0.012-0.020 in.)
Wear Limit . . . . . 1.00 mm (0.039 in.)

Valves

Valve Head (Minimum Thickness). . . . . 0.50 mm (0.020 in.)
Intake and Exhaust Valve Stem OD . . . . . 7.96-7.97 mm (0.3134-0.3138 in.)
Wear Limit . . . . . 7.90 mm (0.311 in.)

Test and Adjustment Specifications

Camshaft

End Play . . . . . 0.05-0.25 mm (0.002-0.010 in.)

Connecting Rod

Side Play . . . . . 0.2-0.4 mm (0.008-0.016 in.)
Connecting Rod-to-Crankshaft Journal Clearance. . . . . 0.038-0.074 mm (0.001-0.003 in.)

Cooling System

Maximum Pressure. . . . . 97 kPa (14 psi)
Minimum Pressure (After 15 Seconds). . . . . 88 ± 15 kPa (12.8 ± 2.2 psi)
Radiator Cap Pressure. . . . . 88 kPa (12.8 psi)
Temperature Switch (Contact Closing Temperature) . . . . . 107-113°C (225-235°F)

Crankshaft

End Play . . . . . 0.09-0.27 mm (0.004-0.011 in.)
Main Bearing-to-Crankshaft Journal Oil Clearance . . . . . 0.038-0.074 mm (0.001-0.003 in.)

ENGINE - DIESEL   SPECIFICATIONS

Cylinder Compression pressure

Cylinder Compression Pressure - at 250 RPM (Standard)	**3234 kPa (469 psi)**
Cylinder Compression Pressure - at 250 RPM (Minimum)	**2551 kPa (370 psi)**
Difference Between Cylinders - at 250 RPM (Maximum)	**296 kPa (43 psi)**

Fan/Alternator Belt

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

Fuel Injection Nozzles

Opening Pressure	**21 600 ± 979 kPa (3133 ± 142 psi)**

Oil Pressure

Engine Oil Pressure	**345 ± 48 kPa (50 ± 7.0 psi)**

Thermostat

Begins to Open	**71°C (160°F)**
Fully Open	**85°C (184°F)**
Lift Height	**8 mm (0.310 in.)**

Timing Gear

Backlash	**0.04-0.12 mm (0.001-0.005 in.)**

Throttle Lever

Friction	**36-53 N (8-12 lb-force)**

Valve Adjustment

Clearance	**0.15-0.25 mm (0.006-0.010 in.)**

Valve Lift

Valve Lift	**8.8 mm (0.350 in.)**

Torque Specifications (All Engines)

Alternator

Pulley Nut Torque . . . 69 N•m (51 lb-ft)

Camshaft

Thrust Plate Mounting Cap Screw Torque . . . 26 N•m (226 lb-in.)

Crankshaft

Main Bearing Cap Screw Torque (3TNE78A and 3TNE82A) . . . 79 N•m (58 lb-ft)

Main Bearing Cap Screw Torque (3TNE84) . . . 98 N•m (72 lb-ft)

Connecting Rod Cap Screw Torque (3TNE78A and 3TNE82A) . . . 39 N•m (28 lb-ft)

Connecting Rod Cap Screw Torque (3TNE84) . . . 47 N•m (35 lb-ft)

Cylinder Head Cap Screw Torque (3TNE78A and 3TNE82A)[1]

Initial Torque . . . 35 N•m (26 lb-ft)

Second Torque . . . 48 N•m (36 lb-ft)

Final Torque . . . 69 N•m (51 lb-ft)

Cylinder Head Cap Screw Torque (3TNE84)[1]

Initial Torque . . . 44 N•m (33 lb-ft)

Second Torque . . . 62 N•m (45 lb-ft)

Final Torque . . . 88 N•m (65 lb-ft)

Exhaust Manifold

Cap Screws and Nuts Torque . . . 26 N•m (19 lb-ft)

Fuel Injection Pump

Gear Nut Torque . . . 90 N•m (66 lb-ft)

Injection Pump Nut Torque . . . 27 N•m (20 lb-ft)

Lube LIne Mounting Bolt Torque. . . . 25 N•m (217 lb-in.)

Fuel Injectors

Retaining Nut Torque . . . 8 N•m (70 lb-in.)

Intake Manifold

Cap Screw Torque . . . 26 N•m (19 lb-ft)

Oil Pressure Regulating Valve

Housing Cap Screw Torque . . . 27 N•m (20 lb-ft)

Rocker Arm Assembly

Support Cap Screw Torque . . . 26 N•m (19 lb-ft)

Rocker Arm Cover

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

Breather Cover Cap Screw Torque . . . 22 N•m (16 lb-ft)

---

1. Cylinder head cap screw torque must be checked for proper torque after 50 hours of engine operation.

Tools and Materials

Tools

Special or Required Tools

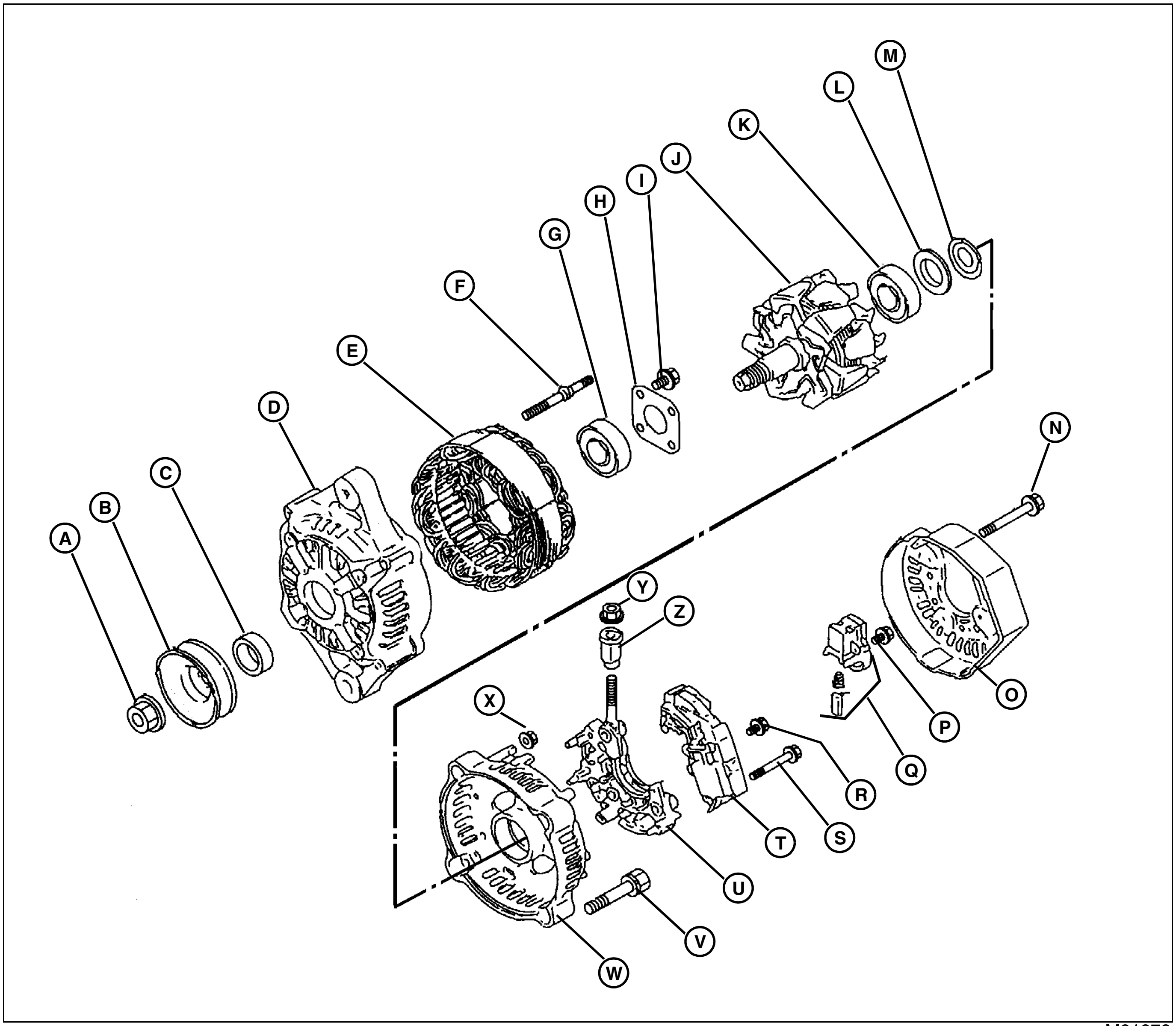
Tool Name	Tool No.	Tool Use
Straight Adapter	23622	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Cooling System Pressure Pump	D05104ST	Used to test cooling system and radiator cap pressure.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.
Fuel Injector Nozzle Cleaning Kit	JDF13	Used to clean fuel injector nozzles.
Belt Tension Gauge	JDG529 or JDST28	Used to adjust belt tension.
Adapter	JDG560	Used to measure cylinder compression and pressurize cylinder with compressed air for cylinder leakdown test.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system and radiator cap pressure.
Compression Gauge Assembly	JT01682	Used to measure cylinder compression.
Hose Assembly	JT03017	Used to test engine oil pressure.
Connector 1/8 Male BSP x 7/16 Male 37° Flare	JT03349	Used to test engine oil pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Elbow 7/16” Male 37° Flare x 7/16” Male 37° Flare	JT05483	Used to test engine oil pressure.
Hand Held Digital Tachometer	JT05719	Used to check engine rpm when setting slow and fast idle speeds.
Pressure Gauge 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Heating Unit	NA	Used to check coolant temperature switch.
Dial Indicator	NA	Used to measure valve lift, crankshaft-to-engine block side clearance, camshaft gear end journal-to-thrust plate side clearance and check wear between meshing gears.
Glass Container	NA	Used to check coolant temperature switch.
Ohmmeter	NA	Used to check coolant temperature switch.
PLASTIGAGE®	NA	Used to measure oil clearance between connecting rod and crankshaft journal. Also used to check main bearing-to-crankshaft journal clearance.
Straightedge	NA	Used to adjust belt tension.
Thermometer	NA	Used to check thermostat opening temperature and coolant temperature switch.
Timing Tool (Number One Fuel Injection Line Cut Off at First Bend)	NA	Used to adjust injection static pump timing.
Volt-Ohm-Amp Meter	NA	Used to test alternator components.

Component Location

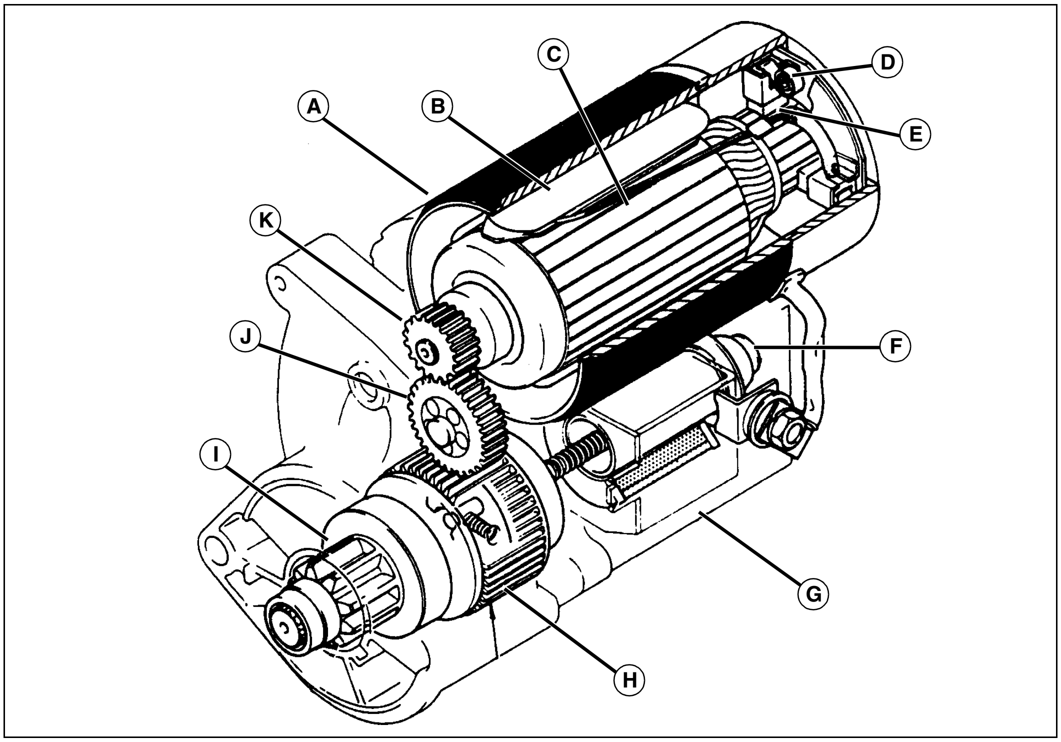
Alternator Components



M91878

- A - Nut
- B - Pulley
- C - Spacer (40 amp only)
- D - Front Frame
- E - Stator
- F - Stud
- G - Bearing
- H - Cover
- I - Screw
- J - Rotor
- K - Bearing
- L - Cover
- M - Thrust Washer (40 amp)
- N - Cap Screw
- O - Cover
- P - Screw
- Q - Brush Assembly
- R - Screw
- S - Screw
- T - Regulator
- U - Diode Assembly
- V - Cap Screw
- W - Rear Frame
- X - Nut
- Y - Nut
- Z - Insulator Bushing

Starter Components



MX2734

A - Motor
B - Field Coil
C - Armature
D - Brush Spring
E - Brush
F - Plunger
G - Solenoid
H - Overrunning Clutch
I - Pinion
J - Idler Gear
K - Drive Gear

Theory of Operation

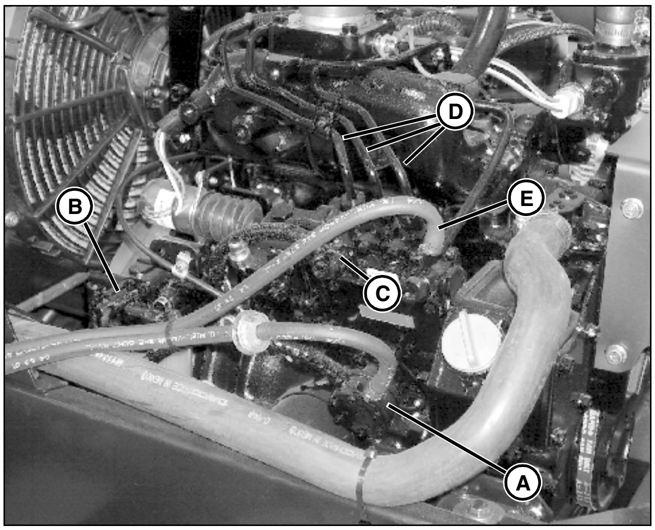
Fuel and Air System Operation

Function

Fuel system supplies fuel to injection nozzles.

The air intake system filters and supplies air needed for combustion.

Theory of Operation



MX18005

Fuel System

A mechanical fuel transfer pump (A) draws fuel from the tank outlet. The low pressure fuel from the fuel pump flows through the filter/water separator (B) to the fuel injector pump inlet (C). The injection pump then directs high pressure fuel through the injector lines (D) for combustion. Excess fuel is returned, along with fuel from the injectors, through the return line (E) to the fuel tank.

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

The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key in the START or ON position), 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 contain trapped fuel whenever injection is not taking place.

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

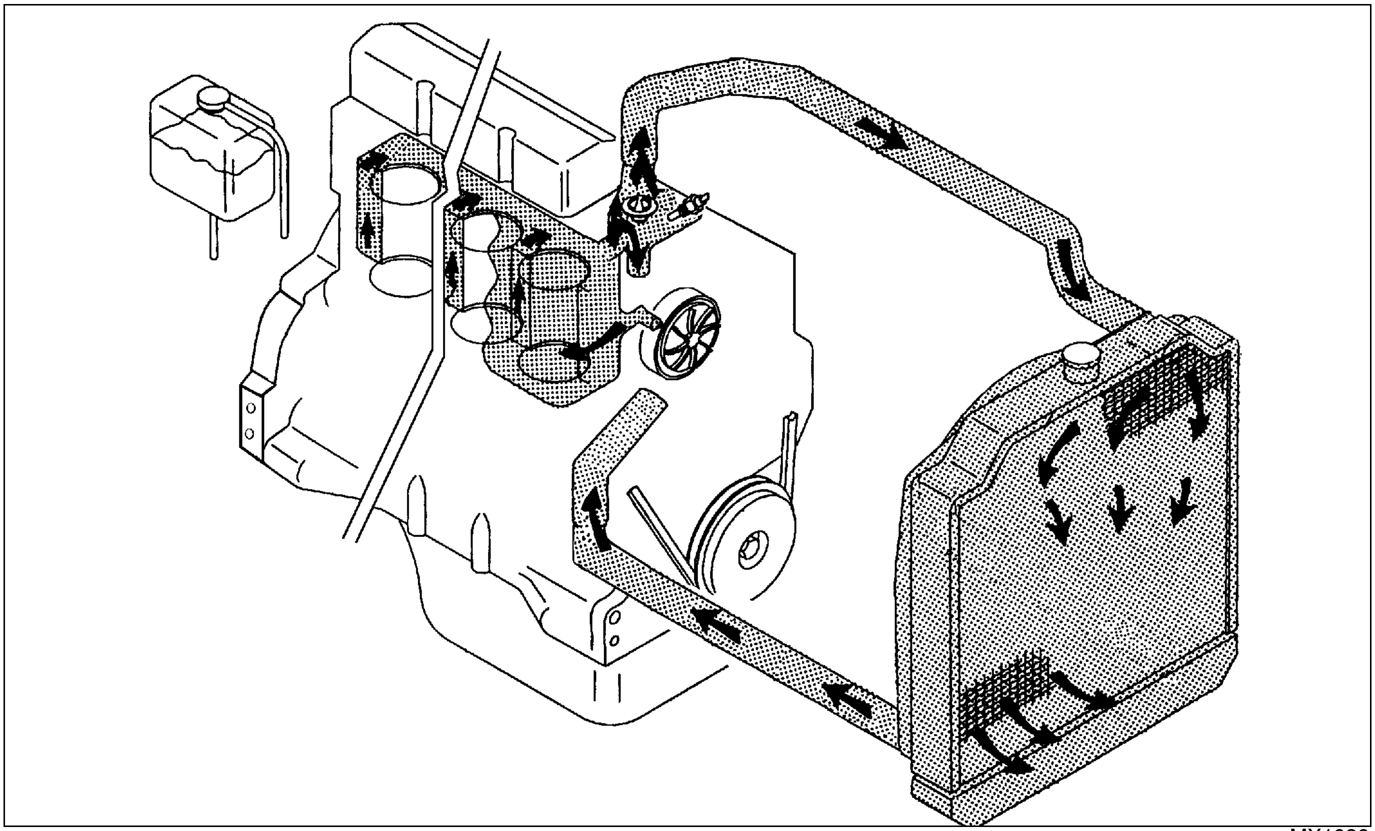
A fuel level sensor mounted in the fuel tank informs the operator of the fuel level.

Air Intake System

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

An air filter restriction switch informs the operator when the air filter needs servicing. The air filter restriction switch closes when the vacuum reaches a specified level and lights a lamp. A small amount of vacuum is always present due to some restriction of air movement through the filter elements. The unloading valve is like a one-way valve. It ejects heavy dirt particles from the air stream during engine operation, but does not let air into the air filter housing. The operator can squeeze the valve to let the large particles out.

Cooling System Operation



MX1026

Function

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

Theory of Operation

The pressurized cooling system includes the radiator, coolant 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.

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, 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 88.3 kPa (12.8 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.

Lubrication System Operation

Function

A full pressure system lubricates engine parts with filtered 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 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, cam followers and valves.

Lubrication oil is supplied to the fuel injection pump from the main oil galley through external oil lines.

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

Diagnostics

Diesel Engine Troubleshooting

CAUTION: Avoid Injury! The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Coolant in the radiator is extremely hot during operation.

Symptom: Engine Will Not Start

(1) Proper starting procedure being used is correct for conditions.

Yes - Go to step (2).

No - Use correct procedure for conditions. See the Operator's Manual.

(2) Battery 12.7 VDC or higher?

Yes - Go to step (3).

No - Charge and check battery.

(3) No open circuits in wiring?

Yes - Go to step (4).

No - Repair or replace as needed.

(4) Starting motor functioning properly?

Yes - Go to step (5).

No - Repair or replace starting motor. See "Disassemble and Assemble Starter Motor" on page 118.

(5) Engine oil of correct viscosity and type?

Yes - Go to step (6).

No - Replace engine oil with oil of proper viscosity and type. Replace oil filter.

(6) No water in fuel?

Yes - Go to step (7).

No - Drain and replace fuel.

(7) Fuel filter not clogged?

Yes - Go to step (8).

No - Replace fuel filter.

(8) No air leak in fuel system?

Yes - Go to step (9).

No - Repair fuel system.

(9) Fuel lines not plugged, pinched or cracked?

Symptom: Engine Will Not Start

Yes - Go to step (10).

No - Repair or replace fuel lines as needed.

(10) Correct volume of fuel supplied to injection pump?

Yes - Go to step (11).

No - Replace fuel transfer pump.

(11) Intake and/or exhaust valve clearance correct?

Yes - Go to step (12).

No - Adjust valve clearance. See “Adjust Valve Clearance” on page 61.

(12) Is injection pump timing correct?

Yes - Go to step (13).

No - Correctly time injector pump.

(13) Intake and/or exhaust valve not seized?

Yes - Go to step (14).

No - Replace valve and check valve guide. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(14) Piston rings not broken or seized?

Yes - Go to step (15).

No - Replace rings. Check piston and cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

(15) Piston rings, piston or cylinder not worn?

Yes - Go to step (16).

No - Replace piston and/or rings, bore or hone cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

(16) Crankshaft pin or bearing not seized?

No - Regrind crankshaft and replace bearings. See “Inspect Crankshaft and Main Bearings” on page 96.

Symptom: Engine Starts But Does Not Continue Running - No Exhaust Smoke

(1) Engine oil of proper viscosity and type.

Yes - Go to step (2).

No - Replace engine oil filter and oil of proper viscosity and type.

(2) Fuel filter not clogged?

Yes - Go to step (3).

Symptom: Engine Starts But Does Not Continue Running - No Exhaust Smoke

No - Replace fuel filter.

(3) No air leak in fuel system?

Yes - Go to step (4).

No - Repair fuel system.

(4) Fuel lines not plugged, pinched or cracked?

Yes - Go to step (5).

No - Repair or replace fuel lines as needed.

(5) Correct volume of fuel supplied to injection pump?

Yes - Go to step (6).

No - Replace fuel transfer pump.

(6) Valve clearance proper?

Yes - Go to step (7).

No - Adjust valve clearance. See “Adjust Valve Clearance” on page 61.

(7) Crankshaft pin or bearing not seized?

No - Regrind crankshaft and replace bearings. See “Inspect Crankshaft and Main Bearings” on page 96.

Symptom: Engine Starts But Does Not Continue Running - Excess Exhaust Smoke

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter.

(3) Intake and/or exhaust valve not seized?

Yes - Go to step (4).

No - Replace valve and check valve guide. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(4) Piston rings not broken or seized?

Yes - Go to step (5).

No - Replace rings. Check piston and cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

(5) Piston rings, piston or cylinder not worn?

Symptom: Engine Starts But Does Not Continue Running - Excess Exhaust Smoke

No - Replace piston and/or rings, bore or hone cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

Symptom: Low Engine Output - Exhaust Color NORMAL

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Proper type and viscosity of oil being used?

Yes - Go to step (3).

No - Replace engine oil and filter.

(3) Fuel filter not clogged?

Yes - Go to step (4).

No - Replace fuel filter.

(4) Fuel lines not clogged, cracked or pinched?

Yes - Go to step (5).

No - Clean or replace fuel lines.

(5) No air leakage into fuel system?

Yes - Go to step (6).

No - Repair fuel supply system.

(6) Proper volume of fuel to injection pump?

Yes - Go to step (7).

No - Check or replace fuel transfer pump.

(7) Intake and exhaust valve clearance correct?

Yes - Go to step (8).

No - Adjust valve clearance. See “Adjust Valve Clearance” on page 61.

(8) Intake or exhaust valves not leaking compression?

Yes - Go to step (9).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(9) Intake or exhaust valves not seized?

Yes - Go to step (10).

No - Replace valve and check valve guide. See “Inspect Cylinder Head and Valves” on page 80.

Symptom: Low Engine Output - Exhaust Color NORMAL

(10) Cylinder head gasket not leaking compression?

No - Replace head gasket. See “Remove and Install Cylinder Head and Valves” on page 78. Resurface head and block if necessary. See “Inspect Cylinder Head and Valves” on page 80.

Symptom: Low Engine Output - Exhaust Color WHITE

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

No - Repair or replace fuel injector pump or fuel injectors.

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. See “Remove and Install Fuel Injection Nozzles” on page 115.

(5) Intake or exhaust valve stems not worn?

Yes - Go to step (6).

No - Replace valve guides and valves. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(6) Is injection pump timing correct?

Yes - Go to step (7).

No - Correctly time injector pump.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. See “Disassemble and Assemble Piston and Connecting Rod” on page 87.

(8) Piston ring ends staggered?

Yes - Go to step (9).

Symptom: Low Engine Output - Exhaust Color WHITE

No - Stagger piston ring ends. See “Disassemble and Assemble Piston and Connecting Rod” on page 87.

(9) Piston, rings, or cylinder not worn?

Yes - Go to step (10).

No - Replace pistons and rings, bore or hone cylinders. See “Remove and Install Piston and Connecting Rod” on page 85.See “Inspect Cylinder Bore” on page 92.

(10) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85.See “Inspect Cylinder Bore” on page 92.

Symptom: Low Engine Output - Exhaust Color BLACK

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load.

(2) Correct type of fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Air filter elements not clogged?

Yes - Go to step (4).

No - Clean or replace air filter elements.

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

(5) Engine running cool enough?

Yes - Go to step (6).

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

(6) Cooling system filled to correct level?

Yes - Go to step (7).

No - Check for leaks and fill system to correct level.

(7) Correct volume of fuel being injected?

Yes - Go to step (8).

Symptom: Low Engine Output - Exhaust Color BLACK

No - Replace faulty fuel injector pump or fuel injectors.

(8) Correct pattern from fuel injectors?

Yes - Go to step (9).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(9) Is injector pump timing correct?

Yes - Go to step (10).

No - Correctly time injector pump.

(10) Intake or exhaust valves not leaking compression?

Yes - Go to step (11).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(11) Intake or exhaust valve not seized?

No - Replace valve and check valve guide. See “Inspect Cylinder Head and Valves” on page 80.

Symptom: Exhaust Color WHITE Under Load

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Engine not running too cool?

Yes - Go to step (4).

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injector pump.

(5) Correct pattern from fuel injectors?

Yes - Go to step (6).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

Symptom: Exhaust Color WHITE Under Load

(6) Is injector pump timing correct?

Yes - Go to step (7).

No - Adjust injection pump timing.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. See “Disassemble and Assemble Piston and Connecting Rod” on page 87.

(8) Pistons, rings or cylinders not worn?

Yes - Go to step (9).

No - Replace pistons and rings, bore or hone cylinders. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

(9) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Exhaust Color BLACK Under Load

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load.

(2) Correct type of fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Air filter elements not clogged?

Yes - Go to step (4).

No - Clean or replace air filter elements.

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

(5) Even volume of fuel being injected?

Yes - Go to step (6).

No - Replace faulty fuel injector pump or fuel injectors.

(6) Correct volume of fuel being injected?

Yes - Go to step (7).

Symptom: Exhaust Color BLACK Under Load

No - Replace faulty fuel injector pump or fuel injectors.

(7) Proper spray pattern from injectors?

Yes - Go to step (8).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(8) Is injector pump timing correct?

Yes - Go to step (9).

No - See injection pump timing.

(9) Intake or exhaust valves not leaking compression?

Yes - Go to step (10).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(10) Intake or exhaust valves not seized?

No - Replace valve and check valve guide. See “Inspect Cylinder Head and Valves” on page 80.

Symptom: Exhaust Temperature Too High

(1) Cooling system filled to correct level?

Yes - Go to step (2).

No - Check for leaks and fill system to correct level.

(2) Engine running cool enough?

Yes - Go to step (3).

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

(3) Exhaust pipe not clogged?

Yes - Go to step (4).

No - Clean exhaust pipe.

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injector pump or fuel injectors.

(5) Intake or exhaust valve clearance correct?

Yes - Go to step (6).

No - Adjust valve clearance. See “Adjust Valve Clearance” on page 61.

Symptom: Exhaust Temperature Too High

(6) Intake or exhaust valves not leaking compression?

Yes - Go to step (7).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(7) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Engine Runs Rough - Misfiring

(1) Intake or exhaust valve clearance correct?

Yes - Go to step (2).

No - Adjust valve clearance. See “Adjust Valve Clearance” on page 61.

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors.

(3) Is injector pump timing correct?

Yes - Go to step (4).

No - See adjust injection pump timing.

(4) Backlash of timing gear not excessive?

Yes - Go to step (5).

No - Repair gears as needed. See “Check Timing Gear Backlash” on page 67.

(5) Combustion chambers clean of foreign matter?

Yes - Go to step (6).

No - Clean combustion chambers. See “Remove and Install Cylinder Head and Valves” on page 78.

(6) Intake or exhaust valves not leaking compression?

Yes - Go to step (7).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(7) Intake or exhaust valves not seized?

Yes - Go to step (8).

Symptom: Engine Runs Rough - Misfiring

No - Replace valve and check valve guide. See “Inspect Cylinder Head and Valves” on page 80.

(8) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Engine Runs Rough - Uneven Combustion Sound

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel. Check fuel filter.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

No - Replace faulty fuel injector pump or fuel injectors.

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(5) Air filter elements not clogged?

Yes - Go to step (6).

No - Clean or replace air filter elements.

(6) Exhaust pipe not clogged?

No - Clean exhaust pipe.

Symptom: Engine Runs Rough - Engine Surges DURING IDLING

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Check fuel filter.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors.

(3) Proper spray pattern from injectors?

Symptom: Engine Runs Rough - Engine Surges DURING IDLING

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(4) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Engine Runs Rough - Engine Surges UNDER LOAD

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Check fuel filters.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors.

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(4) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Engine Runs Rough - Excessive Engine Vibration

(1) Even volume of fuel injected?

Yes - Go to step (2).

No - Replace faulty fuel injector pump or fuel injectors.

(2) Proper spray pattern from injectors?

Yes - Go to step (3).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(3) Piston rings not broken or seized?

Yes - Go to step (4).

Symptom: Engine Runs Rough - Excessive Engine Vibration

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

(4) Crankshaft pin or bearing not worn or seized?

Yes - Go to step (5).

No - Regrind crankshaft and replace bearings. See “Inspect Crankshaft and Main Bearings” on page 96.

(5) Connecting rod bolts torqued properly?

No - Replace damaged components. Tighten to correct specification. See “Remove and Install Cylinder Head and Valves” on page 78.

Symptom: Excessive Fuel Consumption

(1) Engine not running too cool?

Yes - Go to step (2).

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors.

(3) Correct pattern from fuel injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. See “Test Fuel Injection Nozzles” on page 67.

(4) Intake or exhaust valves not leaking compression?

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

Symptom: Excessive Oil Consumption

(1) Engine oil of correct viscosity and type?

Yes - Go to step (2).

No - Replace engine oil with oil of proper viscosity and type. Replace oil filter.

(2) No external or internal oil leak?

Yes - Go to step (3).

Symptom: Excessive Oil Consumption

No - Repair as needed.

(3) Intake or exhaust valve stems not worn?

Yes - Go to step (4).

No - Replace valve guides and valves. See “Remove and Install Cylinder Head and Valves” on page 78.

(4) Piston rings installed correctly and properly staggered?

Yes - Go to step (5).

No - Install piston rings correctly. See “Disassemble and Assemble Piston and Connecting Rod” on page 87.

(5) Pistons, rings or cylinders not worn?

Yes - Go to step (6).

No - Replace pistons and rings, bore or hone cylinders. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

(6) Piston rings not broken or seized?

Yes - Go to step (7).

No - Replace rings. Check piston and cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

(7) No foreign matter in combustion chamber?

No - Clean head and top of piston. Check for damage.

Symptom: Fuel Oil in Crankcase

(1) Correct volume of fuel being injected”

Yes - Go to step (2).

No - Replace faulty fuel injector pump or fuel injectors.

(2) Intake or exhaust valve not seized or broken?

Yes - Go to step (3).

No - Replace valve and check valve guide. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings. Check piston and cylinder. See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 92.

(4) Pistons rings, piston or cylinders not worn?

Symptom: Fuel Oil in Crankcase

No - Replace pistons and rings, bore or hone cylinders. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

Symptom: Coolant in Crankcase

(1) Cylinder head gasket not leaking?

Yes - Go to step (2).

No - Replace head gasket. Resurface head and block if necessary. See “Remove and Install Cylinder Head and Valves” on page 78. See “Inspect Cylinder Head and Valves” on page 80.

(2) Is cylinder block not cracked?

No - Replace cylinder block.

Symptom: Low Oil Pressure

(1) Oil at correct level?

Yes - Go to step (2).

No - Add oil.

(2) Engine oil of correct viscosity and type?

Yes - Go to step (3).

No - Replace engine oil with oil of proper viscosity and type. Replace oil filter.

(3) No external or internal oil leak?

Yes - Go to step (4).

No - Repair as needed.

(4) Oil pressure relief valve not worn or damaged?

Yes - Go to step (5).

No - Clean or replace relief valve. See “Remove and Install Oil Pressure Regulating Valve” on page 106. See “Inspect Oil Pump” on page 104.

(5) Crankshaft pin or bearing not worn?

Yes - Go to step (6).

No - Regrind crankshaft and replace bearings. See “Inspect Crankshaft and Main Bearings” on page 96.

(6) Connecting rod bolts torqued properly?

Yes - Go to step (7).

No - Replace damaged components. Tighten to correct specification.

(7) Is engine oil pump not worn excessively?

Symptom: Low Oil Pressure

No - Replace oil pump. See “Remove and Install Oil Pump” on page 104.

Symptom: Engine Is Overheating

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load on engine.

(2) Cooling system filled to correct level?

Yes - Go to step (3).

No - Check for leaks and fill system to correct level.

(3) Is radiator clear of debris?

Yes - Go to step (4).

No - Clean radiator fins.

(4) Is radiator core free from blockage?

Yes - Go to step (5).

No - Clean or replace radiator.

(5) Is thermostat operating correctly?

Yes - Go to step (6).

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

(6) Is cylinder head gasket not leaking?

Yes - Go to step (7).

No - Replace head gasket. Resurface head and block if necessary. See “Remove and Install Cylinder Head and Valves” on page 78. See “Inspect Cylinder Head and Valves” on page 80.

(7) Is cylinder block not cracked?

No - Replace cylinder block.

Symptom: Low Engine Coolant Temperature

(1) Is thermostat operating correctly?

No - Check thermostat. See “Test Thermostat Opening” on page 69. Replace if faulty. Adjust fan belt tension. See “Adjust Fan/Alternator Drive Belt” on page 70.

Symptom: Low Compression

(1) Engine oil of correct viscosity and type?

Symptom: Low Compression

Yes - Go to step (2).

No - Replace engine oil with oil of correct viscosity and type. Replace oil filter.

(2) Intake or exhaust valves not leaking compression?

Yes - Go to step (3).

No - Grind valves and seats. See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.

(3) Intake or exhaust valve stems not worn?

Yes - Go to step (4).

No - Replace valve guides and valves. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(4) Intake or exhaust valve not seized?

Yes - Go to step (5).

No - Replace valve guides and valves. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

(5) Pistons, rings or cylinders not worn or seized?

Yes - Go to step (6).

No - Replace pistons and rings, bore or hone cylinders. See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 92.

(6) Piston rings installed correctly and properly staggered?

No - Install piston rings correctly. See “Disassemble and Assemble Piston and Connecting Rod” on page 87.

Tests and Adjustments

Test Cylinder Compression

Reason

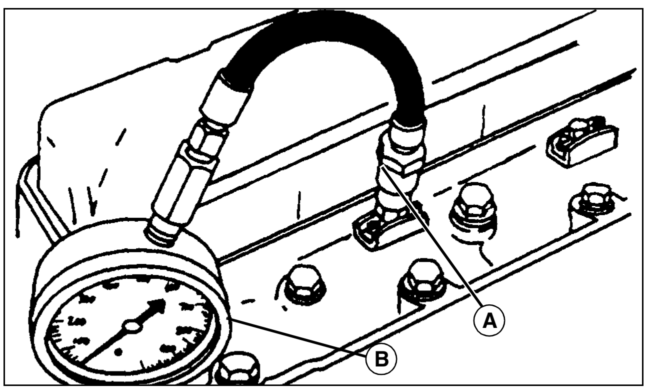
To determine the condition of the pistons, rings, cylinder walls and valves.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used to measure cylinder compression.
Adapter	JDG560	Used to measure cylinder compression.

Procedure

1. Remove the injection nozzles.



T6333EU

2. Install heat protector from end of injector and install on JDG560 Adapter (A).

3. Install JT01682 Compression Gauge Assembly (B) and JDG560 Adapter.

4. Disconnect fuel control solenoid connector.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test.

5. Crank the engine for five seconds with the starting motor. Minimum cranking speed is 250 rpm.

6. Record the pressure reading for each cylinder.

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.

Specifications

Cylinder Compression Pressure 3TNE78A - at 250 RPM (Standard) . . . . 3137 kPa (455 psi)

Cylinder Compression Pressure 3TNE78A - at 250 RPM (Minimum) . . . . 2551 kPa (370 psi)

Cylinder Compression Pressure 3TNE82A - at 250 RPM (Standard) . . . . 3040 kPa (441 psi)

Cylinder Compression Pressure 3TNE82A - at 250 RPM (Minimum) . . . . 2455 kPa (356 psi)

Cylinder Compression Pressure 3TNE84 - at 250 RPM (Standard) . . . . 3234 kPa (469 psi)

Cylinder Compression Pressure 3TNE84 - at 250 RPM (Minimum) . . . . 2551 kPa (370 psi)

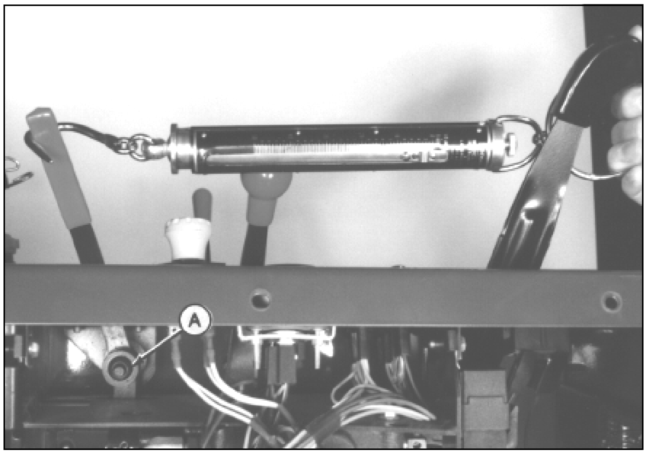
Difference Between Cylinders All Engines - at 250 RPM (Maximum) . . . . 296 kPa (43 psi)

Adjust Throttle Lever

Reason

To achieve smooth throttle lever movement with enough tension to maintain throttle setting.

Procedure (Check Throttle Lever Friction)



M46949

1. Connect a spring scale near the end of the throttle lever.
2. Pull throttle lever forward using spring scale.
3. If force required to pull throttle lever forward is within specifications, no adjustment is required.

Procedure (Adjust Throttle Lever Friction)

NOTE: Make sure throttle cable is not binding or stuck.

1. Remove right side panel.
2. Adjust friction disks (A) by tightening or loosening lock nut until throttle lever movement in forward direction meets specifications.
3. Install right side panel.

Results

Throttle lever should move smoothly through full range of motion with a slight drag set to specifications.

Specifications

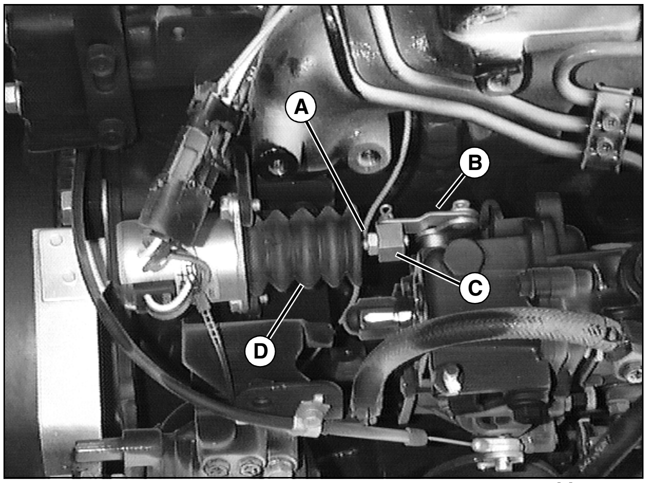
Throttle Lever Friction . . . . 36-53 N (8-12 lb-force)

Adjust Fuel Shutoff Solenoid

Reason

To make sure that fuel shutoff solenoid retracts fully, moving the injection pump shutoff control lever far enough to allow full rack travel.

Procedure



M86160

1. Loosen lock nut (A).
2. Disconnect link (B) from knuckle (C).
3. Hold solenoid plunger (D) bottomed in solenoid body.
4. Move link toward solenoid until it stops.

NOTE: Turning the knuckle two additional turns ensures that the solenoid bottoms out before the linkage.

5. Turn knuckle in or out on plunger until knuckle and link holes line up. Turn knuckle out two additional turns.
6. Assemble and start engine. Check for free movement of the linkage while engine is running.

Results

- Linkage should return completely to the STOP position when key switch is turned OFF.
- Plunger should be fully bottomed in solenoid body with key switch turned to the ON position.

Adjust Slow Idle

Reason

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

Special or Required Tools

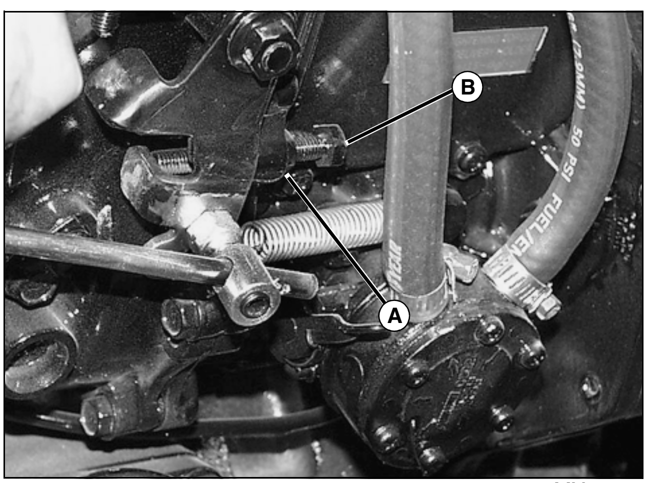
Tool Name	Tool No.	Tool Use
Hand Held Digital Tachometer	JT05719	Used to check engine rpm when setting slow idle speed.

Procedure

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

1. Place a small piece of reflective tape on the crankshaft pulley.
2. Start the engine and run for 5 minutes to attain operating temperature.
3. Move the throttle lever to slow idle position.
4. Use JT05719 Hand Held Digital Tachometer to check engine speed at the crankshaft pulley.
5. Visually check that the injection pump throttle lever is against slow idle stop screw.

Results



MX9887

- If the slow idle rpm is not according to specifications, loosen the nut (A) and turn the slow idle stop screw (B) clockwise to increase the engine speed, or counterclockwise to decrease the engine speed until the slow idle speed is correct. After adjustment, tighten the nut.

Specifications

Slow Idle Speed . . . . 950 ± 50 rpm

Adjust Fast Idle 3TNE78A (Engine S.N.-13510) and 3TNE84 (Engine S.N. -011149)

Reason

To achieve proper fast idle speed setting and ensure that engine is running at proper rpm for peak performance.

Special or Required Tools

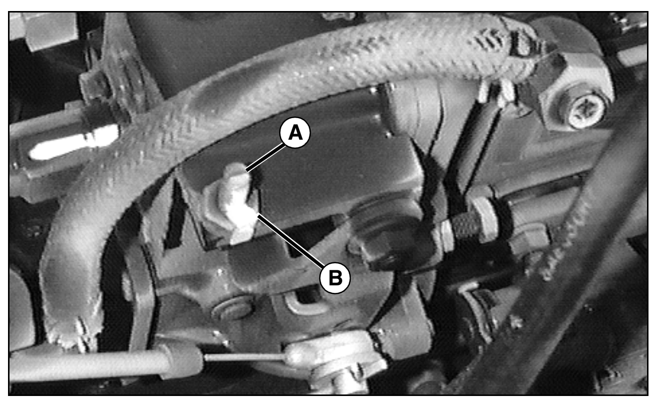
Tool Name	Tool No.	Tool Use
Hand Held Digital Tachometer	JT05719	Used to check engine rpm when setting fast idle speed.

Procedure

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

1. Place a small piece of reflective tape on crankshaft pulley.
2. Start engine and run for five minutes to attain operating temperature.
3. Move throttle lever to fast idle position.
4. Visually check that injection pump throttle lever is against fast idle stop screw.
5. Use JT05719 Hand Held Digital Tachometer to check engine speed at crankshaft pulley.

Results



M86161

- If fast idle rpm is not according to specifications, loosen nut (B). Turn fast idle stop screw (A) until fast idle speed is correct. After adjustment, tighten nut.

Specifications

Fast Idle Speed. . . . . 3150 ± 25 rpm

Adjust Fast Idle 3TNE78A (Engine S.N. 013511-), 3TNE82A (All) and 3TNE84 (Engine S.N. 011150-)

IMPORTANT: Avoid damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are pre-set by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by authorized diesel service facilities.

Because the FAST idle speed and torque capsule are NOT adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first MAKE SURE that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

Adjust Torque Capsule

IMPORTANT: Avoid damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are pre-set by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by authorized diesel service facilities.

Because the FAST idle speed and torque capsule are NOT adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first MAKE SURE that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

Adjust Injection Pump Timing (3TNE78A-RJFE and 3TNE84-JFE)

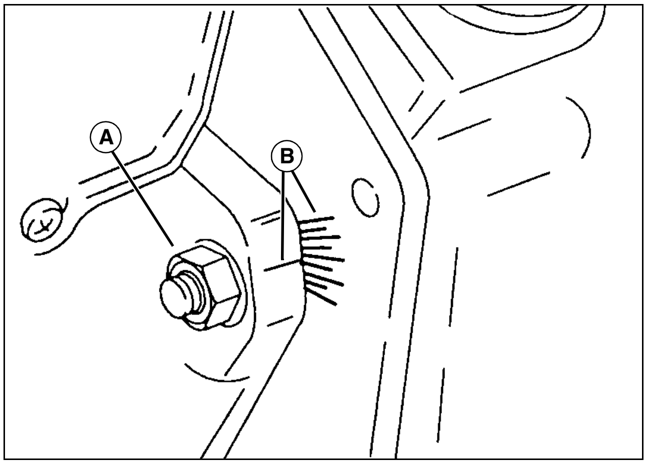
Reason

To make sure that injection pump timing is set to manufacturer's specifications.

Procedure

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

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



M57132

1. Clean around injection pump area.
2. Injection pump timing is set by aligning the mark on injection pump flange with the sixth line from the top on the timing housing.
3. Loosen injection pump mount nuts (A) and rotate to align marks (B).
4. Tighten injection pump mount nuts to specification.

Results

- If engine performance is poor, check air cleaners, fuel filter, fuel supply, injectors and cylinder compression before attempting to adjust timing. Then reset injection pump timing by aligning marks. Retest performance.
- If performance did not change, have pump tested by a diesel injection service center.

Specifications

Injection Pump Mounting Nut Torque . 27 N•m (20 lb-ft)

Adjust Injection Pump Static Timing (3TNE78A-RJFE and 3TNE84-JFE)

Reason

To make sure that the injection pump timing is set to manufacturers specification.

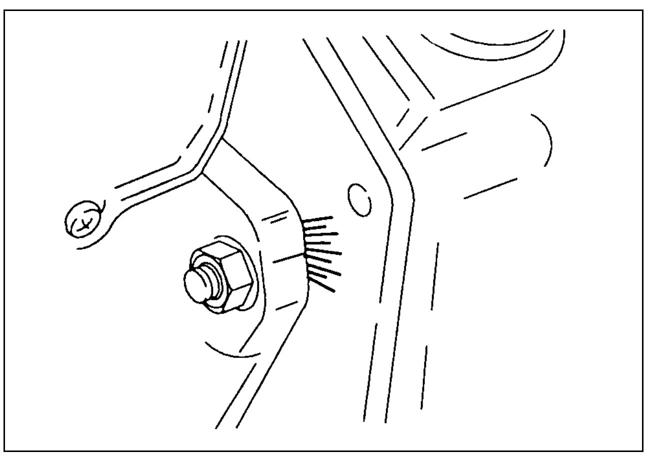
Special or Required Tools

Tool Name	Tool No.	Tool Use
Timing Tool (Number One Fuel Injection Line Cut Off at First Bend)	NA	Used to adjust injection static pump timing.

Procedure

IMPORTANT: Avoid damage! The injection pump timing should be correct. The timing is set at the factory, and will not normally change during the life of the engine. Check and adjust the timing only as the last option, or if there is reason to believe the timing has been altered.
Check the fuel, fuel supply system, injectors, air intake system and cylinder compression before continuing.

NOTE: If the injection pump has been removed from engine without disturbing engine crankshaft and pump gear, perform step 1 to obtain a close starting point, then perform the entire timing procedure.

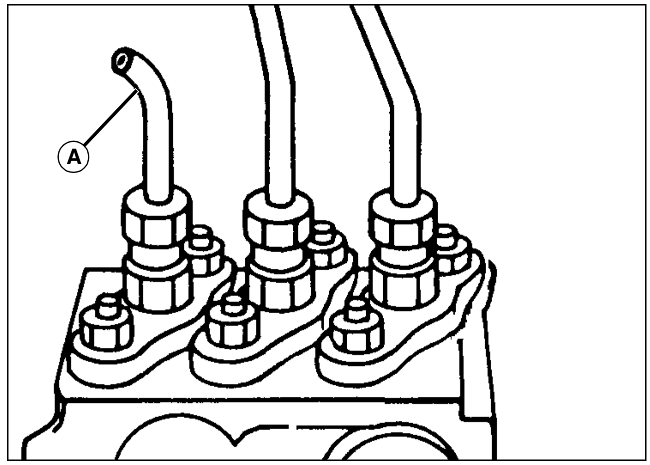


M57132

1. Align the arrow or line on the injection pump flange between fifth and sixth marks (from top) on timing gear mounting plate.

NOTE: Normal rotation, as viewed from the flywheel end, is counterclockwise. The number one fuel injection line is toward the flywheel.

2. Remove the number one fuel injection line.

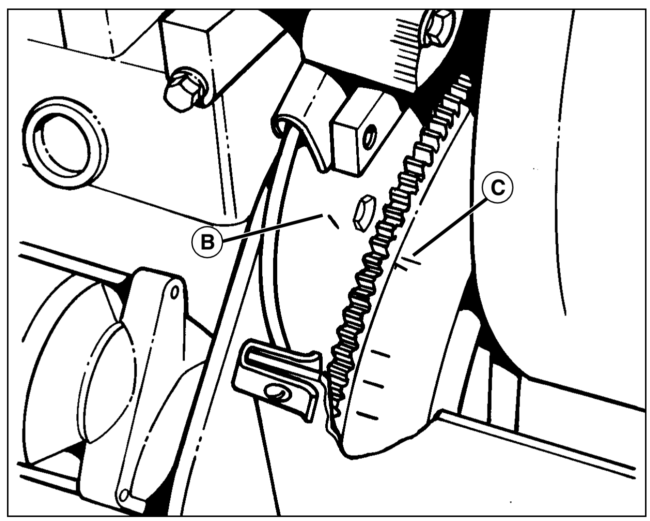


T6530AB

3. Install the timing tool (number one fuel line cut off at first bend) (A).

4. Remove flywheel shield on starter side of engine.

5. Remove battery.



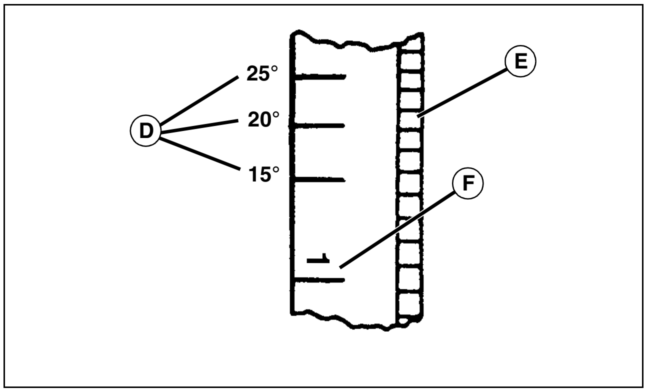
M76565

6. Turn the crankshaft pulley in either direction until the No. 1 cylinder top dead center (TDC) mark (C) aligns with the index mark (B) on the flywheel housing/plate.

7. Prime pump to fill it with fuel. 1 L (1.06 qt) of fuel is more than adequate.

8. Hold fuel shutoff solenoid linkage in RUN position.

9. Slowly turn the flywheel clockwise (as viewed from the flywheel end) until tip of timing tool has become moist with fuel.



M82373AB

10.Check timing mark on flywheel (F). The index mark must line up with the injection pump timing marks (D) on flywheel (E). See specifications.

Results

- If the timing is not within specifications, loosen the pump mounting bolts and turn the pump toward the engine block to retard the timing or away from the block to advance the timing. Recheck the timing.
- If the timing did not change, remove pump and have tested by an authorized diesel injection service shop.
- If the timing is correct, remove timing tool, install number one injection line, install the access cover to the flywheel housing.

Specifications

Injection Pump Timing (Number one Cylinder Compression Stroke) . . . . 16 ± 1° BTDC

Adjust Injection Pump Static Timing (3TNE78A-ERJFE, 3TNE82A-EJF and 3TNE84-EJFE)

IMPORTANT: Avoid damage! DO NOT attempt to adjust the fuel injection pump timing. For most engine problems, the fuel injection pump timing will not have to be adjusted. If the engine performed well at one time, then the performance dropped, the fuel injection timing is NOT the problem. Fuel injection timing, once set by the engine manufacturer, must NOT change during the life of the engine.

Fuel injection pump timing should NOT change during the life of the engine unless the pump has been altered illegally, or there is excessive wear to the camshaft injection pump cam lobes and lifters.

First check the fuel quality, fuel supply, fuel injectors, air intake system and engine compression in all cylinders before considering fuel injection timing problems.

If all other possibilities have been ruled out and it is determined that the fuel injection pump and governor assembly are in need of repair, they must be replaced ONLY as complete assemblies.

Only an authorized factory trained technician is allowed to remove and install these assemblies.

Adjust Valve Clearance

Reason

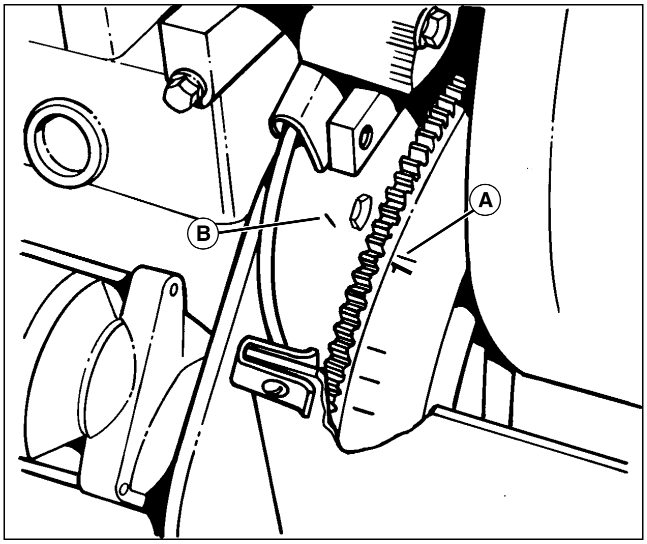
To set valve clearance for proper engine operation.

Procedure

CAUTION: Avoid injury! Be sure ignition key is OFF before attempting to turn engine by hand.

NOTE: The engine must be cool (room temperature) before the valve clearance is checked.

1. Remove battery.
2. Remove the rocker arm cover. See “Remove and Install Rocker Cover” on page 75.
3. Remove flywheel cover from starter side of engine.

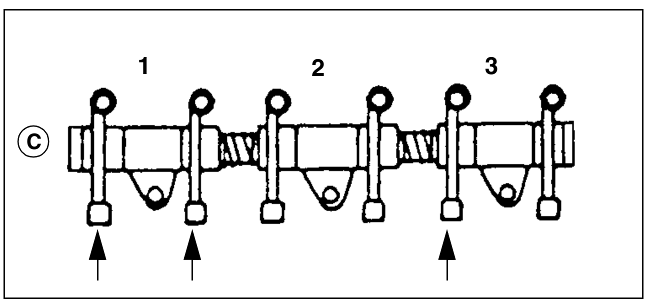


M76565

4. Turn crankshaft pulley clockwise, as viewed from flywheel end, until number one cylinder top dead center (TDC) mark (A) on flywheel aligns with index mark (B) on flywheel plate.

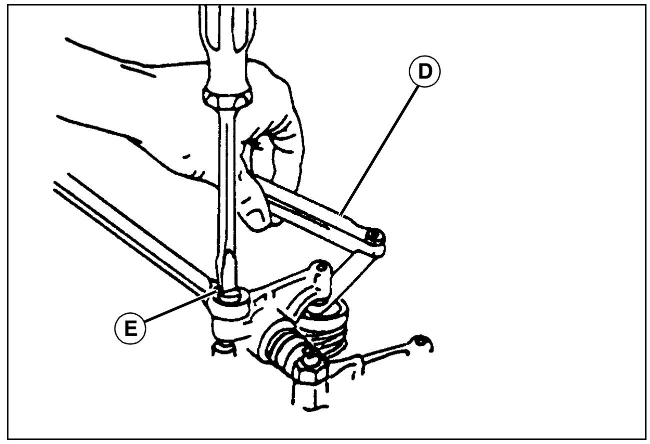
5. Try to move rocker arms and/or push rods for No. 1 cylinder:

- If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 8.
- If the rocker arms and/or push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.



M82327A

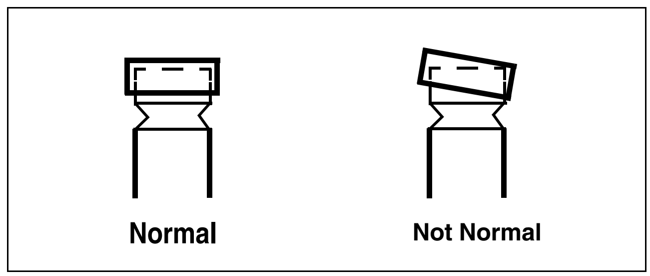
6. Measure and adjust valve clearance (if necessary) on the valves (arrows) with number one piston at TDC. Number one piston is at the flywheel end (C). Valve clearance should be at specifications.



T6105BF

7. If valve clearance is not at specifications, loosen the lock nut and turn the adjusting screw (E) until the blade of the feeler gauge (D) can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the lock nut.

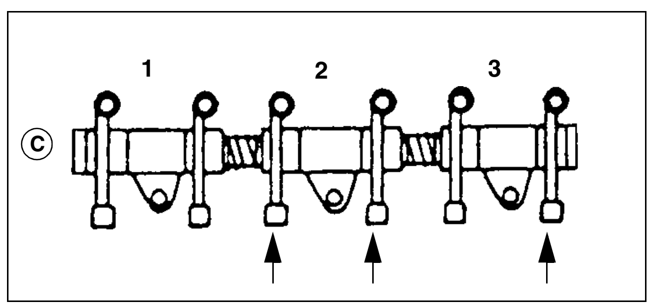
8. Recheck the valve clearance after tightening the lock nut.



MIF

9. Check that the valve cap on the valve stem remained seated on the valve and inside the valve spring retainer.

10.Turn crankshaft pulley one revolution (360°). This puts the piston in number two cylinder at TDC compression stroke.



M82327A

11.Measure and adjust valve clearance (if necessary) on the valves (arrows) with number two piston at TDC.

12.Install flywheel cover.

13.Install rocker arm cover. Tighten rocker arm cover nuts to specifications.

Results

If valve clearance cannot be adjusted to specification, check rocker arm assembly for wear or damage.

Specifications

Valve Clearance . . . . 0.15-0.25 mm (0.006-0.010 in.)

Rocker Arm Cover Nuts . . . . 18 N•m (160 lb-in.)

Check Valve Lift

Reason

Check wear on cam lobes, followers, and/or push rods.

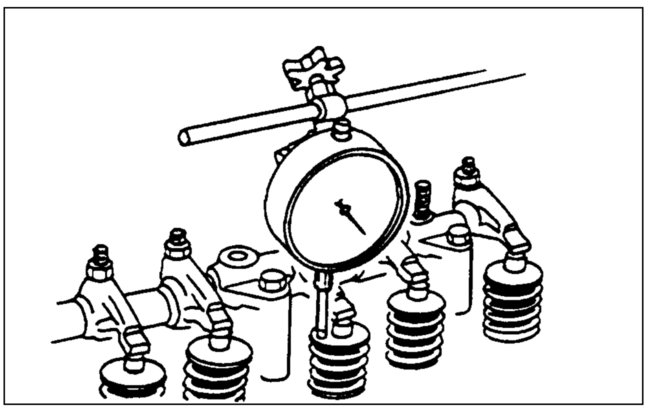
Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to measure valve lift.

Procedure

1. Remove the rocker arm cover. See “Remove and Install Rocker Cover” on page 75.

2. Adjust the valve clearance. See “Adjust Valve Clearance” on page 61.



T6333DT

3. Fasten the dial indicator to the engine and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.

4. Zero the dial indicator.

5. Manually turn the crankshaft pulley clockwise (viewed from flywheel end).

6. Observe the dial indicator as the valve is moved to the full open position and compare with specification. Repeat for each valve.

Results

- The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers and push rods. See “Remove and Install Camshaft” on page 98. If the camshaft, followers and push rods are within specification remove and inspect the cylinder head. See “Remove and Install Cylinder Head and Valves” on page 78.

Specifications

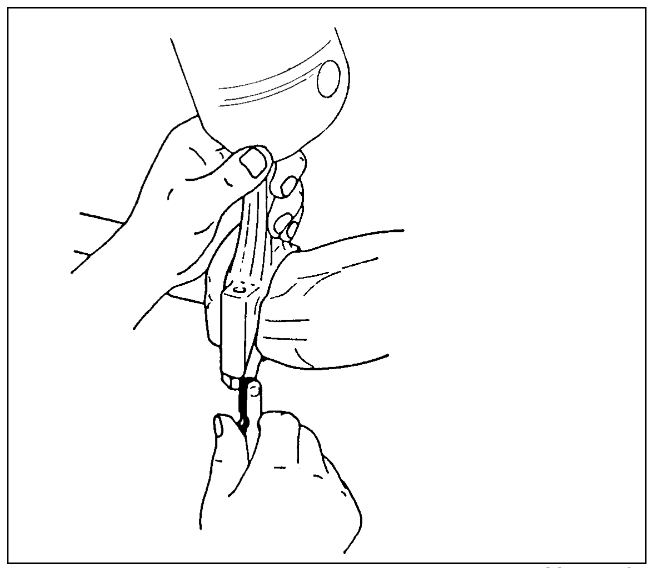
Valve Lift . . . . 8.8 mm (0.350 in.)

Check Connecting Rod Side Play

Reason

To determine proper side clearance between the crankshaft and the connecting rod.

Procedure



M82116A

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

Results

- If the side play exceeds specification, replace the bearing inserts or the connecting rod.

Specifications

Connecting Rod Side Play   0.2-0.4 mm (0.008-0.016 in.)

Check Connecting Rod Bearing Clearance

Reason

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

Special or Required Tools

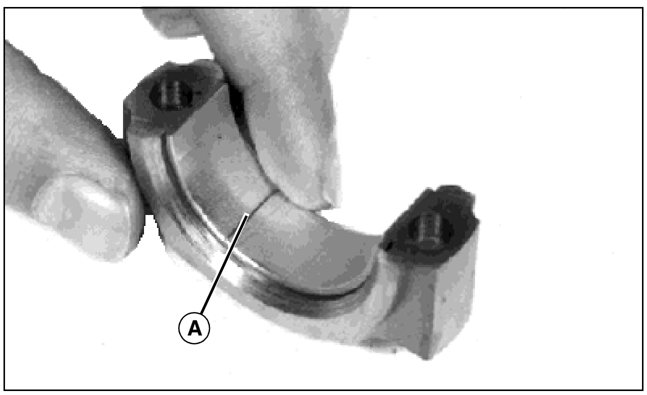
Tool Name	Tool No.	Tool Use
PLASTIGAGE®	NA	Used to measure oil clearance between connecting rod and crankshaft journal.

Procedure

IMPORTANT: Avoid damage! The 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 the connecting rod cap.

2. Wipe oil from the bearing insert and the crankshaft journal.



M35351

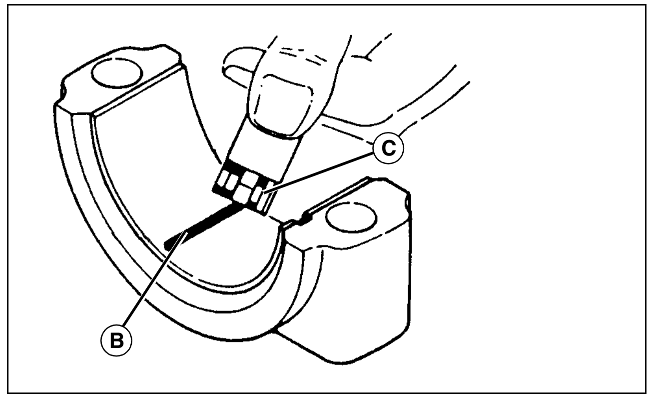
3. Put a piece of Plastigage (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.25 in.) off center.

4. Turn the crankshaft approximately 30° from bottom dead center.

5. Install the connecting rod end cap and original rod end cap screws. Tighten the rod end cap screws to specification.

NOTE: The flattened Plastigage (A) will be found on either the bearing insert or crankshaft journal.

6. Remove the rod end cap screws and the connecting rod cap.



M82117A

7. Use the graduation marks on the envelope (C) to compare the width of the flattened Plastigage (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

8. Measure the connecting rod bearing oil clearance.

9. Remove the Plastigage.

Results

• If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Connecting Rod Cap Screw Torque (3TNE78A and 3TNE82A) Engines . . . . 39 N•m (28 lb-ft)

Connecting Rod Cap Screw Torque (3TNE84 Engines) . 47 N•m (35 lb-ft)

Connecting Rod-to-Crankshaft Journal Clearance (3TNE78A and 3TNE82A Engines) . . . . 0.038-0.090 mm (0.001-0.004 in.)

Connecting Rod-to-Crankshaft Journal Clearance (3TNE84 Engine). . . . . 0.038-0.074 mm (0.001-0.003 in.)

Check Crankshaft End Play

Reason

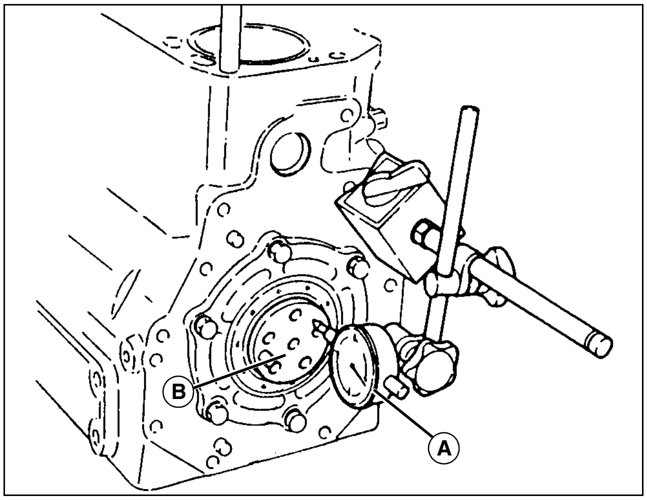
To determine proper side clearance between the crankshaft and the engine block.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check crankshaft-to-engine block side clearance.

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.



M82118A

1. Fasten the dial indicator (A) to engine and position indicator tip on end of crankshaft (B).

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

2. Push the 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.

Results

- If the end play exceeds specifications, replace the thrust bearings.

Specifications

Crankshaft End Play. . . . 0.09-0.27 mm (0.004-0.011 in.)

Check Crankshaft Main Bearing Clearance

Reason

To measure oil clearance between main bearing and crankshaft journal.

Special or Required Tools

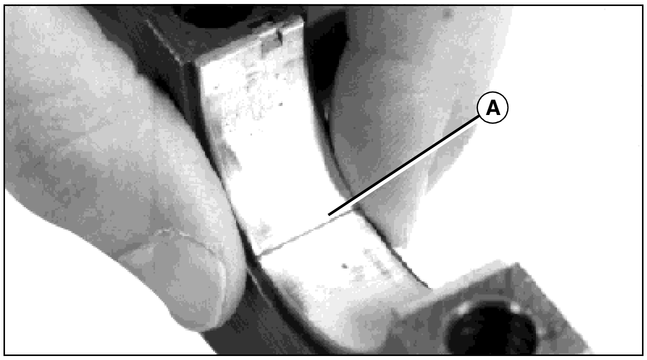
Tool Name	Tool No.	Tool Use
PLASTIGAGE®	NA	Used to check main bearing-to-crankshaft journal clearance.

Procedure

IMPORTANT: Avoid damage! 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 the main bearing cap.

2. Wipe oil from the bearing insert and the crankshaft journal.



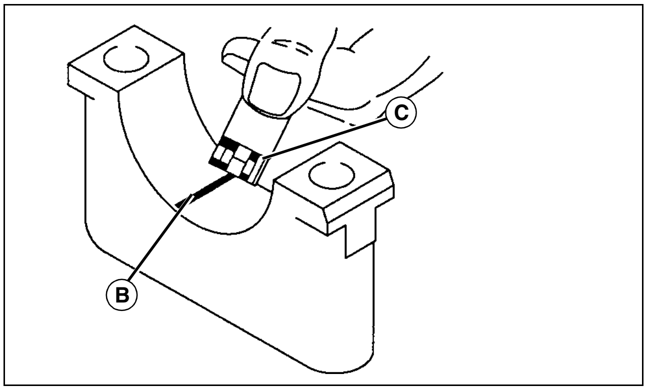
M35382

3. Put a piece of Plastigage (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.25 in.) off center.

4. Install the main bearing cap and cap screws. Tighten the cap screws to specification.

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

5. Remove the cap screws and main bearing caps.



M82119A

6. Use the graduation marks (C) on the envelope to compare the width of the flattened Plastigage (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.

7. Remove Plastigage.

Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Main Bearing Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 79 N•m (58 lb-ft)

Main Bearing Cap Screw Torque (3TNE84 Engine) . . 98 N•m (72 lb-ft)

Main Bearing-to-Crankshaft Journal Oil Clearance (3TNE78A and 3TNE82A Engines) . . . . 0.038-0.090 mm (0.001-0.004 in.)

Main Bearing-to-Crankshaft Journal Oil Clearance (3TNE84 Engine) . . . . . 0.038-0.074 mm (0.001-0.003 in.)

Check Camshaft End Play

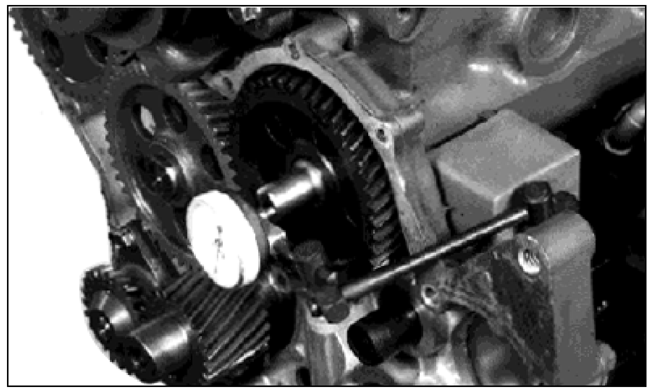
Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check camshaft gear end journal-to-thrust plate side clearance.

Procedure



M37512

1. Remove the timing gear cover. See “Remove and Install Timing Gear Cover” on page 102.

2. Fasten the dial indicator to the engine and position indicator tip on end of camshaft.

3. Push the camshaft toward the rear as far as possible.

4. Zero the dial indicator.

5. Pull the camshaft forward as far as possible.

Results

- If the end play exceeds specifications, remove the camshaft and replace the thrust plate. See “Remove and Install Camshaft” on page 98.

Specifications

Camshaft End Play. . . . . 0.05-0.25 mm (0.002-0.010 in.)

Check Timing Gear Backlash

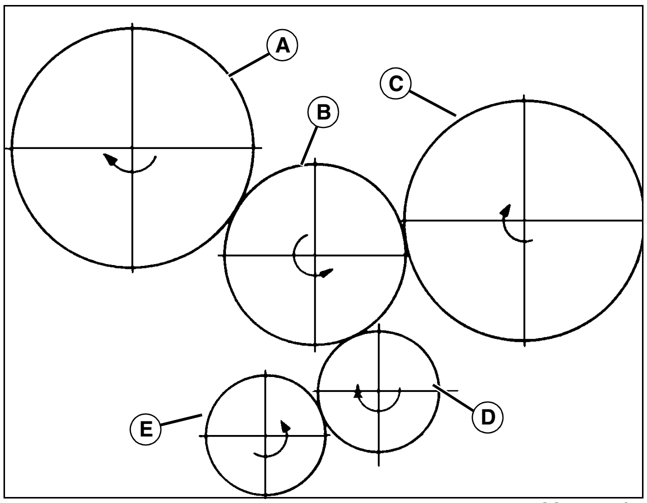
Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check wear between meshing gears.

Procedure



M82252A

1. Measure the backlash between meshing gears.

Results

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

- Fuel Injection Pump Gear (A)
- Idler Gear (B)
- Camshaft Gear (C)
- Crankshaft Gear (D)
- Oil Pump Gear (E)

Specifications

Gear Backlash. . . . . 0.04-0.12 mm (0.001-0.005 in.)

Test Fuel Injection Nozzles

CAUTION: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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

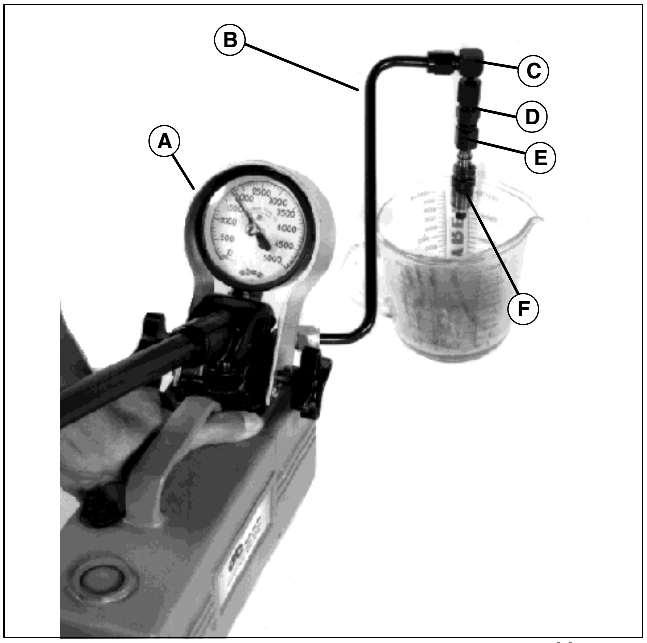
Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Straight Adapter	23622	Used to test fuel injection nozzles.

Connections



M35913

1. Connect the fuel injection nozzle (F) to D01109AA Diesel Fuel Injection Nozzle Tester (A) using parts 36352 (B), 23617 (C), 23621 (D) from D01110AA Adapter Set, and 23622 straight adapter (E).

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

Procedure 1

Test the fuel injection nozzle opening pressure following the nozzle tester manufacturer's instructions. The opening pressure should be at specifications.

Results

- If the pressure reading does not meet specification, disassemble the injection nozzle and inspect for contamination or a 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 the nozzle completely using a lint-free cloth.

2. Pressurize 3TNE78A and 3TNE82A engines nozzle to 17 640 kPa (2558 psi). Pressurize 3TNE84 engine nozzle to 19 400 kPa (2814 psi)

3. Watch for leakage from nozzle spray orifice for a minimum of five seconds.

Results

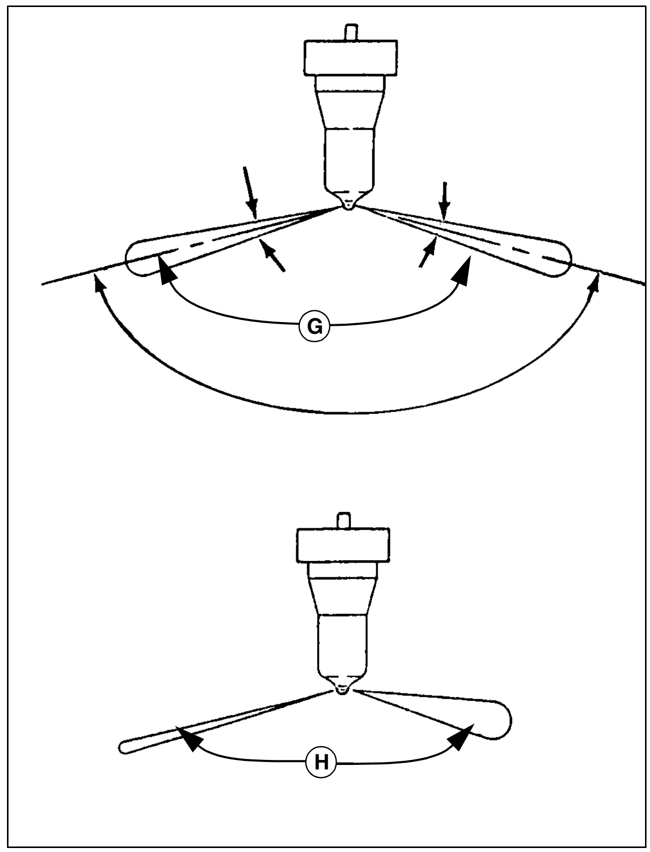
- Fuel should not leak from the nozzle when the nozzle is pressurized.
- If the injection nozzle leaks fuel, disassemble and inspect the nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary.

Procedure 3

Test the fuel injection nozzle chatter and spray pattern following the nozzle tester manufacturer's instructions.

1. Pressurize 3TNE78A and 3TNE82A engines nozzle to 19 600 kPa (2845 psi). Pressurize 3TNE84 engine nozzle to 21 600 kPa (3133 psi)

2. Listen for chatter sound and watch spray pattern.



M82121A

3. With slow hand lever movement there should be a “chatter” sound and a fine stream spray pattern.

4. With fast hand lever movement the nozzle should exhibit an even, fine atomized spray pattern (G), unlike spray pattern (H).

5. Place a sheet of white paper 30 cm (12 in.) below the nozzle. The injection spray should form a perfect circle on the paper.

Results

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

Specifications

Fuel Injection Nozzle Opening Pressure (3TNE78A and 3TNE82A). . . . . 19 600 ± 979 kPa (2845 ± 142 psi)

Fuel Injection Nozzle Opening Pressure (3TNE84) . . 21 600 ± 979 kPa (3133 ± 142 psi)

Test Thermostat Opening

Reason

To determine opening temperature of thermostat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	NA	Used to check thermostat opening temperature.

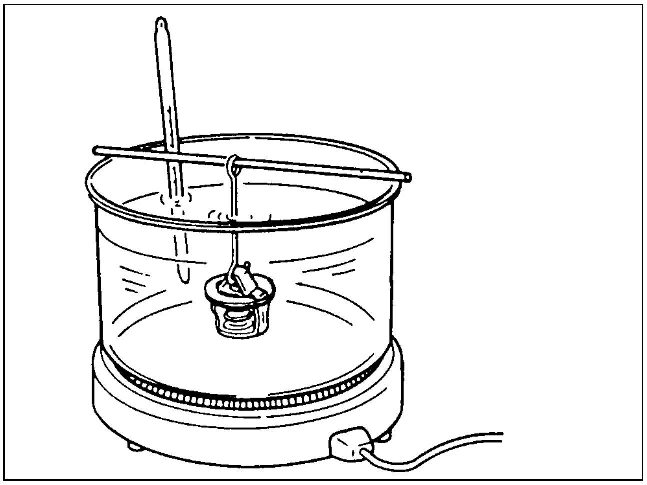
Procedure

CAUTION: Avoid Injury! 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 the thermostat and a thermometer in a container of water.

2. Heat and stir the water. Observe the opening action of the thermostat as the water heats up.

3. Remove the thermostat and observe the closing action as it cools.



M82122A

Results

Thermostat opening temperature, fully open temperature and lift height should meet specifications.

Specifications

Thermostat Begins to Open . . . . 71°C (160°F)

Thermostat Fully Open . . . . 85°C (184°F)

Thermostat Lift Height. . . . . 8 mm (0.310 in.)

Adjust Fan/Alternator Drive Belt

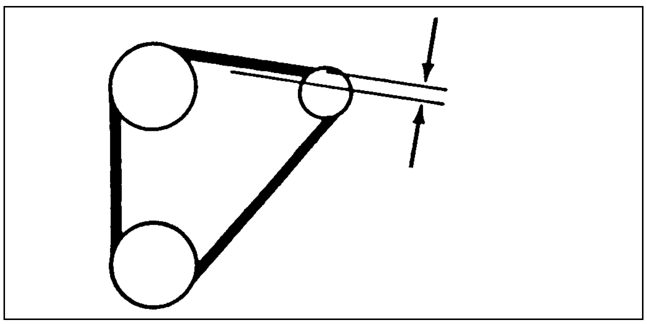
Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Belt Tension Gauge	JDG529 or JDST28	Used to adjust belt tension.
Straightedge	NA	Used to adjust belt tension.

Procedure (Check Belt Tension)



M54014

1. Check belt tension between coolant pump and alternator using a belt tension gauge and a straightedge. Belt deflection should be at specification. If not, adjust belt.
2. Check belt tension between fan and crankshaft pulley using belt tension gauge and a straightedge. Belt deflection should be at specifications. If not, adjust fan belt.

Procedure (Adjust Alternator Belt)

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

Procedure (Adjust Fan Belt)

1. Loosen idler pulley mounting cap screws/nuts.
2. Apply force to pulley (near belt) until tension is correct.
3. Tighten cap screws/nuts.

Results

Both belts should meet specifications.

Specifications

Fan/Alternator Belt Deflection @ 98 N (22 lb-force) 10-15 mm (0.4-0.6 in.)

Test Cylinder Leakdown

Reason

To determine if compression pressure is leaking from cylinder.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter	JDG560	Used to pressurize cylinder with compressed air for cylinder leakdown test.

Procedure

1. With the coolant at the proper level and the radiator cap tight, run the engine for 5 minutes to bring it to operating temperature.
2. Remove the recovery tank cap.
3. Check for bubbles coming from the overflow hose at the bottom of the tank.
4. If bubbles are present, isolate the source of the compression leak.
   a. Remove the injection nozzles.
   b. Install JDG560 Adapter in the injection port of the cylinder to be tested.
   c. Move the piston to the bottom of the stroke with intake and exhaust valves closed.
   d. Connect the hose from a compressed air source to the adapter.
   e. Apply shop air pressure into the cylinder.
   f. Check for bubbles in the recovery tank or air escaping from the muffler, air cleaner or oil fill opening.
   g. Repeat for each cylinder.

Results

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

Test Cooling System Pressure

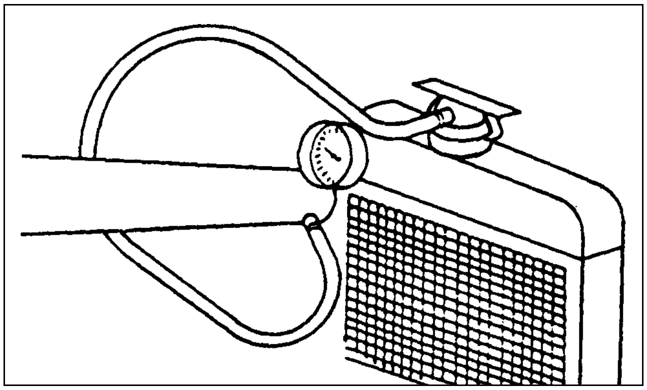
Reason

Inspect the cooling system for leaks.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to test cooling system pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system pressure.

Procedure



T6333AW

1. Remove cap and attach pressure pump to radiator.

2. Apply pressure according to specifications. DO NOT exceed maximum pressure specification.

3. Check for leaks throughout the cooling system. The pressure should not go below the minimum pressure specification for at least 15 seconds.

Results

- If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.

- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. See “Test Cylinder Leakdown” on page 70.

Specifications

Maximum Pressure. . . . . 97 kPa (14 psi)

Minimum Pressure (After 15 Seconds). . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Test Radiator Pressure Cap

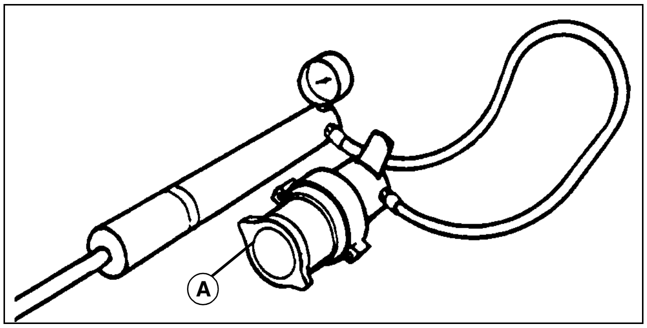
Reason

Test the radiator cap for operating in the correct pressure range.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to test radiator cap pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test radiator cap pressure.

Procedure



T6333AX

1. Install the radiator cap (A) on the pressure pump.

2. Apply pressure. Pressure valve in the cap should open at specification.

Results

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

Specifications

Radiator Cap Pressure . . . . 88 kPa (12.8 psi)

Test Engine Oil Pressure

Reason

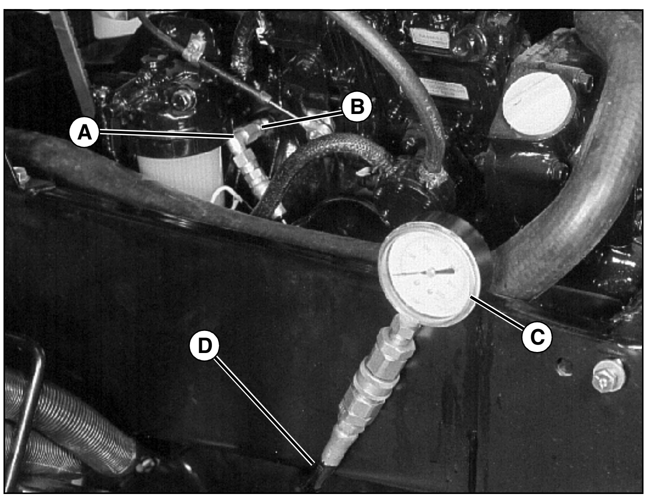
To determine if engine bearings or lubrication system components are worn.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Assembly	JT03017	Used to test engine oil pressure.
Pressure Gauge 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Elbow 7/16” Male 37° Flare x 7/16” Male 37° Flare	JT05483	Used to test engine oil pressure.
Connector 1/8 Male BSP x 7/16 Male 37° Flare	JT03349	Used to test engine oil pressure.

Procedure

1. Remove oil pressure sender.



M76562

2. Install JT05483 Elbow (A) and JT03349 Connector (B).

3. Connect JT03017 Hose Assembly (D) and JT07034 Pressure Gauge (C).

IMPORTANT: Avoid damage! DO NOT run engine if there is insufficient oil pressure!

4. Start engine. If pressure reading is below **69 kPa (10 psi)**, STOP engine and discontinue this procedure.

5. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.

Results

- If the oil pressure is not within specifications, inspect the oil pump.
- Inspect oil pressure regulating valve for wear or damage. Add or remove shims as necessary.

Specifications

Engine Oil Pressure . . . . . . 345 ± 48 kPa (50 ± 7.0 psi)

Fast Idle Speed. . . . . 3150 ± 25 rpm

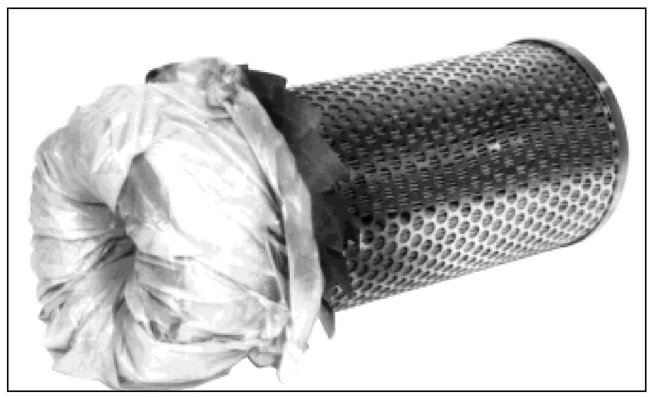
Test Air Intake System Leakage

Reason

Check for leaks in air intake system.

Procedure

1. Remove air filter restriction switch.
2. Remove air cleaner cover and main filter element.



M82124

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

4. Apply 34-69 kPa (5-10 psi) air pressure to air intake system. 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.

Adjust Throttle Cable

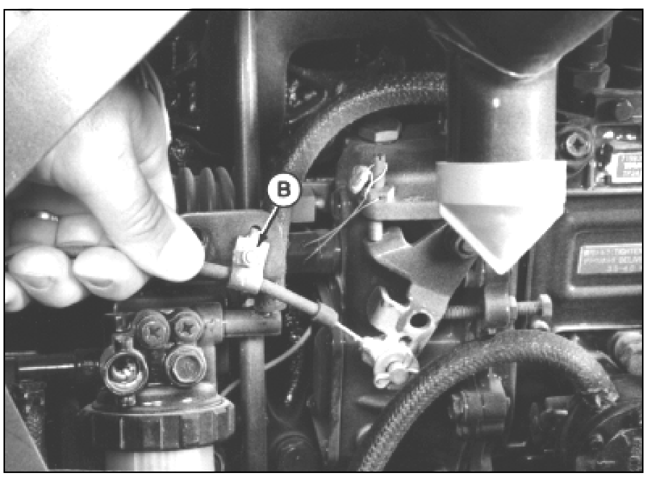
Reason

To make sure that throttle lever and cable moves governor lever fully from slow idle to fast idle position.

Procedure

M46950

1. Move throttle lever on instrument panel to within 2-3 mm (0.080-0.120 in.) from fast idle end of slot (A).



M46951

2. Loosen throttle cable clamp (B).

3. Pull throttle cable to hold governor linkage against fast idle stop. Tighten cable clamp (B).

Results

Throttle lever should move governor linkage throughout full range of travel, against stops.

Test Fuel System Leakage

Reason

Tests fuel system plumbing for external leakage. This test also determines if air is entering the fuel system at connections, allowing fuel to siphon back to tank.

Procedure

1. Disconnect fuel lines from fuel filter.

2. Place fuel line from fuel pump to fuel filter into a suitable container to catch drained fuel.

CAUTION: Avoid Injury! DO NOT apply more than 103 kPa (15 psi) air pressure to the fuel system. Damage to the injection pump or personal injury may result.

3. Apply 34-69 kPa (5-10 psi) air pressure to fuel supply hose until all fuel is drained from the system. DO NOT exceed maximum pressure of 103 kPa (15 psi).

4. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results

- Find leaks and repair or replace parts as necessary.

Bleed Fuel System

CAUTION: Avoid injury! Be careful of moving fan blades, alternator pulley and belts when engine is running. Engine may also be hot.

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

All engines are equipped with an automatic air venting system which makes the fuel system self-bleeding.

1. Ensure that all fuel line connections are securely tightened.

2. Add fuel to the fuel tank.

3. Crank engine to allow fuel system to bleed itself.

Test Coolant Temperature Switch

Reason

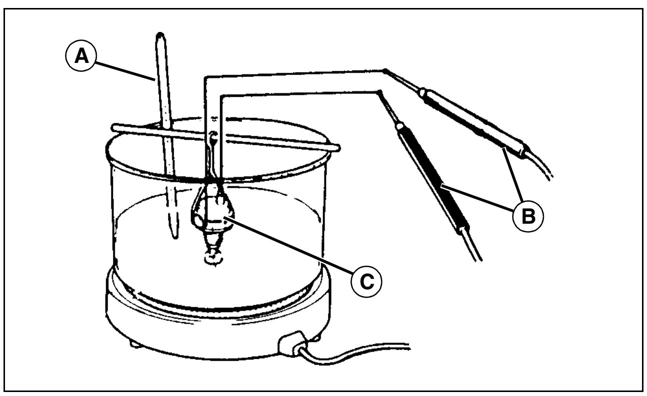
To determine operating temperature of sender.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	NA	Used to check coolant temperature switch.
Glass Container	NA	Used to check coolant temperature switch.
Heating Unit	NA	Used to check coolant temperature switch.
Ohmmeter	NA	Used to check coolant temperature switch.

Procedure

IMPORTANT: Avoid damage! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



M82123A

1. Connect lead wires from ohmmeter probes (B) to sender terminal and body.
2. Suspend sender (C) and a thermometer (A) in a container of water.
3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be at specifications.

Results

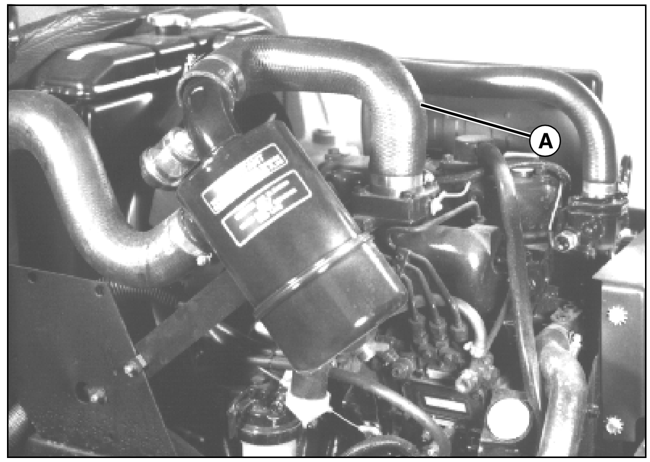
If continuity does not occur within temperature listed, replace sender.

Specifications

Coolant Temperature Switch (Contact Closing Temperature). . . . . 107-113°C (225-235°F)

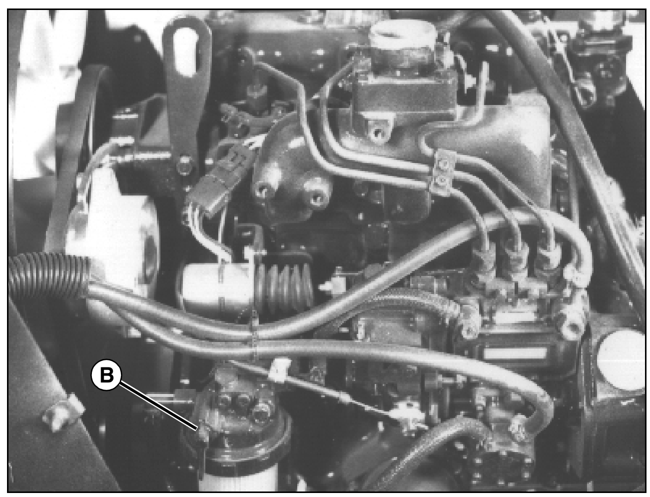
Repair

Remove Engine



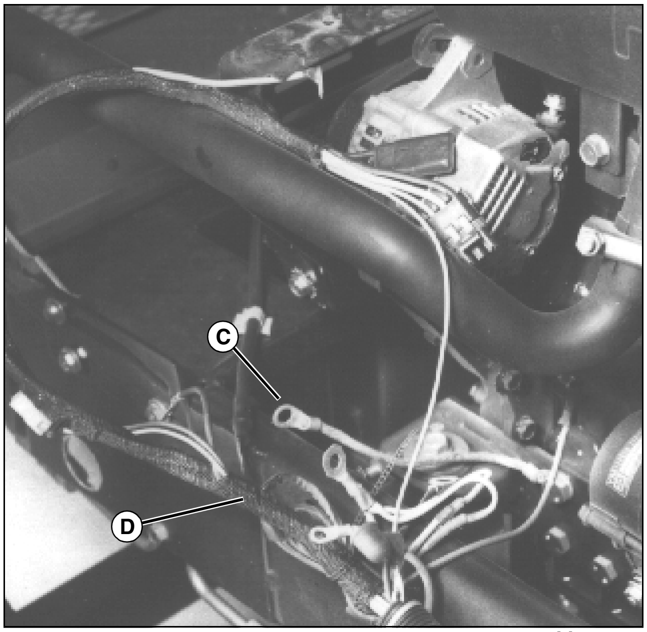
M56658

1. Remove hood from engine compartment.
2. Disconnect battery.
3. Disconnect drive shaft.
4. Drain coolant from radiator and remove hoses.
5. Disconnect air cleaner hose (A).



M56663

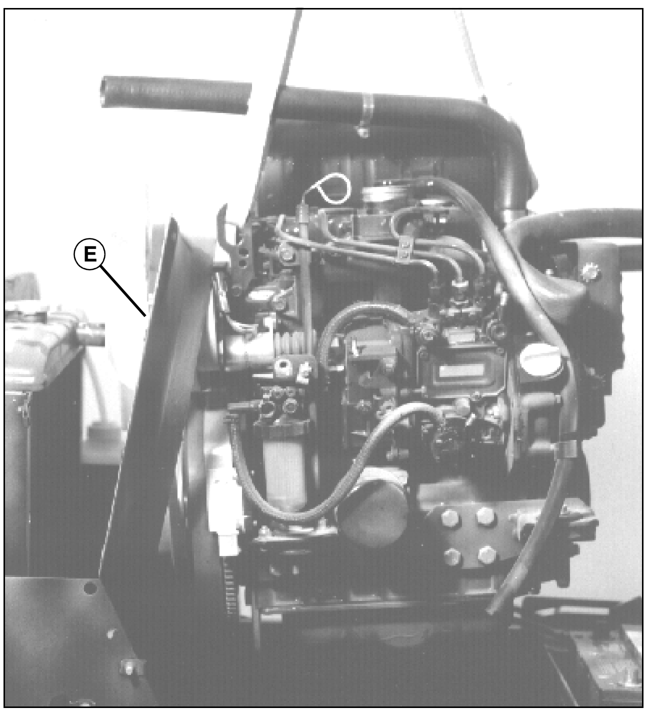
6. Close fuel shutoff (B) at fuel filter.
7. Disconnect and plug fuel lines.
8. Disconnect throttle cable.



M56662

9. Disconnect engine wiring harness (D) at fuel shutoff solenoid, alternator, starter, engine preheat, oil pressure switch and water temperature switch.

10.Disconnect engine ground strap (C).



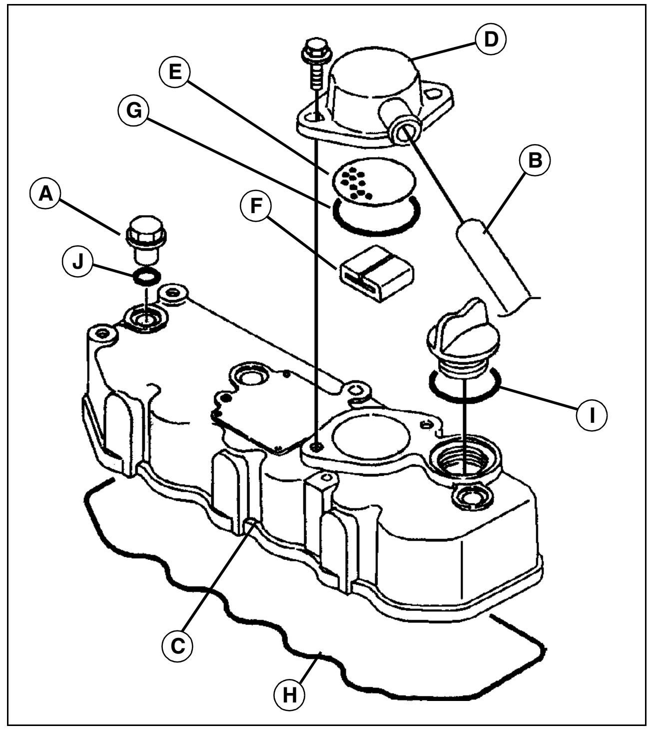
M56661

11.Remove the four cap screws securing the fan shroud to the radiator and position the shroud (E) over the fan for removal with the engine.

12.Attach slings to engine lift lugs, remove engine mounting cap screws and remove the engine.

Remove and Install Rocker Cover

Removal



M91950

1. Remove muffler.
2. Remove three rocker cover nuts (A).
3. Remove the breather hose (B).
4. Remove the rocker cover (C) from the cylinder head.
5. Remove the breather cap (D), plate (E), and baffle (F).
6. Wash the baffle in a safe solvent and blow dry with air. Replace the baffle if it comes apart or is deteriorated.

Installation

1. Install the baffle.
2. Install the breather plate and a new O-Ring (G) before replacing breather cover. Torque breather cover cap screws to specification.
3. Inspect the rocker cover gasket (H) and O-rings (I and J) before reinstalling the rocker arm cover. Replace if damaged.
4. Clean the cylinder head surface and install the rocker cover to the cylinder head. Install the rocker cover nuts to specifications.

Specifications

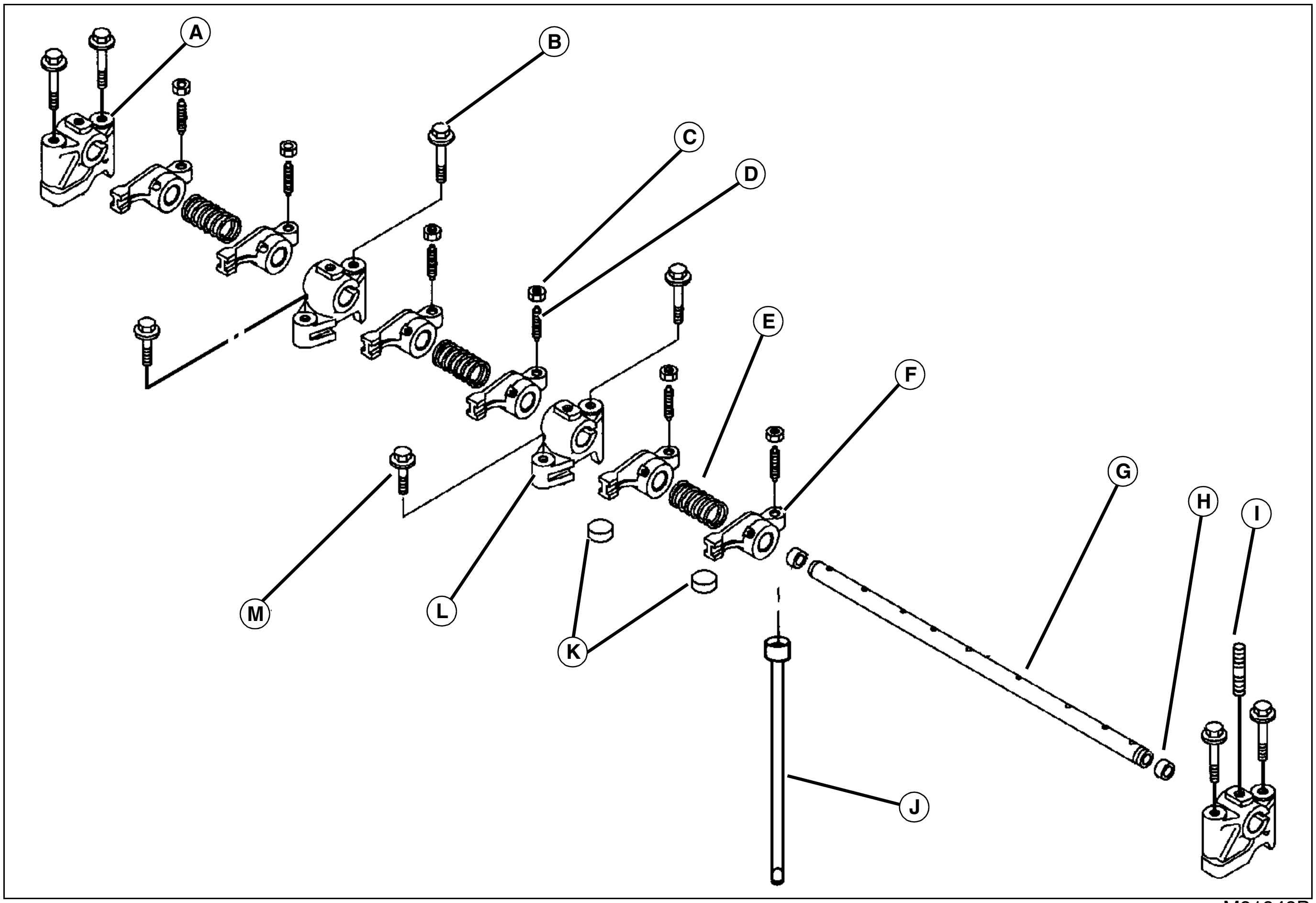
Breather Cover Cap Screw Torque . . . . 22 N•m (16 lb-ft)

Rocker Arm Cover Nut Torque . . . . 18 N•m (13 lb-ft)

Remove and Install Rocker Arm Assembly

Removal

1. Remove the rocker cover. See “Remove and Install Rocker Cover” on page 75.



A - Shaft End Support (2)
B - Cap Screw, M8 x 50 (6)
C - Jam Nut (6)
D - Adjuster Screw (6)
E - Spring (3)
F - Rocker Arm
G - Rocker Arm Shaft
H - Plug (2)
I - Stud
J - Push Rod (6)
K - Valve Caps (6)
L - Center Support (2)
M - Cap Screw, M8 x 25 (2)

2. Remove the rocker arm end supports (A) and rocker arm center support mounting cap screws (B and M).

3. Lift the rocker arm assembly from the cylinder head and set the assembly on a bench.

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

4. Note the positions of the rocker arm assembly components. Slide the components off the rocker arm shaft.

5. Lift the push rods from the cylinder head and note the order of removal for reassembly.

6. Inspect the rocker arm components and push rods.

Installation

1. Reinstall the push rods to their original location in the cylinder head, with the ball shaped end down in head.

2. Lubricate all parts with clean oil during assembly.

3. Assemble the rocker arm assembly components in the reverse order of removal.

4. Place the rocker arm assembly on the cylinder head.

- Align the rocker arms with the valves and push rods.
- Align the rocker arm end supports and center supports with the corresponding holes in the head.

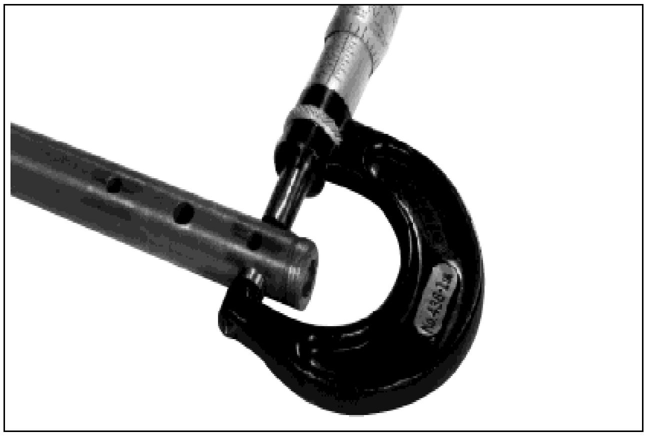
5. Install the rocker arm support cap screws. Tighten the cap screws to specification.

6. Adjust the valve clearance. See “Adjust Valve Clearance” on page 61.

Specifications

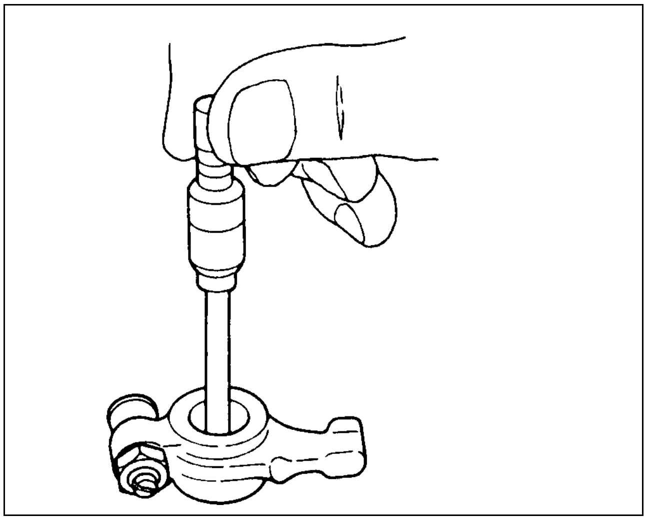
Rocker Arm Support Cap Screws Torque 26 N•m (19 lb-ft)

Inspect Rocker Arm Assembly



M35262

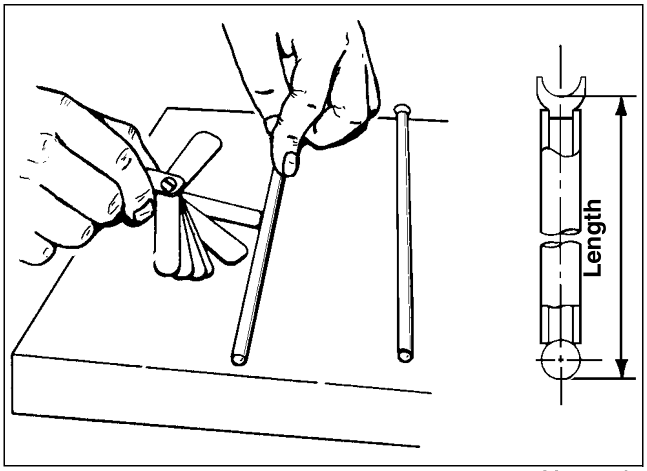
1. Measure the rocker arm shaft OD and compare with specifications. Replace rocker arm shaft if below wear limit.



M82022A

2. Measure the inner diameters of the rocker arms and supports. Compare with specifications. Replace rocker arms or supports if greater than wear limit.

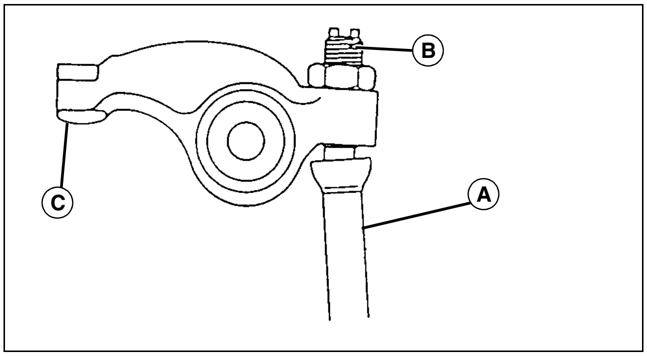
3. Measure the rocker arm shaft to rocker arm bushing oil clearance. Oil clearance is the difference between the OD of the rocker arm shaft and the ID of the rocker arms. If oil clearance is not within specifications, replace parts as necessary.



M82023A

4. Place the push rod on a flat surface. Use a feeler gauge to measure any gaps between the push rod and flat surface. Replace push rod(s) if not within specification.

5. Measure push rod length. If not within specification, replace push rod.



M76398

6. Check the surface of the adjusting screw that contacts the push rod (A) for wear. Replace the adjusting screw (B) if it is worn or damaged.

7. Check the surface (C) of the rocker arm that comes in contact with the valve cap for wear. Replace rocker arm if necessary.

8. Check the socket portion of the push rod where the valve clearance adjusting screw contacts the push rod. Replace the push rod if it is worn or damaged.

Specifications

Rocker Arm Shaft

Rocker Arm Shaft OD. 15.97-15.98 mm (0.628-0.629 in.)

Rocker Arm Shaft Wear Limit . . . . 15.95 mm (0.628 in.)

Rocker Arms and Supports

Rocker Arm and Support ID . . 16.00-16.02 mm (0.630-0.631 in.)

Rocker Arm and Support Wear Limit . 16.09 mm (0.633 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance. . . . . 0.02-0.05 mm (0.001-0.002 in.)

Oil Clearance Wear Limit . . . . 0.14 mm (0.006 in.)

Push Rods

Maximum Bend. . . . . 0.03 mm (0.001 in.)

Length . . . . 178.25-178.75 mm (7.018-7.037 in.)

Remove and Install Cylinder Head and Valves

Removal

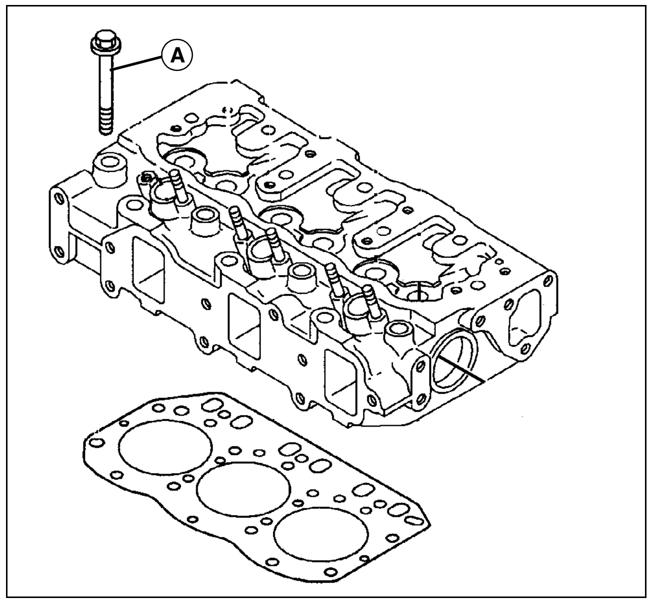
1. Remove the rocker arm cover. See “Remove and Install Rocker Cover” on page 75.

2. Remove the rocker arm assembly, push rods and valve caps. See “Remove and Install Rocker Arm Assembly” on page 76.

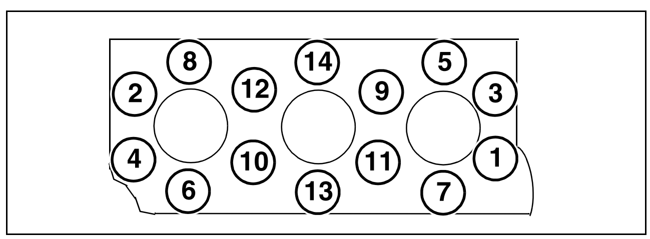
3. Remove the exhaust and intake manifolds. See “Remove and Install Exhaust Manifold” on page 83. See “Remove and Install Intake Manifold” on page 83.

4. Remove the coolant pump. See “Remove and Install Coolant Pump” on page 107.

5. Remove the fuel injection nozzles. See “Remove and Install Fuel Injection Nozzles” on page 115.



M91949A



MIF

6. Remove the cylinder head cap screws (A) in the order shown.

7. Remove the cylinder head from the engine block.

8. Disassemble and inspect the cylinder head and valves. See “Disassemble and Assemble Cylinder Head and Valves” on page 79.

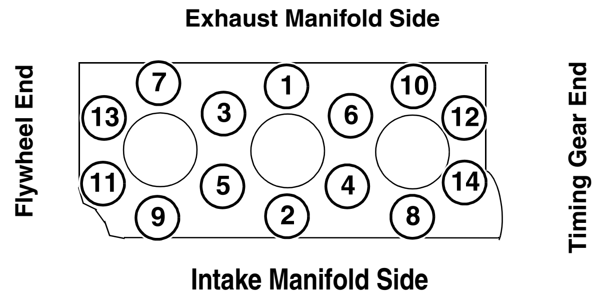
Installation

1. Reassemble cylinder head and valves. See "Disassemble and Assemble Cylinder Head and Valves" on page 79.

IMPORTANT: Avoid damage! The oil passage in the gasket must be located over the oil passage in cylinder block.

2. Place a new cylinder head gasket on the engine block. Dowels in the engine block will assist in aligning the gasket.
3. Place the cylinder head on the engine block. Dowels in the engine block will again assist in alignment.

IMPORTANT: Avoid damage! Cylinder head cap screws must be checked for proper torque after 50 hours of engine operation.



Cylinder Head Bolt-Tightening Order

MIF

4. Dip the cylinder head cap screws in clean engine oil. Install and tighten in the sequence shown, using the three stages of torque values listed in specifications.
5. Install the fuel injection nozzles.
6. Install the coolant pump.
7. Install the exhaust and intake manifolds.
8. Install rocker arm assembly, push rods and valve caps.
9. Install rocker arm cover.

Specifications

3TNE78A and 3TNE82A Engine Cylinder Head Cap Screw Torque

Initial Torque . . . . 35 N•m (26 lb-ft)

Second Torque . . . . 48 N•m (36 lb-ft)

Final Torque . . . . 69 N•m (51 lb-ft)

3TNE84 Engine Cylinder Head Cap Screw Torque

Initial Torque . . . . 44 N•m (33 lb-ft)

Second Torque . . . . 62 N•m (45 lb-ft)

Final Torque . . . . 88 N•m (65 lb-ft)

Disassemble and Assemble Cylinder Head and Valves

Removal

1. Remove the valve caps from the valves. The valve caps should be installed on the valves they were removed from.
2. Compress the valve spring using a valve spring compressor and remove the collet halves, retainer, valve spring and valve stem seal for each valve.
3. The intake and exhaust valve guides are press fit. Remove the guides only if necessary.

Installation

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

1. Install new valve stem seals over the valve guides.
2. Apply clean engine oil on intake and exhaust valve stems during assembly.
3. Install the valve springs with smaller pitch end or paint mark toward cylinder head.
4. Compress the valve springs and retainer until the collet halves are able to be installed in the grooves of the valve stem.
5. Carefully release the tension on the spring compressor.
6. Tap on the end of the valve with a plastic hammer to ensure the collet halves have seated properly on the valve stem.
7. Repeat for the remaining valves.
8. Measure valve recession if new valves were installed. See "Inspect Cylinder Head and Valves" on page 80

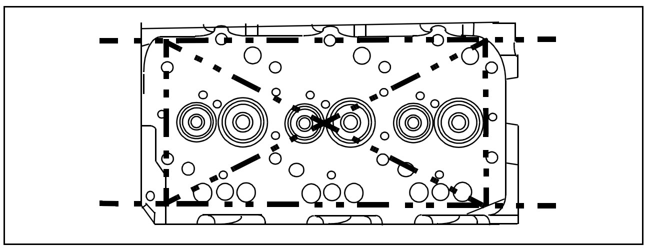
Inspect Cylinder Head and Valves

Special or Required Tools

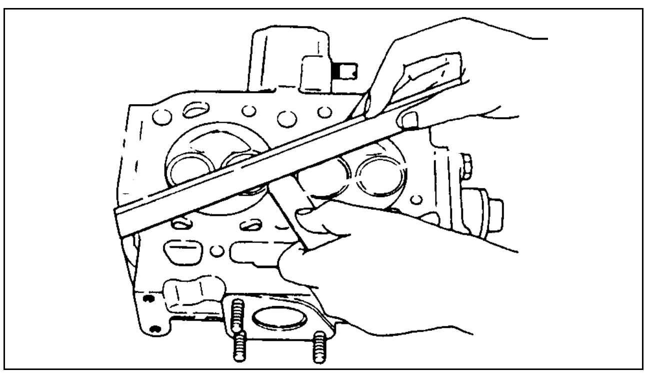
Tool Name	Tool No.	Tool Use
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.

IMPORTANT: Avoid damage! Before inspection, thoroughly clean all components of carbon or dirt.

Cylinder Head



MIF



M82028A

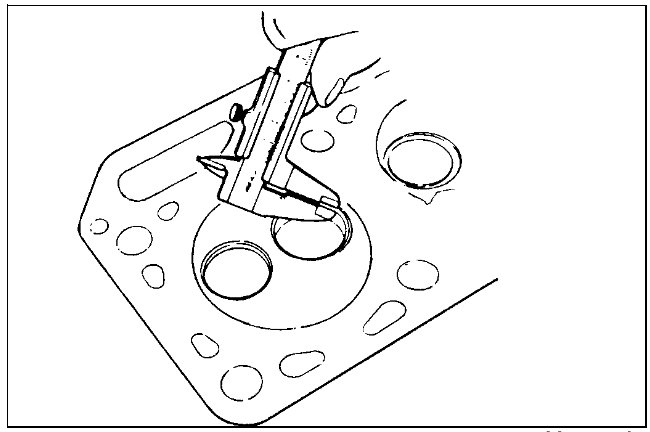
1. To measure cylinder head flatness, place a straightedge along each of the four sides and each diagonal. Measure clearance between straightedge and combustion surface with a feeler gauge and compare with specifications.

2. If the cylinder head was resurfaced:

- Measure piston-to-cylinder head clearance. See “Measure Piston-to-Cylinder Head Clearance” on page 85.
- Measure valve recession. See “Inspect Cylinder Head and Valves” on page 80
- Measure valve seat width in this procedure.

Valve Seats

NOTE: The valve seats are not replaceable. If inspection of the cylinder head reveals valve seats that are damaged or worn beyond repair, the cylinder head must be replaced.

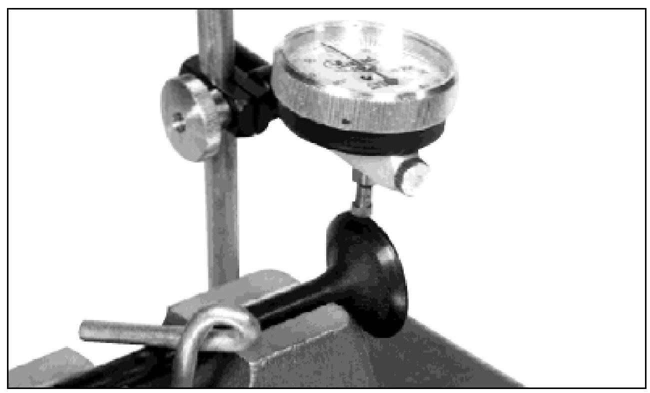


M82029A

1. Measure the valve seat widths and compare with specifications.

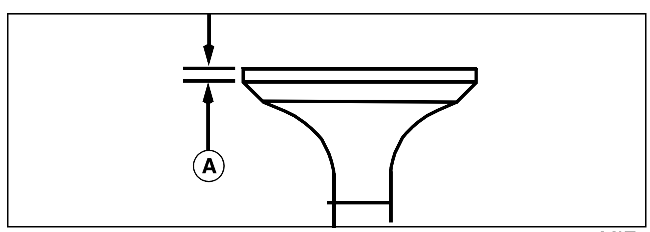
2. If necessary, grind the valve seats to meet specifications. See “Grind Valve Seats” on page 84.

Valves



M35307

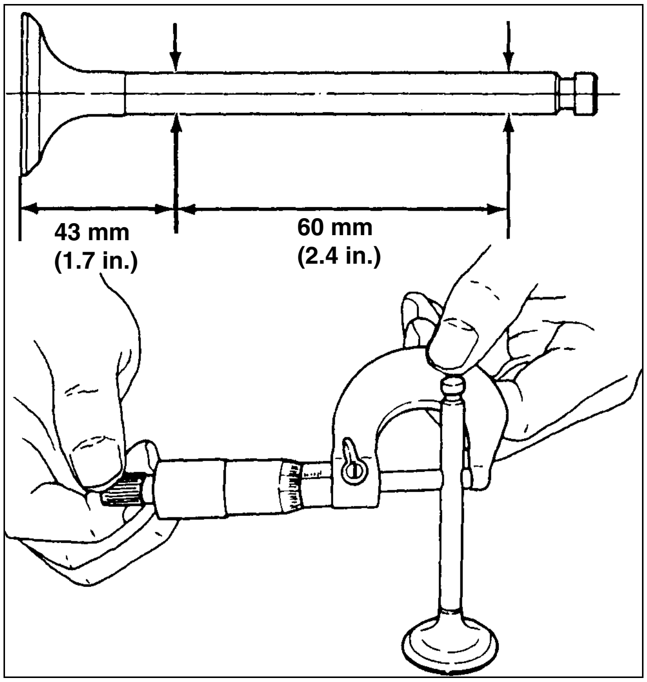
1. Check valves for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



MIF

2. If the valve faces are worn, burned or pitted, grind valves to proper face angle.

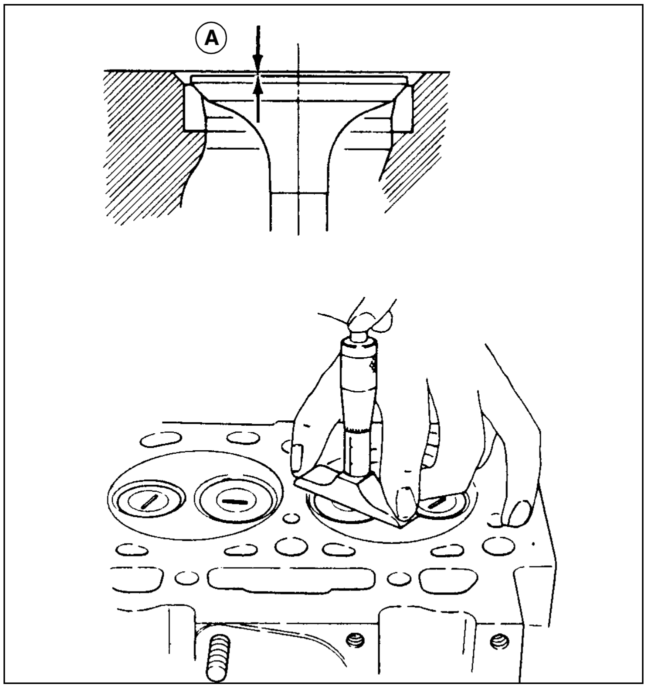
3. Measure valve head thickness (A). If measurement is less than specifications after grinding, replace valve.



M82031A

4. Measure the valve stem diameter at two locations, as shown. If valve stem diameter is less than specifications, replace the valve.

Valve Recession



M82032A

1. Measure valve recession (A) using a depth gauge. If recession is not within specifications, repair or replace parts as needed.

Valve Guides

1. Clean the valve guides using a valve guide brush.

2. Measure the valve guide inside diameter and compare with specifications.

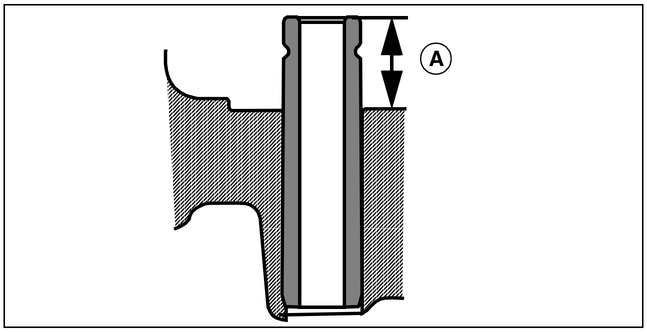
3. Subtract the valve stem OD from the valve guide ID to obtain the oil clearance and compare with specifications.

4. Determine the guide-to-stem oil clearance (guide diameter minus stem diameter).

- If the oil clearance exceeds 0.15 mm (0.006 in.) but is less than 0.20 mm (0.008 in.), knurl the valve guides using D-20019WI Valve Guide Knurler.
- If clearance exceeds 0.20 mm (0.008 in.), replace valve guides using JDE118 Valve Guide Driver.

IMPORTANT: Avoid damage! New valve guides must be cooled in a container of liquid nitrogen or equivalent before driving into cylinder head.

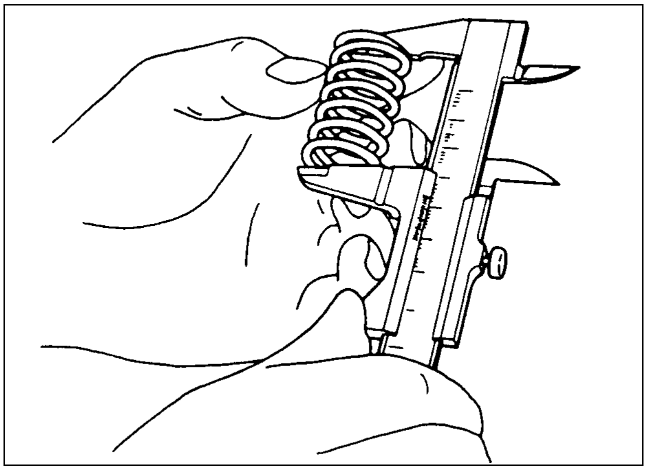
The intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none.



5. If replacing valve guide, install the valve guides with the tapered ends down. Push the valve guides into the cylinder head until the valve guide projection (A) is within specification.

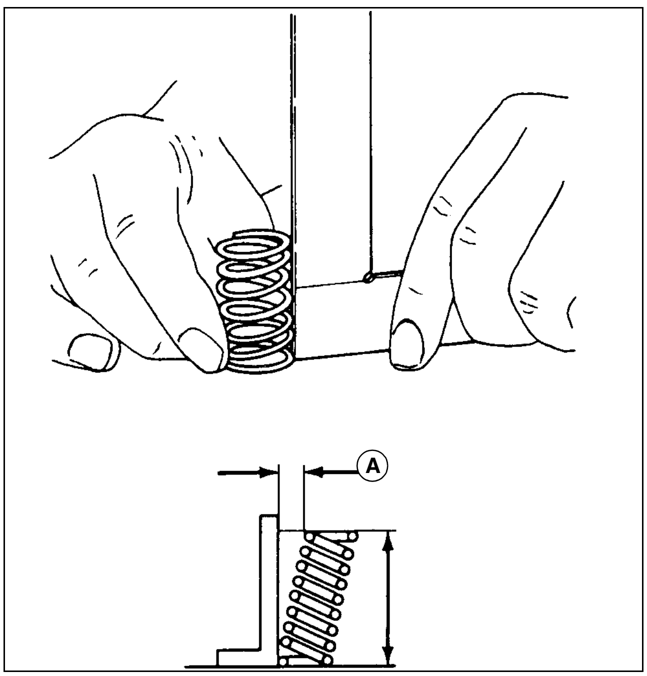
6. Ream the inside diameter of valve guides using D-20021WI Valve Guide Reamer.

Springs



M82034A

1. Measure the valve spring free length and compare with specifications.



M82035A

2. Measure the spring inclination (A) and compare with specifications.

Specifications

Cylinder Head

Cylinder Head Flatness (Allowable Distortion Without Resurfacing) . . . . 0.05 mm (0.002 in.)

Cylinder Head Flatness (Resurface Range) . . 0.05-0.15 mm (0.002-0.006 in.)

Cylinder Head Flatness (Maximum Distortion) 0.15 mm (0.006 in.)

Valve Seats (3TNE78A and 3TNE82A Engines)

Intake Valve Seat Width . 1.36-1.53 mm (0.054-0.060 in.)

Wear Limit . . . . 1.98 mm (0.078 in.)

Exhaust Valve Seat Width . . 1.66-1.87 mm (0.066-0.074 in.)

Wear Limit . . . . 2.27 mm (0.089 in.)

Valve Seats (3TNE84 Engines)

Intake Valve Seat Width . 1.07-1.24 mm (0.042-0.049 in.)

Wear Limit . . . . 1.74 mm (0.069 in.)

Exhaust Valve Seat Width . . 1.24-1.45 mm (0.049-0.057 in.)

Wear Limit . . . . 1.94 mm (0.076 in.)

Valves (3TNE78A and 3TNE82A Engines)

Valve Head (Minimum Thickness) . . 0.50 mm (0.020 in.)

Intake and Exhaust Valve Stem OD . . . . . 6.95-6.96 mm (0.2736-0.2740 in.)

Wear Limit . . . . 6.90 mm (0.272 in.)

Valves (3TNE84 Engines)

Valve Head (Minimum Thickness) . . 0.50 mm (0.020 in.)

Intake and Exhaust Valve Stem OD . . . . . 7.96-7.97 mm (0.3134-0.3138 in.)

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

Valve Recession

Valve Recession . . . . 0.30-0.50 mm (0.012-0.020 in.)

Wear Limit . . . . 1.00 mm (0.039 in.)

Valve Guides (3TNE78A and 3TNE82A Engines)

Valve Guide ID . . . . . 7.00-7.015 mm (0.2756-0.2762 in.)

Wear Limit . . . . 7.08 mm (0.279 in.)

Oil Clearance . . . . 0.015-0.075 mm (0.001-0.003 in.)

Valve Guide Projection . . . . 12 mm (0.472 in.)

Valve Guides (3TNE84 Engines)

Valve Guide ID . . . . 8.010-8.025 mm (0.3154-0.3160 in.)

Wear Limit . . . . 8.10 mm (0.319 in.)

Oil Clearance . . . . 0.035-0.070 mm (0.001-0.003 in.)

Valve Guide Projection . . . . 15 mm (0.591 in.)

Springs (3TNE78A and 3TNE82A Engines)

Valve Spring Free Length . . . . 44.4 mm (1.75 in.)

Wear Limit . . . . 43.9 mm (1.728 in.)

Spring Inclination . . . . 1.10 mm (0.044 in.)

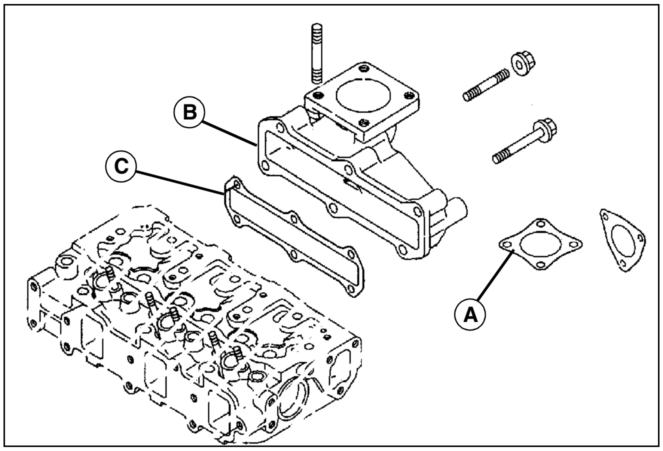
Springs (3TNE84 Engines)

Valve Spring Free Length . . . . 42 mm (1.654 in.)

Wear Limit . . . . 41.50 mm (1.630 in.)

Spring Inclination . . . . 1.10 mm (0.044 in.)

Remove and Install Exhaust Manifold



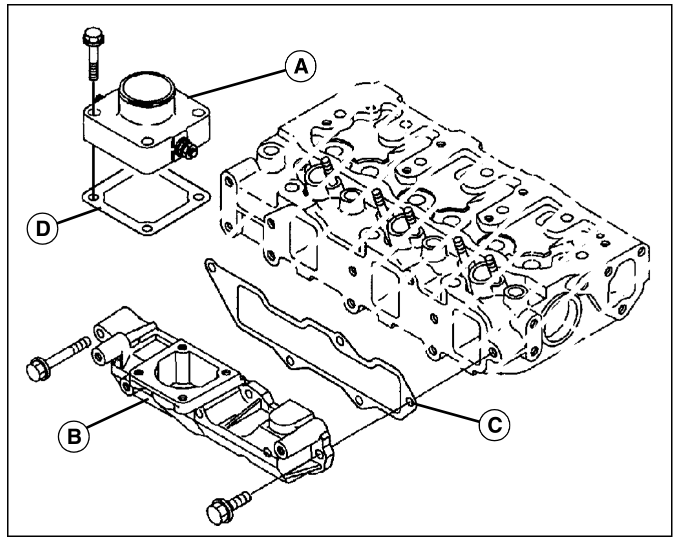
M94810

1. Remove the muffler and gasket (A).
2. Remove the exhaust manifold (B) and gasket (C).
3. Clean the mating surfaces, and replace the exhaust manifold gasket.
4. Install the exhaust manifold. Tighten all fasteners to specification.

Specifications

Exhaust Manifold Cap Screws and Nuts . . . . 26 N•m (19 lb-ft)

Remove and Install Intake Manifold



M94811

1. Remove the fuel filter bracket (not shown).
2. Remove the intake air heater (A).
3. Remove the fuel injection lines (not shown).
4. Remove the intake manifold (B).
5. Clean the mating surfaces, and replace the intake manifold gasket (C).
6. Install the intake manifold.
7. Replace the intake air heater gasket (D), and install the intake air heater.
8. Install the fuel injection lines.
9. Tighten all fasteners to specification.

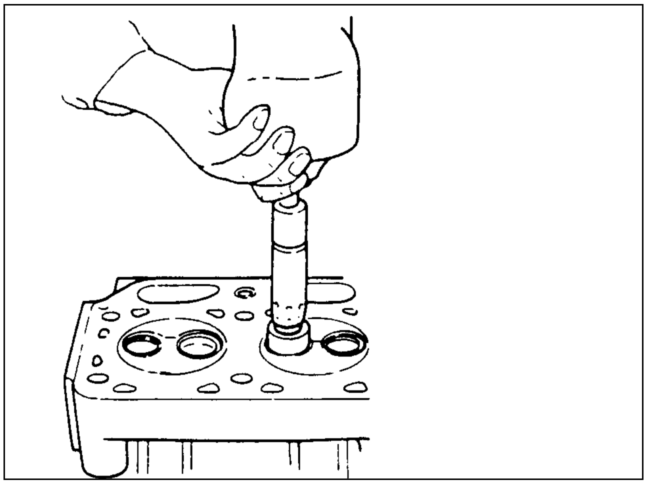
Specifications

Intake Manifold Cap Screws . . . . 26 N•m (19 lb-ft)

Grind Valve Seats

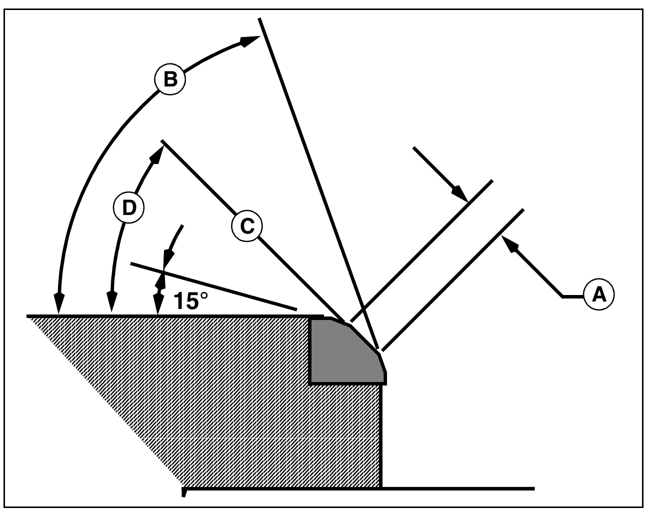
NOTE: LIGHTLY grind the valve seats for only a few seconds to avoid excessive valve seat width.

1. Grind the intake valve seat using a 30° seat grinder and the exhaust valve seat using a 45° seat grinder. Follow the tool manufacturer's instructions.



M82039A

2. Measure the valve seat width after grinding and compare with specifications.



MIF

3. If the seat width (A) is too wide after grinding, grind the lower seat surface (B) using a 70° seat grinder until the seat width is close to specifications.

4. Grind the upper seat surface (C) using a 15° seat grinder until the seat width is narrowed to specifications.

5. If the valve seats (D) are ground, measure valve recession. See "Inspect Cylinder Head and Valves" on page 80. Check the contact pattern between the seat and valve with bluing dye.

6. Lap the valves. See "Lap Valves" on page 84.

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

Specifications

Valve Seats (3TNE78A and 3TNE82A Engines)

Intake Valve Seat Width. 1.36-1.53 mm (0.054-0.060 in.)

Wear Limit. . . . . 1.98 mm (0.078 in.)

Exhaust Valve Seat Width . . 1.66-1.87 mm (0.066-0.074 in.)

Wear Limit. . . . . 2.27 mm (0.089 in.)

Valve Seats (3TNE84 Engines)

Intake Valve Seat Width. 1.07-1.24 mm (0.042-0.049 in.)

Wear Limit. . . . . 1.74 mm (0.069 in.)

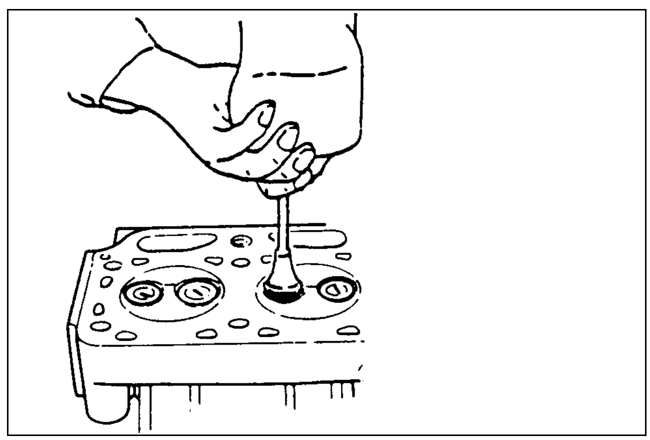
Exhaust Valve Seat Width . . 1.24-1.45 mm (0.049-0.057 in.)

Wear Limit. . . . . 1.94 mm (0.076 in.)

Lap Valves

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

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



M82041A

1. Apply a small amount of fine lapping compound to the face of the valve.

2. Turn the valve to lap the valve to the seat.

3. Lift the valve from the 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 all parts.

5. Check the position of the lap mark on the valve face. Lap marks must be on or near the center of the valve face.

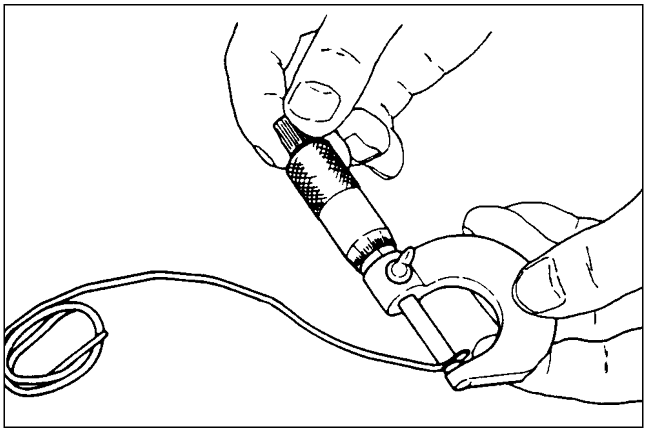
Measure Piston-to-Cylinder Head Clearance

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.

2. Install the cylinder head and old gasket. Install cylinder head bolts and tighten in proper sequence. See “Remove and Install Cylinder Head and Valves” on page 78.

3. Slowly turn the crankshaft one complete revolution.

4. Remove the cylinder head and gasket.



M82042A

5. Measure the thickness of the flattened section of each piece of wire. Calculate the average thickness of the wires to obtain the piston-to-cylinder head clearance specification.

- If the clearance is less than specification, replace cylinder head.

Specifications

Piston-to-Cylinder Head Clearance . . . . . 0.64-0.82 mm (0.025-0.032 in.)

Remove and Install Piston and Connecting Rod

Removal

1. Remove the oil pan, and oil pickup tube.

2. Remove the cylinder head. See “Remove and Install Cylinder Head and Valves” on page 78.

3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.

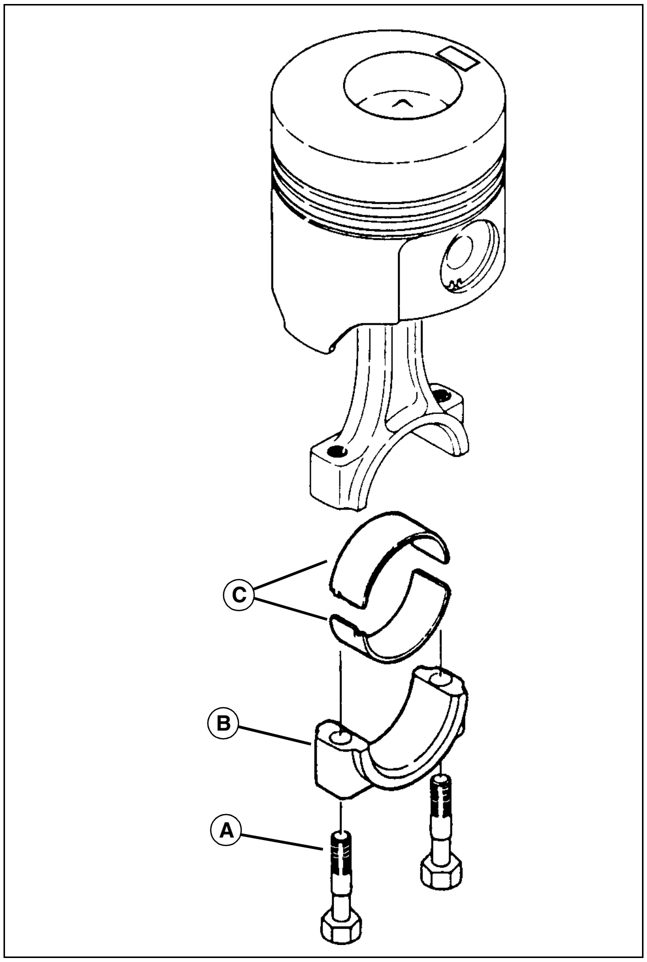
4. If necessary, remove any ridge from the top of the cylinder bore using a ridge reamer.

5. Measure the connecting rod side play. See “Check Connecting Rod Side Play” on page 63.

6. Measure the crankshaft end play. See “Check Crankshaft End Play” on page 65.

7. Measure the connecting rod bearing clearance. See “Check Connecting Rod Bearing Clearance” on page 64.

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



M82196AB

8. Remove the rod cap screws (A), connecting rod cap (B) and bearing inserts (C).

IMPORTANT: Avoid damage! The pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.

9. Note the connecting rod alignment mark in relation to the cylinders. Starting at the flywheel end with cylinder number one, then two, etc.

10. Push the piston and connecting rod out of the cylinder bore using a wooden dowel.

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

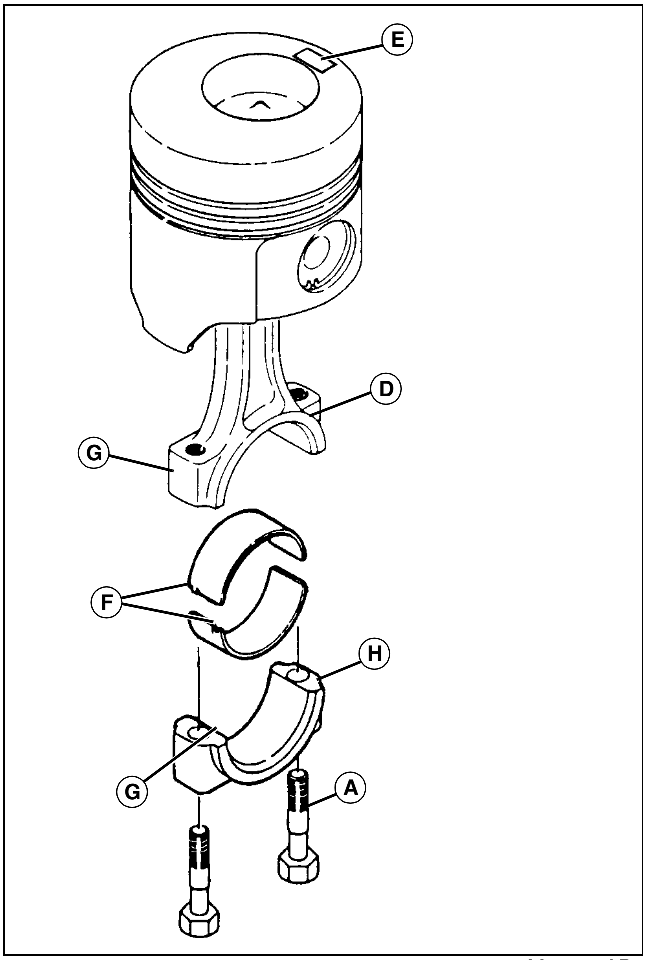
12. Inspect the cylinder bore. See “Inspect Cylinder Bore” on page 92. See “Inspect Cylinder Bore Taper and Out-of-Round” on page 93.

Installation

- Apply clean engine oil to all parts during installation.
- Always replace the connecting rod cap screws. DO NOT reuse the cap screws.

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

1. Assemble the piston and connecting rod. See "Disassemble and Assemble Piston and Connecting Rod" on page 87.



M82196AB

2. Install the piston and connecting rod into the cylinder from which it was removed. The alignment mark on the connecting rod (D) and/or the piston size mark (E) on top of piston should point toward the fuel injection pump.

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

3. Install the bearing inserts to the connecting rod and rod cap, aligning tangs (F) with grooves (G).

IMPORTANT: Avoid damage! 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 (H). Install the rod caps.

5. Dip the entire connecting rod cap screw in clean engine oil. Install new cap screws (A) and tighten to specification.

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

7. Install the cylinder head.

8. Install oil pan and oil pickup tube.

Specifications

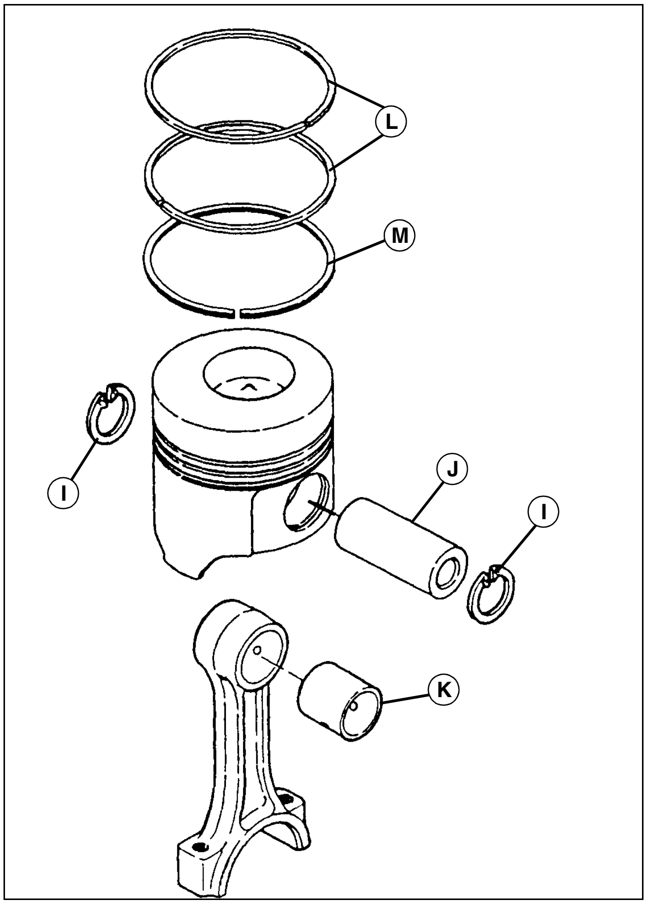
Connecting Rod Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 39 N•m (29 lb-ft)

Connecting Rod Cap Screw Torque (3TNE84 Engines) . 47 N•m (35 lb-ft)

Disassemble and Assemble Piston and Connecting Rod

Disassemble

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



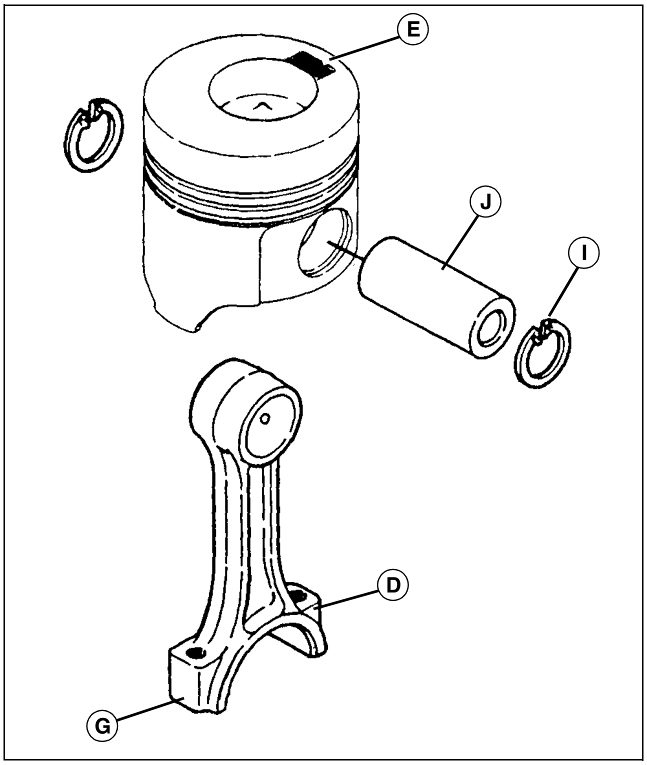
M82197AB

- Put a mark on each piston and connecting rod to aid in assembly.
- Remove snap rings (I) from piston pin (J) and remove pin.
- The piston pin bushing (K) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary.
- Inspect all parts for wear or damage. Replace as necessary.
- Remove the 1st and 2nd compression rings (L) and oil ring with expander (M).

Assemble

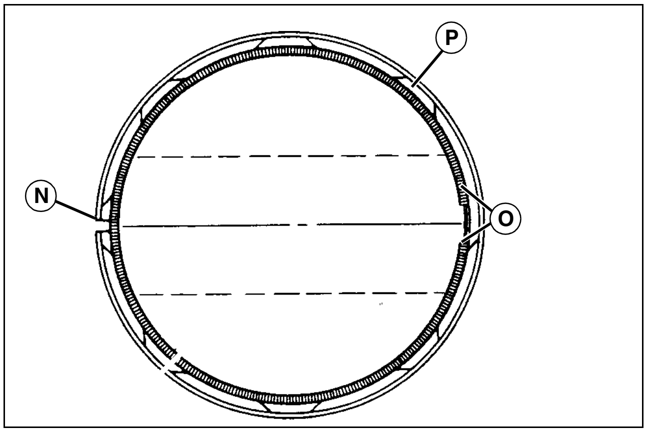
- Apply clean engine oil to all parts during assembly.

IMPORTANT: Avoid damage! The pistons must be installed on the same connecting rod they were removed from.



M82198AB

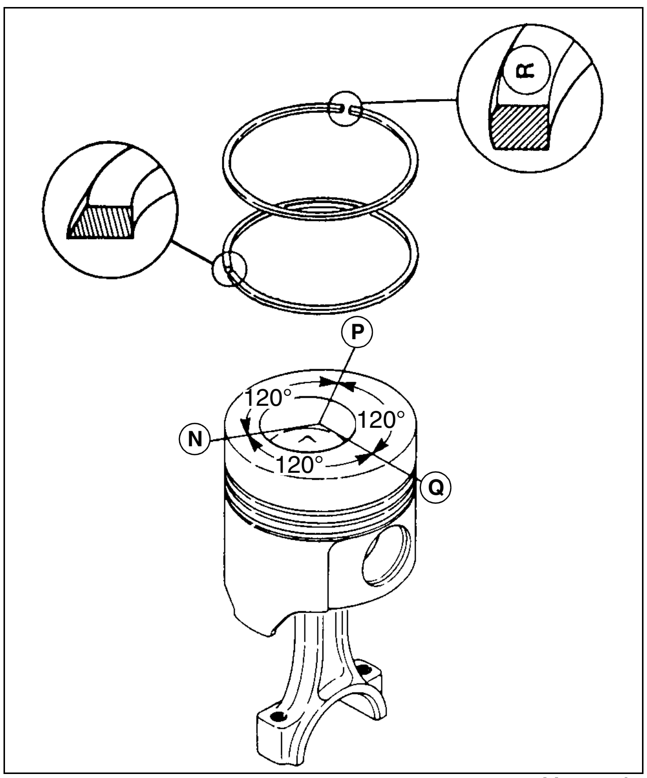
1. Assemble the piston to the connecting rod with piston mark (E) on the same side as the connecting rod stamped mark (D). If a new connecting rod is used, assemble the piston to the connecting rod with piston mark opposite the connecting rod bearing insert groove (G). Be sure the oil hole in the piston pin bushing is aligned with the hole in the connecting rod.
2. Install the piston pin (J) and retaining/snap rings.
3. Install an oil ring expander (M) in the bottom ring groove of the piston, with the ends above either end of the piston pin.



M82046A

4. Install the oil ring over the expander with the ring gap (N) opposite (180°) of the expander ends (O).

5. Install the second compression ring, with the small diameter of taper toward top of piston, in the middle groove. Turn the ring until the gap (P) is 120° away from the oil ring gap (N).



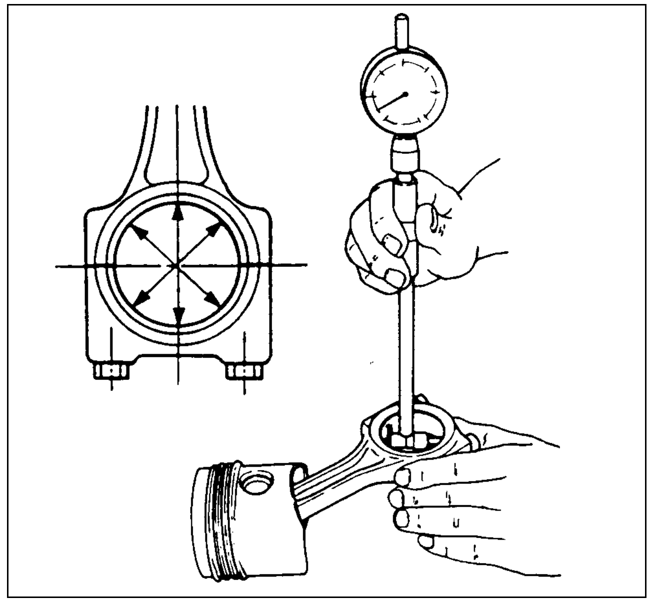
M82199A

6. Install the first compression ring (chrome plated), with the manufacturer's mark “R”, “T” or “RN” (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the gap (Q) is 120° away from the second ring gap (P) and 120° away from the oil ring gap (Q).

Inspect Piston and Connecting Rod

Connecting Rod Bearing

1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.



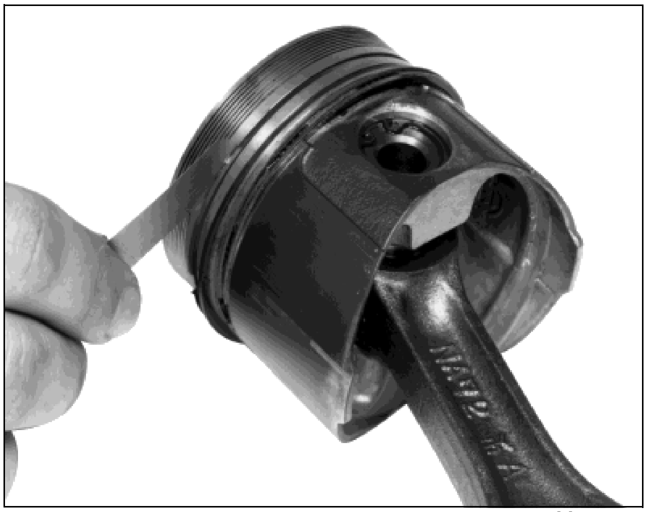
M82048a

2. Measure the connecting rod bearing inside diameter and compare with specifications. Replace bearing if bearing ID is greater than wear limit.

3. Measure the oil clearance between the bearing inserts and the crankshaft. Compare measurement with specification.

- If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

Piston Ring Groove Clearance

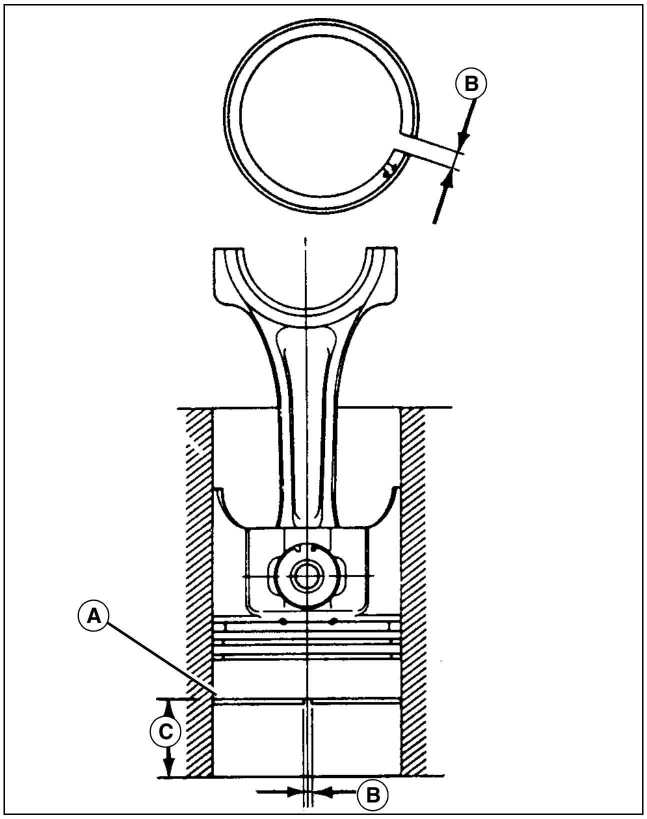


M35360

1. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston and compare with specification.

2. Replace the rings or the piston if the clearances exceed specification.

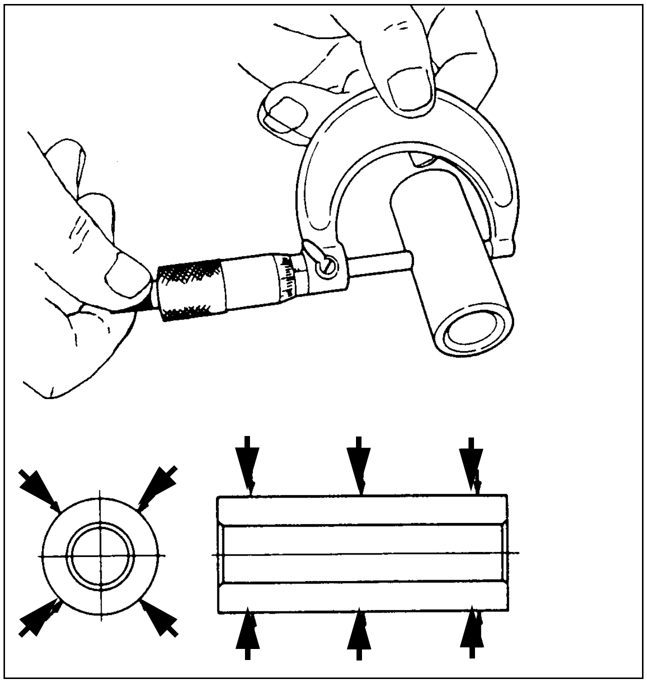
Piston Ring End Gap



M82049A

1. Use a piston to push the ring (A) approximately 30 mm (1.18 in.) (C) from the bottom of the cylinder bore. Measure the piston ring end gap (B) and compare with specificatons.

Piston Pin Diameter



M82050A

1. Measure the piston pin diameter at six places and compare with specifications. Replace any pin that is not within specification.

Piston Pin Bore

M37683

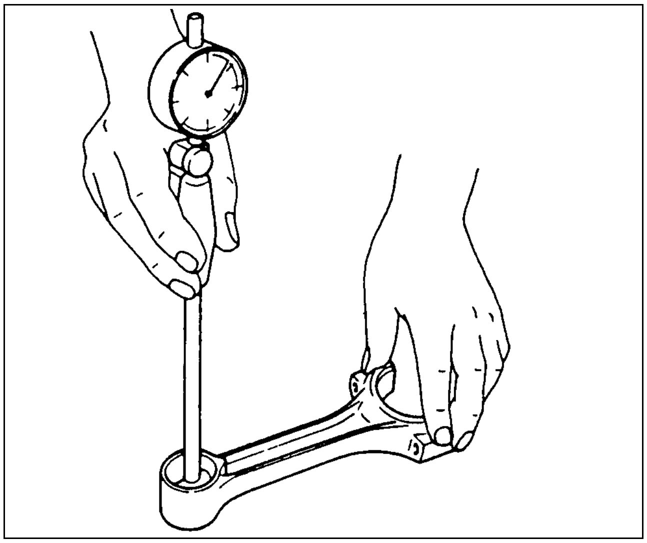
1. Measure the pin bore diameter in the piston and compare with specifications.

2. Piston pin-to-piston oil clearance is the bore ID minus the pin OD. Compare piston pin-to-piston clearance with specifications.

- If the piston pin bore exceeds the wear limit, replace the piston.
- If the piston pin is less than the wear limit, replace the piston pin.
- If the bore clearance exceeds the wear limit, replace the piston, piston pin or both.

Piston Pin Bushing

NOTE: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.

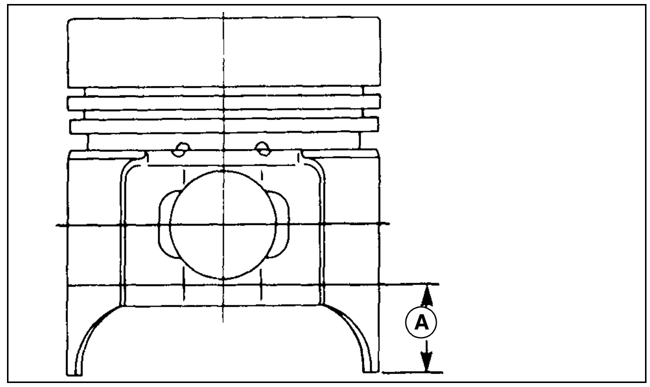


M82051A

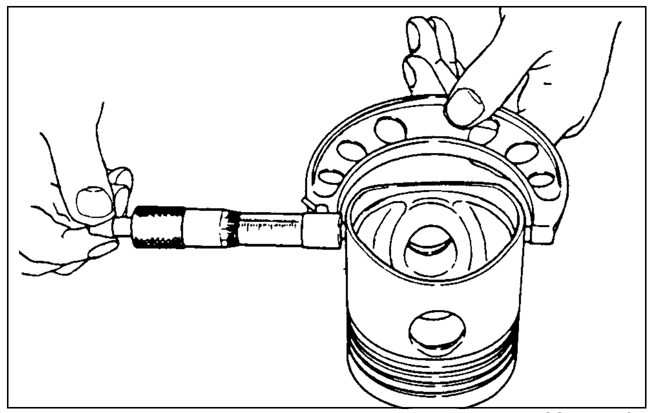
1. Measure the piston pin bushing diameter in the connecting rod and compare with specifications.
   - If the bushing diameter exceeds the wear limit, replace bushing.
2. Piston pin-to-rod bore oil clearance is the bore ID minus the pin OD.
   - If the bushing clearance (bushing ID minus pin OD) exceeds specification replace the bushing or the piston pin.

Piston Diameter

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



M82200A



M82052A

1. Measure the piston diameter perpendicular to the piston pin bore 23 mm (0.905 in.) (A) from the bottom of the piston skirt and compare with specifications.

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

Specifications

Connectiong Rod Bearing (3TNE78A and 3TNE82A Engines)

Connecting Rod Cap Screw Torque . . . 39 N•m (29 lb-ft)

Bearing ID . . . . 46.00-46.016 mm (1.811-1.812 in.)

Wear Limit. 46.07 mm (1.814 in.)

Bearing Oil Clearance 0.038-0.090 mm (0.001-0.004 in.)

Connectiong Rod Bearing (3TNE84 Engines)

Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)

Bearing ID. . . . . 48.00-48.028 mm (1.888-1.891 in.)

Wear Limit. 48.07 mm (1.893 in.)

Bearing Oil Clearance 0.038-0.074 mm (0.001-0.003 in.)

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance. 0.075-0.11 mm (0.003-0.004 in.)

Wear Limit . . . . 0.025 mm (0.010 in.)

Second Compression Ring Groove Side Clearance (3TNE78A Engines) . . 0.035-0.065 mm (0.001-0.003 in.)

Second Compression Ring Groove Side Clearance (3TNE82A and 3TNE84 Engines). . . . . . 0.045-0.080 mm (0.002-0.003 in.)

Wear Limit . . . . 0.025 mm (0.010 in.)

Oil Control Ring Groove Side Clearance . . 0.025-0.060 mm (0.001-0.002 in.)

Wear Limit . . . . 0.020 mm (0.008 in.)

Piston Ring End Gap

Piston Ring End Gap . . . 0.20-0.40 mm (0.008-0.016 in.)

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

Piston Pin Diameter

Piston Pin OD (3TNE78A and 3TNE82A Engines) 22.99-23.00 mm (0.905-0.906 in.)

Wear Limit . . . . 22.90 mm (0.902 in.)

Piston Pin OD (3TNE84 Engines) . . . . . 25.99-26.00 mm (1.023-1.024 in.)

Wear Limit . . . . 25.90 mm (1.020 in.)

Piston Pin Bore

Piston Pin Bore ID (3TNE78A and 3TNE82A Engines) . 23.00-23.01 mm (0.9055-0.9060 in.)

Wear Limit . . . . 23.02 mm (0.907 in.)

Piston Pin Bore ID (3TNE84 Engines). . 26.00-26.01 mm (1.0236-1.0240 in.)

Wear Limit . . . . 26.02 mm (1.0244 in.)

Piston Pin-to-Piston Oil Clearance 0.00-0.02 mm (0.00-0.001 in.)

Wear Limit . . . . 0.12 mm (0.005 in.)

Piston Pin Bushing (3TNE78A and 3TNE82A Engines)

Piston Pin Bushing ID . 23.025-23.038 mm (0.906-0.907 in.)

Wear Limit . . . . 23.10 mm (0.909 in.)

Piston Pin-to-Rod Bore Oil Clearance . . . 0.03-0.05 mm (0.001-0.002 in.)

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

Piston Pin Bushing (3TNE84 Engines)

Piston Pin Bushing ID . . . . . 26.025-26.038 mm (1.0246-1.0251 in.)

Wear Limit. 26.10 mm (1.028 in.)

Piston Pin-to-Rod Bore Oil Clearance . . . 0.03-0.05 mm (0.001-0.002 in.)

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

Piston (3TNE78A Engines)

Standard Piston OD . . 77.95-77.98 mm (3.069-3.070 in.)

Wear Limit. 77.90 mm (3.067 in.)

Oversize Piston OD . . 78.20-78.23 mm (3.079-3.080 in.)

Wear Limit. 78.15 mm (3.077 in.)

Piston (3TNE82A Engines)

Standard Piston OD . . 81.95-81.98 mm (3.069-3.070 in.)

Wear Limit. 81.90 mm (3.067 in.)

Oversize Piston OD . . 81.20-81.23 mm (3.079-3.080 in.)

Wear Limit. 81.15 mm (3.077 in.)

Piston (3TNE84 Engines)

Standard Piston OD . . 83.95-83.98 mm (3.305-3.306 in.)

Wear Limit. 83.90 mm (3.303 in.)

Oversize Piston OD . . 84.20-84.23 mm (3.315-3.316 in.)

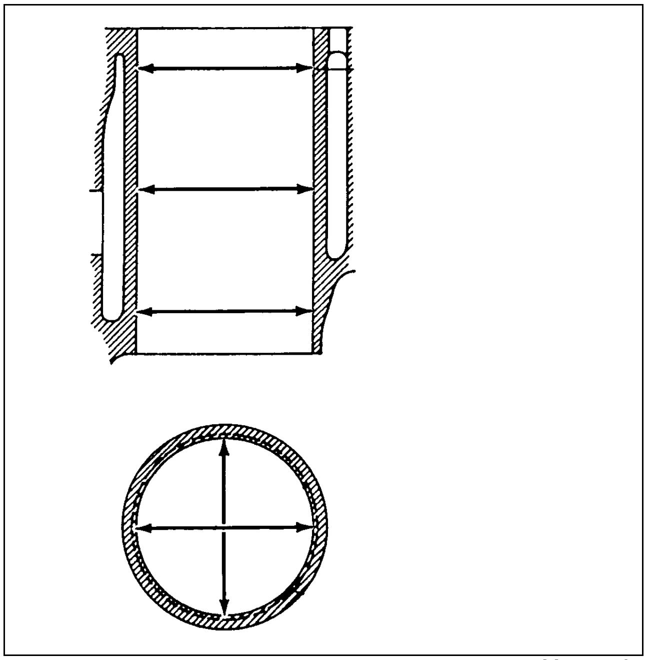
Wear Limit. 84.10 mm (3.311 in.)

Inspect Cylinder Bore

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

Cylinder Bore Diameter

NOTE: Slight uneven wear, flaws, or minor damage may be corrected by deglazing.



M82053A

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

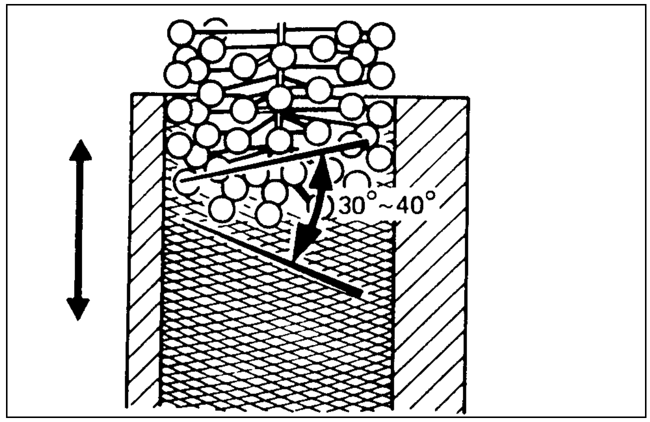
- If the cylinder bore standard ID exceeds the wear limit, have the cylinder rebored.
- If the cylinder is rebored, oversize pistons and rings must be installed.
- If the cylinder bore exceeds the oversize bore ID, replace the cylinder block.

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

Deglazing

IMPORTANT: Avoid damage! If the 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 the cylinder bores using a flex-hone with 180 grit stones.



M82054A

2. Use the flex-hone as instructed by the manufacturer to obtain a 30-40° crosshatch pattern as shown.

IMPORTANT: Avoid damage! 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 the cylinder walls using a clean dry rag. Clean the cylinder walls using clean white rags and warm soapy water. Continue to clean the 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.) oversize.

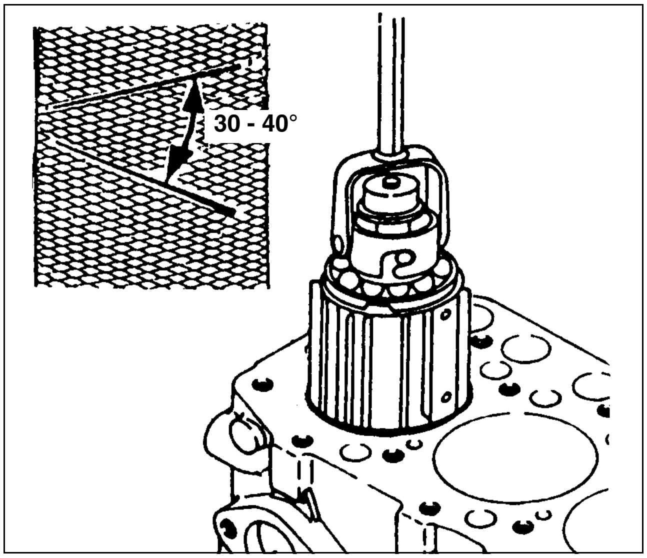
1. Align the center of bore to the drill press center.

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

2. Adjust the hone so the lower end is even with the lower end of cylinder bore.

3. Adjust the rigid hone stones until they contact the narrowest point of the cylinder.

4. Coat the cylinder with honing oil. The hone should turn by hand. Adjust the hone if it is too tight.



M52959

5. Run the drill press at about 250 rpm. Move the hone up and down in order to obtain a 30-40° crosshatch pattern.

NOTE: Measure the bore when the cylinder is cool.

6. Stop the press and check the cylinder diameter.

NOTE: Finish should not be smooth. It should have a 30-40° crosshatch pattern.

7. Remove the rigid hone when the 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 the bore for size.

10.Check bore for taper and out-of-round. See “Inspect Cylinder Bore Taper and Out-of-Round” on page 93.

IMPORTANT: Avoid damage! Do not use solvents to clean the cylinder bores. Solvents will not remove all the metal particles and abrasives produced during honing.

11.Clean the cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

12.Dry the cylinder and apply engine oil.

Specifications

Cylinder Bore (3TNE78A Engines)

Standard Cylinder Bore ID 78.00-78.03 mm (3.071-3.072 in.)

Wear Limit . . . . 78.20 mm (3.079 in.)

Oversize Cylinder Bore ID 78.25-78.28 mm (3.081-3.082 in.)

Wear Limit . . . . 78.45 mm (3.089 in.)

Piston-to-Cylinder Bore Clearance. . . . 0.040-0.070 mm (0.001-0.003 in.)

Cylinder Bore (3TNE82A Engines)

Standard Cylinder Bore ID 82.00-82.03 mm (3.228-3.230 in.)

Wear Limit. 82.20 mm (3.236 in.)

Oversize Cylinder Bore ID 82.25-82.28 mm (3.238-3.239 in.)

Wear Limit. 82.45 mm (3.246 in.)

Piston-to-Cylinder Bore Clearance. . . . 0.035-0.065 mm (0.001-0.003 in.)

Cylinder Bore (3TNE84 Engines)

Standard Cylinder Bore ID 84.00-84.03 mm (3.307-3.308 in.)

Wear Limit. 84.20 mm (3.315 in.)

Oversize Cylinder Bore ID 84.25-84.28 mm (3.317-3.318 in.)

Wear Limit. 84.45 mm (3.325 in.)

Piston-to-Cylinder Bore Clearance. . . . 0.040-0.070 mm (0.001-0.003 in.)

Inspect Cylinder Bore Taper and Out-of-Round

1. Use a cylinder dial gauge and inside micrometer, or a telescope gauge and outside micrometer to measure cylinder bore.

2. Measure the bore parallel to the crankshaft at the top end of the ring travel zone.

3. Measure the bore in the same position at the bottom end of the ring travel zone.

4. Measure the bore at right angles to the crankshaft at the top end of the ring travel zone.

5. Measure the bore in the same position at the bottom end of the ring travel zone.

6. Compare measurements from steps 2 and 4 to find the out-of-round wear at the top end of the bore.

7. Compare measurements from steps 3 and 5 to find the out-of-round wear at the bottom end of the bore.

8. Compare results of measurements from steps 2, 3, 4 and 5 to find out whether or not the bore has worn tapered.

Specifications

Cylinder Roundness . . . 0.00-0.01 mm (0.00-0.0004 in.)

Wear Limit. . . . . 0.03 mm (0.001 in.)

Cylinder Taper . . . . 0.00-0.01 mm (0.00-0.0004 in.)

Wear Limit. . . . . 0.03 mm (0.001 in.)

Remove and Install Crankcase Extension Housing

1. Remove flywheel. See "Remove and Install Flywheel" on page 97.

2. Remove oil pan.

3. Remove oil strainer tube.

4. Remove flywheel plate cap screws.

5. Remove rear oil seal case to crankcase extension cap screws.

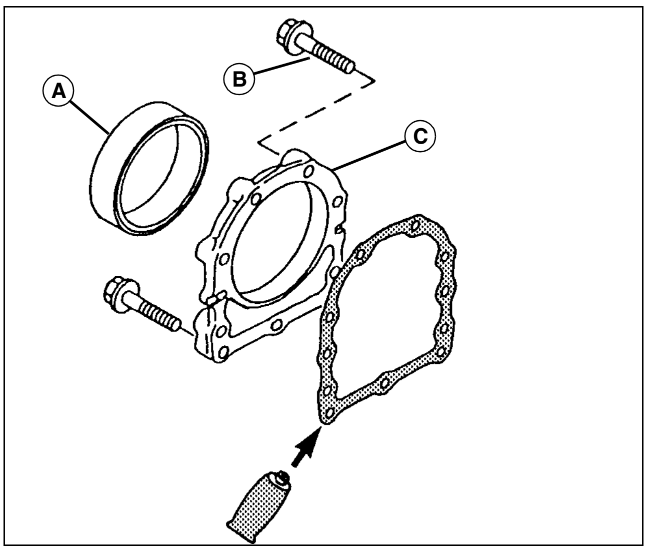
6. Remove extension housing cap screws and extension housing.

7. Inspect extension housing for cracks.

8. Clean mating surfaces of gasket material before installing extension housing.

Replace Crankshaft Rear Oil Seal

1. Remove flywheel. See "Remove and Install Flywheel" on page 97."



M82349A

2. Remove the rear oil seal (A), case-to-crankcase extension cap screws and the oil seal case-to-crankcase cap screws (B).

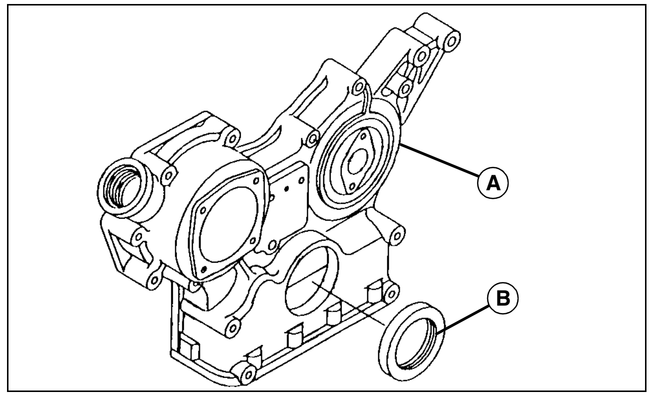
3. Remove the rear oil seal case (C).

4. Replace the oil seal using an appropriate seal driver, with the lip toward the cylinder block, flush with the surface of the oil seal case.

NOTE: If the crankshaft is grooved at the oil seal contact point, the seal can be installed 3 mm (0.12 in.) farther into the oil seal case.

5. Install the oil seal case to the crankcase and crankcase extension.

Replace Crankshaft Front Oil Seal



M82203A

1. Remove the timing gear cover (A). See "Remove and Install Timing Gear Cover" on page 102.

2. Replace the oil seal (B). Install new seal with the lip toward inside of gear housing cover, flush with the surface of the cover.

Remove and Install Crankshaft and Main Bearings

Removal

1. Check the crankshaft end play. See "Check Crankshaft End Play" on page 65.

2. Remove the cylinder head. See "Remove and Install Cylinder Head and Valves" on page 78.

3. Remove rear oil seal. See "Replace Crankshaft Rear Oil Seal" on page 94.

4. Remove timing gear cover mounting plate. See "Remove and Install Timing Gear Cover Mounting Plate" on page 103.

5. Check the crankshaft rod bearing clearance. See "Check Connecting Rod Bearing Clearance" on page 64

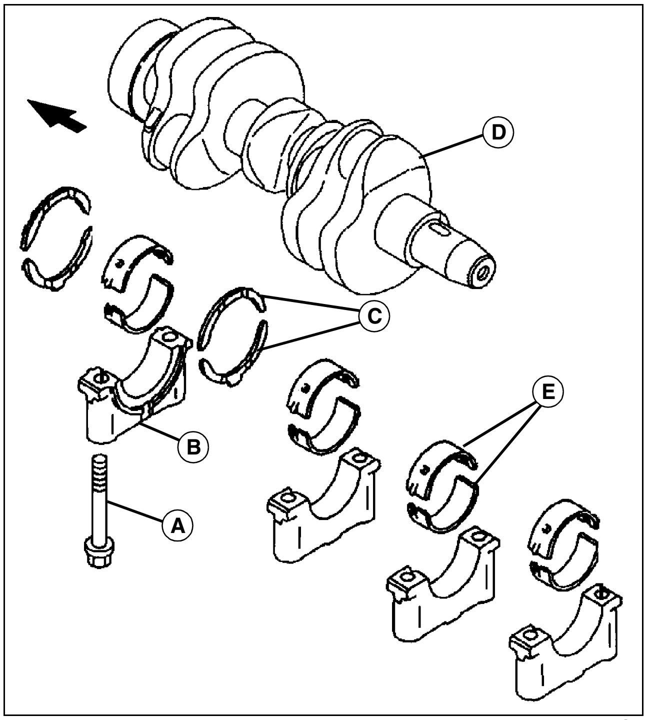
IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rods from which they were removed. Note the alignment marks on the caps and rods.

6. Check the crankshaft main bearing clearance. See "Check Crankshaft Main Bearing Clearance" on page 65.

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

7. Remove the connecting rod cap screws and rod caps. Discard the connecting rod cap screws.

8. Push the pistons and connecting rods away from crankshaft.



M91948C

9. Remove the main bearing cap screws (A), caps (B) and cap thrust bearings (C).

10.Remove the crankshaft (D).

11.Remove the block thrust bearings and main bearing inserts (E).

12.Inspect all parts for wear or damage.

Installing

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

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

2. Install the grooved bearing inserts in the crankshaft bearing bores, aligning the tangs with the slots in the bores.

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

4. Install the crankshaft.

5. Install the bearing inserts in the main bearing caps, aligning the tangs with the slots in the caps.

NOTE: The main bearing caps have "raised arrows" that are stamped with numbers. Both correspond to their location on the engine block. Install all bearing caps with the "arrow" toward the flywheel end of the engine. Install the bearing caps beginning with the thrust bearing cap (no number), number 1, then 2, etc. The main bearing cap at the gear train end does not have a number.

6. Install the thrust bearings, with the oil grooves facing away from the cap, in the number "1" main bearing cap.

7. Install the main bearing caps in their original locations with arrows pointing toward the flywheel side of the engine.

IMPORTANT: Avoid damage! DO NOT use high speed power tools or air wrenches to tighten main bearing bolts.

8. Dip each main bearing cap screw entirely in clean engine oil. Install the cap screws but do not tighten.

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 the main bearing cap screws to specification. When tightening, start at the center main bearing cap and work your way out, alternating to the ends. Turn the crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rods they were removed from.
Never reuse connecting rod cap screws; replace with new.

11.Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

12.Dip entire connecting rod cap screw in clean engine oil. Install new cap screws and tighten to specification. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

13.Install the timing gear cover mounting plate.

14.Install the rear oil seal.

15.Install the flywheel.

16.Install the timing gear cover.

17.Install the front oil seal.

18.Install the oil pan.

Specifications

Main Bearing Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 79 N•m (58 lb-ft)

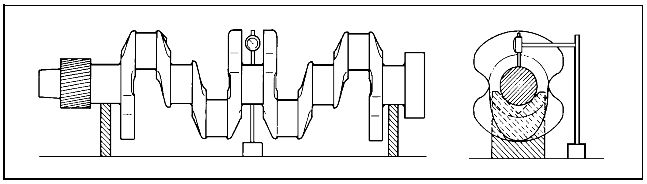
Main Bearing Cap Screw Torque (3TNE84 Engines). . . . . 98 N•m (72 lb-ft)

Connecting Rod Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 39 N•m (29 lb-ft)

Connecting Rod Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 47 N•m (35 lb-ft)

Inspect Crankshaft and Main Bearings

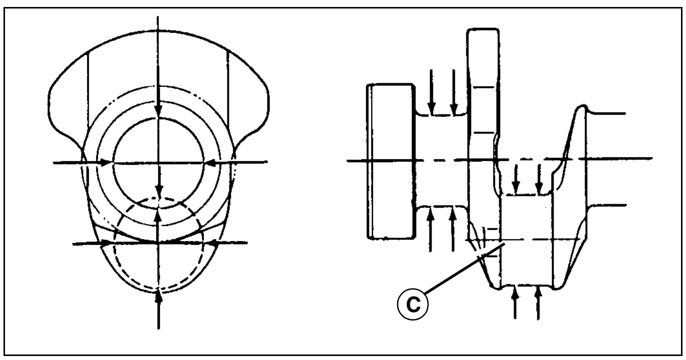
1. Inspect the crankshaft gear for chipped or broken teeth. Replace if necessary.



M82061A

2. Inspect the crankshaft for bend using V-blocks and a dial indicator. Turn the crankshaft slowly and read variations on the indicator. If the variation is greater than specification, replace the crankshaft.

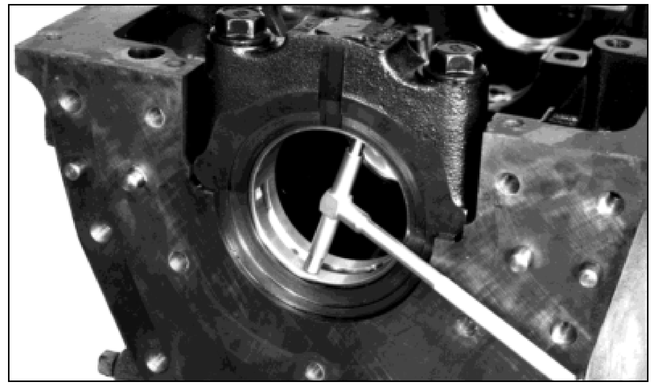
3. Measure the crankshaft connecting rod journal and main bearing journal diameters at several places around each journal.



M82062A

- If the journal diameter (C) is less than the specification, but greater than the wear limit, have the 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.
- If the journal diameter is less than the wear limit, replace the crankshaft.

4. Install the bearing inserts and main bearing caps on the main bearings. Tighten the main bearing cap screws to specification.



M82063

5. Measure the main bearing inner diameter.

6. Subtract the main bearing journal OD of the crankshaft from the main bearing ID to obtain the main bearing oil clearance.

- If the crankshaft is within specification, but the main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If the crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.
- If the crankshaft is worn past the wear limit, replace the crankshaft.

7. Clean and inspect the oil passages in the main bearing journals, connecting rod journals and main bearing bores in cylinder block.

8. Inspect the crankshaft for cracks or damage. Replace if necessary.

Specifications

Crankshaft Bend Variation . . . . 0.02 mm (0.001 in.)

Connecting Rod Journal OD (3TNE78A and 3TNE82A Engines) . . . . 42.95-42.96 mm (1.6909-1.6913 in.)

Wear Limit. 42.91 mm (1.689 in.)

Connecting Rod Journal OD (3TNE84 Engines) . 47.95-47.96 mm (1.8878-1.8882 in.)

Wear Limit. 47.91 mm (1.886 in.)

Main Bearing Journal OD (3TNE78A and 3TNE82A Engines) . . . . 46.95-46.96 mm (1.8484-1.8488 in.)

Wear Limit. 46.91 mm (1.847 in.)

Main Bearing Journal OD (3TNE84 Engines). . . . 53.95-53.96 mm (2.1240-2.1244 in.)

Wear Limit. 53.91 mm (2.122 in.)

Main Bearing Cap Screw Torque (3TNE78A and 3TNE82A Engines) . . . . 79 N•m (58 lb-ft)

Main Bearing Cap Screw Torque (3TNE84 Engines). 96-100 N•m (71-74 lb-ft)

Main Bearing Oil Clearance (3TNE78A and 3TNE82A Engines) . . . . 0.038-0.090 mm (0.001-0.004 in.)

Wear Limit . . . . 0.25 mm (0.010 in.)

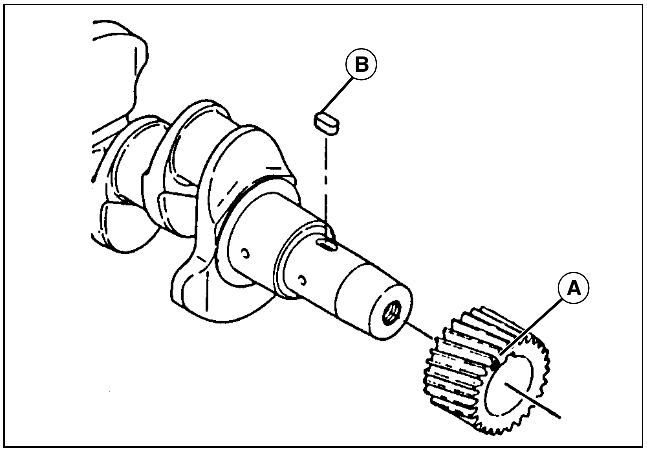
Main Bearing Oil Clearance (3TNE84 Engines) . . 0.038-0.074 mm (0.001-0.003 in.)

Wear Limit . . . . 0.15 mm (0.006 in.)

Remove and Install Crankshaft Gear

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

CAUTION: Avoid injury! 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.

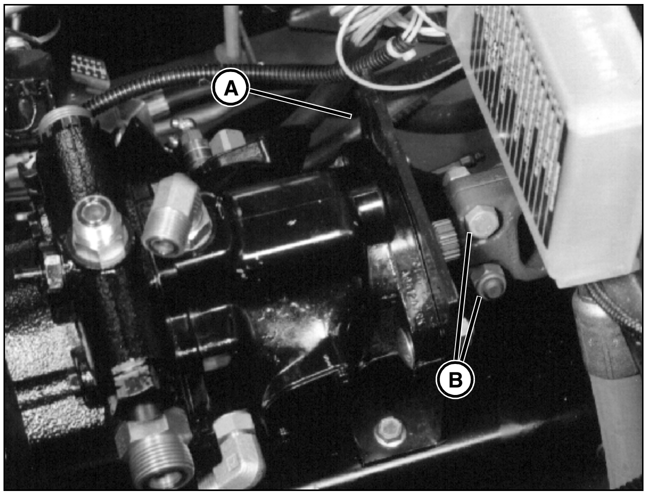


M82060A

2. Heat new gear to approximately 150°C (302°F). Install gear with timing mark (A) toward press table. Align slot in gear with key (B) in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.

Remove and Install Flywheel

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.



M76498

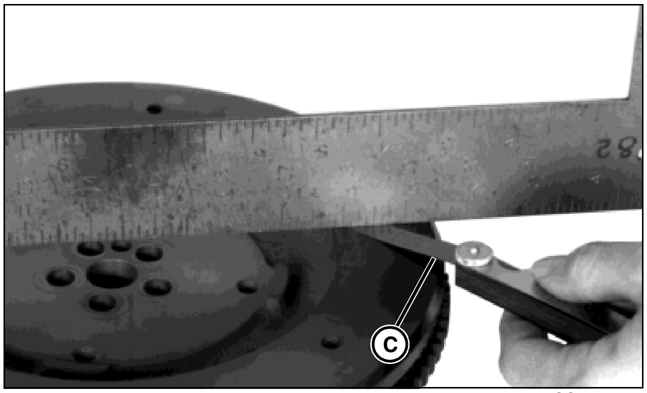
1. Raise seat and remove shield from hydraulic pump mounting bracket (A).

2. Loosen drive shaft coupler cap screws (B).

3. Remove three cap screws that attach drive shaft to isolator mounted on flywheel and remove drive shaft assembly from machine.

4. Remove eight cap screws that attach isolator mounting plate to flywheel and remove isolator mounting plate.

5. Remove six cap screws that attach flywheel to crankshaft and remove flywheel.



M35337

6. Measure flywheel flatness. Place a straightedge across flywheel surface opposite of ring gear. Measure clearance between straightedge and flywheel surface with a feeler gauge (C). If clearance exceeds specifications, replace flywheel.

Specifications

Flywheel Flatness . . . . 0.02 mm (0.001 in.)

Remove and Install Camshaft

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.

Removal

1. Remove the rocker arm assembly and push rods. See “Remove and Install Rocker Arm Assembly” on page 76.

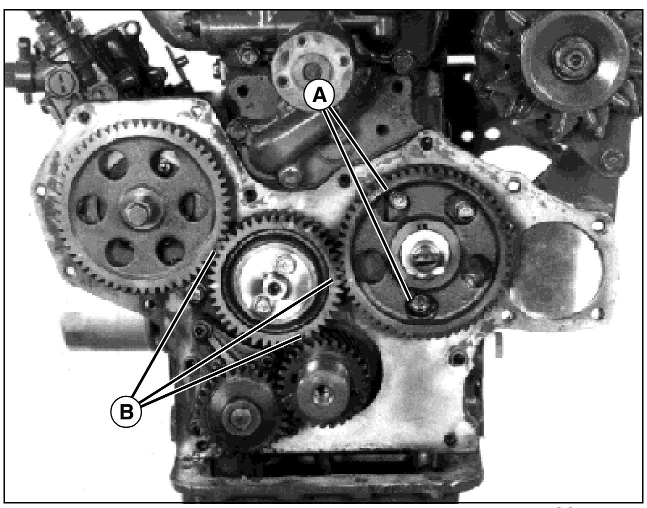
2. Remove the timing gear cover. See “Remove and Install Timing Gear Cover” on page 102.

3. Check the camshaft end play. See “Check Camshaft End Play” on page 66.

4. Check the backlash of the timing gears. See “Check Timing Gear Backlash” on page 67.

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

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



M37836

6. Rotate the crankshaft and align the timing marks (B).

IMPORTANT: Avoid damage! DO NOT allow the camshaft lobes to hit any bearing surfaces while removing the camshaft. Machined surfaces can be damaged.

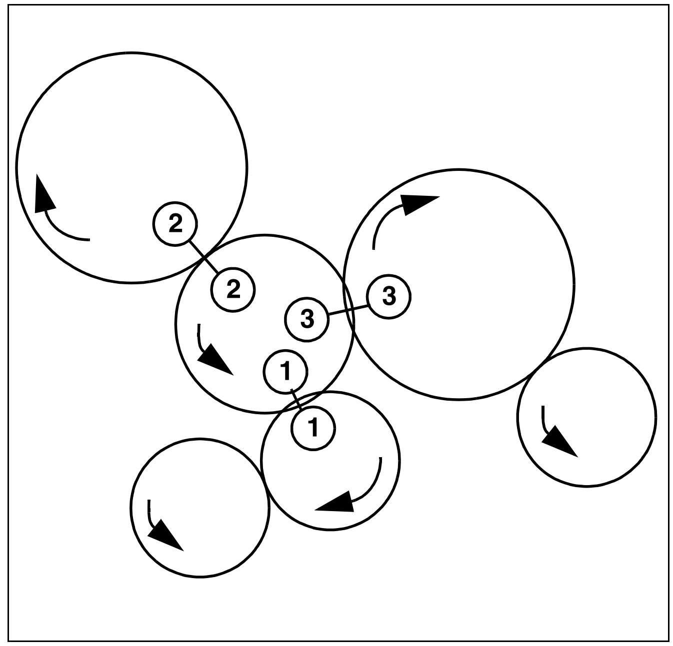
7. Remove two thrust plate mounting cap screws (A), the thrust plate, and the camshaft.

8. Inspect all parts for wear or damage.

Installation

Apply clean engine oil on all parts during installation.

IMPORTANT: Avoid damage! DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces and bearings can be damaged.



MIF

Picture Note: Viewed from Gear Case

1. Rotate the crankshaft to align the timing marks (1, 2 and 3).

2. Install the camshaft.

3. Install the thrust plate and thrust plate mounting cap screws. Tighten cap screws to specification.

4. Install the timing gear cover.

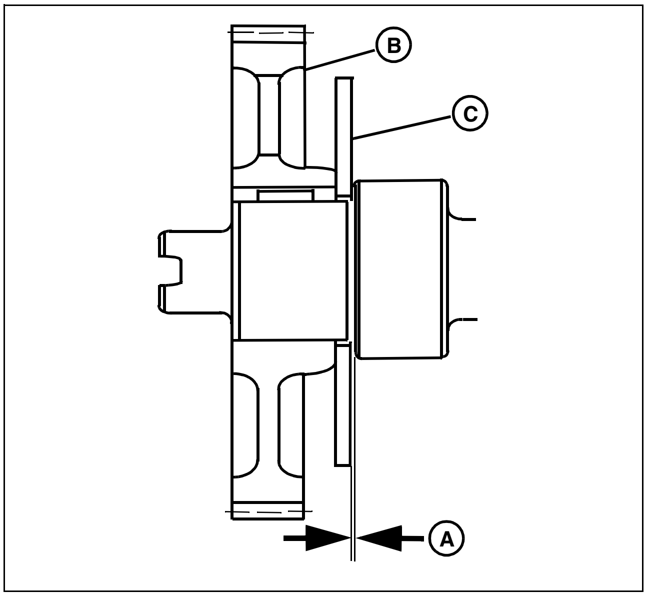
5. Install push rods and rocker arm assembly.

Specifications

Thrust Plate Mounting Cap Screws . 26 N•m (226 lb-in.)

Inspect Camshaft

Camshaft End Play

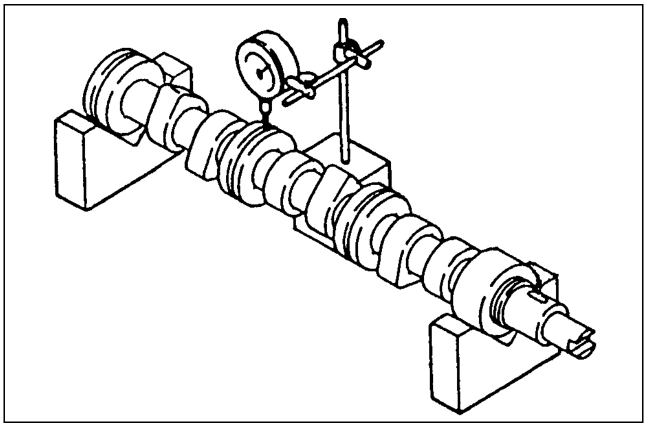


MIF

1. Check the camshaft end play (A) using a feeler gauge.

2. If the end play exceeds specification, remove the camshaft gear (B) and replace thrust plate (C). See “Remove and Install Camshaft Gear” on page 101.

Camshaft Bend

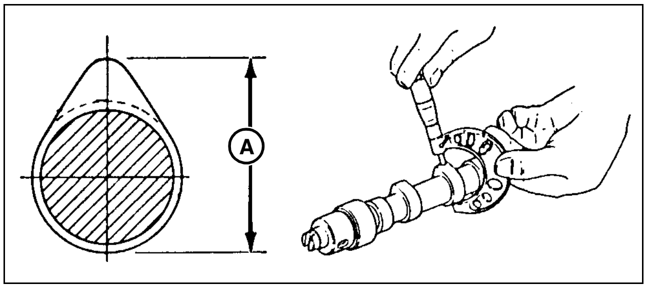


M82291A

1. Inspect the camshaft for bend using V-blocks and a dial indicator. Turn the camshaft slowly and read variation on the indicator.

    - If the variation is greater than specification, replace the camshaft.

Camshaft Lobe Height

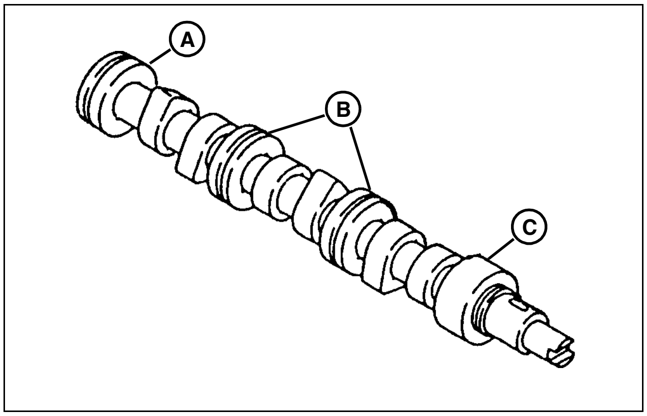


M82070A

1. Measure the camshaft lobe height (A) and compare with specifiactions.

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

Camshaft Journals



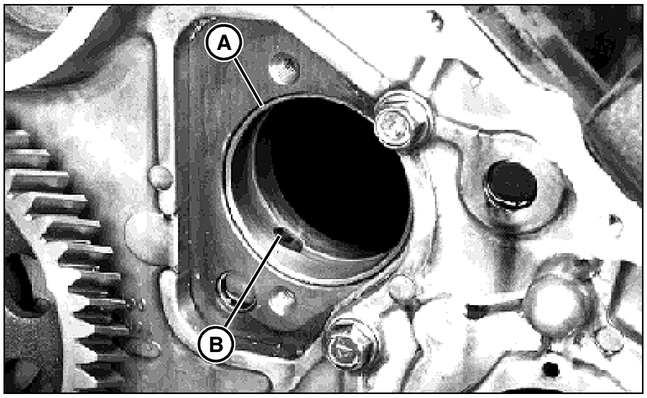
M82292A

1. Measure gear housing (C) and flywheel end (A) camshaft journal outside diameters and compare with specifications.

2. Measure intermediate (B) camshaft journal outside diameters and compare with specifications.

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

Camshaft Bushings



M82072

1. Measure the camshaft bushing (A) inside diameter at the gear housing end and compare with specifications.

2. If bushing diameter exceeds wear limit, replace bushing.

3. If bushing clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft or both.

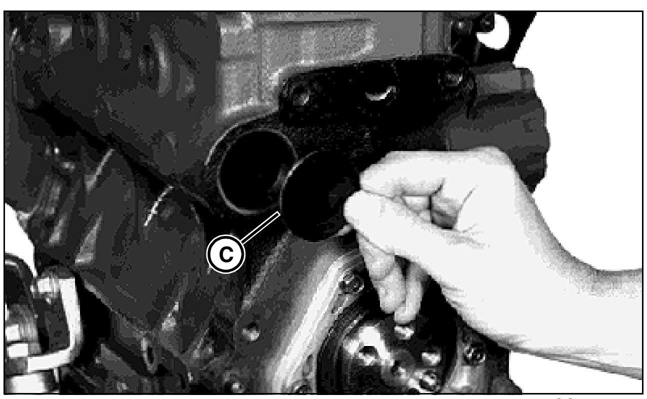
4. If replacing the camshaft bushing:

   a. Use a chisel to remove the bushing. Be careful not to push the bushing inside the engine.

   b. Align the oil holes (B) in new bushing and cylinder block. Install bushing using a driver set.

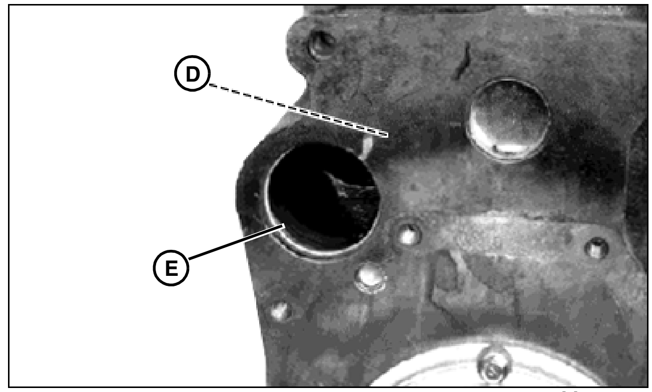
NOTE: Flywheel plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

5. Remove flywheel plate.



M35287

6. Remove plug (C) using a long wooden dowel. Insert wooden dowel through gear housing side.



M82073

7. Measure the intermediate (D) and flywheel end (E) camshaft bore diameters and compare with specifications.

8. Apply John Deere Form-In-Place Gasket, or an equivalent, on the outer edge of the plug. Install the plug until it bottoms in the bore.

Specifications

Camshaft End Play. . . . . 0.05-0.25 mm (0.002-0.010 in.)

Camshaft Bend (Maximum). . . . . . 0.02 mm (0.0021 in.)

Camshaft Lobe Height 38.64-38.77 mm (1.521-1.526 in.)

Wear Limit. . . . . 38.40 mm (01.512 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journal OD 44.93-44.95 mm (1.769-1.770 in.)

Intermediate Camshaft Journal 44.91-44.94 mm (1.768-1.769 in.)

Wear Limit. 44.85 mm (1.766 in.)

Camshaft Bushings

Camshaft Bushing ID at Gear Housing . . 44.990-45.055 mm (1.771-1.774 in.)

Camshaft Bushing ID at Intermediate and Flywheel End 45.00-45.025 mm (1.772-1.773 in.)

Wear Limit (All). . . . . 45.10 mm (1.776 in.)

Camshaft Bushing-to-Journal Clearance (All) 0.20 mm (0.008 in.)

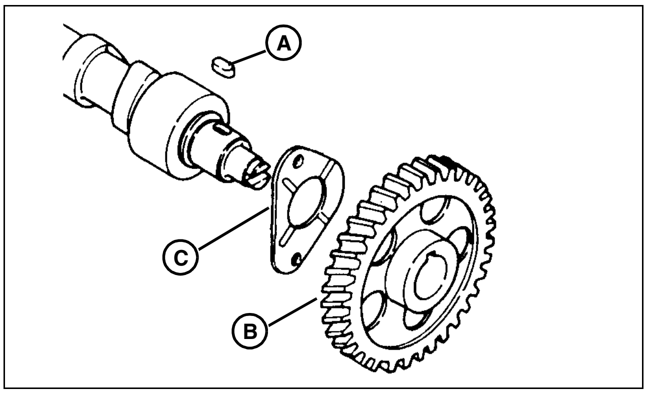
Remove and Install Camshaft Gear

CAUTION: Avoid injury! 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.

1. Heat the gear in oil to approximately 150°C (300°F).

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

NOTE: Thrust plate must spin freely on camshaft.



M82068A

2. Install the thrust plate (C) if removed. Install the gear (B) with timing mark “C” side toward press table. Align the slot in the gear with key (A) in shaft. Press the camshaft into gear until gear is tight against camshaft shoulder.

Remove and Install Cam Followers

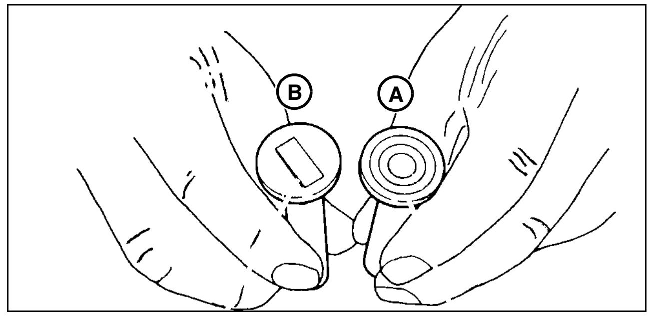
1. Remove camshaft. See “Remove and Install Camshaft” on page 98.
2. Remove the oil pan and strainer.

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

3. Put a mark on each cam follower and cylinder block bore to aid in installation.
4. Remove cam followers.
5. Inspect all parts for wear or damage.
6. Apply clean engine oil to all parts during installation.

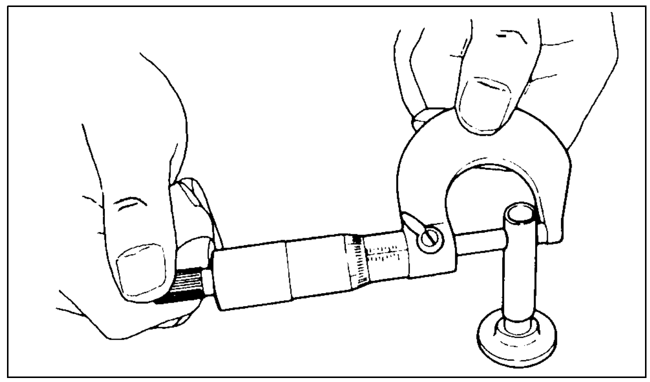
Installation is done in reverse order of removal.

Inspect Cam Followers



M82074A

1. Inspect the cam follower contact surface for normal contact (A) or abnormal wear (B). Replace if necessary.



M82075A

2. Measure the cam follower stem diameter and compare with specifications. If stem diameter is less then wear limit, replace cam follower.
3. Measure the cam follower bore diameter in the cylinder block and compare with specifications. If the cam follower bore diameter exceeds wear limit, replace the cylinder block.
4. If the bore clearance (bore ID minus follower stem OD) exceeds specification, replace the cam follower, cylinder block or both.

Specifications

Cam Follower Stem

Stem OD . . . . 11.98-11.99 mm (0.471-0.472 in.)

Wear Limit. 11.93 mm (0.470 in.)

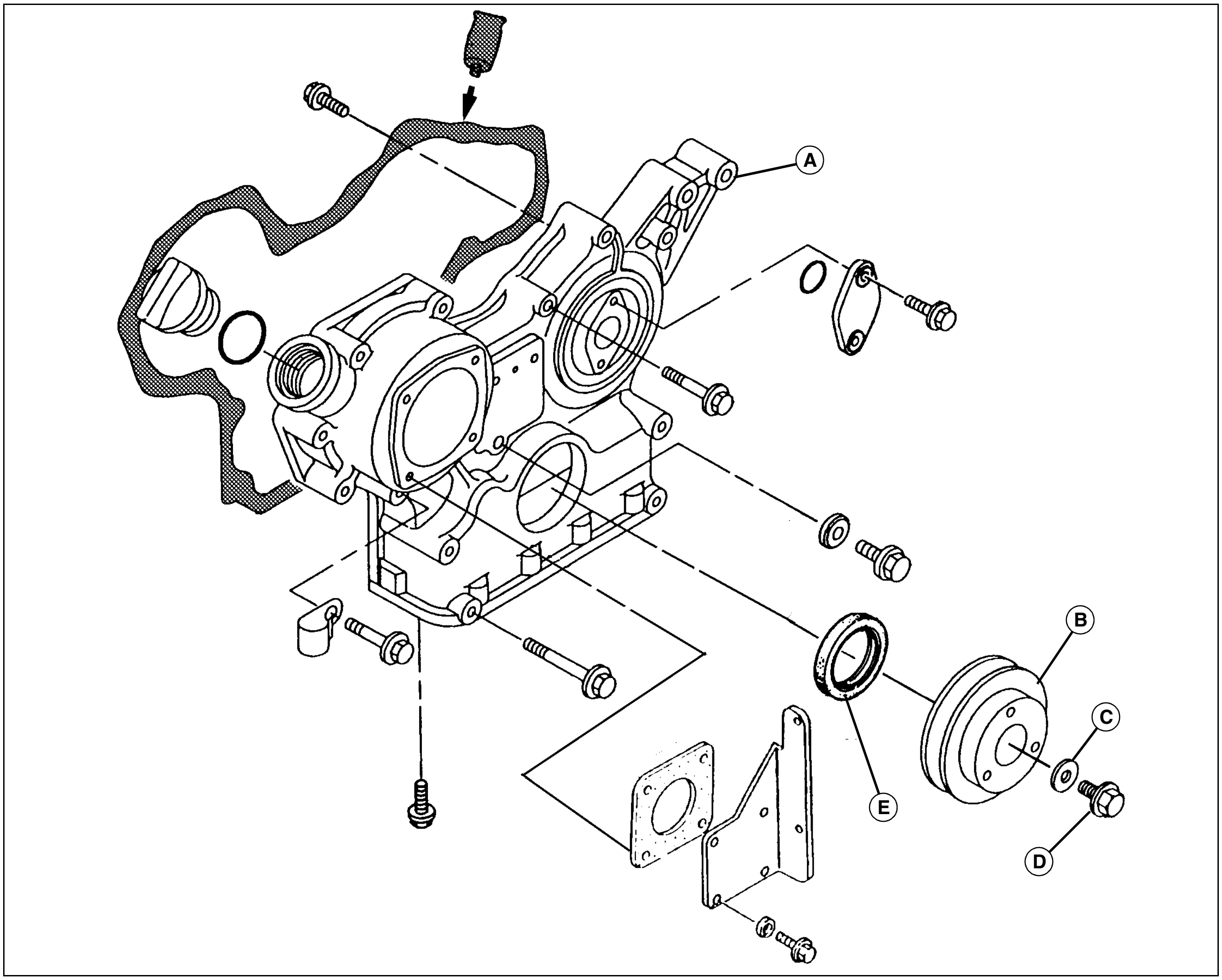
Cam Follower Bore

Bore ID . . . . 12.00-12.02 mm (0.472-0.473 in.)

Wear Limit. 12.05 mm (0.474 in.)

Clearance . . . . 0.010-0.043 mm (0.0.001-0.002 in.)

Remove and Install Timing Gear Cover

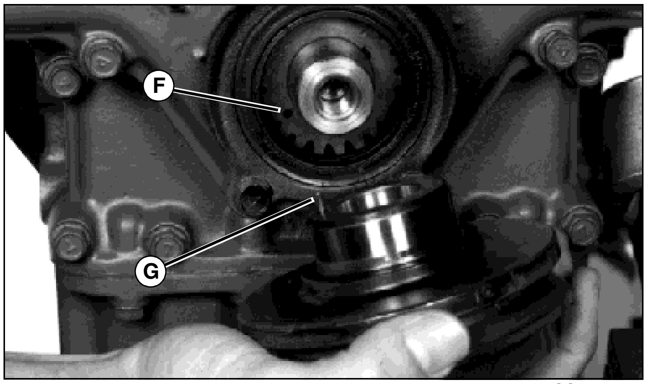


M57126A

1. Remove hood and battery.
2. Remove alternator and belt.
3. Remove crankshaft pulley cap screw (D) and washer (C).
4. Remove crankshaft pulley (B) using a puller kit.

NOTE: It is not necessary to remove end cover and O-ring or fuel injection pump gear cover to remove timing gear cover.

5. Drain coolant.
6. Remove lower radiator hose from coolant pump.
7. Remove mounting cap screws and timing gear cover (A).
8. Inspect crankshaft oil seal (E) for wear or damage. Replace if necessary.
   - Replace oil seal using a driver set. Install seal with lip toward inside of gear housing cover. Install seal flush with surface of cover.
9. Installation is done in the reverse order of removal.
   - Replace seal washer.
   - Tighten all timing gear cover mounting cap screws to specifications.



M35295

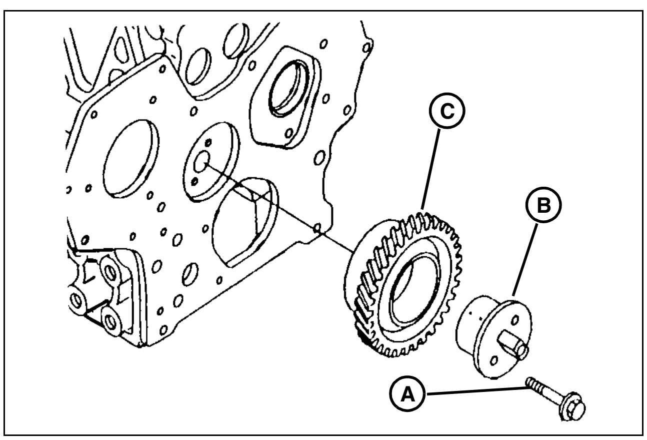
- Align pin (G) in crankshaft pulley with hole (F) in crankshaft gear. Install crankshaft pulley.
- Adjust alternator drive belt tension. (See “Adjust Fan/ Alternator Drive Belt” on page 70.)

Remove and Install Idler Gear

1. Remove the timing gear cover. See “Remove and Install Timing Gear Cover” on page 102.
2. Check the backlash of timing gears. See “Check Timing Gear Backlash” on page 67.

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 coolant pump is at TDC on compression stroke. Number one cylinder is closest to the flywheel.

3. Rotate the crankshaft and align the timing marks.



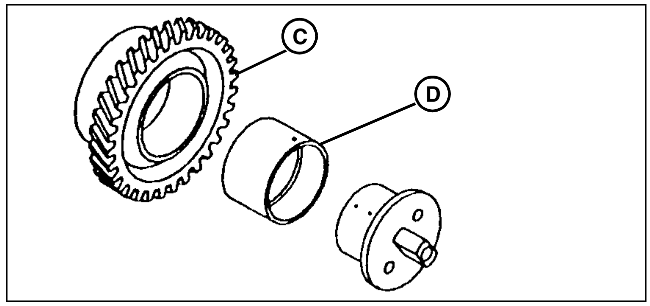
M82209A

4. Remove two cap screws (A), shaft (B) and gear (C).
5. Inspect all parts for wear or damage.

Installation is done in the reverse order of removal.

Inspect Idler Gear

1. Inspect the gear for chipped or broken teeth. Replace if necessary.
2. Measure the idler gear shaft diameter and compare with specifications.
3. Measure the idler gear bushing diameter and compare with specifications.
4. If the bore clearance (bushing ID minus shaft OD) exceeds specification, replace the bushing, shaft, or both.



M82210A

5. Remove and install bushing:
   a. Replace the bushing using a driver set.
   b. Align the oil holes in bushing (D) and idler gear (C).
   c. Install the bushing flush with surface of idler gear.

Specifications

Idler Gear Shaft OD 45.950-45.975 mm (1.809-1.810 in.)

Wear Limit. 45.93 mm (1.808 in.)

Idler Gear Bussing ID 46.00-46.025 mm (1.811-1.812 in.)

Wear Limit. 46.08 mm (1.814 in.)

Idler Gear Shaft and Bushing Clearance . . . . . 0.15 mm (0.006 in.)

Remove and Install Timing Gear Cover Mounting Plate

1. Remove the camshaft. See “Remove and Install Camshaft” on page 98.
2. Remove the idler gear. See “Remove and Install Idler Gear” on page 103.
3. Remove the fuel injection pump.
4. Remove the oil pump. See “Remove and Install Oil Pump” on page 104.
5. Remove the mounting cap screws and plate.
6. Replace the O-rings.

Install in reverse order of removal.

Remove and Install Oil Pan and Strainer

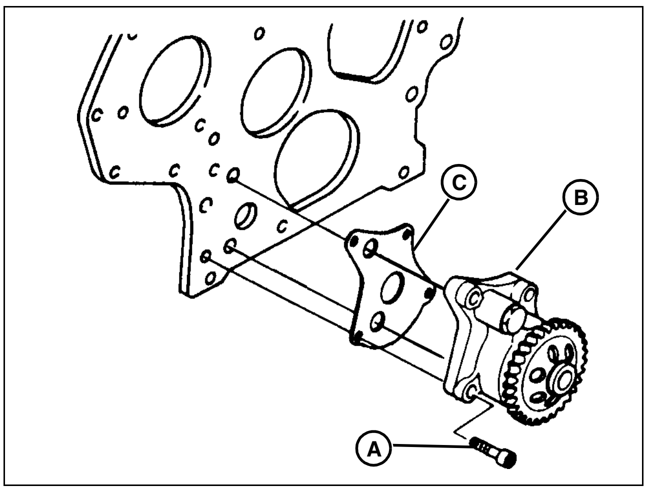
NOTE: The engine must be removed from the machine to remove the oil pan.

1. Remove the oil pan.
2. Remove the oil pick-up strainer.
3. Clean and inspect all parts.
4. Install the oil pick-up strainer.
5. Install the oil pan.
6. Fill the engine with correct engine oil.

Remove and Install Oil Pump

1. Remove the timing gear cover. See "Remove and Install Timing Gear Cover" on page 102.

2. Check the oil pump gear backlash. Replace the oil pump assembly if backlash is more than specification.



M82215A

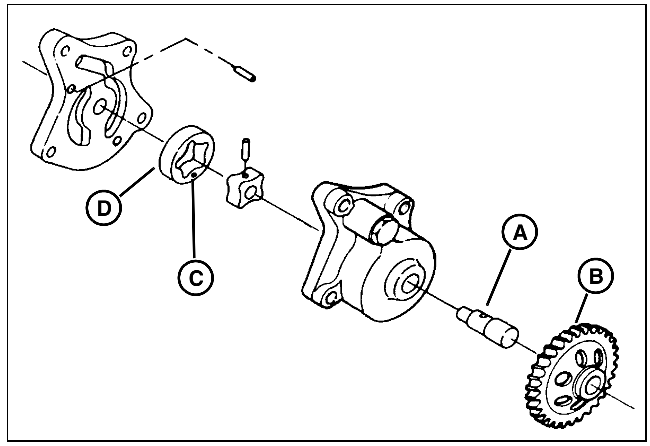
3. Remove the mounting cap screws (A), the oil pump (B) and gasket (C).

4. Inspect all parts for wear or damage.

Specifications

Oil Pump Gear Backlash . . . . 0.12 mm (0.005 in.)

Disassemble and Assemble Oil Pump



M82216A

1. The gear (B) is press fit on rotor shaft (A). Remove gear using a knife-edge puller and a press.

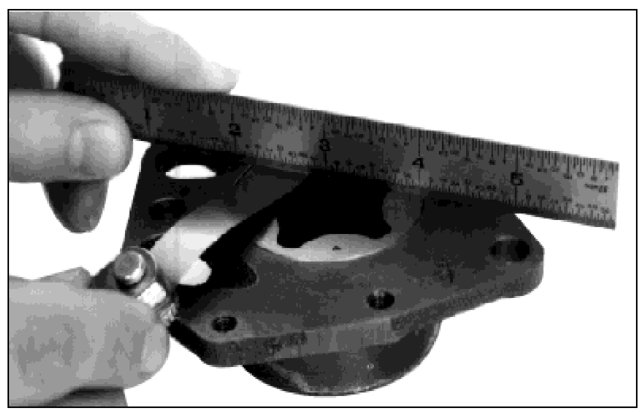
2. Inspect all parts for wear or damage.

3. Coat all parts with clean engine oil.

4. Install the outer rotor (D) with identification mark (C) facing toward rotor shaft assembly.

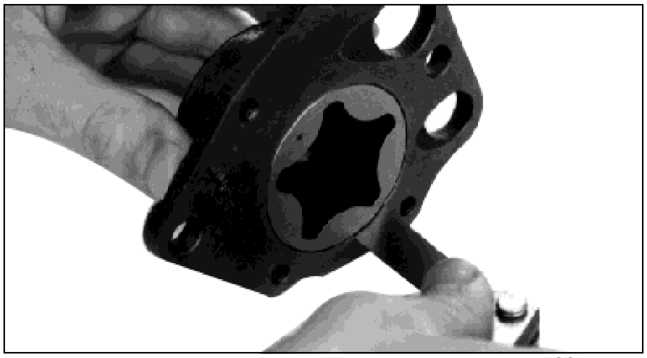
Inspect Oil Pump

1. Measure the rotor shaft outer diameter and the shaft hole diameter in cover and compare with specifications. If clearance is more than wear limit, replace entire assembly.



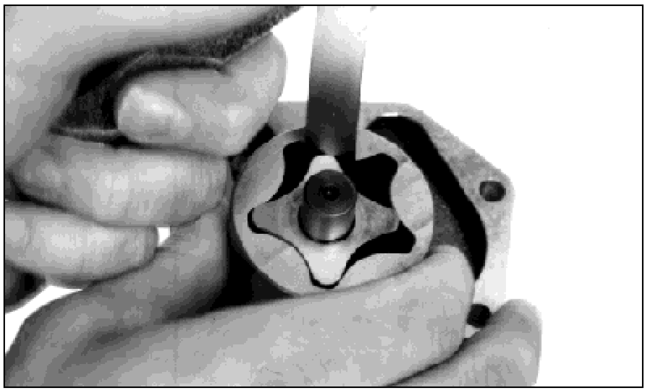
M51571

2. Check the rotor recess. If rotors are below face of pump housing more than wear limit, replace rotor assembly.



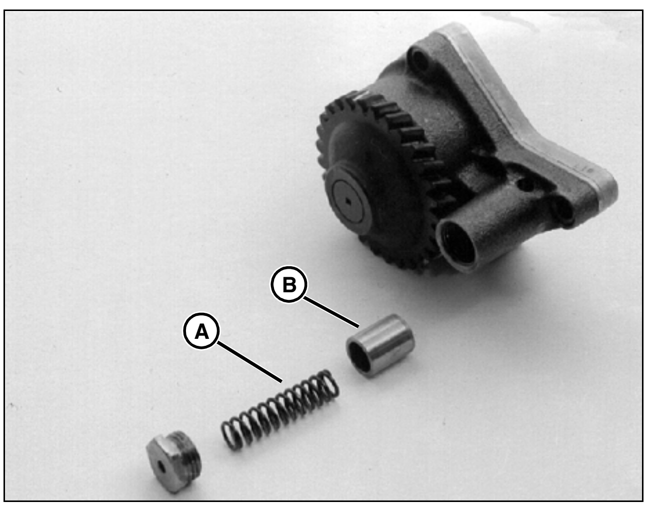
M51572

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



M51573

4. Check inner-to-outer rotor clearance. If clearance is more than wear limit, replace rotor assembly.



M76428

5. Check the oil pressure relief valve. If the relief valve piston (B) is sticking in the pump body, clean parts to allow free movement of the piston in pump body.

6. Inspect the spring (A) for cracks. The spring is not serviceable. If damage is identified, replace the oil pump assembly.

Specifications

Rotor Shaft OD-to-Backing Plate ID Clearance

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

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

Rotor Recess

Standard . . . . 0.03-0.09 mm (0.001-0.002 in.)

Wear Limit. . . . . 0.15 mm (0.006 in.)

Outer Rotor-to-Pump Body Clearance

Standard . . . . 0.10-0.16 mm (0.004-0.006 in.)

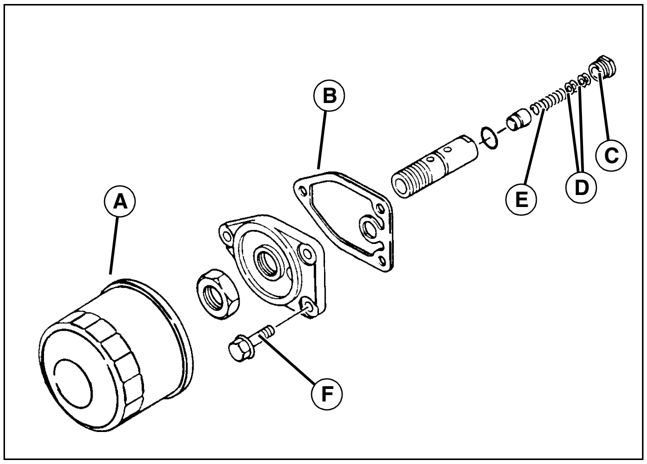
Wear Limit. . . . . 0.25 mm (0.010 in.)

Inner-to-Outer Rotor Clearance

Standard . . . . 0.05-0.10 mm (0.002-0.004 in.)

Wear Limit. . . . . 0.15 mm (0.006 in.)

Remove and Install Oil Pressure Regulating Valve



M82219A

1. Remove oil filter (A).

2. Remove three cap screws (F), valve assembly and gasket (B).

NOTE: Retaining nut does not need to be removed if only adjusting engine oil pressure.

3. If adjusting pressure only, remove cap (C) and add shims (D). Each 1 mm (0.039 in.) of shim thickness increases oil pressure 15.6 kPa (2.3 psi).

NOTE: Valve compoments 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 (E) free and compressed length and compare with specifications.

Installation is done in the reverse order of removal.

- Tighten cap screws (F) to specification.

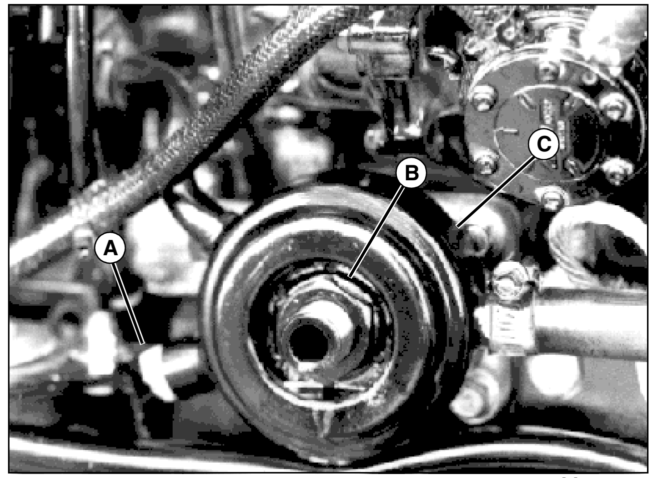
Specifications

Spring Free Length. . . . . 46 mm (1.810 in.)

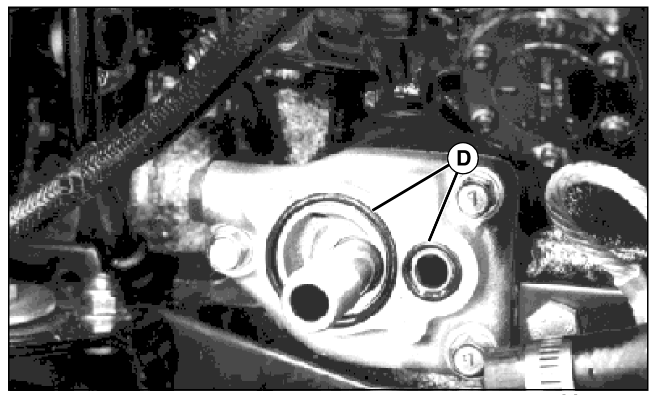
Spring Compressed Length (at 20.5 N (4.6 lb-force)) . . 27.5 mm (1.080 in.)

Housing Cap Screw Torque . . . . 27 N•m (20 lb-ft)

Remove and Install Optional Oil Cooler



M48394



M48395

1. Remove drain plug (A) to drain engine cooling system.

2. Remove oil filter.

3. Disconnect coolant hoses.

4. Remove nut (B), oil cooler (C) and O-rings (D).

5. Pressure test oil cooler for leakage by applying 206-483 kPa (30-70 psi) of compressed air to oil cooler and submersing in water.

Installation is done in reverse order of removal.

- Replace O-rings.

Remove and Install Thermostat and Housing - 3TNE84

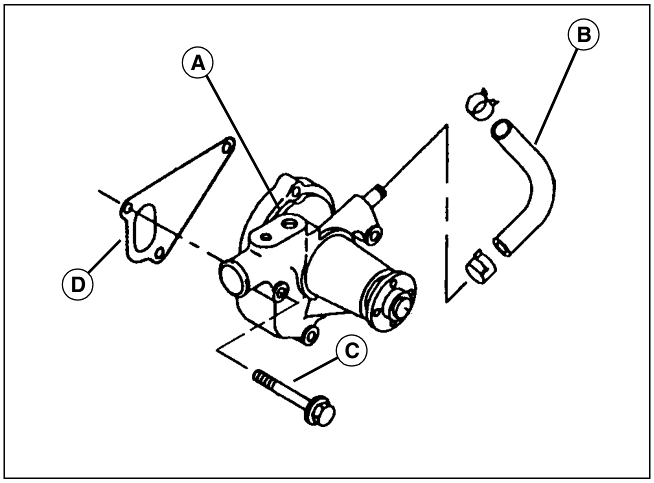
1. Drain engine coolant.
2. Remove upper radiator hose.
3. Disconnect coolant temperature switch/sender wiring lead(s).
4. Loosen alternator-to-bracket mounting cap screw.
5. Loosen clamps and remove thermostat housing-to-coolant pump hose.
6. Remove mounting cap screws, housing and gasket.
7. Inspect all parts for wear or damage. Replace as necessary.
8. Test thermostat. See "Test Thermostat Opening" on page 69.

Installation is done in reverse order of removal.

- Adjust alternator drive belt tension. (See "Adjust Fan/ Alternator Drive Belt" on page 70.)

Remove and Install Coolant Pump

1. Drain engine coolant.
2. Remove belt guard.
3. Remove alternator belt.
4. Remove coolant pump pulley.
5. Remove lower radiator hose.



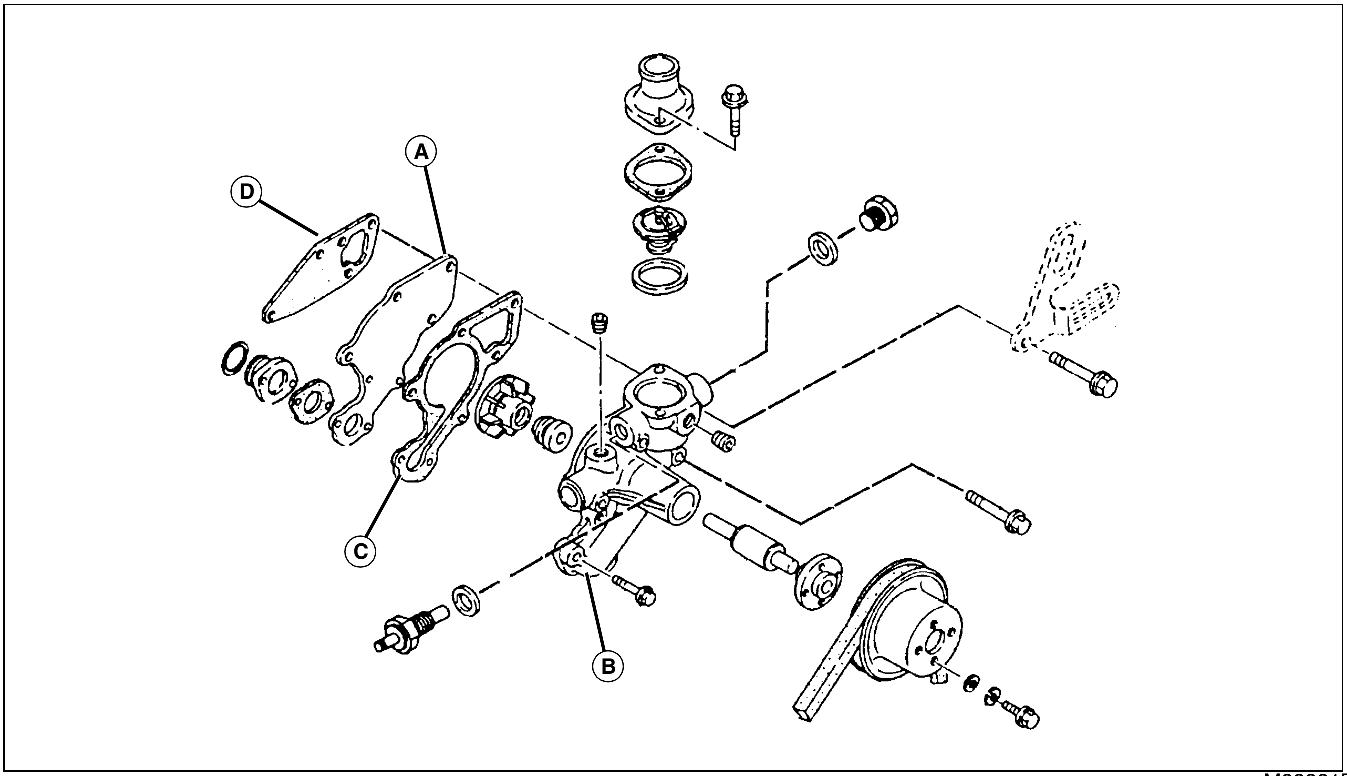
M82223A

Picture Note: 3TNE84 Shown

6. 3TNE84 - Loosen clamps and remove thermostat housing-to-coolant pump hose (B).
7. 3TNE84 - Remove three mounting cap screws (C), pump (A) and gasket (D).
8. 3TNE78A and 3TNE82A - Remove six mounting cap screws, pump and gasket.
9. 3TNE78A and 3TNE82A - If pump is to be replaced:
    - Remove plug and copper seal washer.
    - Remove thermostat housing.
    - Remove sending unit.
    - Remove pipe and O-ring from engine block.

Use new copper seal washers for installation.

Inspect Coolant Pump



M82221B

Picture Note: 3215 (3TNE78A) Shown

1. Inspect coolant pump (B) for coolant leakage. If origin of leak cannot be determined, perform cooling system pressure test. (See “Test Cooling System Pressure” on page 71.)

- If coolant leaks at pulley flange, shaft seal is defective. Replace coolant pump.
- If coolant leaks between plate (A) and pump housing, gasket (C) between plate and pump housing is defective. Remove plate and replace gasket.
- If coolant leaks between plate (A) and engine block, remove coolant pump and replace gasket (D).

2. Inspect coolant pump for worn bearing shaft by removing alternator belt and checking for excessive movement of pulley. Replace coolant pump if excessive movement is noticed.

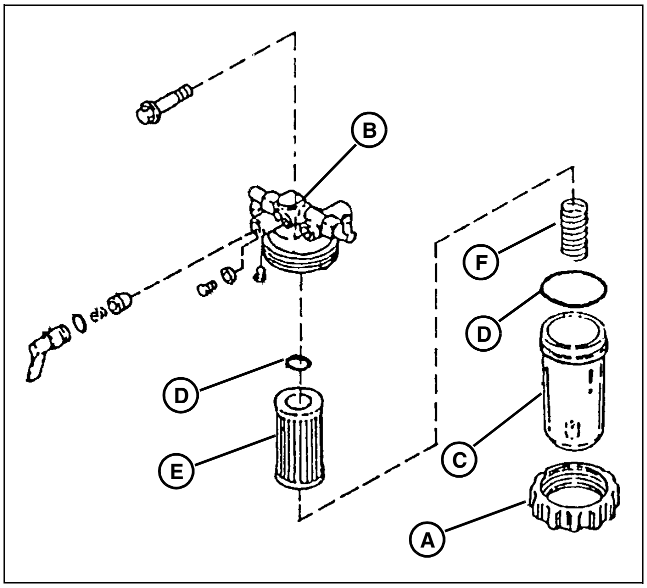
- If bearing shaft is making noise when operating, check alternator belt tension. (See “Adjust Fan/ Alternator Drive Belt” on page 70.) If adjustment does not relieve the noise, bearing shaft is defective. Replace coolant pump.

Disassemble and Assemble Fuel Filter Assembly

IMPORTANT: Avoid damage! Replace all copper washers on injection pump fittings. Damaged or used washers will leak.

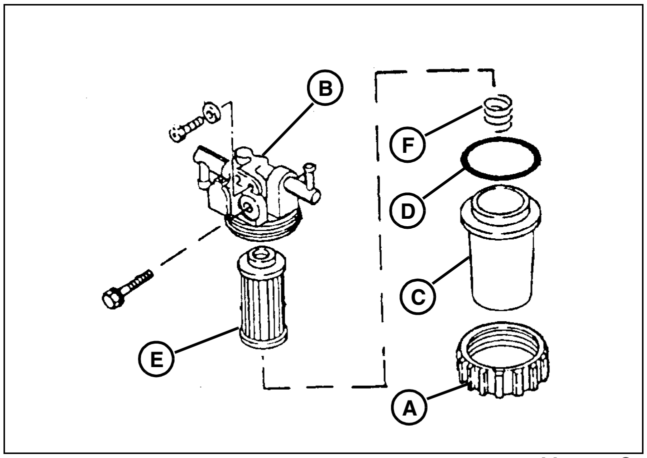
Always use new O-ring seals whem replacing filter.

NOTE: Fuel filter assemblies will be slightly different for each engine model.



M82370B

Picture Note: 3TNE84 Shown



M82370C

Picture Note: 3TNE78A Shown

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).

2. Remove the filter cover from the mounting base.

3. Remove and replace O-rings (D) and filter element (E).

4. Be sure the spring (F) is in the filter cover and place the filter element in the filter cover.

5. Before installing the filter cover and element in the mounting base, verify the O-ring is in the groove inside the mounting base.

6. Install the filter cover and the element in the mounting base.

IMPORTANT: Avoid damage! Tighten only enough to keep the filter assembly from leaking. Overtightening the retaining nut may damage the filter cover or retaining ring.

7. Place the retaining ring over filter cover and screw on the mounting base to retain filter cover to mounting base.

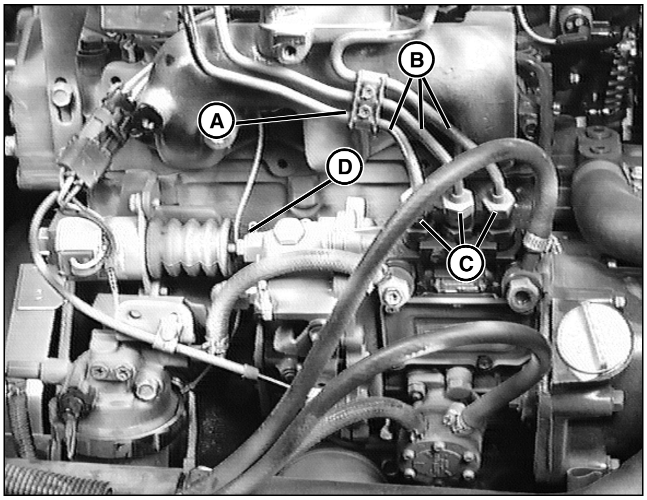
Remove Fuel Injection Pump (For 3TNE78RJFE and 3TNE84JFE Only)

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other high-pressure 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 source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

IMPORTANT: Avoid damage! Do NOT attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

IMPORTANT: Avoid damage! 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 injection pump lines and area around pump using a parts cleaning solvent or steam cleaner.



M86164

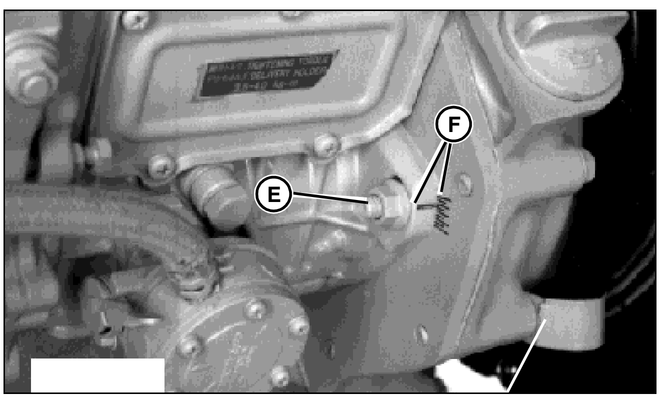
2. Loosen fuel injection lines (B) slightly to release pressure in the fuel system. When loosening lines, use another wrench to keep delivery valves (C) from loosening.

3. Loosen line clamp(s) (A) and remove fuel injection lines (B).

4. Disconnect hoses to/from fuel filter, if equipped.

5. Remove external lube line.

6. Disconnect fuel shutoff solenoid link (D).



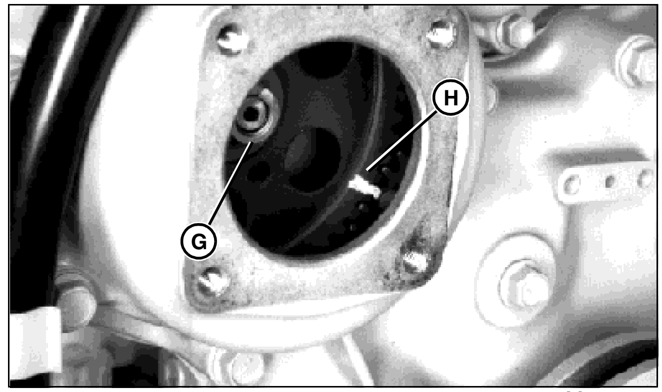
M82230

7. Note position of timing marks (F) on injection pump and gear cover mounting plate.

8. Remove three mounting nuts (E).

9. Remove fan guard, if equipped.

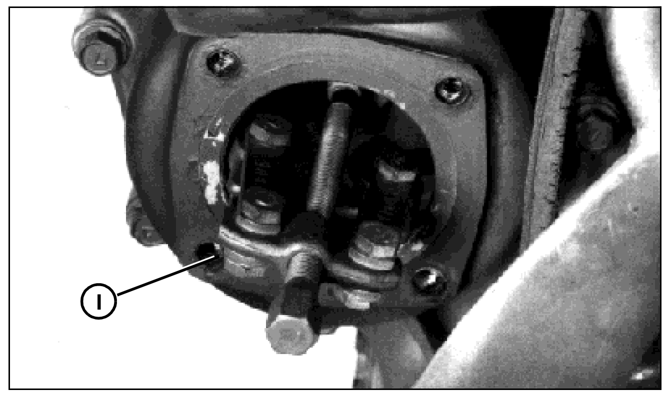
10.Remove four cap screws, washers, cover and gasket.



M82231

11.Use chalk or paint to mark (H) injection pump gear to idler gear.

12.Remove nut and lock washer (G).



M37794

13.Pull gear from injection pump shaft using a two-jaw puller (I).

14.Remove injection pump and O-ring.

Remove Fuel Injection Pump (For 3TNE78-ERJFE, 3TNE82A-EJF and 3TNE84-EJFE Only)

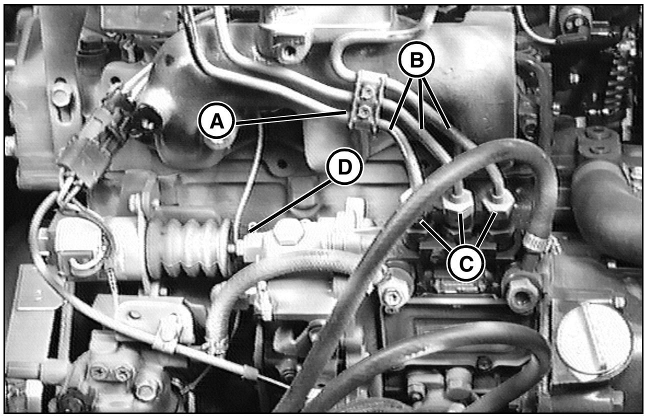
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect 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 source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

IMPORTANT: Avoid damage! DO NOT attempt to service th injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

DO NOT rotate engine while injection pump is removed. If engine is rotated, timing gear cover must be removed to ensure correct timing.

IMPORTANT: Avoid damage! 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 injection pump lines and area around pump using a parts cleaning solvent or steam cleaner.



M86164

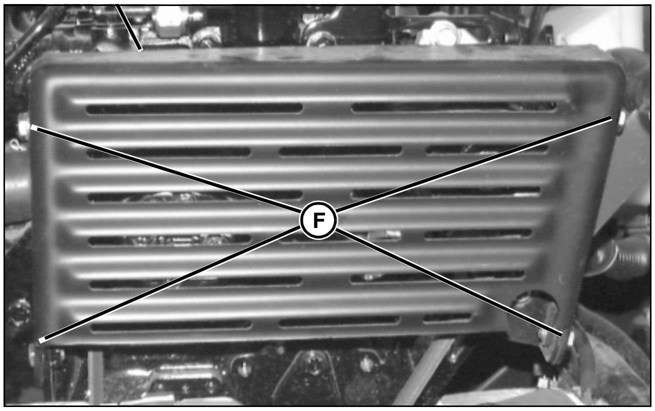
2. Loosen fuel injection lines (B) slightly to release pressure in the fuel system. When loosening lines, use another wrench to keep delivery valves (C) from loosening.

3. Loosen line clamp(s) (A) and remove fuel injection lines.

4. Disconnect hoses to/from fuel filter, if equipped.

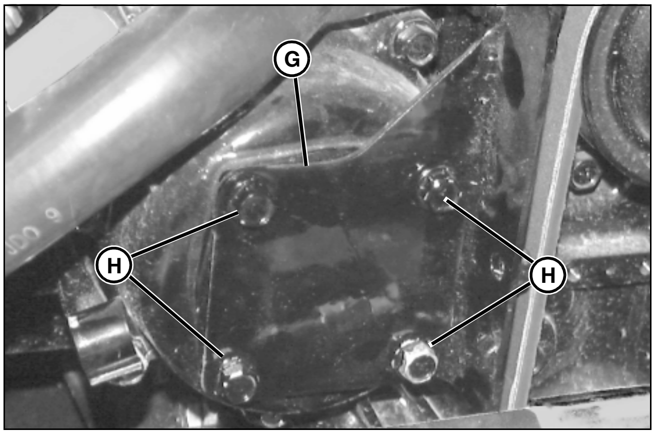
5. Remove external lube line.

6. Disconnect fuel shutoff solenoid link (D).



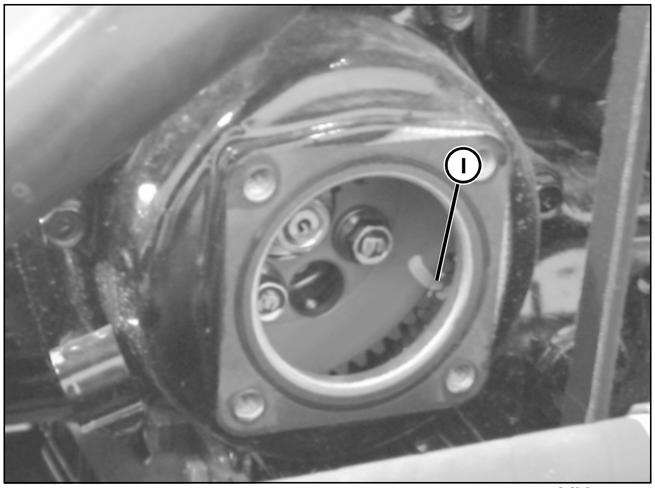
MX2738

7. Remove four cap screws (F) and fan guard (E).



MX2737

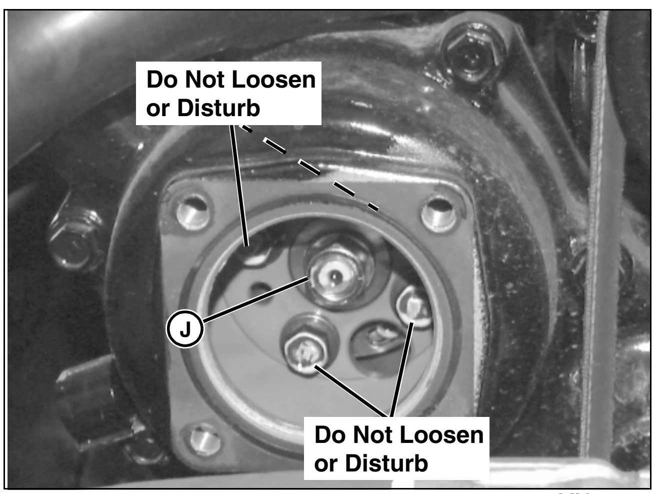
8. Remove four cap screws and washers (H), cover (G) and gasket.



MX2735

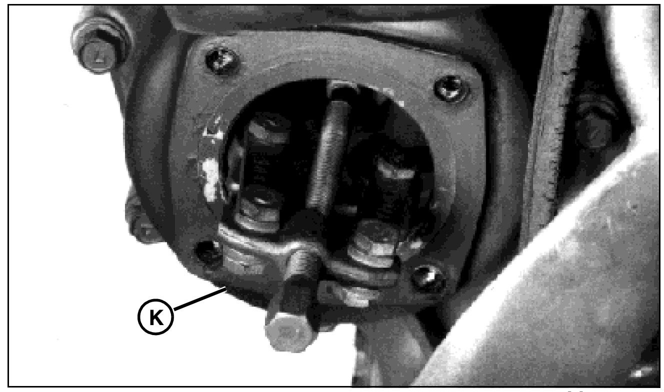
9. Rotate engine until timing marks (I) on pump gear and idler gear line up.

NOTE: DO NOT loosen or disturb cap screws securing gear to hub. Gear-to-hub adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/Environmental Protection Agency (CARB/EPA) emissions requirements and is NOT adjustable. Tampering with the gear-to-hub adjustment may result in severe fines or penalties. If hub or gear is damaged, the entire engine must be replaced.



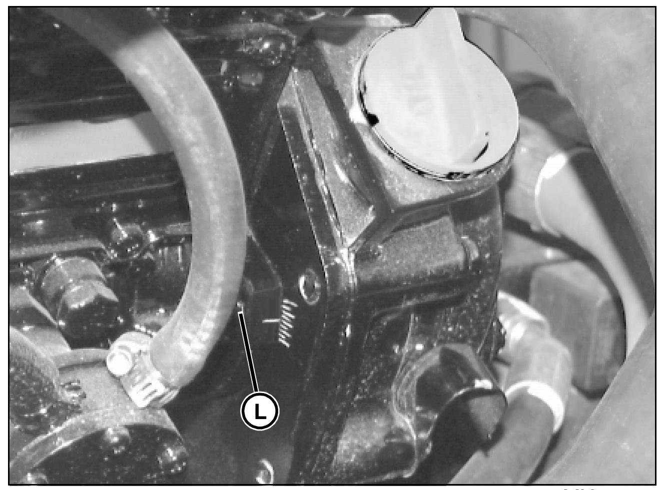
MX2736

10.Remove nut and lock washer (J).



M37794

11.Pull gear from injection pump shaft using a two-jaw puller (K).



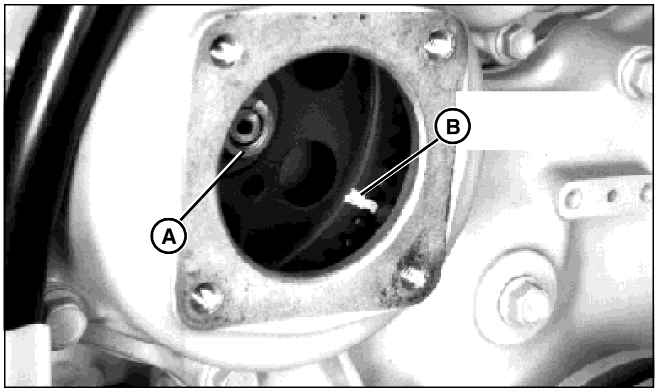
MX2739

12.Remove three mounting nuts (L).

13.Remove injection pump and O-ring.

Install Fuel Injection Pump (For 3TNE78-RJFE and 3TNE84-JFE Only)

1. Install new O-ring on injection pump.



M82231

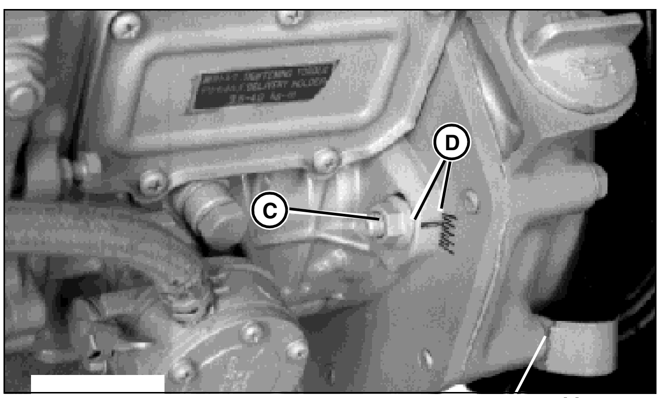
2. Put injection pump onto back of gear cover mounting plate. Align key on shaft with keyway in gear.

3. Be sure to align marks (B) on gears made during removal.

4. Install lock washer and nut (A). Tighten to specification.

5. Install new gasket, cover, four washers and cap screws.

6. Install fan guard, if equipped.



M82230

7. Install three mounting nuts (C). Do not tighten.

8. Be sure to align marks (D) on injection pump and gear cover mounting plate, to same place as when removed and tighten mounting nuts to specification.

9. Connect fuel shutoff solenoid link.

10.Connect hoses to/from fuel filter.

11.Install fuel injection lines and tighten line clamp cap screws.

IMPORTANT: Avoid damage! If oil has been drained out of fuel injection pump housing, add oil as necessary. Fuel injection pump can become damaged if operated dry or without proper amount of oil.

12.Remove fill plug and add clean engine oil to housing. Add until oil begins to drip out of external lube line inlet. (For proper oil specification see Specifications and Information section.)

13.Install external lube line. When installing line, put one copper washer between mounting cap screw head and lube line and the other between lube line and housing. Tighten cap screw to specifications.

If new injection pump is being installed, check and adjust injection pump static timing. (See Tests and Adjustments.)

Specifications

Fuel Injection Pump

Gear Nut Torque . . . . 90 N•m (66 lb-ft)

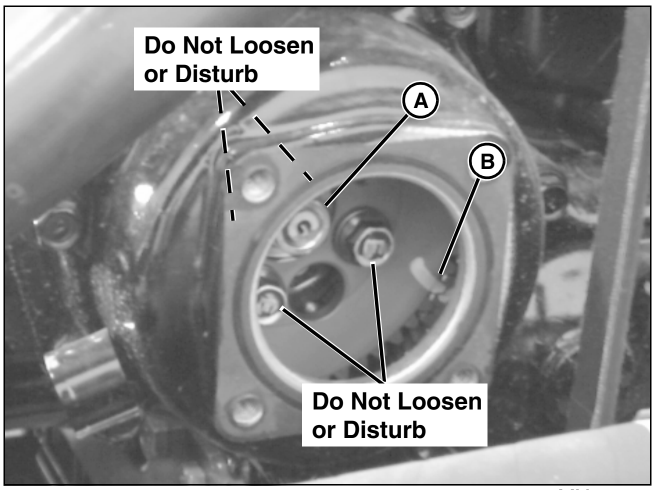
Injection Pump Nut Torque . . . . 27 N•m (20 lb-ft)

Lube LIne Mounting Bolt Torque . . . 25 N•m (217 lb-in.)

Install Fuel Injection Pump (For 3TNE78-ERJFE, 3TNE82A-EJF and 3TNE84-EJFE Only)

1. Install new O-ring on injection pump.

NOTE: DO NOT loosen or disturb cap screws securing gear to hub. Gear-to-hub adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/Environmental Protection Agency (CARB/EPA) emissions requirements and is NOT adjustable. Tampering with the gear-to-hub adjustment may result in severe fines or penalties. If hub or gear is damaged, the entire engine must be replaced.



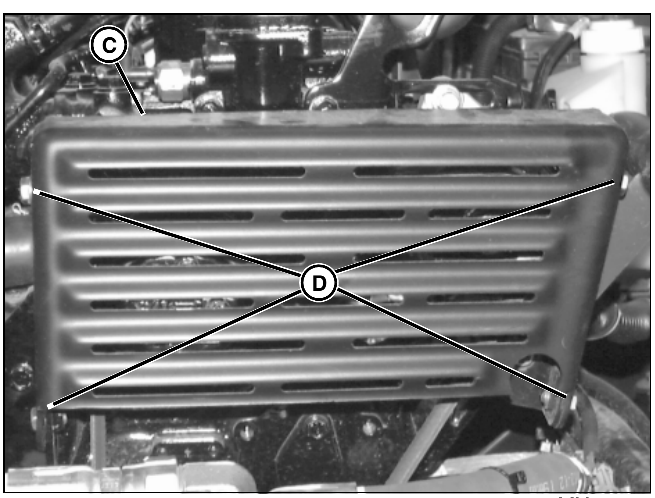
MX2735

2. Put injection pump onto back of gear cover mounting plate. Align key on shaft with keyway in gear.

3. Be sure to align timing marks (B) on pump gear and idler gear.

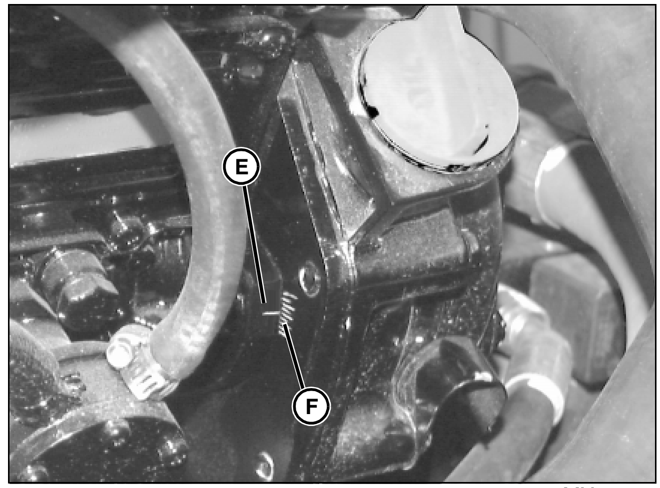
4. Install lock washer and nut (A). Tighten to specifications.

5. Install new gasket, cover, four washers and cap screws.



MX2738

6. Install fan guard (C) and secure with cap screws (D).



MX2739

7. Install three mounting nuts securing injection pump to gear cover mounting plate. Do not tighten.

8. Be sure to align mark on injection pump housing (E) with the 5th mark (F) from the top on gear cover mounting plate and tighten mounting nuts to specifications.

9. Connect fuel shutoff solenoid link.

10.Connect hoses to/from fuel filter.

11.Install fuel injection lines and tighten line clamp cap screws.

IMPORTANT: Avoid damage! If oil has been drained out of fuel injection pump housing, add oil as necessary. Fuel injection pump can become damaged if operated dry or without proper amount of oil.

12.Remove fill plug and add clean engine oil to housing. Add until oil begins to drip out of external lube line inlet. (For proper oil specification see Specifications and Information section.)

13.Install external lube line. When installing line, put one copper washer between mounting cap screw head and lube line and the other between lube line and housing.

Specifications

Fuel Injection Pump Nut Torque . . . . . . 90 N•m (66 lb-ft)

Remove and Install Fuel Injection Nozzles

Removal

IMPORTANT: Avoid damage! 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.

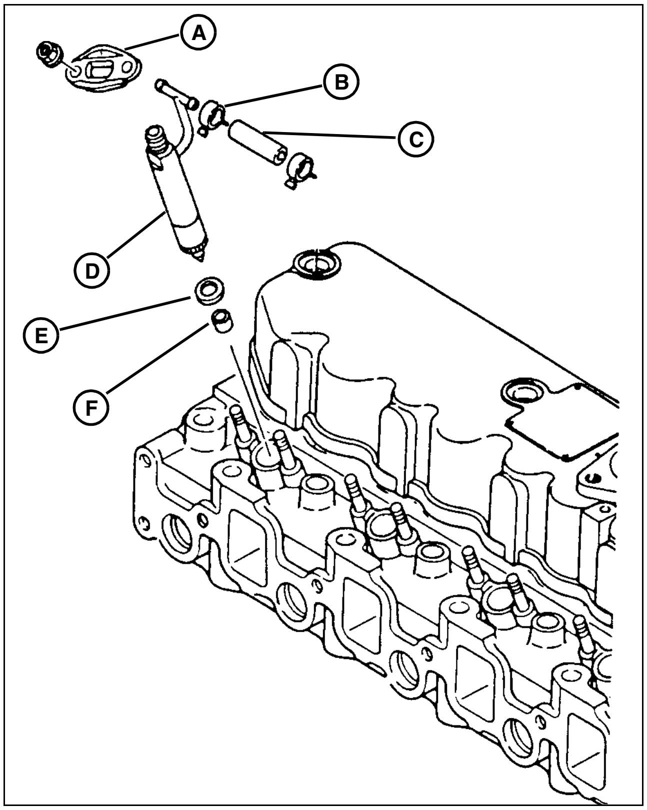
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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

2. Loosen fuel injection line connectors-to-nozzles slightly to relieve pressure in the fuel system.

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

3. Loosen line clamp(s) and remove fuel injection lines.

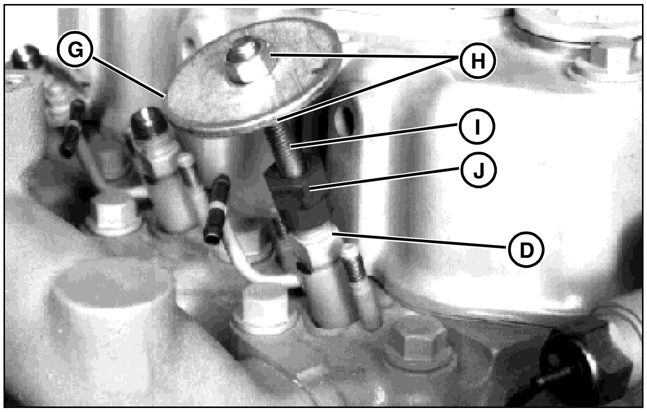


M82092A

4. Remove clamps (B) and leakoff hoses (C).

5. Remove nuts and retaining plates (A).

6. Remove injection nozzle (D), ring (E) and TEFLON® heat protector (F). If ring and protector stay in cylinder head, thread a cap screw into protector and pull from cylinder head.



M82126

7. If nozzles are stuck in cylinder head:

- Grind the head of a cap screw (I) so it fits inside a nut from an old injection line (J).
- Use two nuts (H) to attach a large flat washer (G) to the cap screw.
- Install assembly onto nozzle (D) and use a puller and slide hammer to pull nozzle from cylinder head.

8. Test injection nozzles. See "Test Fuel Injection Nozzles" on page 67.

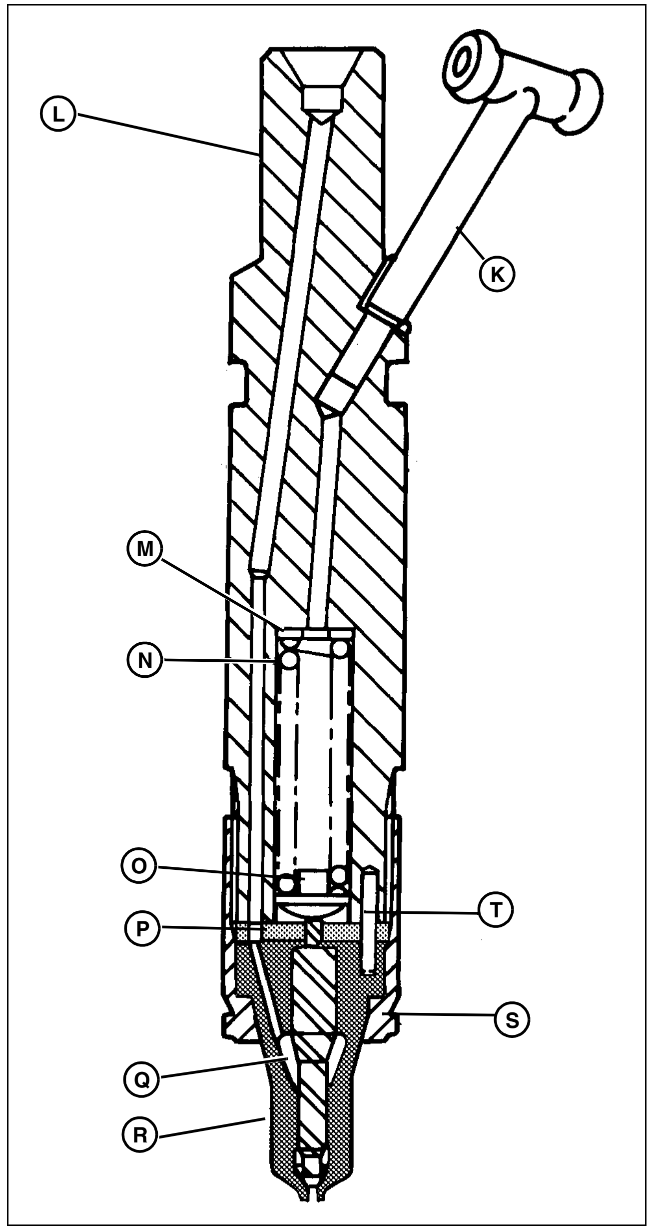
Installation

Installation is done in reverse order of removal.

- Install a new ring and heat protector when installing injection nozzles.

Disassemble and Assemble Fuel Injection Nozzles

Cross Section



M37684

K- Return Pipe

L- Injector Body

M- Shim(s)

N- Spring

O- Spring Seat

P- Separator Plate

Q- Nozzle Valve

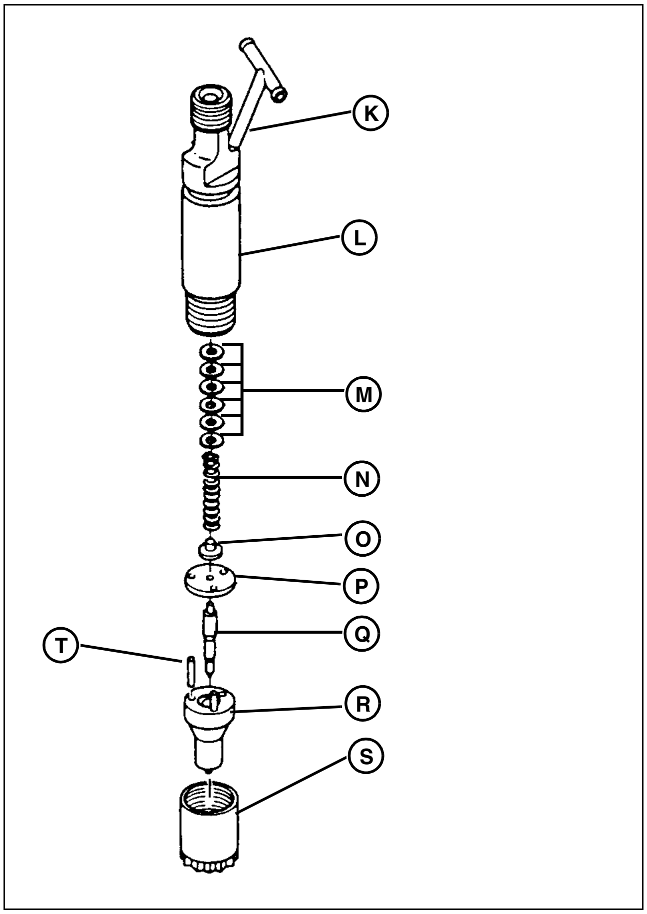
R- Nozzle Body

S- Retaining Nut

T- Index Pin

Disassemble/Assemble

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



M82093A

K- Return Pipe	P- Separator Plate
L- Injector Body	Q- Nozzle Valve
M- Shim(s)	R- Nozzle Body
N- Spring	S- Retaining Nut
O- Spring Seat	T- Index Pin

1. Remove retaining nut (S) and disassemble internal parts of injection nozzle. Keep parts organized for ease of assembly.

2. Clean and inspect nozzle assembly. See "Inspect and Clean Fuel Injection Nozzles" on page 117.

3. Carefully clamp injector body (L) in a soft-jaw vice.

NOTE: Insert the same number of shims (M) that were removed from injector. Number of shims will affect the opening pressure of the fuel nozzle and will be tested after assembly.

4. Reassemble fuel nozzle in the order shown above.

5. Tighten retaining nut to specification.

6. After assembly is complete, test injection nozzle. See "Test Fuel Injection Nozzles" on page 67.

Specifications

Fuel Injector Retaining Nut Torque. . . . 8 N•m (70 lb-in.)

Inspect and Clean Fuel Injection Nozzles

Special or Required Tools

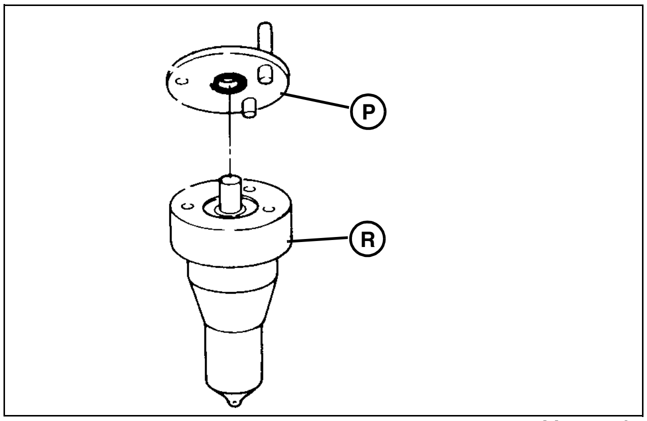
Tool Name	Tool No.	Tool Use
Fuel Injector Nozzle Cleaning Kit	JDF13	Used to clean fuel injector nozzles.

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

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

IMPORTANT: Avoid damage! 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 JDF13 Nozzle Cleaning Kit).

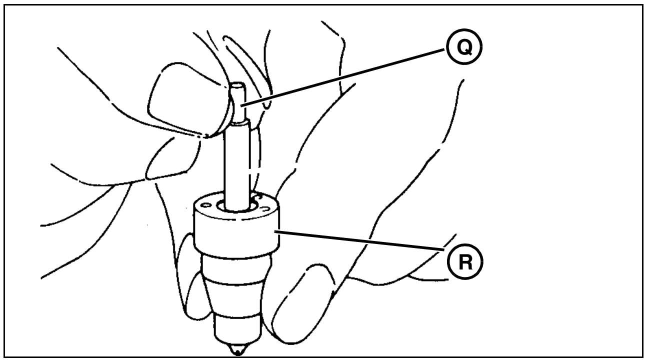


M82094A

3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate (P) and nozzle body (R) for nicks or scratches.

4. 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 specification, replace nozzle assembly.



M82095A

6. Inspect the piston (large) part of nozzle valve (Q) 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 (Q) in clean diesel fuel. Insert valve in nozzle body (R).
- 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.

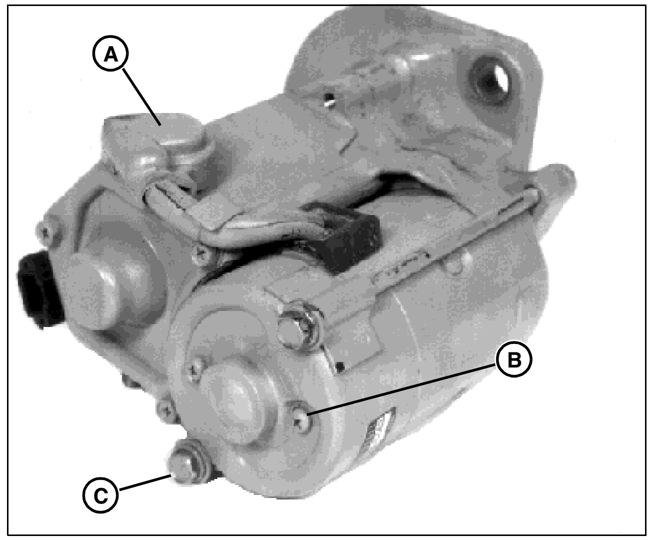
Replace nozzle assembly if the valve does not slide freely to its seat.

Specifications

Nozzle Contact Surface . . . . 0.10 mm (0.004 in.)

Disassemble and Assemble Starter Motor

Disassemble

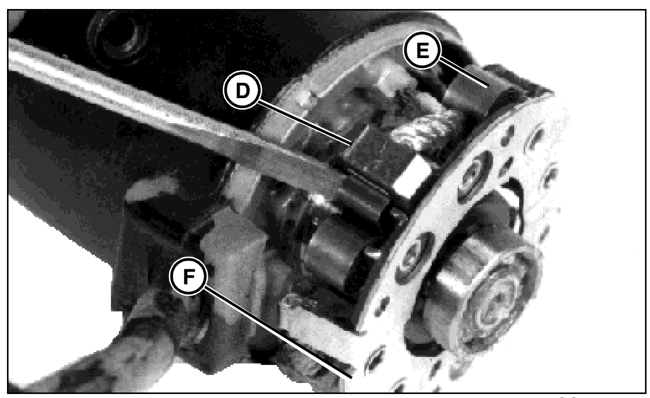


M82233

1. Disconnect field lead (A).

2. Remove two cap screws (C) that attach motor to clutch housing. Remove motor.

3. Remove two screws (B) that attach rear cover to brush holder.

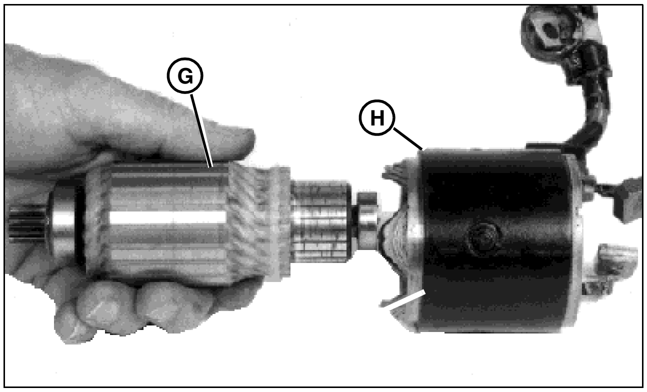


M36754

4. Remove both field coil brushes (D) from brush holder (F).

5. Pry brush springs (E) away and pull negative brushes up enough to allow spring to hold brush in place.

6. Remove brush holder.

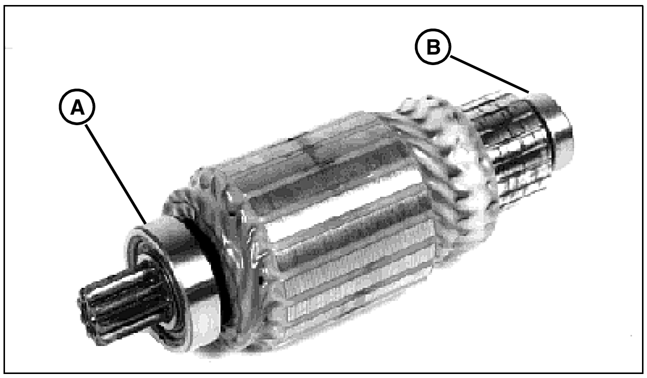


M36759

Picture Note: 1.4 kW Shown, 2.0 kW Is Similar

7. Remove armature (G) from field coil housing (H).

Replace bearings



M82237

1. Bearings are press fit. Remove bearings using a knife-edge puller set.

IMPORTANT: Avoid damage! Install both bearings with sealed side toward armature.

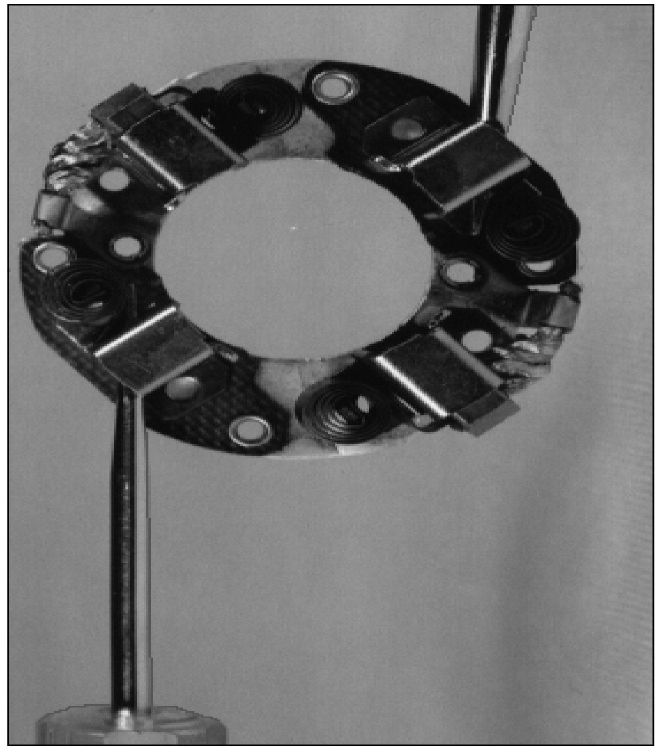
2. Install new housing bearing (A) tight against shoulder of shaft using a piece of pipe.

3. Install new rear cover bearing (B) tight against shoulder of shaft using a driver set.

4. Inspect and test brushes, holder, field coil and armature. See "Inspect and Test Starting Motor" on page 120.

Assembly

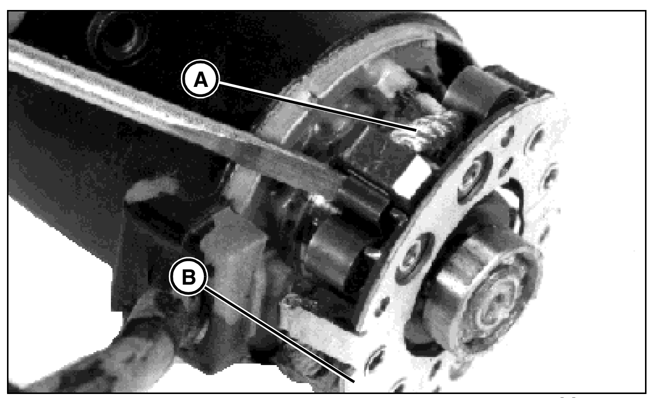
Assembly is done in the reverse order of disassembly.



M58789

NOTE: A pair of small screwdrivers inserted between the brush springs and the housing before assembly will aid in inserting the brushes.

Apply multipurpose grease to bearing cup inside rear cover.



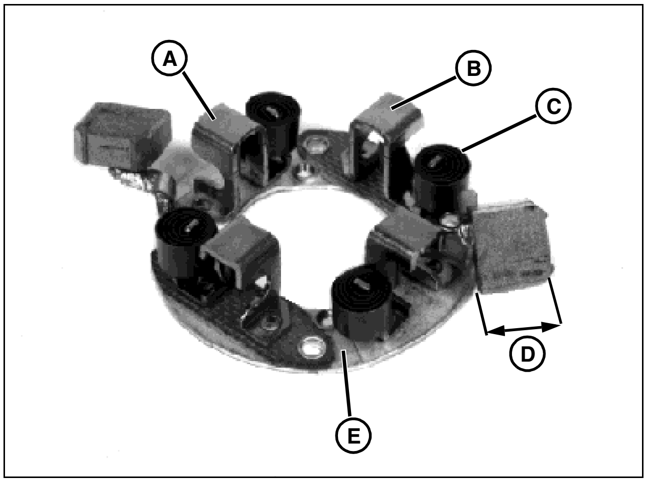
M36754

1. Turn brush holder (B) slightly to take up slack in brush wires.

IMPORTANT: Avoid damage! When installing rear cover, be sure field coil brush wires do not touch cover.

2. Press wires (A) inward to clear rear cover.

Inspect and Test Starting Motor



M82234

1. Measure brush lengths (D). Replace brush if length is below specification.

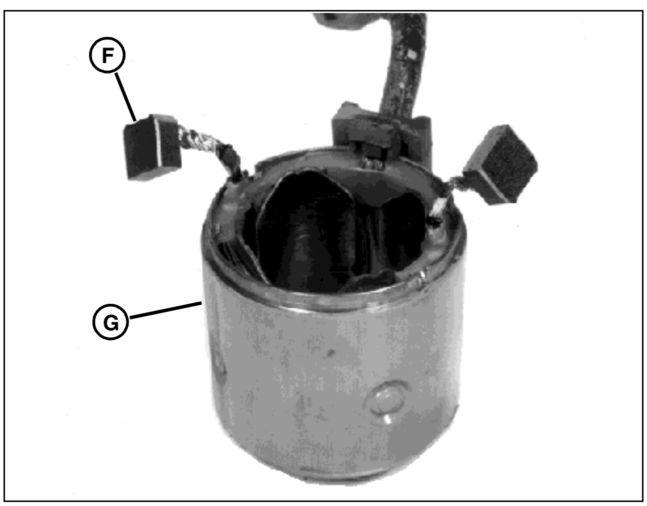
NOTE: Test brush holder using an ohmmeter or test light.

2. Test brush holder (E):

   • 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.



M82235

4. Test for grounded field winding:

   • Touch one probe of tester to field coil brush (F) and other probe to field coil housing (G).

   • 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.

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

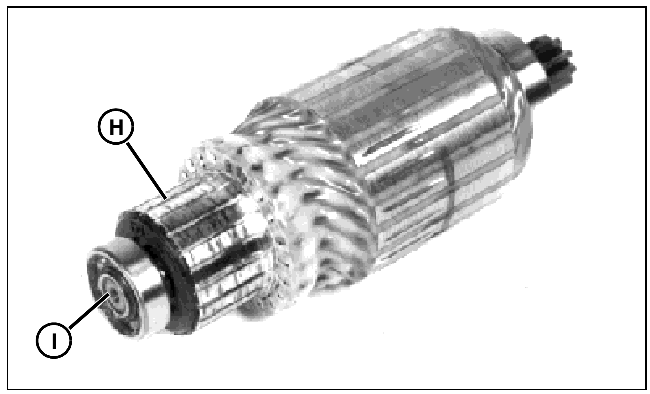
5. Test for open field coil:

   • 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.

6. Inspect armature. Look for signs of dragging against pole shoes.

7. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400-grit sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

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



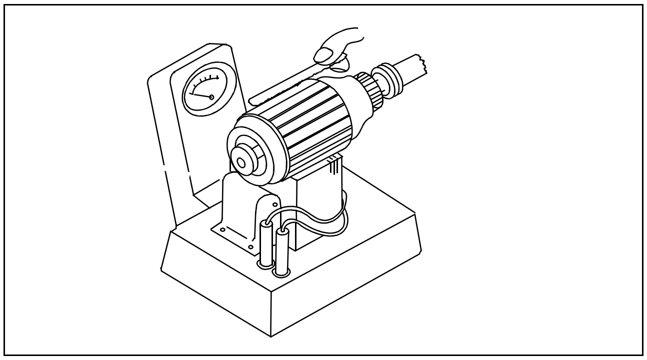
M82236

8. Test for grounded windings:

   • Touch probes on one commutator bar (H) and armature shaft (I). 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 circuit windings:

   • Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



MIF

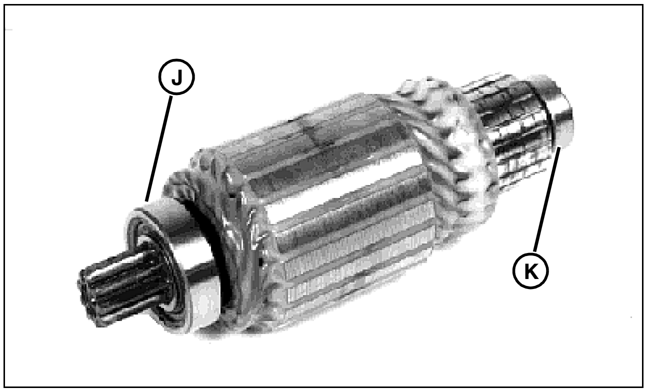
10.Test for short circuit windings using a growler.

- 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 circuit windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

12.Inspect armature cover and housing bearings for wear or damage. Replace if necessary.



M82237

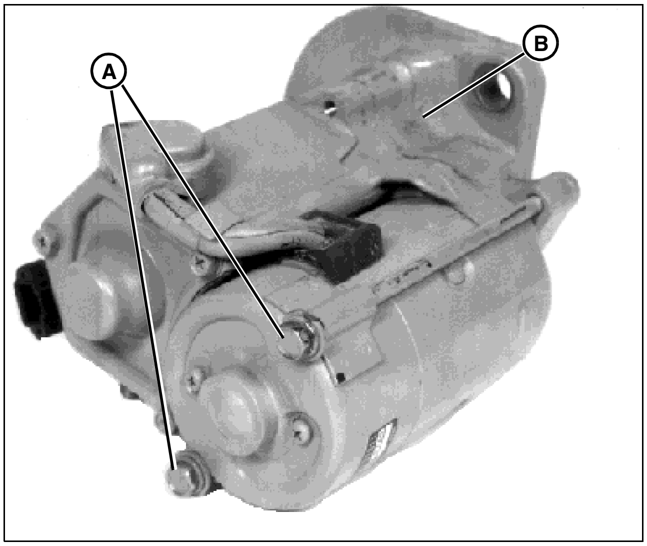
13.See "Disassemble and Assemble Starter Motor" on page 118, if replacement of bearings (J and K) is necessary.

Specifications

Brush Length (Minimum) . . . . 8.5 mm (0.335 in.)

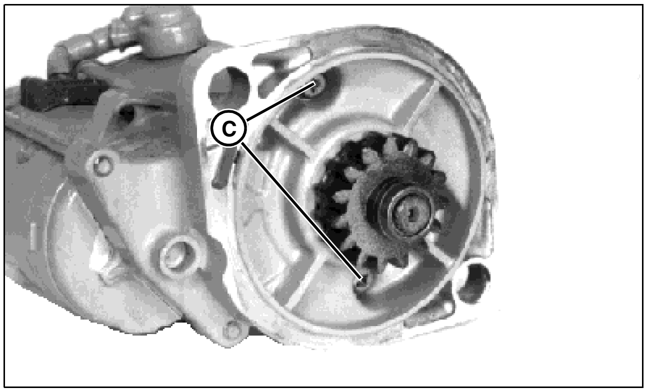
Disassemble and Assemble Starter Gear Train

Disassemble



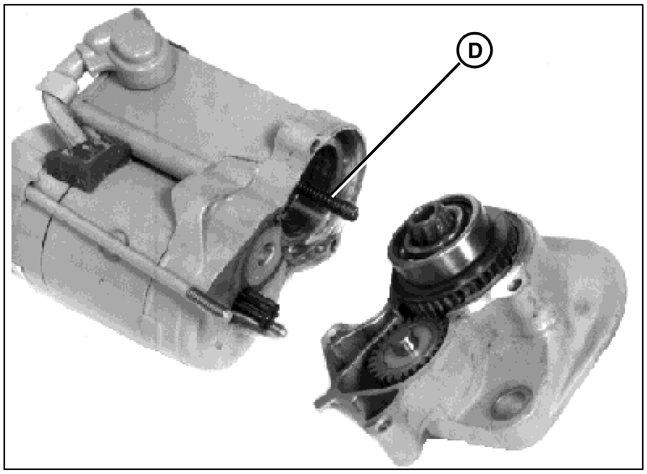
M82233

1. Remove field wire and two motor-to-clutch housing cap screws (A).
2. Remove motor from clutch housing (B).



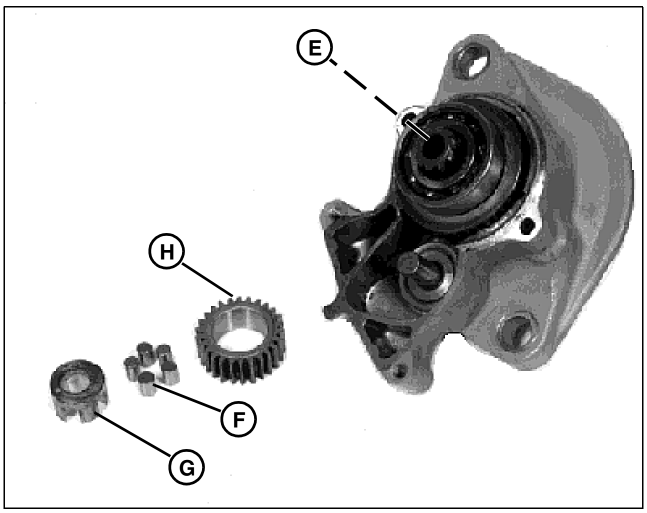
M82238

3. Remove two clutch housing-to-solenoid housing screws (C) to separate clutch housing from solenoid/motor assembly.



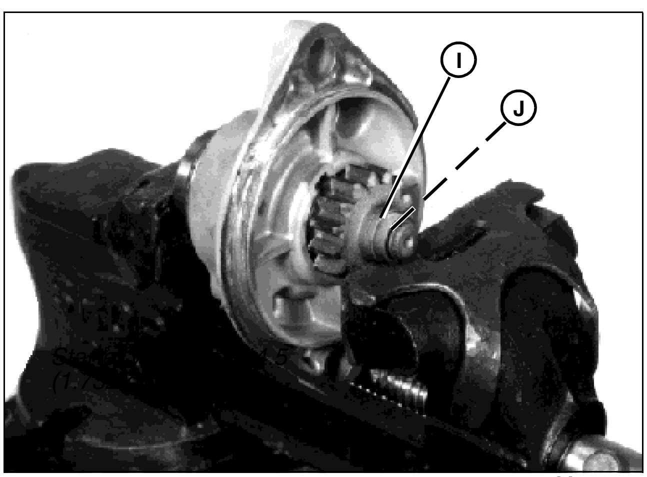
M82239

4. Remove plunger spring (D).



M82240

5. Remove retainer (G), five rollers (F) and pinion gear (H).
6. Remove steel ball (E).



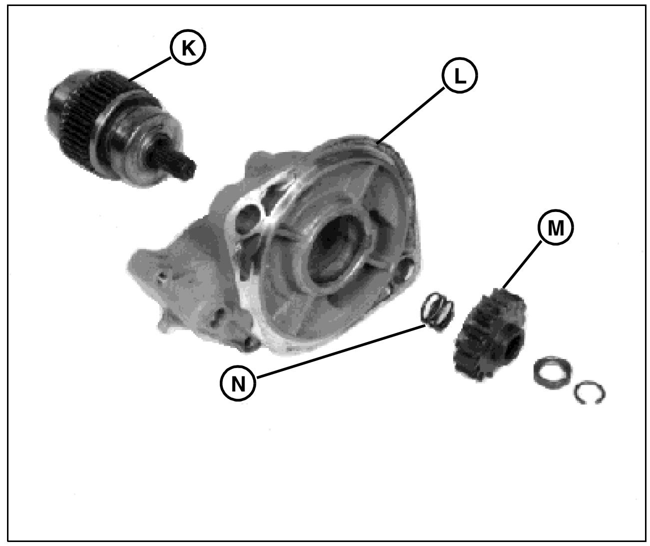
M82241

7. Place clutch (housing) assembly into a soft-jawed vise, as shown.

8. Tighten vise slowly, until drive gear compresses.
9. Remove retainer (I) and circlip (J).

> **CAUTION: Avoid injury! Shaft could be propelled from clutch unit with considerable force if spring is not allowed to extend fully while in vise.**

10.While holding clutch assembly, slowly open vise until all spring compression is relieved.

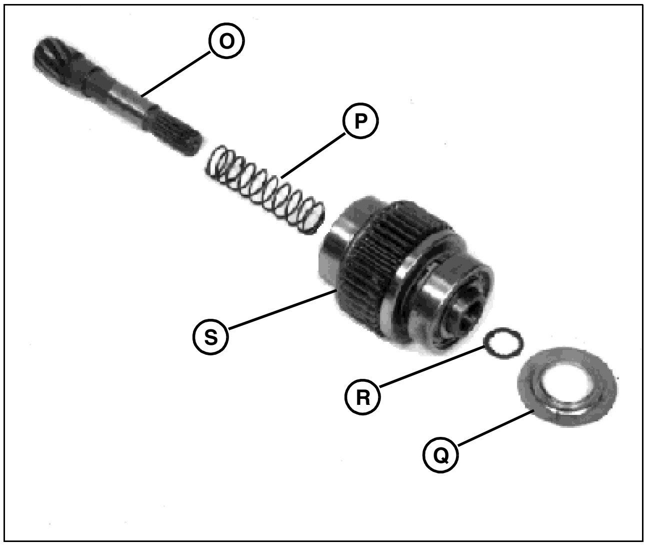


M82242

11.Remove drive gear (M), spring (N) and clutch assembly (K) from housing (L).

12.Remove large washer, toothed washer, spring and clutch shaft.

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



M82243

14.Remove large washer (not applicable to all models) (Q), toothed washer (R), spring (P) and clutch shaft (O) from clutch (S).

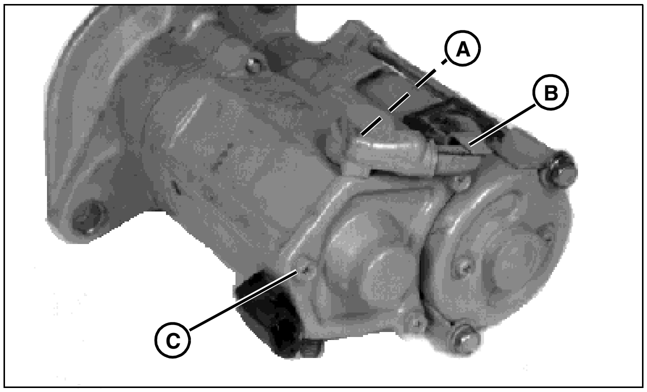
Assemble

Assembly is done in the reverse order of disassembly.

- Apply multipurpose grease to bearings, clutch shaft, springs, pinion gears, retainer, rollers and steel ball.
- Install large washer (not applicable to all models) with flat side toward clutch assembly.
- Install retainer with cupped side away from clutch assembly.

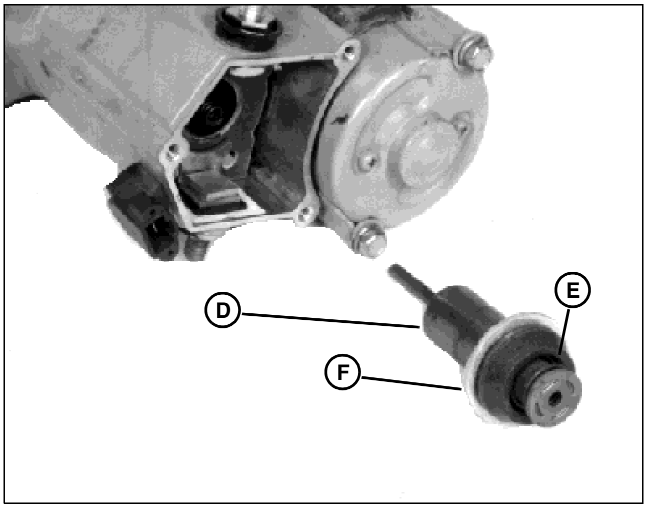
Disassemble, Inspect and Assemble Starter Solenoid

Disassemble



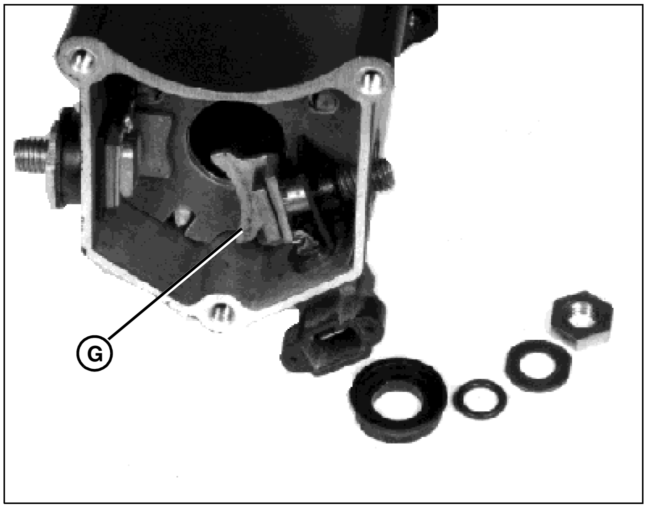
M82244

1. Disconnect field lead (A).
2. Remove three screws (C) and clip (B).
3. Remove cover and gasket.



M82245

4. Remove plunger (D).
5. Inspect the copper washer (F) and spring (E)



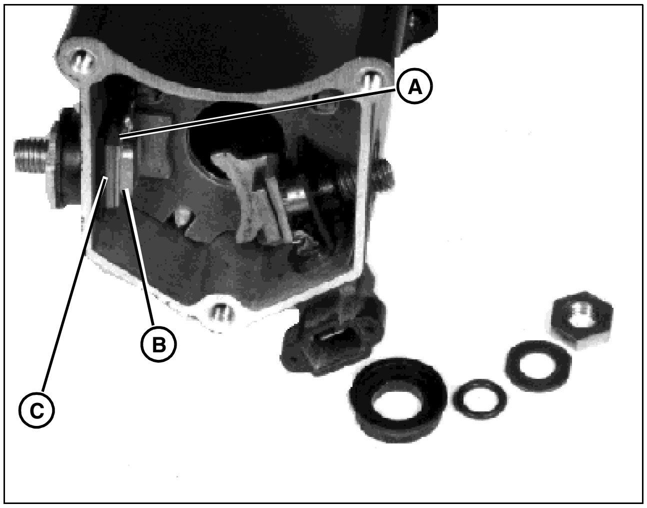
M36771

6. Inspect the contact plates (G) for excessive burning or pitting. Contacts and plunger come as a kit. If contacts or plunger are defective, replace all the parts with the kit.

Assemble

Assembly is done in the reverse order of disassembly.

NOTE: The assembly sequence of the left and right terminals is similar. Make sure smaller contact plate is on the left side.



M36771

- Install solenoid terminal lead (A) between terminal bolt (B) and contact plate (C).

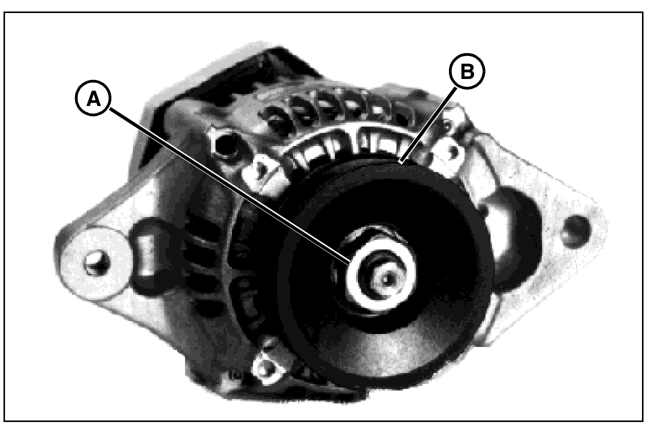
Disassemble, Inspect and Assemble Alternator

Special or Required Tools

Tool Name	Tool No.	Tool Use
Volt-Ohm-Amp Meter	NA	Used to test alternator components.

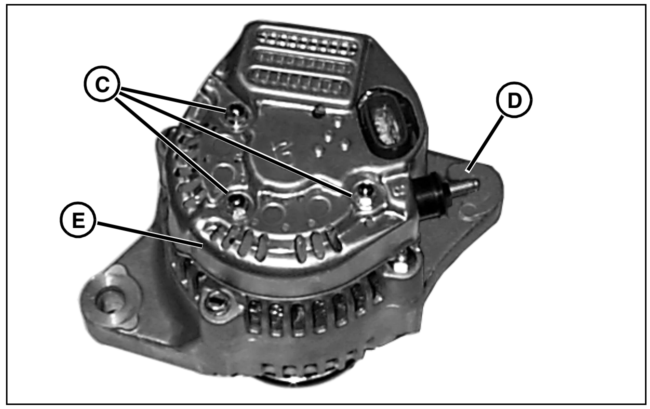
Disassemble

NOTE: Clamp the pulley in a soft-jawed vise and use an air impact wrench to remove the pulley nut.



M52469

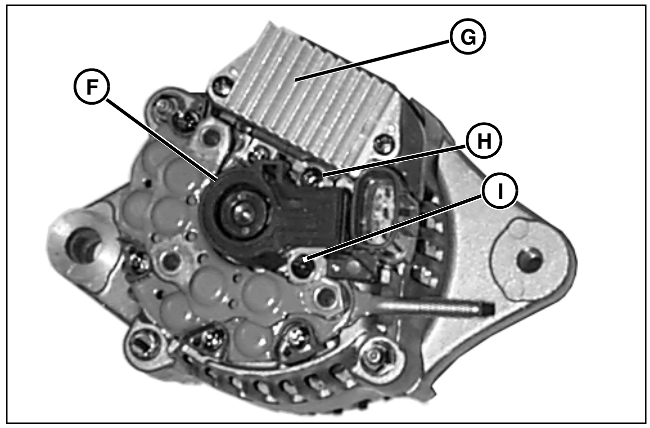
1. Remove the pulley nut (A) and pulley (B).



M52470

2. Remove the nut, washer and insulator from the battery terminal post (D).

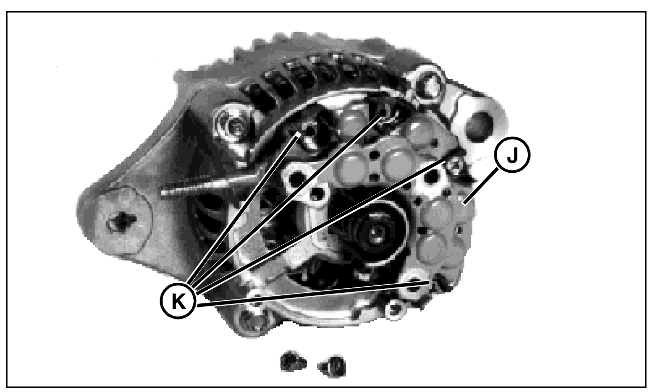
3. Remove three screws (C) securing the cover (E) to the body. Remove the cover.



M52472

4. Note the location of the short screw (H) on the regulator tab, and the long screw (I) on the brush holder. Remove two screws securing the brush holder and cover (F) to the body. Remove the brush holder and cover.

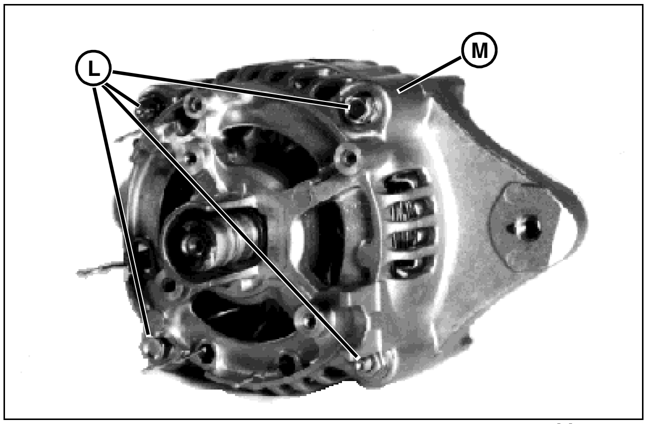
5. Remove the three screws securing the voltage regulator (G) to body. Remove the voltage regulator.



M52471

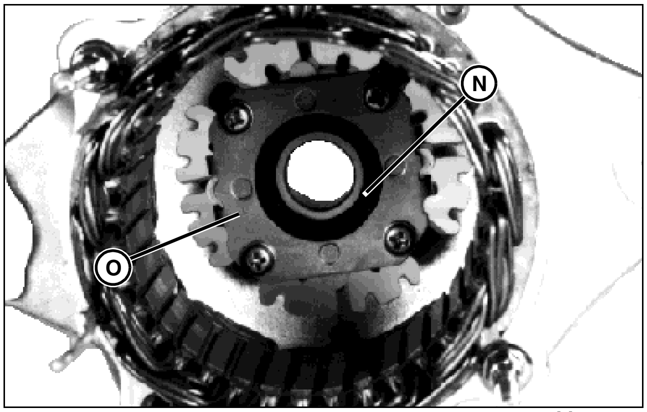
6. Remove four screws (K) and straighten the wire leads.

7. Remove the rectifier (J).



M52473

8. Remove cap screws and nuts (L) and slide off the rear case assembly (M).



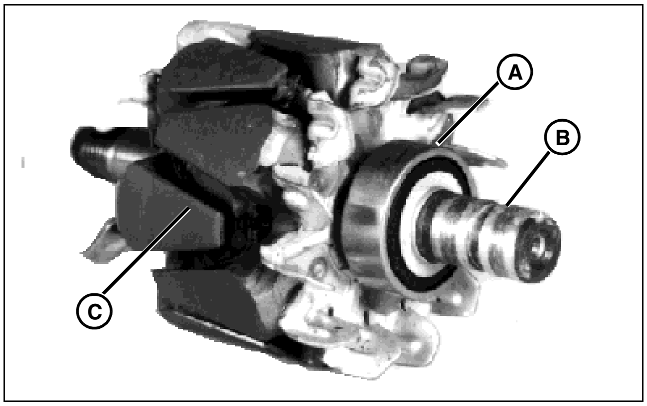
M52475

9. Slide the rotor out of the front frame.

10.Remove the bearing retainer plate (O).

11.Press bearing (N) from the case.

Inspect



M52474

1. Inspect bearing (A) for smooth rotation. Replace if necessary.

2. Inspect slip rings (B) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish the rings.

3. Measure the outer diameter of the slip rings. Replace the rotor if less than specification.

4. Check for continuity between slip rings using an ohmmeter or continuity tester. Replace the rotor assembly if there is no continuity.

5. Check for continuity between the slip rings and the rotor core (C). Replace the rotor assembly if there is continuity.

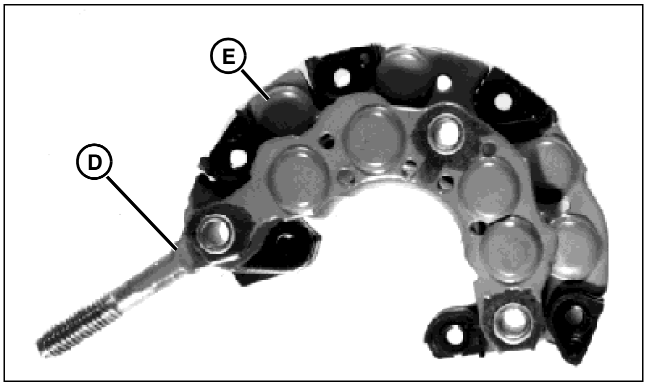
NOTE: Use an ohmmeter that is sensitive to 0-1 ohm.

6. Inspect the stator for defective insulation, discoloration, or burned odor.

NOTE: The stator is not serviced separately. If the stator is bad it must be replaced as part of the frame assembly.

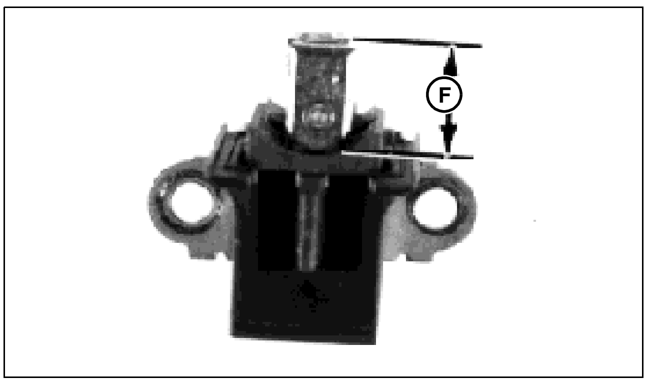
7. Check for continuity between each of the four stator leads and the body. Replace the frame assembly if there is continuity.

NOTE: Set the ohmmeter to the K-ohm range.



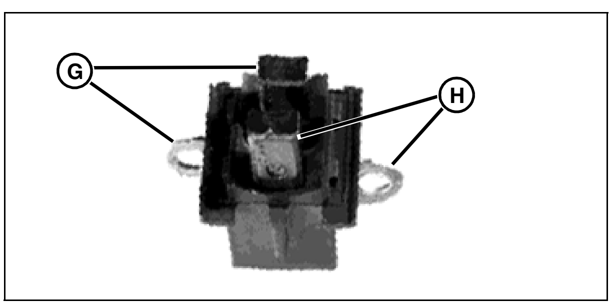
M52477

8. Check for continuity between the main lead (D) and each diode lead (E). Reverse the ohmmeter leads and recheck. If there is continuity in one direction, but not the other, the diode is working correctly. Replace any diode or rectifier plate that is not working correctly.



M52478

9. Measure the length of the brush protruding from the holder (F). Compare dimension with minimum specification. Replace the brushes if worn below the minimum. Check maximum exposed new brush length and compare with specification.



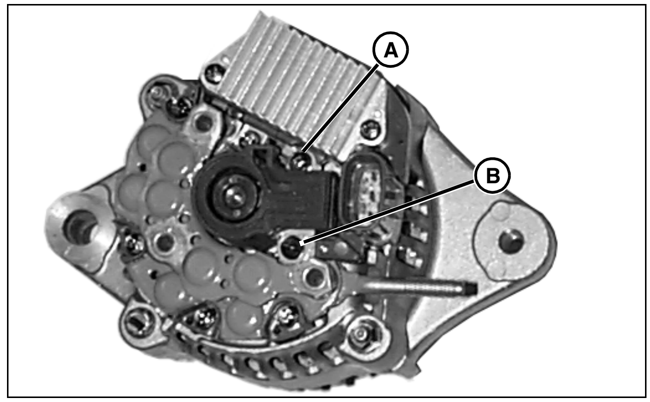
M52479

10.Check for continuity between the brush and terminal (G). Check for continuity between the brush and terminal (H). There should be continuity only at these points.

Assemble

Assembly procedure is the reverse of disassembly.

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



M91674

IMPORTANT: Avoid damage! If the longer screw is installed in the wrong position it will contact the frame and will cause damage to the charging system.

1. Install the short screw in slot (A) and install the longer screw in slot (B).

2. Clamp the pulley in a soft-jawed vise. Install the pulley nut. Tighten the nut to specification.

Specification

Slip Ring Diameter (Min) . . . . 14 mm (0.55 in.)

Exposed Brush Length (Minimum). . . 4.5 mm (0.17 in.)

Exposed Brush Length (Maximum) . 10.5 mm (0.41 in.)

Pulley Nut Torque. . . . . 69 N•m (51 lb-ft)

Table of Contents

Specifications

General Specifications

Battery

Voltage	12
BCI Group	45
CCA Rating at -18°C (0°F)	480
Reserve Capacity (Minutes)	80
Specific Gravity	1.225 or above
Load Test for 5 Seconds (Minimum)	480 amps

Starter

Type	Solenoid shift
Loaded (On Vehicle) Draw - 3215/3215A/3215B (1.0 kW) at 300 rpm (Max)	225 amps
Loaded (On Vehicle) Draw - 3225B/3235/3235A/3235B (1.2 kW) at 300 rpm (Max)	300 amps
No Load (Free Spinning) Draw - 3215/3215A/3215B (1.0 kW) at 3000 rpm (Max)	90 amps
No Load (Free Spinning) Draw - 3215/3225B/3235/3235A/3235B (1.2 kW) at 3000 rpm (Max)	120 amps

Alternator

Type	Nippondenso
Regulator	Internal
Rating	40 amps
Regulated Amperage (Min)	35 amps
Unregulated Amperage (Min)	35 amps
Regulated Voltage	12.2-14.8 volts
Resistor at 25°C (77°F)	47-53 ohms
Tachometer Output (“P” Terminal) (Min)	6.3 volts

Engine Coolant Temperature Sensor Resistance

At 20°C (77°F)	2.21-2.69 k-ohms
At 0-30°C (32-86°F)	1.65-5.88 k-ohms

Fuel Shut-Off Solenoid

Pull-In Amperage for 1/2 Second (Max)	60 amps
Hold-In Amperage Continuous (Max)	1 amp

Hydraulic Oil Temperature Sensor Resistance

At 20°C (68°F)	2.21-2.69 k-ohms
At 0-30°C (32-86°F)	1.65-5.88 k-ohms

Air Manifold Heater

Resistance	0.70-1.65 ohms

Lighting

Headlights (halogen)	37.5 watts
Tail Lights	21 watts

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to test battery.
Battery Tester	JT05685	Used to test battery. Used to test alternator amperage and voltage.
Battery Charger (variable rate) (use according to manufacturer's instructions)	NA	Used to charge battery. Used to test starter loaded amperage draw.
Digital Multimeter	JT05791	Used to test alternator amperage and voltage. Used to test various switches. Used to test relays. Used to test fuel shut-off solenoid. Used to test fuse continuity. Used to test mow valve solenoid. Used to test lift valve solenoid. Used to test fuel level sender.
Ammeter Shunt Assembly	JT05792	Used to test alternator amperage and voltage.
Two (2) Jumper Wires	NA	Used to test starter solenoid. Used to test relays. Used to test fuel shut-off solenoid.
Two (2) Jumper Cables	NA	Used to test starter solenoid.
12-Volt Battery	NA	Used to test starter solenoid. Used to test relays.

General Information

Theory of Operation Information

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

Diagnostic Information

The diagnostic procedures are 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

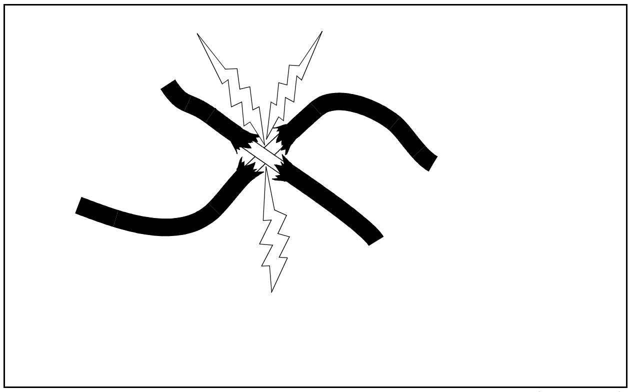
When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. The middle "NORMAL" column gives the reading or condition that should be obtained when performing the test or check. If the results of the test or check are not normal, perform 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 in Tests and Adjustments or Repair. The system diagram that accompanies each test procedure is drawn to resemble machine components.

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.

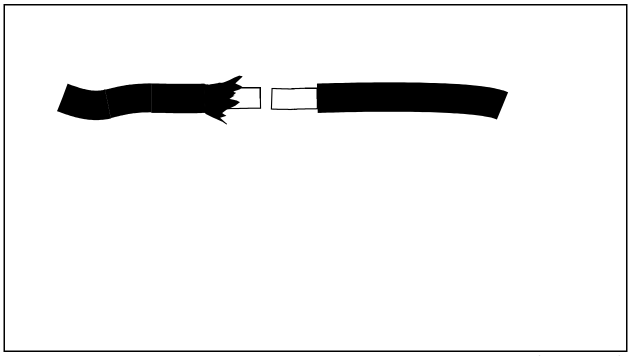


MIF (M85600)

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:

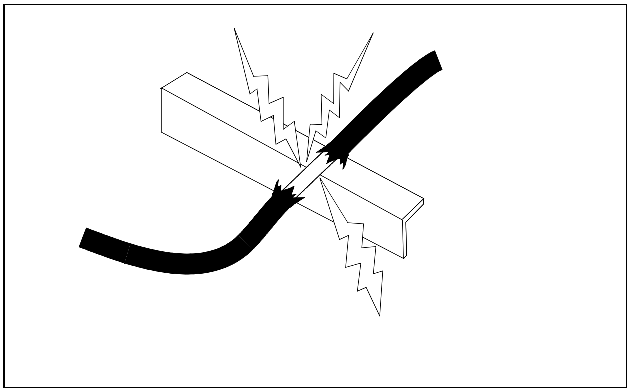
1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

Grounded Circuit

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



MIF (M85602)

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.

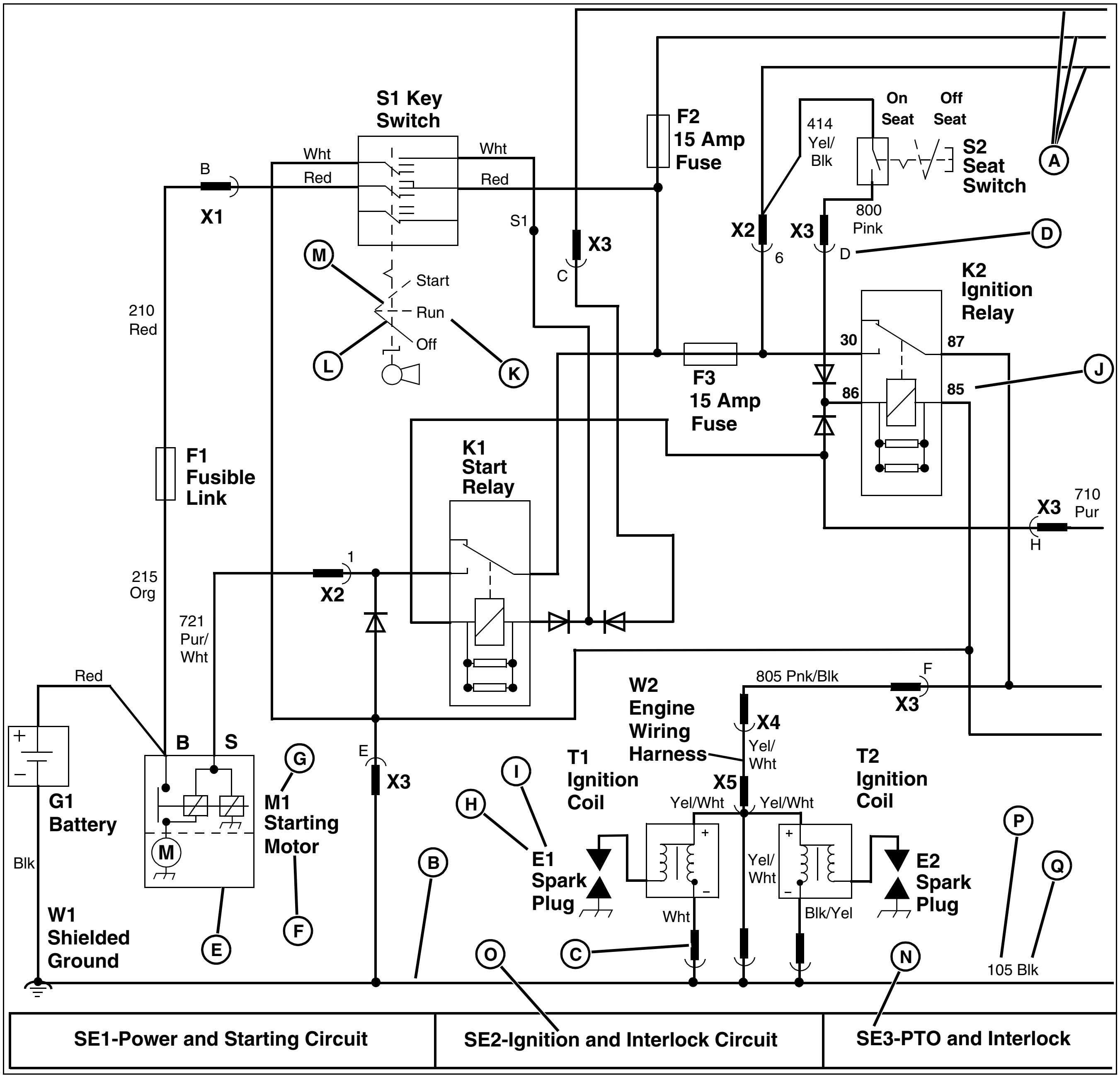
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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.



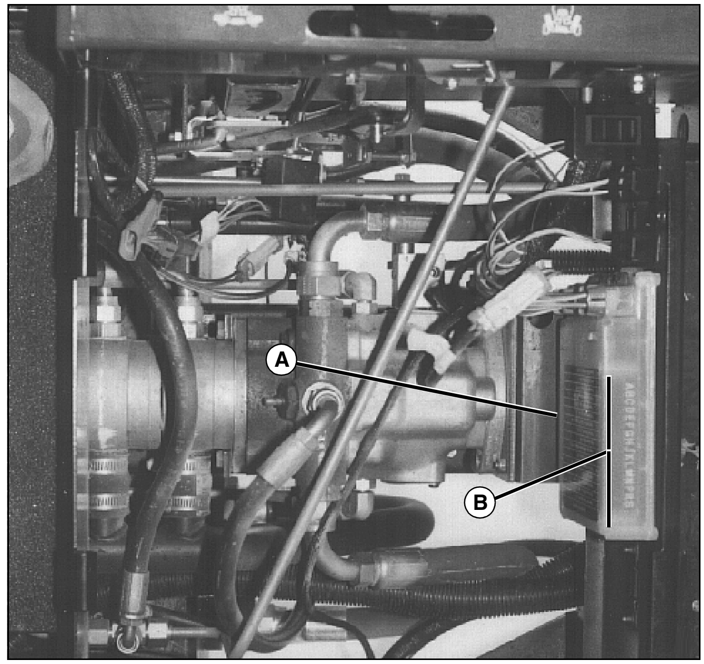
S1 Key Switch
Wht
Red
Wht
Red
S1
B
X1
210 Red
F1 Fusible Link
215 Org
721 Pur/ Wht
Red
G1 Battery
Blk
W1 Shielded Ground
B
S
M1 Starting Motor
Start
Run
Off
X2
1
X3
C
E
K1 Start Relay
F2 15 Amp Fuse
F3 15 Amp Fuse
414 Yel/ Blk
On Seat
Off Seat
S2 Seat Switch
800 Pink
X2
6
X3
D
K2 Ignition Relay
30
87
86
85
X3
710 Pur
H
W2 Engine Wiring Harness
805 Pnk/Blk
F
X4
Yel/ Wht
X5
Yel/Wht
Yel/Wht
T1 Ignition Coil
T2 Ignition Coil
E1 Spark Plug
E2 Spark Plug
Wht
Blk/Yel
105 Blk
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
SE1-Power and Starting Circuit
SE2-Ignition and Interlock Circuit
SE3-PTO and Interlock

MIF

Wire Color Abbreviation Chart

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

Control Module



M56619

The electronic control module (A) is located under the operator seat on the bulkhead between the engine compartment and the hydraulic compartment. The control module performs the following functions:

• Monitors and displays vehicle operating conditions with 16 Light Emitting Diodes (LEDs) (B).

Provides a fast diagnostic tool for verifying operation of vehicle circuits.

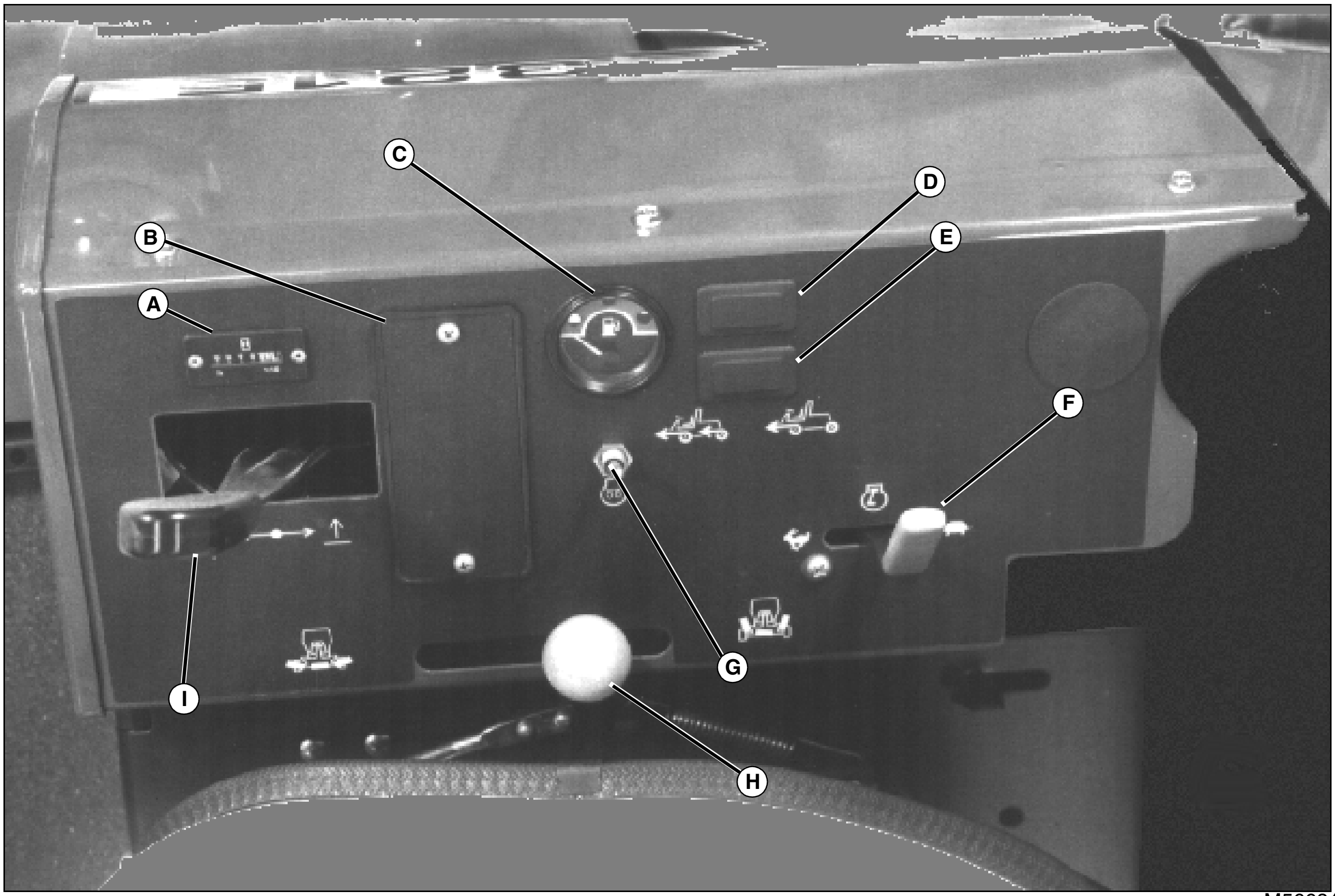
LED Legend

DIAGNOSTIC LIGHTS	
S	Brake OFF from Ign/Hold JI - IA
R	Input from RAISE JI - 2B
P	Neutral Start Input to Hold JI - IOK
N	Seat Input JI - 7G
M	Input from Mow Sustain Switch JI - 3C
L	Service Switch Input JI - 5E
K	Lower Input (Momentary Closed) JI - 8H
J	Mow Switch ON JI - 6F
H	Switched Power IN J3 - 3C
G	Output to Pull-In Coil (0.7 sec) J3 - 5E
F	Seat/Brake Switch J3 -1A
E	Forward Mow Power J2 - IA or 2B
D	Output to Raise Coil (2 sec) J2 - 8H
C	Park Lock/Neural Switches J2 - 8H
B	Hold Coil Output J2 - 5E
A	Reverse Mow Power J2 - 3C

MIF

Component Location

Operator Controls and Indicators



M56681

A - Hour Meter
B - Indicator Light Module
C - Fuel Gauge
D - Light Switch (Optional)
E - Four Wheel Drive Switch (Optional)
F - Throttle Lever
G - Cold Start Switch
H - Mow/Transport Lever
I - Lift/Lower Lever

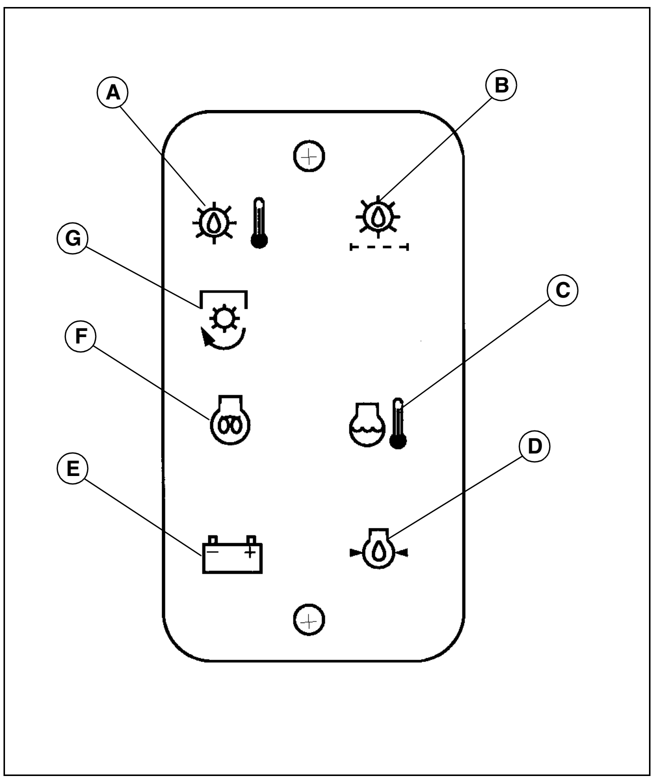
Indicator Light Module

The indicator light module has indicators for the following systems:

- Hydraulic Oil Temperature (HYDRO OVERTEMP)
- Engine Coolant Temperature (ENGINE OVERTEMP)
- Air Preheater (COLD START WAIT)
- Reel Engagement (REEL ENGAGEMENT)
- Battery Low (DISCHARGE)
- Engine Oil Pressure (ENGINE OIL PRES)
- Hydraulic Oil Pressure (HYDRO OIL PRES)

In addition to the above indicators, there is an indicator located under the cold start switch that will light when the cold start switch is used in cool weather and will go out when the operator releases the switch.

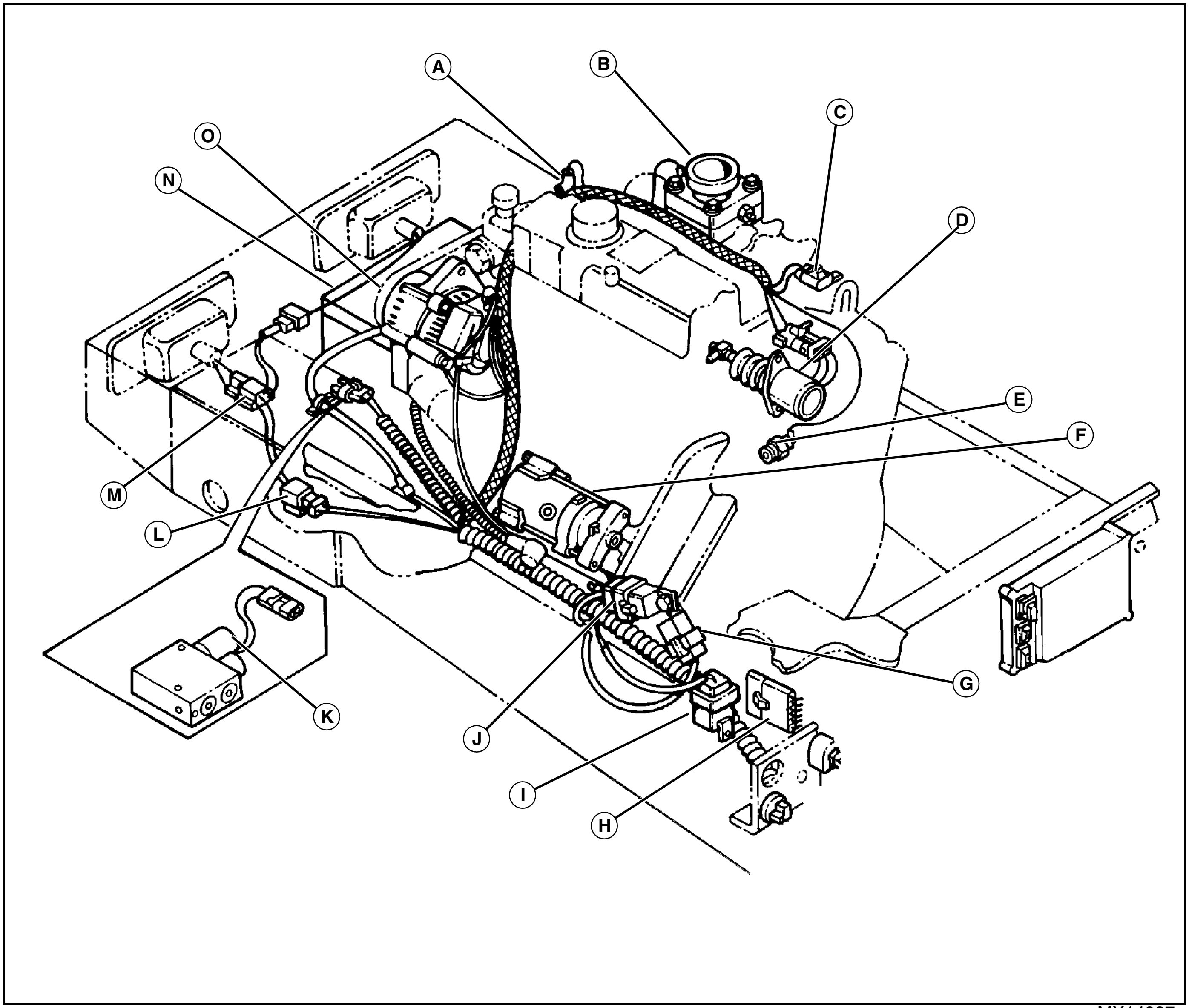
Indicator Light Module



M57571

A - Hydraulic Over temperature Light
B - Hydraulic Oil Pressure Light
C - Engine Over temperature Light
D - Engine Oil Pressure Light
E - Battery Discharge Light
F - Cold Start Wait Light
G - Reel Engagement Light

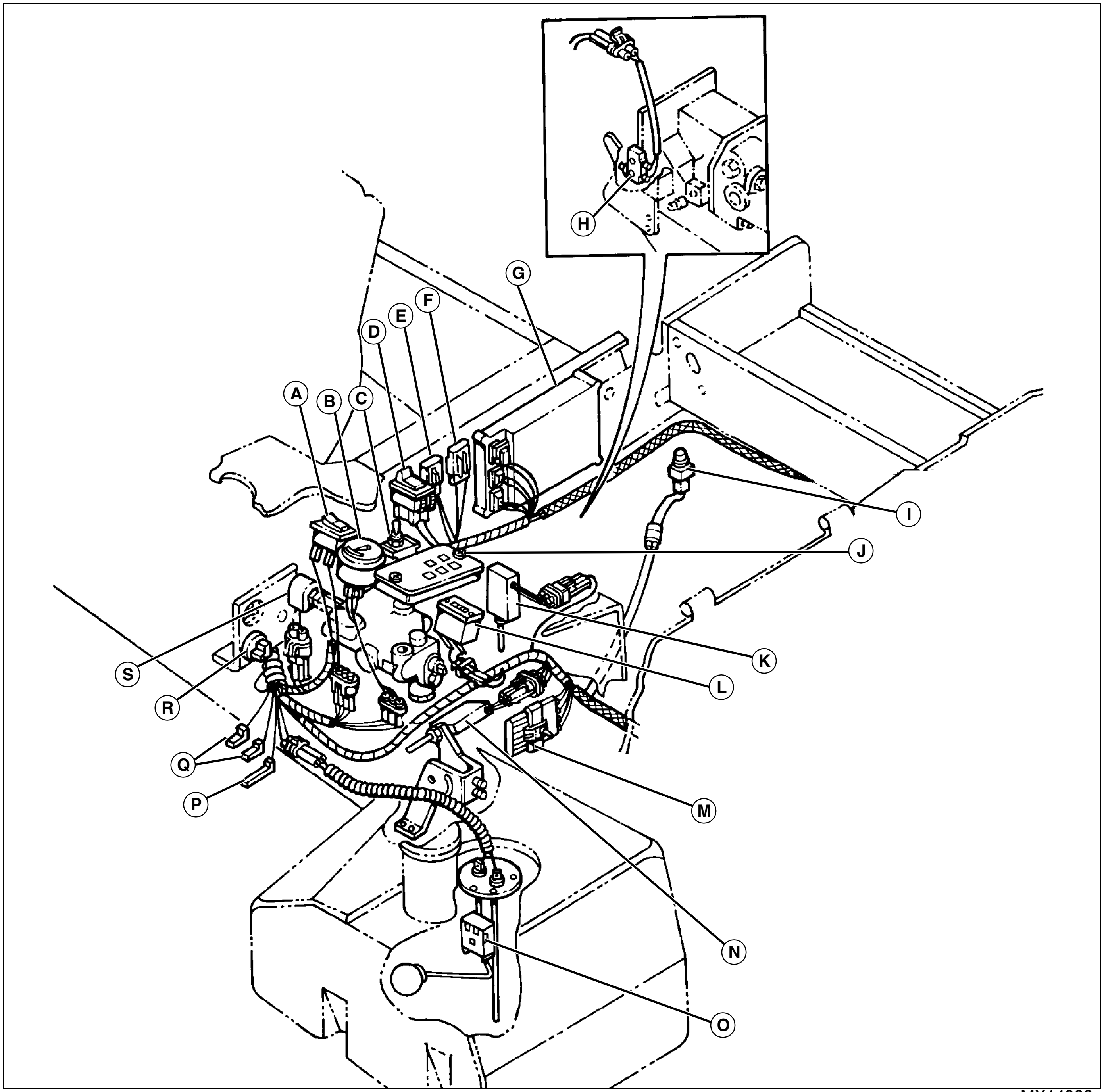
Component Location - 3215 and 3235



MX14987

Picture Note: 3215 and 3235 Illustrated

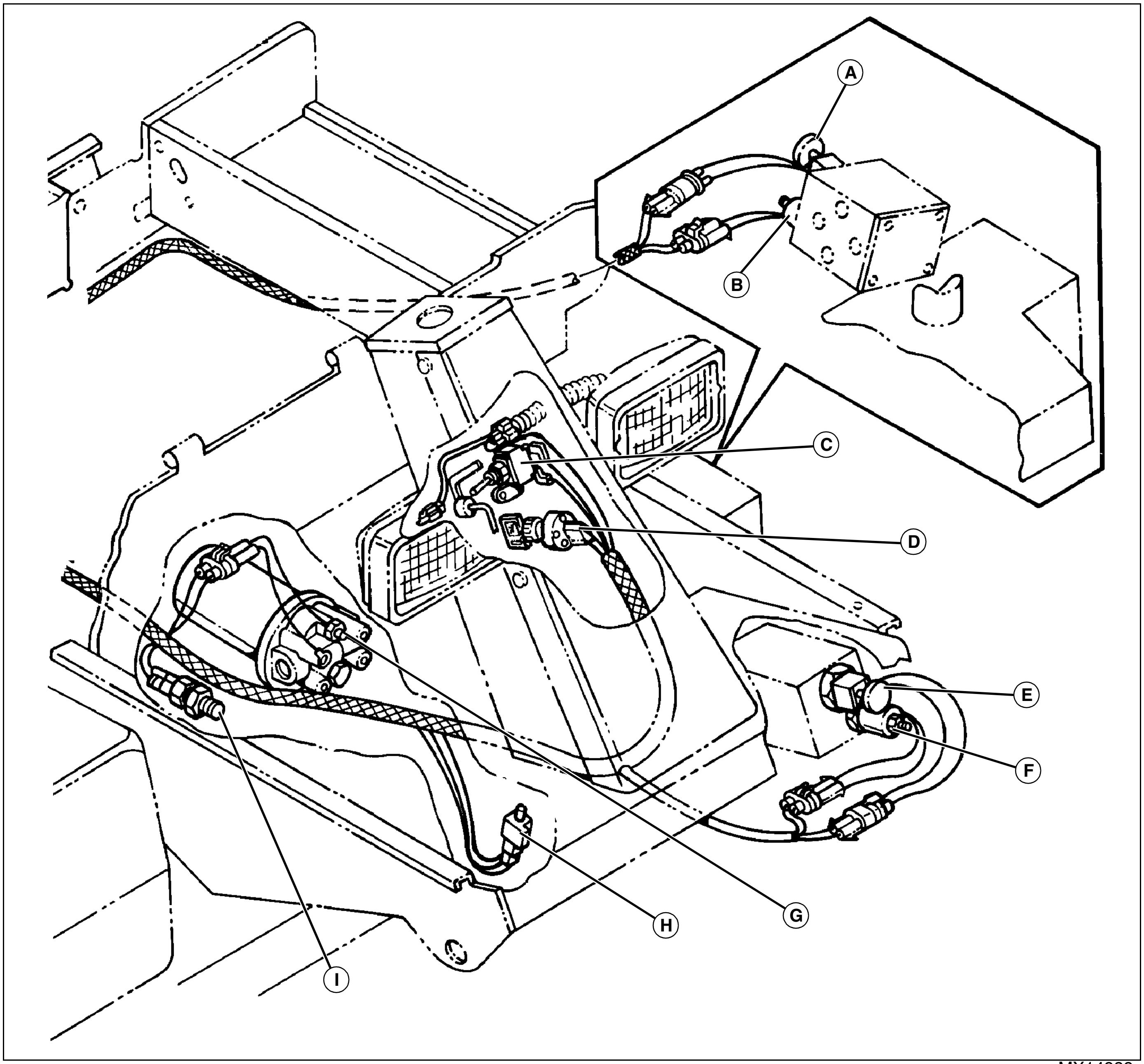
A - Engine Over temperature Switch
B - Air Heater
C - Fuel Shutoff Solenoid Protection Diode
D - Fuel Shutoff Solenoid
E - Engine Oil Pressure Switch
F - Starter
G - Start Relay
H - 7 Diode Pack
I - Pull-In Coil Relay
J - High Current Relay
K - Four Wheel Drive Solenoid (Option)
L - Taillights Connector
M - Taillights Harness
N - Battery
O - Alternator



Picture Note: 3215 and 3235 Illustrated

- **A - Four Wheel Drive Switch (Optional)**
- **B - Fuel Gauge**
- **C - Cold Start Switch**
- **D - Service Switch**
- **E - Fuse 20A**
- **F - Fuse 10A**
- **G - Control Module**
- **H - Neutral Switch**
- **I - Seat Switch**
- **J - Indicator Lights Panel**
- **K - Raise/Lower Switch**
- **L - Hour Meter**
- **M - Diode Pack AMT477**
- **N - Mow/Transport Switch**
- **O - Fuel Level Sensor**
- **P - Cab Auxiliary Connector**
- **Q - Lights Switch Connectors**
- **R - Warning Buzzer**
- **S - Raise/Hold Coil**

ELECTRICAL COMPONENT LOCATION

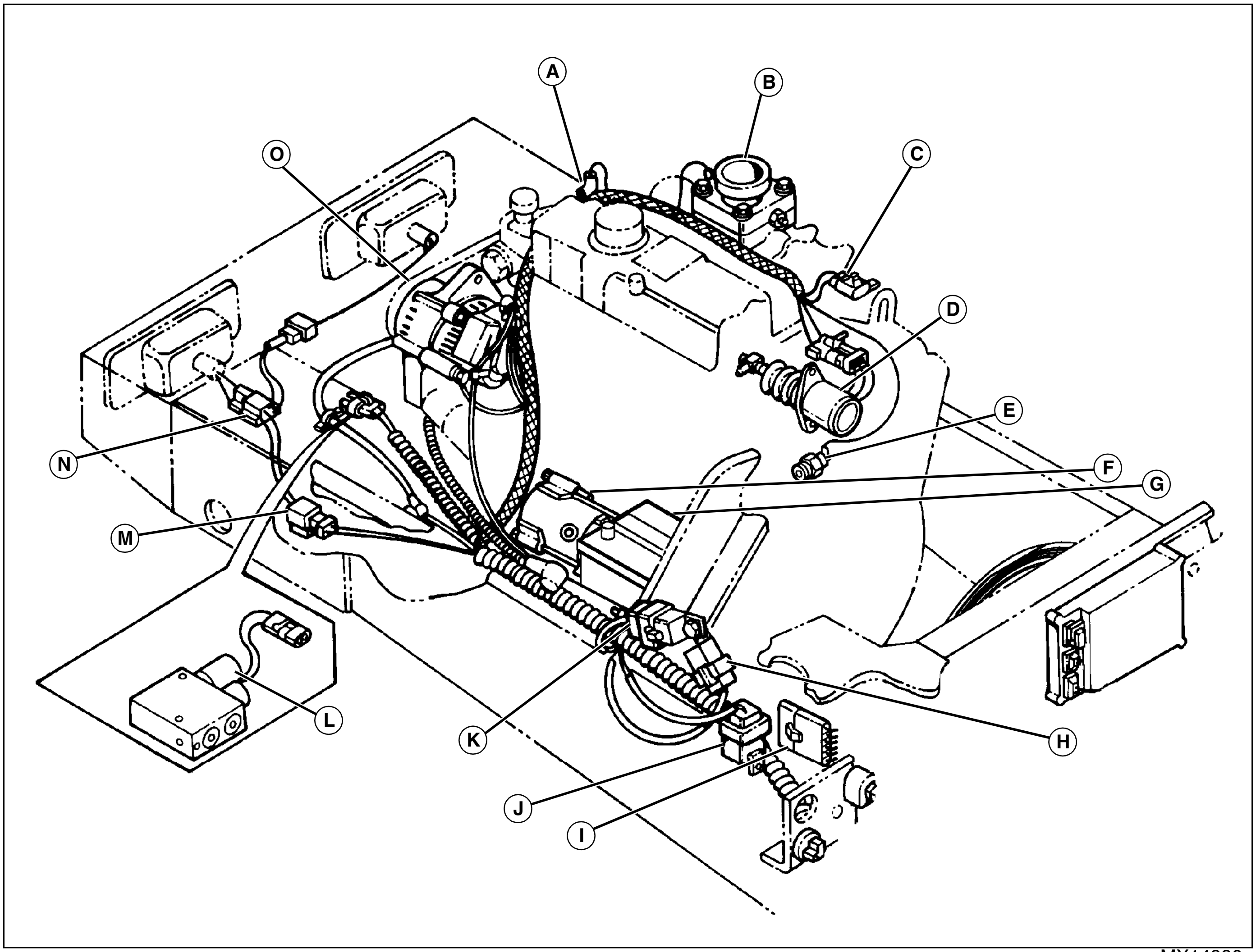


MX14989

Picture Note: 3215 and 3235 Illustrated

A - Rear Backlap Switch
B - Rear Mow Valve Solenoid
C - Park Lock Switch
D - Ignition Switch
E - Front Backlap Switch
F - Front Mow Valve Solenoid
G - Hydraulic Oil Pressure Switch
H - Brake Switch
I - Hydraulic Oil Temperature Sensor

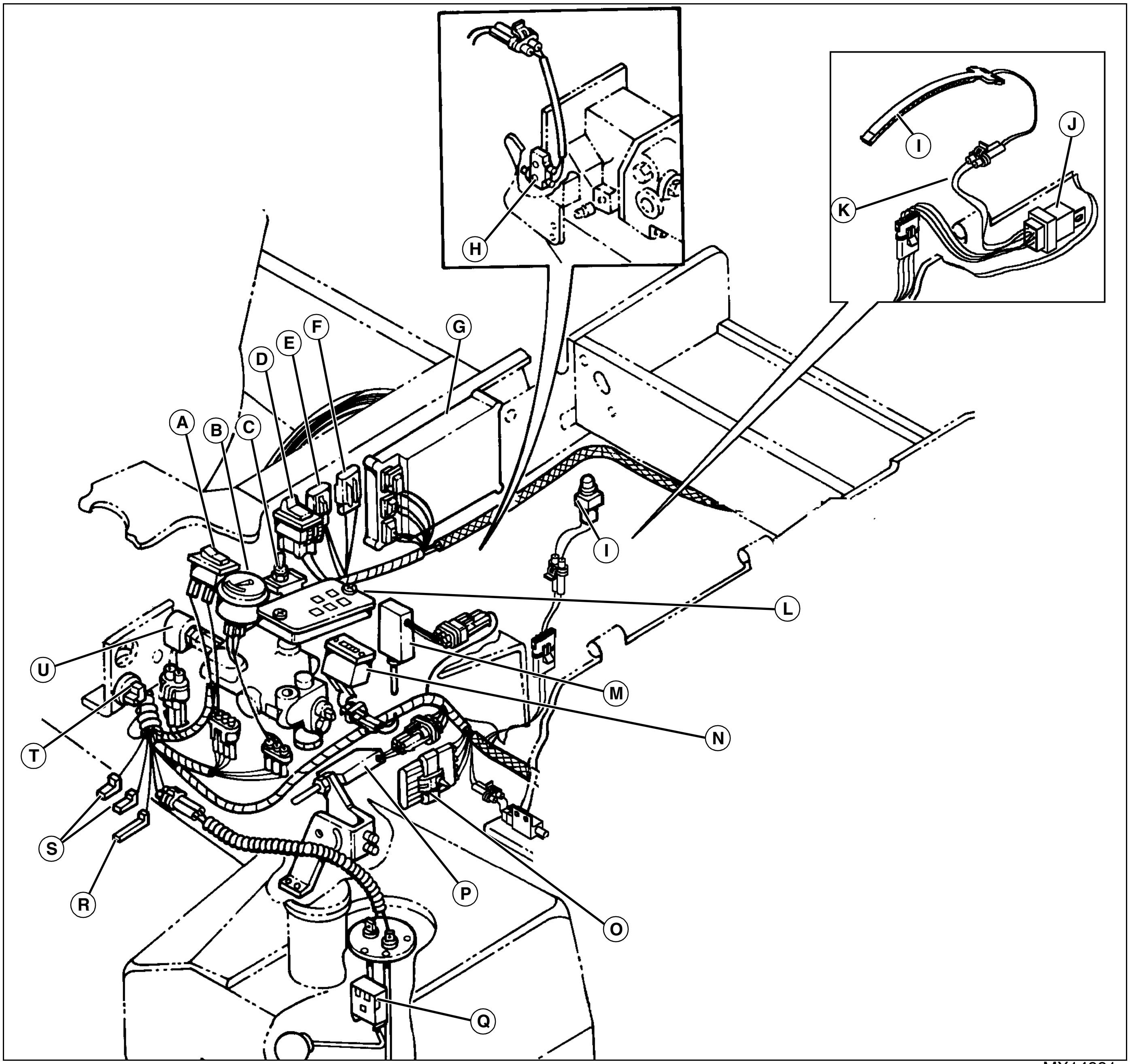
Component Location - 3215A, 3215B, 3225B, 3235A and 3235B



MX14990

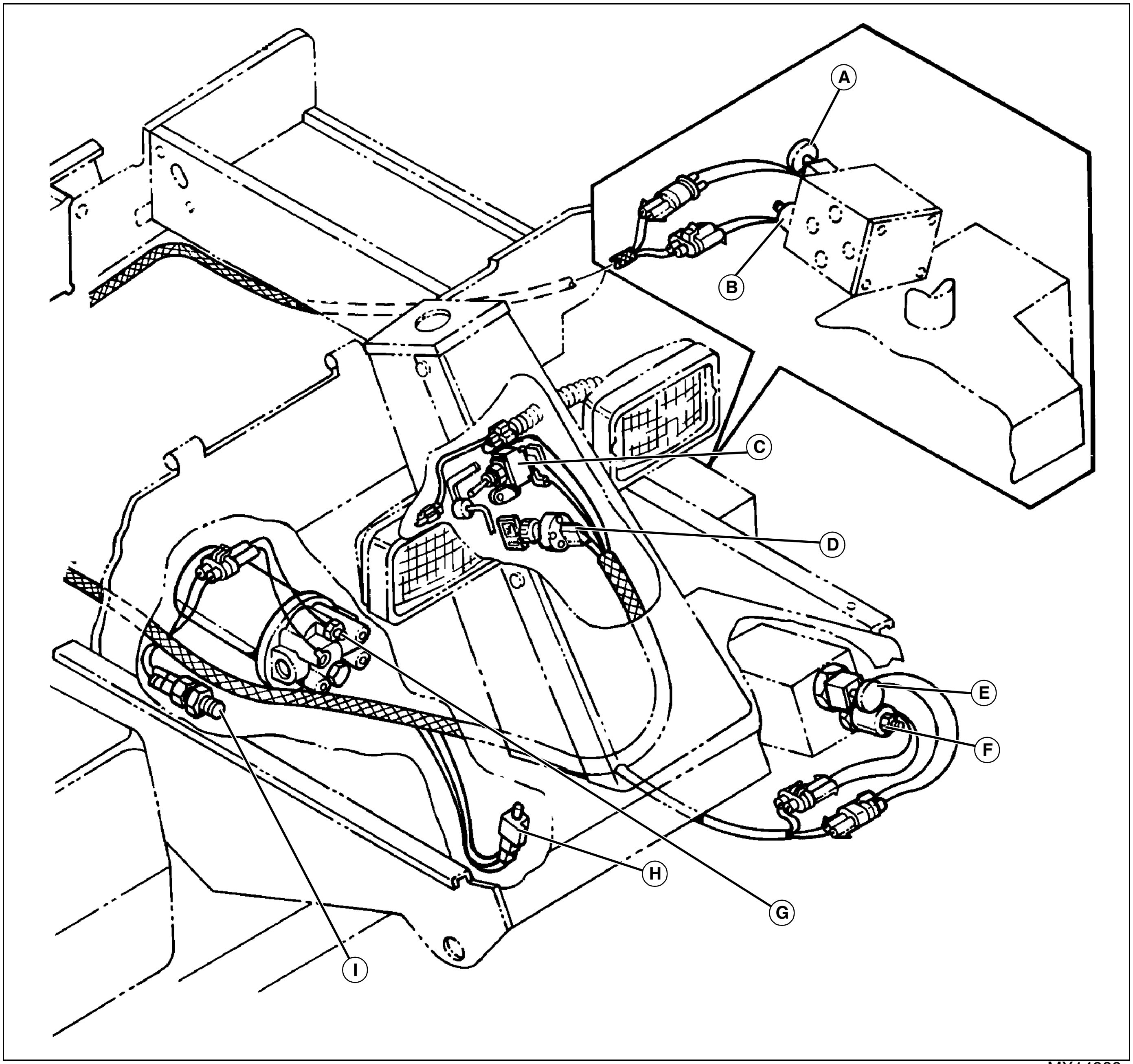
Picture Note: 3215A, 3215B, 3225B, 3235A and 3235B Illustrated

A - Engine Over Temperature Switch
B - Air Heater
C - Fuel Shutoff Solenoid Protection Diode
D - Fuel Shutoff Solenoid
E - Engine Oil Pressure Switch
F - Starter
G - Battery
H - Start Relay
I - 7 Diode Pack
J - Pull-In Coil Relay
K - High Current Relay
L - Four Wheel Drive Solenoid (Option)
M - Taillights Connector
N - Taillights Harness
O - Alternator



Picture Note: 3215A, 3215B, 3225B, 3235A and 3235B Illustrated

- **A - Four Wheel Drive Switch (Optional)**
- **B - Fuel Gauge**
- **C - Cold Start Switch**
- **D - Service Switch**
- **E - Fuse 20A**
- **F - Fuse 10A**
- **G - Control Module**
- **H - Neutral Switch**
- **I - Seat Switch**
- **J - Seat Switch Relay (3215B, 3225B and3235B)**
- **K - Seat Wire Harness (3215B, 3225B and3235B)**
- **L - Indicator Lights Panel**
- **M - Raise/Lower Switch**
- **N - Hour Meter**
- **O - Diode Pack AMT477**
- **P - Mow/Transport Switch**
- **Q - Fuel Level Sensor**
- **R - Cab Auxiliary Connector**
- **S - Lights Switch Connectors**
- **T - Warning Buzzer**
- **U - Raise/Hold Coil**

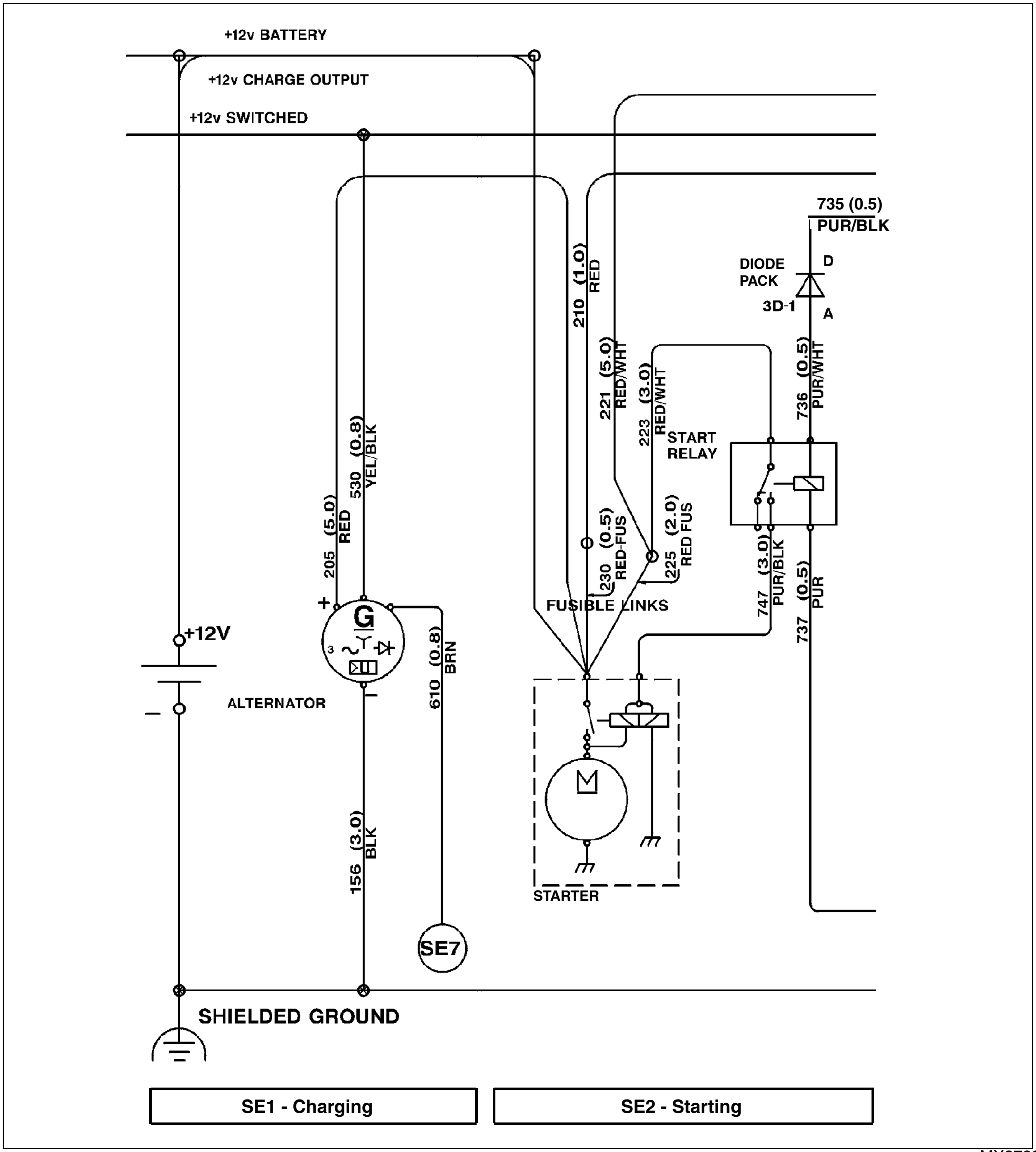


Picture Note: 3215A, 3215B, 3225B, 3235A and 3235B Illustrated

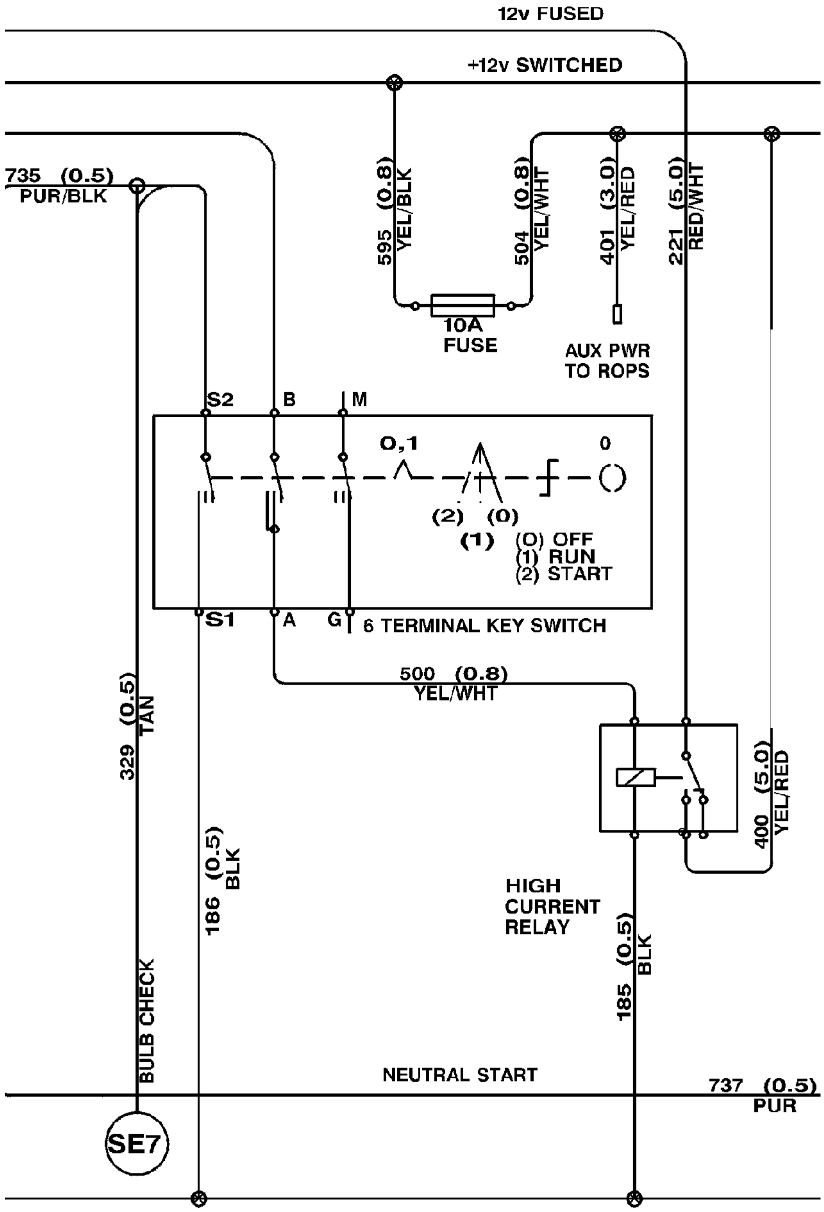
A - Rear Backlap Switch
B - Rear Mow Valve Solenoid
C - Park Lock Switch
D - Ignition Switch
E - Front Backlap Switch
F - Front Mow Valve Solenoid
G - Hydraulic Oil Pressure Switch
H - Brake Switch
I - Hydraulic Oil Temperature Sensor

Schematics and Harnesses

Main Electrical Schematic

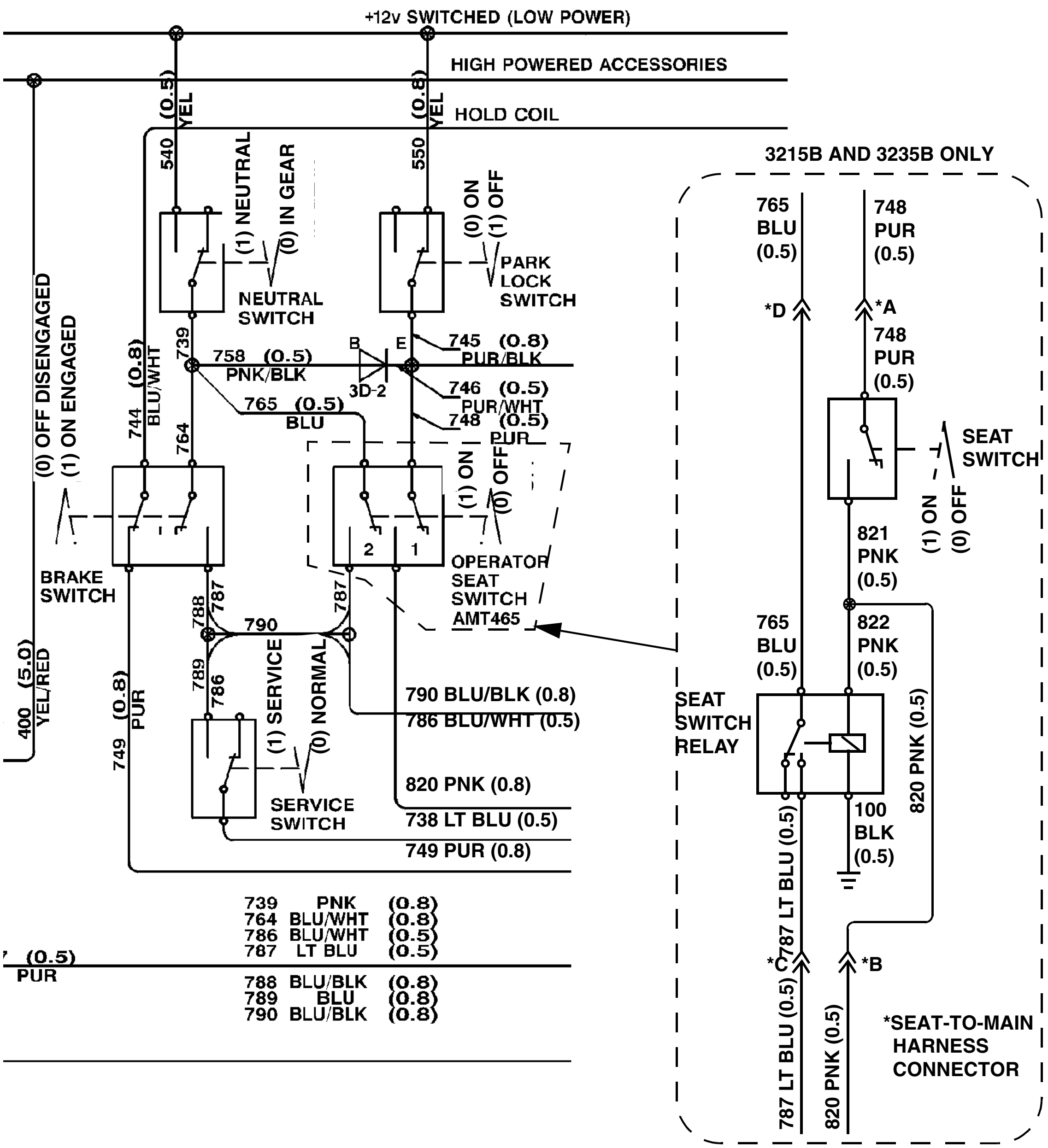


MX2722



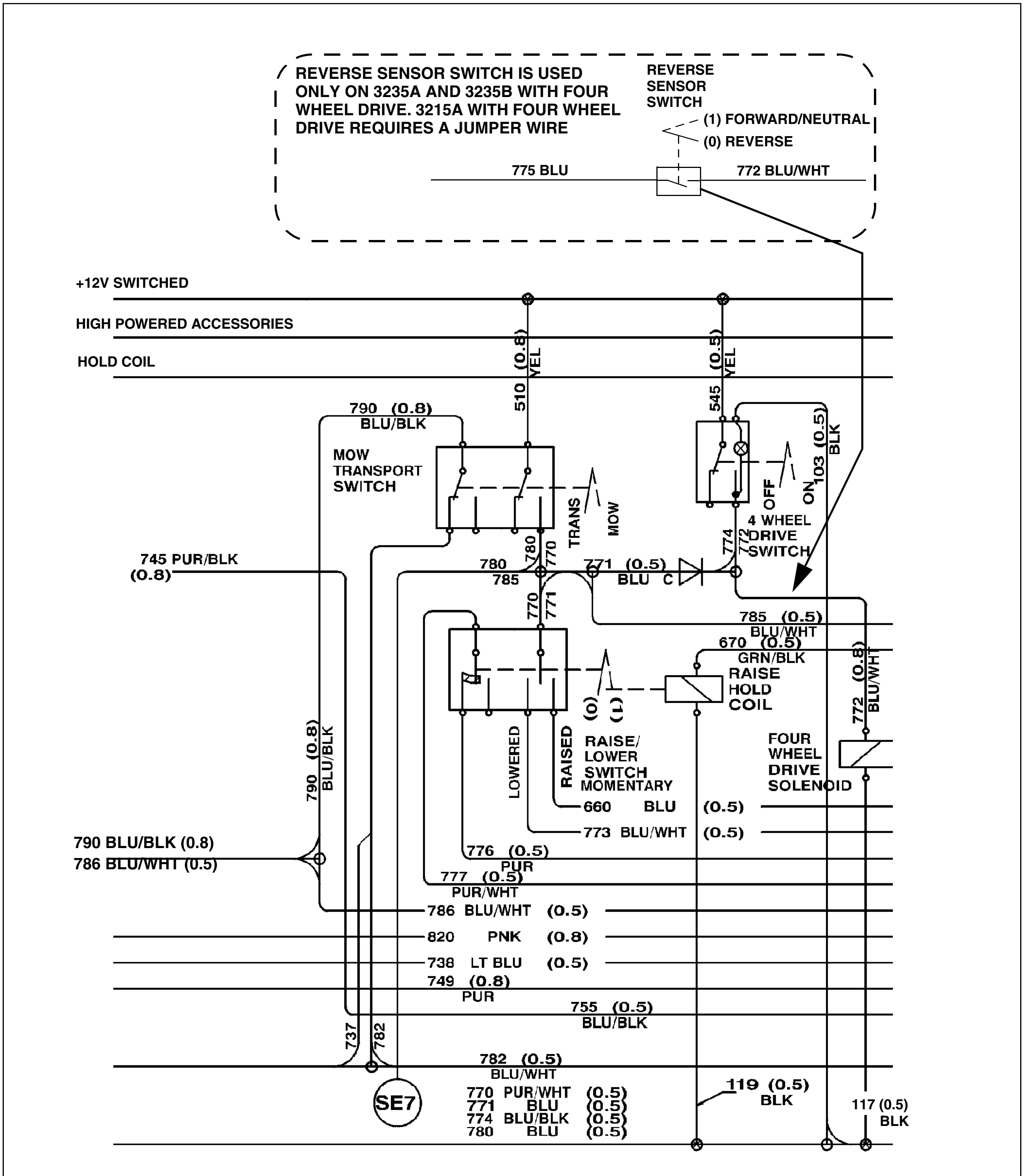
SE3 - Ignition Interlock (Diesel Engine)

MX2722



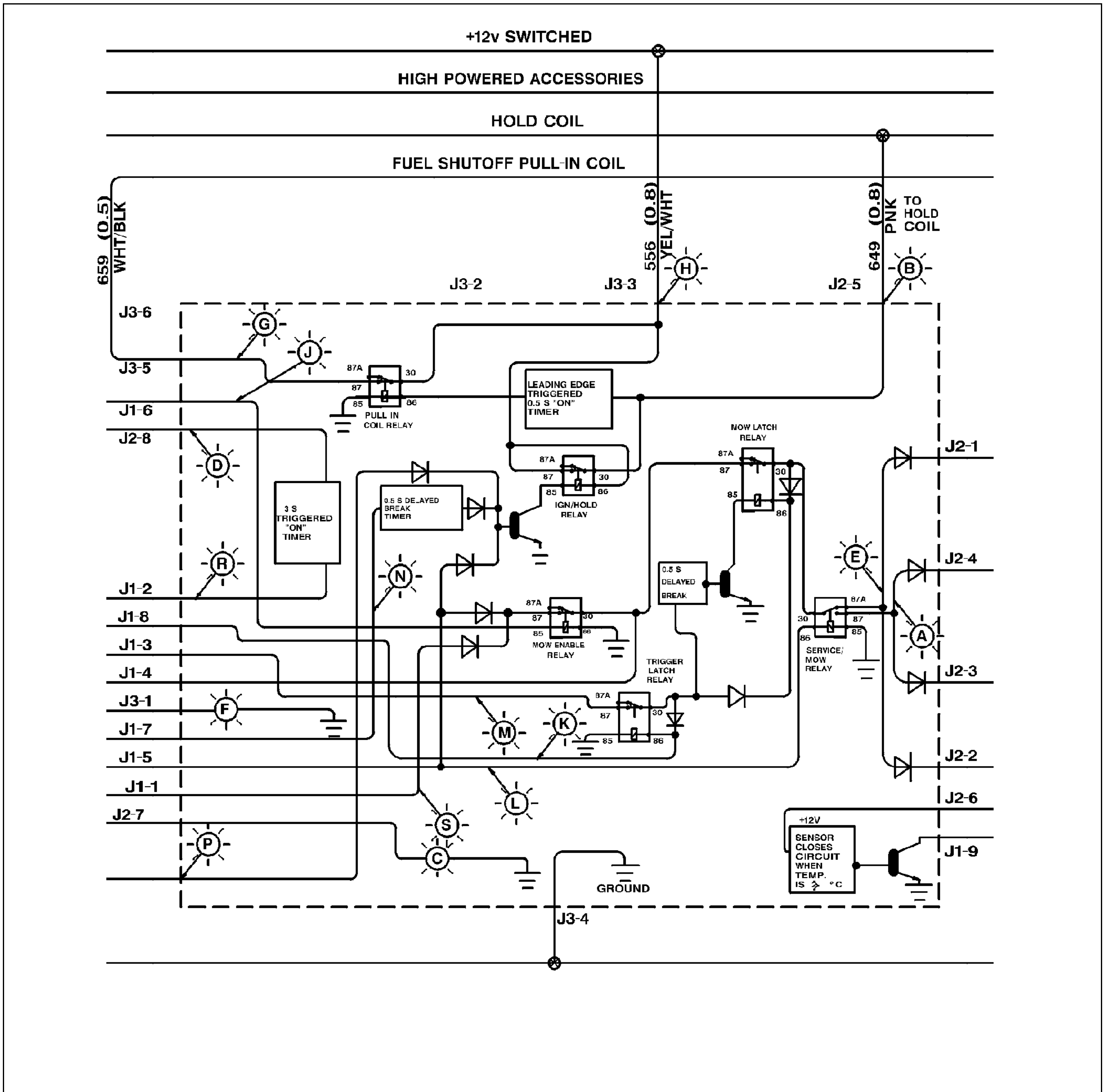
SE3 - Ignition Interlock (Diesel Engine)

MX2722



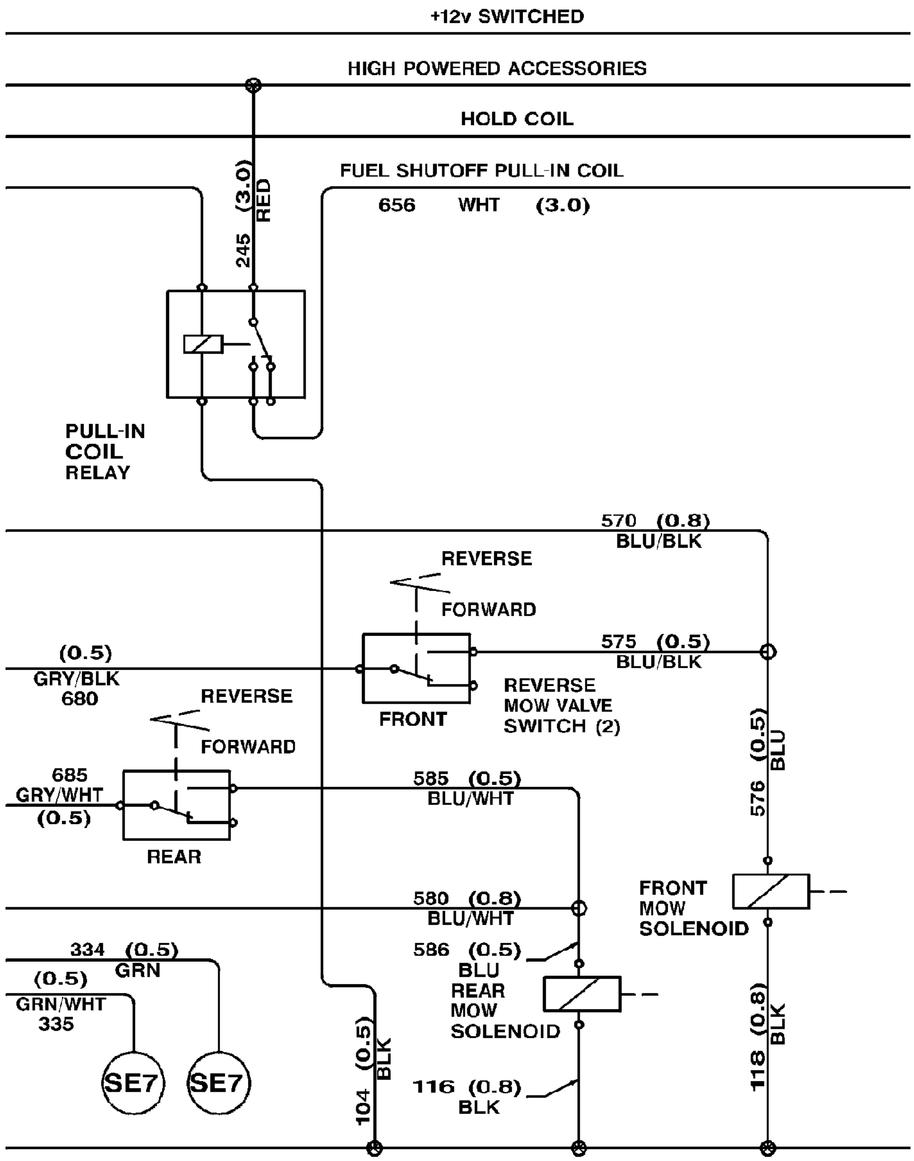
SE3 - Ignition Interlock (Diesel Engine)

MX2723



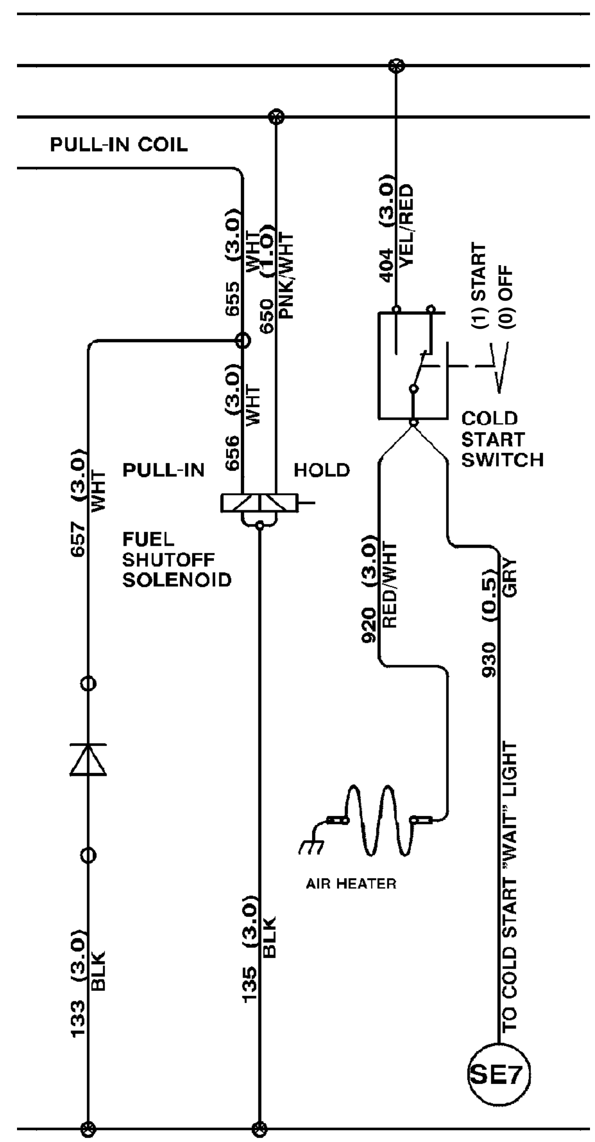
SE4 - Interlock Module

MX2723



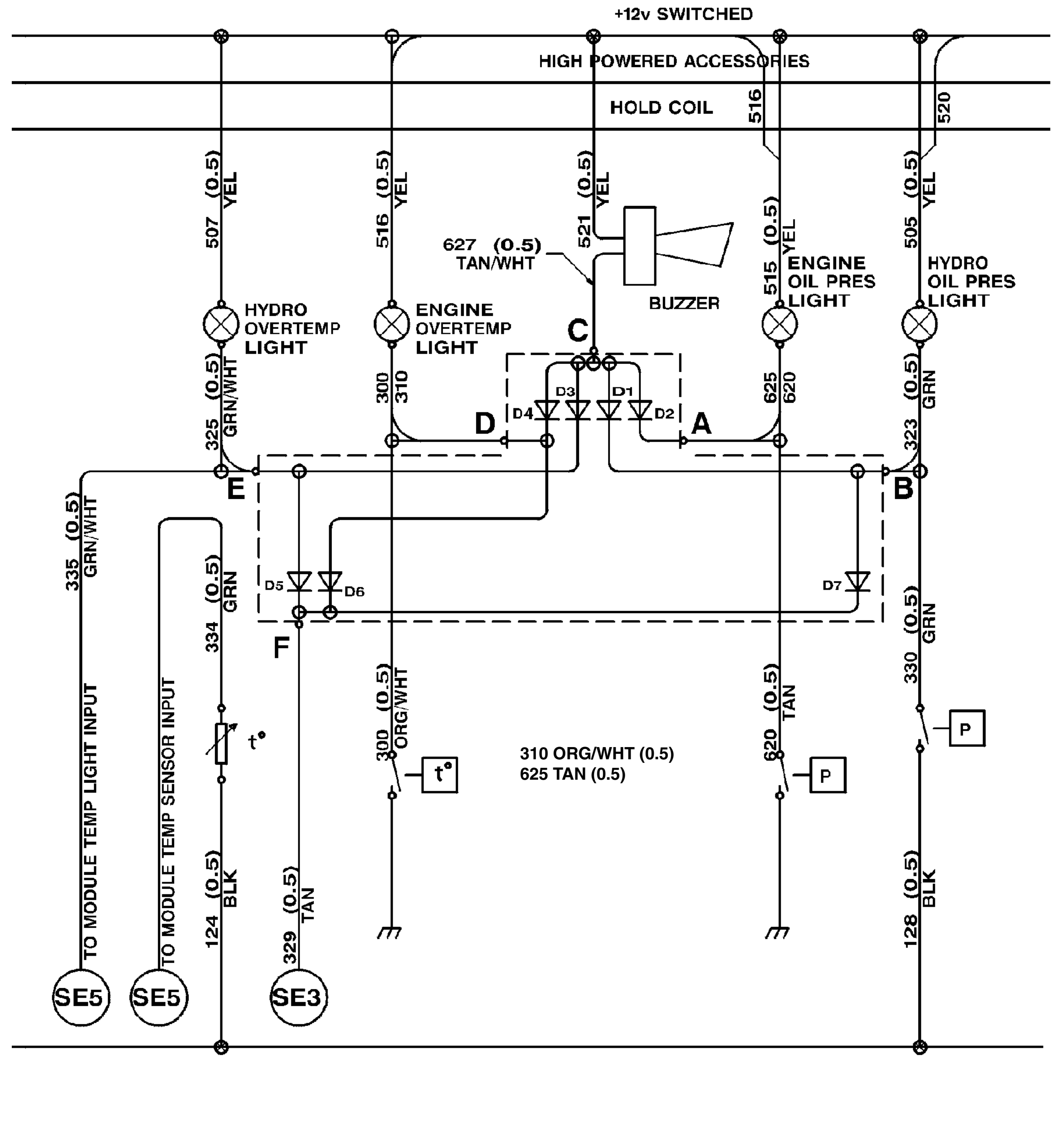
SE5 - Module Outputs (Partial)

MX2724



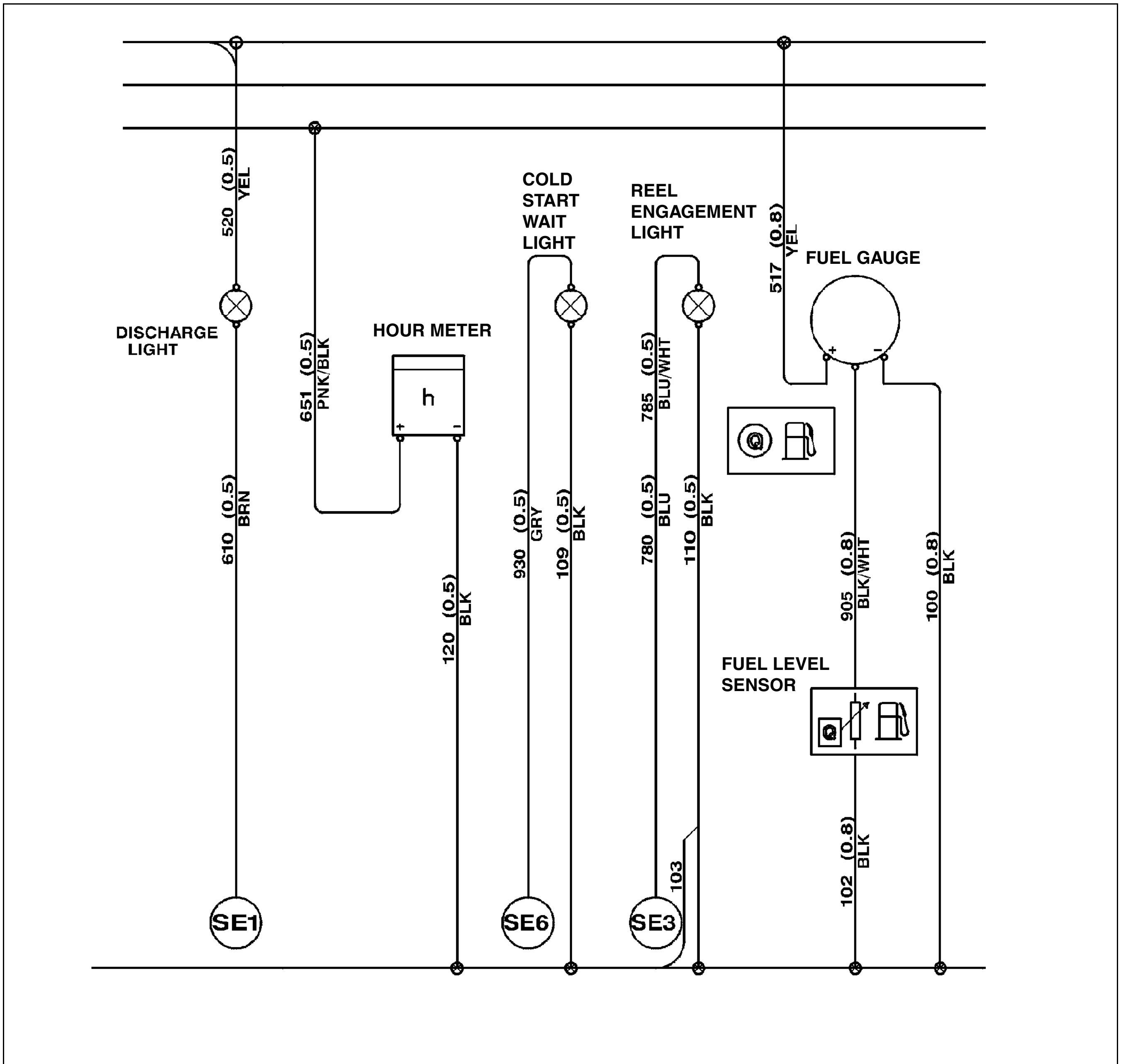
SE6 - Engine (Diesel)

MX2724



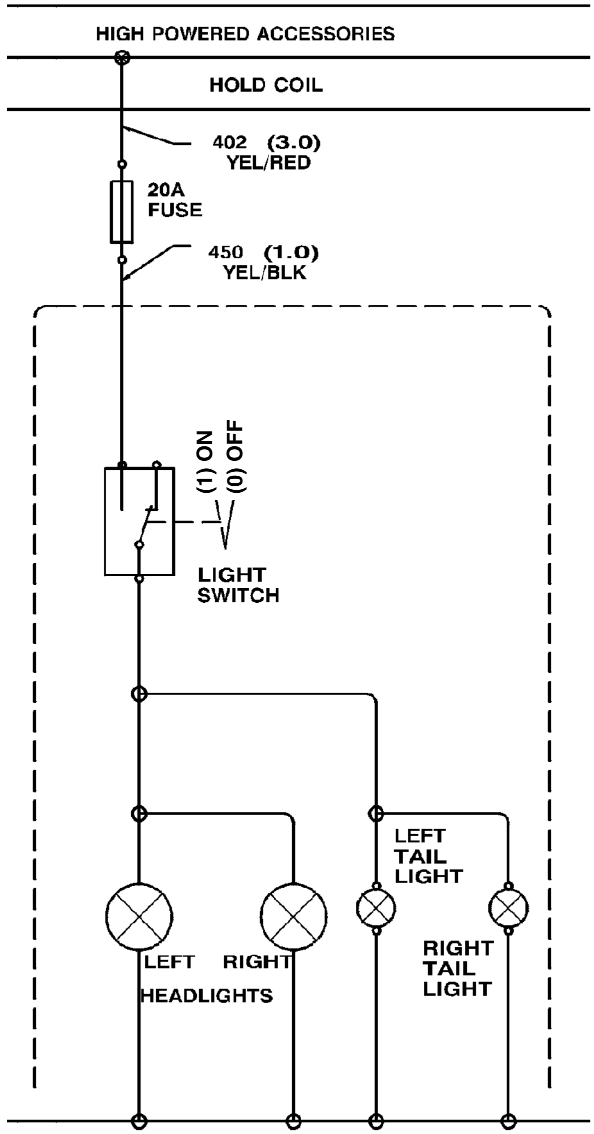
SE7 - Instrumentation

MX2724



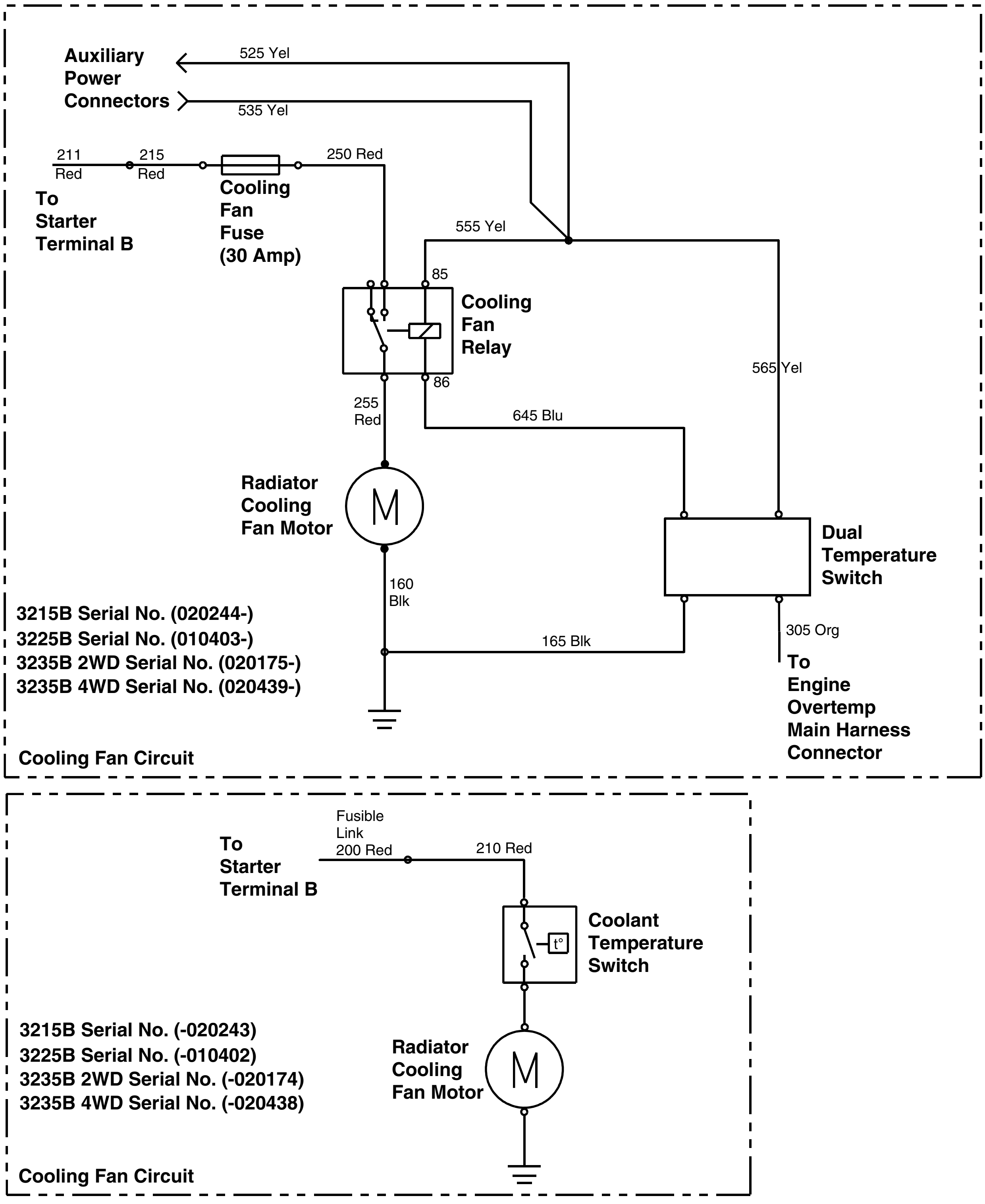
SE7 - Instrumentation

MX2725



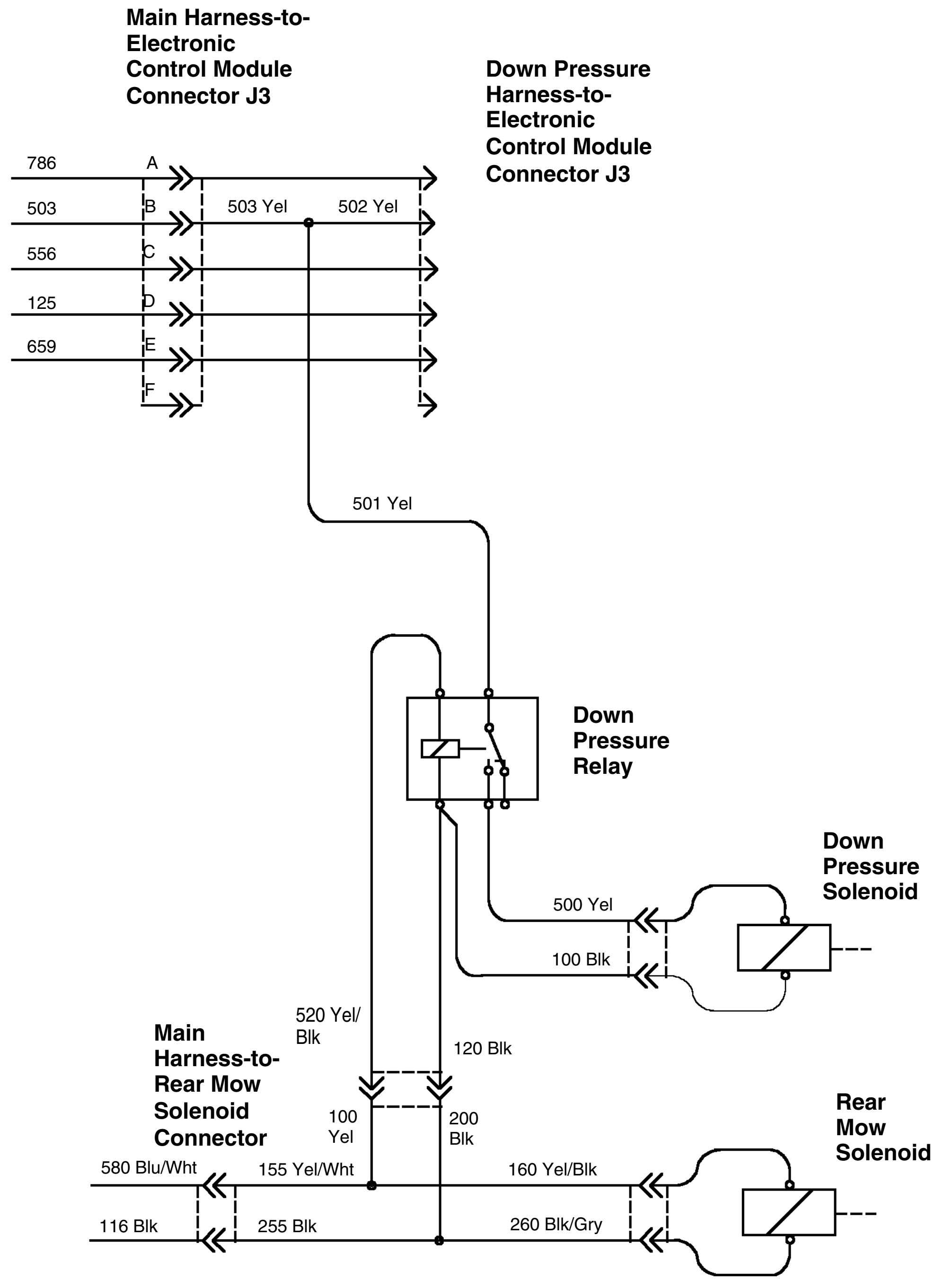
SE8 - Optional Light Kit

MX2725



SE9 - Radiator Cooling Fan Circuit

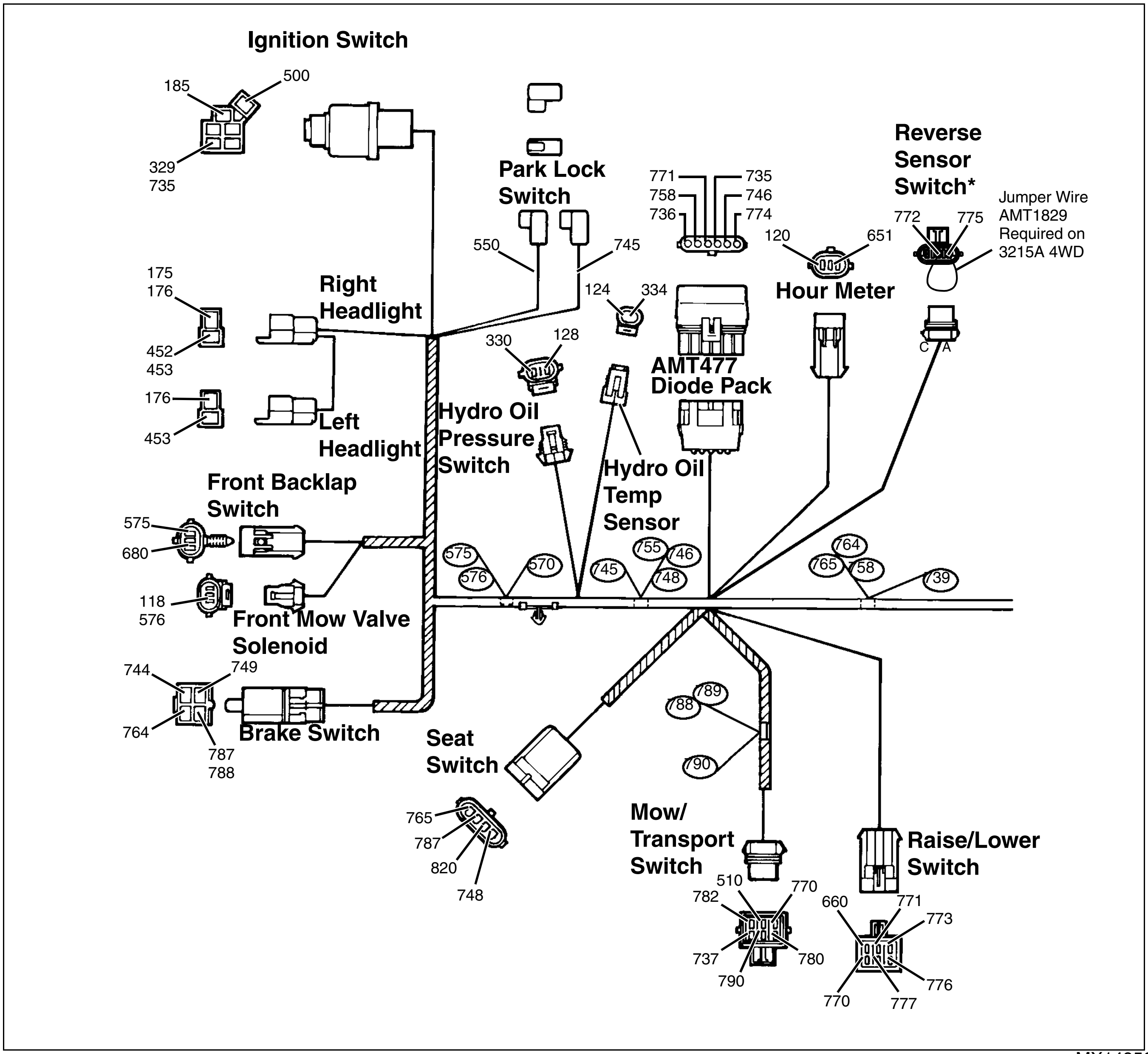
MX14954



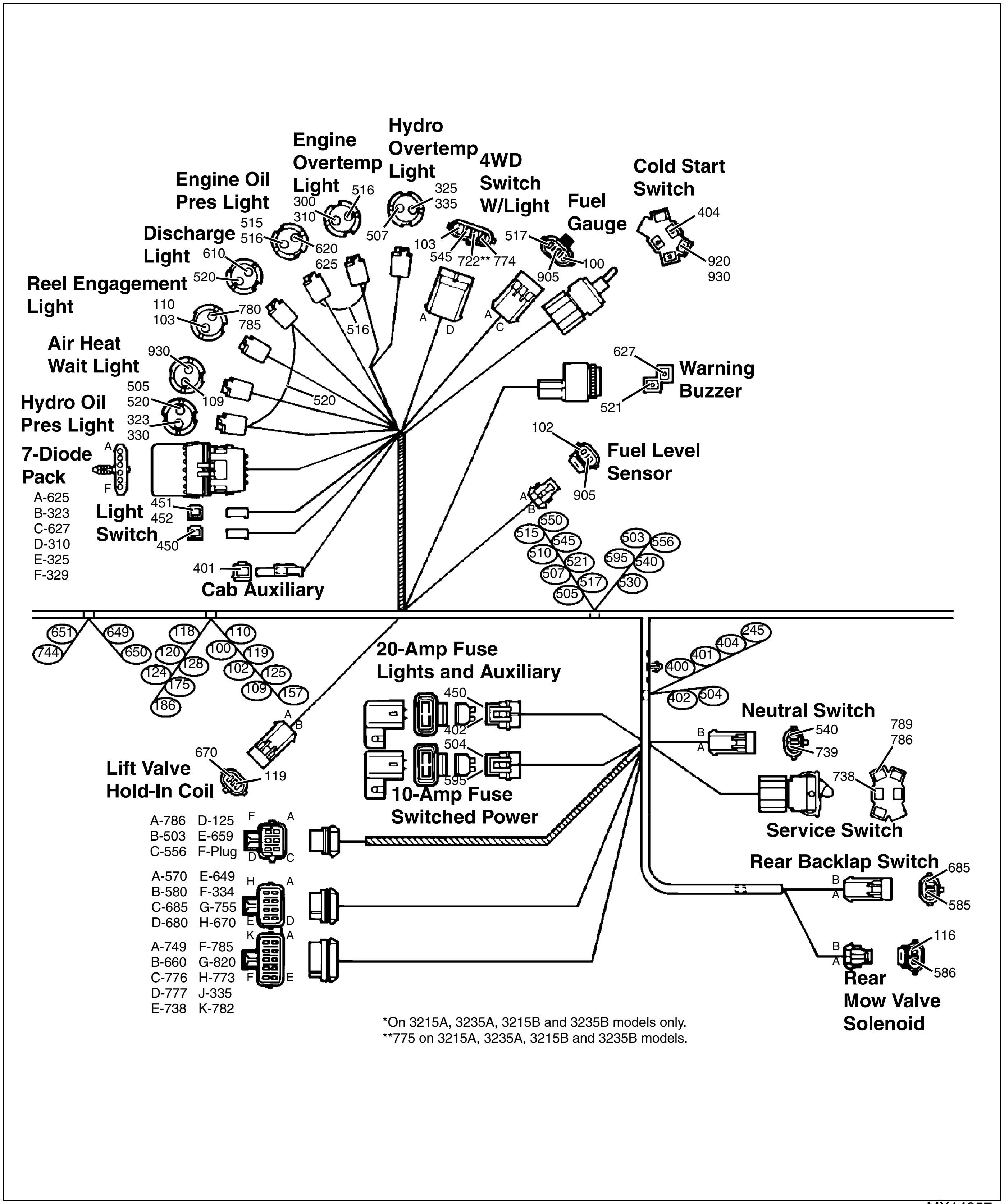
SE10 - Optional Down Pressure Circuit

MX14955

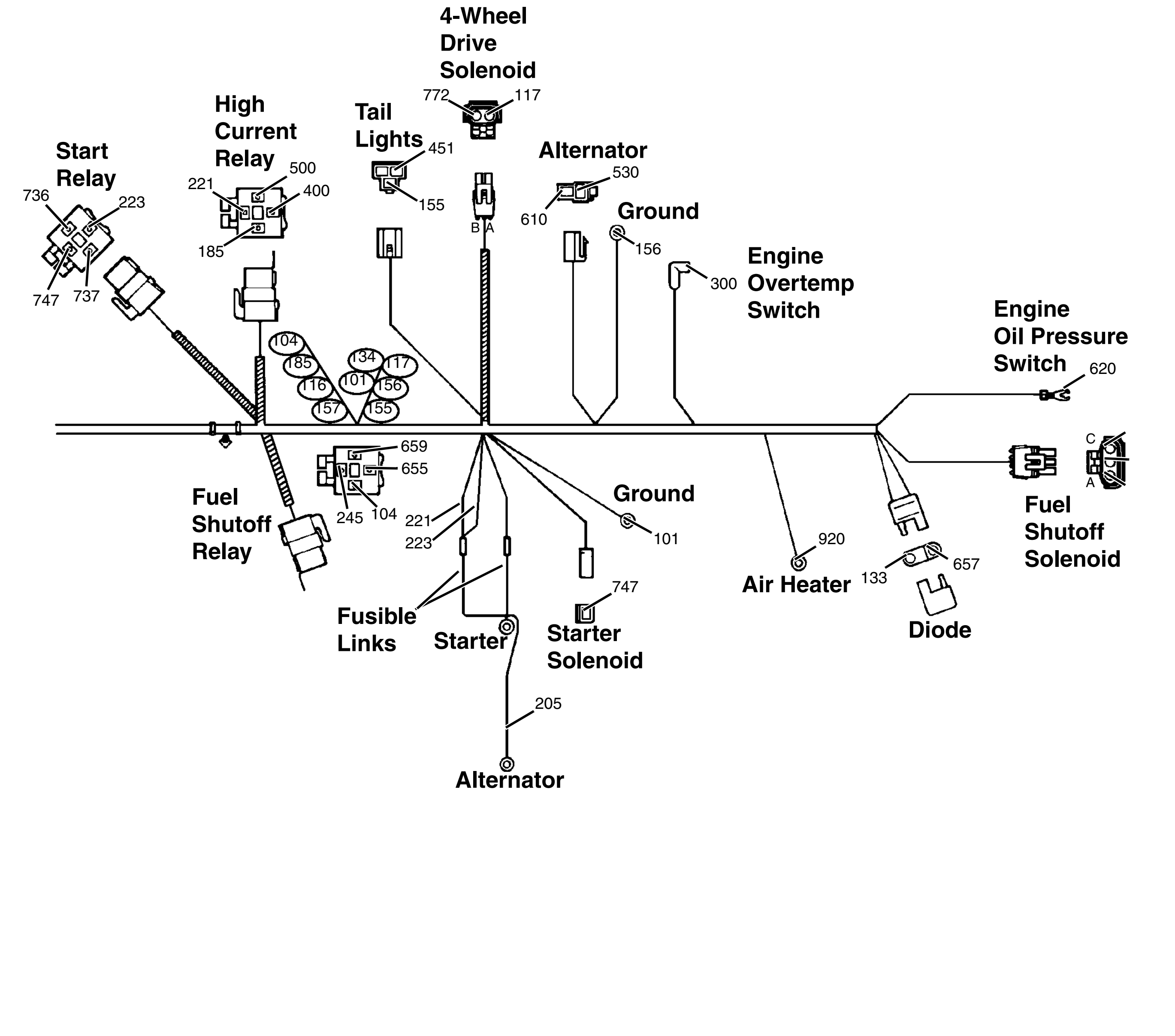
Main Wiring Harness (W1)



MX14956

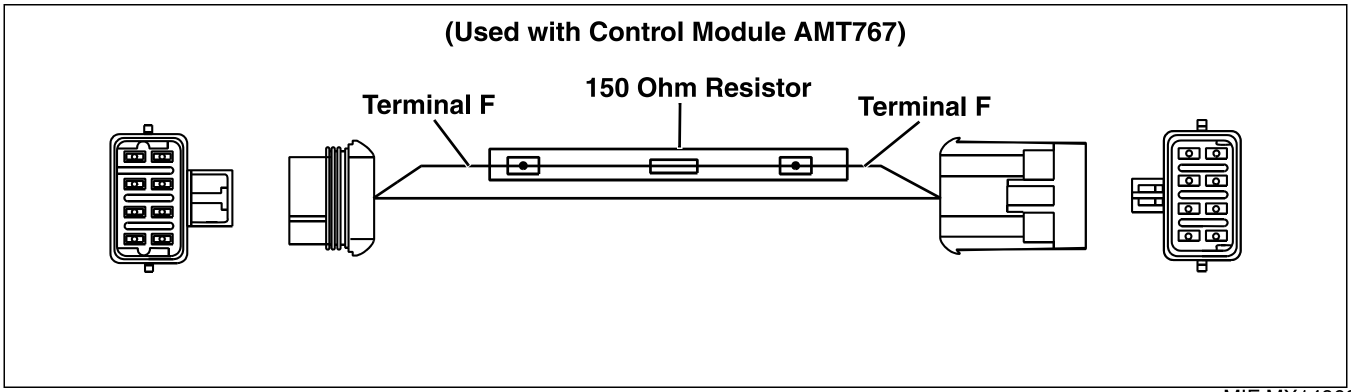

Engine Oil Pres Light
Engine Overtemp Light
Hydro Overtemp Light
4WD Switch W/Light
Cold Start Switch
Fuel Gauge
Discharge Light
Reel Engagement Light
Air Heat Wait Light
Hydro Oil Pres Light
7-Diode Pack
A-625
B-323
C-627
D-310
E-325
F-329
Light Switch
Cab Auxiliary
Warning Buzzer
Fuel Level Sensor
20-Amp Fuse Lights and Auxiliary
10-Amp Fuse Switched Power
Neutral Switch
Service Switch
Rear Backlap Switch
Rear Mow Valve Solenoid
Lift Valve Hold-In Coil
A-786 D-125
B-503 E-659
C-556 F-Plug
A-570 E-649
B-580 F-334
C-685 G-755
D-680 H-670
A-749 F-785
B-660 G-820
C-776 H-773
D-777 J-335
E-738 K-782
*On 3215A, 3235A, 3215B and 3235B models only.
**775 on 3215A, 3235A, 3215B and 3235B models.

MX14957


4-Wheel Drive Solenoid
772
117
High Current Relay
Tail Lights
451
Alternator
Start Relay
500
221
400
530
736
223
155
B A
610
Ground
185
156
Engine Overtemp Switch
300
747
737
Engine Oil Pressure Switch
104
185
134
117
116
101
156
620
157
155
659
655
C
A
Fuel Shutoff Relay
245
104
221
223
Ground
101
Fuel Shutoff Solenoid
920
657
Air Heater
133
747
Fusible Links
Starter
Starter Solenoid
Diode
205
Alternator

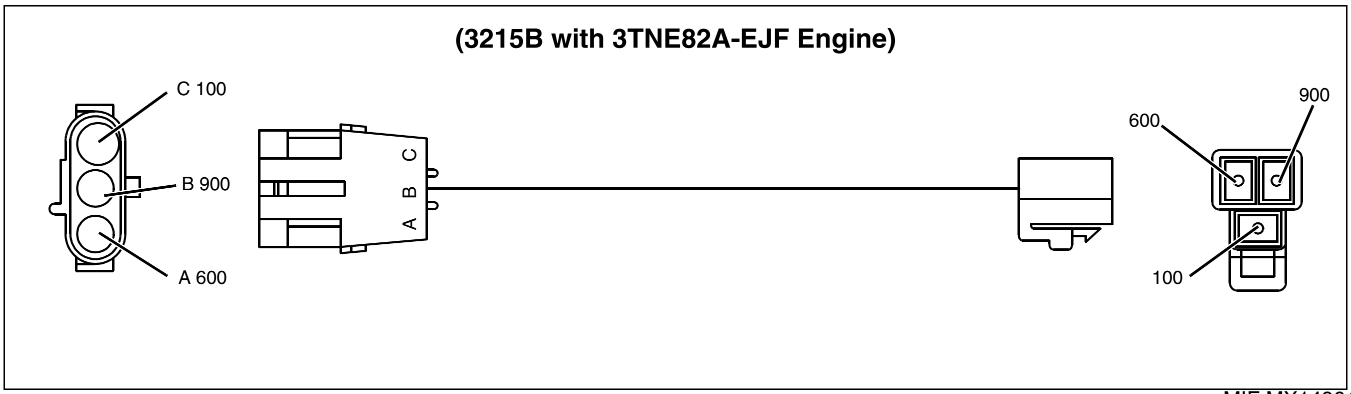
MX14958

Control Module Resistor Wiring Harness



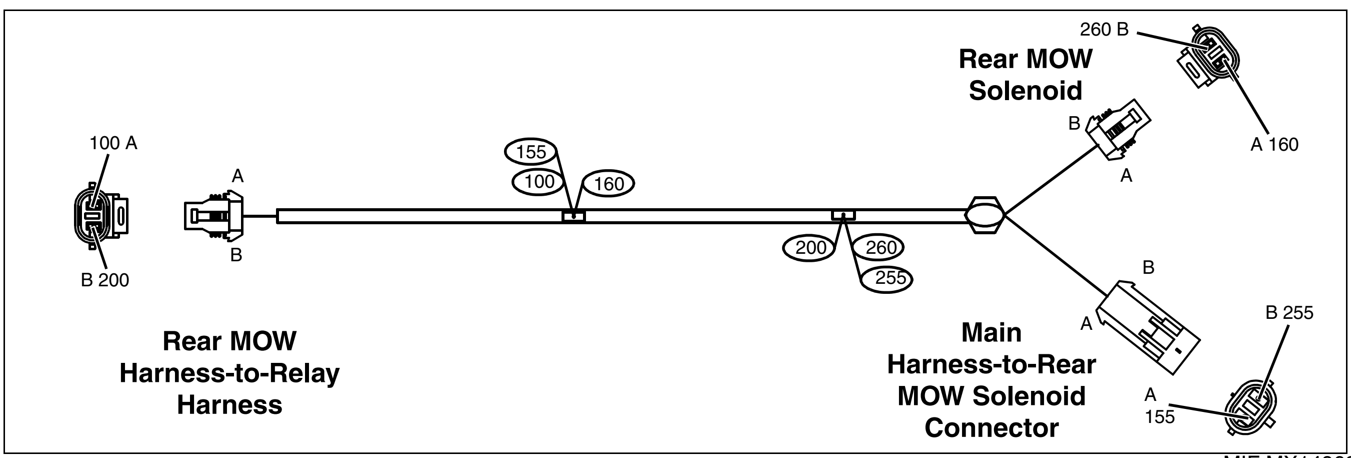
MIF MX14960

Fuel Shutoff Solenoid Wiring Harness



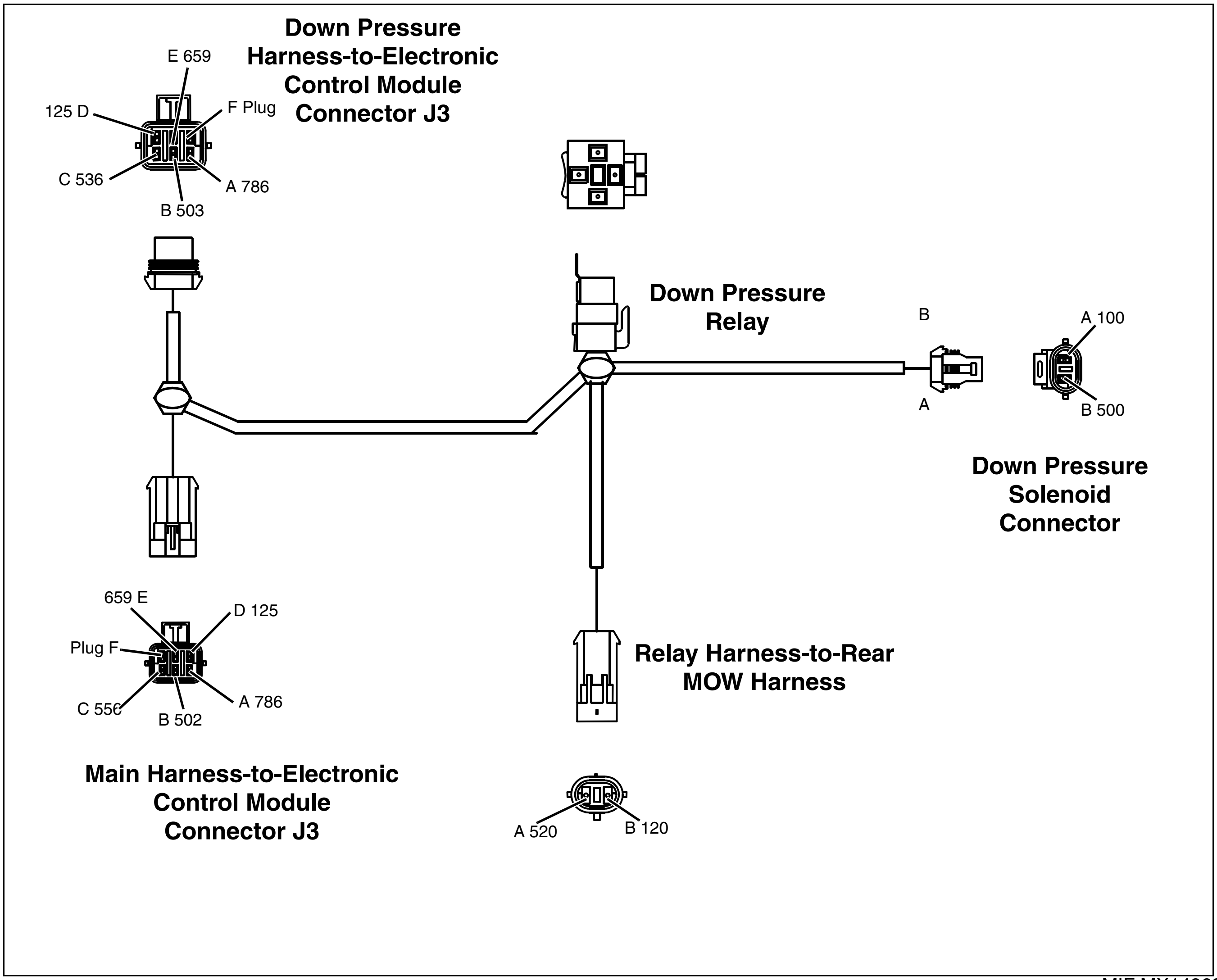
MIF MX14961

Down Pressure Solenoid Wiring Harness



MIF MX14962

Down Pressure Relay Wiring Harness



MIF MX14963

Radiator Fan Motor Wiring Harness

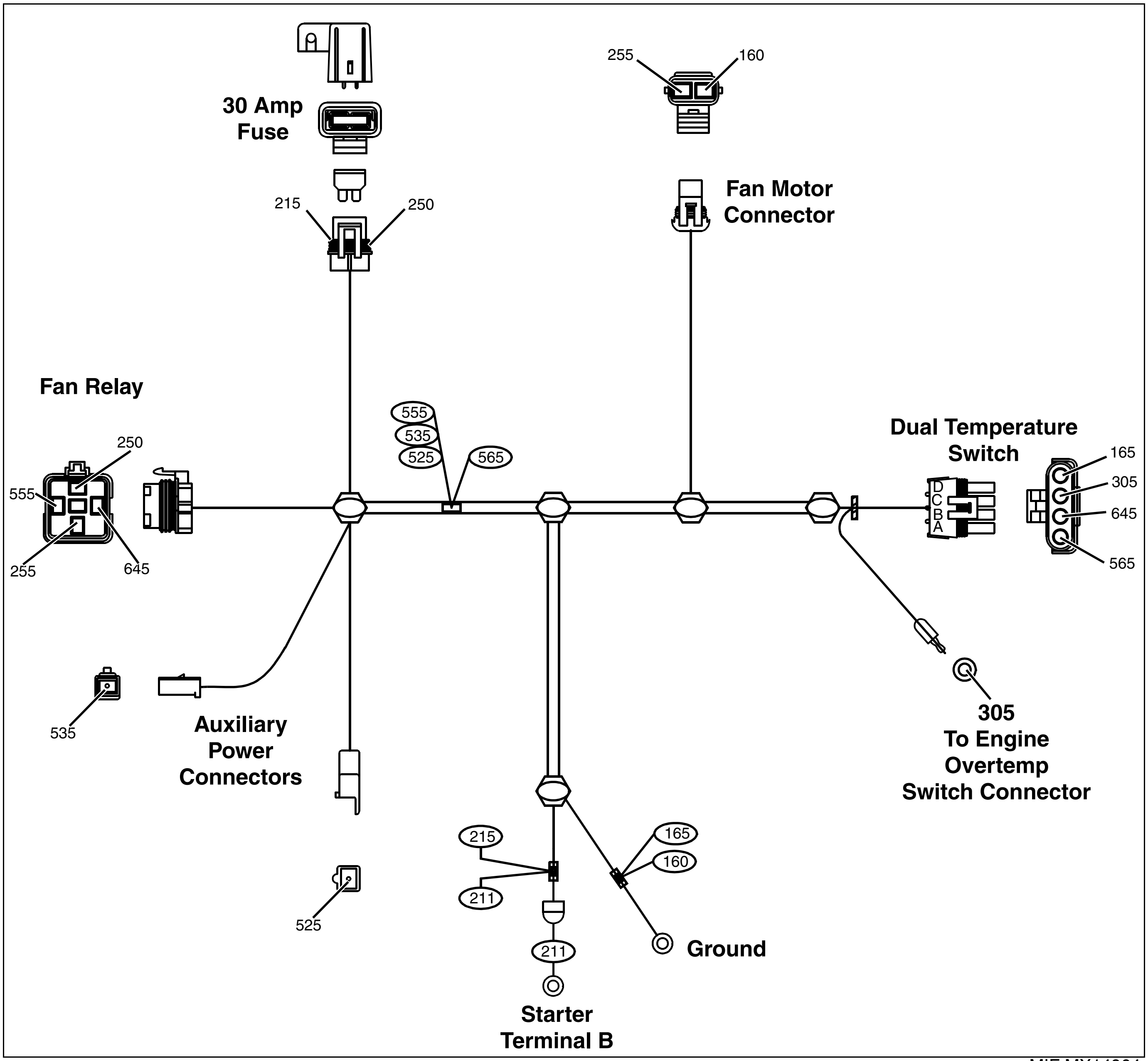
Lightweight Fairway Mower

3215B Serial No. (020244 -)

3225B Serial No. (010403 -)

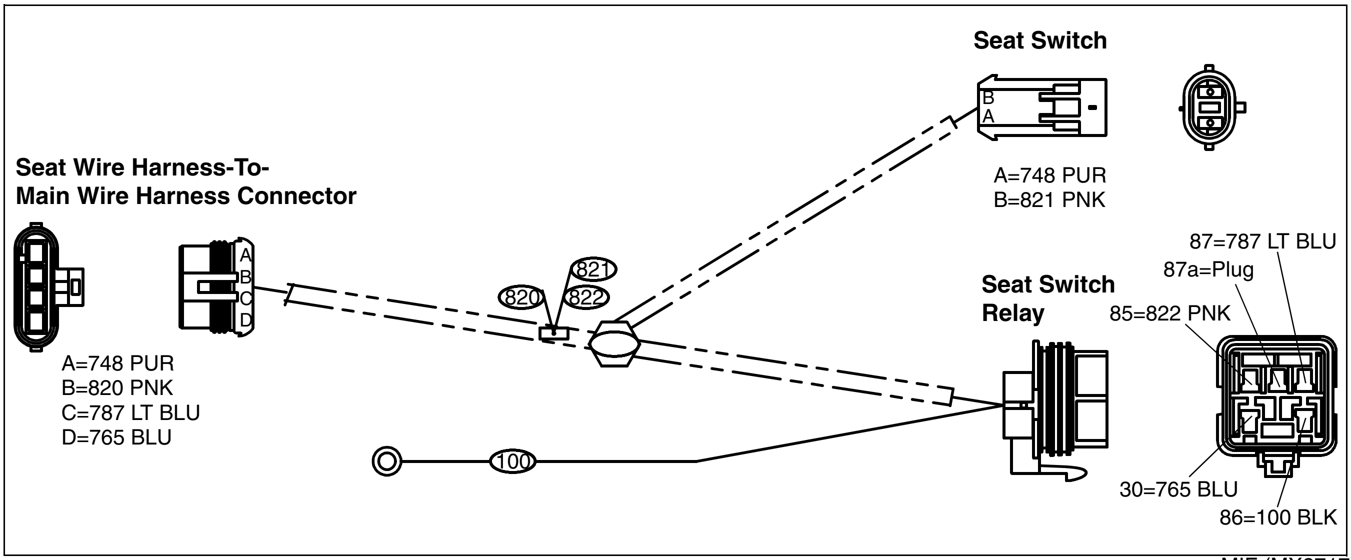
3235B 2WD Serial No. (020175 -)

3235B 4WD Serial No. (020439 -)



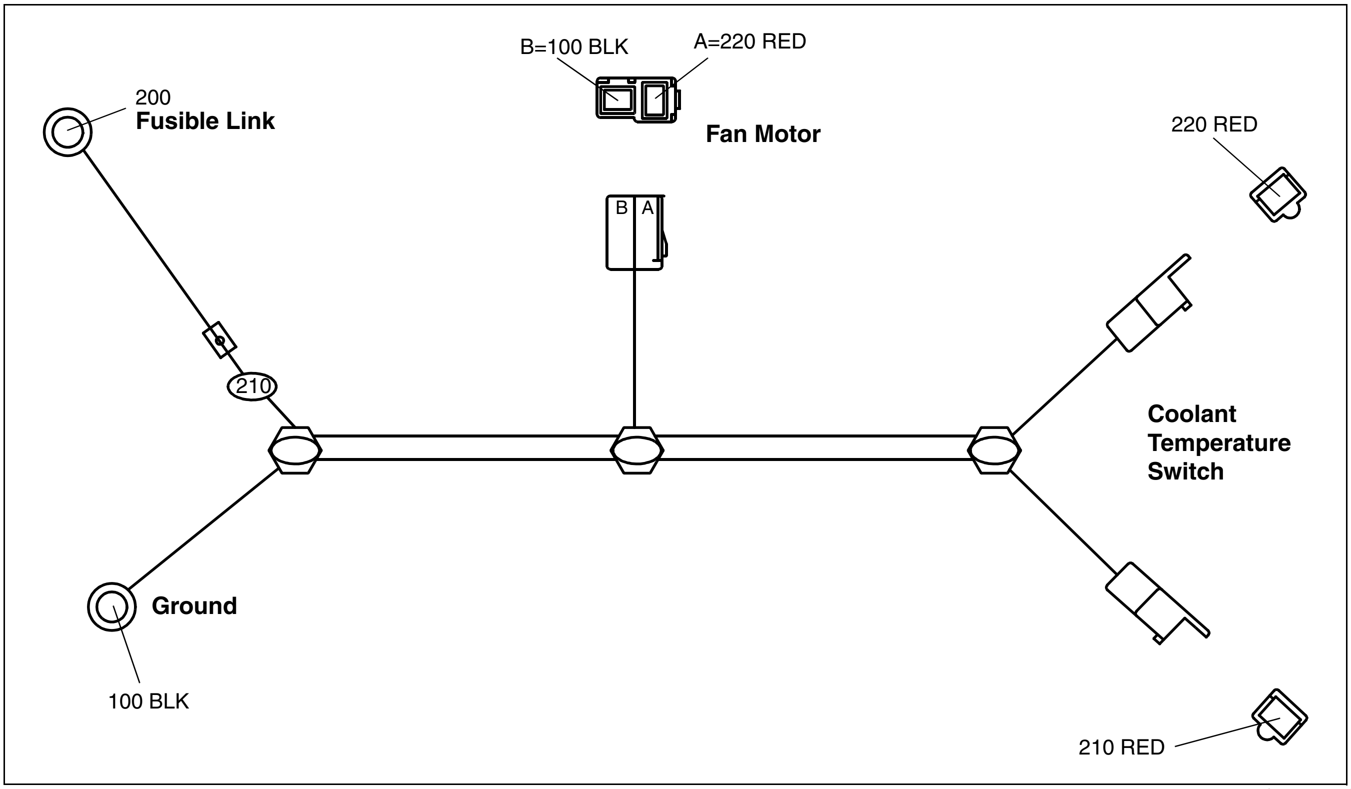
MIF MX14964

Seat Wire Harness - 3215B, 3225B, and 3235B



MIF (MX2717)

Fan Wire Harness - 3215B (Serial No. -020243), 3225B (Serial No. -010402), 3235B 2WD (Serial No. -020174), and 4WD (Serial No. -020438)



MIF (MX2718)

Operation and Diagnostics

Cranking Circuit (Operator Off Seat) Operation

NOTE: Only those circuits required to crank the engine with the operator off the seat will be discussed in the following text.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- Starter Relay
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay and 223 RED/WHT going to the start relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, in the order shown, with the ignition switch in the START position.

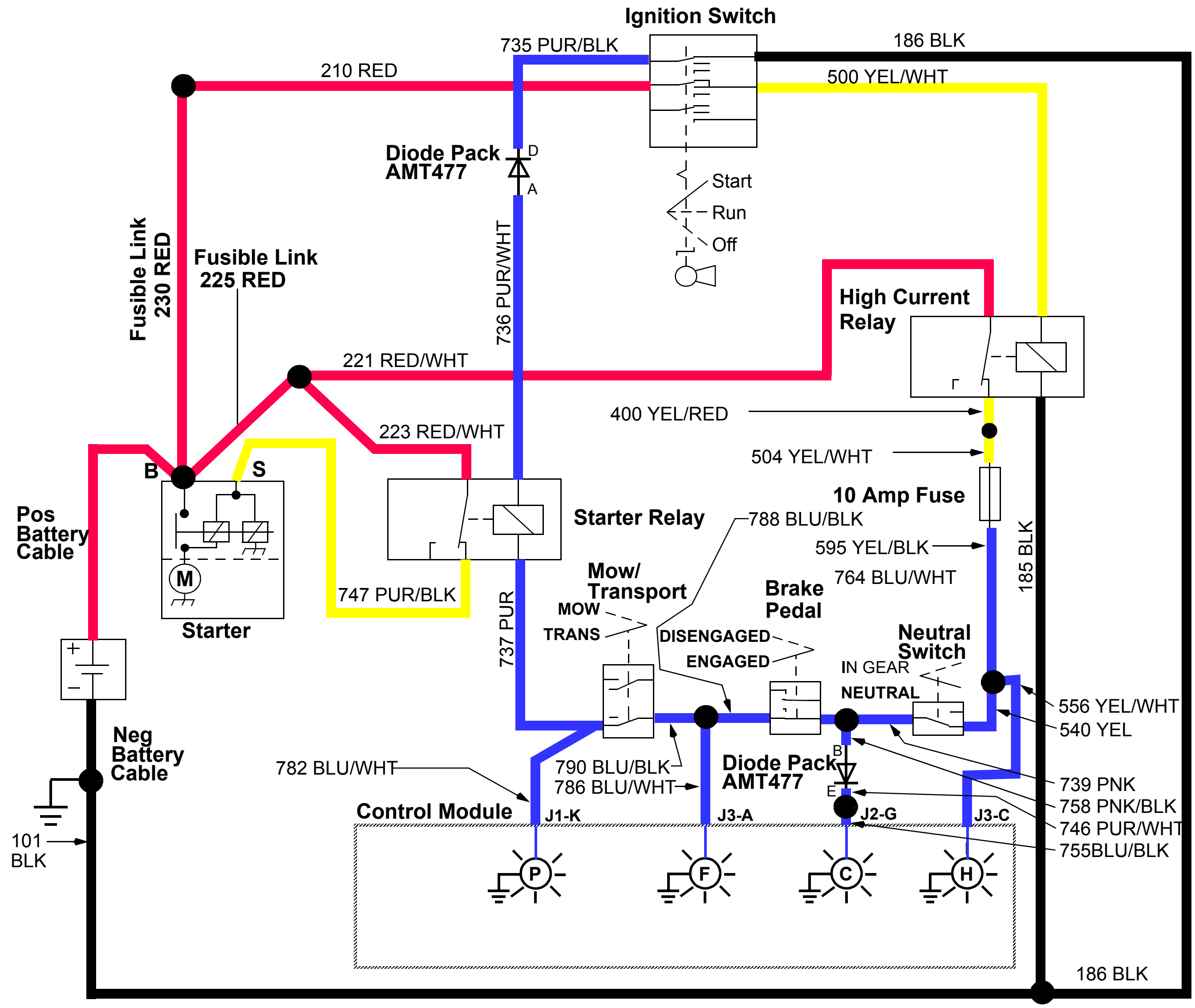
- High Current Relay
- Transmission Neutral Switch
- Brake Pedal Switch
- Mow/Transport Switch
- Start Relay
- Control Module J3-C

Operation

With the ignition switch in the START position, current flows to the high current relay, energizing it. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the transmission neutral switch (NEUTRAL), the brake switch (brake applied), the mow/transport switch (TRANSPORT) and energizes the starter relay. The ground wire for the starter relay, goes through a diode, the ignition switch (START) and then to ground. With the starter relay energized, current flows from the battery, through the contacts in the relay, to the starter solenoid, energizing it. With the starter solenoid energized, current flows from the battery through the contacts in the solenoid to turn the starter motor.

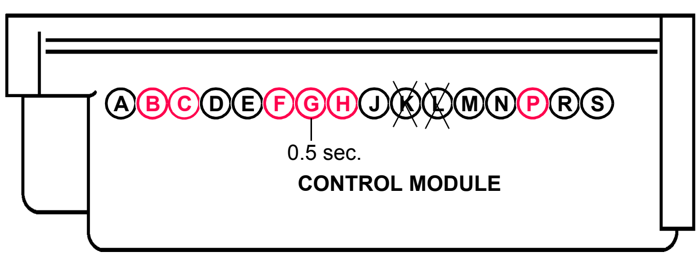
Cranking Circuit (Operator Off Seat) Schematic

Note: Control module is not needed to complete this circuit.



*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive
BLACK- Ground
YELLOW- Switched, Unfused, 12 Volt Positive
PURPLE- Fused 12 Volt Positive
GREEN- Time or Diode Controlled Circuit



MIF

Cranking Circuit (Operator Off Seat) Diagnosis

Test Conditions:

- Operator OFF seat
- Ignition switch in START position
- Park lock ON
- Transmission in NEUTRAL
- Battery fully charged
- Park brake ON
- Mow/transport lever in TRANSPORT

NOTE: See "Test Starter No-Load Amperage and RPM" on page 208, if the following tests are satisfactory.

System: Cranking Circuit (Operator Off Seat)

(1) Observe the following lights on the control panel: battery charge, low oil pressure, coolant over temperature, hydro over temperature and hydraulic oil filter restriction. Are all of the lights on?

Yes - Go to step (2).

No - Check control module LED H. If lit, check individual lights on control panel. If LED H is not lit, check 10-amp fuse. If fuse is bad, determine cause for fuse failure before replacing fuse.

No - If fuse is good, test wire 221 RED/WHT at high current relay for battery voltage. If voltage is present, replace relay. If not present, replace wire harness.

(2) Control module. Is LED H ON?

Yes - Go to step (3).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(3) Control module. Is LED C ON?

Yes - Go to step (4).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

System: Cranking Circuit (Operator Off Seat)

No - If no voltage is present, test continuity from terminal G to the neutral switch. If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See "Test Diode Pack AMT477" on page 204.) If diode pack is good, replace wire harness.

(4) Control module. Is LED F ON?

Yes - Go to step (5).

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal A to the brake pedal switch. If continuity, check or replace brake pedal switch. If no continuity, replace wire harness.

(5) Control module. Is LED P ON?

Yes - Go to step (6).

No - Remove 10-pin connector from module and check for battery voltage at terminal K. If voltage is present, replace the control module.

No - If voltage is not present, test continuity from terminal K to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace wire harness.

(6) Start relay - wire 737 PUR. Is battery voltage present?

Yes - Go to step (7).

No - Replace wire harness.

(7) Place the meter negative (-) lead on ignition switch wire 186 BLK and meter positive (+) lead on battery positive (+) terminal. Is battery voltage present?

Yes - Go to step (8).

No - Check ground connections at battery and frame.

(8) Place the meter negative (-) lead on ignition switch wire 735 PUR/BLK. Is battery voltage present?

Yes - Go to step (9).

No - Replace ignition switch.

(9) Disconnect diode pack AMT477. Place the meter negative (-) lead at diode pack AMT477 connector terminal D. Is battery voltage present?

Yes - Go to step (10).

No - Replace wire harness.

System: Cranking Circuit (Operator Off Seat)

(10) Place the meter positive (+) lead on diode pack AMT477 connector terminal A and meter negative (-) lead on starter relay wire 736 PUR/WHT. Measure resistance. Is there less than 0.1 ohm of resistance?

Yes - Go to step (11).

No - Replace wire harness.

(11) Place meter negative (-) lead on battery negative (-) terminal. Measure voltage at starter relay wire 223 RED/WHT. Is battery voltage present?

Yes - Go to step (12).

No - Test continuity of wire 223 RED/WHT, from the starter relay up to where it splices to the fusible link. Test continuity of the fusible link. If fusible link is blown, replace.

(12) Starter relay - wire 747 PUR/BLK. Is battery voltage present?

Yes - Go to step (13).

No - Replace starter relay.

(13) Starter motor - wire 747 PUR/BLK. Is battery voltage present?

Yes - Go to step (14).

No - Test continuity of wire 747 PUR/BLK. If no continuity, replace wire harness.

(14) Is Cold Start Wait light ON?

No - Test continuity of switch and light for proper function.

Cranking Circuit (Operator On Seat) Operation

NOTE: Only those circuits required to crank the engine with the operator on the seat will be discussed in the following text.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- Starter Relay
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay and 223 RED/WHT going to the start relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, in the order shown, with the ignition switch in the START position.

- High Current Relay
- Transmission Neutral Switch
- Seat Switch
- Mow/Transport Switch
- Starter Relay
- Control Module J3-C

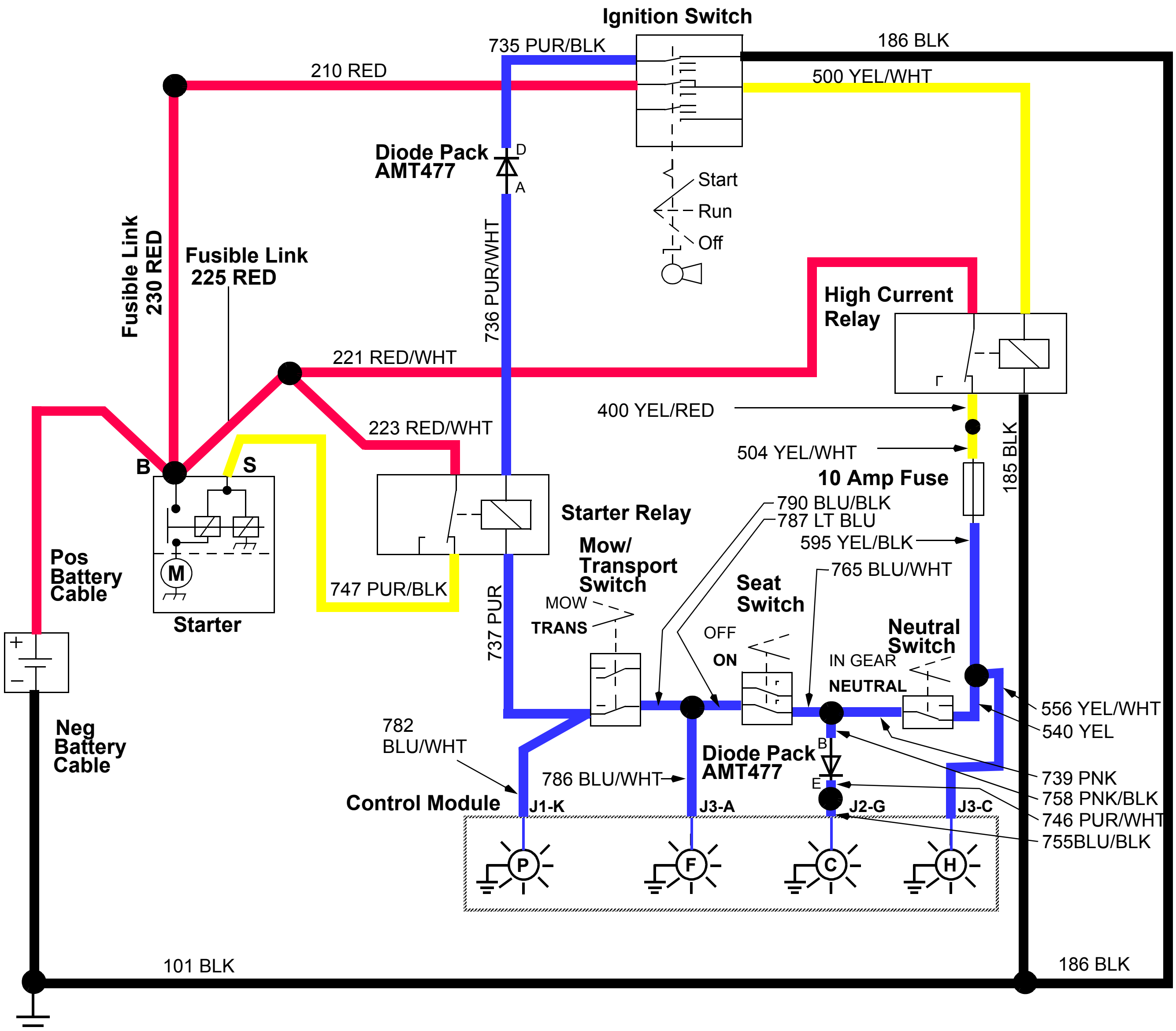
Operation

With the ignition switch in the START position, current flows to the high current relay, energizing it. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the transmission neutral switch (NEUTRAL), the seat switch (ON), the mow/ transport switch (TRANSPORT) and energizes the starter relay. The ground wire for the starter relay, goes through a diode, the ignition switch (START) and then to ground. With the starter relay energized, current flows from the battery through the contacts in the relay, to the starter solenoid, energizing it. With the starter solenoid energized, current flows from the battery through the contacts in the solenoid to turn the starter motor.

On 3215B, 3225B, and 3235B models, the seat switch also energizes the seat switch relay to provide operation as described above.

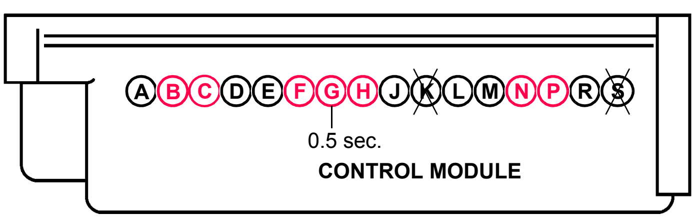
Cranking Circuit (Operator On Seat) Schematic - 3215, 3215A, 3235 and 3235A

Note: Control module is not needed to complete this circuit.



*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

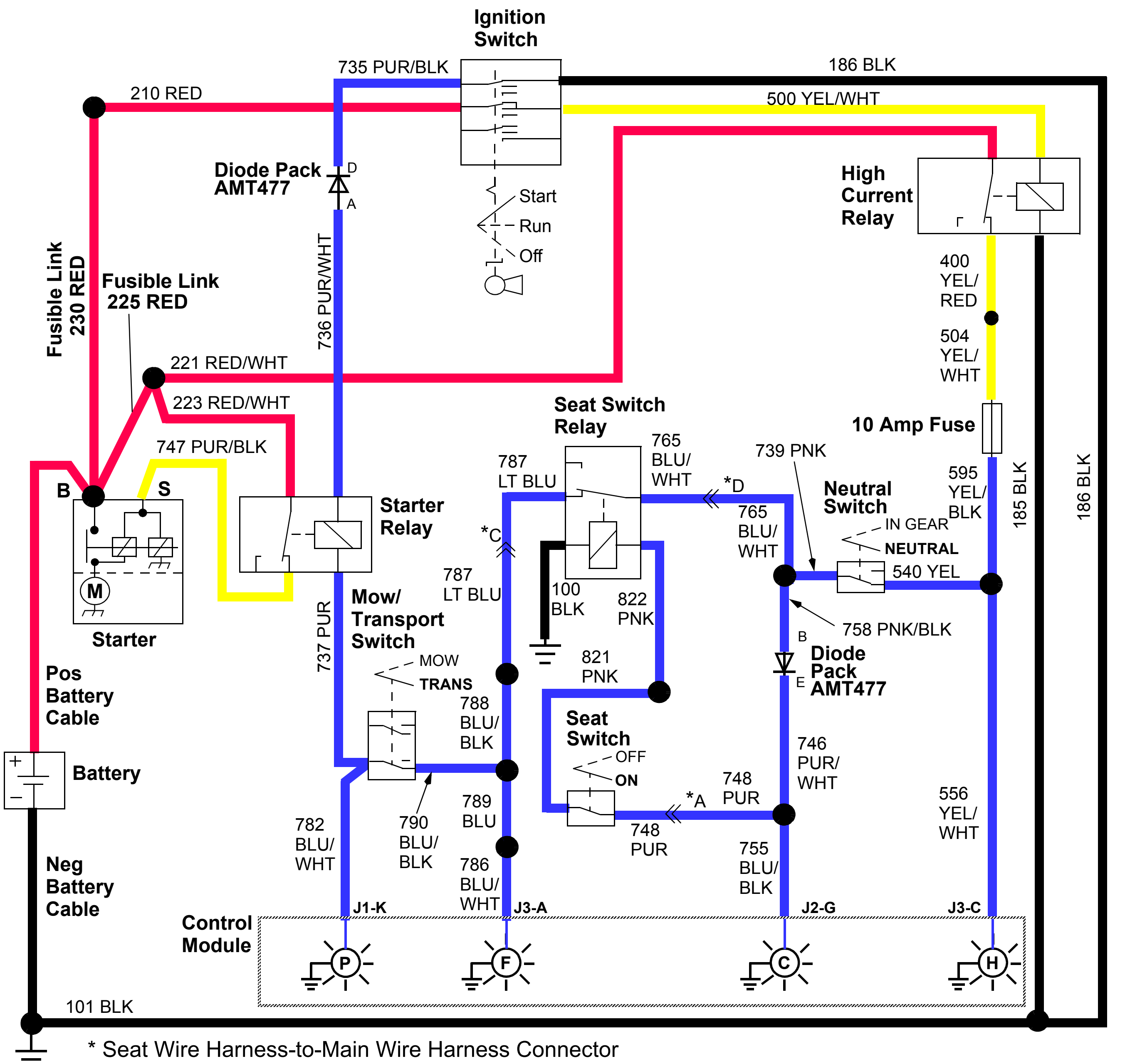
- RED- 12 Volt Positive
- BLACK- Ground
- YELLOW- Switched, Unfused, 12 Volt Positive
- PURPLE- Fused, 12 Volt Positive
- GREEN- Time or Diode Controlled Circuit



MIF

Cranking Circuit (Operator On Seat) Schematic - 3215B, 3225B and 3235B

Note: Control module is not needed to complete this circuit.



* Seat Wire Harness-to-Main Wire Harness Connector

*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**. The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit. All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.*

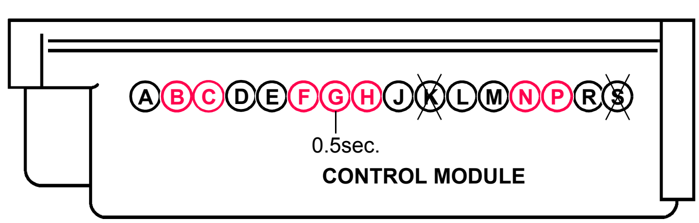
RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive

GREEN- Time or Diode Controlled Circuit



MIF

Cranking Circuit (Operator On Seat) Diagnosis

Test Conditions:

- Battery fully charged
- Transmission in NEUTRAL
- Park lock OFF
- Brake OFF

NOTE: Disconnect seat switch and connect a remote seat switch to the vehicle harness to allow the seat platform to be in the raised position while diagnosing the circuit.

System: Cranking Circuit (Operator On Seat)

(1) With ignition switch in start position, observe the following lights on the control panel: discharge, engine oil pres, engine overtemp, hydro overtemp and hydro oil pres. Are all the lights ON?

Yes - Go to step (2).

No - Check control module LED H. If lit, check individual lights on control panel. If LED H is not lit, check 10-amp fuse. If fuse is bad, determine cause for fuse failure before replacing fuse.

No - If fuse is good, check wire 221 RED/WHT at high current relay for battery voltage. If voltage is present, replace relay. If not present, replace wire harness.

(2) Control module. Is LED H ON?

Yes - Go to step (3).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(3) Control module. Is LED C ON?

Yes - Go to step (4).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

System: Cranking Circuit (Operator On Seat)

No - If no voltage is present, test continuity from neutral switch (VOM positive lead) to terminal G (VOM negative lead). If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See “Test Diode Pack AMT477” on page 204.) If diode pack is good, replace wire harness.

(4) Control module. Is LED F ON?

Yes - Go to step (5).

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If voltage is not present on 3215B and 3235B machines, test seat switch relay circuit. On other machines, if voltage is not present, test continuity from terminal A to the seat switch. If continuity, check or replace seat switch. If no continuity, replace wire harness.

(5) Control module. Is LED P ON?

Yes - Go to step (6).

No - Remove 10-pin connector from module and check for battery voltage at terminal K. If voltage is present, replace the control module.

No - If voltage is not present, test continuity from terminal K to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace wire harness.

(6) Starter relay - wire 737 PUR. Is battery voltage present?

Yes - Go to step (7).

No - Replace wire harness.

(7) Place the meter negative (-) lead on ignition switch wire 186 BLK and meter positive (+) lead on battery positive (+) terminal. Is battery voltage present?

Yes - Go to step (8).

No - Check ground connections at battery and frame.

(8) Disconnect diode pack AMT477 and place the ignition switch in START position. Measure resistance from ignition switch, wire 735 PUR/BLK to ground. Is there less than 0.1 ohm of resistance?

Yes - Go to step (9).

No - Replace ignition switch.

System: Cranking Circuit (Operator On Seat)

(9) Measure resistance from diode pack AMT477 connector, terminal D to ground. Is there less than 0.1 ohm of resistance?

Yes - Go to step (10).

No - Replace wire harness.

(10) Place meter negative (-) lead on battery negative (-) terminal or chassis ground and meter positive (+) lead on starter relay wire 736 PUR/WHT. Is battery voltage present?

Yes - Go to step (11).

No - Replace starter relay.

(11) Diode pack AMT477 connector - terminal A. Is battery voltage present?

Yes - Go to step (12).

No - Replace wire harness.

No - With diode pack connected, if starter relay does not click when ignition switch is moved from RUN to START, check diode pack AMT477.

(12) Starter relay - wire 223 RED/WHT. Is battery voltage present?

Yes - Go to step (13).

No - Test continuity of wire 223 RED/WHT. If fusible link is blown, replace.

(13) Starter relay - wire 747 PUR/BLK. Place ignition switch in START position. Is battery voltage present?

Yes - Go to step (14).

No - Replace starter relay.

(14) Starter relay - wire 747 PUR/BLK. Is battery voltage present?

No - Test continuity of wire 747 PUR/BLK. If no continuity, replace wire harness.

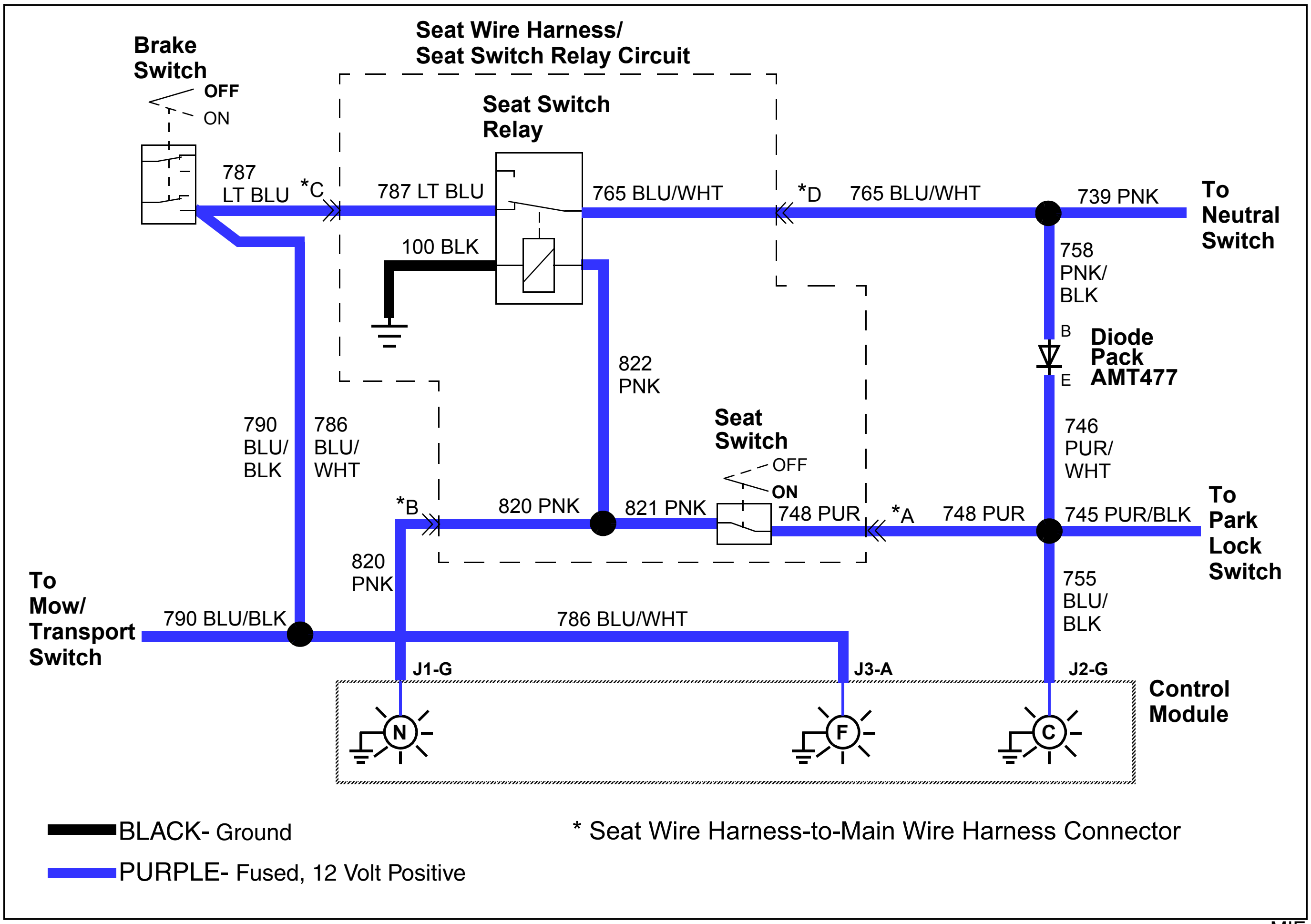
Seat Switch Relay Circuit Operation - 3215B, 3225B and 3235B

The seat switch has only one set of contacts and is used to provide an additional set of switch contacts that are isolated from the seat switch.

Current flows to the seat switch on wire 748 PUR from either the park lock switch on wire 745 PUR/BLK or neutral switch on wire 746 PUR/WHT, diode pack AMT477 and wires 758 PNK/BLK and 739 PNK. When the operator is on the seat, current flows to the coil of seat switch relay on wires 821 PNK and 822 PNK to energize the relay. Current also flows from the seat switch to the interlock module on wires 821 PNK and 820 PNK. The relay coil is grounded through wire 100 BLK.

With the relay energized, current flows from wire 765 BLU/WHT through the relay contacts and wire 787 LT BLU to the brake switch.

Seat Switch Relay Circuit Schematic - 3215B, 3225B and 3235B



MIF

Seat Switch Relay Circuit Diagnosis - Models 3215B, 3225B and 3235B

NOTE: This diagnostic procedure assumes that the control module LED C comes on. This procedure should be performed only when another diagnostic procedure has determined that the seat switch relay circuit is at fault.

Test Conditions:

- Battery fully charged.
- Transmission in NEUTRAL
- Park lock OFF
- Brake OFF

System: Seat Switch Relay Circuit

(1) Control module. Is LED C ON?

Yes - Go to step (2).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace control module.

(2) Disconnect main harness-to-seat harness connector. Measure voltage at main harness-to-seat harness connector wire 748 PUR. Is battery voltage present?

Yes - Go to step (3).

No - Replace main wire harness.

(3) Connect seat harness-to-main harness connector. Disconnect the seat switch. Measure voltage at seat harness-to-main harness connector wire 748 PUR. Is battery voltage present?

Yes - Go to step (4).

No - Replace seat wire harness.

(4) Seat switch relay - wire 822 PNK. Is battery voltage present?

Yes - Go to step (5).

No - Replace seat wire harness.

(5) Control module connector J1 - terminal G, wire 820 PNK. Disconnect control module connector J1. Is battery voltage present?

Yes - Go to step (6).

No - On seat switch harness, test continuity between seat switch connector terminal B (wire 821 PNK) and seat harness-to-main harness connector terminal B (wire 820 PNK). If no continuity, replace seat wire harness. If continuity, replace main wire harness.

System: Seat Switch Relay Circuit

(6) Control module. Connect control module connector J1. Is LED N ON?

Yes - Go to step (7).

No - Replace control module.

(7) Seat switch relay connector - wire 100 BLK. Measure resistance to ground. Is there less than 0.1 ohms of resistance?

Yes - Go to step (8).

No - Test ground connection. If ground connection is good, replace seat wire harness.

(8) Seat switch. Cycle the seat switch between DEPRESSED and RELEASED positions. Does the seat switch relay click when the seat switch is cycled between DEPRESSED and RELEASED positions?

Yes - Go to step (9).

No - Replace seat switch relay.

(9) Brake switch connector - wire 787 LT BLU. Disconnect brake switch. Is battery voltage present?

Yes - Go to step (10).

No - Test continuity of wire 787 LT BLU between brake switch and seat wire harness-to-main wire harness connector terminal C. If no continuity, replace main wire harness. Test continuity of wire 787 LT BLU between seat wire harness-to-main wire harness connector and seat switch relay. If no continuity, replace seat wire harness. If continuity, replace seat switch relay.

(10) Control module. Is LED F ON?

No - Remove 6-pin connector from module and test for battery voltage at terminal A (wire 786 BLU/WHT). If voltage is present, replace the control module. If not, test continuity between brake switch connector wire 788 BLU/BLK and control module 6-pin connector terminal A (wire 786 BLU/BLK). If no continuity, replace main wire harness. If continuity, replace control module.

Run Circuit (Operator Off Seat) Operation

NOTE: Only those circuits required to run the engine with the operator off the seat will be discussed in the following text.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, with the ignition switch in the RUN position.

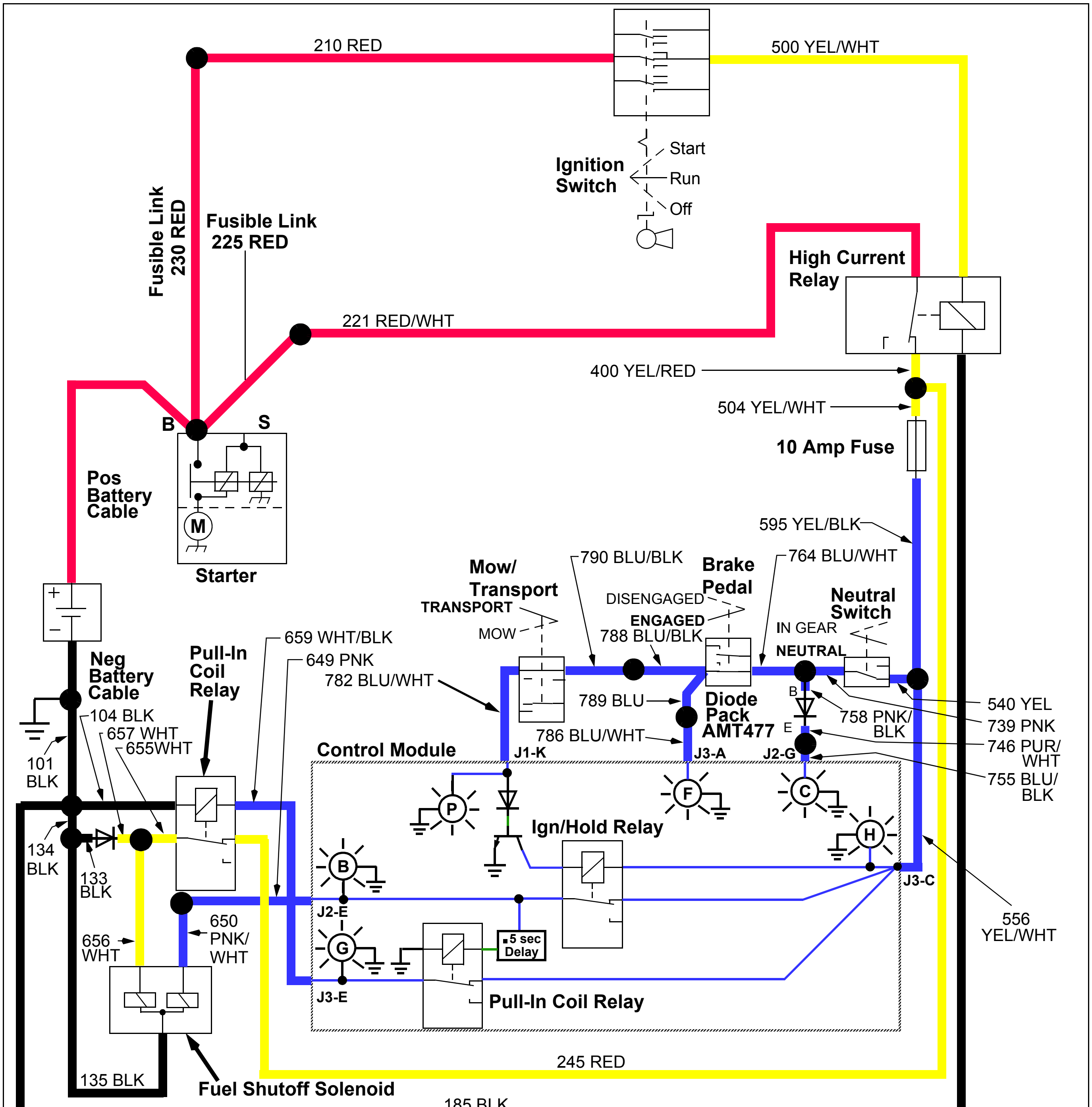
- High Current Relay
- Transmission Neutral Switch
- Control Module, J3-C
- Pull-In Relay
- External Pull-In Coil Relay

Operation

With the ignition switch in the RUN position, current flows to and energizes the high current relay. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the transmission neutral switch (NEUTRAL), the brake pedal switch (brake applied), the mow/transport switch (TRANSPORT) and through terminal J1-K of the control module. Current entering J1-K turns on a transistor inside the control module, providing a ground for the internal ignition/hold relay and LED P should be lit inside the module. Now current standing by at terminal J3-C, energizes the ignition/ hold relay and at the same time, triggers a 0.5-sec timer inside the control module that turns on the internal pull-in coil relay. While the internal pull-in coil relay is energized, LED G is lit. LED B will light when the ignition/hold relay is energized. Pull-in current for the fuel shutoff solenoid comes from the contacts of the high current relay through the contacts of the external pull-in coil relay.

NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Run Circuit (Operator Off Seat) Schematic



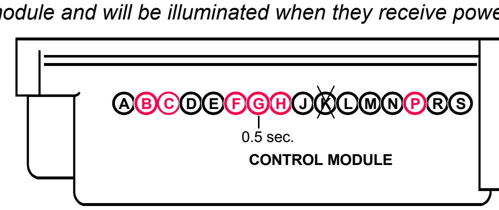
*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**. The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit. All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.*

RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Run Circuit (Operator Off Seat) Diagnosis

NOTE: This diagnostic procedure assumes that the engine cranks, but will not start.

Test Conditions:

- Operator OFF seat
- Park brake ON
- Ignition switch in RUN position
- Transmission in NEUTRAL
- Mow/transport switch in TRANSPORT

System: Run Circuit (Operator Off Seat)

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - if fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(2) Control module. Is LED C ON?

Yes - Go to step (3).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal G to the neutral switch. If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See repair section.) If diode pack is good, replace wire harness.

(3) Control module. Is LED F ON?

Yes - Go to step (4).

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal A to the seat switch. If continuity, check or replace seat switch. If no continuity, replace wire harness.

(4) Control module. Is LED P ON?

Yes - Go to step (5).

System: Run Circuit (Operator Off Seat)

No - Remove 10-pin connector from module and check for battery voltage at terminal K. If voltage is present, replace the control module.

No - If voltage is not present, test continuity from terminal K to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace wire harness.

(5) Control module. Is LED B ON?

Yes - Go to step (6).

No - Replace control module.

(6) Control module. Did LED G go ON for 0.5 second then OFF?

Yes - Go to step (7).

No - Replace control module.

(7) Pull-in coil relay - wire 659 WHT/BLK. Was battery voltage present for 0.5 second?

Yes - Go to step (8).

No - Test continuity of wire 659 WHT/BLK from J3-E to pull-in coil relay.

(8) Pull-in coil relay - wire 104 BLK. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Go to step (9).

No - Test wire 104 BLK and connections. If wire and connections are good, replace relay.

(9) Pull-in coil relay - wire 245 RED. Is battery voltage present?

Yes - Go to step (10).

No - Test continuity of wire 245 RED, from the relay to the splice point.

(10) Pull-in coil relay - wire 655 WHT. Was battery voltage present for 0.5 second?

Yes - Go to step (11).

No - Replace relay.

(11) Fuel shutoff solenoid - wire 656 WHT. Was battery voltage present for 0.5 second? Note - If the fuel shutoff solenoid requires replacement, test the diode located near the connector for proper operation. Replace diode if necessary.

Yes - Go to step (12).

No - Test continuity of wire 656 WHT.

System: Run Circuit (Operator Off Seat)

No - If voltage is present, but solenoid does not pull in, check ground connection and retest. If ground connection is good, replace solenoid.

(12) Fuel shutoff solenoid - wire 650 PNK/WHT. Is battery voltage present?

No - Test continuity of wire 650 PNK/WHT from J2-E of the control module to the fuel shutoff solenoid.

Run Circuit (Operator Off Seat for Service or Backlapping) Operation

NOTE: Only those circuits required to run the engine with the operator off the seat and the service switch in SERVICE position will be discussed here.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, with the ignition switch in the RUN position.

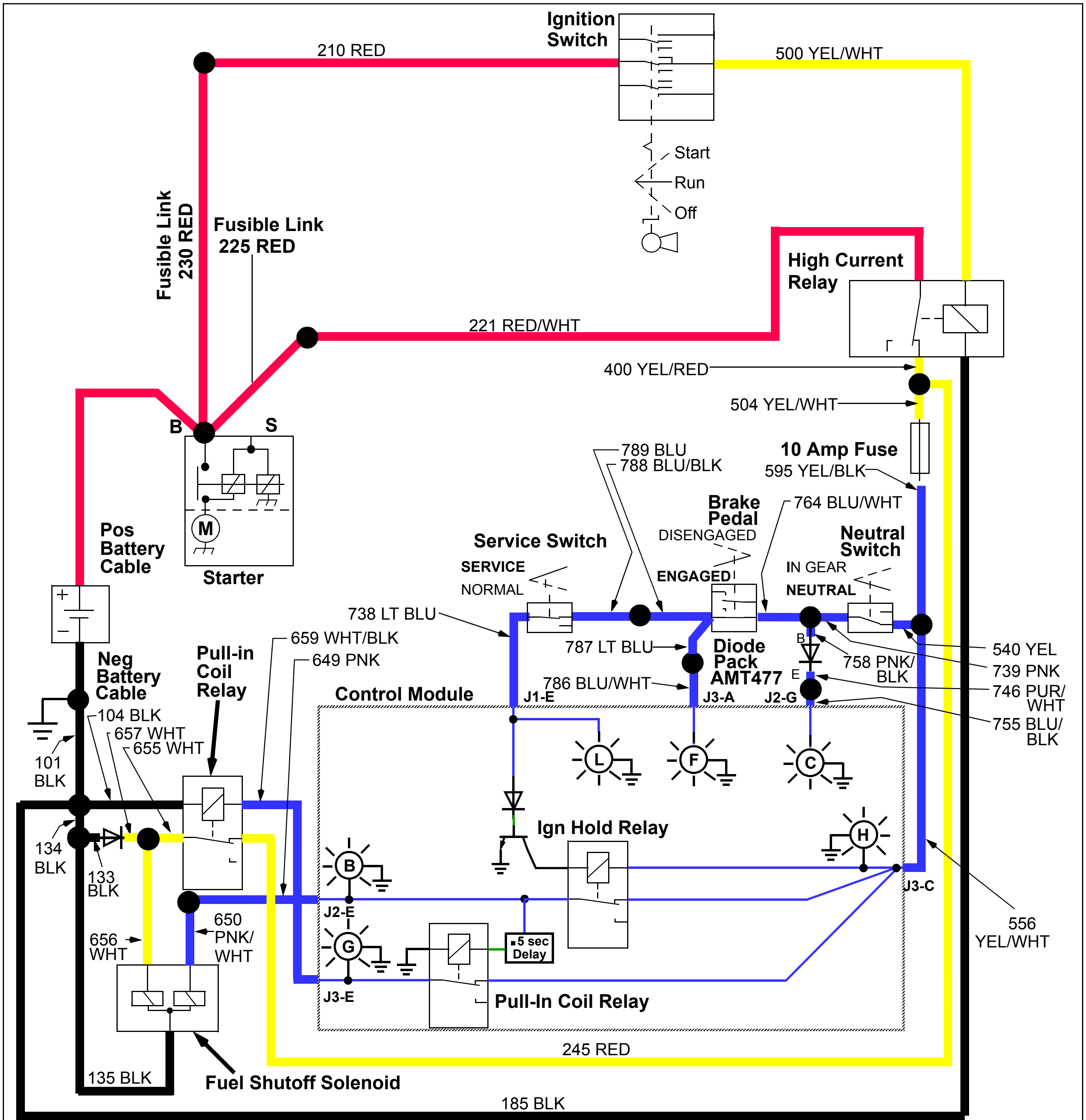
- High Current Relay
- Transmission Neutral Switch
- Control Module, J3-C
- External Pull-In Coil Relay

Operation

With the ignition switch in the RUN position, current flows to and energizes the high current relay. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the transmission neutral switch (in NEUTRAL), the brake pedal switch (brake applied), the service switch (SERVICE) and through terminal J1-E of the control module. Current entering J1-E lights LED L and turns on a transistor inside the control module, providing a ground for the internal ignition/hold relay and lighting LED L inside the module. Now current standing by at terminal J3-C, indicated by the illumination of LED H, energizes the ignition/hold relay, and the pull-in coil relay inside the control module. LED B will light when the internal ignition/hold relay is energized. LED G will light when the internal pull-in coil relay is energized. Pull-in current for the fuel shutoff solenoid comes from the contacts of the high current relay through the contacts of the pull-in coil relay.

NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Run Circuit (Operator Off Seat for Service or Backlapping) Schematic



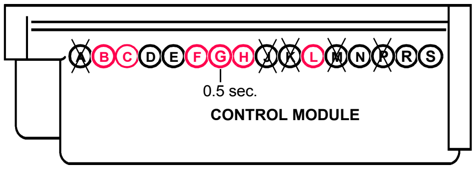
NOTE: *The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Run Circuit (Operator Off Seat for Service or Backlapping) Diagnosis

NOTE: This diagnostic procedure assumes that the engine cranks, but will not start.

Test Conditions:

- Operator OFF seat
- Park brake ON
- Ignition switch in RUN position
- Transmission in NEUTRAL
- Service Switch In SERVICE

System: Run Circuit (Operator Off Seat for Service or Backlapping)

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(2) Control module. Is LED C ON?

Yes - Go to step (3).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal G to the neutral switch. If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See repair section.) If diode pack is good, replace wire harness.

(3) Control module. Is LED F ON?

Yes - Go to step (4).

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal A to the seat switch. If continuity, check or replace seat wire harness.

(4) Control module. Is LED L ON?

Yes - Go to step (5).

System: Run Circuit (Operator Off Seat for Service or Backlapping)

No - Remove 10-pin connector from module and check for battery voltage at terminal E. If voltage is present, replace the control module. If not, test continuity of wire 738 LT BLU from J1-E to the service switch. If continuity, check or replace service switch.

(5) Control module. Is LED B ON?

Yes - Go to step (6).

No - Replace control module.

(6) Control module. Did LED G go on for 0.5 second then OFF?

Yes - Go to step (7).

No - Replace control module.

(7) Pull-in coil relay - wire 659 WHT/BLK. Was battery voltage present for 0.5 second?

Yes - Go to step (8).

No - Test continuity of wire 659 WHT/BLK, from J3-E to the relay.

(8) Pull-in coil relay - wire 104 BLK. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Go to step (9).

No - Test wire 104 BLK and connections. If wire and connections are good, replace relay.

(9) Pull-in coil relay - wire 245 RED. Is battery voltage present?

Yes - Go to step (10).

No - Test continuity of wire 245 RED, from the relay to the splice point.

(10) Pull-in coil relay - wire 655 WHT. Was battery voltage present for 0.5 second?

Yes - Go to step (11).

No - Replace relay.

(11) Fuel shutoff solenoid - wire 656 WHT. Was battery voltage present for 0.5 second? NOTE: If the fuel shutoff solenoid requires replacement, test the diode located near the connector for proper operation. Replace if necessary.

Yes - Go to step (12).

No - Test continuity of wire 656 WHT, from the pull-in coil relay to the fuel shutoff solenoid.

System: Run Circuit (Operator Off Seat for Service or Backlapping)

No - If voltage is present but solenoid does not pull in, check ground connection and retest. If ground connection is good, replace solenoid.

(12) Fuel shutoff solenoid - wire 650 PNK/WHT. Is battery voltage present?

No - Test continuity of wire 650 PNK/WHT, from control module connector J2-E to the fuel shutoff solenoid.

Normal Run Circuit (Operator On Seat and Park Lock Off) Operation

NOTE: Only those circuits required to run the engine with the operator on the seat will be discussed in the following text.

Unswitched Power

The battery provides current tot he following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, with the ignition switch in the RUN position.

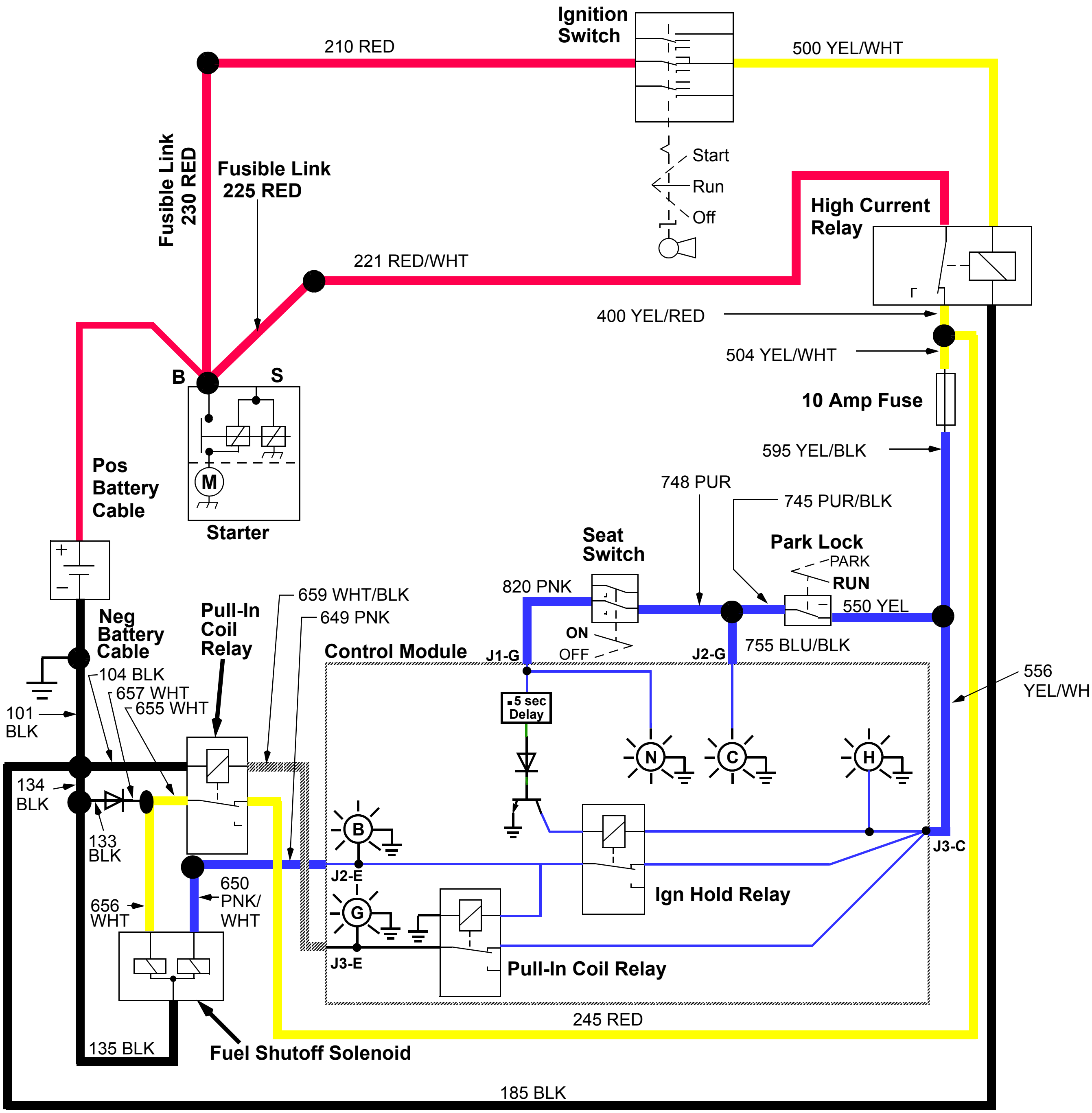
- High Current Relay
- Park Lock Switch
- Control Module
- External Pull-In Coil Relay

Operation

With the ignition switch in the RUN position, current flows to and energizes the high current relay. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the park lock switch (OFF), the seat switch (operator on seat), into the control module. Current entering J1-G lights LED N and turns on a transistor inside the control module, providing a ground for the internal ignition/hold relay and inside the module. Now current standing by at terminal J3-C, indicated by the illumination of LED H, energizes the internal ignition/hold relay, and the internal pull-in coil relay. LED B will light when the internal ignition/hold relay is energized. LED G will light when the internal pull-in coil relay is energized. Pull-in current for the fuel shutoff solenoid comes from the contacts of the high current relay through the contacts of the pull-in coil relay.

NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Normal Run Circuit (Operator On Seat and Park Lock Off) Schematic - 3215, 3215A, 3235 and 3235A



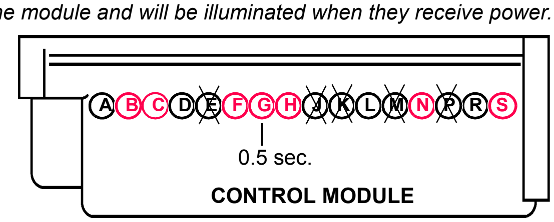
NOTE: *The LED lights shown below in red are* ***ON*** *and relevant to this circuit. LED lights shown in black are* ***OFF****.*
The LED lights that are "X" may be either ***ON*** *or* ***OFF*** *but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive

BLACK- Ground

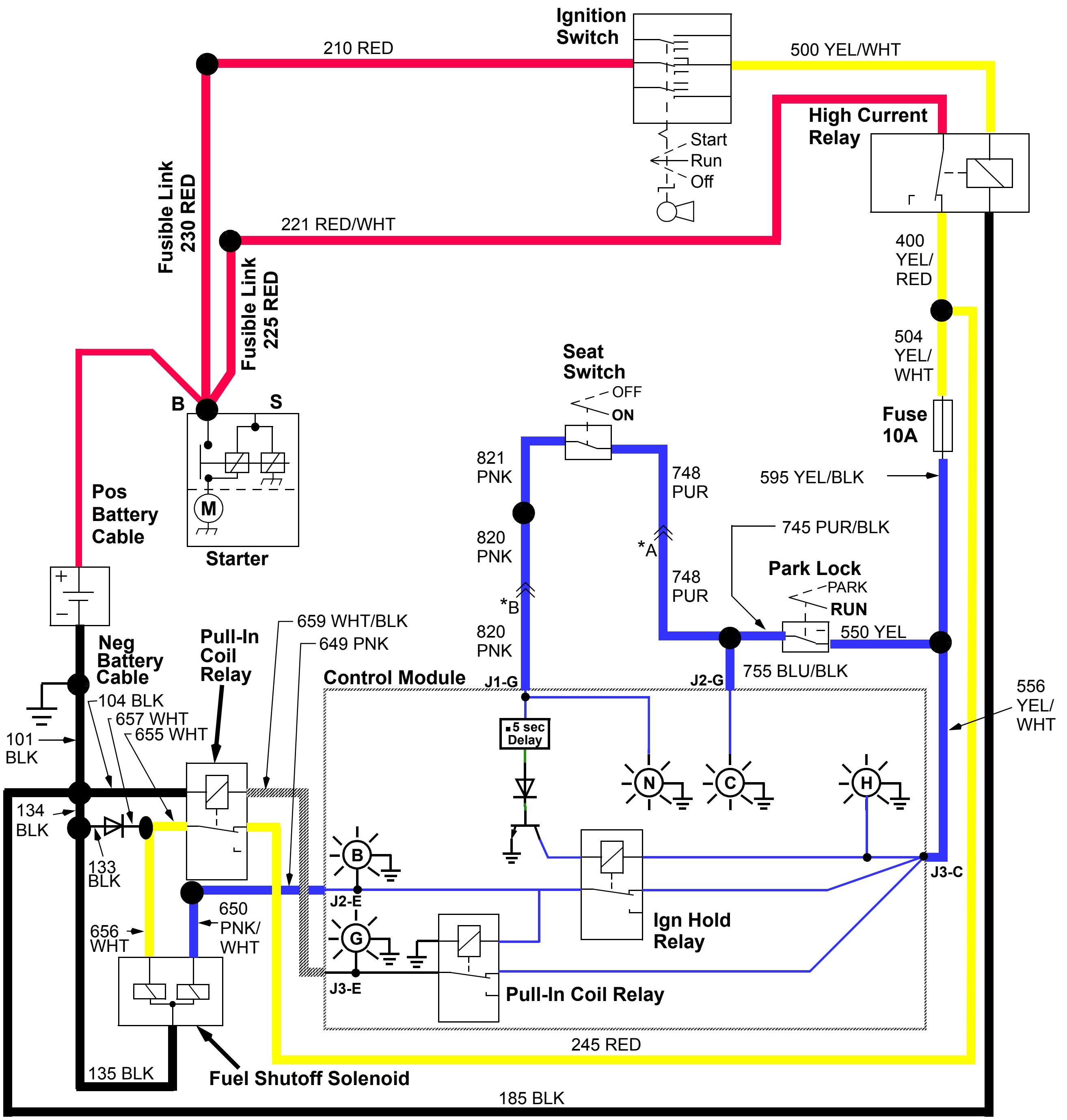
YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Normal Run Circuit (Operator On Seat and Park Lock Off) Schematic - 3215B, 3225B and 3235B



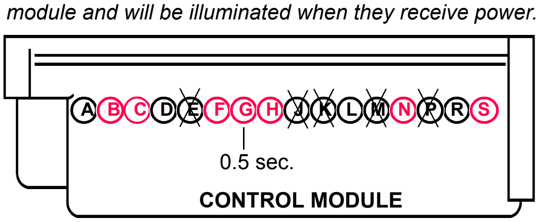
*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Normal Run Circuit (Operator On Seat and Park Lock Off) Diagnosis

NOTE: This diagnostic procedure assumes that the engine cranks, but will not start.

Test Conditions:

- Operator ON seat
- Park lock OFF
- Ignition switch in RUN position

System: Normal Run Circuit (Operator On Seat and Park Lock Off)

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(2) Control module. Is LED N ON?

Yes - Go to step (3).

No - (Models 3215, 3215A, 3235 and 3235A) Remove 10-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module. If voltage is not present, test for voltage at wire 820 PNK at seat switch. If voltage is present, replace wire harness. If not, check voltage at wire 748 PUR at seat switch. If voltage is present, replace seat switch. If not, check voltage at wire 745 PUR/BLK at park lock switch. If voltage is present, replace wire harness. If not, check voltage at wire 550 YEL at park lock switch. If voltage is present, replace park lock switch.

No - (Models 3215B, 3225B, and 3235B) Remove 10-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - (Models 3215B, 3225B, and 3235B) If voltage is not present test wire 820 PNK between control module and seat switch and connections.

(3) Control module. Is LED B ON?

Yes - Go to step (4).

No - Replace control module.

System: Normal Run Circuit (Operator On Seat and Park Lock Off)

(4) Control module. Did LED G go ON for 0.5 second then OFF?

Yes - Go to step (5).

No - Replace control module.

(5) Pull-in coil relay - wire 659 WHT/BLK. Was battery voltage present for 0.5 second?

Yes - Go to step (6).

No - Test continuity of wire 659 WHT/BLK, from J3-E to the relay.

(6) Pull-in coil relay - wire 104 BLK. Measure ground circuit resistance. Is there less than 0.1 ohm resistance?

Yes - Go to step (7).

No - Test wire 104 BLK and connections. If wire and connections are good, replace relay.

(7) Pull-in coil relay - wire 245 RED. Is battery voltage present?

Yes - Go to step (8).

No - Test continuity of wire 245 RED, from the relay to the splice.

(8) Pull-in coil relay - wire 655 WHT. Was battery voltage present for 0.5 second?

Yes - Go to step (9).

No - Replace relay.

(9) Fuel shutoff solenoid - wire 656 WHT. Was battery voltage present for 0.5 second? NOTE: If the fuel shutoff solenoid requires replacement, test the diode located near the connector for proper operation. Replace if necessary.

Yes - Go to step (10).

No - Test continuity of wire 656 WHT, from the pull-in coil relay to the fuel shutoff solenoid.

No - If voltage is present, but solenoid does not pull in, check ground connection and retest. If ground connection is good, replace solenoid.

(10) Fuel shutoff solenoid - wire 650 PNK/WHT. Is battery voltage present?

No - Test continuity of wire 650 PNK/WHT, from J2-E of the control module to the fuel shutoff solenoid.

Primary Run Circuit (Operator On Seat in Neutral) Operation

NOTE: Only those circuits required to run the engine with the operator on the seat will be discussed in the following text.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, with the ignition switch in the RUN position.

- High Current Relay
- Transmission Neutral Switch
- Control Module
- External Pull-In Coil Relay

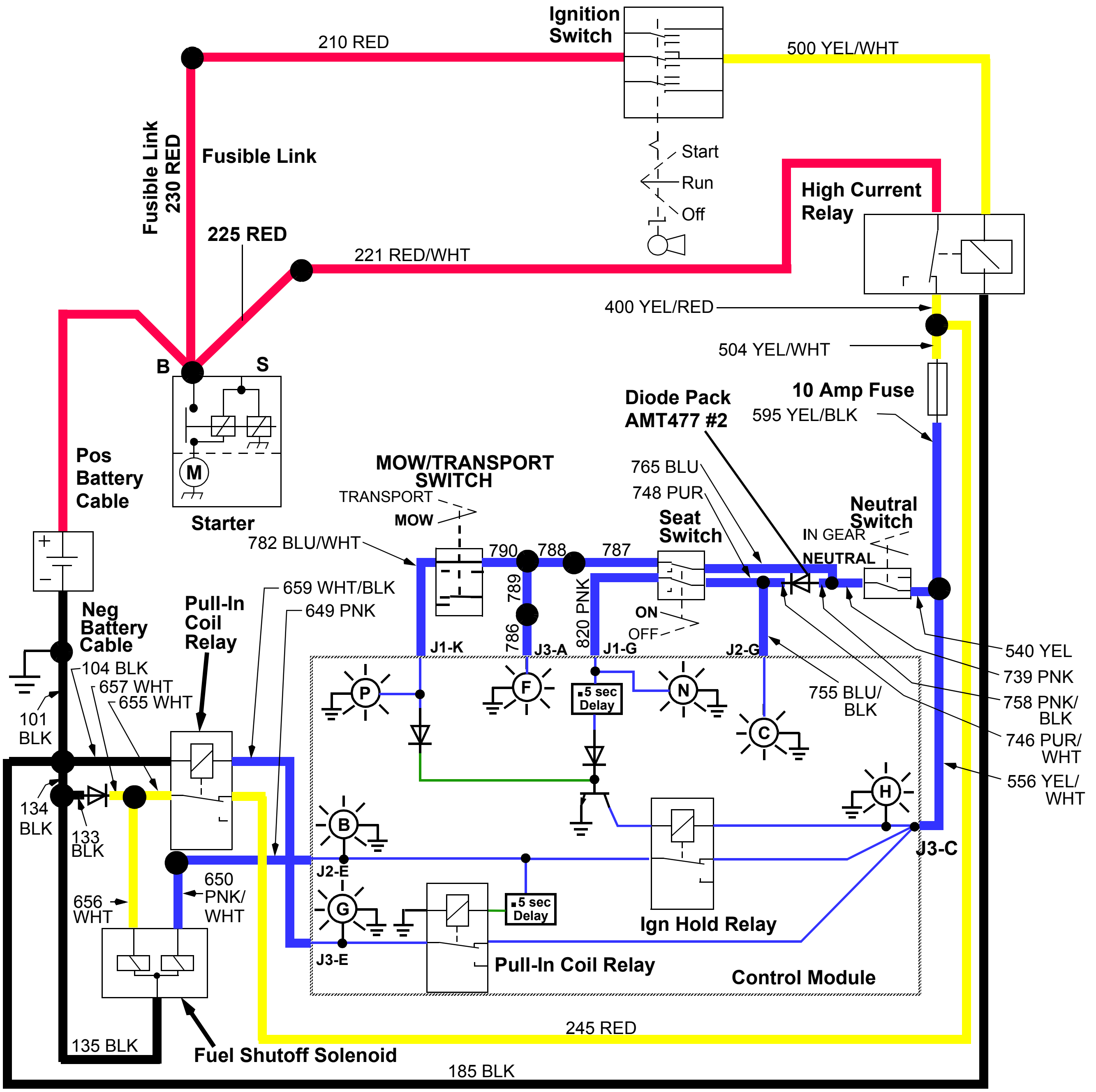
Operation

With the ignition switch in the RUN position, current flows to and energizes the high current relay. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the neutral switch (in NEUTRAL), a diode, the seat switch (ON), and into the control module. Current entering J1-G lights LED N, goes through a 0.5 sec. delayed break timer, and turns on a transistor inside the control module, providing a ground for the internal ignition/hold relay. Now current standing by at terminal J3-C, indicated by the illumination of LED H, energizes the ignition/hold relay and the pull-in coil relay inside the control module. LEDs B and G will light when the internal pull-in coil relay and the internal ignition/hold relay are energized. Pull-in current for the fuel shutoff solenoid comes from the contacts of the high current relay through the contacts of the pull-in coil relay.

On 3215B and 3235B models, the seat switch also energizes the seat switch relay to provide operation as described above.

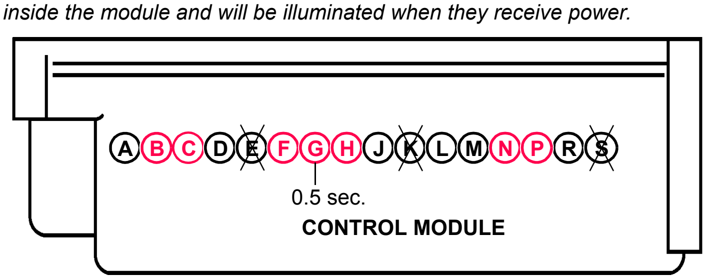
NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Primary Run Circuit (Operator On Seat in Neutral) Schematic - 3215, 3215A, 3235 and 3235A



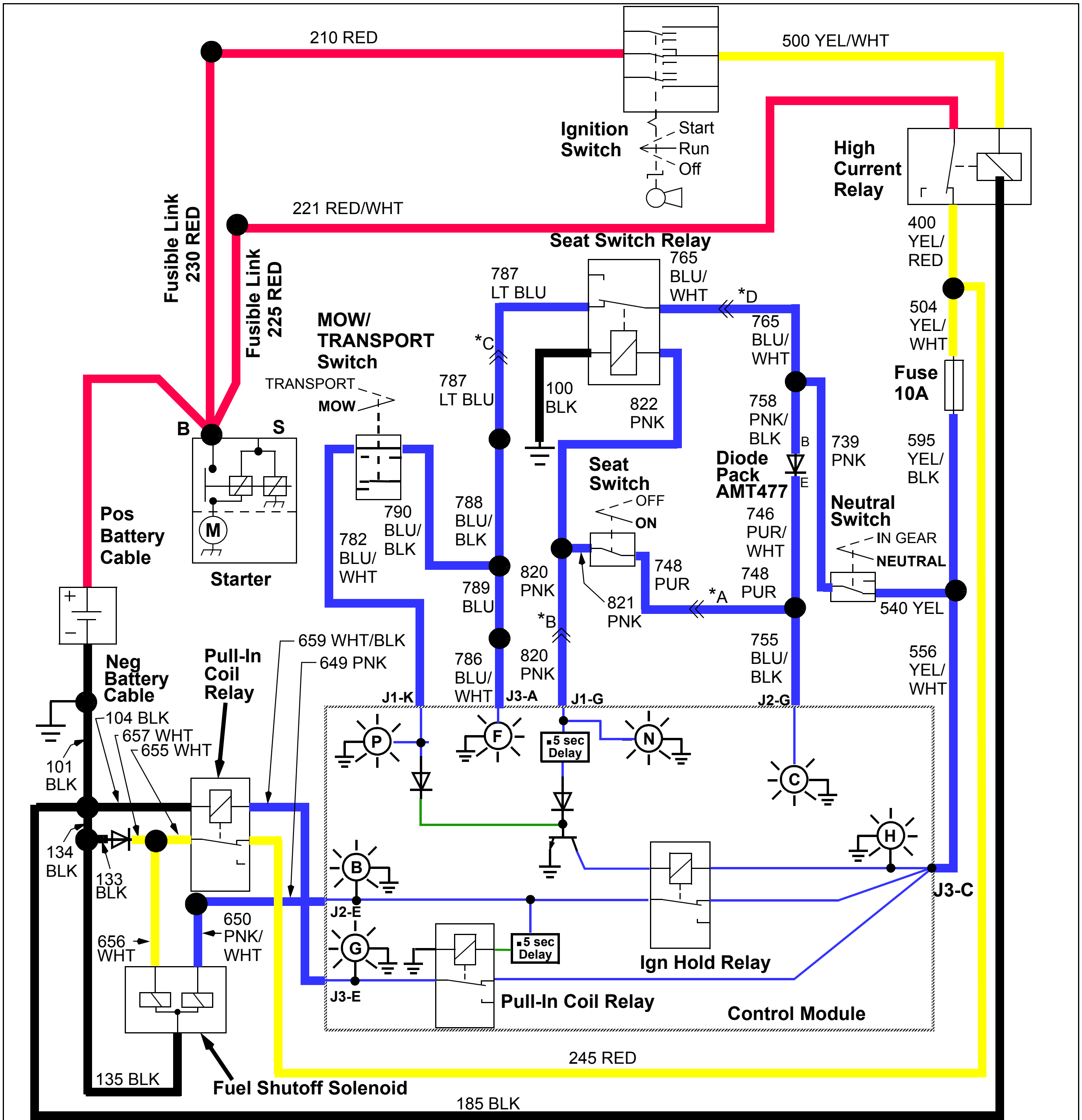
*NOTE: The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive
BLACK- Ground
YELLOW- Switched, Unfused, 12 Volt Positive
PURPLE- Fused, 12 Volt Positive
GREEN- Time or Diode Controlled Circuit



MIF

Primary Run Circuit (Operator On Seat in Neutral) Schematic - 3215B, 3225B and 3235B



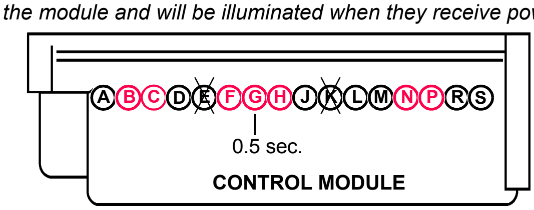
NOTE: The LED lights shown below in red are ***ON*** *and relevant to this circuit. LED lights shown in black are* ***OFF****.*
The LED lights that are "X" may be either ***ON*** *or* ***OFF*** *but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Primary Run Circuit (Operator On Seat in Neutral) Diagnosis

NOTE: This diagnostic procedure assumes that the engine cranks, but will not start.

Test Conditions:

- Operator ON seat
- Ignition switch in RUN
- Transmission in NEUTRAL
- Mow/transport switch in TRANSPORT

System: Primary Run Circuit (Operator On Seat in Neutral)

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of 221 RED/WHT wire.

(2) Control module. Is LED C ON?

Yes - Go to step (3).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal G to the neutral switch. If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See repair section.) If diode pack is good, replace wire harness.

(3) Control module. Is LED N ON?

Yes - Go to step (4).

No - Remove 10-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module. If voltage is not present on 3215B and 3235B machines, test seat switch relay circuit. On other machines, test continuity from terminal G to the seat switch. If continuity, check or replace seat switch. If no continuity, replace wire harness.

(4) Control module. Is LED F ON?

Yes - Go to step (5).

System: Primary Run Circuit (Operator On Seat in Neutral)

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal A to the seat switch. If continuity, check or replace seat switch. If no continuity, replace wire harness.

No - (Models 3215B and 3235B) If no voltage is present, test seat switch relay circuit.

(5) Control module. Is LED P ON?

Yes - Go to step (6).

No - Remove 10-pin connector from module and check for battery voltage at terminal K. If voltage is present, replace the control module.

No - If voltage is not present, test continuity from terminal K to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace wire harness.

(6) Control module. Is LED B ON?

Yes - Go to step (7).

No - Replace control module.

(7) Control module. Is LED G ON?

Yes - Go to step (8).

No - Replace control module.

(8) Pull-in coil relay - wire 659 WHT/BLK. Was battery voltage present for 0.5 second?

Yes - Go to step (9).

No - Test continuity of wire 659 WHT/BLK, from J3-E to the relay.

(9) Pull-in coil relay - wire 104 BLK. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Go to step (10).

No - Test wire 104 BLK and connections. If wire and connections are good, replace relay.

(10) Pull-in coil relay - wire 245 RED. Is battery voltage present?

Yes - Go to step (11).

No - Test wire 245 RED, from the relay to the splice point.

(11) Pull-in coil relay - wire 655 WHT. Was battery voltage present for 0.5 second?

System: Primary Run Circuit (Operator On Seat in Neutral)

Yes - Go to step (12).

No - Replace relay.

(12) Fuel shutoff solenoid - wire 656 WHT. Was battery voltage present for 0.5 second? NOTE: If the fuel shutoff solenoid requires replacement, test the diode located near the connector for proper operation. Replace if necessary.

Yes - Go to step (13).

No - Test continuity of wire 656 WHT, from the pull-in coil relay to the fuel shutoff solenoid.

No - If voltage is present, but solenoid does not pull in, check ground connection and retest. If ground connection is good, replace solenoid.

(13) Fuel shutoff solenoid - wire 650 PNK/WHT. Is battery voltage present?

No - Test continuity of wire 650 PNK/WHT, from J2-E of the control module to the fuel shutoff solenoid.

Mow Circuit Operation

NOTE: Only those circuits required to energize the mow solenoids will be discussed in the following text.

Switched Power

Power is supplied to the following components with the ignition switch in the RUN position.

- High Current Relay
- Park Lock Switch
- Mow/Transport Switch
- Control Module J3-C

Switch Positions

- Ignition Switch - RUN
- Park Lock Switch - OFF or RUN
- Seat Switch - ON (ON seat)
- Mow/Transport Switch - MOW
- Raise/Lower Switch - LOWERED
- Brake Switch - OFF (disengaged)

Operation

NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Step 1 - Current from the contacts of the high current relay, flows through the 10-amp fuse, to the park lock switch (OFF), the seat switch (operator on the seat) and J1-G of the control module to a timer circuit that immediately turns on (with a 0.5 second delayed break) a transistor that supplies ground to the ignition hold relay coil. Current also flows from the high current relay through the mow/transport switch (in mow), to the reel engagement light, through J1-F of the control module and energizes the mow enable relay. Current from the mow/transport switch flows through the raise/lower switch (lowered), and J1-H of the control module energizing the trigger latch relay.

Step 2 - With ground now established for the ignition/hold relay, current standing by at J3-C energizes the ignition/hold relay and allows current to flow out of module at J2-E. Part of this current is fed back through the brake switch (brake OFF), J1-A, the contacts of the mow enable relay, the raise/lower switch, the contacts of the trigger latch relay and to the coil of the mow latch relay coil.

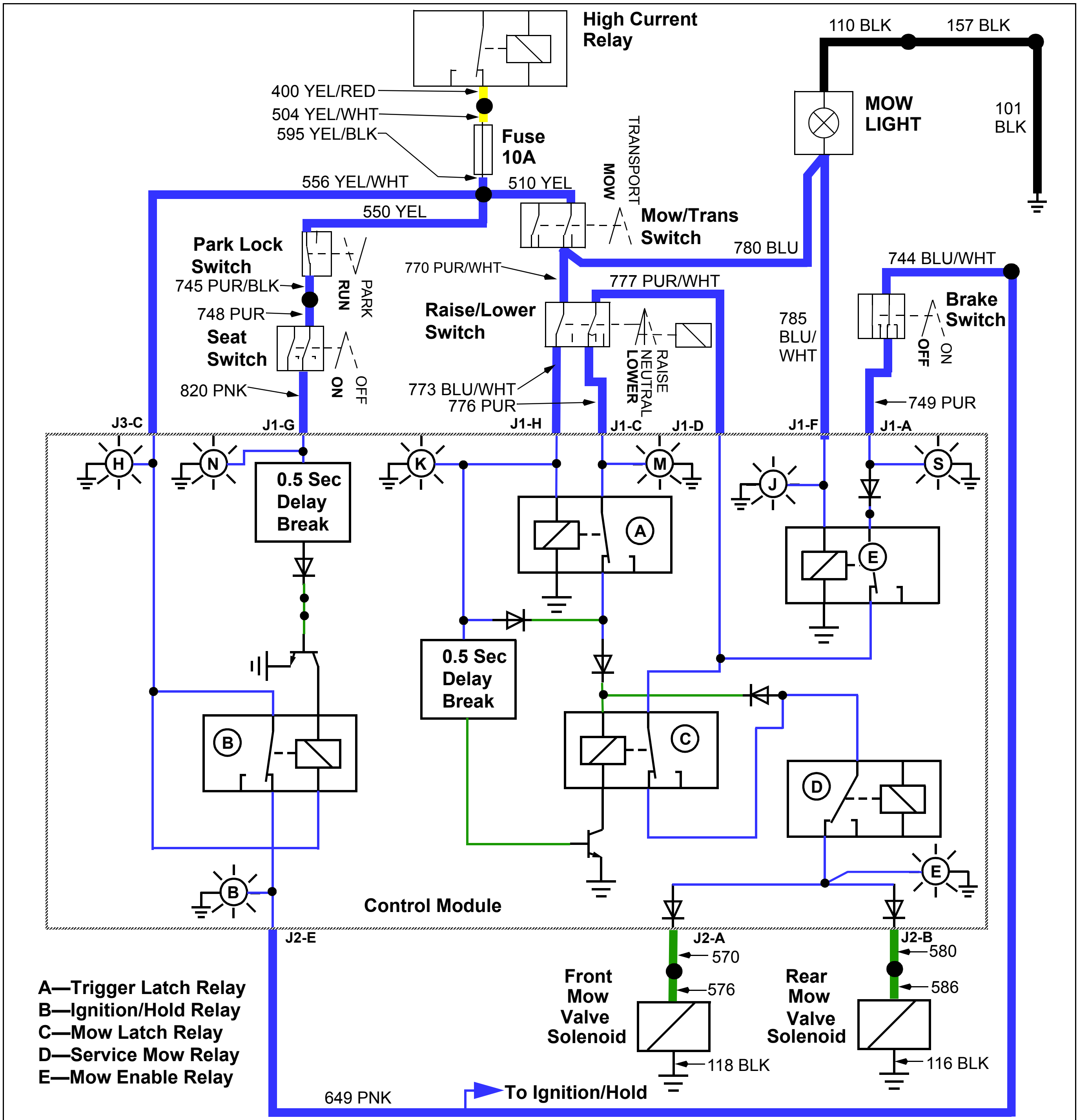
Step 3 - With the mow/transport switch in (MOW) and the raise/lower switch in (LOWER), current flows to J1-H and to a timer circuit that immediately turns on (with a 0.5 sec. delayed break) a transistor that supplies ground to the mow latch relay. With ground now established for the mow latch relay, the relay is energized and current can flow from the mow enable relay through the sustain contact of the raise/lower switch, through the trigger latch relay to the mow latch relay to energize it.

Step 4 - With the mow latch relay energized, current standing by at the mow enable relay flows through the contacts of the mow latch relay and the normally closed contacts of the service/mow relay to energize the mow valve solenoids.

Troubleshooting Hints

Backlapping valve - If the seat switch has failed in the closed position and the service switch has failed in the (SERVICE) position or is not in the (NORMAL) position, the mow valve solenoids will not energize to run the reels in the forward direction. To verify this condition, engage the reverse switch on the backlapping valve and watch for the reels to turn in the reverse direction.

Mow Circuit Schematic - 3215, 3215A, 3235 and 3235A



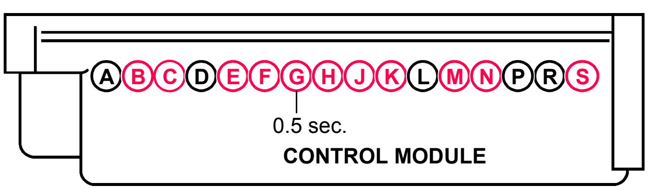
NOTE: *The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive

BLACK- Ground

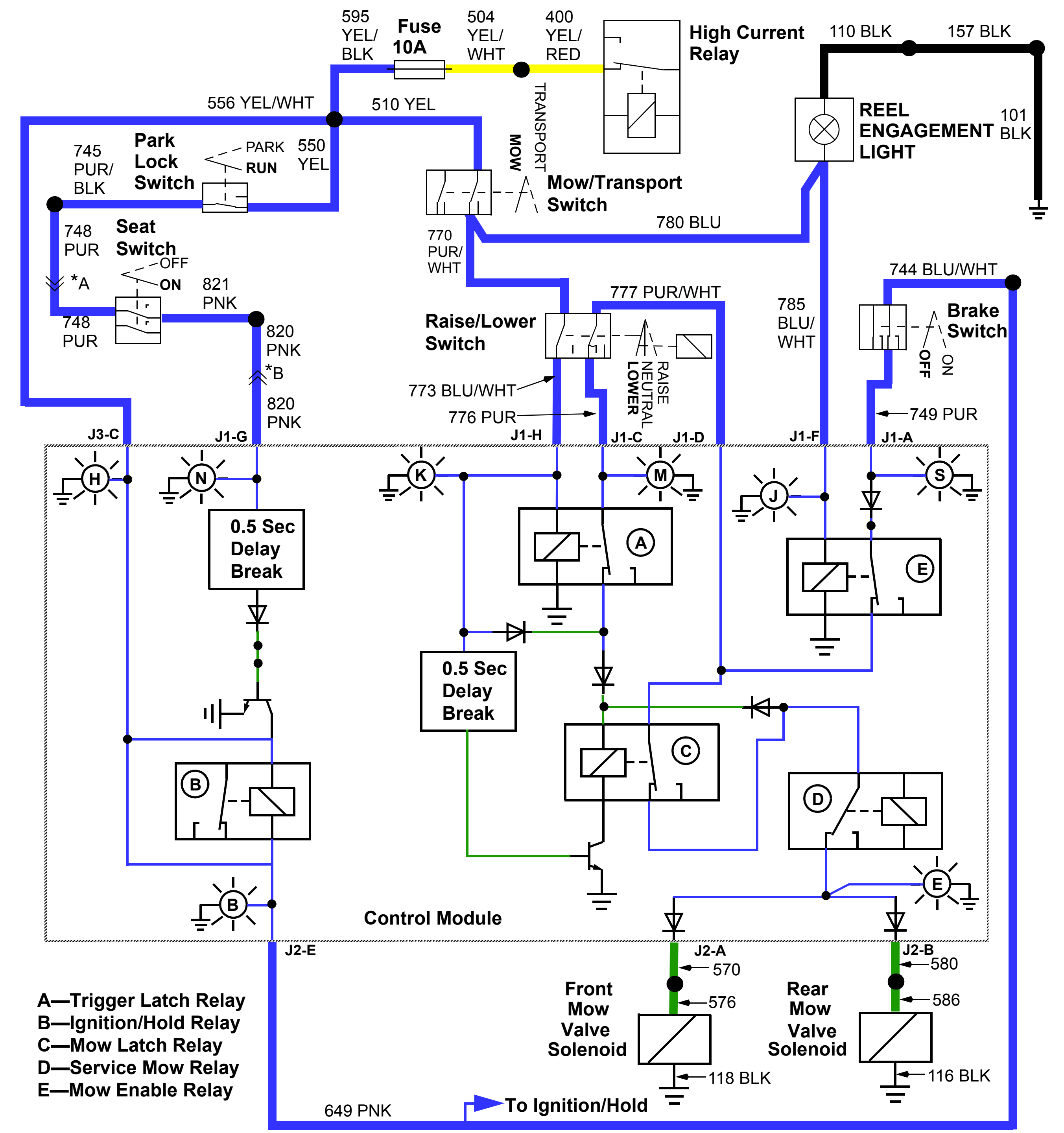
YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive



MIF

Mow Circuit Schematic - 3215B, 3225B and 3235B



NOTE: *The LED lights shown below in red are **ON** and relevant to this circuit. LED lights shown in black are **OFF**.*
*The LED lights that are "X" may be either **ON** or **OFF** but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

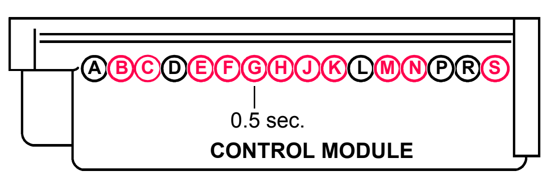
RED- 12 Volt Positive

BLACK- Ground

YELLOW- Switched, Unfused, 12 Volt Positive

PURPLE- Fused, 12 Volt Positive

*Seat Wire Harness-to-Main Wire Harness Connector



MIF

Mow Circuit Diagnosis

NOTE: Disconnect seat switch and connect a remote seat switch to the vehicle harness to allow the seat platform to be in the raised position while diagnosing the circuit.

Test Conditions:

- Park lock OFF
- Mow/transport lever in MOW
- Raise/lower lever in LOWER
- Brake OFF (disengaged)

System: Mow Circuit

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of 221 RED/WHT wire.

(2) Control module. Is LED N ON?

Yes - Go to step (3).

No - (Models 3215, 3215A, 3235 and 3235A) Remove 10-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module. If voltage is not present, test for voltage at wire 820 PNK at seat switch. If voltage is present, replace wire harness. If not, check voltage at wire 748 PUR at seat switch. If voltage is present, replace seat switch. If not, check voltage at wire 745 PUR/BLK at park lock switch. If voltage is present, replace wire harness. If not, check voltage at wire 550 YEL at park lock switch. If voltage is present, replace park lock switch.

No - (Models 3215B, 3225B, and 3235B) Remove 10-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - (Models 3215B, 3225B, and 3235B) If voltage is not present test wire 820 PNK between control module and seat switch and connections.

(3) Control module. Is LED B ON?

Yes - Go to step (4).

No - Replace control module.

System: Mow Circuit

(4) Control module. Is LED S ON?

Yes - Go to step (5).

No - Remove 10-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module. If not, test continuity from terminal A to the brake switch. If continuity, check or replace brake switch. If no continuity, test continuity from terminal A of 10-pin connector to terminal E of 8-pin connector. If continuity, replace control module. If no continuity, replace wire harness.

(5) Control module. Is LED J ON?

Yes - Go to step (6).

No - Check if reel engagement light is on. If on, test continuity of wire 785 BLU/WHT to the reel engagement light. If not on, remove 10-pin connector from module and check for battery voltage at terminal F. If voltage is present, replace the control module. If not, test continuity from terminal F to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace wire harness.

(6) Control module. Is LED M ON?

Yes - Go to step (7).

No - Remove 10-pin connector from module and check for voltage at module pin J1-D. If voltage is not present, replace module. If voltage is present, test continuity between terminal C and terminal D in connector. If continuity, replace module. If no continuity, test continuity across terminals 777 PUR/WHT and 776 PUR at raise/lower switch. If no continuity, replace switch. If continuity, replace wire harness.

(7) Control module LED E. Is LED E ON?

No - Replace control module.

Backlapping Circuit Operation

NOTE: Only those circuits required to energize the mow solenoids will be discussed in the following text.

Switched Power

Power is supplied to the following components with the ignition switch in the RUN position.

- High Current Relay
- Park Lock Switch
- Mow/Transport Switch
- Control Module J3-C

Switch Positions

- Ignition Switch - RUN
- Neutral Switch - NEUTRAL
- Seat Switch - OFF (OFF seat)
- Mow/Transport Switch - MOW
- Raise/Lower Switch - LOWERED
- Brake Switch - ON (engaged)
- Service Switch - SERVICE

Operation

NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Step 1 - Current from the contacts of the high current relay flows through the transmission/neutral switch (NEUTRAL), the brake pedal switch (ON), the service switch (SERVICE) and J1-E of the control module, energizes the service/mow relay and stands by at the contacts of the mow enable relay. Current also flows from the high current relay through the mow/transport switch (MOW), through J1-F of the control module and energizes the mow enable relay. Current from the mow/transport switch flows through the raise/lower switch (LOWERED), and J1-H of the control module, energizing the trigger latch relay.

Step 2 - With the trigger latch relay energized, current flows through the contacts of the mow enable relay, through the raise/lower switch (LOWERED), through the contacts of the trigger latch relay and turns on a transistor to supply a ground for the coil of the mow latch relay.

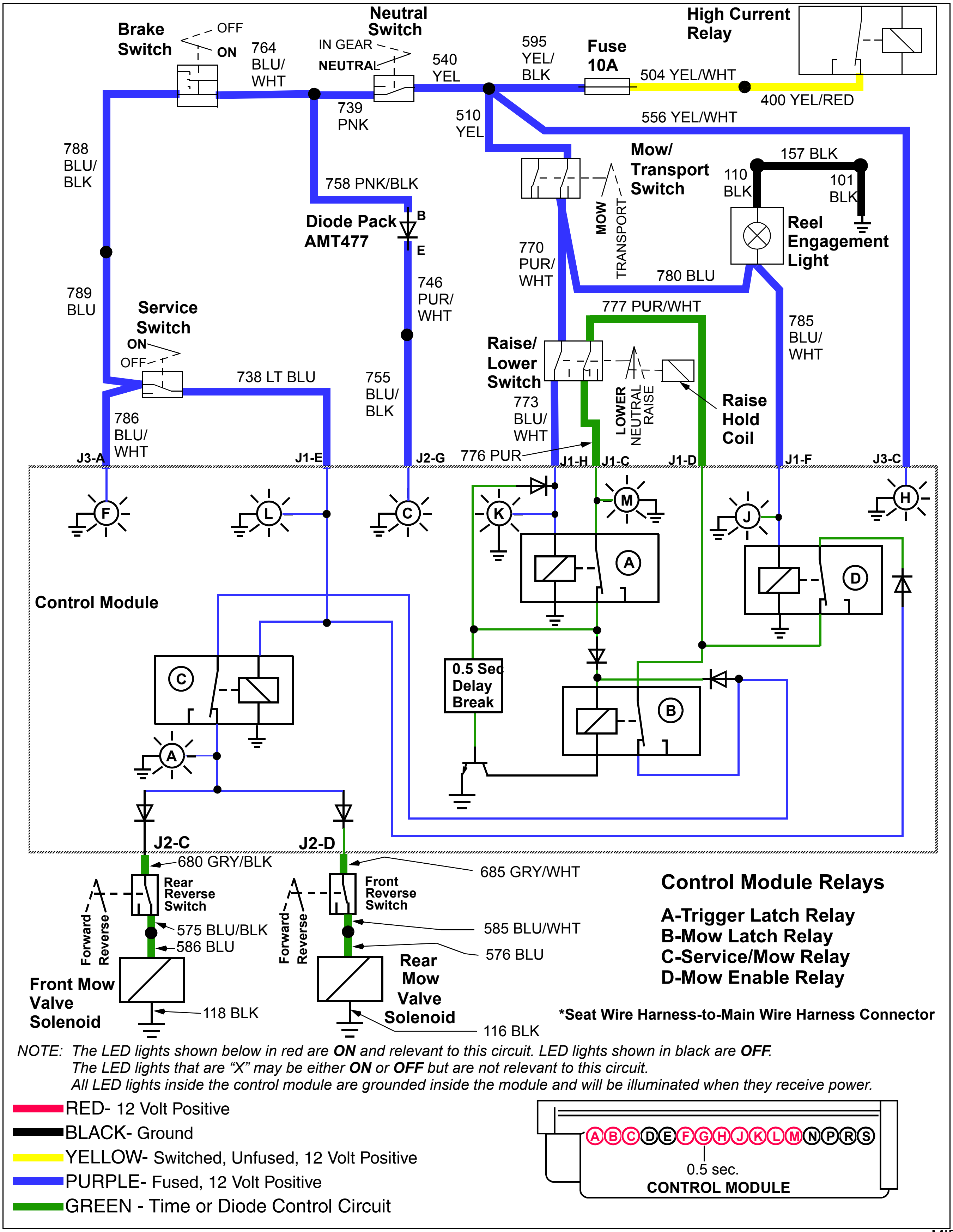
Step 3 - With a ground now established for the mow latch relay, current can flow from the trigger latch relay to the mow latch relay to energize it.

Step 4 - With the mow latch and service/mow relays energized, current standing by at the mow enable relay flows through the contacts of the mow latch relay, through the contacts of the service/mow relay, through the forward/reverse switches of the backlapping valves (REVERSE) and energizes the mow valve solenoids.

Troubleshooting Hints

If the seat switch were to fail in the closed position, an alternate path for power would be supplied to the service switch with the brake switch OFF (brake not applied).

Backlapping Circuit Schematic



Backlapping Circuit Diagnosis

NOTE: The backlapping circuit should function with the operator OFF seat. See "Run Circuit (Operator Off Seat for Service or Backlapping) Diagnosis" on page 178 if backlapping will not function because the engine quits when the operator gets off the seat.

Test Conditions:

- Park lock ON
- Operator OFF seat (seat switch OFF)
- Transmission in NEUTRAL
- Service switch ON (service switch in SERVICE)
- Raise/lower lever in LOWER
- Brake ON
- Mow/transport switch to MOW or service switch ON

System: Backlapping Circuit

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, test continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 RED and continuity of wire 221 RED/WHT.

(2) Control module. Is LED C ON?

Yes - Go to step (3).

No - Remove 8-pin connector from module and check for battery voltage at terminal G. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal G to the neutral switch. If continuity, check or replace neutral switch. If no continuity, check or replace diode pack AMT477. (See Repair section.) If diode pack is good, replace wire harness.

(3) Control module. Is LED F ON?

Yes - Go to step (4).

No - Remove 6-pin connector from module and check for battery voltage at terminal A. If voltage is present, replace the control module.

No - If no voltage is present, test continuity from terminal A to the seat switch. If continuity, check or replace seat switch. If no continuity, replace wire harness.

System: Backlapping Circuit

(4) Control module. Is LED L ON?

Yes - Go to step (5).

No - Check LED F. If on, replace service switch and/or test continuity of wire 738 LT BLU.

No - If LED F is OFF, remove connector at brake switch and test for battery voltage at wire 764 BLU/WHT. If no voltage, test continuity of wire 764 BLU/WHT. If no continuity, replace main wire harness.

No - Remove connector at service switch and test for battery voltage at wire 789 BLU. If no voltage, test brake switch. If brake switch is good, test continuity of wires 788 BLU/BLK and 789 BLU. If no continuity, replace main wire harness. If continuity, test service switch.

(5) Mow/transport switch - wire 510 YEL. Disconnect mow/transport switch. Is battery voltage present?

Yes - Reconnect mow/transport switch. Go to step (6).

No - Test continuity of wire 510. If no continuity, replace main wire harness.

(6) Reel engagement light. Is light ON?

Yes - Go to step (7).

No - Test continuity of wire 780 BLU. If no continuity, replace main wire harness. If continuity, test mow/transport switch. If switch is good, test continuity of ground wires 110 BLK, 157 BLK and 101 BLK. If no continuity, replace main wire harness. If continuity, check bulb in reel engagement light.

(7) Control module. Is LED J ON?

Yes - Go to step (8).

No - Remove 10-pin connector from module and check for battery voltage at terminal F. If voltage is present, replace control module. If voltage is not present, replace main wire harness.

(8) Control module. Is LED K ON?

Yes - Go to step (9).

No - Remove 10-pin connector from module and check for battery voltage at terminal H. If voltage is present, replace the control module. If not, test continuity from terminal H to the raise/lower switch. If no continuity, replace main wire harness. If continuity, check or replace raise/lower switch.

(9) Control module. Is LED M ON?

Yes - Go to step (10).

System: Backlapping Circuit

No - Remove 10-pin connector from module and check for voltage at module pin J1-D. If voltage is present, replace module. If voltage is not present, test continuity between terminal C and terminal D in connector. If continuity, replace module. If no continuity, test continuity across terminals 777 PUR/WHT and 776 PUR at raise/lower switch. If no continuity, replace switch. If continuity, replace main wire harness.

(10) Control module. Is LED A ON?

No - Replace control module.

Raise Lift Arms Circuit Operation

NOTE: Only those circuits required to raise the lift arms with the mow/transport switch in the MOW position will be discussed in the following text.

Unswitched Power

The battery provides current to the following components regardless of ignition switch position.

- Starter Motor
- Ignition Switch
- High Current Relay

The battery POS cable is connected to the high current side of the starter solenoid. Two fusible links, attached to the same terminal, carry current to the unswitched side of the ignition switch, starter relay and high current relay.

Fusible link 225 RED protects 221 RED/WHT going to the high current relay. Fusible link 230 RED protects 210 RED going to the ignition switch.

Switched Power

Current is supplied to the following components, with the ignition switch in the RUN position.

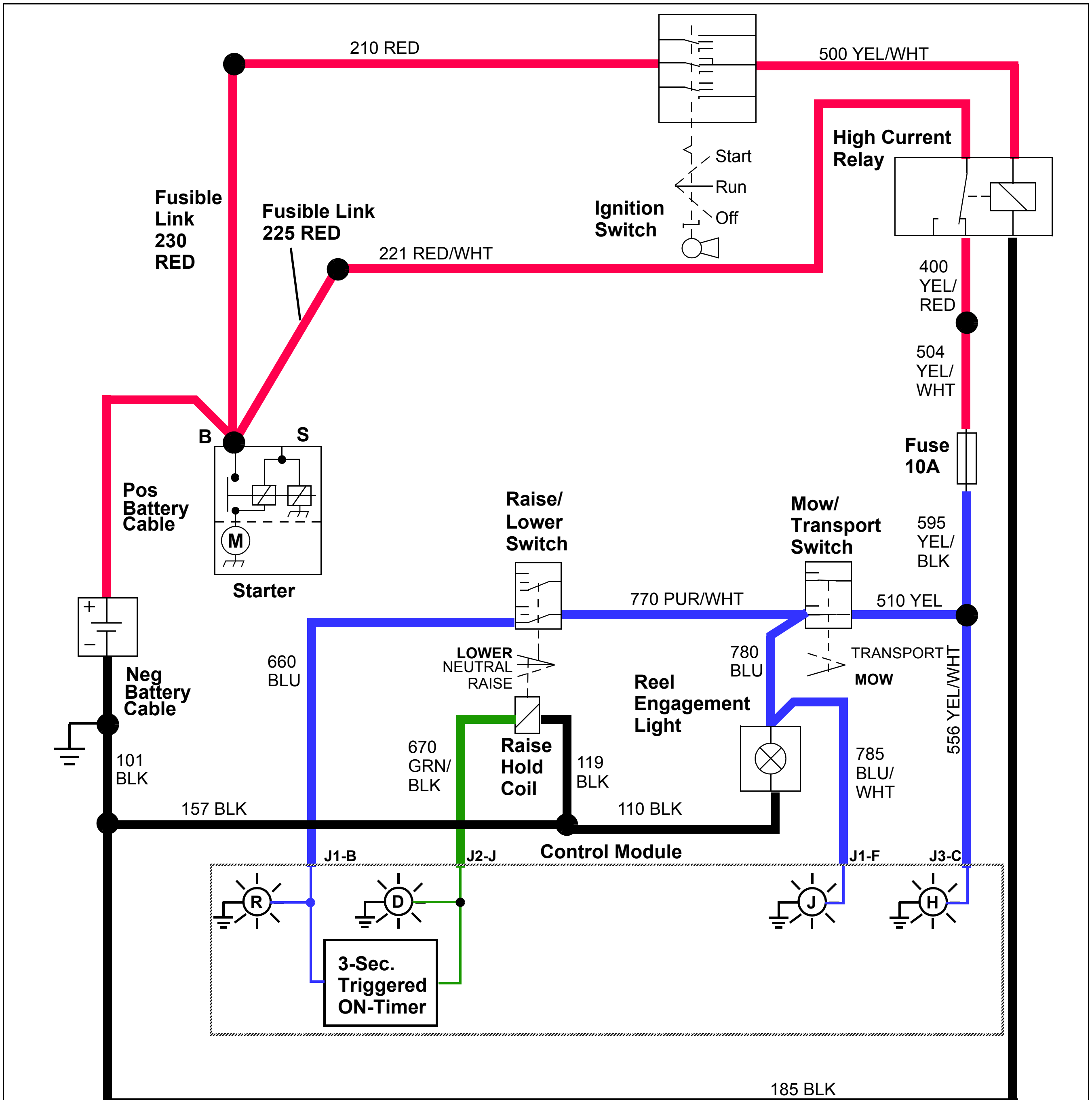
- High Current Relay
- Mow/Transport Switch
- Control Module J3-C

Operation

With the ignition switch in the RUN position, current flows to and energizes the high current relay. With the high current relay energized, current flows from the battery through the contacts in the relay, a 10-amp fuse, the mow/transport switch (TRANSPORT), the raise/lower switch and into the control module. Current entering J1-B triggers a timer inside the module. The timer is a 3-second triggered ON-timer and delivers current to the raise hold coil and LED D for 3 seconds and then shuts off.

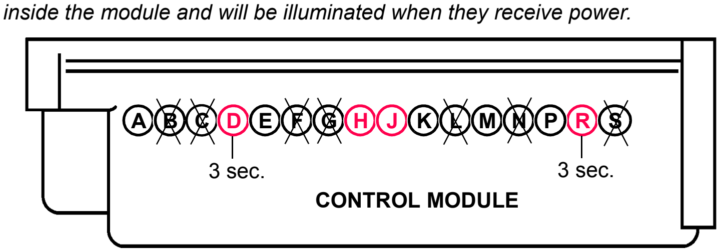
NOTE: All LEDs inside the control module are grounded inside the module and will be illuminated when they receive power.

Raise Lift Arms Circuit Schematic



NOTE: *The LED lights shown below in red are* ***ON*** *and relevant to this circuit. LED lights shown in black are* ***OFF****.*
The LED lights that are “X” may be either ***ON*** *or* ***OFF*** *but are not relevant to this circuit.*
All LED lights inside the control module are grounded inside the module and will be illuminated when they receive power.

RED- 12 Volt Positive
BLACK- Ground
YELLOW- Switched, Unfused, 12 Volt Positive
PURPLE- Fused 12 Volt Positive
GREEN- Time or Diode Controlled Circuit



MIF

Raise Lift Arms Circuit Diagnosis

NOTE: Disconnect seat switch and connect a remote seat switch to the vehicle harness to allow the seat platform to be in the raised position while diagnosing the circuit.

Test Conditions:

- Park Lock OFF
- Operator ON seat
- Transmission in NEUTRAL
- Raise/lower lever in LOWER
- Brake ON
- Mow/transport lever in MOW

System: Raise Lift Arms Circuit

(1) Control module. Is LED H ON?

Yes - Go to step (2).

No - Remove 6-pin connector from module and check for battery voltage at terminal C. If no voltage, test 10-amp fuse.

No - If fuse is good, check continuity between fuse and terminal C in 6-pin connector. If no continuity, replace wire harness. If continuity, check fusible link 225 red and continuity of 221 red/wht wire.

(2) Control module. Is LED J ON?

Yes - Go to step (3).

No - Check if reel engagement light is on. If on, test continuity of wire 785 BLU/WHT. If not on, remove 10-pin connector from module and check for battery voltage at terminal F. If voltage is present, replace the control module. If not, test continuity from terminal F to the mow/transport switch. If continuity, check or replace mow/transport switch. If no continuity, replace main wire harness.

(3) Control module LED B. Is LED B ON?

Yes - Go to step (4).

No - Replace control module.

(4) Control module. Is LED R ON?

Yes - Go to step (5).

No - Remove 10-pin connector from module and check for battery voltage at terminal B. If voltage is present, replace the control module. If not, test continuity from terminal B to the raise/lower switch. If continuity, check or replace raise/lower switch. If no continuity, replace main wire harness.

System: Raise Lift Arms Circuit

(5) Control module. Is LED D ON?

No - Remove 6-pin connector from module and check for battery voltage at terminal J. If voltage is not present, replace the control module. If present, test continuity from terminal J to the solenoid on the raise/lower switch. If continuity, check or replace solenoid. If no continuity, replace main wire harness.

Radiator Fan Motor Circuit - 3215B, 3225B and 3235B

Lightweight Fairway Mower

3215B Serial No. (- 020243)

3225B Serial No. (- 010402)

3235B 2WD Serial No. (- 020174)

3235B 4WD Serial No. (- 020438)

Operation

Fusible link (wire 200 RED) is attached to the starter B+ terminal. Current flows through wire 210 RED to radiator thermal switch. When the coolant in the radiator reaches a predetermined temperature, the switch closes and current flows through wire 220 RED to the radiator fan motor. Ground is supplied to the fan motor by wire 100 BLK.

Radiator Fan Motor Circuit Schematic - 3215B, 3225B and 3235B

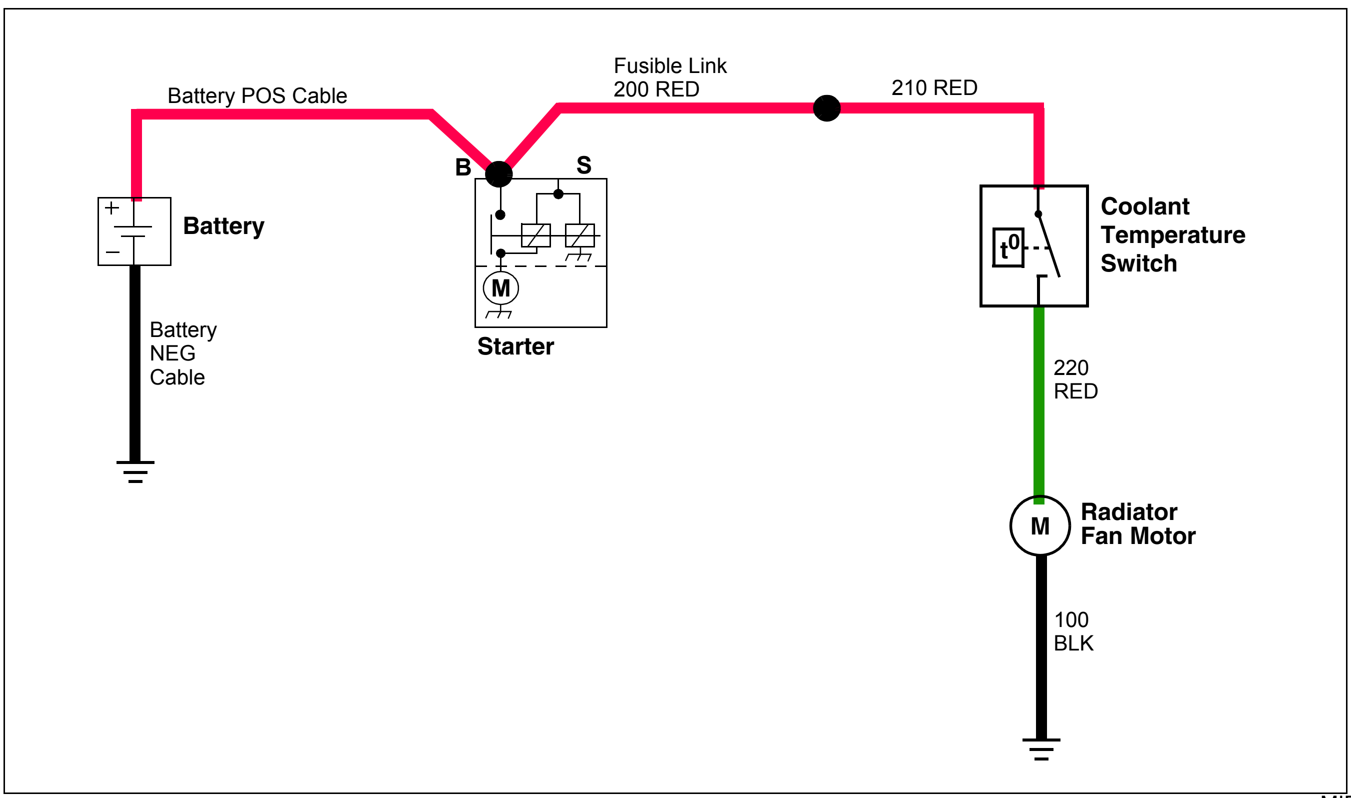
Lightweight Fairway Mower

3215B Serial No. (- 020243)

3225B Serial No. (- 010402)

3235B 2WD Serial No. (- 020174)

3235B 4WD Serial No. (- 020438)



MIF

Radiator Fan Motor Circuit Diagnosis - 3215B, 3225B and 3235B

Lightweight Fairway Mower

3215B Serial No. (- 020243)

3225B Serial No. (- 010402)

3235B 2WD Serial No. (- 020174)

3235B 4WD Serial No. (- 020438)

CAUTION: Avoid injury! The fan can start and stop unexpectedly at any time, due to radiator temperature fluctuation. Keep hands and loose clothing away from fan while diagnosing.

Test Conditions:

- Engine at operating temperature.
- Engine off (key in OFF position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

System: Radiator Fan Motor Circuit

(1) Coolant temperature switch connector - wire 210 RED. Is battery voltage present?

Yes - Go to step (2).

No - Test continuity of fusible link (wire 200 RED) and wire 210 RED on fan wire harness. If no continuity, replace fan wire harness.

(2) Coolant temperature switch connector - wire 220 RED. Is battery voltage present?

Yes - Go to step (3).

No - Replace coolant temperature switch.

(3) Radiator fan motor connector - wire 220 RED. Is battery voltage present?

Yes - Go to step (4).

No - Test continuity of wire 220 RED. If no continuity, replace fan wire harness.

(4) Radiator fan motor connector - wire 100 BLK. Disconnect radiator fan motor connector. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Replace fan motor.

No - Replace fan wire harness.

Radiator Fan Motor Circuit - 3215B, 3225B and 3235B

Lightweight Fairway Mower

3215B Serial No. (020244 -)

3225B Serial No. (010403 -)

3235B 2WD Serial No. (020175 -)

3235B 4WD Serial No. (020439 -)

Function

Provides power to fan motor circuit to maintain engine coolant temperature within normal operating range.

Operation

Power is provided to fan motor circuit by auxiliary power connector and starter B+ terminal.

When coolant temperature rises above approximately 91°C (196°F), dual temperature switch provides a ground and energizes cooling fan relay. The following energizes cooling fan relay:

- Wires 525 and 555 YEL
- Cooling fan relay - terminals (85 and 86)
- Dual temperature switch - wire 645 BLU
- Wire 165 BLK

With the cooling fan relay energized, current flows from starter B+ terminal through cooling fan relay contacts to operate the cooling fan motor. Current flows through the following to operate the cooling fan motor:

- Start B+ terminal
- Fusible link 211 RED
- Wire 215 RED
- Cooling fan relay - terminals (87 and 30)
- Wire 255 RED
- Cooling fan motor
- Wire 160 BLK

The dual temperature switch also provides an over temperature switch for the engine coolant over temperature light.

Radiator Fan Motor Circuit Schematic - 3215B, 3225B and 3235B

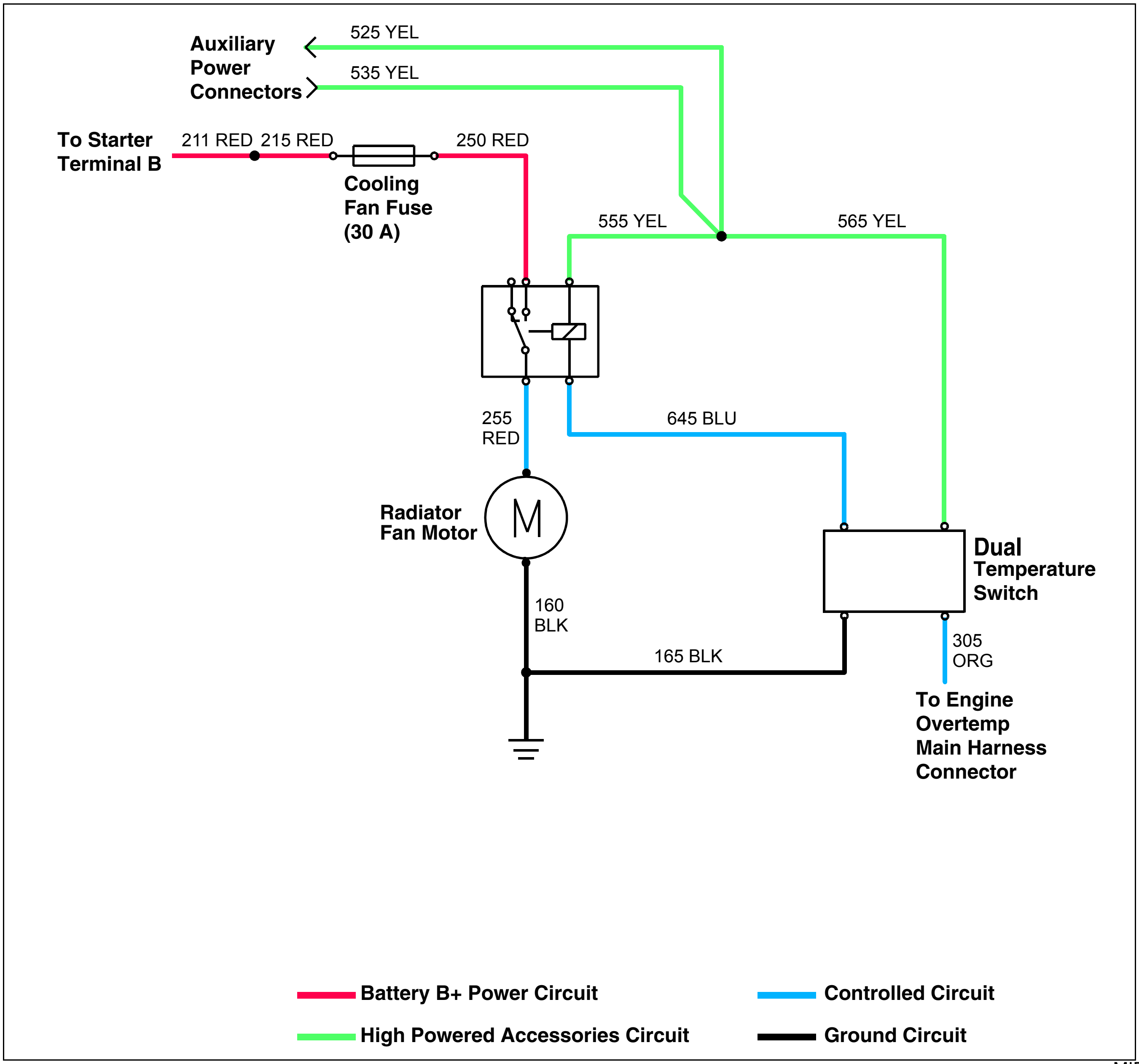
Lightweight Fairway Mower

3215B Serial No. (020244 -)

3225B Serial No. (010403 -)

3235B 2WD Serial No. (020175 -)

3235B 4WD Serial No. (020439 -)



MIF

Radiator Fan Motor Circuit Diagnosis - 3215B, 3225B and 3235B

Lightweight Fairway Mower

3215B Serial No. (020244 -)

3225B Serial No. (010403 -)

3235B 2WD Serial No. (020175 -)

3235B 4WD Serial No. (020439 -)

> **CAUTION: Avoid injury! The fan can start and stop unexpectedly at any time, due to radiator temperature fluctuation. Keep hands and loose clothing away from fan while diagnosing.**

Test Conditions:

- Engine at operating temperature.
- Engine off (key in OFF position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

System: Radiator Fan Motor Circuit

(1) Cooling fan relay - wire 555 YEL. Is battery voltage present?

Yes - Go to step (2).

No - Test wire 555 YEL and connections.

(2) Dual temperature switch - wire 165 BLK. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Go to step (3).

No - Test wire 165 BLK and connections.

(3) Cooling fan fuse connector - wire 215 RED. Place key switch in ON position. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 215 RED and fusible link 211 RED and connections.

(4) Cooling fan fuse connector - wire 250 RED. Is battery voltage present?

Yes - Go to step (5).

No - Replace fuse, check for short circuits before replacing fuse.

(5) Cooling fan relay - wire 250 RED. Is battery voltage present?

System: Radiator Fan Motor Circuit

Yes - Go to step (6).

No - Test wire 250 RED and connections.

(6) Cooling fan relay - wire 645 BLU. Energize cooling fan relay by connecting a jumper wire from wire 645 BLU to ground. Does fan motor relay energize?

Yes - Go to step (7).

No - Replace relay.

No - If relay energizes and fan motor operates, replace dual temperature switch.

(7) Cooling fan motor - wire 255 RED. With fan relay still energized, is battery voltage present?

Yes - Go to step (8).

No - Test cooling fan relay. See “Test Electrical Relays” on page 212. If relay is good, test wire 255 RED and connections.

(8) Cooling fan motor - wire 160 BLK. Place key switch in OFF position. Measure ground circuit resistance. Is there less than 0.1 ohm of resistance?

Yes - Replace cooling fan motor.

No - Test wire 160 BLK and connections.

Tests and Adjustments

Test Indicating Lights Circuits

Reason

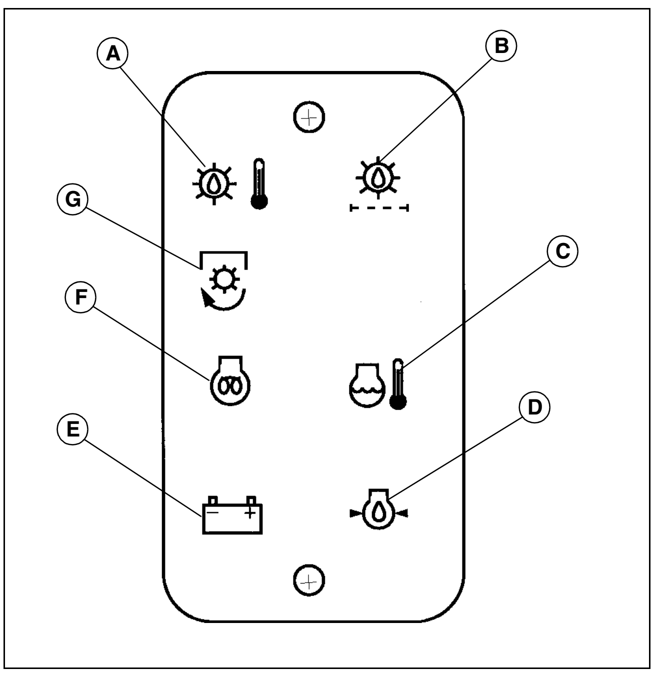
To test the operation of the indicating lights and circuits.

NOTE: If two or more indicators illuminate at the same time, except when the ignition switch is in the START position, test diode pack AMT386, located under the control panel near the bulb receptacles, for proper operation.

Diode pack AMT386 will only affect the hydro oil over temperature, hydro oil pressure and engine over temperature lights when the ignition switch is in the START position.

Procedure

1. Remove the 747 PUR wire from the starter.
2. Place the mow/transport lever to MOW.
3. Position the ignition switch to the START position.
4. Place air preheat switch to ON position.



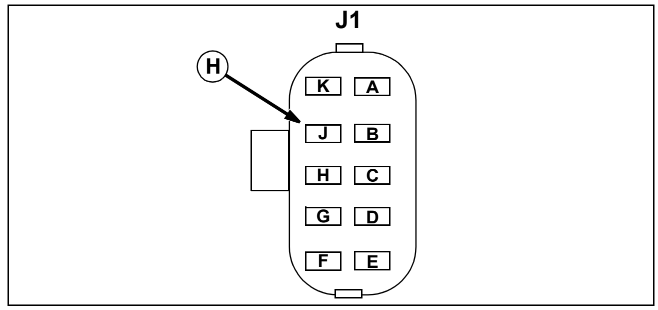
M57571

A - Hydraulic Over Temperature Light
B - Hydraulic Oil Pressure Light
C - Engine Over Temperature Light
D - Engine Oil Pressure Light
E - Battery Discharge Light
F - Cold Start Wait Light
G - Reel Engagement Light

5. Observe the indicator lights for illumination.
6. If ALL indicator lights illuminate, the circuit is good and no further tests are needed.
7. If an indicator light is not illuminated, test or replace the bulb and try again.
8. If the bulb still fails to illuminate, perform the necessary checks as required:

- All Indicator Lights OFF - Check 10-amp fuse located under seat next to control module.

Place ignition switch in RUN position:



MIF

- **Hydraulic Oil High Temp Light OFF -** Connect a jumper wire from 334 GRN on oil temp sensor to ground to test wiring. Light should illuminate. If bulb illuminates, test diode pack. (See "Test Diode Pack AMT386" on page 203.) If light does not illuminate, check sensor ground. If sensor ground is good, check the voltage at terminal J1-J (H) on the control module.

Voltage should be approximately 5.5 VDC. If not, replace the control module.

- **Hydraulic Oil Filter Restriction Light OFF -** Remove connector from oil filter restriction sensor and connect a jumper wire from 330 GRN to ground to test wiring. Light should illuminate. If bulb illuminates, test diode pack. (See "Test Diode Pack AMT386" on page 203.) If light does not illuminate, check sensor ground.
- **Coolant High Temp Light OFF -** Test 516 YEL wire at bulb receptacle for battery voltage. If voltage is not present, repair or replace damaged wire. If voltage is present, connect a jumper wire from 300 ORG on coolant temp sensor to ground to test wiring. Light should illuminate. If bulb illuminates, perform Diode Pack AMT386 Test. If light does not illuminate, repair or replace damaged wire.
- **Reel Engagement Light OFF -** Diode pack is not cause of failure to illuminate. Test 780 BLU wire for battery voltage. If no voltage is present, test mow/transport switch.
- **Air Preheat Light OFF -** Diode pack is not cause of failure to illuminate. Test 930 GRY wire at bulb receptacle for battery voltage when preheat switch is activated. If no voltage, test air preheat switch. If battery voltage is present, test 109 BLK at bulb receptacle for ground.

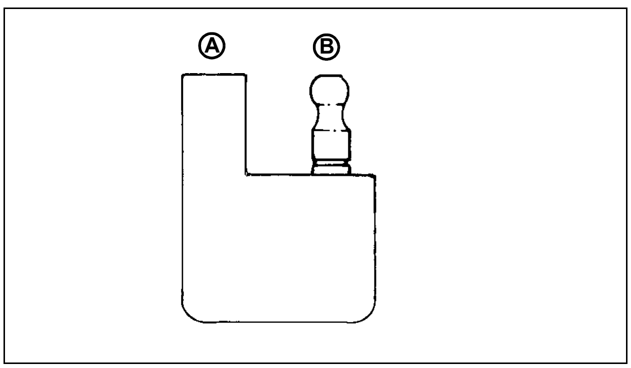
- **Battery Low Light OFF -** Diode pack is not cause of failure to illuminate. Test 520 YEL wire at bulb receptacle for battery voltage. If battery voltage is present, test 610 BRN for ground. If no continuity to ground, test voltage regulator.
- **Engine Oil Pressure Low Light OFF -** Diode pack is not cause of failure to illuminate. Test 515 YEL at bulb receptacle for battery voltage. If voltage is not present, repair or replace damaged wire. If voltage is present, connect a jumper wire from 620 BRN on oil pressure sensor to ground to test wiring. If light illuminates, replace oil pressure sensor. If light does not illuminate, repair or replace damaged wire.

Test Control Module AMT767 Auxiliary Harness

NOTE: If vehicle is equipped with control module AMT767, check short auxiliary harness AMT1002 for continuity.

1. Disconnect from control module and main wire harness.
2. Check resistance of YEL wire, terminal F. Resistance should be 120-170 ohms.
3. If resistance is not within specified limits, replace harness section.

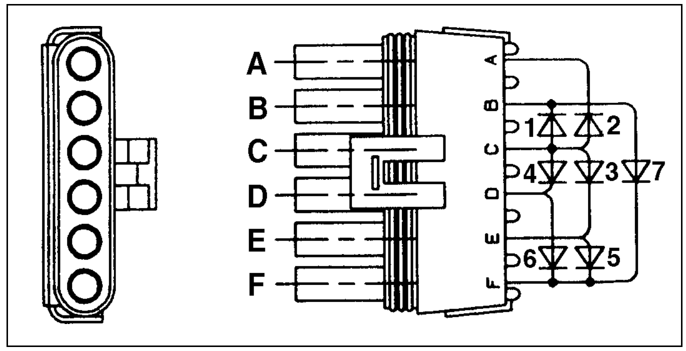
Diode Test



M56502

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

Test Diode Pack AMT386



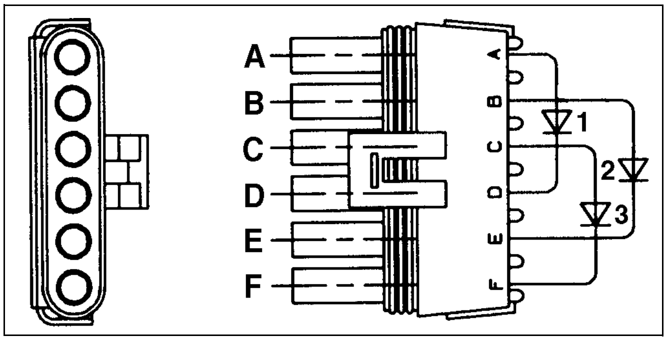
M56553A

1. Remove diode pack and test with a diode tester or ohmmeter as follows.

Diode	Red Lead	Black Lead	Result
2	A	C	NC
7	B	F	C
1	B	C	NC
2	C	A	C
4	C	D	C
3	C	E	C
1	C	B	C
6	D	F	C
4	D	C	NC
3	E	C	NC
5	E	F	C
6	F	D	NC
5	F	E	NC
7	F	B	NC

Test Diode Pack AMT477

1. Remove diode pack and test with a diode tester or ohmmeter as follows.



M56553B

Diode	Red Lead	Black Lead	Result
1	A	D	C
2	B	E	C
3	C	F	C
1	D	A	NC
2	E	B	NC
3	F	C	NC

Test Battery

Reason

To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to test battery.
Battery Tester	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.

2. Turn key OFF and lock park brake.

3. Open engine cover.

4. Disconnect negative (-) and positive cable clamps from battery. Remove battery hold-down clamps.

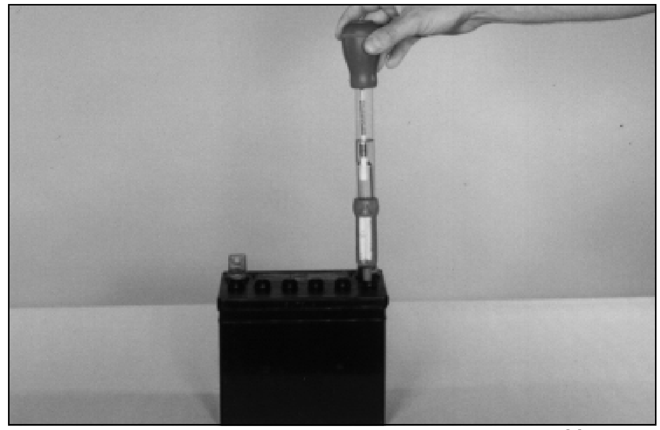
5. Remove battery from machine.

6. Clean battery terminals and case.

7. Inspect battery terminals and case for breakage or cracks.

8. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water is added, charge battery for 20 minutes at 10 amps.

9. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

10. Use a hydrometer to check for a minimum specific gravity of 1.225 with less than 50-point variation between cells:

- If all cells are less than 1.175, charge battery at 10-amp rate (see Charge Battery).
- If all cells are less than 1.225 with less than 50-point variation, charge battery at 10-amp rate (see Charge Battery).
- If cells are above 1.225 with less than 50-point variation, load test battery (see Test Battery Load).
- If more than 50-point variation, replace battery.

11. Use a voltmeter or JT05685 Battery Tester to check for a minimum battery voltage of 12.4 volts:

- If battery voltage is less than 12.4 VDC, charge battery.
- If voltage is above 12.4 VDC, test specific gravity (see step 10).

12. Install battery.

Charge Battery

Reason

To increase battery charge after battery has been discharged.

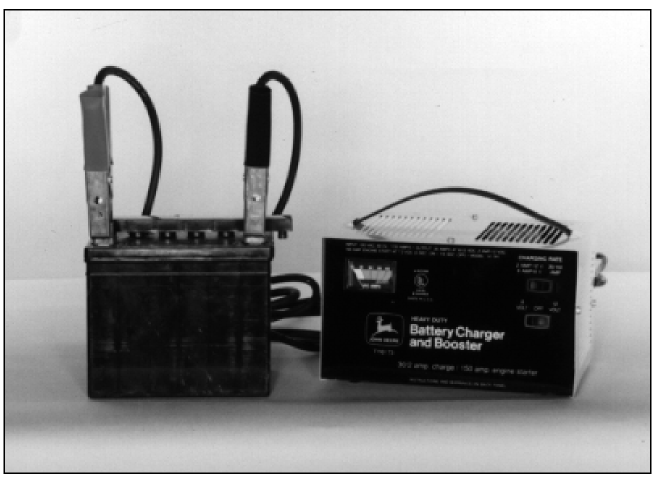
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery charger (variable rate) (use according to manufacturer's instructions)	NA	Used to charge battery.

Procedure

NOTE: See Test Battery before charging battery.

1. Park machine on level surface.
2. Turn key OFF and lock park brake
3. Open engine cover.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.



M49598

7. Connect variable rate charger to battery.

NOTE: Maximum charge time at boost is 10 minutes. Allow additional 5 minutes for each 10° below 21°C (70°F).

8. 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.

9. Check if battery is accepting a 10-amp charge after 10 minutes at boost setting:
   - 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 10 and 11.

10. Set charger at 15-25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gasses or bubbles excessively or if battery becomes too warm to touch.

11. Check specific gravity after 30 minutes:
    - If MORE THAN 50 point variation between cells, replace battery.
    - If LESS THAN 50 point variation between cells, continue test.

NOTE: If battery was discharged at slow or unknown rate, charge at 10-15 amps for 6-12 hours. If battery was discharged at fast rate, charge at 20-25 amps for 2-4 hours.

12. Continue to charge battery until specific gravity is to specification.
13. Load test battery. (See Test Battery Load.)
14. Install battery.

Specifications

Battery Specific Gravity. . . . . 1.230-1.265 points

Test Battery Load

Reason

To check condition of battery under load.

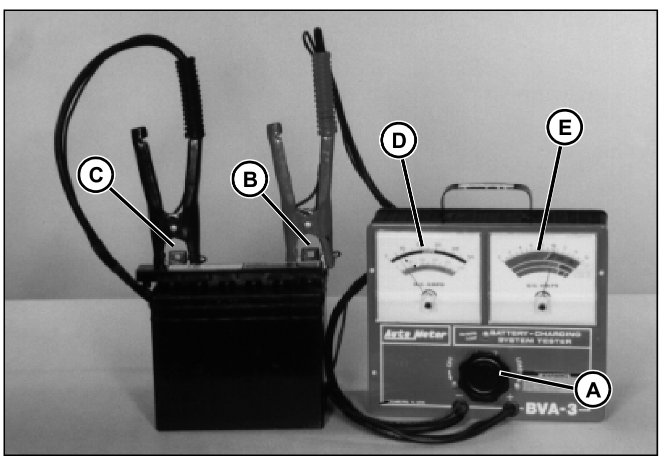
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.

IMPORTANT: Avoid damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



M49597

7. Connect tester positive cable (red) to battery positive (+) terminal (B).
8. Connect tester negative cable (black) to battery negative (-) terminal (C).

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

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).
12. If battery DOES NOT pass test and HAS NOT been charged, charge battery and retest (see Charge Battery).
13. If battery DOES NOT pass test and HAS been charged, replace the battery.

Test Regulated Amperage and Voltage

Reason

To determine regulated charging output of the alternator.

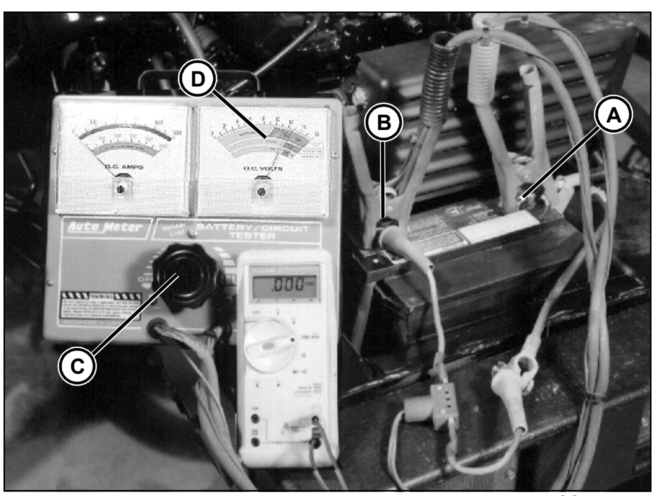
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test alternator amperage and voltage.
Ammeter Shunt Assembly	JT05792	Used to test alternator amperage and voltage.
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test alternator amperage and voltage.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Remove negative battery cable clamp from battery.

IMPORTANT: Avoid damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



M76472

5. Connect tester positive cable (red) to battery positive (+) terminal (A).
6. Connect tester negative cable (black) to battery negative (-) terminal (B).

IMPORTANT: Avoid damage! Perform the following step quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

7. Turn load knob (C) clockwise (in) until voltage on tester voltage scale (D) reads **11 volts for 10 seconds only** to partially drain battery.
8. Quickly turn load knob completely counterclockwise (out) into OFF position.
9. Install JT05792 Ammeter Shunt leads as follows:
   - Red male plug to VOLT/OHM socket on JT05791 Digital Multimeter.
   - Black male plug to COM socket on JT05791 Digital Multimeter.
   - Shunt black clamp to the negative (-) battery post (along with JT05685 Battery Tester ground clamp).
   - Shunt red clamp to the negative (-) battery cable clamp.
10. Set JT05791 Digital Multimeter to read 300 mV.
11. Start and run engine at high idle. Read charging voltage from JT05685 Battery Tester. Voltage should read between **12.2-14.7 volts DC and be steadily rising.**

NOTE: Although the meter is set to read voltage, the meter reading will be the amperage of the circuit through the operation of the shunt. Polarity reading is not relevant. The number (positive or negative) shown on the meter is the amperage of the circuit.

12. Read amperage from JT05791 Digital Multimeter. Amperage should read 40 amps (or less) and decrease as voltage approaches 14.8 volts.
13. If at any time voltage exceeds 14.8 volts DC, replace alternator/regulator assembly.

Test Starter Loaded Amperage Draw

Reason

To determine the amperage required to crank the engine and check starter motor operation under load.

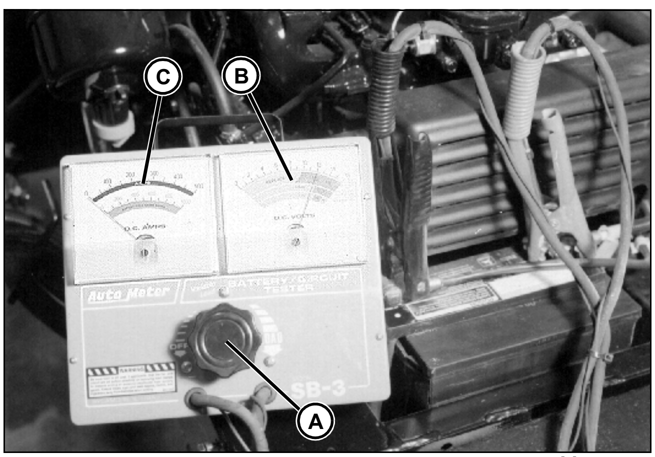
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test starter loaded amperage draw.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Load test battery. (See Test Battery Load.)
5. Disconnect fuel shutoff solenoid connector.

IMPORTANT: Avoid damage! Turn knob (A) fully counterclockwise (out) into OFF position before making any test connections.



M76473

6. Connect JT05685 Battery Tester to battery.
7. Crank engine. Read and record voltage on DC voltage scale (B) of battery tester.
8. Turn key switch to OFF position.

IMPORTANT: Avoid damage! Perform the following step within 10 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

Starter should have a maximum draw as follows:

3215/3215A/3215B - 1.0 kW MODEL 124520-77011	3225B/3235/3235A/3235B - 1.2 kW MODEL 2280000-0250
225 Amps @ 300 RPM (Max)	300 Amps @ 300 RPM (Max)

- If amperage is above specification, perform Starter No-Load Amperage and RPM tests to determine if starter is binding or damaged.
- If starter passes no-load test but amperage draw remains high, check internal engine components for binding, wear, or damage.

Test Starter No-Load Amperage and RPM

Reason

To determine if starter is binding or has excessive amperage draw under no-load.

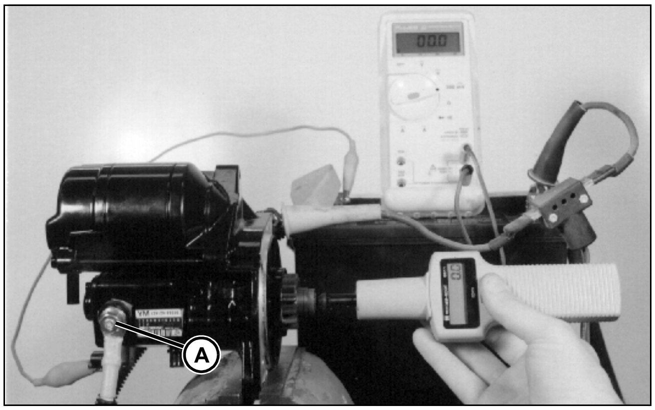
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test starter no-load amperage and rpm.
Ammeter Shunt	JT05792	Used to test starter no-load amperage and rpm.
Hand-Held Digital Tachometer	JT05719	Used to test starter no-load amperage and rpm.
One (1) jumper wire	NA	Used to test starter no-load amperage and rpm.
One (1) jumper cable	NA	Used to test starter no-load amperage and rpm.
12-volt battery	NA	Used to test starter no-load amperage and rpm.

Procedure

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on level surface.
2. Turn key OFF and lock park brake
3. Open engine cover.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M76474

7. Install JT05792 Ammeter Shunt leads as follows:
   - Red male plug to VOLT/OHM socket on JT05791 Digital Multimeter.
   - Black male plug to COM socket on JT05791 Digital Multimeter.
   - Shunt black clamp to the negative (-) battery post.
   - Shunt red clamp to starter case ground.
8. Set JT05791 Digital Multimeter to read 300 mV.
9. Connect positive jumper cable between starter solenoid right terminal (A) and positive battery post.

IMPORTANT: Avoid damage! Complete the following step in 20 seconds or less to prevent starter damage.

10. Momentarily connect a jumper lead from positive battery post to small solenoid spade terminal. Solenoid should pull in and the drive gear and shaft should move out and spin.
11. Record amperage from multimeter.
12. Place JT05719 Digital Tachometer drive cone against end of spinning starter drive gear, and record rpm.
13. Remove jumper from solenoid.

Results

No-load starter specifications are as follows:

3215/3215A/3215B - 1.0 kW MODEL 124520-77011	3225B/3235/3235A/3235B - 1.2 kW MODEL 2280000-0250
90 Amps (Max)	120 Amps (Max)
3000 RPM (Min)	3000 RPM (Min)

- If amperage is above specification, check for binding or seized bearings, sticking brushes, and dirty or worn commutator. Repair or replace starter.
- If starter passes no-load test but amperage draw remains high when mounted on engine, check internal engine components for binding, wear, or damage.

Test Starter Solenoid

Reason

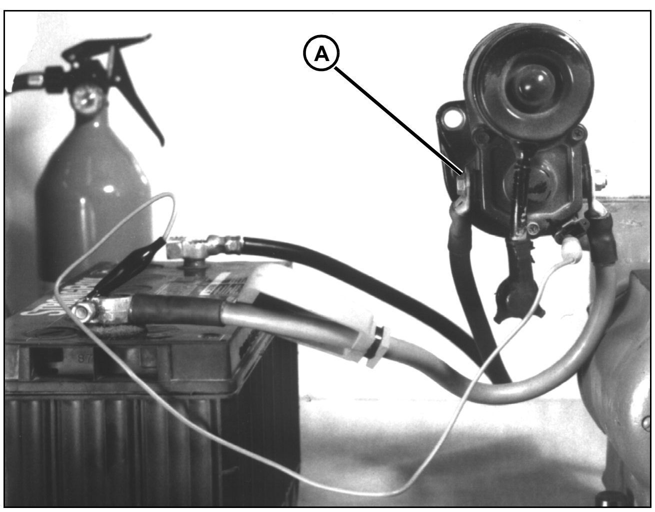
To determine if starter solenoid is defective. The solenoid has separate pull-in and hold-in windings which do not ground together. This test requires two ground jumper cables to test each winding.

Special or Required Tools

Tool Name	Tool No.	Tool Use
One (1) jumper wire	NA	Used to test starter solenoid.
Two (2) jumper cables	NA	Used to test starter solenoid.
12-volt battery	NA	Used to test starter solenoid.

Procedure

1. Park machine on level surface.
2. Turn key OFF and LOCK park brake.
3. Open engine cover.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M57730

7. Disconnect starter motor lead from left solenoid terminal (A).
8. Connect NEGATIVE jumper cable from left solenoid terminal to NEGATIVE battery post.
9. Connect POSITIVE jumper cable from right solenoid terminal to POSITIVE battery post.
10. Momentarily connect a jumper wire from the positive battery post to the small solenoid spade terminal. The solenoid should pull in and the drive gear and shaft should move out.
11. Remove the positive jumper wire to the solenoid spade terminal. The solenoid drive gear and shaft should move back.

Results

- The solenoid should pull in freely with a loud click when energized. The starter drive gear and shaft should be moved out.
- If solenoid does not move, disconnect jumper leads and try to pull drive gear out by hand by rotating counterclockwise:
  - If drive gear will not turn by hand, check starter motor for bad bearings, frozen armature, or sticking brushes.
  - If drive gear turns but will not pull out, check solenoid plunger and shaft for binding.
  - If drive gear turns and moves out freely, but solenoid does not energize, check continuity from solenoid primary spade terminal to left terminal lug (where starter motor lead attaches). Maximum resistance should be 1.0 ohm through solenoid. Replace open circuit solenoid.

Bench Test Electrical Switches

Reason

To determine of electrical switches are opening and closing as required.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test various switches.

Procedure

1. Disconnect negative battery cable
2. Tag and mark wires to switch and disconnect.
3. Remove switch from machine.
4. Set meter to read continuity or resistance (ohms).
5. Connect meter to listed test points, set switch to proper position and test for continuity.

Component	Switch Position	Test Points	Normal
1. Seat Switch	Up	A-B	No Continuity
	Down	A-B	Continuity
2. Light Switch	Centered (Off)	C-G	Continuity
	Down (Road Lights)	C-G-D-E	Continuity
	Up (Work Lights)	C-G-E-F	Continuity
3. Service Switch	Up (Service)	A-B	Continuity
	Down (Run)	A-B	No continuity
4. Manual Preheat Switch	Off	A-B	No Continuity
	On	A-B	Continuity
5. Ignition Switch	Off	All Terminals	No Continuity
	On (Run)	210-Blk, 210-500, Blk-500	Continuity
	Start	All Terminals	Continuity
6. Brake Pedal Switch	Up	744 Blu/Wht-749 Pur	Continuity
	Up	764 Blu/Wht-788 Blu/Blk	No Continuity
	Down (Brake Applied)	744 Blu/Wht-749 Pur	No Continuity
	Down (Brake Applied)	764 Blu/Wht-788 Blu/Blk	Continuity
7. Transmission Neutral Switch	Out	N-O	No Continuity
	In	N-O	Continuity
8. Park Lock Switch	Up	All Terminals	No Continuity
	Down	All Terminals	Continuity
9.Raise Lower Switch	Raised	A-F, A-E, E-F	Continuity
	Centered	A-E, B-C	Continuity
	Momentary	A-E, A-D, B-C	Continuity
10. Mow/Transport Switch	Transport	A-E, A-F, C-D, E-F	Continuity
	Mow	A-F, B-C, B-D, C-D	Continuity
11. 4-Wheel Drive Switch	On	All Terminals	Continuity
	Off	Blk-Blu/Wht, Blk-Blu, Blu/Wht-Blu	Continuity
12. Backlapping Switch	In	All Terminals	No Continuity
	Out	All Terminals	Continuity

Results

If switch shows no continuity or resistance higher than 0.05 ohm when contacts are closed, replace switch.

Test Electrical Relays

Reason

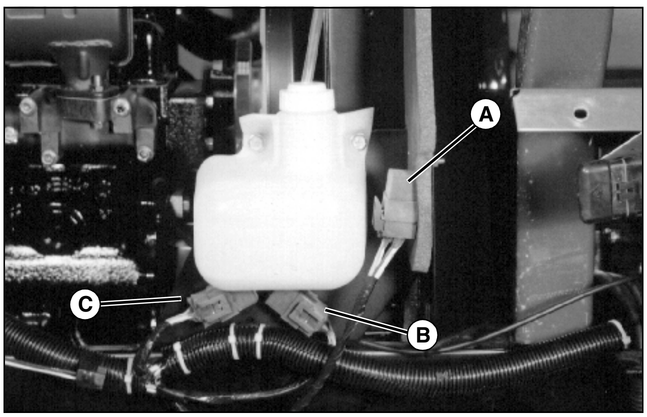
To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

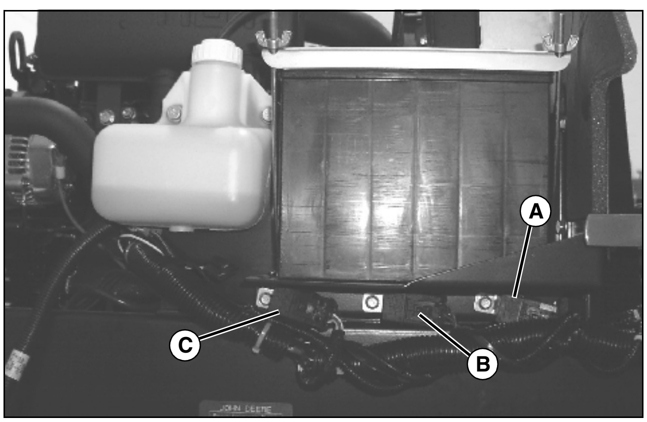
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test relays.
Jumper Wires (2)	NA	Used to test relays.
12-Volt Battery	NA	Used to test relays.

Procedure

1. Disconnect negative battery cable.



M76476

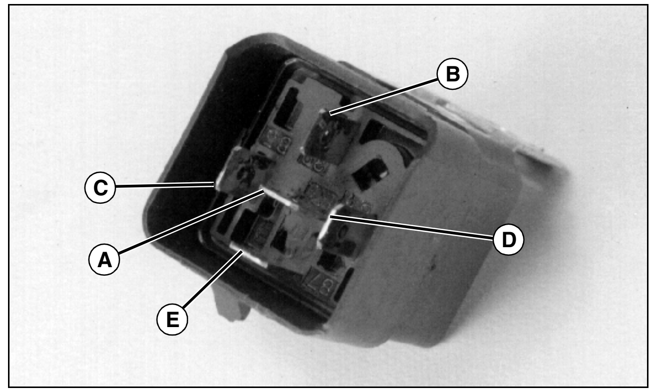


MX18024

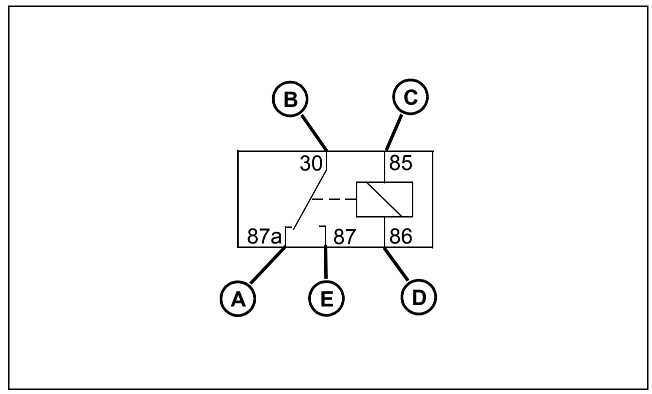
2. Disconnect wiring harness from fuel shutoff solenoid relay (A), start relay (B) or high current relay (C).

3. Remove relay from machine.

NOTE: All relays function the same. The relay schematic below reflects the operation of the relays.



M76475



MIF

4. Check terminal continuity using an ohmmeter or continuity tester.

- Continuity should exist between relay terminals 87a and 30 (A and B) and between 85 and 86 (C and D).
- No continuity between relay terminals 30 and 87 (B and E).

5. Connect jumper wire from battery positive (+) terminal to relay terminal 85 (C). Connect another jumper wire from relay terminal 86 (D) to battery negative (-) terminal.

- Continuity could exist between relay terminals 30 and 87 (B and E).
- No continuity between relay terminals 30 and 87a (B and A).

Results

If continuity is not correct, replace relay.

Test Fuel Shut-Off Solenoid - 3TNE78A and 3TNE84 Engines

Reason

To determine if the fuel shutoff solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test fuel shut-off solenoid.
Jumper Wire (2)	NA	Used to test fuel shut-off solenoid.

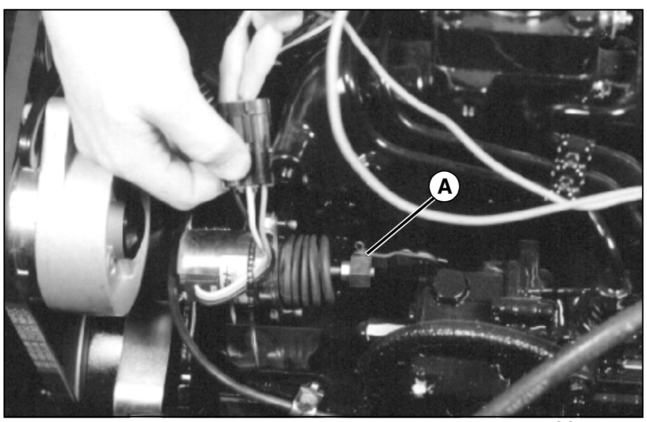
Procedure

1. Open engine hood.

2. Turn key switch to ON while on the seat. Fuel shut-off solenoid should click and solenoid plunger should pull into solenoid case.

3. Turn key switch to OFF.

- If solenoid moves and holds in solenoid case, solenoid is good, test is complete.
- If solenoid does not move or hold in solenoid case, pull-in coil or hold coil may be defective. Continue with test.



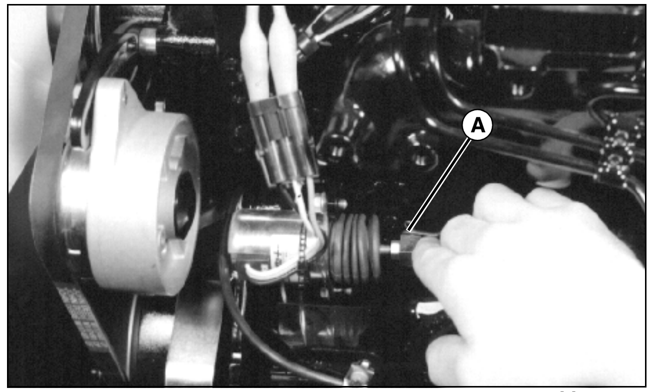
M76483

4. Disconnect fuel shut-off solenoid connector.

5. Use a jumper wire to connect black wire of solenoid to battery negative (-) terminal.

6. Briefly connect white wire of solenoid directly to battery positive (+) terminal using a jumper wire. Fuel shut-off solenoid plunger (A) should pull in.

- If plunger pulls in, pull-in windings are good. Continue test.
- If plunger does not pull in, pull-in windings are bad. Replace fuel shut-off solenoid.



M76484

7. Disconnect jumper wire from white wire. Leave solenoid black wire connected to ground.

8. Connect jumper wire to red wire of solenoid and to battery positive (+) terminal.

9. Push solenoid plunger (A) into solenoid case. Solenoid should hold plunger in solenoid case.

- If plunger stays in, hold-in windings are good. Continue test.
- If plunger does not remain in case, hold-in windings are bad. Replace fuel shut-off solenoid.

10. Turn key switch to OFF and remove jumper wires.

11. Check continuity of main harness black wire #135 from fuel shut-off solenoid connector to ground terminal on inside right rear of frame.

Results

- If continuity is good, test is complete. Check fuel shut-off solenoid adjustment.
- If tester does not show continuity, check chassis ground connection. Repair or replace black ground wires.

Test Fuel Shutoff Solenoid - 3TNE82A Engines

Reason

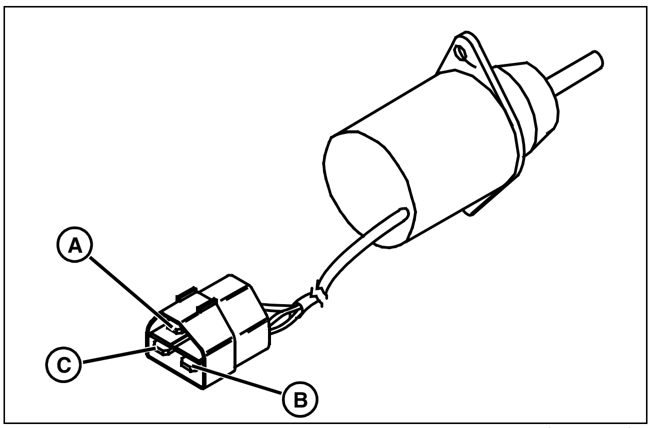
To verify that the solenoid coils are operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test fuel shut-off solenoid.
Jumper Wire (2)	NA	Used to test fuel shut-off solenoid.

Procedure

1. Raise hood and remove engine right side cover.
2. Disconnect fuel shutoff solenoid connector.



MIF (M87349)

3. Check resistance between solenoid terminals (A, B, and C).
4. Check for continuity between the connector terminals and the solenoid housing.
5. Connect fuel shutoff solenoid connector.
6. Listen for click from fuel shutoff solenoid when the key switch is turned to the RUN position.

Results

- If resistance does not meet specifications, replace fuel shutoff solenoid.
- If continuity exists between connector terminals and solenoid housing, replace fuel shutoff solenoid.
- See “Run Circuit (Operator Off Seat) Diagnosis” on page 175, if click is not heard from fuel shutoff solenoid.

Specifications

Fuel Shutoff Solenoid Resistance:

Terminals A and B . . . . 0.4 ohm

Terminals A and C . . . . 24 ohms

Terminals B and C . . . . 24 ohms

Test Fuse

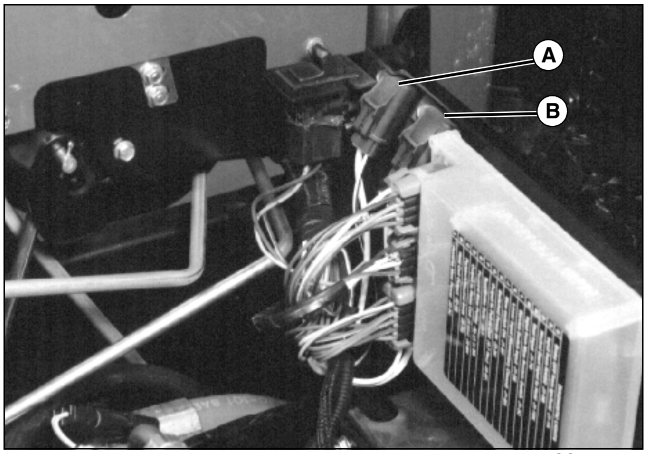
Reason

To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test fuse continuity.

Procedure



M76480

1. Remove fuse (A or B) from wire harness.
2. Set ohmmeter to ohms function.
3. Connect one meter lead to one post of fuse. Connect other meter lead to other post of fuse.

Results

If there is no continuity between posts, replace fuse.

Test Mow Valve Solenoid Coil

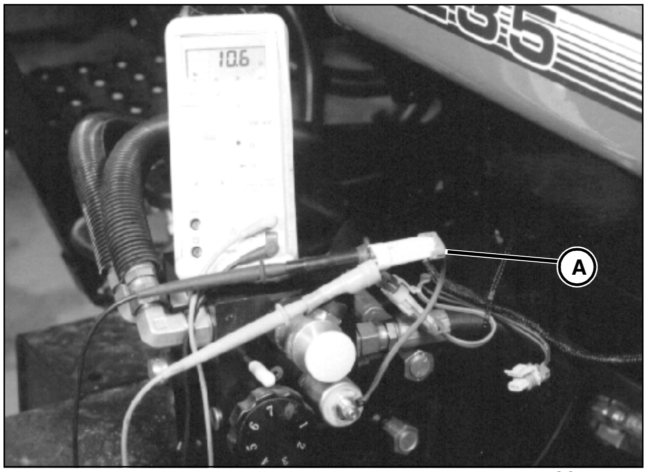
Reason

To determine condition of mow valve solenoid coil.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test mow valve solenoid.

Procedure



M76482

1. Disconnect mow solenoid connector (A).
2. Check resistance between coil terminals. Resistance must be within specification.
3. Check for grounds or shorts by connecting one tester lead to coil terminal and the other lead to bare metal of the coil case. There should be no continuity between terminal and case.

Results

- If resistance between terminals is not within specification, replace coil.
- If continuity exists between terminal and case, replace coil.

On earlier models, wires from solenoid to connector have lighter insulation and may be worn through and shorting on the solenoid case.

Specifications

Mow Valve Solenoid Resistance. . . . . 10 ±1 Ohms

Test Lift Valve Solenoid Coil

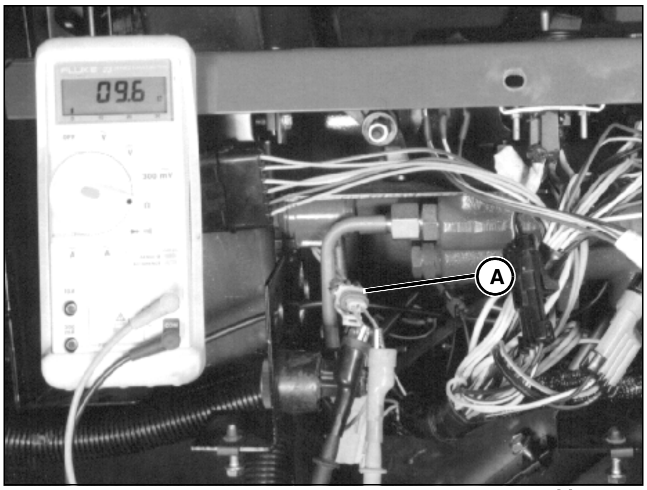
Reason

To determine condition of the lift valve solenoid coil.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test lift valve solenoid coil.

Procedure



M76481

1. Disconnect lift solenoid connector (A).

2. Check resistance between coil terminals. Resistance must be within specification.

3. Check for grounds or shorts by connecting one tester lead to coil terminal and the other lead to bare metal of the coil case. There should be no continuity between terminal and case.

Results

- If resistance between terminals is not within specification, replace coil.

- If continuity exists between terminal and case, replace coil.

On earlier models, wires from solenoid to connector have lighter insulation and may be worn through and shorting on the solenoid case.

Specifications

Lift Valve Solenoid Resistance . . . . 10 ±1 Ohms

Test Fuel Level Sensor

Reason

To determine if the fuel level sensor changes resistance as float is raised and lowered.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Multimeter	JT05791	Used to test fuel level sender.

Procedure

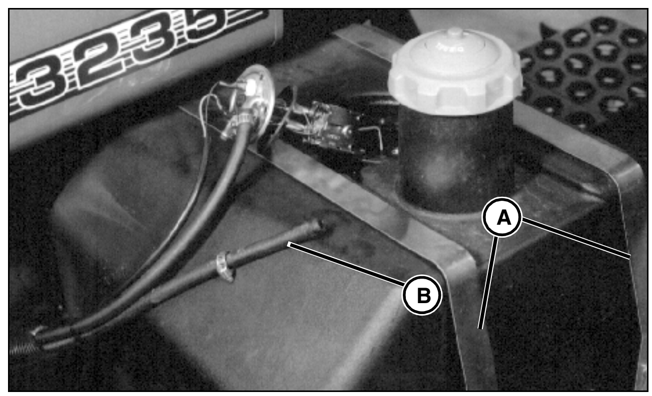
1. Park machine on level surface.

2. Turn key OFF and lock park brake.

3. Jack front right side of vehicle. Place an appropriate jack stand under vehicle frame.

4. Remove right front wheel.

5. Remove screws holding fender to frame.



M76477

6. Disconnect fuel level sensor connector from main wire harness under control panel.

7. Remove fuel line (B) that interferes with screw removal. If removal of both fuel lines becomes necessary, mark the fuel lines for proper reassembly.

8. Remove nuts from fuel tank mounting straps (A). Disengage straps from between fuel tank and frame.

9. Slide fuel tank and fender away from frame.

10. Remove fuel cap and fender. Reinstall fuel cap after fender is removed to prevent hardware from entering fuel tank.

11. Remove five machine screws holding fuel level sensor to tank.

12. Remove sensor from tank using care not to tear gasket.

13. Connect leads from JT05791 Digital Multimeter to terminals on main wire harness fuel level sensor connector. Set meter to read ohms.

14.Move float lever to bottom of travel (empty tank position). Note meter reading.

15.Move float lever to top of travel (full tank position). Note meter reading.

Results

If readings are not within specifications, replace fuel level sensor.

Specifications

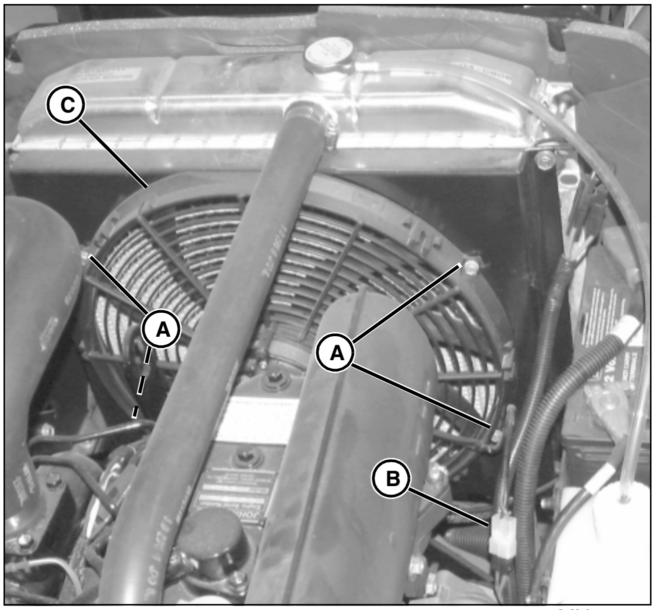
Fuel Lever Sensor Resistance (Tank Full) . . . . 174-192 Ohms

Fuel Lever Sensor Resistance (Tank Empty) 7-13 Ohms

Repair

Remove and Install Fan - 3215B, 3225B, and 3235B

CAUTION: Avoid injury! The fan can start unexpectedly at any time. Disconnect fan harness connector before removing fan to prevent injury.



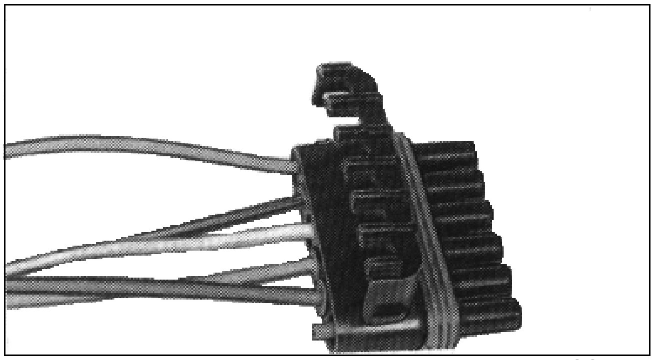
MX2721

1. Disconnect fan harness connector (B).
2. Remove four cap screws (A).
3. Remove fan (C).

Installation is done in reverse order of removal.

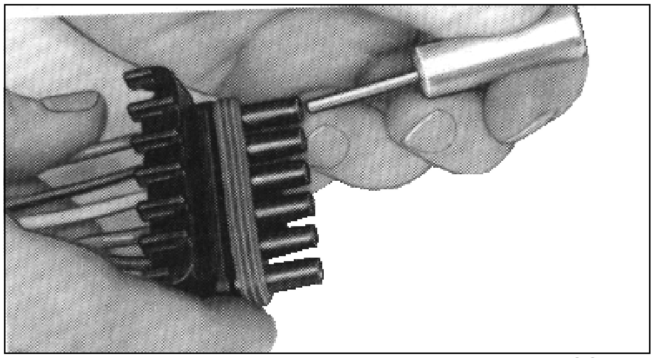
WEATHER PACK™ Connector Removal

IMPORTANT: Avoid damage! Identify wire color locations with connector terminal letters.



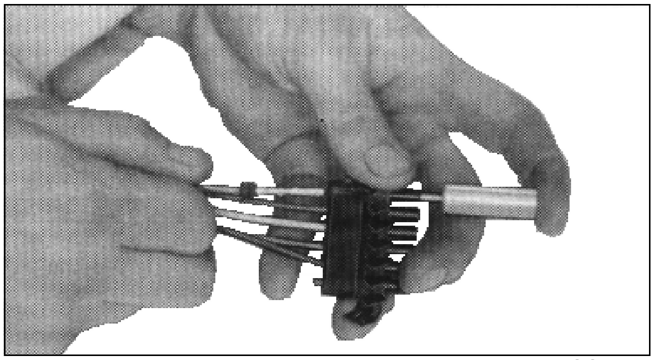
TSO127

1. Open connector body.



TSO128

2. Insert JDG364 Extraction Tool over terminal contact in connector body.



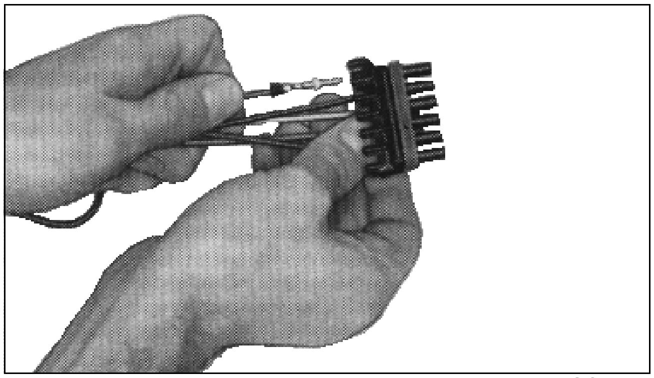
TSO129

3. Hold the extractor tool fully seated and pull wire from connector body.

IMPORTANT: Avoid damage! Carefully spread contact lances to ensure good seating on connector body.

NOTE: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.

Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.



TSO130

4. Push contact into new connector body until fully seated.

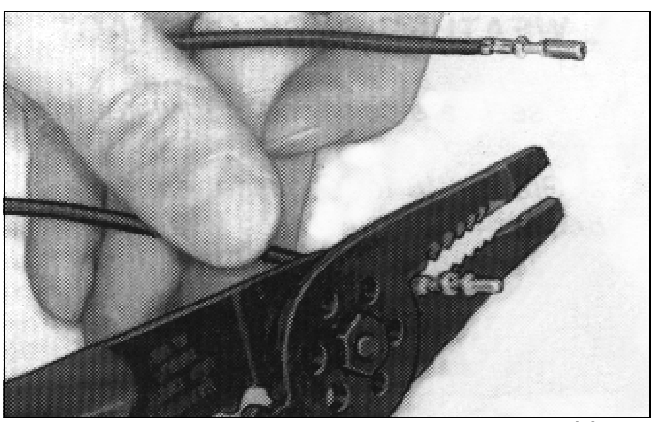
5. Pull on wire slightly to be certain contact is locked in place.

6. Transfer remaining wires to correct terminal in new connector.

7. Close connector body.

Replace WEATHER PACK™ Connector Terminal

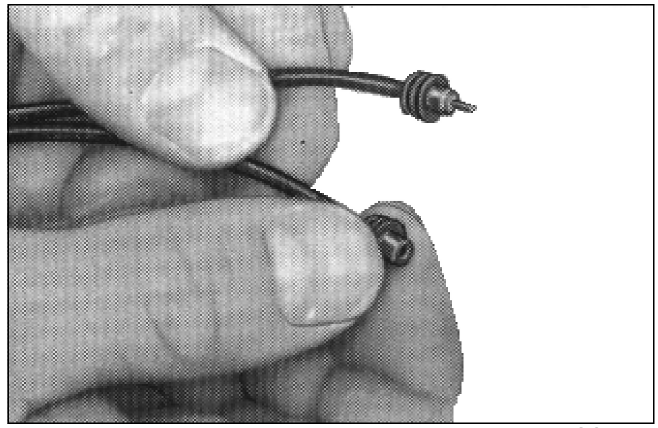
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

IMPORTANT: Avoid damage! WEATHER PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.

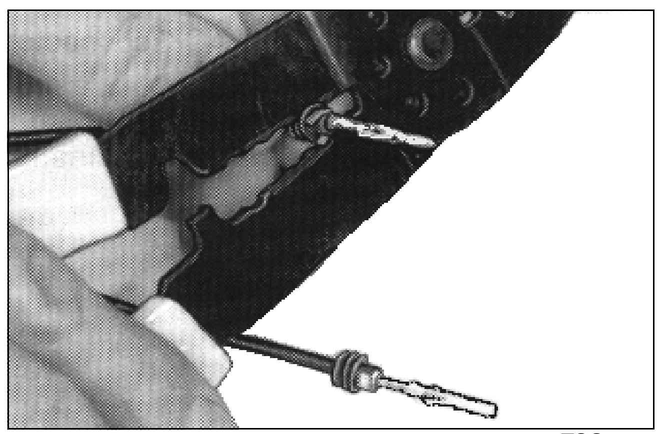


TSO136

3. Install correct size cable seal on wire.

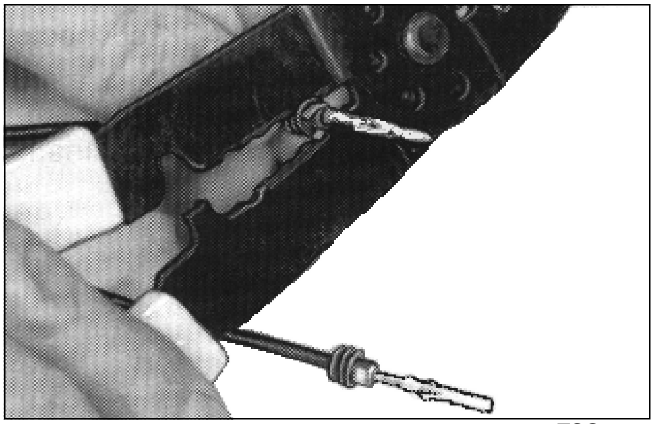
NOTE: Cable seals are color coded for three sizes of wire:
• Green - 18 to 20 gauge wire
• Gray - 14 to 16 gauge wire
• Blue - 10 to 12 gauge wire

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.



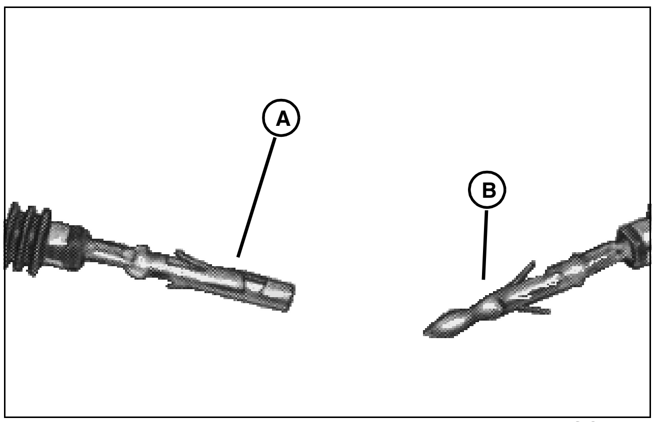
TSO138

5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a "W" type crimp.



TSO138

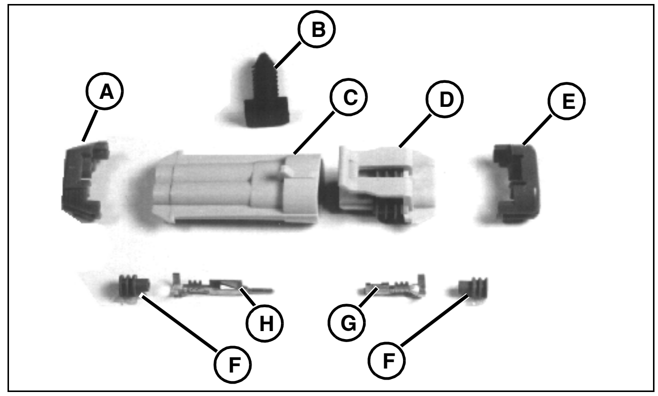
6. Use JDG776 Crimper to secure cable seal to contact as shown.



TSO139

IMPORTANT: Avoid damage! Proper contact installation for “sleeve (A) and pin (B)” is shown.

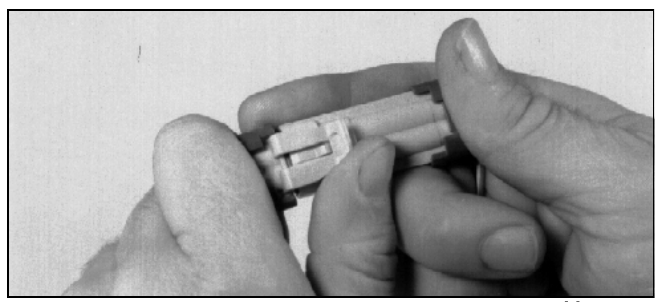
Remove METRI-PACK™ Connector



M56685

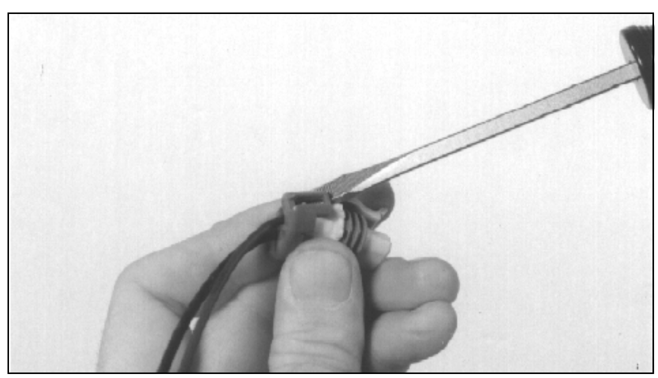
A - Wire Retainer
B - Mounting Post
C - Pin Body
D - Sleeve Body
E - Wire Retainer
F - SHURE-Seal
G - Sleeve
H - Pin

IMPORTANT: Avoid damage! Identify wire number/color locations with connector terminal letters.



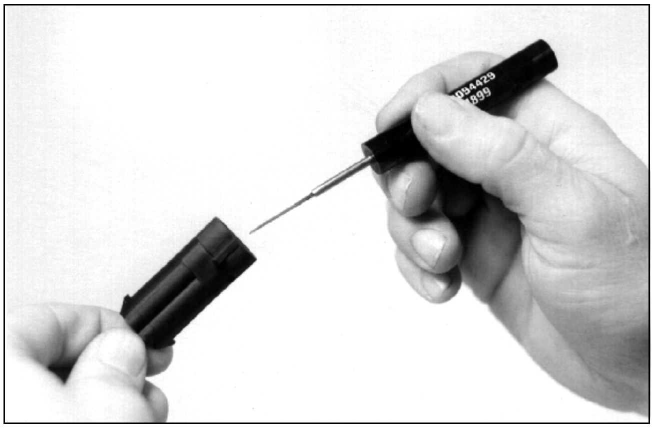
M56682

1. Open connector body.

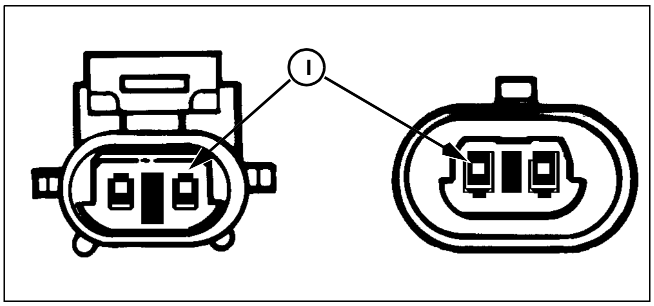


M56684

2. Remove retainer on wire end of connector with a screwdriver.



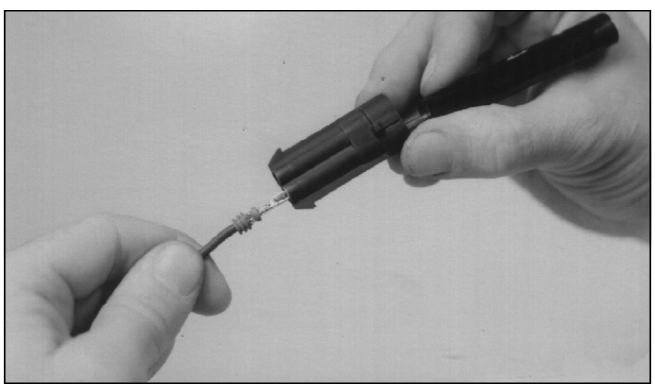
M56690



M56691

3. Use JDG777 Terminal Removal Tool to remove contact from connector body at position (I).

NOTE: To remove sleeve connector from sleeve body (short connector half), insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half), insert tool in center of contact.

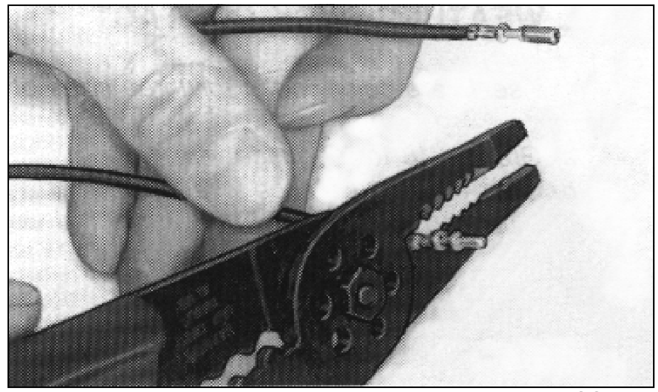


M56689

4. Hold the removal tool fully seated and pull wire from connector body.

Replace METRI-PACK™ Connector

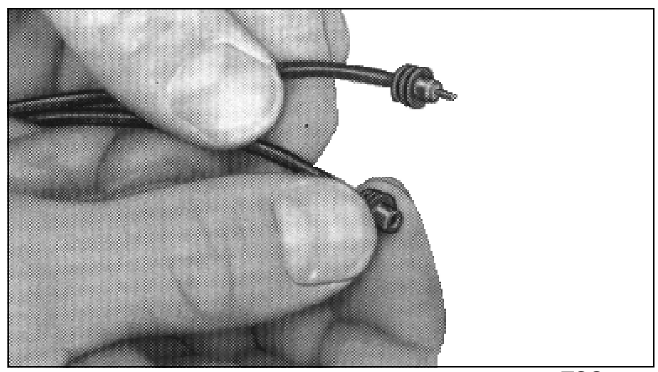
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

IMPORTANT: Avoid damage! METRI-PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.

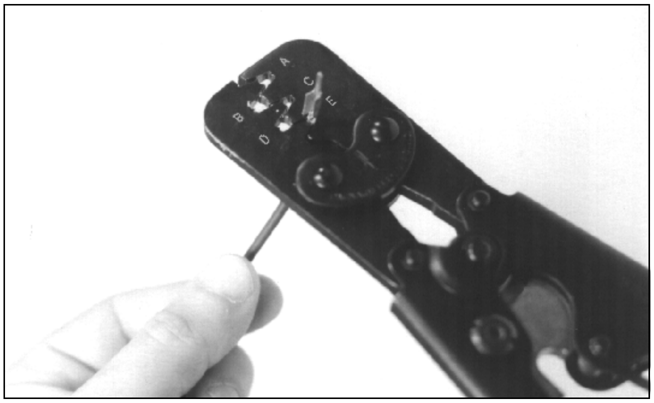


TSO136

3. Install correct size cable seal on wire.

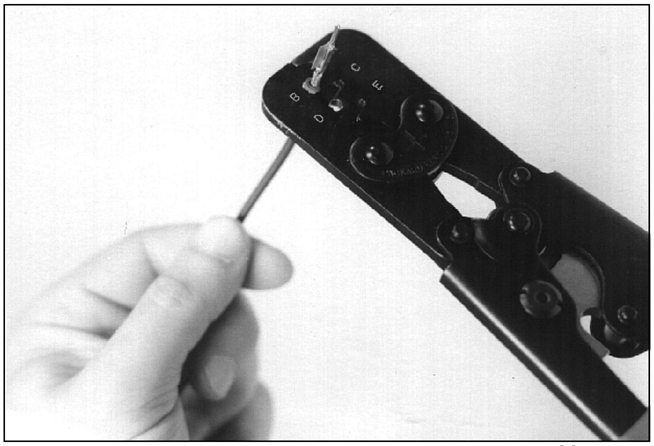
NOTE: Cable seals are available for three sizes of wire:
• Large - 1.0 mm (16 gauge) wire
• Medium - 0.8 mm (18 gauge) wire
• Small - 0.5 mm (20 gauge) wire

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.



M56686

5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a “W” type crimp.

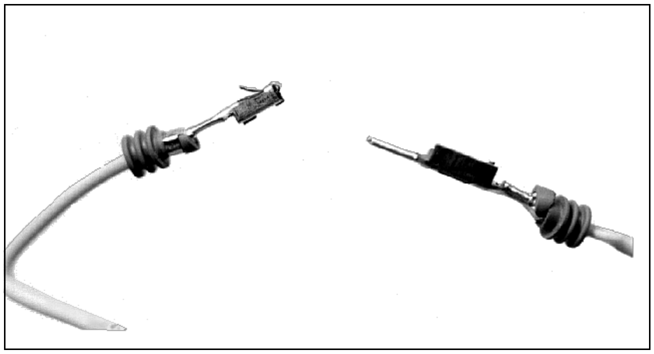


M56687

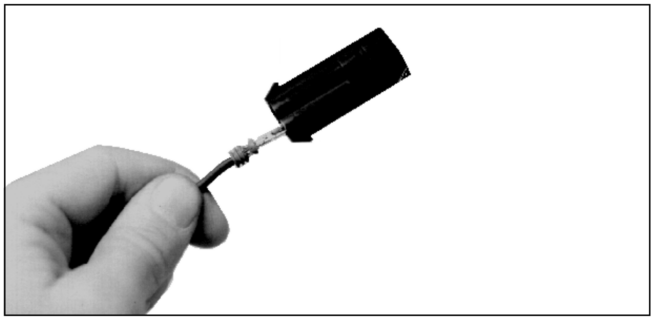
6. Use JDG776 Crimper to secure cable seal to contact as shown.

IMPORTANT: Avoid damage! Proper barb location and orientation for installation of sleeve and pin is shown.

NOTE: Connector bodies are keyed for proper contact mating. Be sure contacts are in proper alignment.



M56688

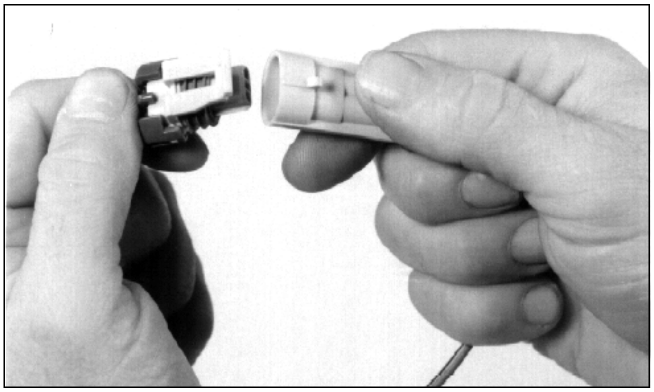


M56689

7. Push contact into new connector body until fully seated.

8. Pull on wire slightly to be certain terminal is locked in place.

9. Install wire retainer.



M56683

10. Transfer remaining wires to correct terminal in new connector.

11. Place retainer on wire end of connector and snap in place.

12. Close connector body.

Table of Contents

Specifications

General Specifications

Triple Pump (Front Gear Set)

Make . . . . . **Danfoss**

Flow . . . . . **16 L/min (4.25 gpm)**

Required Pressure at Hydro Input . . . . . **414-1103 kPa (60-160 psi)**

Filter

Type . . . . . **Spin on**

Clogged Filter Bypasses Fluid to Tank At . . . . . **345 kPa (50 psi)**

Filter Bypass Light Comes On At . . . . . **276 kPa (40 psi)**

Hydrostatic Transmission (3215, 3215A, 3215B, 3225B and 3235)

Make . . . . . **Eaton**

Model **70145**

Type . . . . . **Rotating piston, variable flow**

Main Relief Valve Setting . . . . . **31026 kPa (4500 psi)**

Charge Relief Valve Setting . . . . . **758-1103 kPa (110-160 psi)**

Hydrostatic Transmission (3235A, 3235B)

Make . . . . . **Eaton**

Model **72400**

Type . . . . . **Servo controlled piston pump**

Main Relief Valve Setting . . . . . **24 131 kPa (3500 psi)**

Charge Relief Valve Setting . . . . . **1310-1861 kPa (190-270 psi)**

Front Wheel Motors

Make . . . . . **Eaton**

Series **2000**

Model **1051172-006**

Rear Wheel Motors

Make . . . . . **Eaton or Fluiddrive**

Series . . . . . **Eaton 2000**

Model . . . . . **1051170-006 or 104796**

Repair Specifications

Hydrostatic Transmission (3215, 3215A, 3215B, 3225B and 3235)

Trunnion Covers Screw Torque. . . . . 4-5 N•m (35-44 lb-in.)
Charge Relief Valve Torque . . . . 37-40 N•m (27-30 lb-ft)
Backplate-to-Housing Cap Screw Torque . . . . 23-27 N•m (17-20 lb-ft)
Dump Valve Torque . . . . 37-40 N•m (27-30 lb-ft)
Relief Valves Torque. . . . . 129-142 N•m (95-105 lb-ft)

Hydrostatic Transmission (3235A and 3235B)

Needle Bearing Recessed Inside Bore. . . . . 1.8 mm (1/16 in.)
Cylinder Cap and Gasket (w/ Piston Screw Hole in Center) Mounting Screw Torque . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Pump Piston Distance from Edge of Cylinder (Installed). . . . . 12.7 mm (0.500 in.)
Outside Jam Nut Torque . . . . 17.5 ± 1 N•m (155 ± 5 lb-in.)
Cylinder Cap and Gasket Mounting Screw Torque . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Servo Valve Feedback Rod Mounting Screw Torque . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Cradle Mounting Screw Torque. . . . . 36 ± 2 N•m (26 ± 2 lb-ft)
Wear Plate Retaining Screw Torque . . . . 1.7 ± 0.1 N•m (15 ± 1 lb-in.)
Gerotor Bearing Position in Bore . . . . 2.29 mm (0.090 in.)
Roll Pin Protrusion from Backplate . . . . 4.39 mm (0.173 in.)
Backplate Assembly Resting Position . . . . 1.5 mm (0.06 in.)
Gerotor Bearing Race Position in Bore . . . . 2.41 mm (0.095 in.)
Gerotor Housing Cap Screw Torque (4 used) . . . . 40 ± 2 N•m (29 ± 2 lb-ft)
Main Drive Pressure Relief Valve Torque. . . . . 143 ± 6 N•m (105 ± 5 lb-ft)
Charge Pump Relief Valve Torque . . . . 39 ± 2 N•m (29 ± 1 lb-ft)
Manual Servo Control Set Screw Torque . . . . 2-3 N•m (17-25 lb-in.)

Wheel Motors

Valve Housing Cap Screws . . . . 50 N•m (37 lb-ft)
Wheel Motor Shaft Nut. . . . . 190 N•m (140 lb-ft)
Wheel Motor Mount Bolts . . . . 142 N•m (105 lb-ft)
Motor Fitting Torque. . . . . 46 N•m (34 lb-ft)
Large Hydraulic Line Torque . . . . 102 N•m (75 lb-ft)
Small Hydraulic Line Torque . . . . 50 N•m (37 lb-ft)
Manifold Block Torque . . . . 176 N•m (130 lb-ft)
Caliper Mounting Bracket Cap Screw Torque . . . . 140 N•m (105 lb-ft)

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Elbow (2 Wheel Drive Only)	38H1003	Used to test hydrostatic forward and reverse relief valve pressure.
T-Fitting	38H1030	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.
Hose	AMT846	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Balance Ring Tool	JDG859	Used to install balance ring in wheel motor.
Connector (2) - 3/4” Female NPT x 1-1/16” Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Hose 34 473 kPa (5000 psi)	JT03017	Used to verify hydrostatic charge pressure.
Gauge 2000 kPa (300 psi)	JT03344	Used to verify hydrostatic charge pressure.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to test hydrostatic forward/reverse relief valve pressure.
Hose 70 000 kPa (10,000 psi)	JT03364	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose (2) - 3/4” Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector - 1-3/16” Male ORFS x 1-1/16” Male 37° Flare	JT03483	Used to check hydrostatic pump flow.
Connector - 3/4”-14 F NPT x 1-7/16”-12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1”-14 M ORFS x 1-7/16”-12-F ORFS	JT03493	Used to check hydrostatic pump flow.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.
Connector - 1-1/16”-12 Male 37° Flare x 1”-14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 1-3/16” Female ORFS x 1-1/16” Male 37° Flare	JT05690	Used to check hydrostatic pump flow.
7/16-20 M 37° Flare x 3/4-16 M ORB Connector	JT05494	Used to verify hydrostatic charge pressure.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.
Male Quick Coupler Adapter	MT1531	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.
Female Quick Coupler	RE48122	Used to test hydrostatic forward/reverse relief valve pressure and charge pressure.

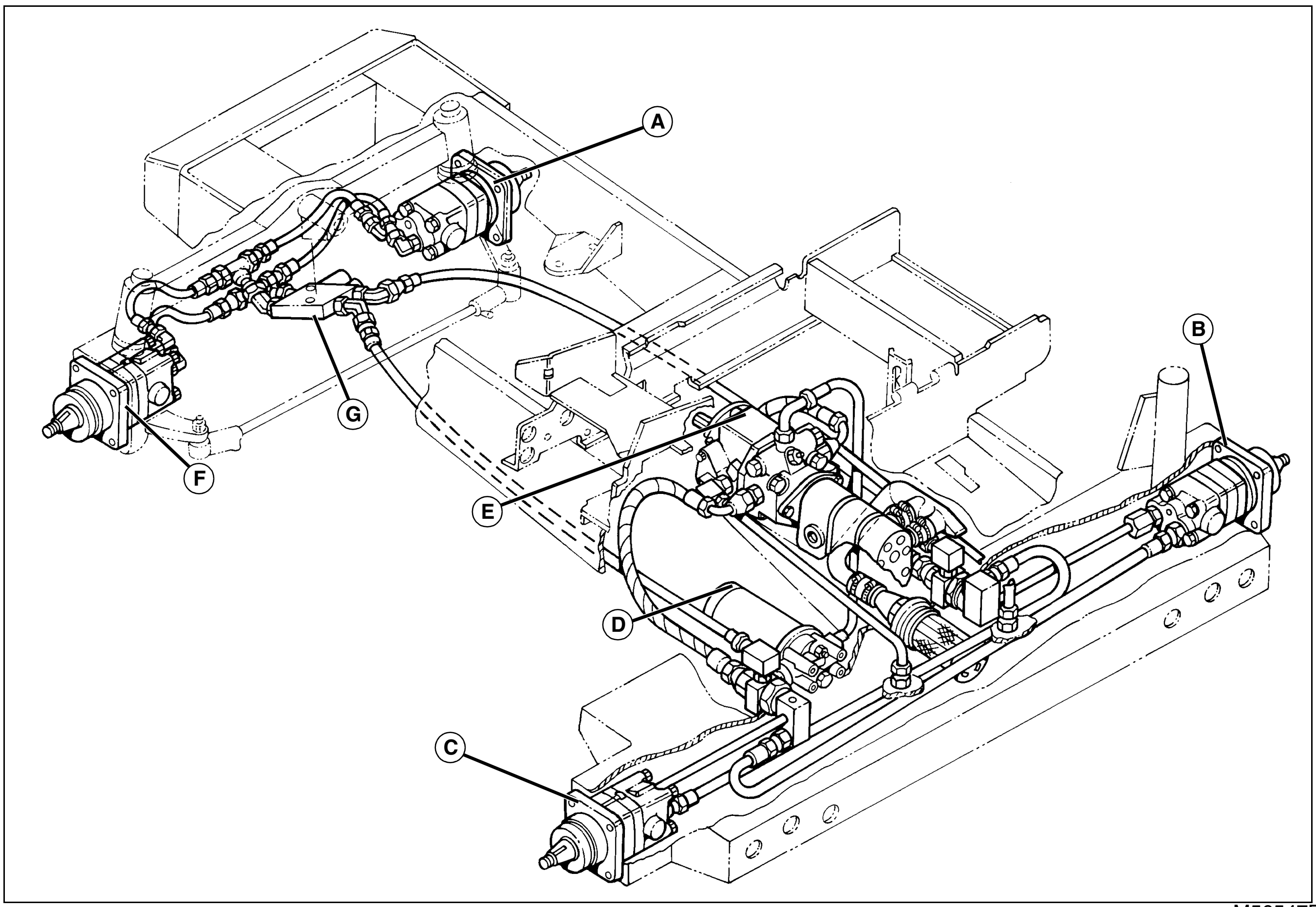
Materials

Other Material

Part No.	Part Name	Part Use
NA	LOCTITE Superflex 598	Apply to sides of Hydrostatic pump gasket.
T43512 (US) 242 (Loctite) TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of set screw.

Component Location

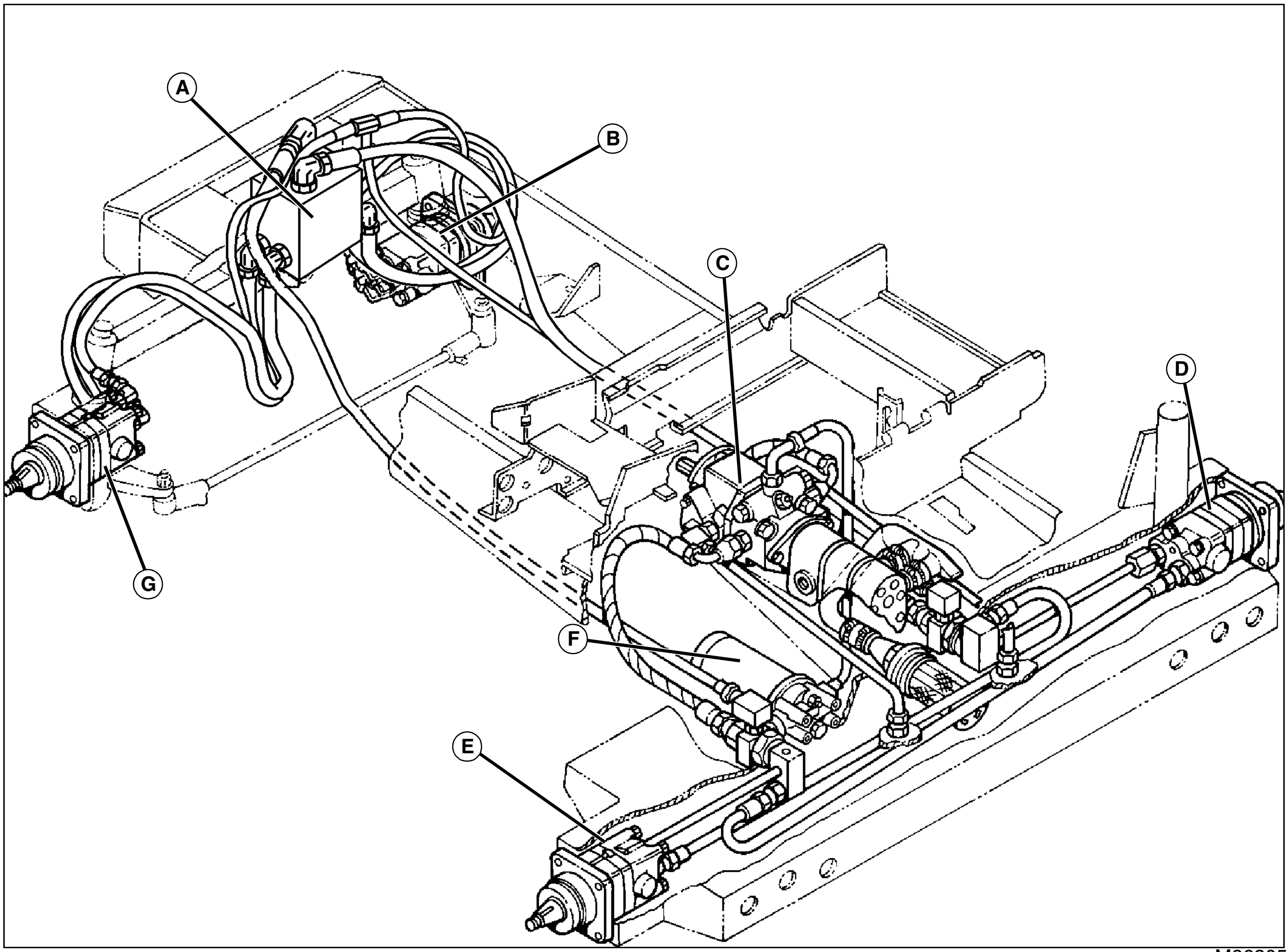
Component Location - 3215, 3215A, 3215B, 3225B and 3235



M56547B

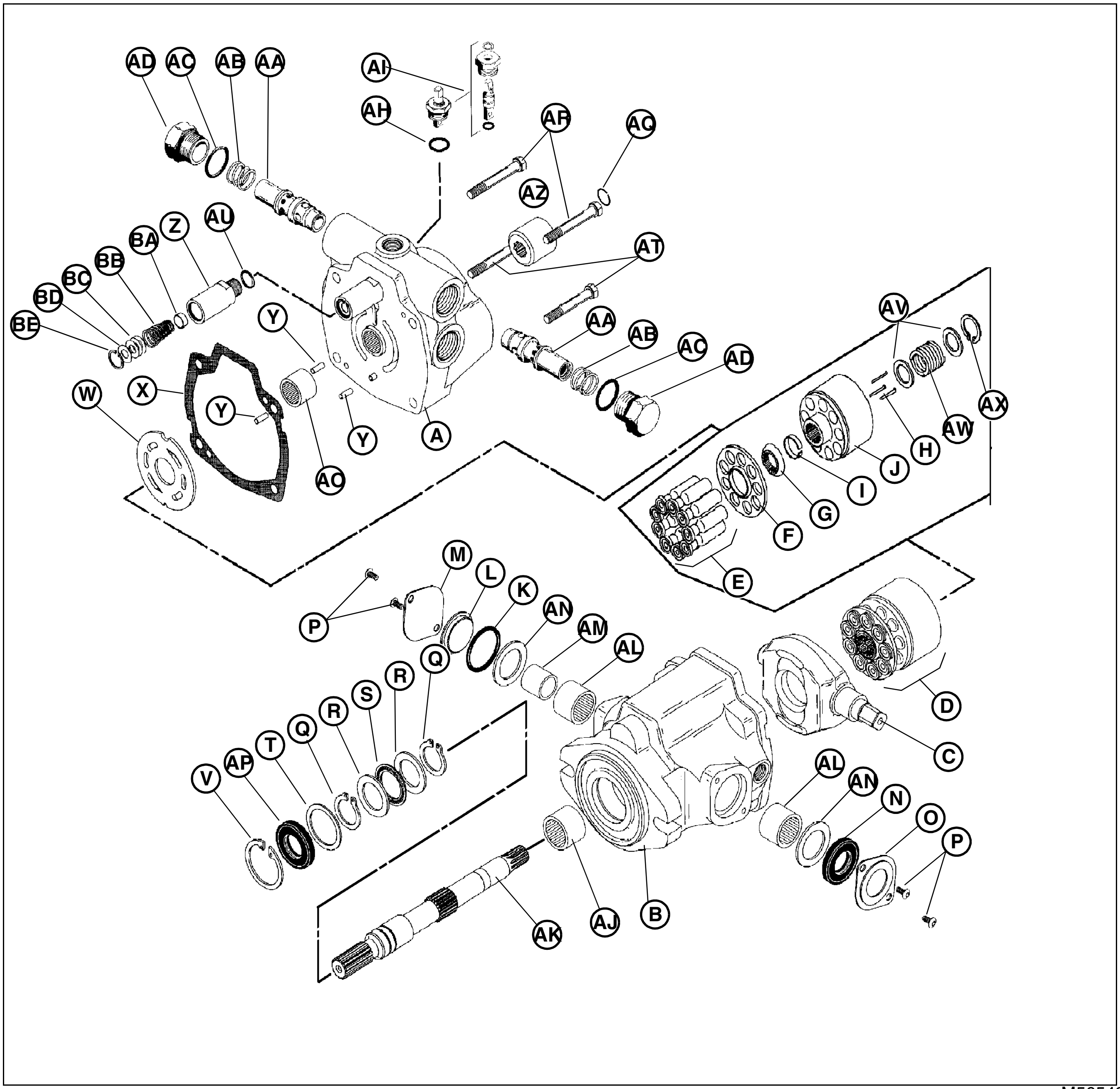
A - Rear Left Motor
B - Front Left Motor
C - Front Right Motor
D - Filter
E - Pump
F - Rear Right Motor
G - Rear Wheel Motor Valve

Component Location - 3235A and 3235B



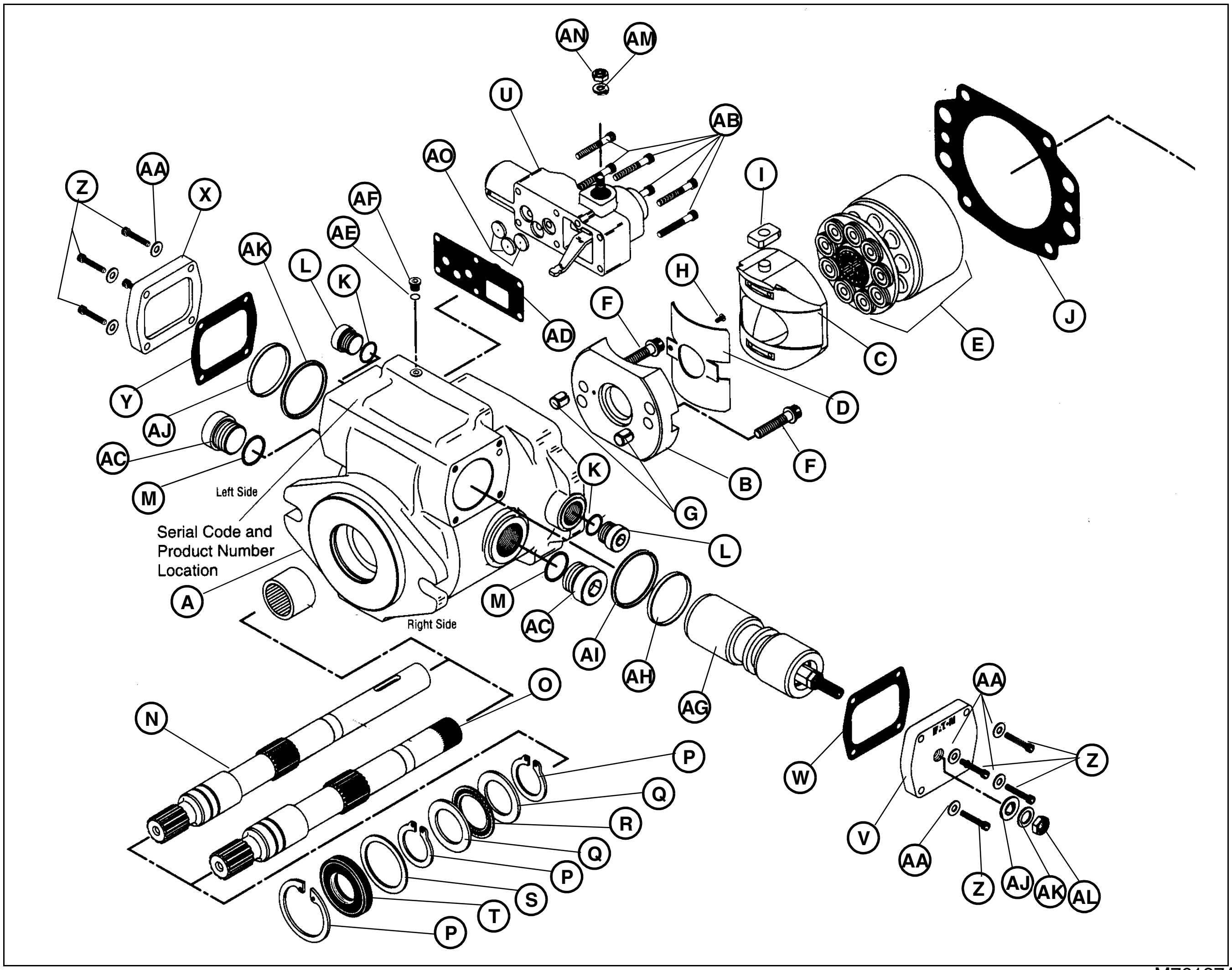
- A - Rear Wheel Motor Valve
- B - Rear Left Motor
- C - Pump
- D - Front Left Motor
- E - Front Right Motor
- F - Filter
- G - Rear Right Motor

Hydrostatic Pump - 3215, 3215A, 3215B, 3225B and 3235



A - Backplate
B - Body
C - Camplate
D - Rotating Assembly
E - Piston Assembly
F - Spider
G - Spider Pivot
H - Pin
I - Pin Keeper
J - Piston Block
K - O-Ring
L - O-Ring Cover
M - Trunnion Cover
N - Trunnion Seal
O - Seal Cover
P - Cover Screws
Q - Snap Ring
R - Bearing Race
S - Thrust Bearing
T - Washer
U - Spacer
V - Retaining Ring
W - Valve Plate
X - Gasket
Y - Pin
Z - Housing
AA- Dump Valve
AB- Spring
AC- O-Ring
AD- Plug
AE- Cap Screws
AF- O-Ring
AG- Cap Screws
AH- O-Ring
AI - Plug
AJ- Bearing, Body
AK- Shaft, Front Pump
AL- Trunnion Bearing
AM- Bearing Race
AN- Washer
AO- Bearing, Backplate
AP- Seal, Main Shaft
AQ- O-Ring
AR- Cap Screws
AS- Backplate
AT- Cap Screws
AU- O-Ring
AV- Washer
AW- Spring
AX- C-Clip
AY- Shaft, Rear Pump
AZ- Coupler
BA- Poppet
BB- Spring
BC- Shims
BD- Washer
BE- Snap Ring

Hydrostatic Pump - 3235A and 3235B

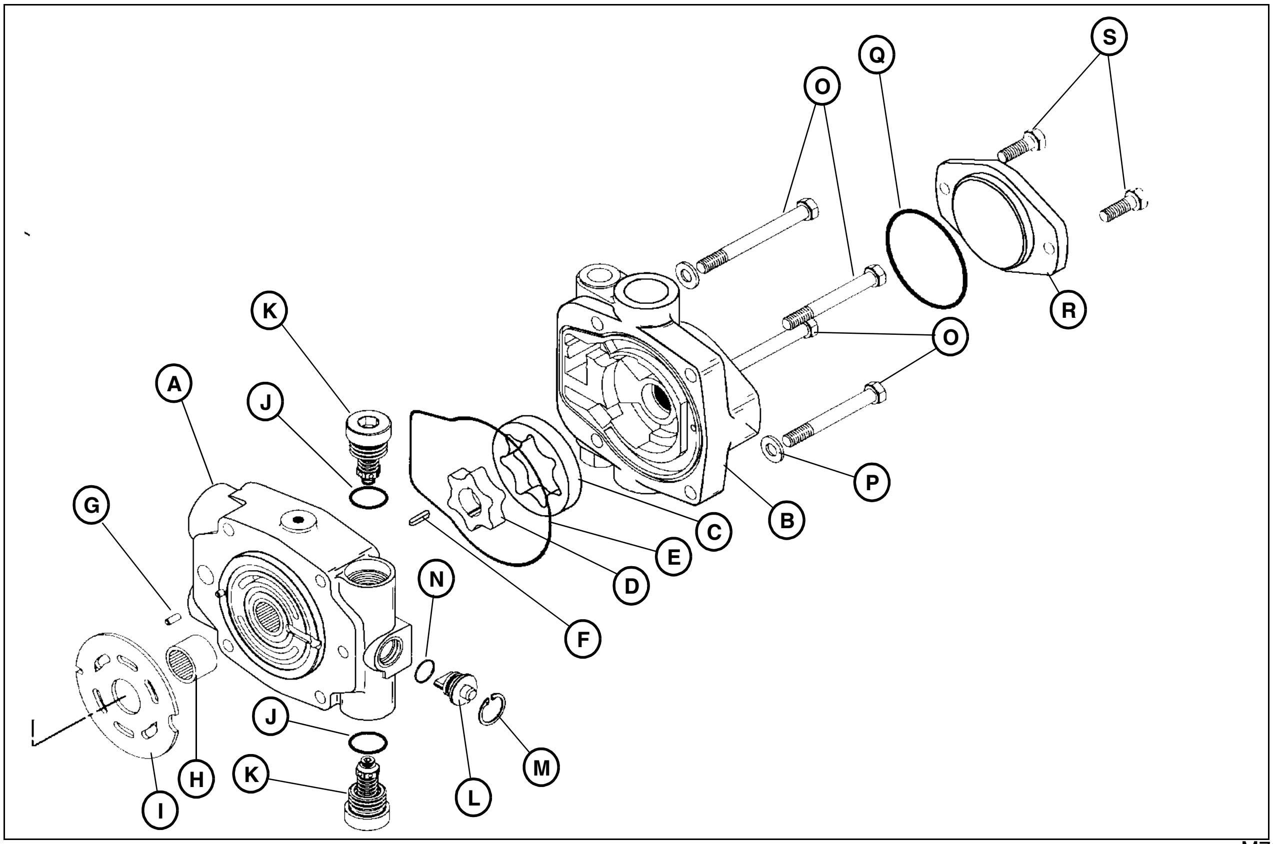


M76187A

HYDROSTATIC POWER TRAIN   COMPONENT LOCATION

A - Main Pump Housing
B - Cradle
C - Camplate
D - Wear Plate
E - Rotating Assembly
F - Cap Screw
G - Dowel Bushing
H - Retaining Screw
I - Servo Piston Follower
J - Gasket
K - O-Ring
L - Plug
M - O-Ring
N - Shaft
O - Shaft
P - Retaining Ring
Q - Thrust Washer
R - Thrust Bearing
S - Washer
T - Seal
U - Servo Valve
V - Cover
W - Gasket
X - Cover
Y - Gasket
Z - Cap Screws #10-24 x 25.5 mm (1 in.)
AA- Washer
AB- Cap Screws
AC- Plug
AD- Gasket
AE- O-Ring
AF- Plug
AG- Servo Piston
AH- Seal
AI - Ring
AJ- Seal Washer
AK- Flat Washer
AL- Jam Nut
AM- Lock Washer
AN- Nut
AO- Control Valve Orifice

Hydrostatic Pump Backplates - 3235A and 3235B



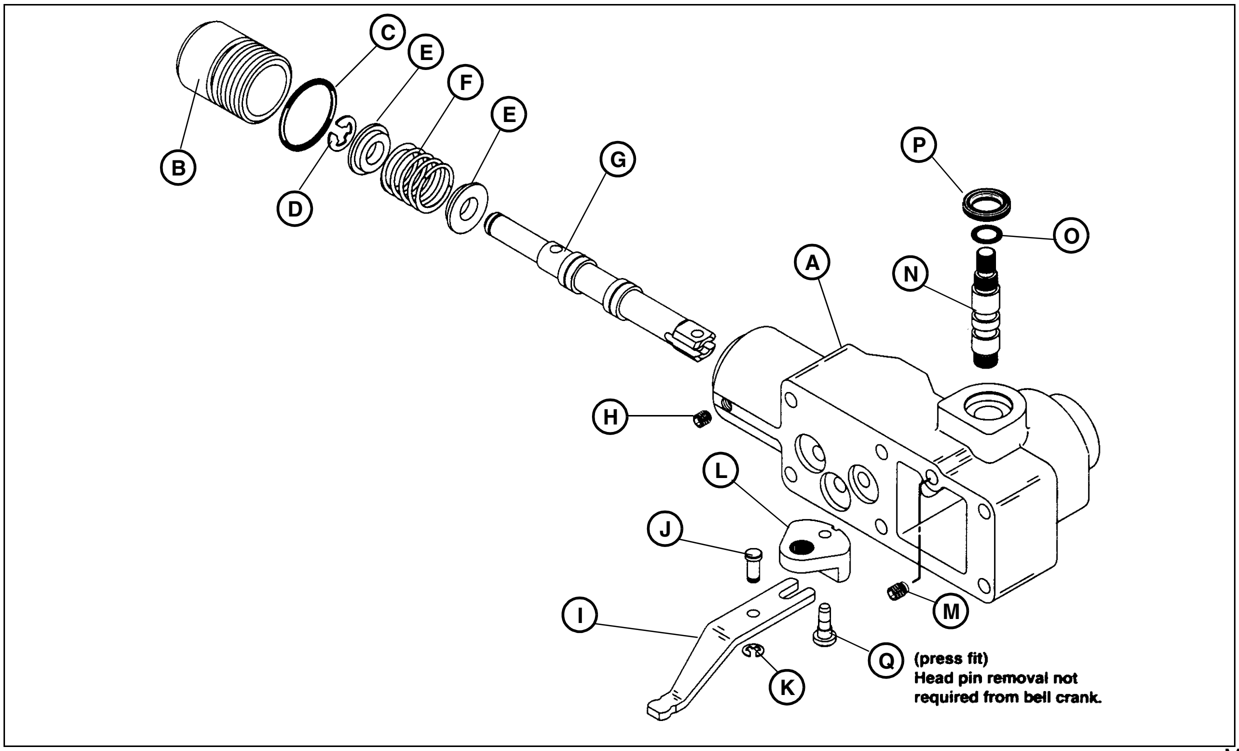
M76188

A - Backplate, Right Pump
B - Gerotor Pump Housing
C - Gerotor, Outer Ring[1]
D - Gerotor, Inner Ring[1]
E - O-Ring, Shaped
F - Key
G - Pin
H - Needle Bearing
I - Valve Plate
J - O-Ring
K - Relief Valve
L - Plug
M - Retaining Ring
N - O-Ring
O - Cap Screw
P - Washer
Q - O-Ring
R - Cover
S - Cap Screw

---

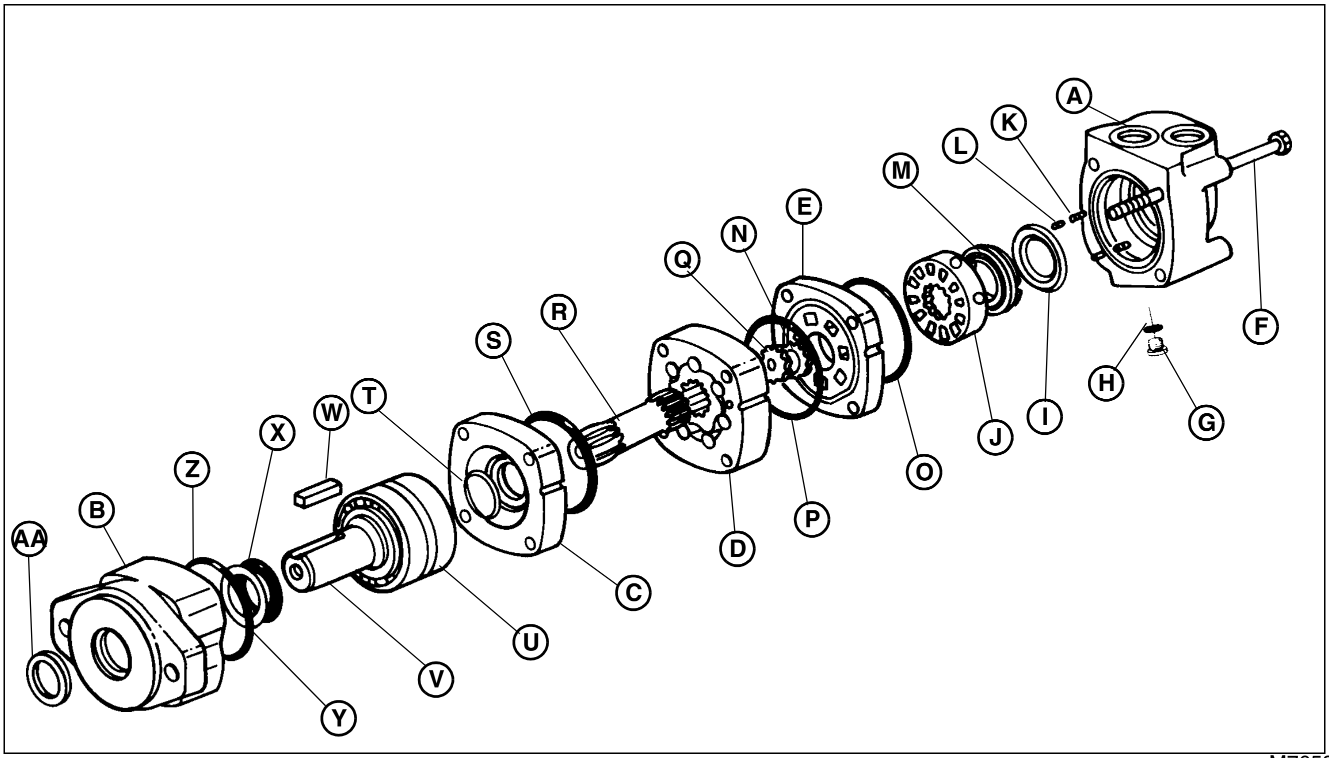
1. 3235A mowers and 3235B mowers S.N.'s TC3235T010001-TC3235T020000 and TC3235F010001-TC3235F020000 only.

Manual Servo Control Basic Assembly - 3235A and 3235B



A - **Control Housing**
B - **Plug**
C - **O-Ring**
D - **Retaining Ring**
E - **Spring Retainer**
F - **Spool Centering Spring**
G - **Valve Spool**
H - **Set Screw**
I - **Feedback Link**
J - **Dowel Pin**
K - **Retaining Ring**
L - **Bell Crank**
M - **Set Screw**
N - **Input Shaft**
O - **O-Ring**
P - **Wiper Seal**
Q - **Head Pin (Press Fit)**

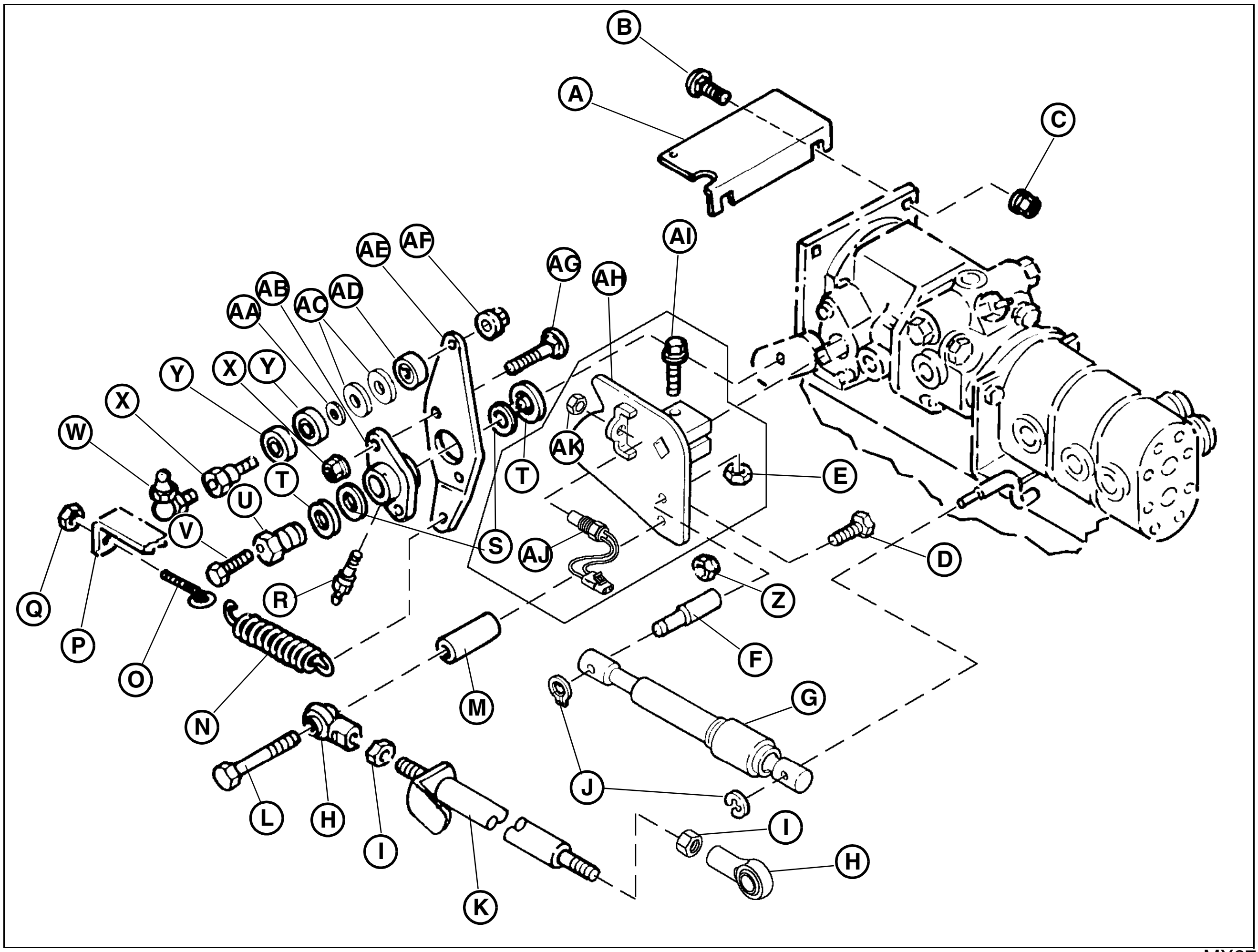
Hydrostatic Motor



M76535

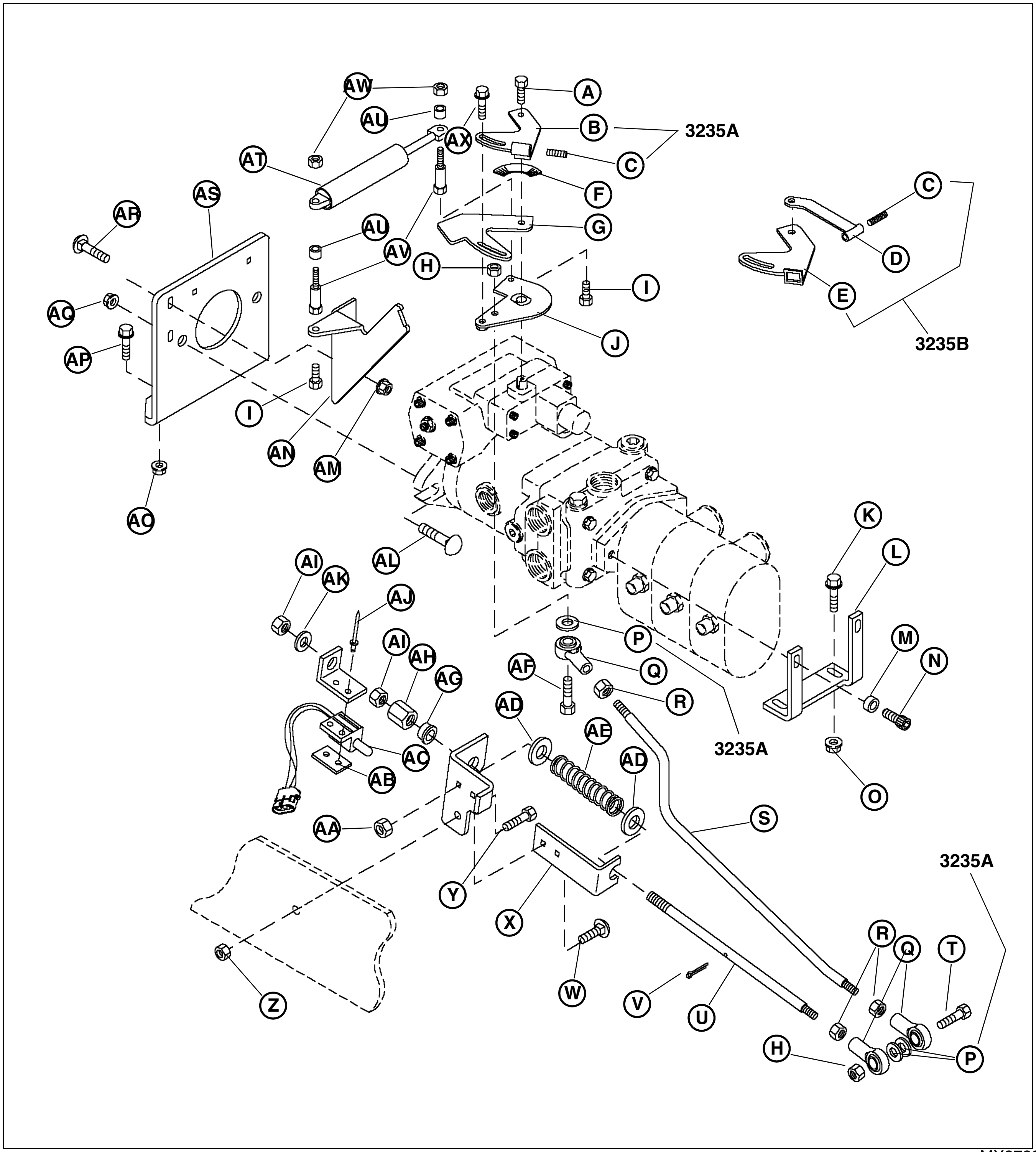
A - Valve Housing
B - Bearing Housing
C - Wear Plate
D - Geroler Assembly
E - Valve Plate
F - Cap Screw
G - Plug
H - Seal
I - Inner Face Seal
J - Valve
K - Spring
L - Pin
M - Balancing Ring
N - Valve Drive
O - O-Ring
P - O-Ring
Q - Gear
R - Splined Drive Shaft
S - Seal
T - Face Seal
U - Bearing
V - Main Shaft
W - Key
X - Shaft Seal
Y - Back-Up Washer
Z - O-Ring
AA- Exclusion Seal

Transmission Linkage - 3215, 3215A, 3215B, 3225B, and 3235



A - Plate
B - Cap Screw (2 used)
C - Lock Nut (2 used)
D - Cap Screw
E - Nut
F - Pin
G - Absorber
H - Ball Joint (2 used)
I - Nut (2 used)
J - Snap Ring (2 used)
K - Rod Assembly
L - Cap Screw
M - Spacer
N - Spring
O - Eye Bolt
P - Frame Member
Q - Lock Nut
R - Lubrication Fitting
S - Seal
T - Cap (2 used)
U - Eccentric
V - Cap Screw
W - Lubrication Fitting
X - Shoulder Bolt
Y - Ball Bearing (2 used)
Z - Lock Nut (2 used)
AA- Washer
AB- Bushing
AC- Washer (2 used)
AD- Needle Bearing
AE- Cam Follower
AF- Lock Nut
AG- Bolt (2 used)
AH- Cam
AI - Cap Screw
AJ- Switch (Only on 3215A and 3215B, with 4WD)
AK- Nut (Only on 3215A and 3215B, with 4WD)

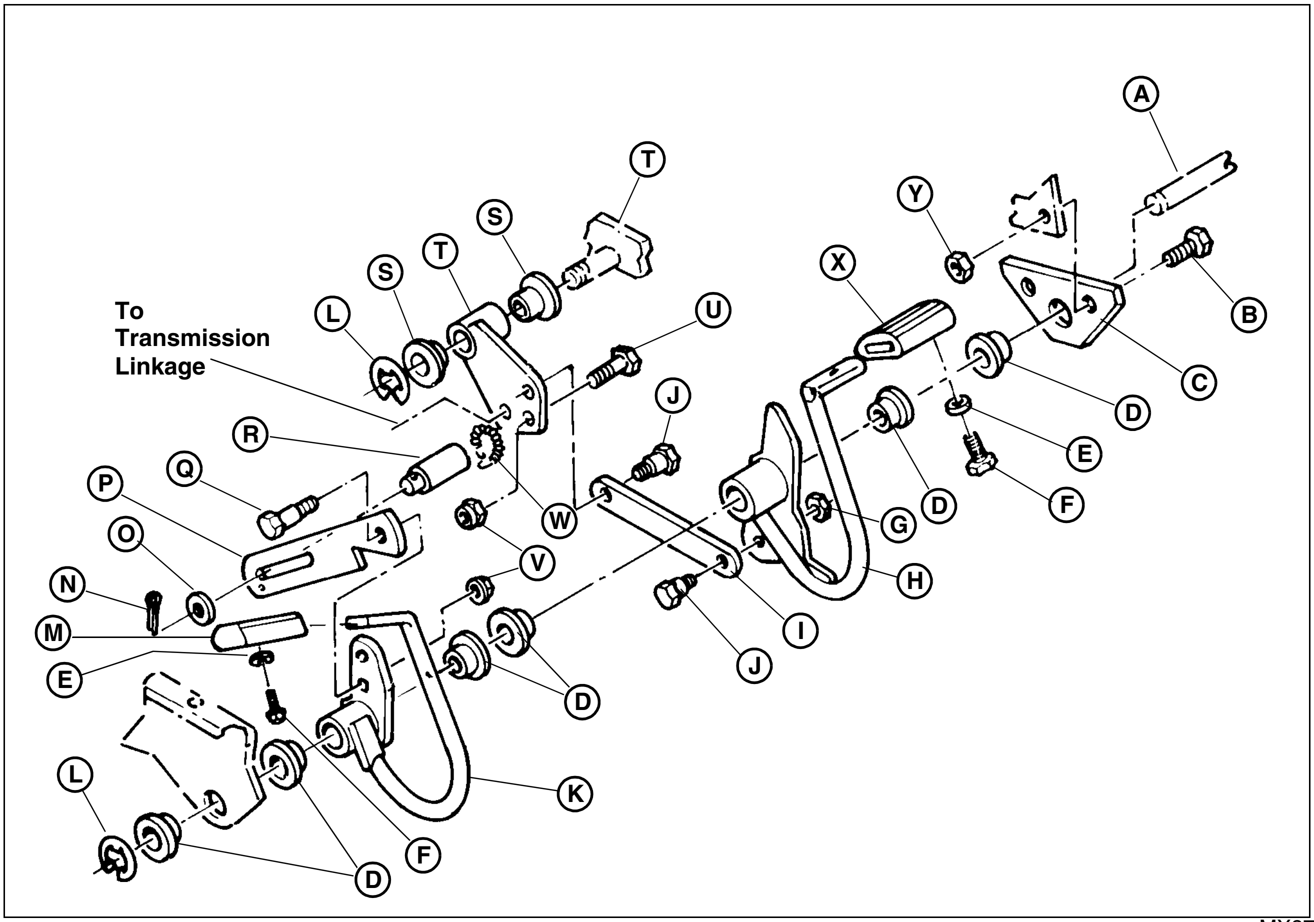
Transmission Linkage - 3235A and 3235B



MX2729

A - Cap Screw
B - Stop - 3235A Only
C - Set Screw
D - Stop - 3235B Only
E - Plate - 3235B Only
F - Label
G - Plate
H - Lock Nut (2 used)
I - Cap Screw
J - Pivot
K - Cap Screw
L - Angle Bracket
M - Washer (2 used)
N - Hex Socket Head Screw (2 used)
O - Nut (2 used)
P - Washer - 3235A Only (4 used)
Q - Ball Joint (3 used)
R - Nut (3 used)
S - Rod
T - Cap Screw
U - Rod
V - Cotter Pin
W - Bolt - M6x20 (2 used)
X - Bracket
Y - Cap Screw - M12x60
Z - Nut
AA- Nut
AB- Strap
AC- Switch
AD- Washer (2 used)
AE- Compression Spring
AF- Cap Screw
AG- Bushing
AH- Nut
AI - Nut (2 used)
AJ- Rivet (2 used)
AK- Washer (as required)
AL- Bolt (2 used)
AM- Nut (2 used)
AN- Bracket
AO- Nut (2 used)
AP- Cap Screw (2 used)
AQ- Nut (2 used)
AR- Bolt (2 used)
AS- Angle Bracket
AT- Torsional Dampener
AU- Spacer (2 used)
AV- Stud (2 used)
AW- Nut (2 used)
AX- Cap Screw

Forward and Reverse Pedals and Linkage

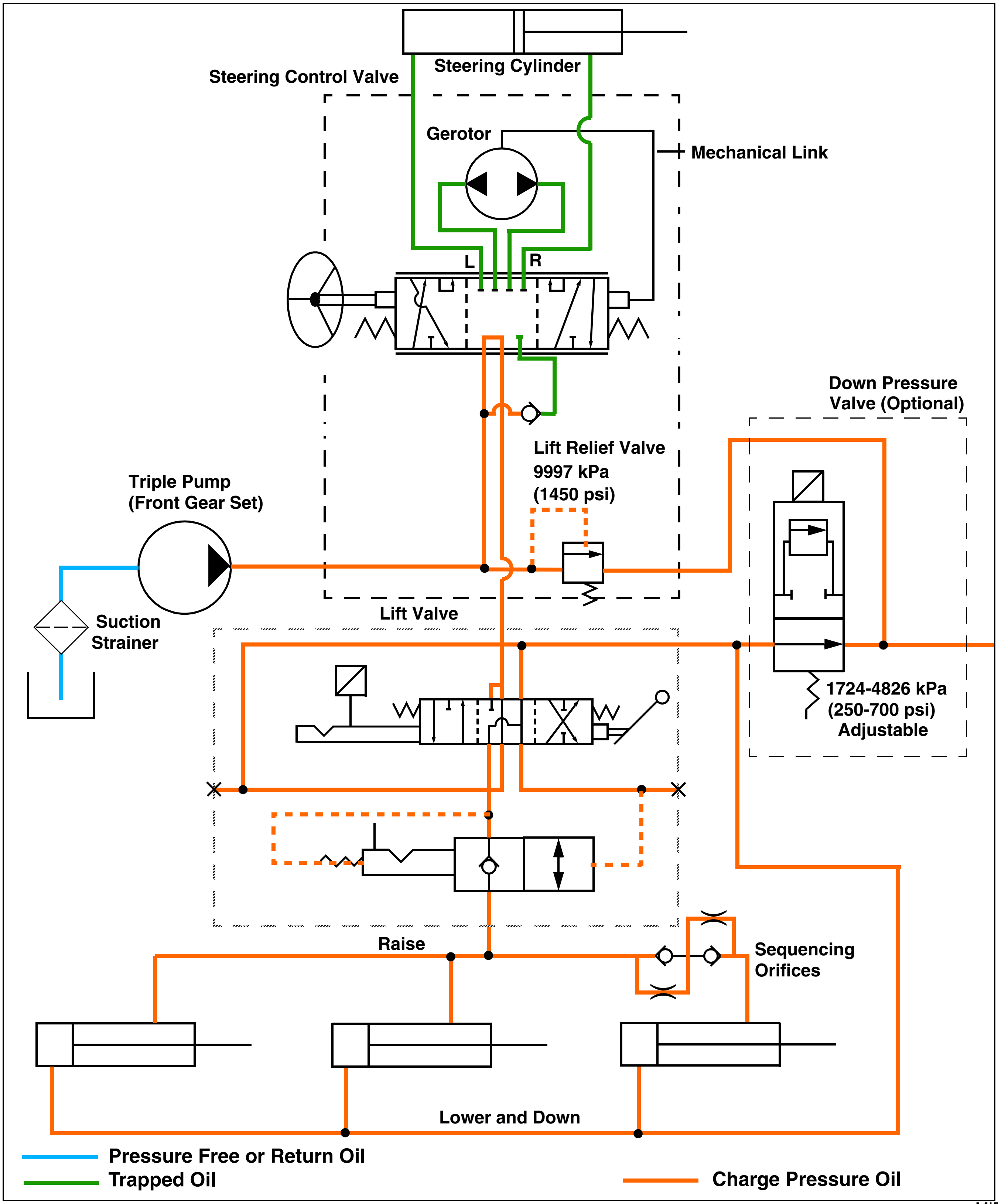


A - Shaft
B - Cap Screw - M10x20 (2 used)
C - Support
D - Bushing (6 used)
E - Washer (2 used)
F - Cap Screw - M6x20 (2 used)
G - Lock Nut
H - Pedal, LH (Forward)
I - Link
J - Shoulder Bolt (2 used)
K - Pedal RH (Reverse)
L - Snap Ring (2 used)
M - Pad, LH (Reverse)
N - Cotter Pin
O - Washer
P - Link
Q - Shoulder Bolt
R - Spacer
S - Bushing (2 used)
T - Arm
U - Cap Screw
V - Lock Nut (2 used)
W - Extension Spring
X - Pad, LH (Forward)
Y - Nut - M10 (2 used)

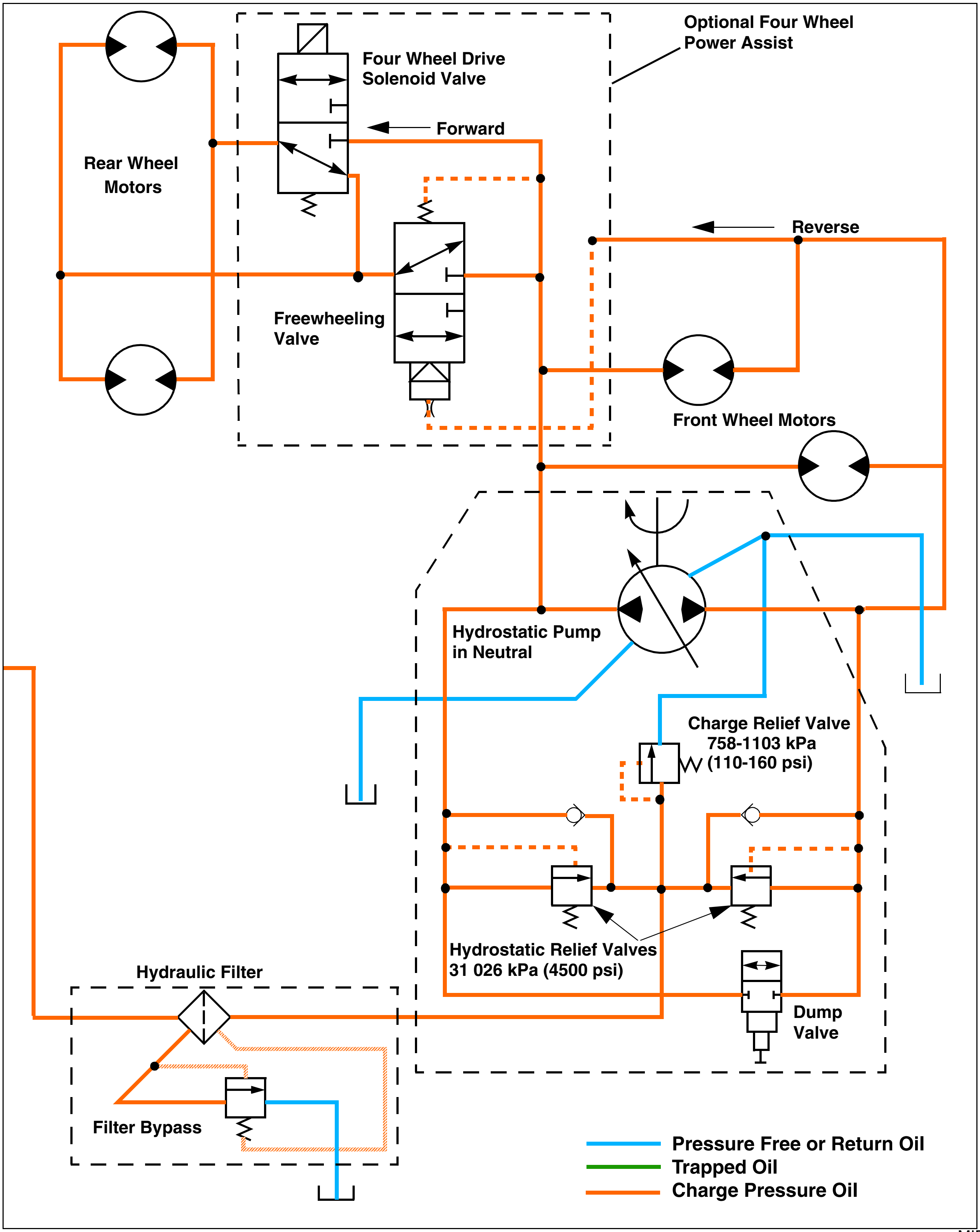
This Page Intentionally Left Blank

Schematics

Hydrostatic Schematic - 3215, 3215A, 3215B, 3225B and 3235

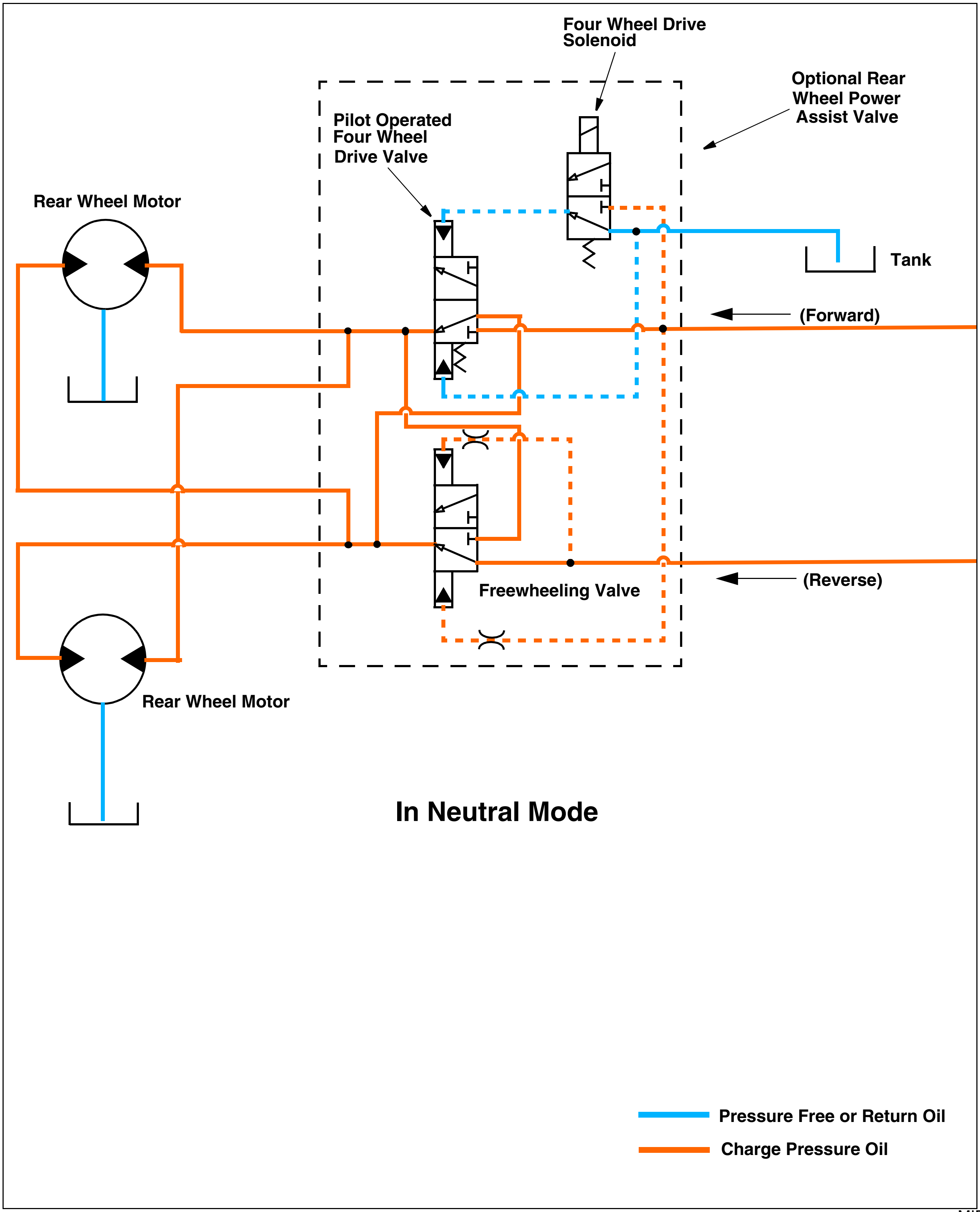


MIF

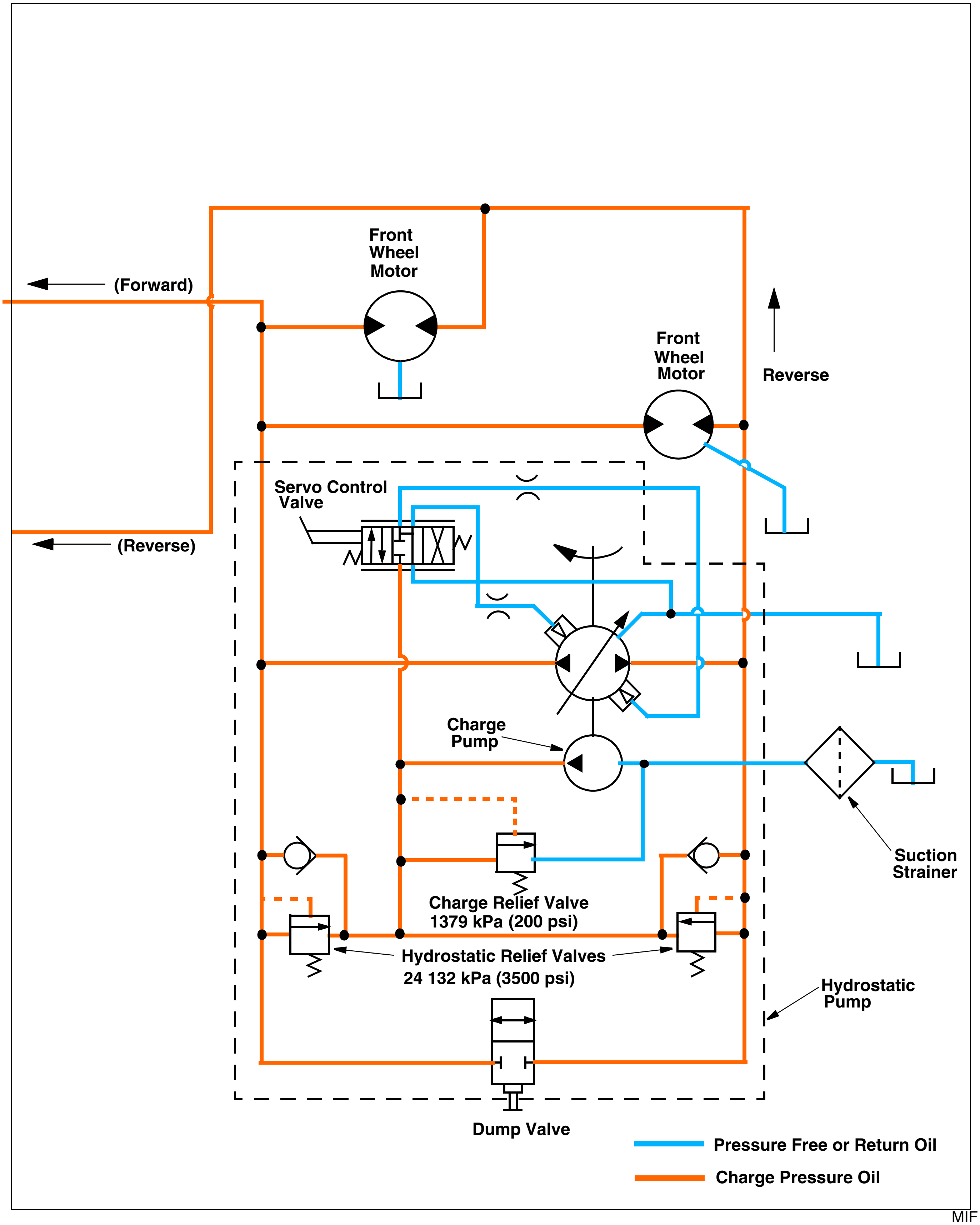

Optional Four Wheel Power Assist
Four Wheel Drive Solenoid Valve
Rear Wheel Motors
Forward
Reverse
Freewheeling Valve
Front Wheel Motors
Hydrostatic Pump in Neutral
Charge Relief Valve 758-1103 kPa (110-160 psi)
Hydrostatic Relief Valves 31 026 kPa (4500 psi)
Hydraulic Filter
Dump Valve
Filter Bypass
Pressure Free or Return Oil
Trapped Oil
Charge Pressure Oil

MIF

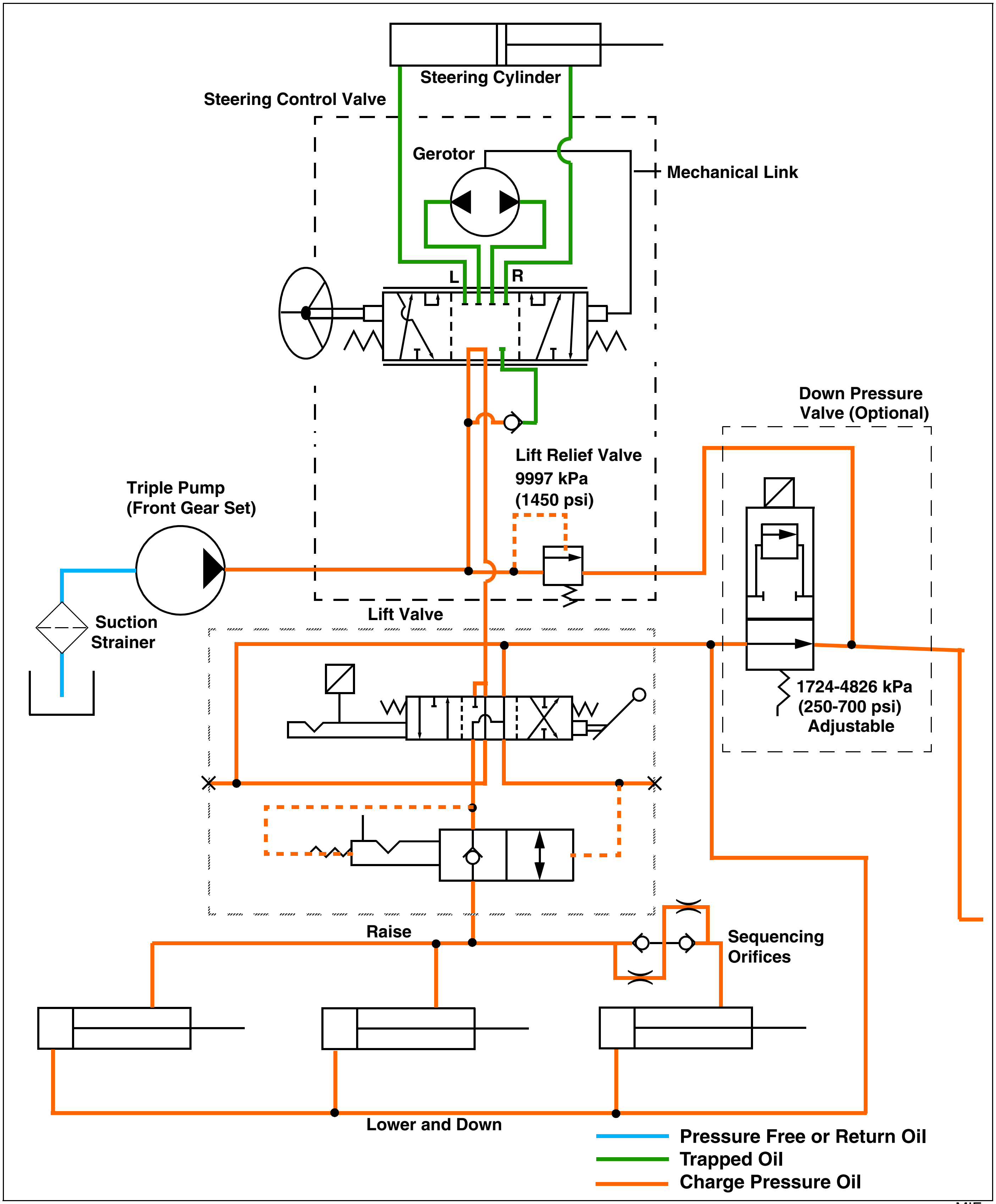
Hydrostatic Schematic - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235F020000)



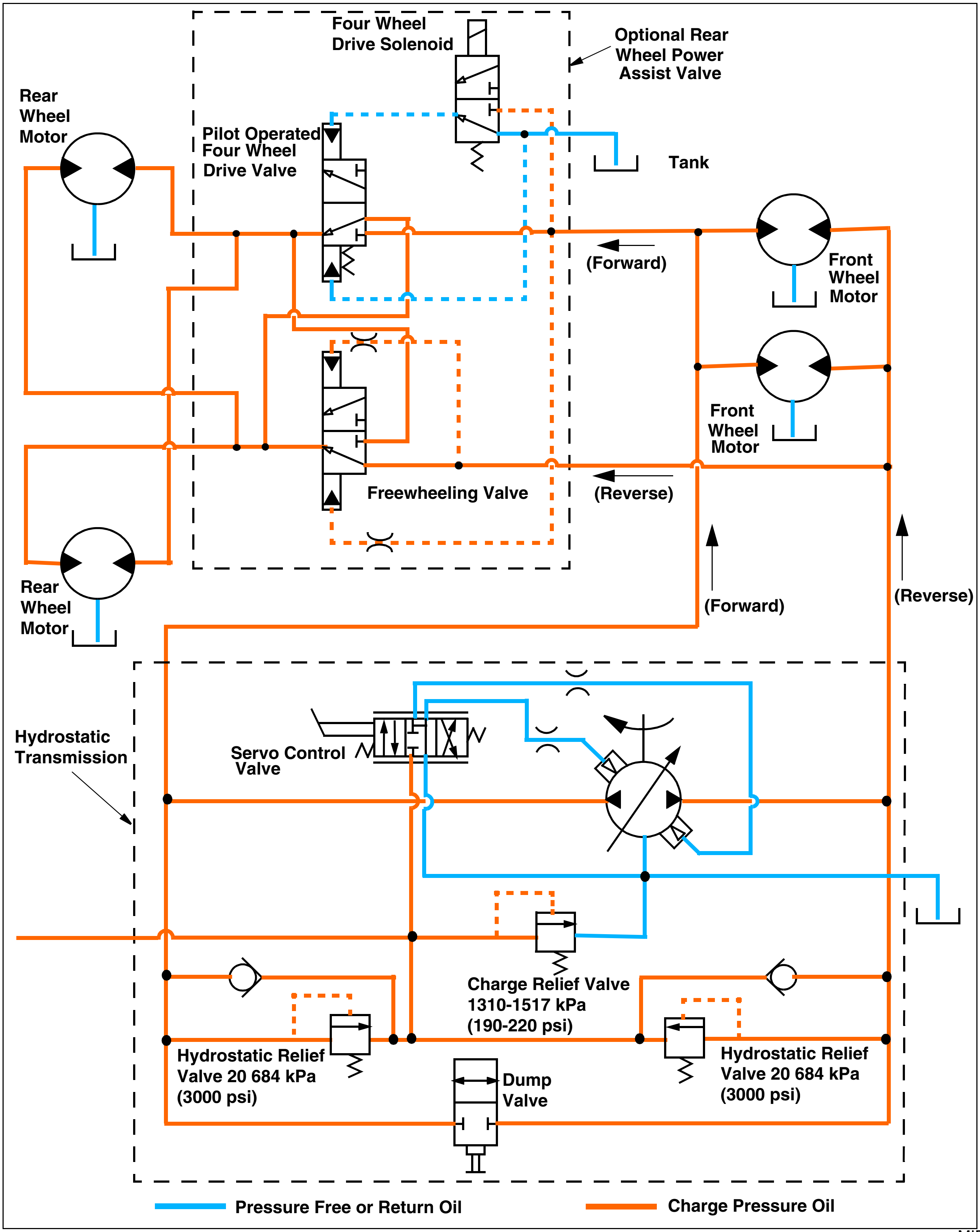
MIF


Front Wheel Motor
(Forward)
Front Wheel Motor
Reverse
(Reverse)
Servo Control Valve
Charge Pump
Suction Strainer
Charge Relief Valve 1379 kPa (200 psi)
Hydrostatic Relief Valves 24 132 kPa (3500 psi)
Hydrostatic Pump
Dump Valve
Pressure Free or Return Oil
Charge Pressure Oil
MIF

Hydrostatic Schematic - 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)

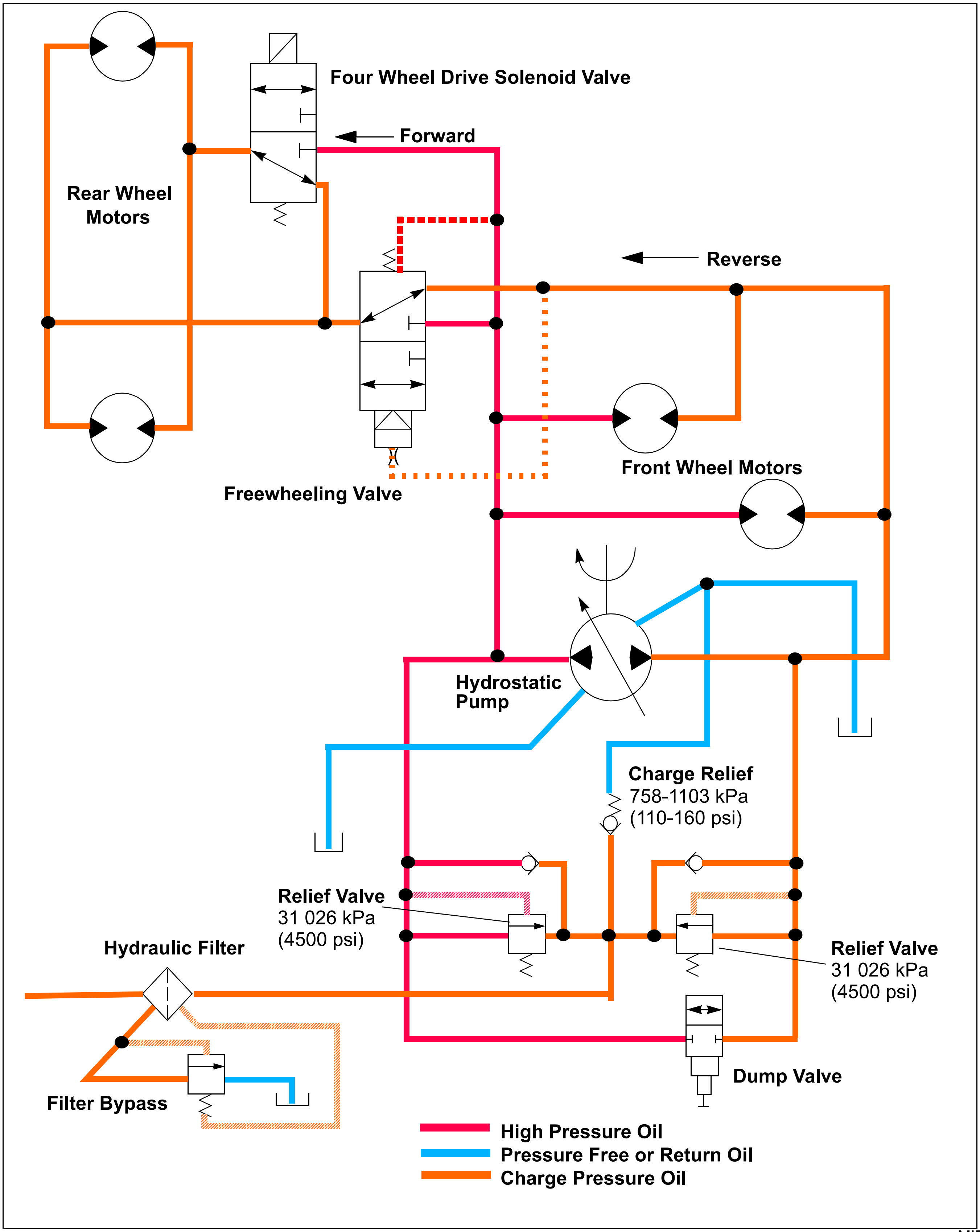


MIF


Four Wheel Drive Solenoid
Optional Rear Wheel Power Assist Valve
Rear Wheel Motor
Pilot Operated Four Wheel Drive Valve
Tank
(Forward)
Front Wheel Motor
Front Wheel Motor
Freewheeling Valve
(Reverse)
Rear Wheel Motor
(Forward)
(Reverse)
Hydrostatic Transmission
Servo Control Valve
Charge Relief Valve 1310-1517 kPa (190-220 psi)
Hydrostatic Relief Valve 20 684 kPa (3000 psi)
Dump Valve
Hydrostatic Relief Valve 20 684 kPa (3000 psi)
Pressure Free or Return Oil
Charge Pressure Oil

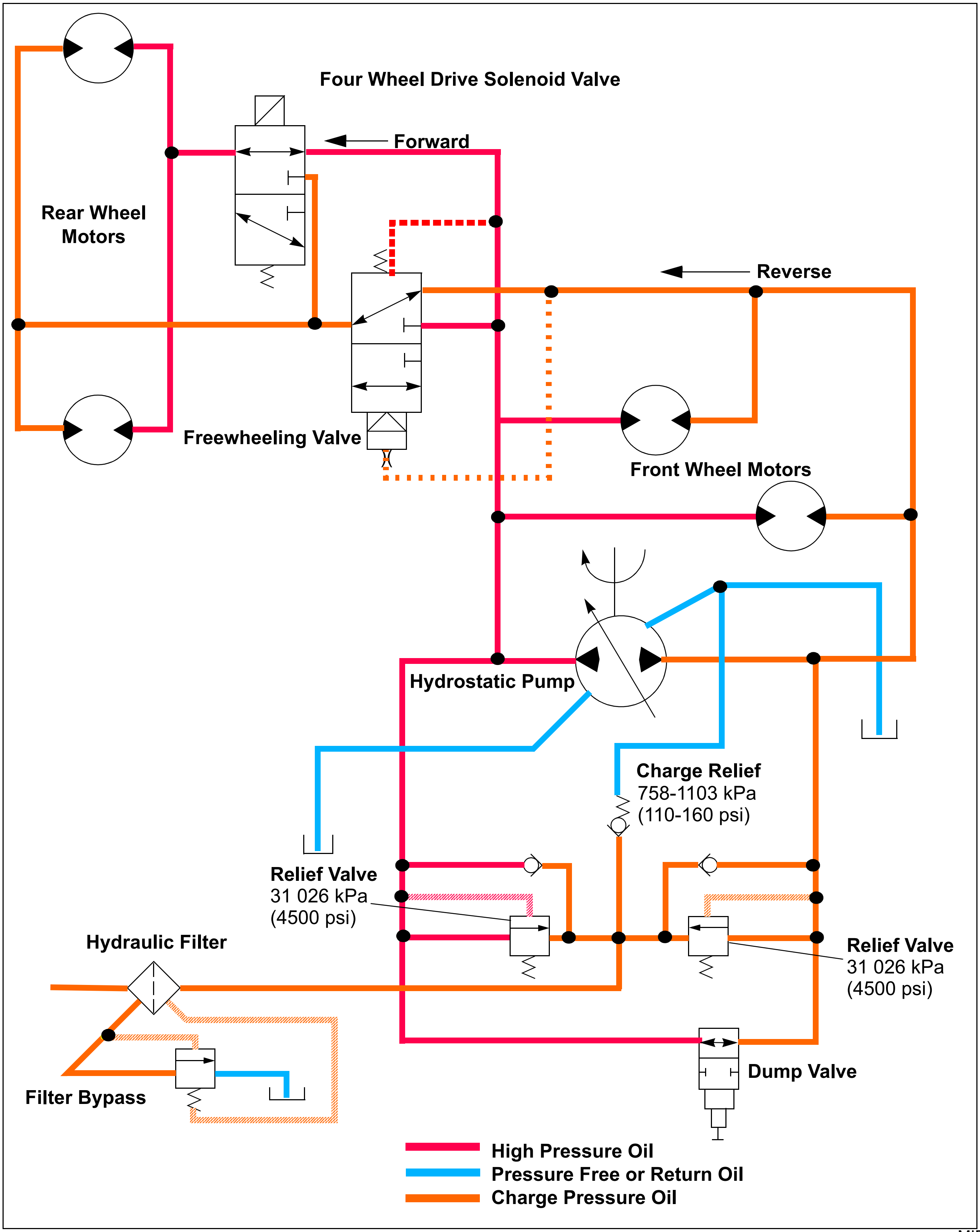
MIF

Forward Without Four Wheel Drive - 3215, 3215A, 3215B, 3225B and 3235



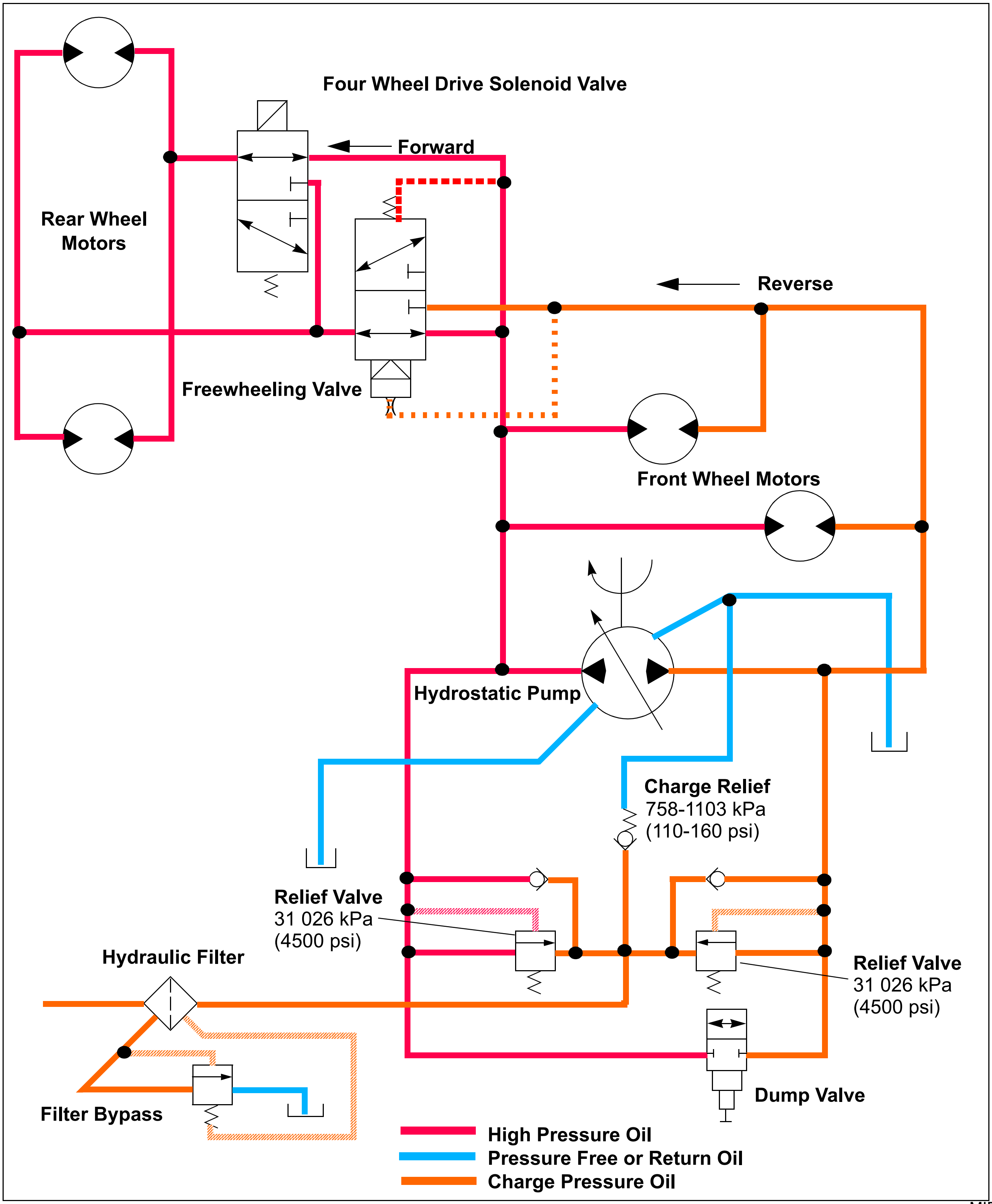
MIF

Forward With Four Wheel Drive - 3215, 3215A, 3215B, 3225B and 3235



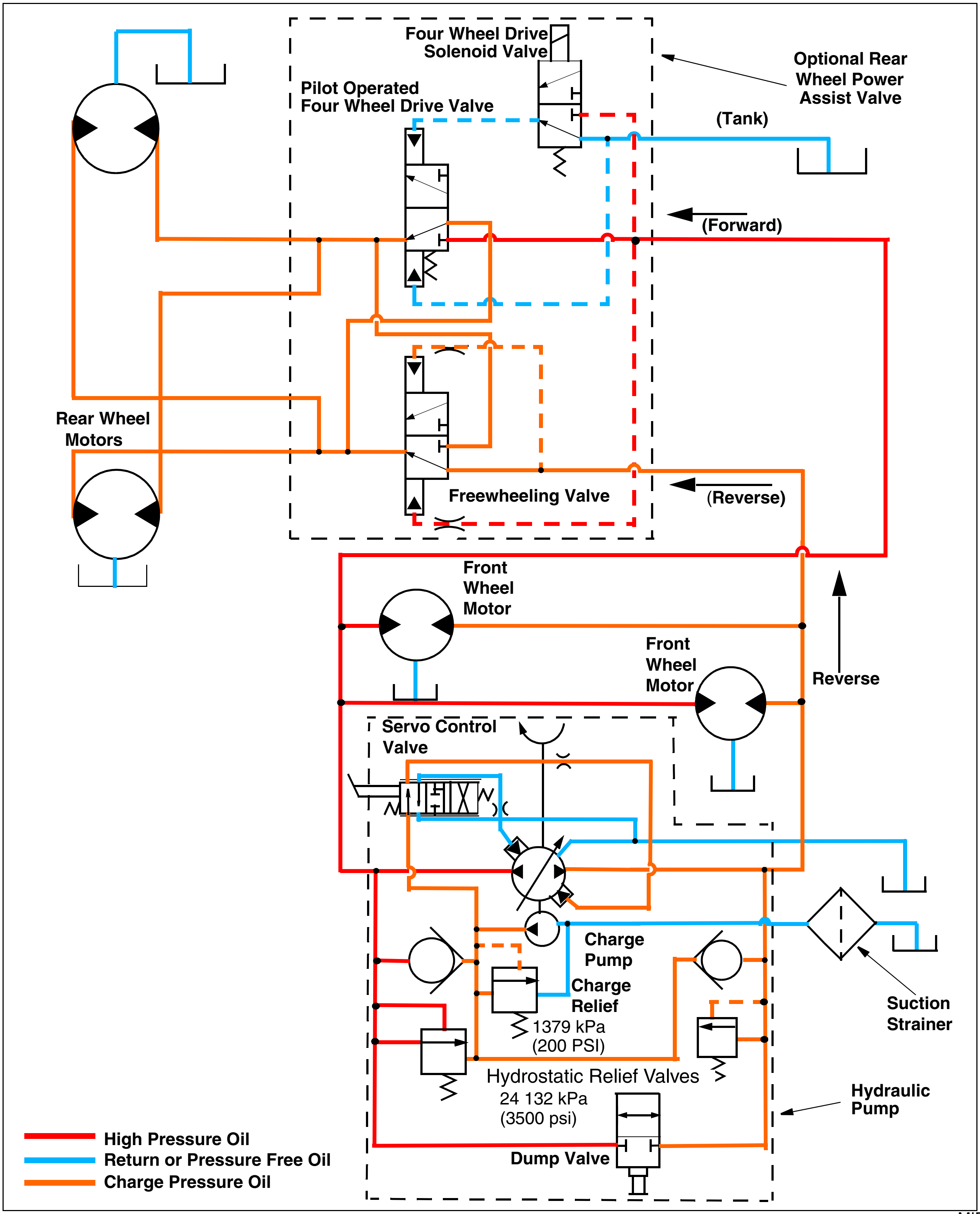
MIF

Forward With Four Wheel Drive and Rear Wheels Freewheeling - 3215, 3215A, 3215B, 3225B and 3235



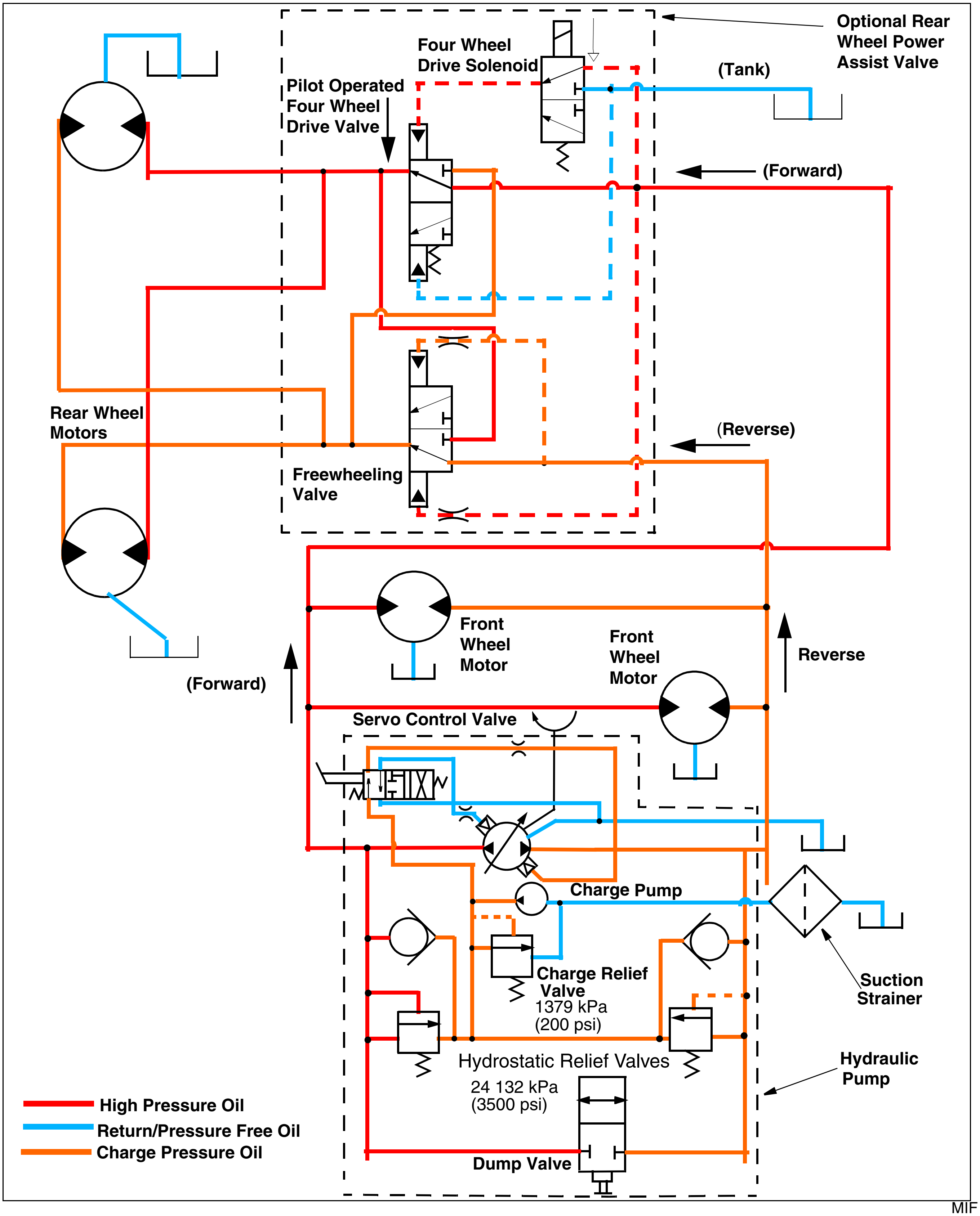
MIF

Forward Without Four Wheel Drive - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235F020000)

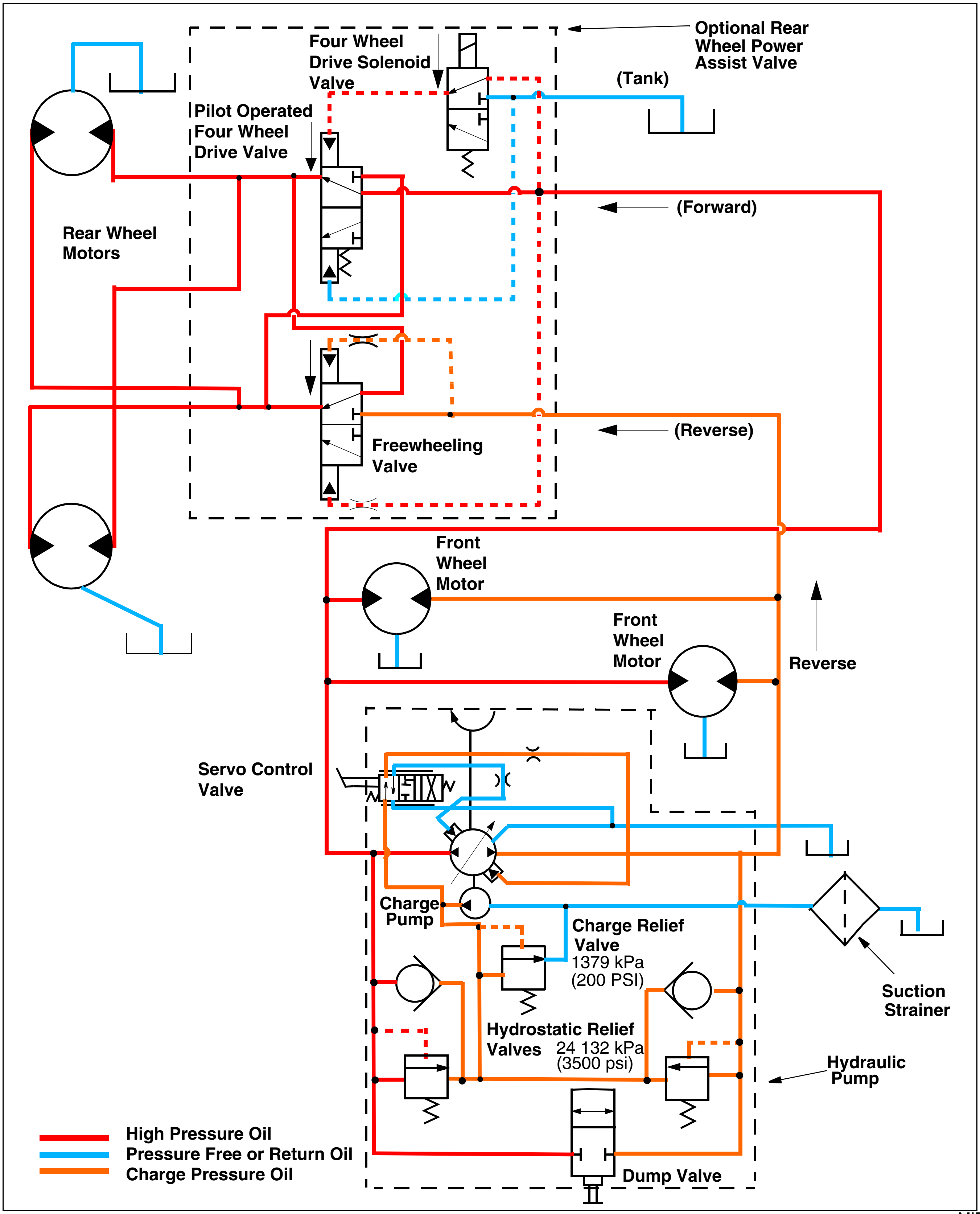


MIF

Forward With Four Wheel Drive - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235F020000)

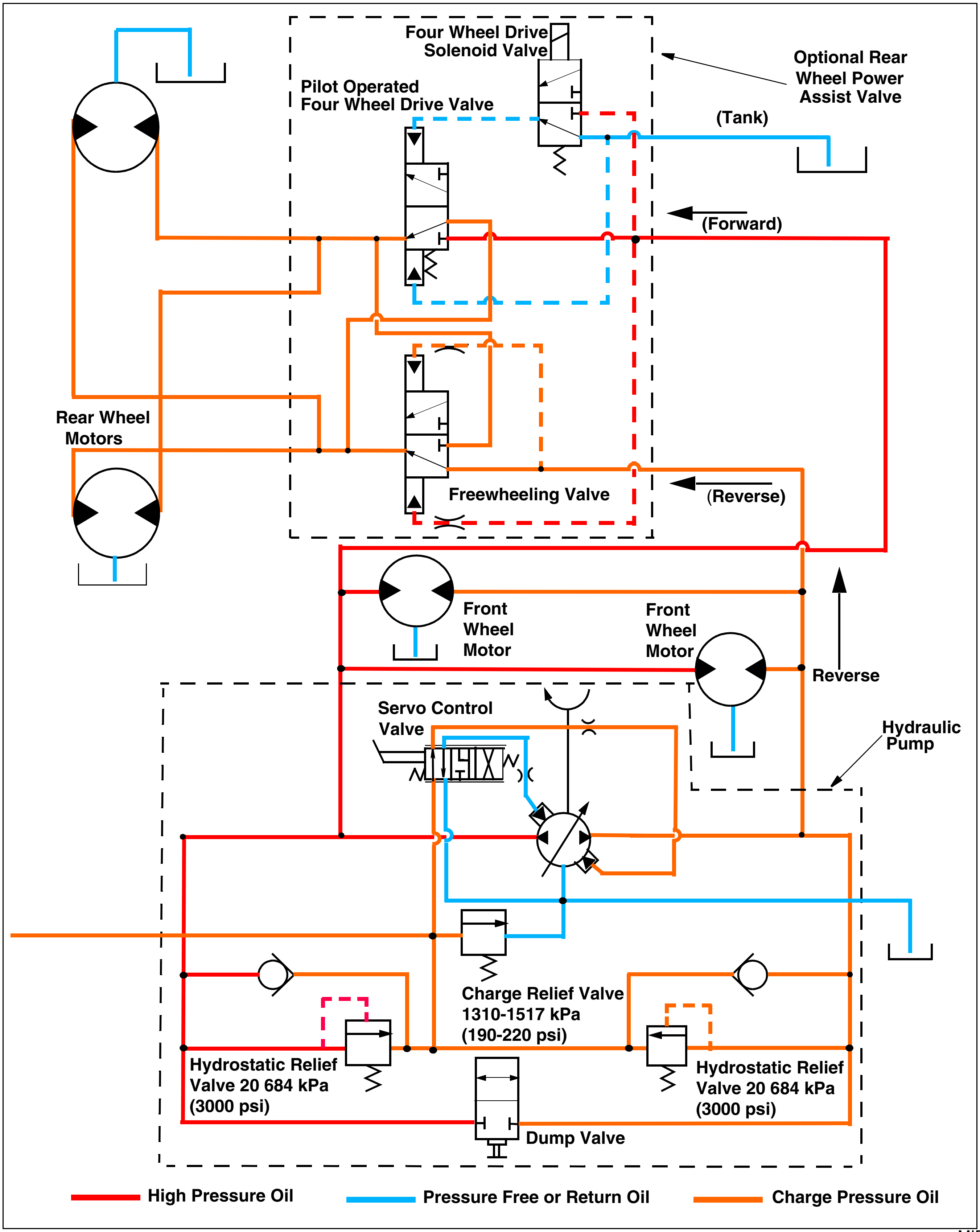


Forward With Four Wheel Drive and Rear Wheels Freewheeling - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235F020000)



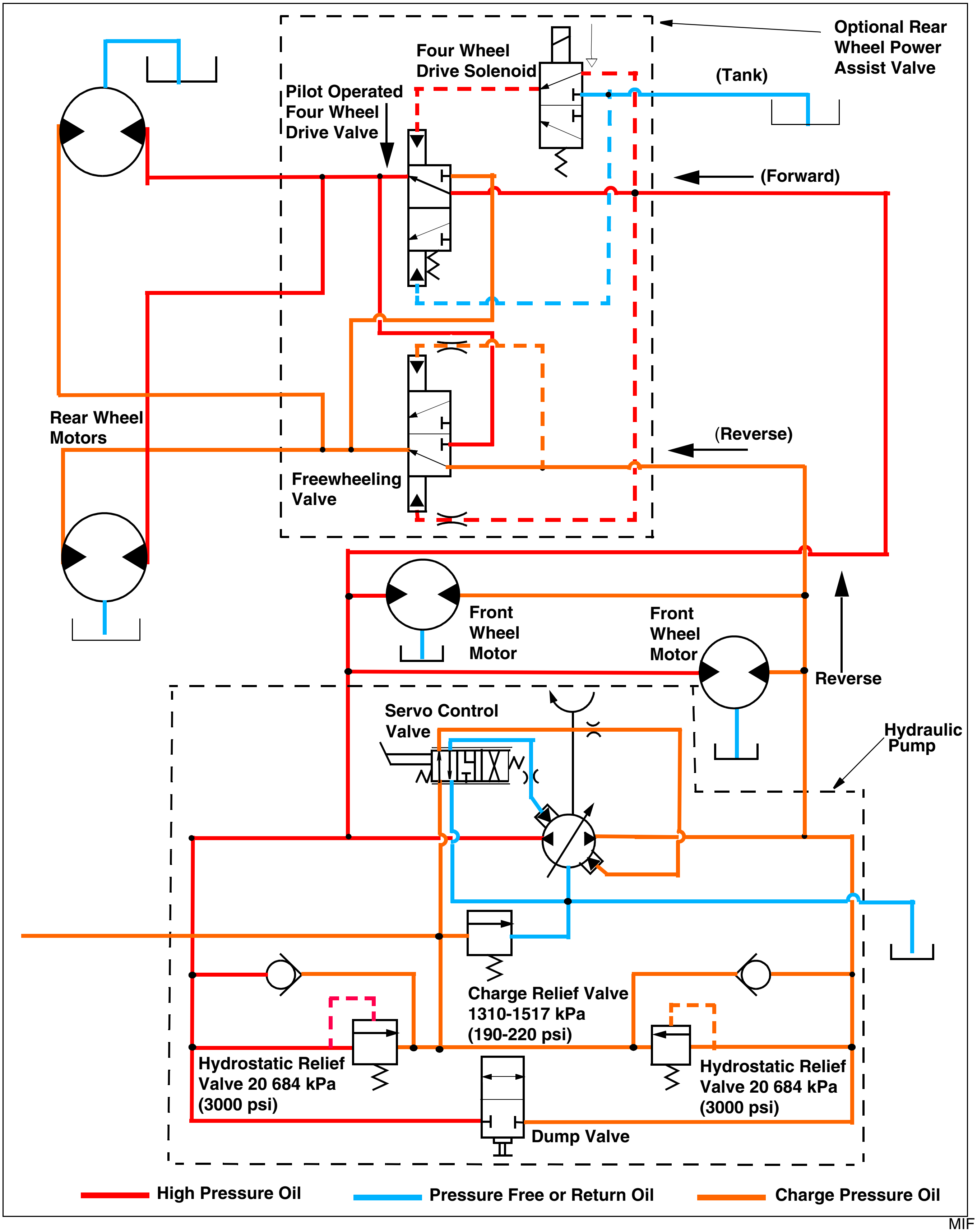
MIF

Forward Without Four Wheel Drive - 3235B (S.N. TC3235T020001-) (SN TC3235F020001-)



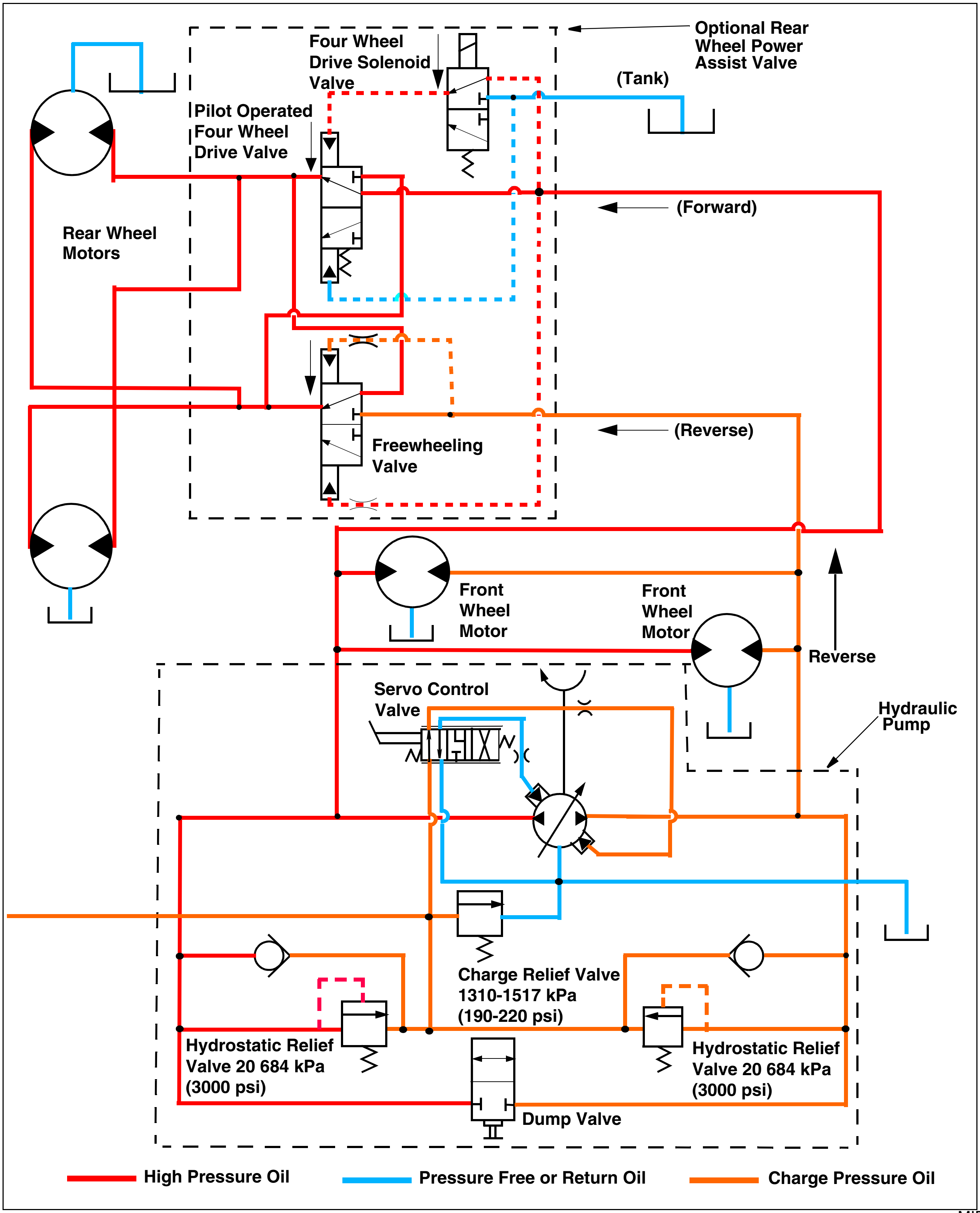
MIF

Forward With Four Wheel Drive - 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)



MIF

Forward With Four Wheel Drive and Rear Wheels Freewheeling - 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)



MIF

This Page Intentionally Left Blank

Theory of Operation

Hydrostatic Transmission

Function

The hydrostatic system provides a means to transfer power from the engine to the final drive for the wheels. It also provides infinitely variable speed control.

Theory

The hydrostatic system is a closed loop fluid power system that consists of an Eaton Piston Pump and two (two-wheel drive) or four (four-wheel drive) motors. Speed and direction are controlled by two foot pedals.

Hydrostatic Pump - 3215, 3215A, 3215B, 3225B and 3235

The pump is an Eaton Model 70145 axial piston, manually variable displacement pump.

Power is transferred to the hydrostatic pump by a drive shaft connected to the engine flywheel. The Eaton piston pump, or hydrostatic transmission, is mounted on the firewall under the operator seat.

Directional control, forward or reverse, is controlled by varying the direction of fluid flow through the hydrostatic pump by varying the direction of rotation of the swash plate in the pump. Control of the rotation is provided by two foot pedals. The left pedal controls forward motion; the right pedal controls reverse motion.

Speed is controlled by the displacement of the swash plate. The greater the displacement of the swash plate from the center position, neutral, the greater the volume of fluid the pump will displace and the faster the vehicle travels. Speed is governed by depressing foot pedals. Maximum speed is limited by an adjustable stop located under the operator seat. This stop allows pre-setting optimum ground speed for consistent cutting of turf.

The hydrostatic pumps provide hydraulic fluid to the motors through hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. Fluid leaves the pump, flows through the motor and is returned to the pump, not the reservoir. Fluid that leaves this closed loop circuit, such as case drain, is replenished by fluid from the front gear set of the triple pump assembly. (See Hydraulic section.)

Hydrostatic Pump - 3235A and 3235B

NOTE: 3235B fairway mowers (S.N. TC3235T020001-) and (S.N. TC3235F020001-) have no gerotor (charge pump) internal to the hydrostatic pump. Charge pressure is supplied from the triple pump (front gear set).

The pump is an Eaton Model 72400 servo controlled piston pump. It is a closed (loop) hydrostatic transmission and is in neutral when there is no output flow being generated by the variable displacement pump. It consists of a manual servo controlled variable piston pump with a gerotor charge pump and a fixed displacement motor.

Power is transferred to the hydrostatic pump from a pressurized charge pump flow. The Eaton servo pump or hydrostatic transmission, is mounted on the front axle under the operator's platform.

The charge pump provides several functions to the hydrostatic circuits:

- Provides flow to keep circuits primed and make up internal leakages.
- Provides flow, under pressure, for maintaining back pressure on pump/motors pistons.
- Provides flow, under pressure, for hydraulic control purposes.
- Provides cooled and cleansed fluid for temperature control and flushing.

Fluid from the charge pump is directed through the two dual purpose system relief and check valves located in the pump backplate.

The charge pump/check valve combination introduces fluid to both sides of the hydrostatic circuit and fills or primes all lines, valves, etc., between the pump and the motor. When the circuit is primed, the charge pump flow dumps across the charge pump relief valve to the pump housing to aid in cooling and flushing the pump. The fluid then returns to the reservoir.

The charge pump relief valve maintains a minimum charge pressure level of 1310-1862 kPa (190-270 PSI)

Servo Control Function

Transmission output is initiated by movement of the variable displacement pump control lever. As the lever is rotated, it moves the servo control spool first, from its spring centered position, allowing pressurized charge pump flow past the spool to one side of the servo piston. The pressurized servo piston pushes against the camplate causing the camplate to rotate to a position out of neutral. Fluid in the servo piston side with the spring under compression is exhausted through the control valve spool to the pump housing.

As the camplate attains any position selected by the control lever, by the connecting feedback link and servo piston, it relocates the control valve spool to a metering position. The spool meters the fluid between the spool and servo piston to hold the camplate in its desired location.

Cam Angle Forward Position

As the control lever is slowly moved forward or reverse, the vehicle starts a forward or reverse movement. The movement of the pump camplate in either the forward or reverse position controls the direction of the motor rotation. In the reverse position, the pump shaft still rotates in the same direction, but the discharge of oil from the pump is reversed, thus reversing the motor rotation. When the camplate begins to move, the piston assemblies start to reciprocate further, generating a flow; more oil is being pumped and the speed of the vehicle is increased. Flow rate is determined by length and frequency of stokes. When full cam angle is reached, which also is maximum volume of oil being discharged from the pump, the speed of the motor increases. When the camplate begins to move, the relief valve on the discharge or pressure side seats because of the higher pressure differential. The other relief valve serves as a charge check, remaining open, on the intake or low pressure side to continue supplying the closed loop system with charge oil.

The motor in this case is a fixed displacement type delivering a constant output torque for a given pressure throughout the speed range of the motor.

Cam Angle Reverse Position with Relief Valve Cross Relieving

The function of the system relief valve is to relieve the pressure side of the system of excessive high pressure when the vehicle encounters a heavy load or stalls out.

When the maximum pressure exists and surrounds the closed loop system relief valve, it starts to open internally. Due to high pressure, the large spring in the relief valve compresses and opens an orifice allowing oil to bypass and take a pressure drop. The opposite relief valve serving as a check valve opens and allows the oil to flow to the intake side of the pump.

Wheel Motors

The wheel motors are Eaton Series 2000, positive displacement geroter motors.

The motors for the front wheels are mounted on the ends of the fluid reservoir. The motors for the rear wheels, with rear wheel drive option only, are mounted on the ends of the control arms.

The wheels are mounted on hubs which are, in turn, keyed onto the output shafts of each motor.

Four-Wheel Drive Solenoid Valve

The four-wheel drive solenoid valve is an electrically operated, spring return shuttle valve. When energized, fluid from the forward side of the pump is directed to the rear wheel motors for added traction. When de-energized, fluid in the rear motors and lines circulates in a closed loop, allowing the rear wheels to freewheel.

The four-wheel drive solenoid can only be energized when moving in the forward direction.

Freewheeling Valve (Four-Wheel Drive Units Only)

The freewheeling valve is a pilot operated, spring return shuttle valve.

During four-wheel drive operation and while descending inclines, it is possible to build higher pressures in the return lines of the rear wheel motors. This happens when the machine's momentum develops more pressure in the reverse lines of the hydraulic system than the hydrostatic pump develops in the forward lines. Effectively, the wheel motors try to drive the hydrostatic pump. Higher pressure in the return lines can cause the rear wheels to stop turning or start them turning in the reverse direction. Either case will result in loss of steering control. The freewheeling valve is installed in the rear wheel drive circuit to counteract this effect.

The freewheeling valve compares the pressure in the forward and reverse lines of the wheel motors. If reverse pressure is higher than forward pressure, the valve shifts and sets up a bypass circuit in the rear wheel drive system. When a higher pressure is sensed in the forward side of the wheel motors, the freewheeling valve returns to normal position and allows full four-wheel drive again.

Dump Valve

The purpose of the dump valve is to allow the movement of a disabled vehicle, or if you want to just push it a short distance, without starting the engine. If an attempt is made to push the vehicle, the hydrostatic motor becomes a pump, trying to pump oil to the hydrostatic pump. This creates a hydraulic lock between the motor and pump. To overcome this condition, a dump valve has been installed between the high pressure relief valves in the backplate of this piston pump.

The dump valve is a plug that contains a rotating stem which has a flat spade end that fits between the two ends of the high pressure relief valves. When the dump valve is in the closed position the relief valves are also in the closed position. When the dump valve stem is rotated 90°, the flat spade end spreads the relief valves to the open position. This allows the oil in the hydrostatic closed loop to bypass around the high pressure relief valves inside the pump backplate. The bypassing of oil inside the pump backplate will allow the motor to rotate freely when the vehicle is moved a short distance. The dump valve is intended only for moving a vehicle a very short distance and not intended for towing a vehicle behind a truck or tractor.

IMPORTANT: Avoid damage! Serious damage to the hydrostatic drive will result if the vehicle is towed.

Diagnostics

Troubleshooting Hints

The most noticeable result of a worn pump or motor is reduced travel speed. This results from either the pump's inability to provide the necessary flow at the required pressure, or the pump/motor bypassing fluid to case drain.

Component wear is normally caused by either fluid contamination or pump cavitation. Pump cavitation can be a result of fluid contamination, clogged filter, or insufficient fluid in the system.

Before testing the hydrostatic pump, check the charge pump pressure. (See Hydraulics section.) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency (forward and reverse) with a flow meter. If the hydrostatic pump is delivering the required flow at full output pressure, the problem is probably with a wheel motor.

Hydrostatic Power Train Troubleshooting

Symptom: Mower Will Not Move in Forward or Reverse

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Do the pedals move freely down and back? Is the linkage connected properly?

Yes - Go to step (5).

No - Check linkage for bent or broken components. Repair or replace parts as necessary.

(5) Is the suction strainer clear of restrictions?

Yes - Go to step (6).

No - Clean suction strainer.

(6) Check charge pressure. See "Test Charge Pressure - 3215, 3215A, 3215B, 3225B, 3235 and 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)" on page 268. See "Test Charge Pressure - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235T020000)" on page 270. Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

(7) Is the drive shaft secure?

No - Secure, repair or replace drive shaft.

Symptom: Mower Will Not Reach Full Speed

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Symptom: Mower Will Not Reach Full Speed

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Do the pedals move freely down and back? Is the linkage connected properly?

Yes - Go to step (5).

No - Check linkage for bent or broken components. Repair or replace parts as necessary.

(5) Is the suction strainer clear of restrictions?

Yes - Go to step (6).

No - Clean suction strainer.

(6) Is hydraulic fluid free from air bubbles?

Yes - Go to step (7).

No - Check suction line for air leaks. Repair as necessary.

(7) Check charge pressure. See "Test Charge Pressure - 3215, 3215A, 3215B, 3225B, 3235 and 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)" on page 268. See "Test Charge Pressure - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235T020000)" on page 270. Is charge pressure within specifications?

Yes - Go to step (8).

No - If pressure does not meet specification, follow results of procedure.

(8) Perform hydrostatic transmission flow test. See "Test Hydrostatic Transmission Flow - 3235A and 3235B" on page 262. See "Test Hydrostatic Transmission Flow - 3215, 3215A, 3215B, 3225B, and 3235" on page 264. Are hydrostatic transmission flow and pressure within specifications?

Yes - Go to step (9).

No - Check and/or replace relief valves. Repair or replace pump as necessary.

(9) Remove drive motors and bench check. See "Disassemble Front and Rear Wheel Motor" on page 299.

No - Repair or replace as necessary.

Symptom: Sluggish Response to Acceleration or Deceleration

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Is the suction strainer clear of restrictions?

Yes - Go to step (5).

No - Clean suction strainer.

(5) Is hydraulic fluid free from air bubbles?

Yes - Go to step (6).

No - Check suction line for air leaks. Repair as necessary.

(6) Check charge pressure. See "Test Charge Pressure - 3215, 3215A, 3215B, 3225B, 3235 and 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)" on page 268. See "Test Charge Pressure - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235T020000)" on page 270. Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

(7) Perform hydrostatic transmission flow test. See "Test Hydrostatic Transmission Flow - 3235A and 3235B" on page 262. See "Test Hydrostatic Transmission Flow - 3215, 3215A, 3215B, 3225B, and 3235" on page 264. Are hydrostatic transmission flow and pressure within specifications?

No - Replace relief valve(s).

Symptom: Hydrostatic System Operating Hot

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

Symptom: Hydrostatic System Operating Hot

No - Fill reservoir to proper level with hydraulic fluid.

(2) Are oil cooler fins free of dirt and debris?

Yes - Go to step (3).

No - Clean oil cooler fins of dirt and debris.

(3) Check charge pressure. See "Test Charge Pressure - 3215, 3215A, 3215B, 3225B, 3235 and 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)" on page 268. See "Test Charge Pressure - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235T020000)" on page 270. Is charge pressure within specifications?

Yes - Go to step (4).

No - If pressure does not meet specification, follow results of procedure.

(4) Perform hydrostatic transmission forward and reverse relief valve tests. See "Test Hydro Relief Valve (Forward)" on page 267. See "Test Hydro Relief Valve (Reverse)" on page 266. Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

No - Replace relief valve(s).

Symptom: Noisy Pump

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is dump valve closed?

Yes - Go to step (3).

No - Close dump valve.

(3) Is hydraulic fluid free from air bubbles?

Yes - Go to step (4).

No - Check suction line for air leaks. Repair as necessary.

(4) Is oil filter clean (free from restrictions)?

Yes - Go to step (5).

No - Replace filter. Find source of any excess contamination.

Symptom: Noisy Pump

(5) Perform hydrostatic transmission forward and reverse relief valve tests. See "Test Hydro Relief Valve (Forward)" on page 267. See "Test Hydro Relief Valve (Reverse)" on page 266. Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

Yes - Go to step (6).

No - Replace relief valve(s).

(6) Disassemble and Inspect pump for damage. See procedures in this section. Was any damage found?

No - Repair or replace as necessary.

Tests And Adjustments

Test Hydrostatic Transmission Flow - 3235A and 3235B

Reason

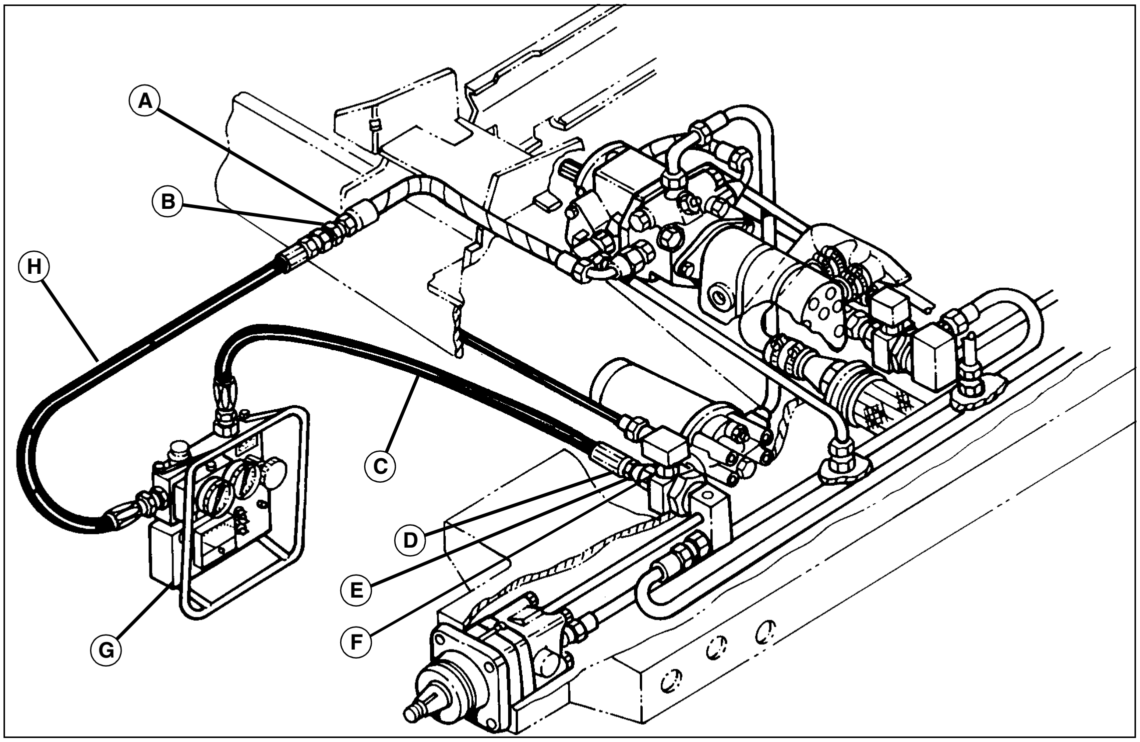
To verify that hydrostatic pump is operating at optimum efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4" Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4" Female NPT x 1-1/16" Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-1/16"-12 Male 37° Flare x 1"-14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 3/4"-14 F NPT x 1-7/16"-12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1"-14 M ORFS x 1-7/16"-12-F ORFS	JT03493	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands.



M56692A

1. Install JT03492 Connector (A) and JT03012 Connector (B) between large hydraulic line that connects the right side of the hydrostatic pump with the reservoir fitting that leads to the front wheel motors and JT03377 Hose (H).

2. Install D01074AA In-Line Hydraulic Tester (G) to JT03377 Hose (H).

3. Install JT03377 Hose (C), JT03012 connector (D), JT05689 Connector (E) and JT03493 Connector (F) as shown.

4. Place a piece of reflective tape on crankshaft pulley.

IMPORTANT: Avoid damage! Make sure that pressure control valve on tester is screwed out to a non-restrictive setting. Be careful not to screw handle completely out of valve.

5. Start engine.

6. Using JT05719 Hand Held Digital Tachometer to verify setting, set throttle at 2000 rpm.

7. Depress reverse pedal fully. DO NOT let up on reverse pedal or move throttle lever until flow specification at 20 684 kPa (3000 psi) is read.

NOTE: Accuracy in recording readings is very important!

8. Record flow reading. Note flow reading for efficiency calculation at end of test.

9. Turn hydraulic tester load valve until pressure is 20 684 kPa (3000 psi).

10.Record reading. Note flow reading.

11.Return load valve to full flow position. Release reverse pedal and turn engine OFF.

12.Divide reading recorded at 20 684 kPa (3000 psi) by free flow reading to determine pump efficiency.

Example:

Pump Free Flow = 24.6 L/min (6.5 gpm)

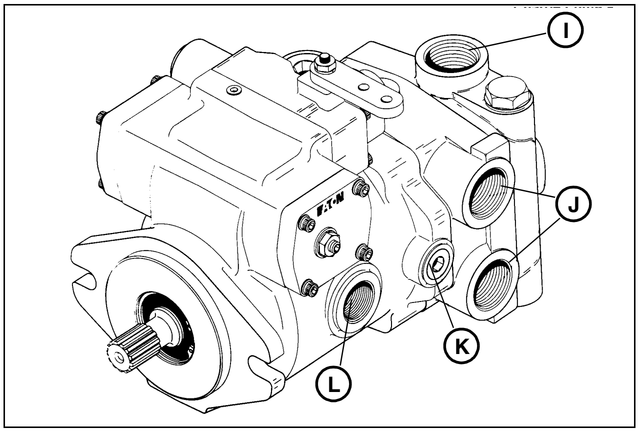
Pump Flow with 20 684 kPa (3000 psi) load = 23 L/min (6 gpm)

Pump Efficiency = 6 ÷ 6.5 = 0.923 or 92%

Results

If pump efficiency is below the minimum requirements, rebuild and/or replace pump.

Recommended Gauge Locations



M79118

Recommended Gauges

- Inlet vacuum gauge: 0-207 kPa (0 - 30 psi)
- System pressure gauge: 68 948 kPa (10,000 psi)
- Charge pressure gauge:0-4137 kPa (0-600 psi)
- Case pressure gauge: 0-2068 kPa (0-300 psi)

Test Locations

Charge pump suction port (I) tee in-line to check inlet vacuum

Pressure ports (J) tee in-line to check system pressure.

Auxiliary port (K) check charge pressure.

Drain port (L) tee in-line to check case pressure.

Specifications

Pump Efficiency Requirement. . . . . Not Less Than 80%

Test Hydrostatic Transmission Flow - 3215, 3215A, 3215B, 3225B, and 3235

Reason

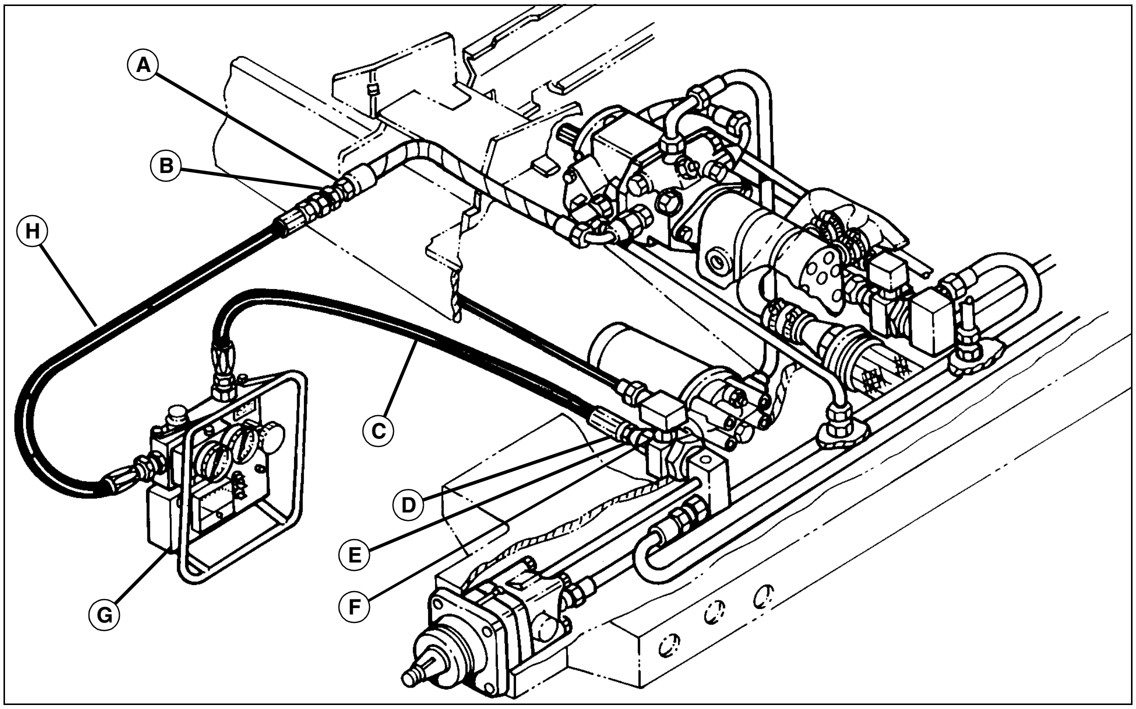
To verify that hydrostatic pump is operating at optimum efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4” Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4” Female NPT x 1-1/16” Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-3/16” Female ORFS x 1-1/16” Male 37° Flare	JT05690	Used to check hydrostatic pump flow.
Connector - 1-3/16” Male ORFS x 1-1/16” Male 37° Flare	JT03483	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands.



M56692A

1. Install JT03492 Connector (A) and JT03012 Connector (B) between large hydraulic line that connects the right side of the hydrostatic pump with the reservoir fitting that leads to the front wheel motors and JT03377 Hose (H).

2. Install D01074AA In-Line Hydraulic Tester (G) to JT03377 Hose (H).

3. Install JT03377 Hose (C), JT03012 connector (D), JT05689 Connector (E) and JT03493 Connector (F).

4. Place a piece of reflective tape on crankshaft pulley.

IMPORTANT: Avoid damage! Make sure that pressure control valve on tester is screwed out to a non-restrictive setting. Be careful not to screw handle completely out of valve.

5. Start engine.

6. Using JT05719 Hand Held Digital Tachometer to verify setting, set throttle at 2000 rpm.

7. Depress reverse pedal fully. DO NOT let up on reverse pedal or move throttle lever until flow specification at 20 684 kPa (3000 psi) is read.

NOTE: Accuracy in recording readings is very important!

8. Record flow reading. Note flow reading for efficiency calculation at end of test.

9. Turn hydraulic tester load valve until pressure is 20 684 kPa (3000 psi).

10.Record reading. Note flow reading.

11.Return load valve to full flow position. Release reverse pedal and turn engine OFF.

12.Divide reading recorded at 20 684 kPa (3000 psi) by free flow reading to determine pump efficiency.

Example:

Pump Free Flow = 24.6 L/min (6.5 gpm)

Pump Flow with 20 684 kPa (3000 psi) load = 23 L/min (6 gpm)

Pump Efficiency = 6 ÷ 6.5 = 0.923 or 92%

Results

If pump efficiency is below the minimum requirements, rebuild and/or replace pump.

Specifications

Pump Efficiency Requirement . . . . Not Less Than 80%

Test Hydro Relief Valve (Reverse)

Reason

To ensure that the hydrostatic system reverse relief valve is set at correct operating pressure.

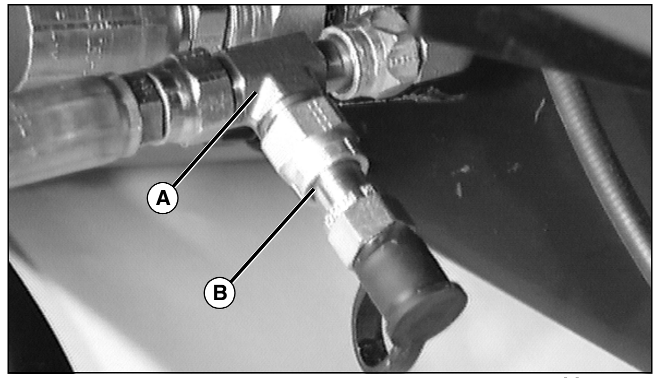
NOTE: If the machine does not have the optional test kit AMT814 installed, the following test fittings from the kit will have to be installed into the plugged port (two-wheel drive) or in series with the elbow and line for the rear wheel motors (four-wheel drive), of the reservoir fitting.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Used to test hydrostatic reverse relief valve pressure.
T-Fitting (4-Wheel Drive Only)	38H1030	Used to test hydrostatic reverse relief valve pressure.
Elbow (2-Wheel Drive Only)	38H1003	Used to test hydrostatic reverse relief valve pressure.
Cover	XPD6-285	Used to protect test fitting port.
Hose	AMT846	Used to test hydrostatic reverse relief valve pressure.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to test hydrostatic reverse relief valve pressure.
Female Quick Coupler	RE48122	Used to test hydrostatic reverse relief valve pressure.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to test hydrostatic reverse relief valve pressure.
Hose 70 000 kPa (10,000 psi)	JT03364	Used to test hydrostatic reverse relief valve pressure.

Procedure

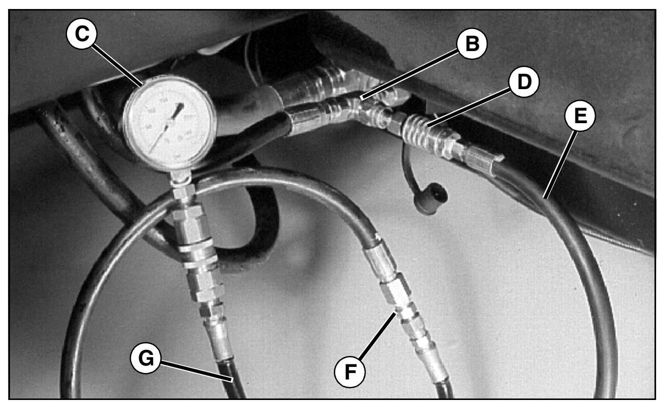
IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.



M56668

Picture Note: Right Rear View of Axle

1. Locate test port by lower right-hand front drive wheel.
2. (4-Wheel Drive) Install 38H1030 T-Fitting (A) in series with line to rear wheel motor and reservoir fitting. Install MT1531 Adapter (B) on T-fitting.
3. (2-Wheel Drive) Install 38H1003 Elbow in the plugged port of the reservoir fitting and MT1531 Adapter on elbow.



M76540

4. Install JT05486 Connector (F) and RE48122 Female Quick Coupler (D) on ends of AMT846 Hose (E) and install AMT846 Hose on MT1531 Adapter (B).
5. Install JT03364 Hose (G) and JT03362 Gauge (C) to AMT846 Hose (E).
6. Start engine and set throttle to 2000 rpm (min).

NOTE: If parking lock is engaged, engine will shut off when reverse pedal is depressed.

7. Apply the parking brake.
8. Step on reverse pedal enough to achieve relief pressure setting without stalling engine.
9. Record reading on gauge.

Results

- Relief pressure is dependent upon a good hydrostatic pump and no leakage at hydrostatic motors or associated plumbing. These variables should be suspect before a faulty relief valve.
- If relief valve does not meet specifications, replace relief valve.

IMPORTANT: Avoid damage! Relief valves are not adjustable. If unit is defective, replace entire unit.

Specifications

Relief Valve Pressure (3235A and 3235B) 24 131 ± 1378 kPa (3500 ± 200 psi)

Relief Valve Pressure (3215, 3215A, 3215B, 3225B and 3235) . . . . 31 026 ± 130 kPa (4500 ± 200 psi)

Test Hydro Relief Valve (Forward)

Reason

To ensure that the hydrostatic system forward relief valve is set at correct operating pressure.

NOTE: If the machine does not have the optional test kit AMT814 installed, the following test fittings from the kit will have to be installed into the plugged port (two wheel drive) or in series with the elbow and line for the rear wheel motors (four wheel drive), of the reservoir fitting.

Special or Required Tools

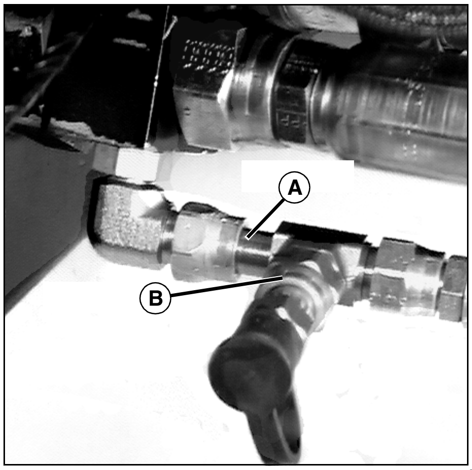
Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Used to test hydrostatic forward relief valve pressure.
T-Fitting (4-Wheel Drive Only)	38H1030	Used to test hydrostatic forward relief valve pressure.
Elbow (2-Wheel Drive Only)	38H1003	Used to test hydrostatic forward relief valve pressure.
Cover	XPD6-285	Used to protect test fitting port.
Hose	AMT846	Used to test hydrostatic forward relief valve pressure.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to test hydrostatic forward relief valve pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Female Quick Coupler	RE48122	Used to test hydrostatic forward relief valve pressure.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to test hydrostatic forward relief valve pressure.
Hose 70 000 kPa (10,000 psi)	JT03364	Used to test hydrostatic forward relief valve pressure.

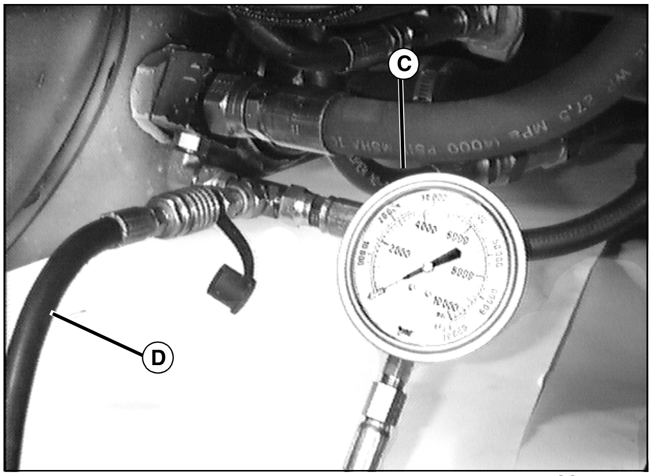
Procedure

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



M56668

1. Locate test port by lower left rear drive wheel.
2. (4-Wheel Drive) Install 38H1030 T-Fitting (A) in series with line to rear wheel motor and reservoir fitting. Install MT1531 Adapter (B) on T-fitting.
3. (2-Wheel Drive) Install 38H1003 Elbow in the plugged port of the reservoir fitting and MT1531 Adapter on elbow.



M58742

4. Install JT05486 Connector and RE48122 Female Quick Coupler on ends of AMT846 Hose (D) and install AMT846 Hose on MT1531 Adapter.

5. Install JT03364 Hose and JT03362 Gauge (C) to AMT846 Hose.

6. Start engine and set throttle to 2000 rpm (min).

NOTE: If parking lock is engaged, engine will shut off when reverse pedal is depressed.

7. Apply the parking brake.

8. Step on forward pedal enough to achieve relief pressure setting without stalling engine.

9. Note reading on gauge.

Results

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

- Relief pressure is dependent upon a good hydrostatic pump and no leakage at hydrostatic motors or associated plumbing. These variables should be suspect before a faulty relief valve.
- If relief valve does not meet specifications, replace relief valve.

Specifications

Relief Valve Pressure (3235A and 3235B) 24 131 ± 1378 kPa (3500 ± 200 psi)

Relief Valve Pressure (3215, 3215A, 3215B, 3225B and 3235) . . . . 31 026 ± 130 kPa (4500 ± 200 psi)

Test Charge Pressure - 3215, 3215A, 3215B, 3225B, 3235 and 3235B (S.N. TC3235T020001-) (S.N. TC3235F020001-)

Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged.

NOTE: For further charge pump tests and diagnostics see Hydraulics section.

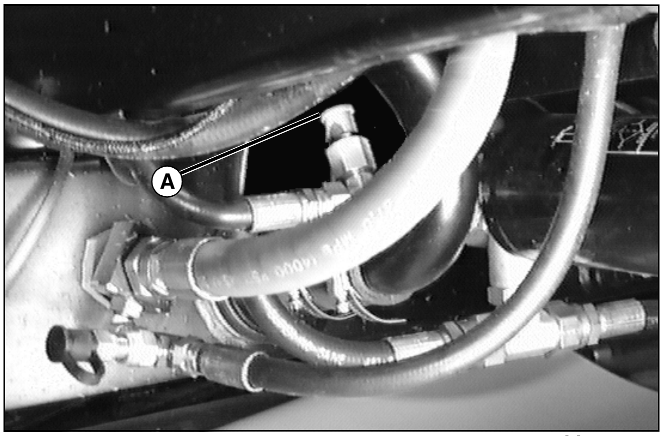
If the machine does not have the optional test kit AMT814 installed, the following test fittings from the kit will have to be installed between the left side of oil filter base and line from left side of oil filter base and hydrostatic pump charge port.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Used to verify hydrostatic charge pressure.
T-Fitting	38H1030	Used to verify hydrostatic charge pressure.
Hose	AMT846	Used to verify hydrostatic charge pressure.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to verify hydrostatic charge pressure.
Female Quick Coupler	RE48122	Used to verify hydrostatic charge pressure.
Gauge 2000 kPa (300 psi)	JT03344	Used to verify hydrostatic charge pressure.
Hose 34 473 kPa (5000 psi)	JT03017	Used to verify hydrostatic charge pressure.

Procedure

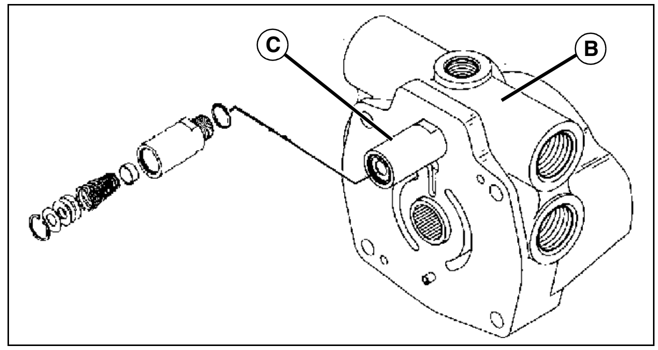
NOTE: MT1531 connects to hose that routes from hydraulic oil filter base to top of hydrostatic transmission.



M58756

1. Install JT05486 Connector and RE48122 Female Quick Coupler on ends of AMT846 Hose and install AMT846 Hose on MT1531 Adapter (A).
2. Install JT03017 Hose and JT03344 Gauge 2000 kPa (300 psi) to AMT846 Hose.
3. Apply the parking brake.
4. Start engine and set throttle to 2000 rpm (min).
5. DO NOT move steering wheel or actuate lift arms while performing this test. Inaccurate readings will result.
6. Note reading on gauge.

Results



M56549B

- Charge pressure is dependent upon only acceptable leakage from hydrostatic motor.

If relief pressure is low, inspect motor O-rings for damage. If O-rings are good, inspect hydrostatic pump (B) internal components during relief valve (C) replacement. If damage to internal components is found, replace damaged internal components of pump.

If relief pressure is high, excessive pump case pressure may be suspect. Check case drain hoses for blockage before replacing relief valve.

- If relief valve pressure still does not meet specifications, replace relief valve.

Specifications

Hydrostatic Pump Charge Pressure (3215, 3215A, 3215B, 32225B, and 3235) . . 758-1103 kPa (110-160 psi)

Test Charge Pressure - 3235A and 3235B (S.N. TC3235T010001-TC3235T020000) (S.N. TC3235F010001-TC3235T020000)

Reason

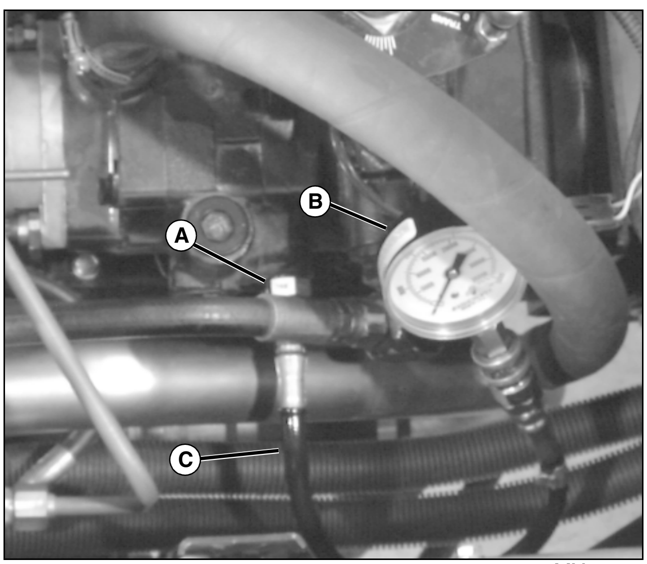
To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged.

NOTE: For further charge pump tests and diagnostics see Hydraulics section.

Special or Required Tools

Tool Name	Tool No.	Tool Use
2000 kPa (300 psi) Gauge	JT03344	Used to verify hydrostatic charge pressure.
34 473 kPa (10,000 psi) Hose	JT03364	Used to verify hydrostatic charge pressure.
7/16-20 M 37° Flare x 3/4-16 M ORB Connector	JT05494	Used to verify hydrostatic charge pressure.

Procedure



MX2731

1. Remove plug from left side of the hydraulic pump and install JT05494 Connector (A).
2. Install JT03364 Hose (C) and JT03344 Gauge (B).
3. Apply the parking brake.
4. Start engine and set throttle to 2000 rpm (min).
5. DO NOT move steering wheel or actuate lift arms while performing this test. Inaccurate readings will result.
6. Note reading on gauge.

Results

- If pressure is low, inspect hydrostatic motor O-rings for damage. If O-rings are okay, inspect internal pump components during relief valve replacement. If damage to internal components are found, replace damaged internal pump components.
- If relief valve pressure still does not meet specifications, replace relief valve.

Specifications

Hydrostatic Pump Charge Pressure (3235A and 3235B)
1310-1862 kPa (190-270 psi)

Adjust Transmission Neutral Position - 3215, 3215A, 3215B, 3225B, and 3235

Reason

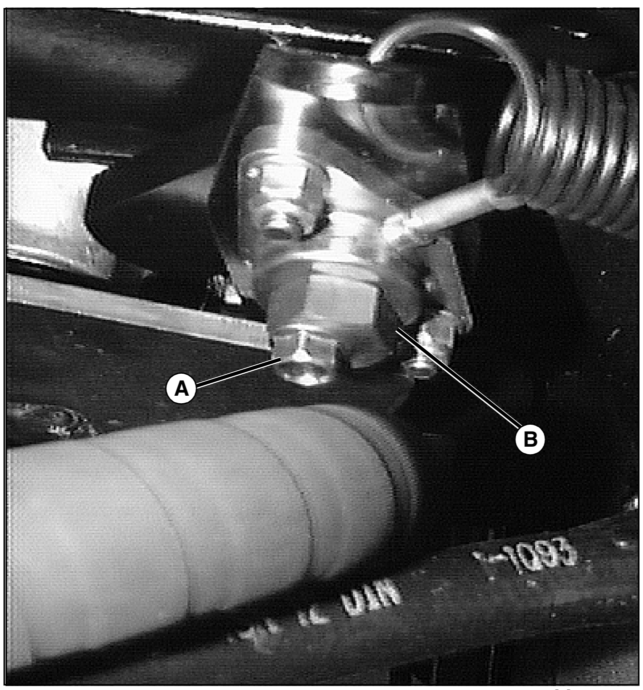
To ensure that the machine does not creep when pedals are released.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands. Ensure left wheel is off the ground (four-wheel drive units).
Drive wheel is free to spin during this adjustment. Stay clear and keep other people clear of drive wheels during adjustment.

1. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair as necessary.

NOTE: Eccentric mechanism is located under the operator's seat and is accessible from the right side of the hydrostatic drive.



M56258

2. Loosen cap screw (A).

3. Start engine and run at low idle.

4. With an operator in the operator's seat, release the parking brake.

5. Rotate eccentric (B) forward or backward until drive wheels stop turning.

6. Tighten cap screw while holding eccentric in position.

7. Have the operator depress the drive pedals in both directions and release.

Results

Drive wheels should stop turning when pedals are released. If not, repeat adjustment.

Adjust Transmission Neutral Position - 3235A and 3235B

Reason

To ensure that the machine does not creep when pedals are released.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands. Ensure left wheel is off the ground (four-wheel drive units).
Drive wheel is free to spin during this adjustment. Stay clear and keep other people clear of drive wheels during adjustment.

IMPORTANT: Avoid damage! This adjustment should be done ONLY if the machine creeps when pedals are in NEUTRAL position. If creep is intermittent, inspect transmission control linkage for wear or damage or return to neutral linkage for binding before adjusting transmission neutral.

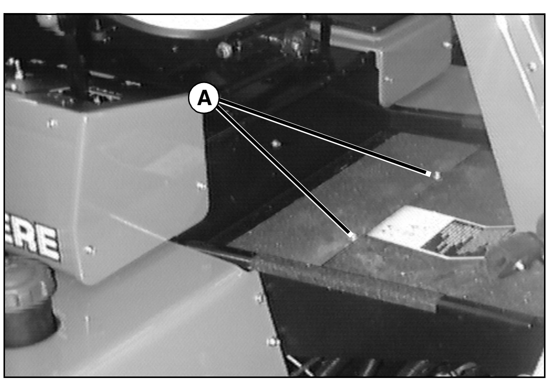
1. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair as necessary.

2. Stop engine and lower cutting units to floor.

CAUTION: Avoid injury! Avoid bodily injury. Use a safe lifting device to raise the machine safely and support it with a suitable jackstand. Raise left tire and make needed adjustments from right side of machine.

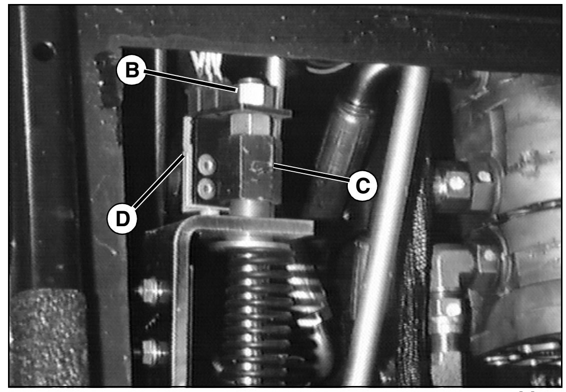
3. Shut off four-wheel drive if installed on machine.

4. Raise left side of machine until left front tire is off the ground. Support tire with a jackstand.

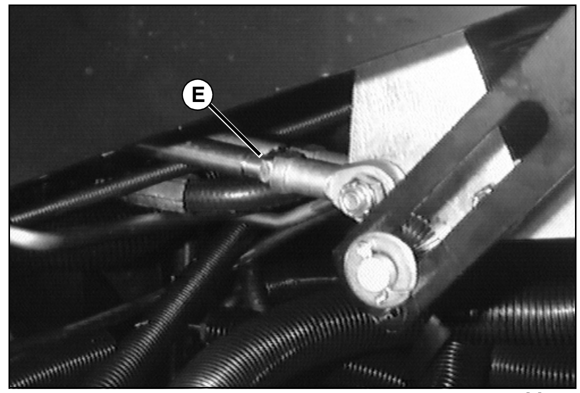


M85464

5. Remove access panel (A) on floorboard.



M85465



M85466

6. If machine is equipped with 4WD option, loosen nut (B) to allow 4WD switch (D) to hang freely.

7. For all 3235A models, loosen nut (E) on ball joint located under front right side of floor board.

8. Place a 9 kg (20 lb) weight on the seat to activate the seat switch or use a jumper wire to bypass the seat switch.

9. Start engine and run at slow idle.

10.Turn large adjusting nut (C) forward and backward until drive wheels stop turning.

11.Put pedals in NEUTRAL. Depress both forward and reverse speed pedals, then release.

12.Check neutral adjustment. Repeat adjustment until drive wheels stop turning.

13.Tighten nut at ball joint end of rod assembly.

14.On four wheel-drive units, tighten nut to hold four-wheel drive switch in the original position.

15.Install access panel. Lower machine to the ground and test drive the machine to make sure the machine is not moving while in neutral.

Results

Drive wheels should stop turning when pedals are released. If not, repeat adjustment.

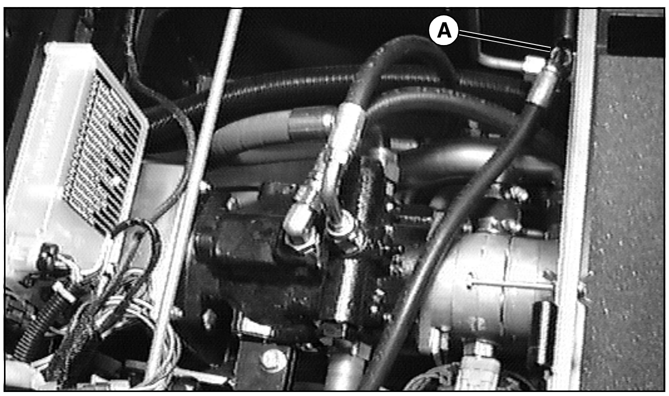
Repair

Remove Hydrostatic Pump - 3215, 3215A, 3215B, 3225B, and 3235

1. Park vehicle on a level surface, reels lowered, park brake locked, engine off. Block wheels to prevent inadvertent movement of the machine.

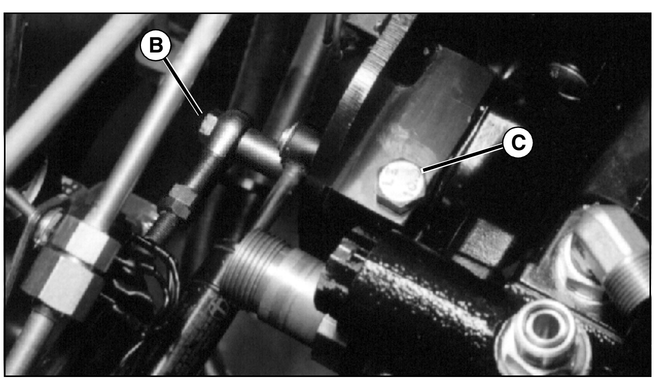
> **CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.**

2. Disconnect battery.
3. Remove seat.
4. Disconnect drive shaft at engine drive sheave. A pry bar in the universal joint of drive shaft will help to prevent drive shaft from turning.



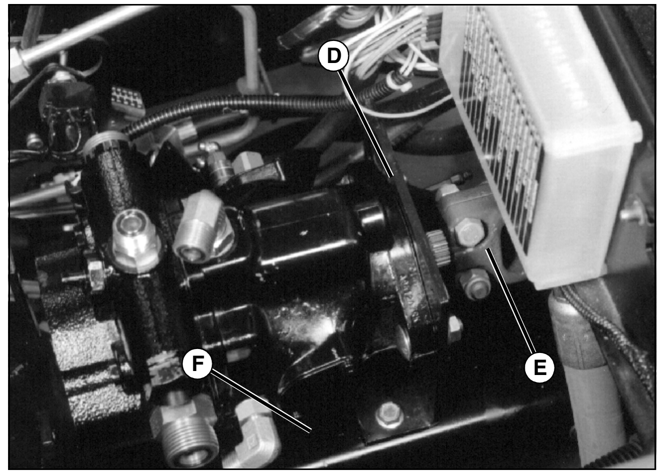
M56614

5. Disconnect hydraulic line from oil filter to cross fitting (A) or down pressure valve, if equipped.
6. Mark for reinstallation and disconnect all hydraulic lines connected to the hydrostatic pump.



M76500

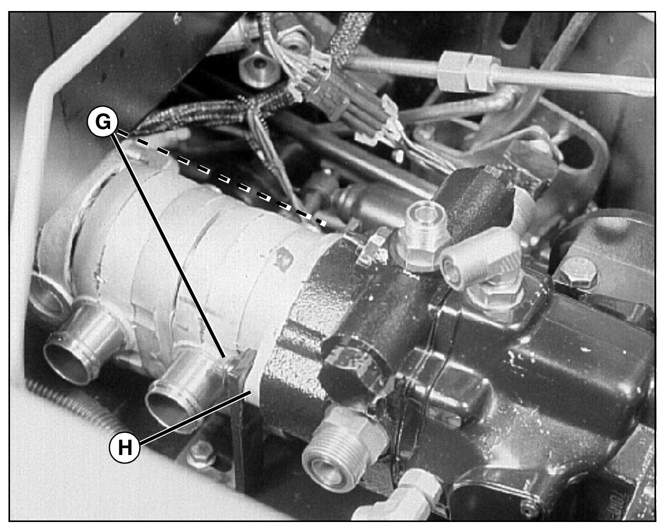
7. Disconnect forward/reverse linkage (B) at the camplate on the hydrostatic pump shaft.
8. Remove pinch bolt (C) that holds camplate on hydro-static pump shaft and remove camplate from shaft. Moderate pressure with a pry bar is required due to neutral spring pressure.
9. Remove neutral cam return spring hanging from cam follower.



M76498

10. Remove drive shaft shield from hydrostatic pump mounting bracket.
11. Loosen two cap screws and disconnect the drive shaft universal joint (E) from the hydrostatic pump drive shaft.
12. Remove two carriage bolts and nuts securing the hydrostatic pump to the pump mounting bracket (D).
13. Remove cap screws and nuts that attach hydrostatic pump mounting bracket to the frame (F). Remove mounting bracket.

NOTE: Hoses on triple pump removed for clarity.

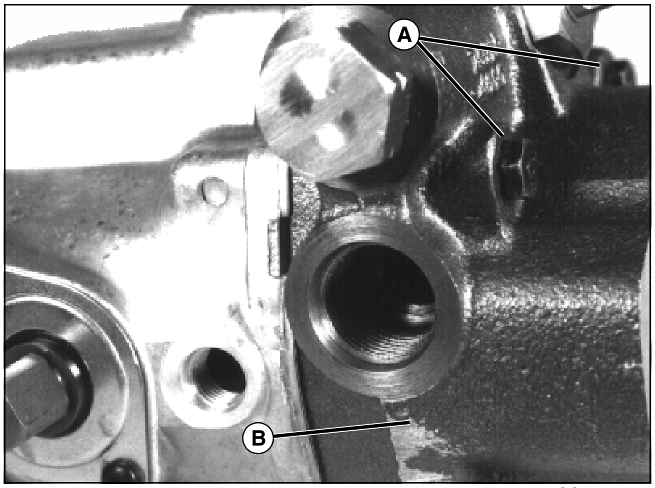


M76523

14. Remove the two cap screws (G) from triple pump mounting flange (H) to separate triple pump assembly from hydrostatic pump.
15. Remove hydrostatic pump from machine.

Disassemble Hydrostatic Pump - 3215, 3215A, 3215B, 3225B, and 3235

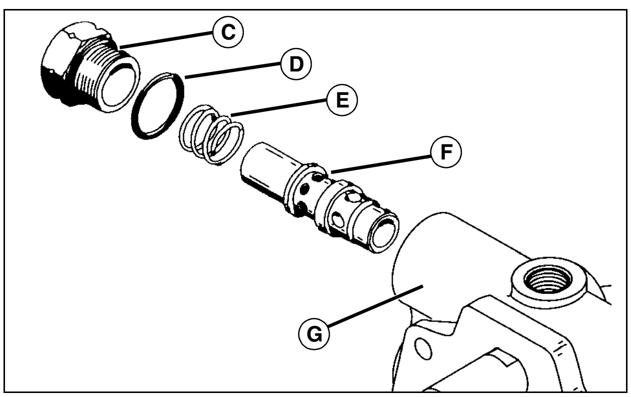
IMPORTANT: Avoid damage! Plug all ports and thoroughly clean the outside of the pump. Remove plugs and drain oil.



M56568

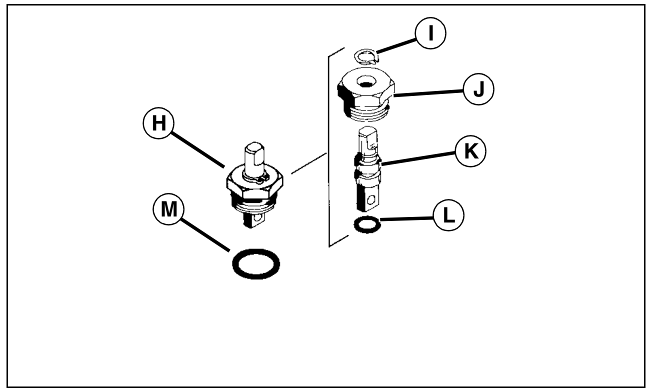
1. Remove four cap screws (A) from the backplate (B).

2. Tap backplate with a plastic mallet to loosen, then pull the backplate straight up to remove. Remove gasket and valve plate from backplate.



M56533

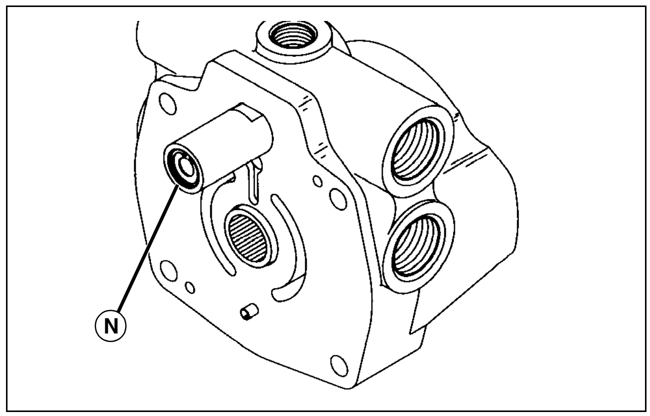
3. Remove plug (C), O-ring (D), spring (E) and relief valve (F) from backplate (G). Repeat step for other relief valve.



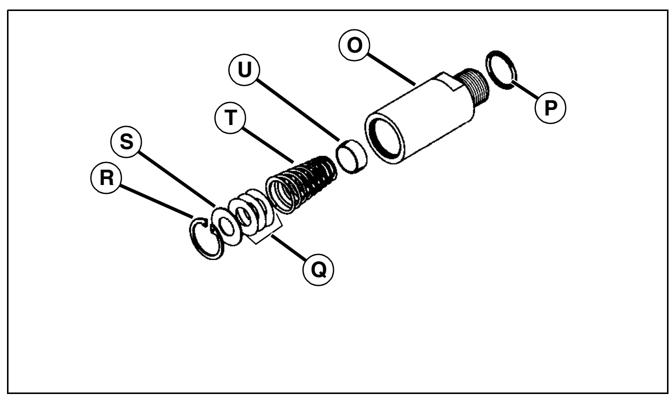
M56542

4. Remove dump valve assembly (H-M) from backplate.

5. Disassemble dump valve by removing retaining ring (I) and pulling the spreader (K) from the spreader plug (J).



M56540

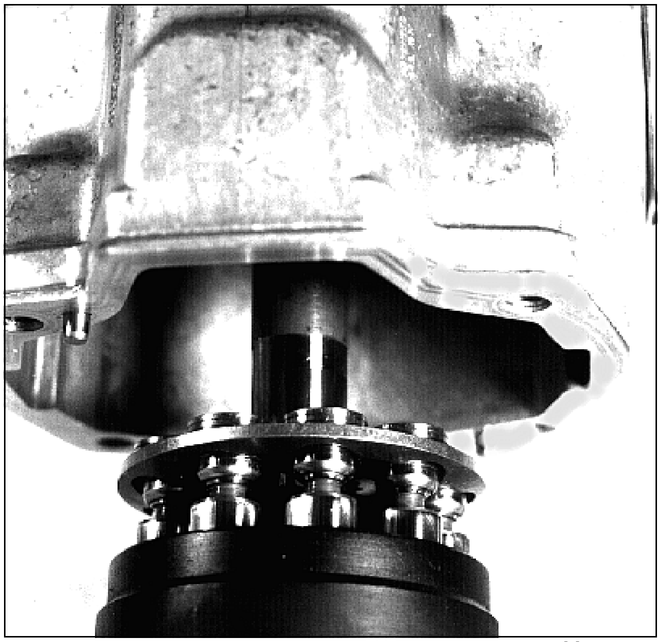


M56535

6. Remove charge relief valve (N) from backplate.

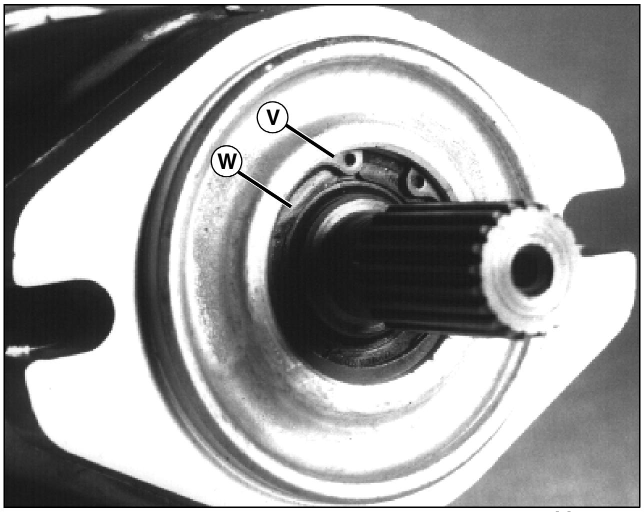
7. Disassemble by removing retaining ring (R), washer (S), shim(s) (Q), conical spring (T) and plunger (U) from charge relief valve (O). Remove O-ring (P) from charge relief valve body. Make note of the number of shims removed for reassembly.

IMPORTANT: Avoid damage! Try to keep the pistons and piston block together as an assembly when removing the rotating assembly.



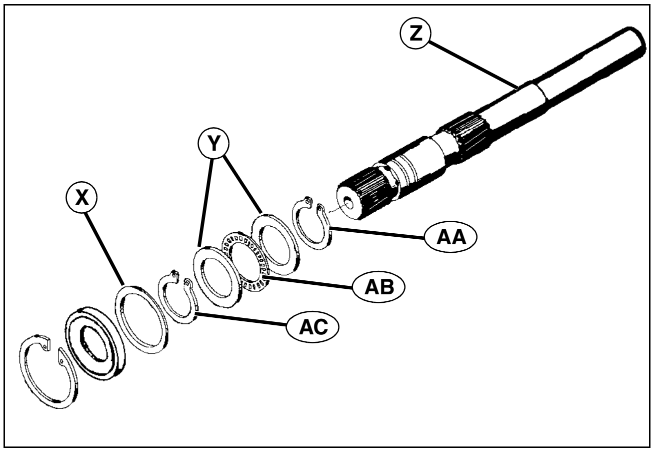
M56566

8. Hold your hand over the rotating assembly and turn the housing upside down. Remove the rotating assembly and any pistons that did not come out with the assembly.



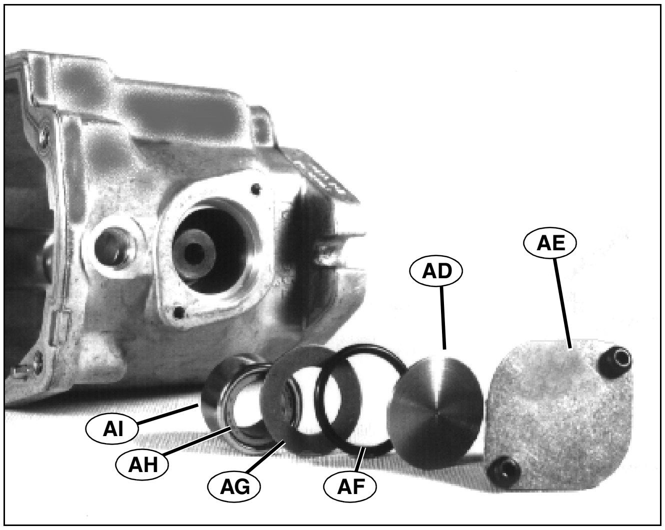
M56564

9. Remove snap ring (V) and tap the shaft and oil seal (W) from the housing with a soft-faced mallet.



M57918

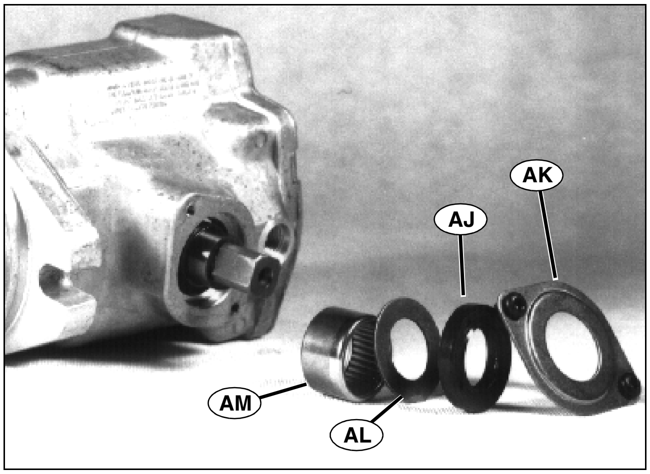
10. Remove washer (X), snap rings (AA and AC), thrust washers (Y) and thrust bearing (AB) from main pump shaft (Z).



M56562

11. Remove trunnion cover (AE).

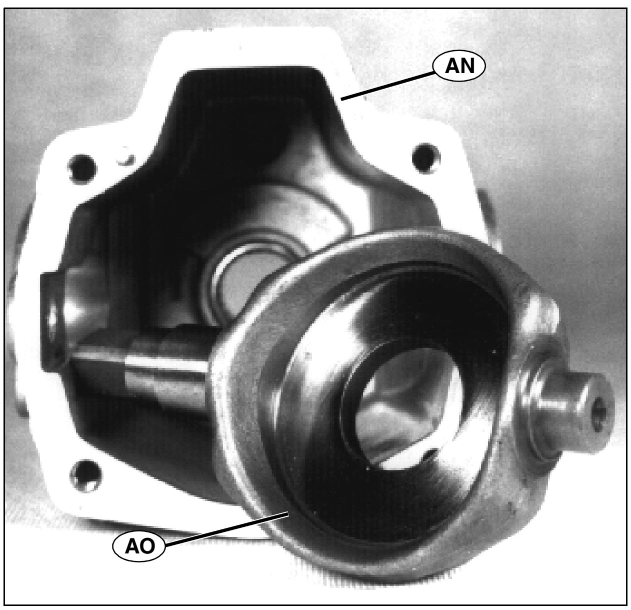
12. Tap on square end of camplate shaft to remove plate (AD), O-ring (AF), washer (AG), bearing (AI) and race (AH).



M56565

13.Remove trunnion cover (AK).

14.Seal (AJ), washer (AL) and bearing (AM) can be removed by tapping on opposite end of camplate shaft to drive seal out of housing.



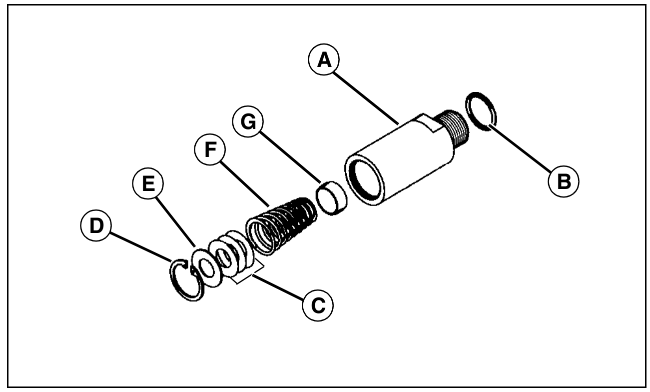
M56561

15.Remove camplate (AO) from housing (AN).

Inspect Hydrostatic Pump - 3215, 3215A, 3215B, 3225B, and 3235

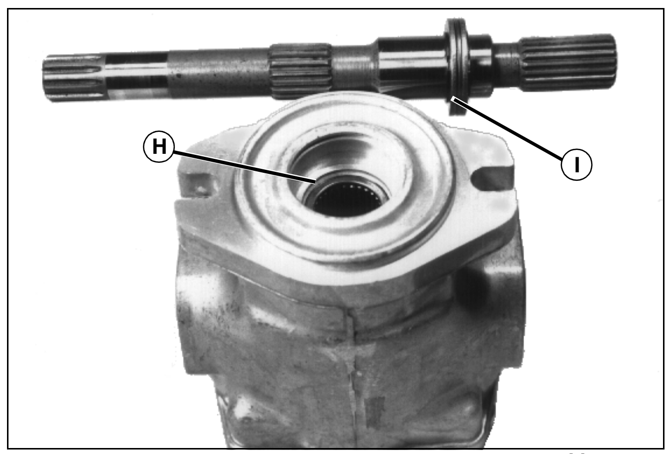
IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection.

1. Inspect the main pressure relief valves for condition and wear. Replace if necessary.



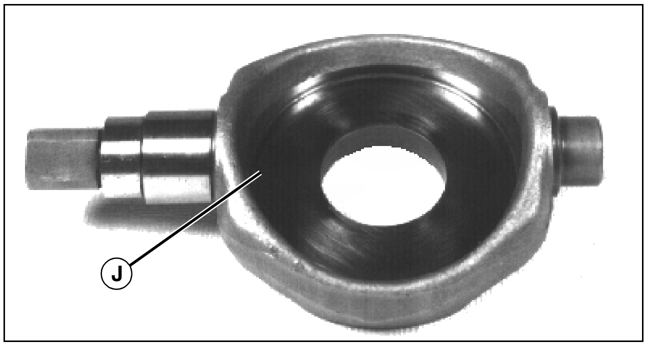
M56535

2. Inspect the charge pump relief valve components (A-G) for wear . Replace the entire relief valve if worn.



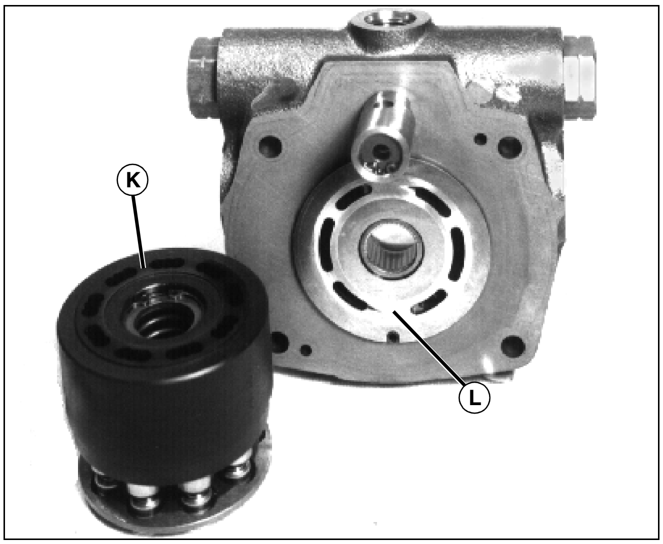
M56557

3. Inspect the needle bearings (H) in the housing assembly, making sure bearings remain in bearing cage. Inspect the complete shaft, thrust bearing (I) and thrust washers for wear.



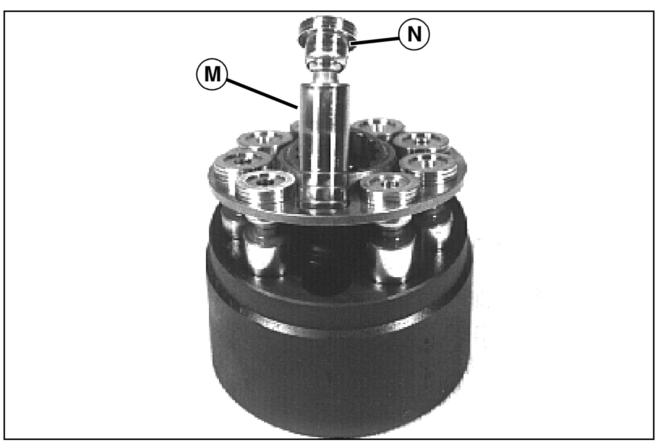
M56555

4. Inspect the polished surface (J) of the camplate for scoring, galling or fretting. Replace if necessary.



M56558

5. Inspect the piston block surface (K) and the valve plate (L) for scoring or wear. Replace if necessary.

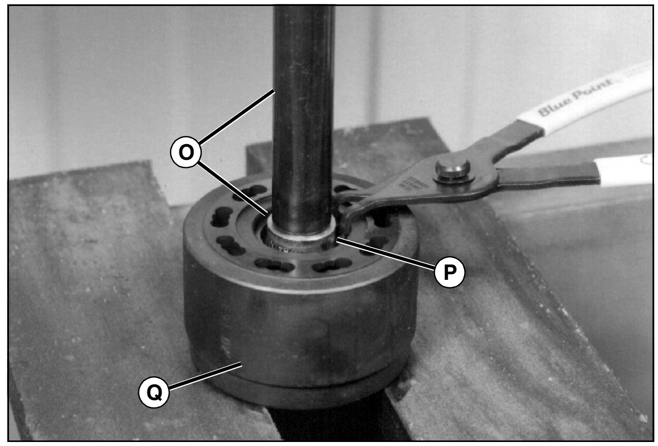


M56554

6. Examine the outside diameter of each piston (M) for finish condition. They should not show wear or deep scratches. Inspect each shoe (N) for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the valve plate. DO NOT LAP PISTON SHOES.

CAUTION: Avoid injury! The spring inside the piston block is compressed and should not be removed without compressing the spring first. Use the following procedure to remove the spring safely.

NOTE: Disassembling the piston block assembly is not required unless the pins are damaged.



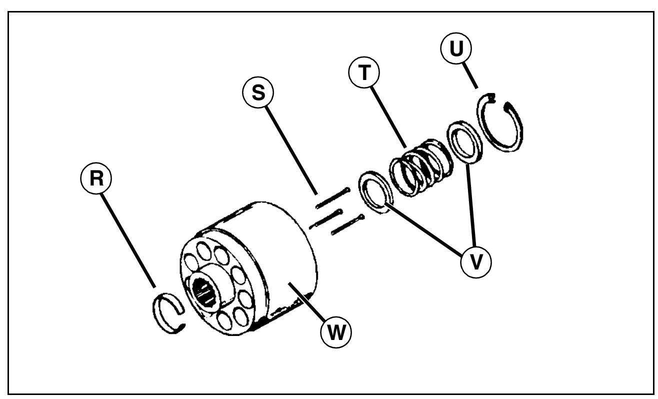
M76495

7. Place piston block (Q) in an arbor press. DO NOT support piston block by pins. Place supports outside splined hole.

NOTE: Select a seal driver with a large enough diameter to cover ID of washer inside block, yet small enough in diameter to allow snap ring to be removed.

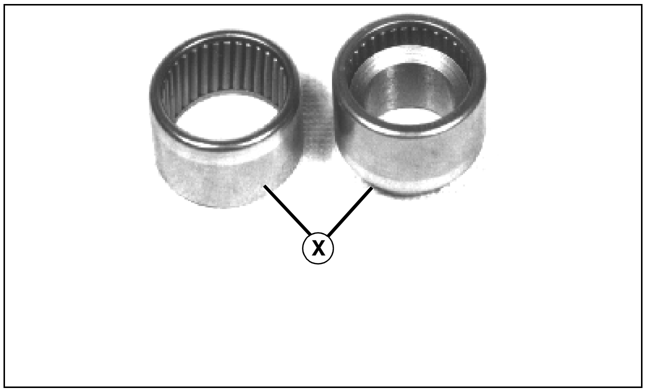
8. Use a seal driver (O) to compress snap ring (P) inside piston block.

9. Remove snap ring. Release pressure on spring and remove piston block from press.



M56625

10.Remove snap ring (U), washers (V), spring (T), pins (S) and pin retainer (R) from piston block (W).

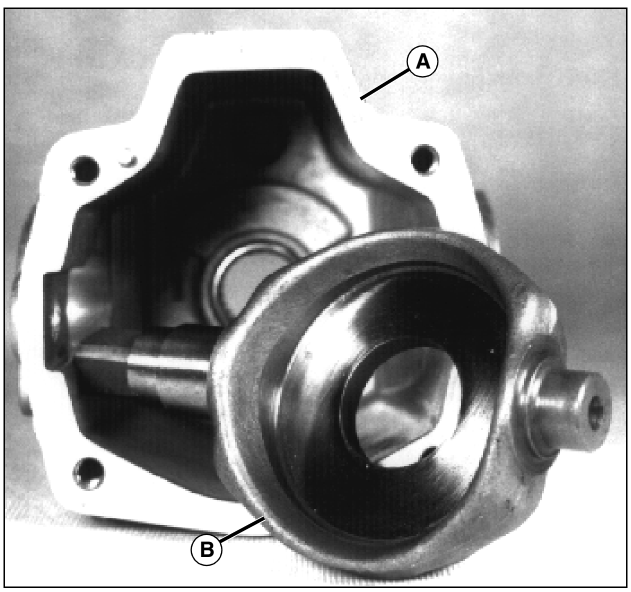


M56556

11.Inspect the needle bearings (X) and sleeve of the camplate trunnion bearings for wear or galling, keeping the needle bearings in the cage.

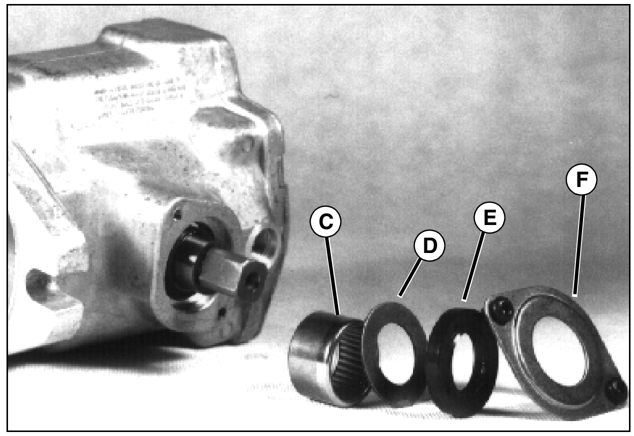
Assemble Hydrostatic Pump - 3215, 3215A, 3215B, 3225B, and 3235

IMPORTANT: Avoid damage! Ensure work area is clean. Ensure all parts are clean and free of lint. Use plenty of clean hydraulic fluid when assembling the pump.



M56561

1. Place camplate (B) in housing (A), long end first.

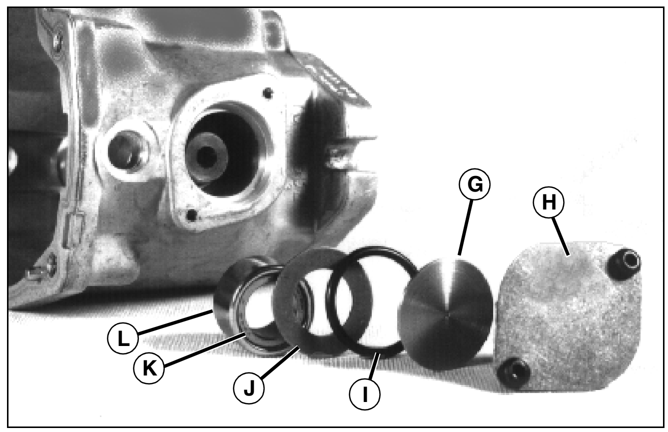


M56565

2. Install bearing (C), washer (D), seal (E) and trunnion cover (F). Use plenty of hydraulic fluid to lubricate bearings and to aid in seal installation.

3. Use a large socket to drive seal into housing.

4. Tight trunnion cover screws to specification.

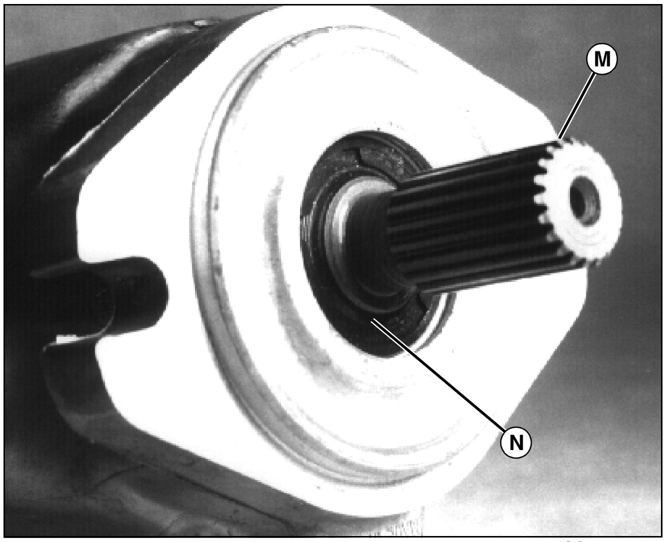


M56562

5. Install bearing race (K) with bevel toward camplate.

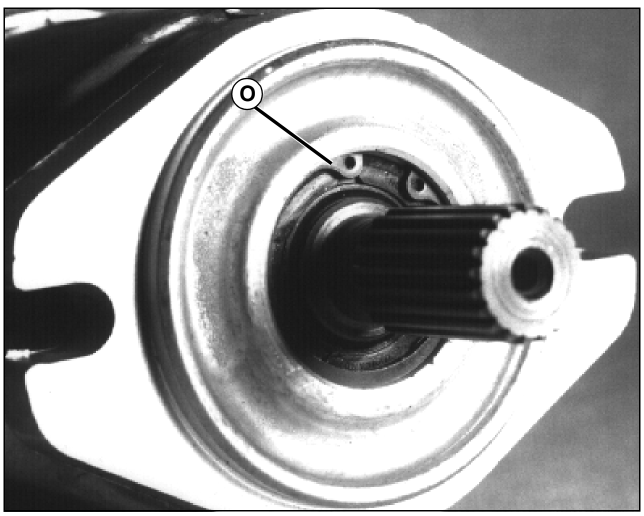
6. Assemble bearing (L), washer (J), O-ring (I), plate (G) and trunnion cover (H). Use plenty of hydraulic fluid to lubricate bearings and O-ring. Ensure camplate has full travel and moves freely.

7. Tighten trunnion cover screws to specification.



M56560

8. Install shaft (M) and shaft seal (N). Use hydraulic fluid liberally to avoid damaging the seal during installation. Ensure seal is positioned below the retaining ring groove. Use 1-1/8” deep well socket to drive seal into pump housing.

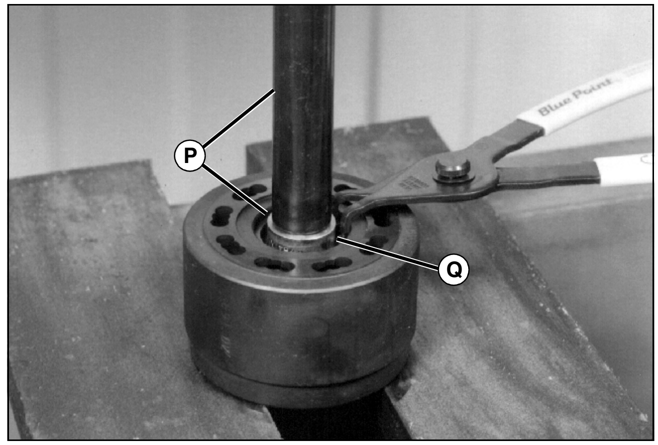


M56564

9. Install retaining ring (O) with sharp edge of ring facing the outside of the case. The sharp edge can be felt with your finger.

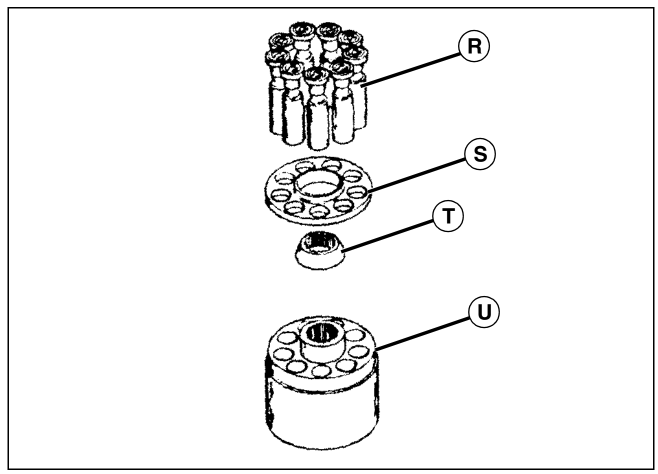
10.If the piston block assembly was disassembled, complete the following.

- Compress the pin keeper and install in the spline of the piston block.
- Install the three pins with the head end to the inside of the block and install in the special grooves of the piston block spline.
- Install the washer, spring and second washer in the piston block.



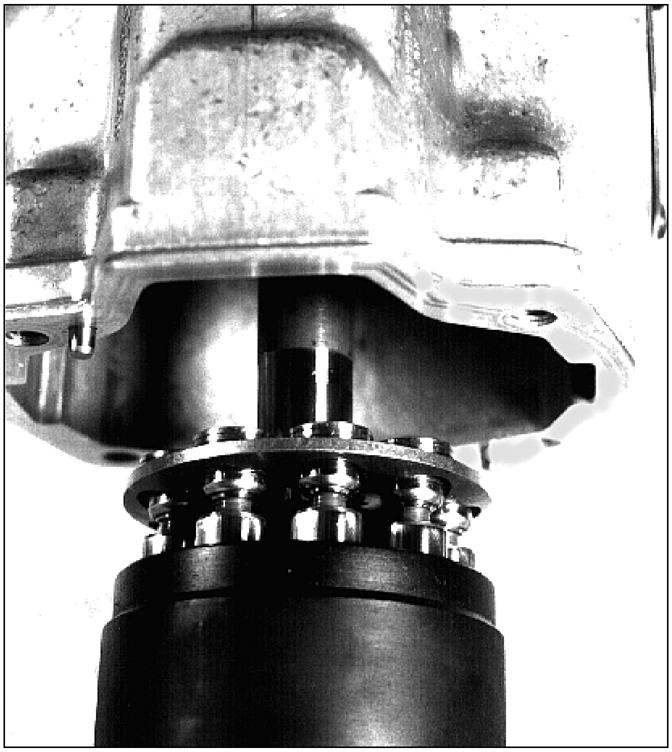
M76495

- Compress the spring with the arbor press and seal driver (P) used to compress the spring during disassembly.
- Install the retaining ring (Q). Ensure the sharp edge of the retaining ring faces away from the spring.



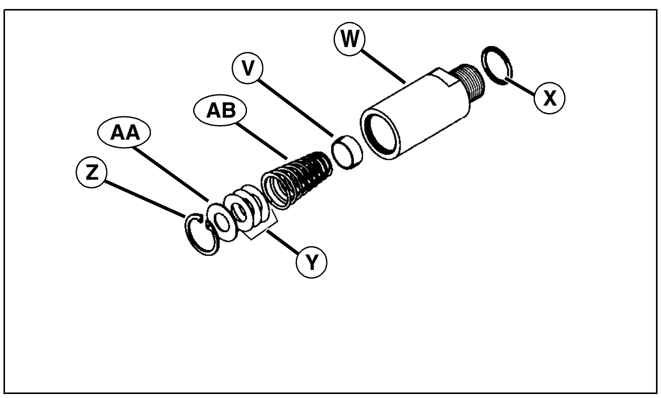
M56559

11.Assemble spider pivot (T), spider plate (S) and pistons (R) to piston block (U).



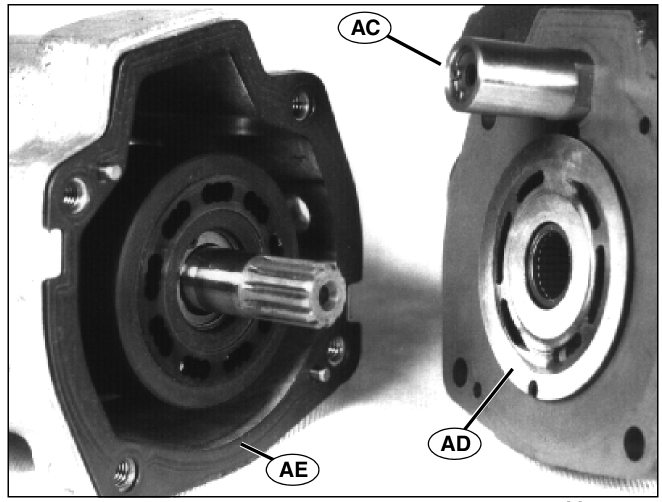
M56566

12.Hold the housing upside down and install the rotating assembly. Make sure the rotating assembly shoes are seated against the camplate.



M56535

13.Assemble O-ring (X), plunger (V), spring (AB), shim(s) (Y) (use the same number and thickness of shims as removed), washer (AA) and retaining ring (Z) into relief valve body (W).

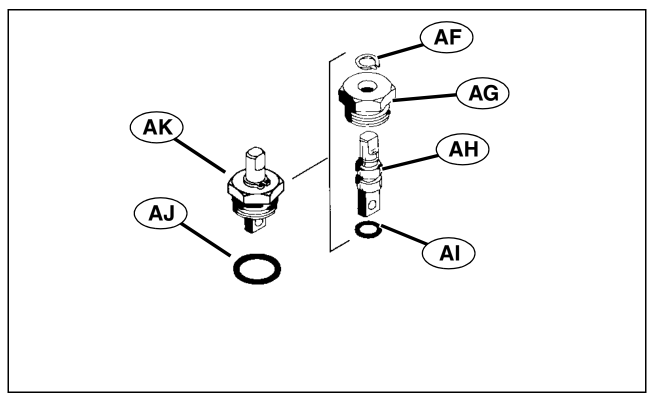


M56567

14.Install charge relief valve (AC), gasket (AE) and valve plate (AD). Be sure valve plate bronze side faces piston block. Tighten relief valve to specification.

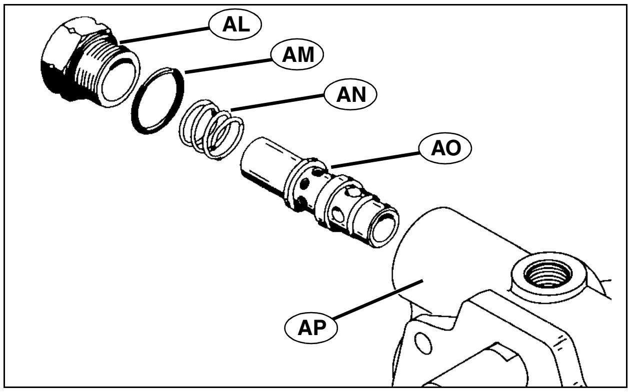
15.Assemble the backplate and housing. Secure with four cap screws and tighten to specifications.

IMPORTANT: Avoid damage! DO NOT use the bolts to force the parts to mate when assembling backplate to housing.



M56551

16.Assemble and install dump valve parts (AF-AK) and tighten to specifications.



M56533

17.Install each relief valve (AO), spring (AN), O-ring (AM) and plug (AL) into backplate (AP). Tighten plug to specifications.

Specifications

Trunnion Covers Screw Torque . . 4-5 N•m (35-44 lb-in.)

Charge Relief Valve Torque . . . . 37-40 N•m (27-30 lb-ft)

Backplate-to-Housing Cap Screw Torque . . 23-27 N•m (17-20 lb-ft)

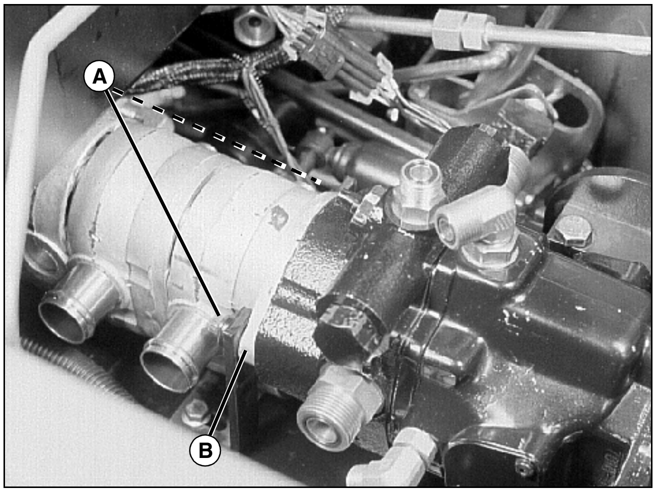
Dump Valve Torque . . . . 37-40 N•m (27-30 lb-ft)

Relief Valves Torque. . . . . . . 129-142 N•m (95-105 lb-ft)

Install Hydrostatic Pump - 3215, 3215A, 3215B, 3225B, and 3235

Other Material

Part No.	Part Name	Part Use
NA	LOCTITE Superflex 598	Apply to sides of hydrostatic pump gasket.



M76523

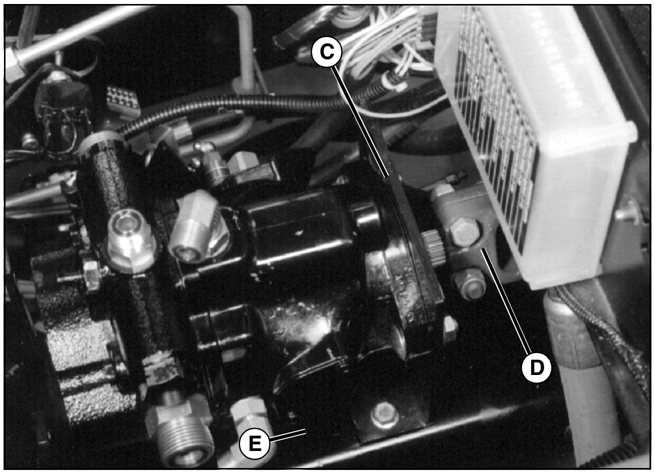
1. Install hydrostatic pump mounting bracket to pump with two nuts and carriage bolts. (Not shown.)

2. Place the hydrostatic pump into position in machine.

3. Apply LOCTITE Superflex No. 598 to both sides of gasket to be installed between hydrostatic pump and triple pump assembly.

4. Install gasket between hydrostatic and triple pump assembly.

5. Install two mounting cap screws (A) through triple pump mounting bracket, triple pump mounting flange (B) and into hydrostatic pump mounting flange.



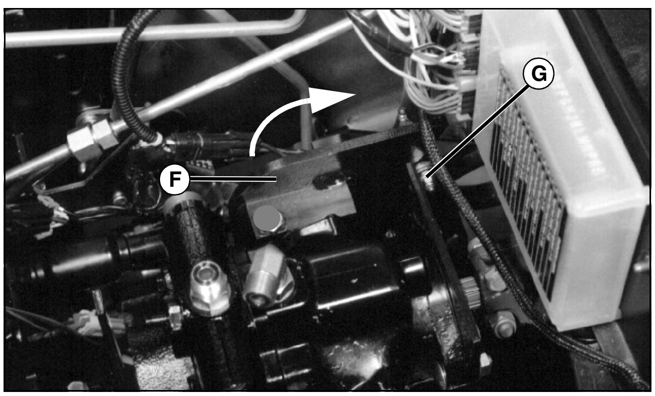
M76498

6. Install two bolts that secure the hydrostatic pump mounting bracket (C) to frame (E).

7. Slide drive shaft universal joint (D) on hydrostatic pump drive shaft.

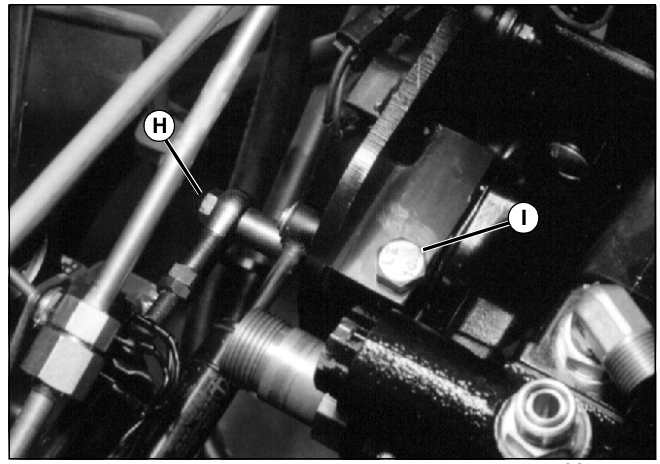
8. Connect drive shaft at engine drive sheave.

9. Tighten two cap screws in drive shaft universal joint.



M76499

10.Connect neutral spring to neutral lever (G) and anchor under frame. Place camplate (F) into position and rotate camplate to force neutral lever rearward, applying tension to neutral spring. Install camplate on hydrostatic pump shaft.



M76500

11.Install pinch bolt (I) to secure camplate on shaft.

12.Install forward/reverse linkage (H) on the camplate.

13.Install drive shaft shield on mounting bracket.

14.Connect all hydraulic lines to the hydrostatic pump, including line from oil filter to cross fitting or down pressure valve.

15.Install seat.

16.Connect battery.

17.Fill hydraulic reservoir.

Perform start-up procedure before returning machine to service.

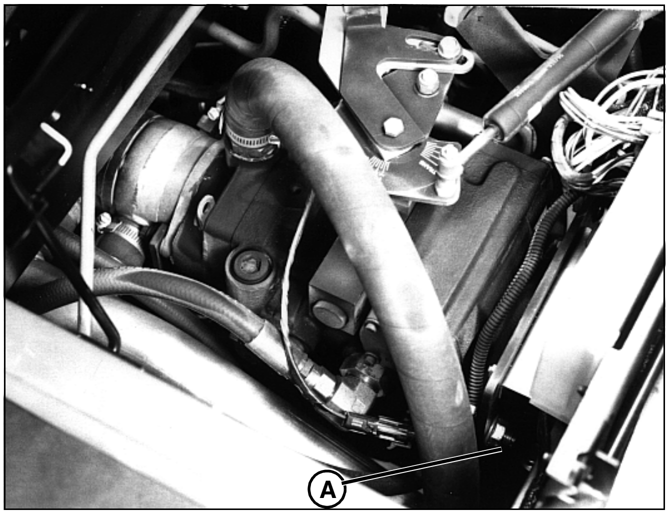
Remove Hydrostatic Pump - 3235A and 3235B

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park vehicle on a level surface, reels lowered, park brake locked, engine off. Block wheels to prevent inadvertent movement of the machine.

2. Disconnect battery.

3. Remove seat.

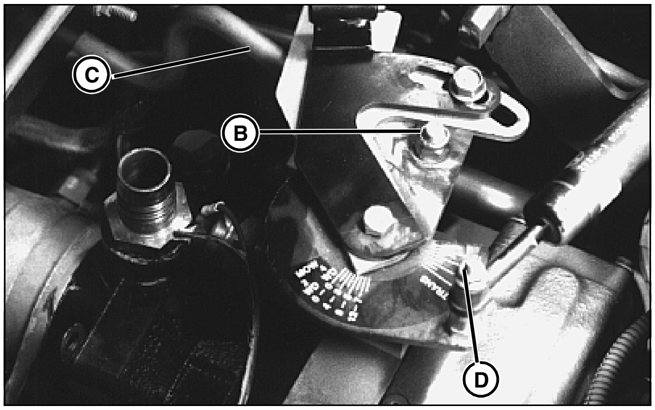


M86001

4. Disconnect drive shaft (A) at engine drive sheave. A pry bar in the universal joint of drive shaft will help to prevent drive shaft from turning.

5. Disconnect hydraulic line from oil filter to cross fitting or down pressure valve (if equipped).

6. Mark for reinstallation and disconnect all hydraulic lines connected to the hydrostatic pump.

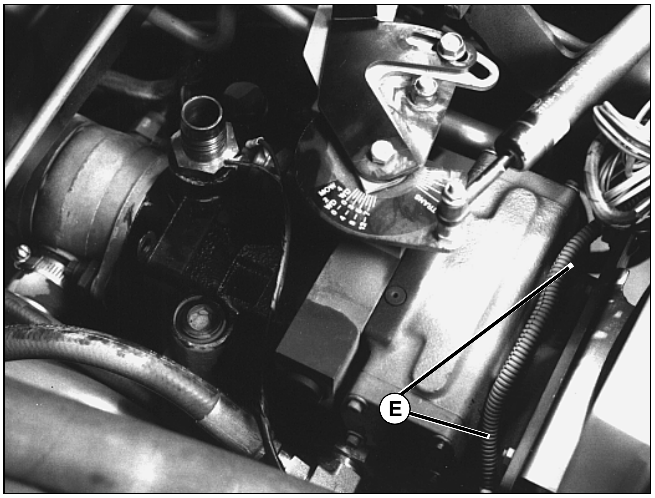


M86005

7. Remove nut (B) from mow/transport linkage, and remove arm (C).

8. Remove nut from the shock damper (D) and remove shock. Moderate pressure with a pry bar is required due to neutral spring pressure.

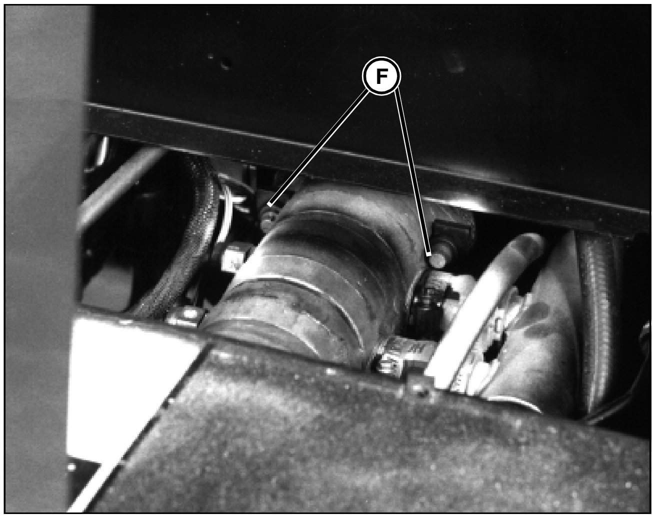
NOTE: Control plate is not keyed to control shaft, to allow easy shifting into neutral.



M86005

9. Remove drive shaft (E) shield from hydrostatic pump mounting bracket.

10.Loosen two cap screws and disconnect the drive shaft universal joint from the hydrostatic pump drive shaft.



M86006

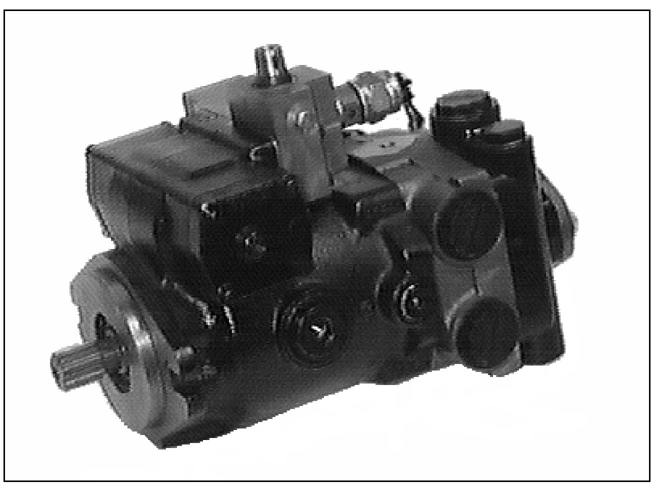
11.Remove two carriage bolts and nuts (F) securing the hydrostatic pump to the pump mounting bracket.

12.Remove cap screws and nuts that attach hydrostatic pump mounting bracket to the frame. Remove mounting bracket.

13.Remove the two cap screws from triple pump mounting flange to separate triple pump assembly from hydrostatic pump.

14.Remove hydrostatic pump from machine.

Disassemble Hydrostatic Pump - 3235A and 3235B

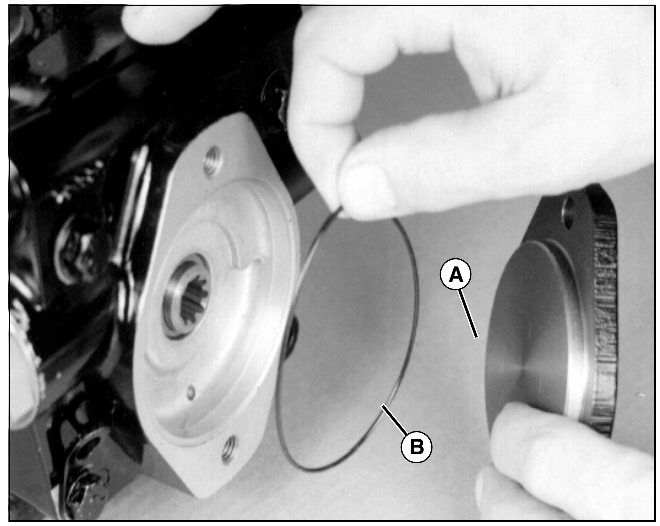


M86009

The pump is equipped with a backplate that adapts to the gerotor charge pump. This gerotor charge pump supplies the charge pressure for the hydrostatic piston pumps as well as the operating pressure for the servo controls and the two-speed cylinder.

Remove Charge Pump Adapter

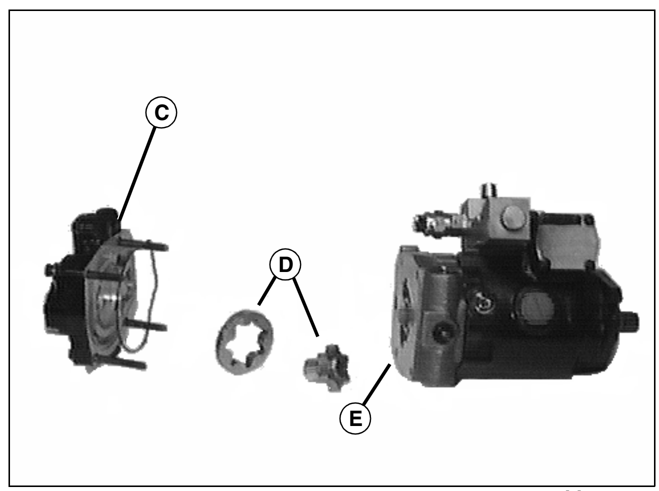
NOTE: Gerotor assembly is not installed on 3235B mowers (S.N. TC3235T020001-) and (S.N. TC3235F020001-)



M76139

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

2. Remove the flange cover (A) and O-ring (B) by removing two mounting screws.



M86013

3. Remove the four cap screws that hold the charge pump adapter assembly (C) to the backplate (E).

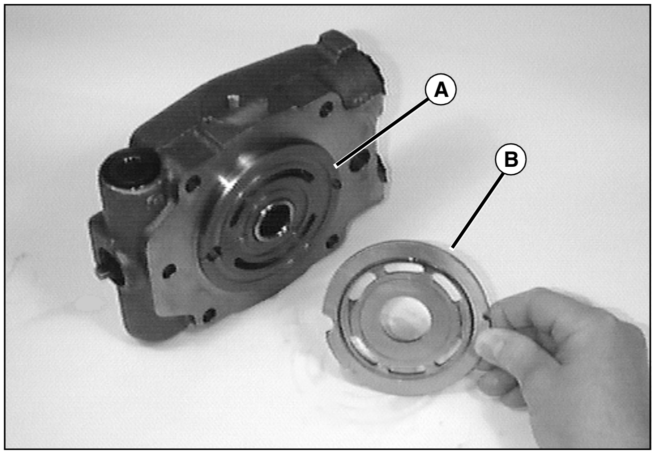
4. Pull the housing away from the backplate and remove the O-ring.

5. Remove the inner and outer rotors (D) from the shaft. The rotors are a loose fit on the shaft. However, they may adhere slightly to the backplate due to oil between the machined surfaces. Be careful not to lose the key that is located between the shaft and the inner gerotor ring.

Remove and Disassemble Backplate

1. Tap the backplate with a plastic mallet to loosen it from the housing.

2. Remove the backplate and gasket from the hydrostatic pump housing.

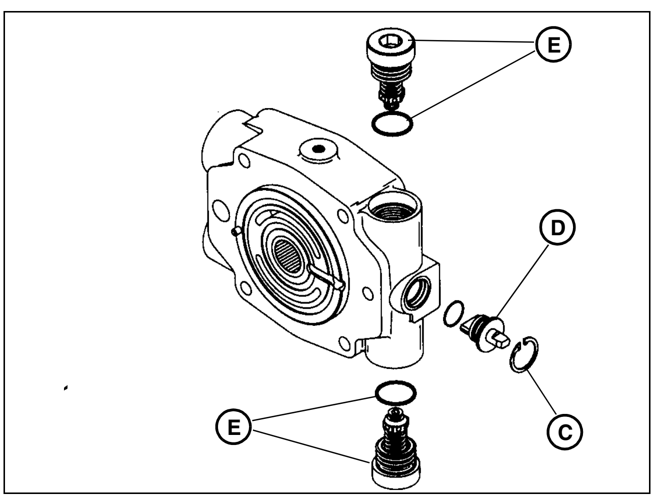


M86012

3. Remove the valve plate (B) from the backplate. The valve plate is not fastened to the backplate, but may adhere slightly due to oil between machined surfaces.

4. In most cases it should not be necessary to remove the spring pin (A) that is used to keep the valve plate properly located. If the pin is tight in the hole and is not damaged, there is no need to replace it. However, if the spring pin is damaged, it can be removed. In doing so, be extremely careful not to scratch the machined surface of the backplate.

IMPORTANT: Avoid damage! Mark the relief valve in relation to the cavity it was removed from, for reassembly purposes.



M86019

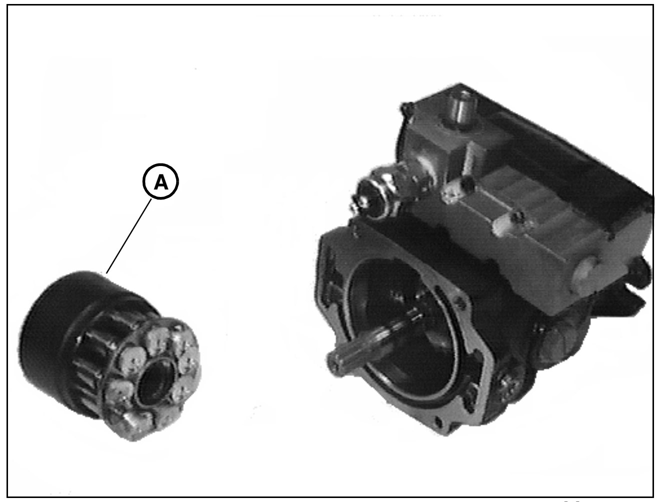
5. From backplate, remove dump valve retaining ring (C), dump valve (D) and relief valve assemblies (E).

Inspect Backplate

Check the bearing (press fit) in backplate. If needles remain in cage and move freely, removal is not required.

Check roll pin in backplate. If tight, removal is not required.

Remove and Disassemble Rotating Assembly



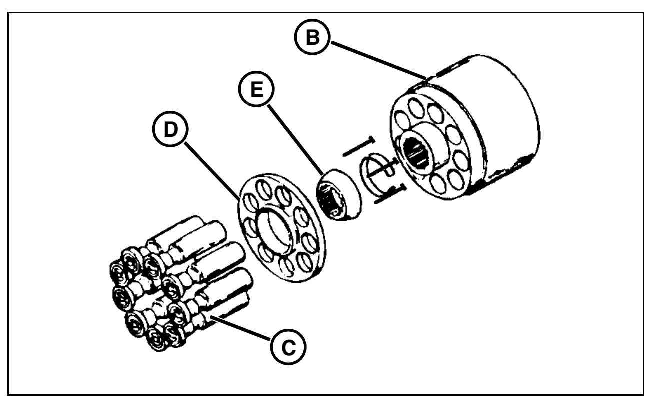
M86014

1. Remove the rotating assembly (A) from the housing.

2. If the pistons did not come out with the piston block, remove the pistons along with the spider and pivot.

The following parts will be needed to disssemble the piston block:

- 3/8” ID x 1-1/4” OD flat washers (2 ea.)
- 3/8” x 5" NC cap screw (1 ea.)
- 3/8” NC nut (1 ea.)
- 1/2” drive socket with 1-1/8” OD (1 ea.)

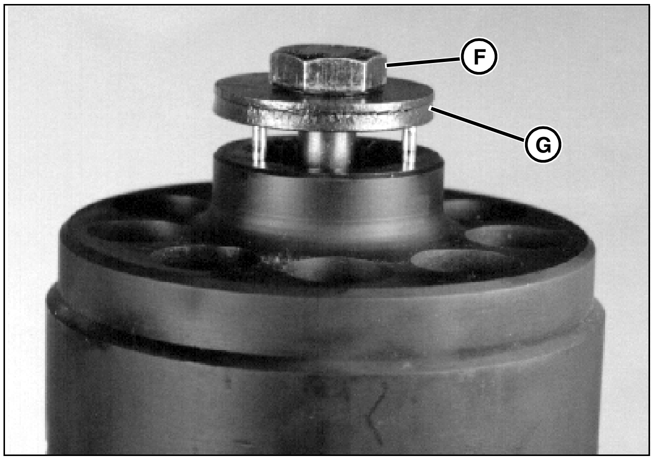


M58106

3. Disassemble pistons (C), spider (D) and pivot (E) from piston block (B).

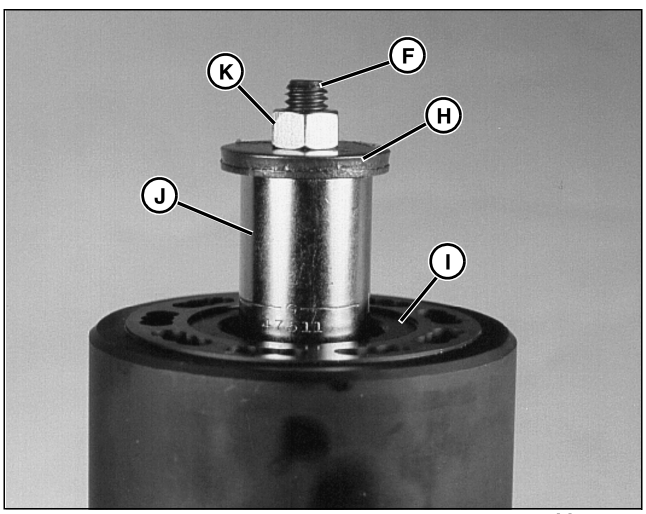
CAUTION: Avoid injury! The spring inside the piston block is compressed and should not be removed without compressing the spring first. Use the following procedure to remove the spring safely.

NOTE: Disassembling the piston block assembly is not necessary unless the pins are damaged.



M76099

4. Place one of the flat washers (G) over the 3/8" x 5" cap screw (F). Install cap screw through spline end of piston block so that the washer rests on the three pins.



M58132

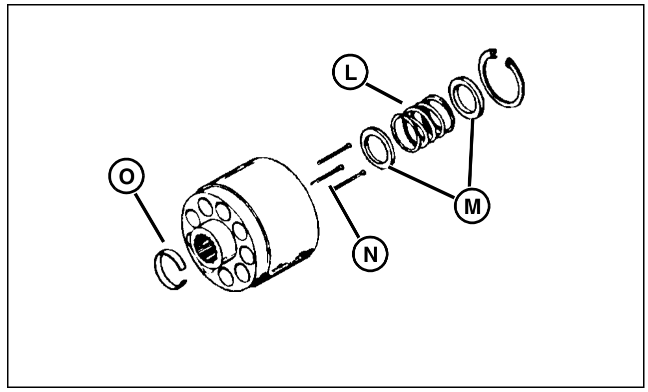
5. Place the socket (J) and then the washer (H) over the end of the cap screw (F).

6. Screw the nut (K) on and slightly compress the spring inside the piston block.

7. Use retaining ring pliers to remove the internal retaining ring (I).

8. Carefully back off tension on nut until spring is slack.

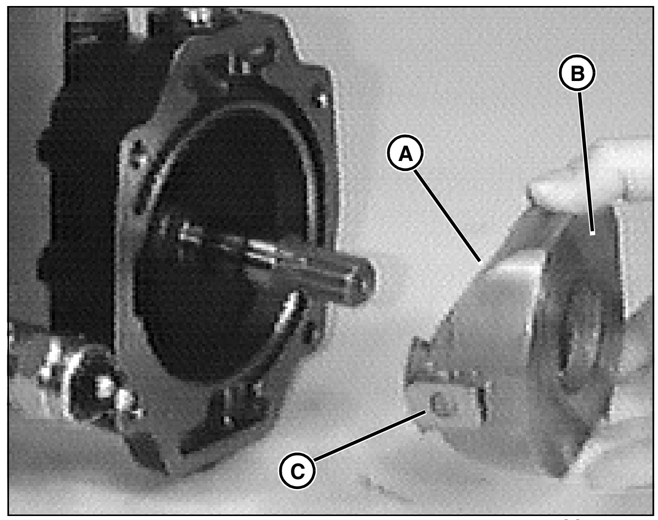
9. Remove the nut, washer, and cap screw.



M56625

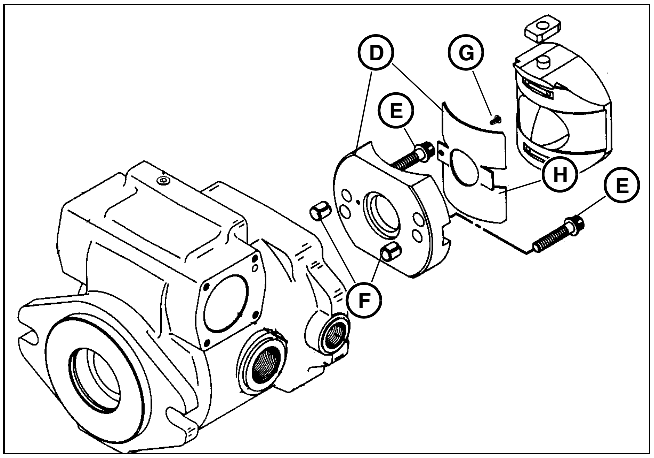
10.Remove washers (M), spring (L), pins (N), and pin retainer (O).

Remove and Disassemble Camplate and Shaft



M86015

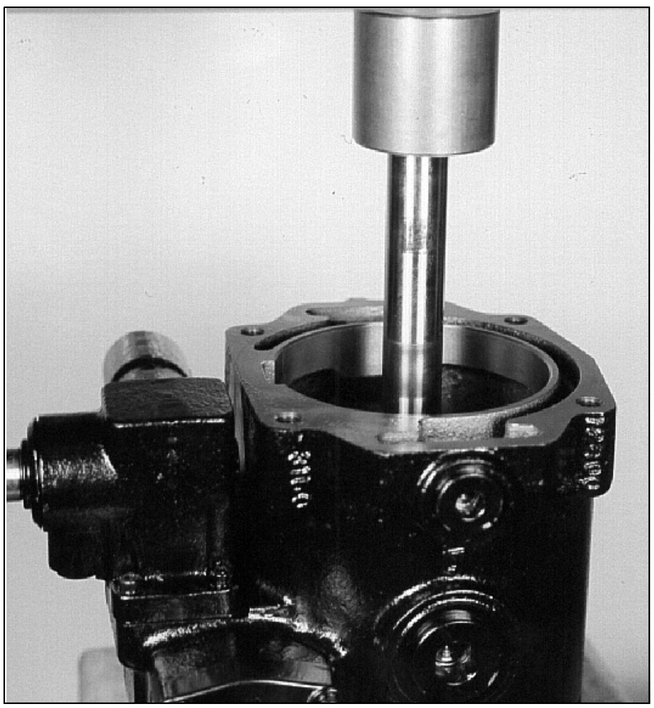
1. Remove the camplate (A) and follower (C) from the housing; this may require some maneuvering of the camplate. When removing the camplate, be sure not to damage the shoe surface (B).



M79111

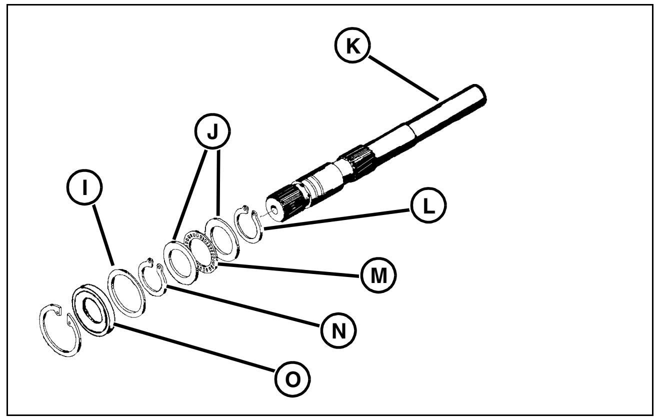
2. Remove the cradle sub-assembly (D) by removing two retaining screws (E), retaining cradle inside housing. Move the cradle back and forth to release the dowel bushings (F) and remove the cradle sub-assembly from the housing.

3. Remove the button head cap screw (G) to remove the bushing (H).



M76157

4. Remove retaining ring and press the shaft out of the housing as shown until the rubber seal releases from the bore. Be sure that the shaft is supported below so that it does not drop and become damaged when it releases from the housing.

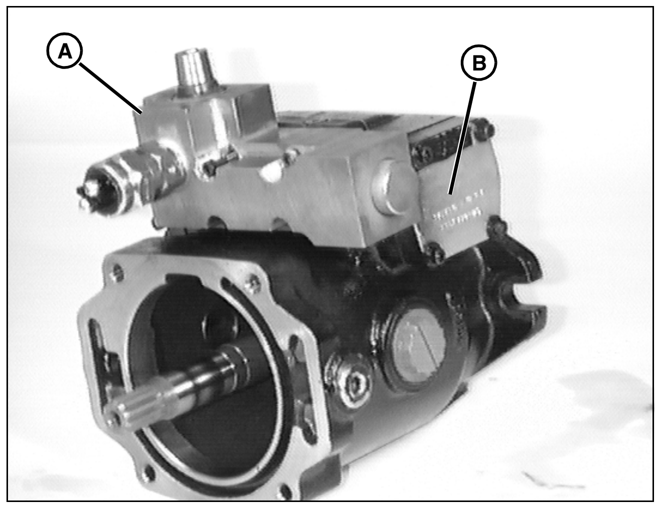


M57918

5. Remove the seal (O) and washer (I).

6. Remove the retaining ring (N) from the main shaft (K) and remove the thrust washers (J), thrust bearing (M) and retaining ring (L).

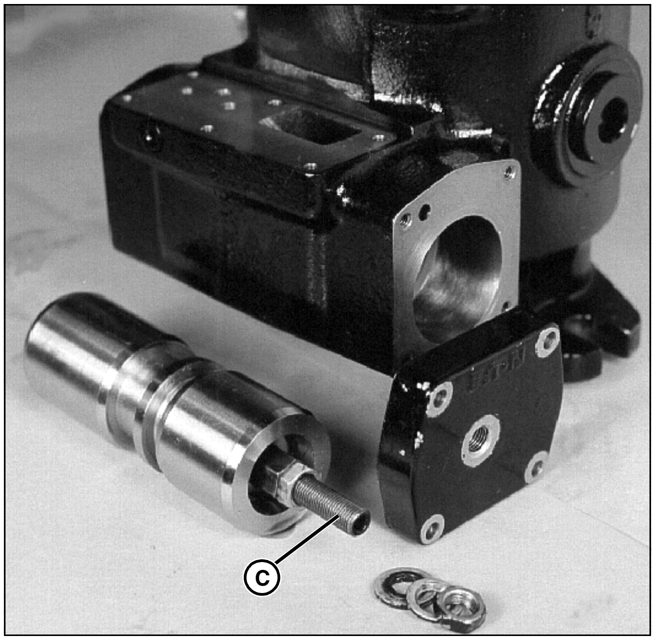
Disassemble Servo Control



M86017

1. Remove the servo valve (A) and gasket by removing the six socket head cap screws that fasten the valve to the housing.

2. Remove the cylinder cap (B) that does not have the screw and lock nut through the center.



M76165

3. Remove the lock nut from the piston screw (C).

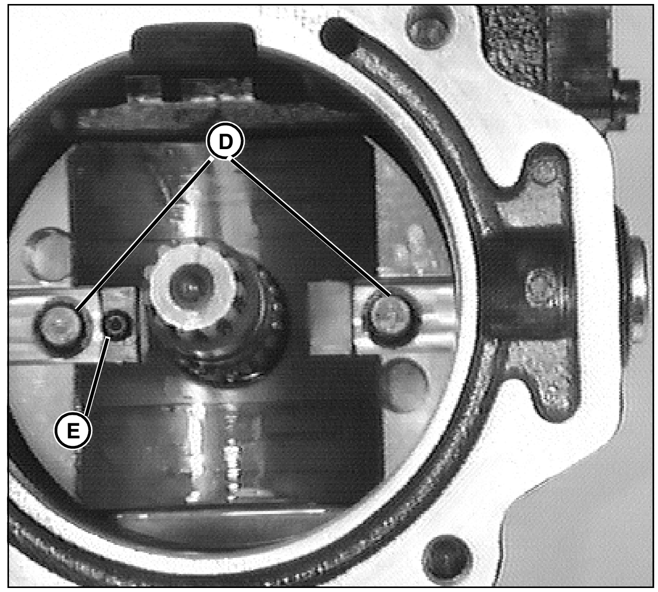
4. Remove the flat washer and rubber washer from the piston screw.

5. Using a hex wrench (Allen wrench) in the end of the piston screw, turn it clockwise until it threads completely out of the cover.

6. Remove the cap with the piston screw hole through the center.

7. Push the piston out of the piston bore.

NOTE: Do not disassemble the piston any further. The piston spring tension is preset at the time of manufacture. The service piston assembly is only sold as an assembled unit.



M79114

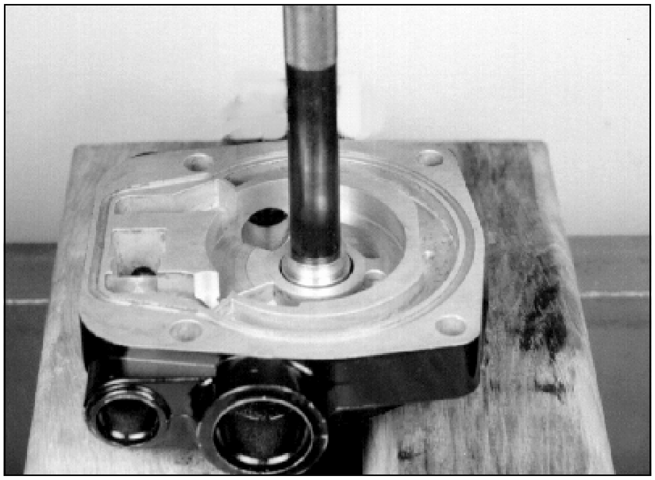
8. The cradle for the camplate can be removed by taking out the two mounting screws (D) and moving the cradle back and forth to release the dowel bushings that hold the cradle in place.

9. Remove button head cap screw (E) to remove bushing from cradle

Inspect Hydrostatic Pump - 3235A and 3235B

1. Inspect the needle bearing in the housing; needles should be free-spinning and not fall out of bearing cage. If the bearing needs to be replaced, it can be pressed out from the inside of the housing outward.

2. Inspect the needle bearings in the gerotor housing, the backplate, and the pump housing. If the needles remain in the cage and spin freely, there is no need to replace them.



M76153A

3. If it is necessary to remove the bearing from the gerotor housing, it can be pressed from the inside of the gerotor housing to the outside as shown.

IMPORTANT: Avoid damage! The gerotor housing is aluminum and the machined surfaces can be easily damaged. Do not press the housing against unprotected steel surfaces.

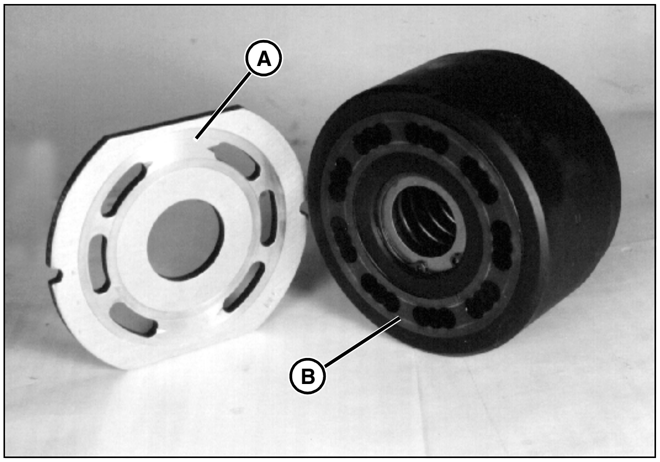
4. If the bearing in the backplate needs to be replaced, it can be pressed out in the same fashion as that of the gerotor housing.

IMPORTANT: Avoid damage! When removing bearing from backplate, be extremely careful not to damage machined surfaces.

5. Inspect the inside of the gerotor housing for excessive wear, particularly at the surfaces that meet the gerotor rotors.

6. Inspect the inner and outer rotors; check for nicks or large scratches, particularly between the two rotors.

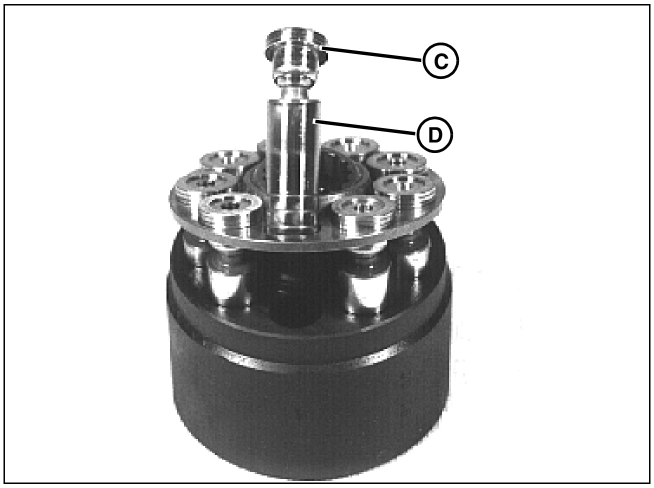
7. Inspect the charge pressure check valve and the check valve seat in the gerotor housing. Be sure that there are no burrs, excessive wear, or defects on the check valve or the check valve seat.



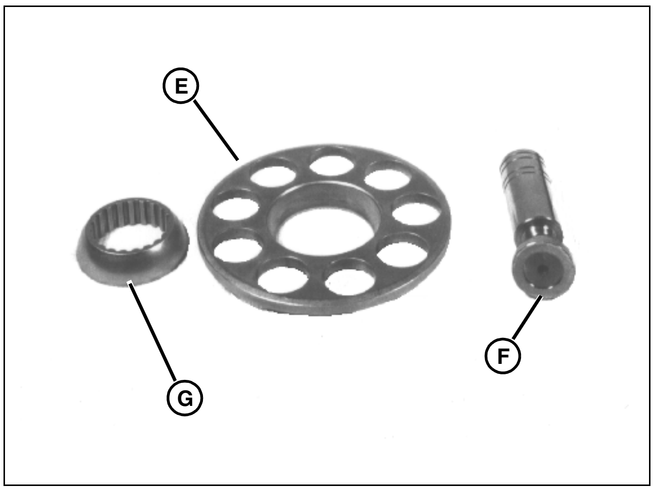
M76105

8. Inspect the valve plate (A) on the bronze side next to the piston block (B) for wear. Replace the valve plate if any wear, scoring, or scratches exist.

9. Inspect the piston block surface that makes contact with the valve plate. This surface should be smooth and free of deep scratches.



M56554



M58088

10.Check the piston (D) movement in the block bore. If the pistons are sticky in the bore, examine the bore for scoring or contamination.

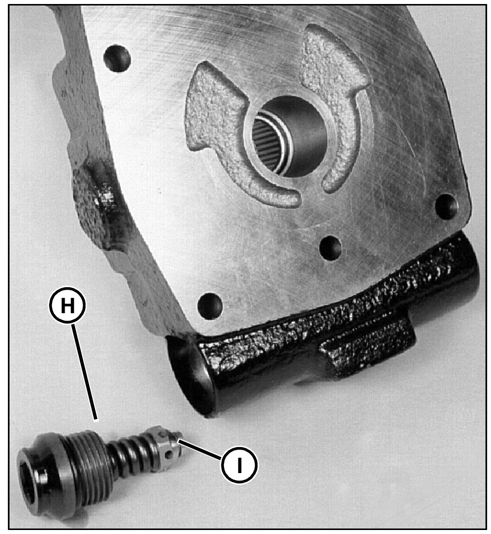
11.Examine the OD of the pistons for finish condition. They should not show wear or deep scratches.

12.Inspect the each piston shoe (C) for a snug fit on the ball end of the pistons. Check the shoe face (F) for a flat smooth surface.

13.Examine the spider (E) for wear in the pivot area.

14.Examine the pivot (G) to ensure smoothness and no signs of wear.

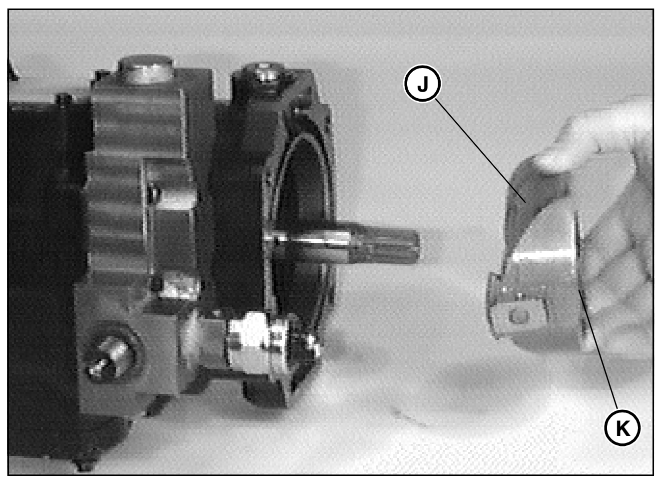
IMPORTANT: Avoid damage! Piston face roll can be caused by towing unit, dry start-up, or loss of charge pressure.



M76161

15.Examine the main drive pressure relief valves (H) and seats. Inspect the check valve (I) at the end of the relief valve. The check valve at the end of the relief valve should be loose and easily operated. The seat for the check valve should be free of burrs and defects.

16.Examine the machined surfaces of the backplate, particularly the gerotor side.

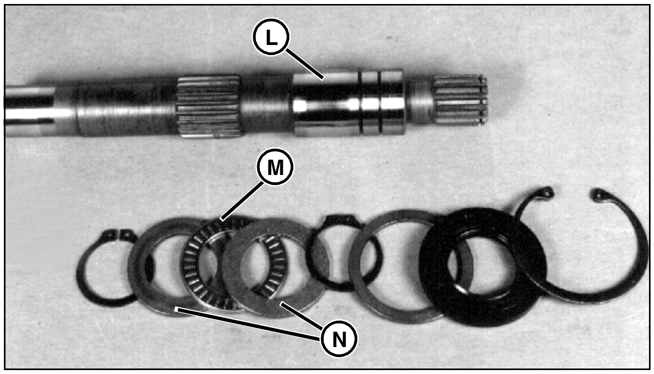


M79113

17.Examine the shoe surface (K) of the camplate. Be sure that there are no scratches, grooves, or excessive wear on the shoe surface. Check that the lubrication holes in the camplate are open.

18.Inspect the cradle surface (J) on the back side of the camplate for excessive wear.

19.Examine the wear plate; if the fiber surface of the wear plate is worn, replace the wear plate.



M76112

20.Inspect the shaft (L) for fretting in the bearing and spline area.

21.Inspect thrust bearing (M) and washers (N) for wear.

22.Inspect the servo piston for scratches and wear.

23.Examine the servo piston cylinder in the pump housing. If the seals in the cylinder are worn or damaged, replace them.

Assemble Hydrostatic Pump - 3235A and 3235B

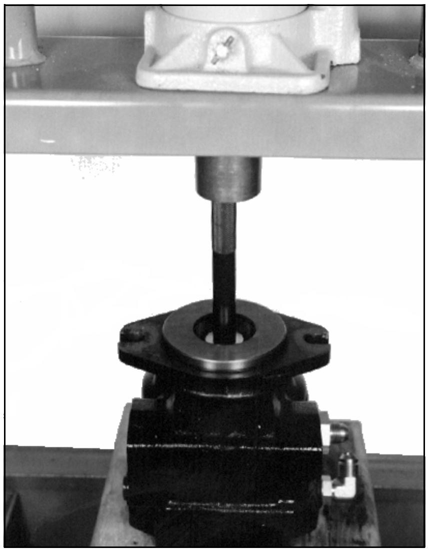
Clean all parts in a suitable solvent and dry with a lint-free rag.

Other Material

Part No.	Part Name	Part Use
T43512 (US) 242 (Loctite) TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of set screw.

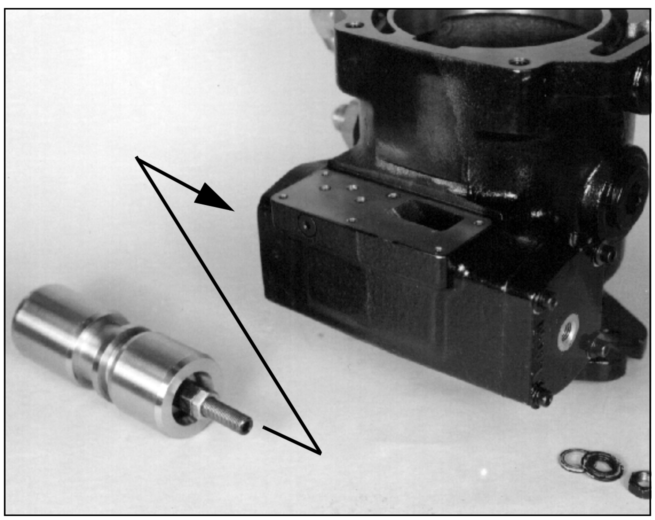
IMPORTANT: Avoid damage! Due to extremely tight tolerances and finish of pump internal surfaces, it is very important to maintain absolute cleanliness during the assembly of the pump. Coat all internal surfaces with clean 10W30 motor oil when assembling the pump.

Reassemble Housing, Servo Control and Shaft



M76181

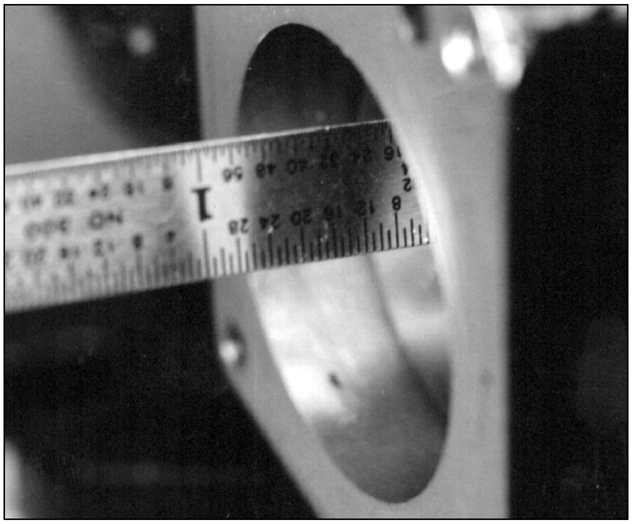
1. If the needle bearing was removed from the housing, the new one can be pressed from the outside inward until the bearing race is recessed in the bore according to specifications. Be sure that the numbers on the bearing race are facing to the outside of the housing.



M76182

2. Install the cylinder cap and gasket that has the piston screw hole through the center. Tighten the mounting screws to specifications.

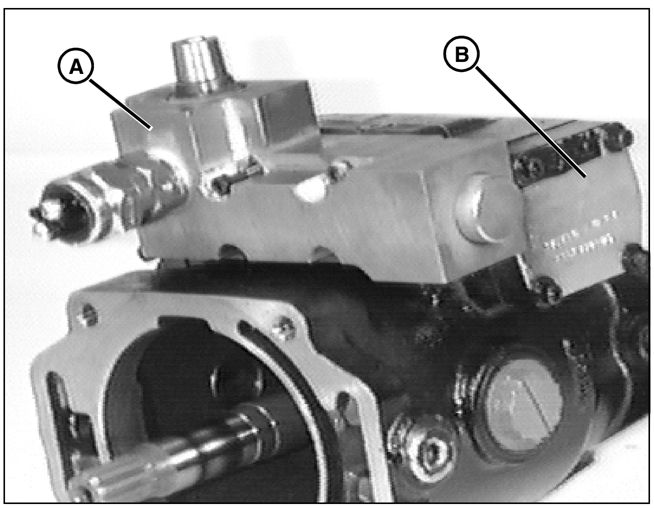
3. Install the piston into the cylinder as indicated above.



M76186

4. Insert a hex wrench (Allen wrench) into the end of the piston screw and thread it through the cover until the flat end of the piston is located according to specifications from the edge of the cylinder.

5. Install the rubber washer, flat washer, and outside jam nut onto the piston screw. Tighten the jam nut to specifications.



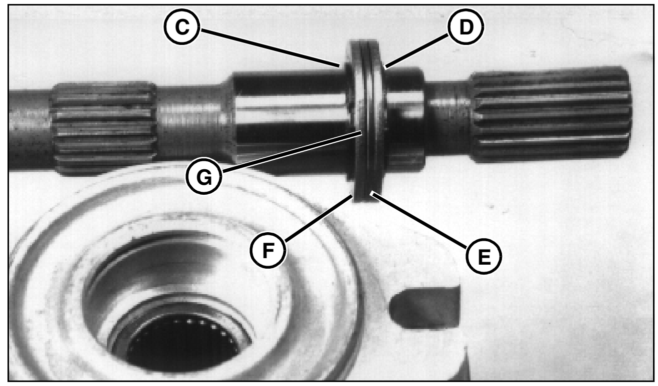
M86017

6. Install the remaining cylinder cap (B) and gasket. Tighten the mounting screws to specifications.

7. Install the servo valve (A) and gasket onto the housing. Be sure the servo valve feedback rod is positioned into the narrow groove on the servo piston. Tighten the mounting screws to specifications.

8. Place the cradle into the housing, being sure that the dowel bushings are located in the holes in the housing. Draw the cradle tight by evenly torquing the two mounting screws to specifications.

9. Install the wear plate onto the cradle and tighten the retaining screw to specifications.



M56557a

10.Install the inside retaining ring (C), thrust washer (F), and thrust bearing (G) on the shaft. Install the outside thrust washer (E) and retaining ring (D).

11.Install the shaft into the housing. Install the washer and a new shaft seal. Secure it with the retaining ring.

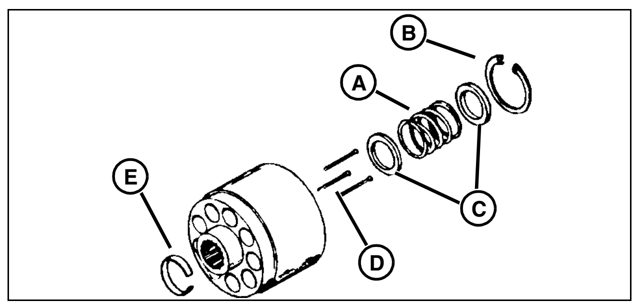
12.Install the camplate follower onto the camplate.

13.Place the camplate over the shaft with the shoe surface outward.

14.Use a long screwdriver to guide the camplate follower into the large groove in the servo piston.

Install Rotating Assembly (LH and RH Pump)

1. If the piston block assembly was disassembled, complete the following. If not skip to step 8.



M56625

2. Install the three pins (D) in oversize grooves in spline end of piston block with the heads facing inside of the block.

3. Install the pin retainer (E).

4. Install the washers (C) and spring (A).

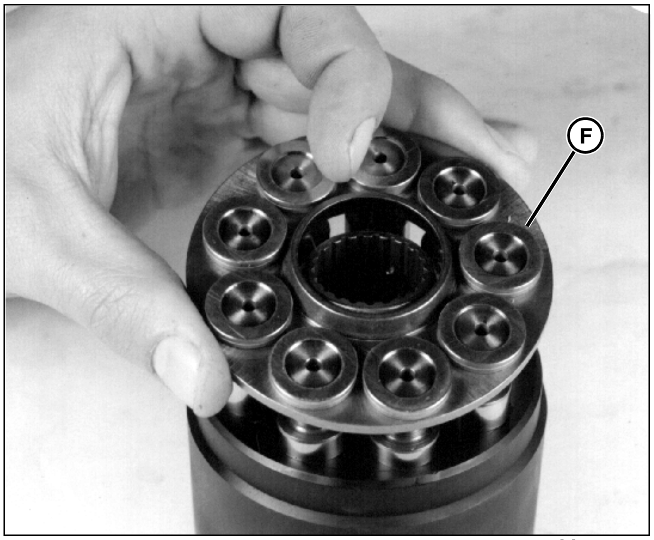
5. Using same tools used to compress spring during disassembly of block, install washer, spring, second washer, cap screw and nut in the piston block.

6. Compress spring.

7. Install retaining ring (B).

8. Remove spring compression tools from the piston block.

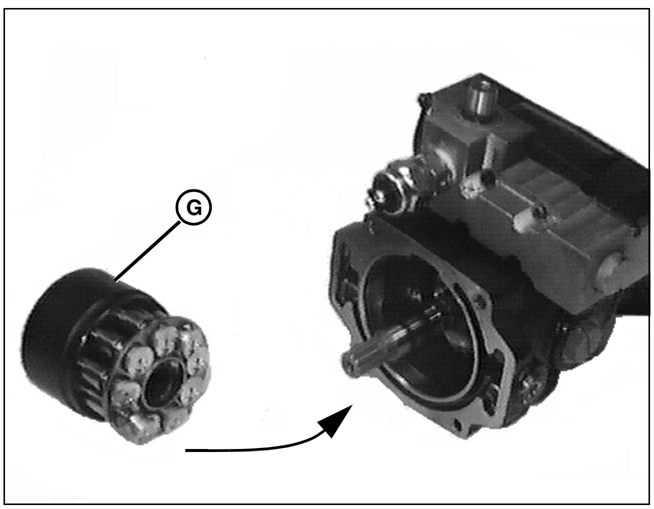
9. Place the pivot so that the flat side rests on the top of the three pins.



M76117

10.With each piston (F) in place in the spider, lower the pistons into the piston block.

NOTE: It is not necessary to put the pistons in the original positions. Any piston can be installed in any hole.

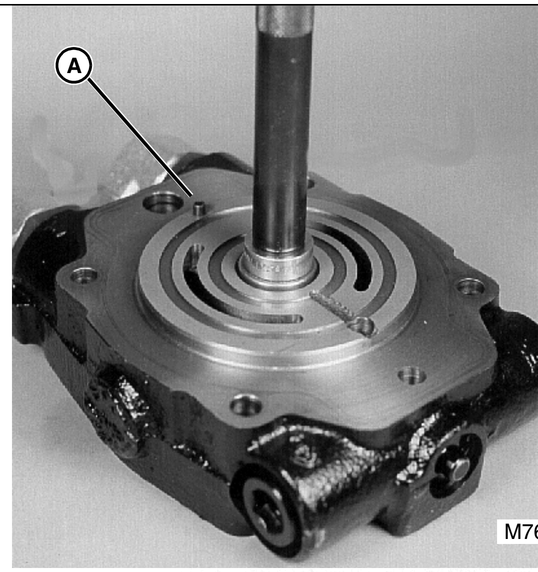


M86014

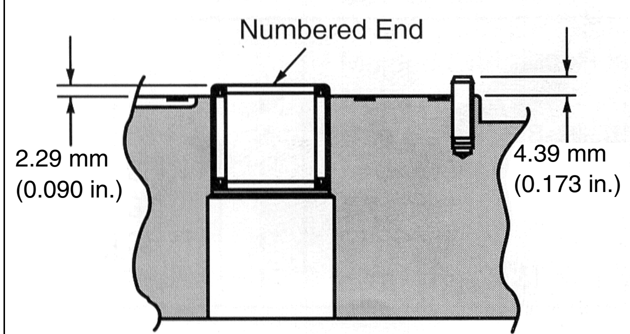
11.Tilt the pump housing so that the open end is facing slightly downward, but not so much that the camplate falls out of position.

12.Slide the rotating unit (G) up the shaft until it meshes with the splines on the shaft.

Assemble and Install Backplate and Gerotor



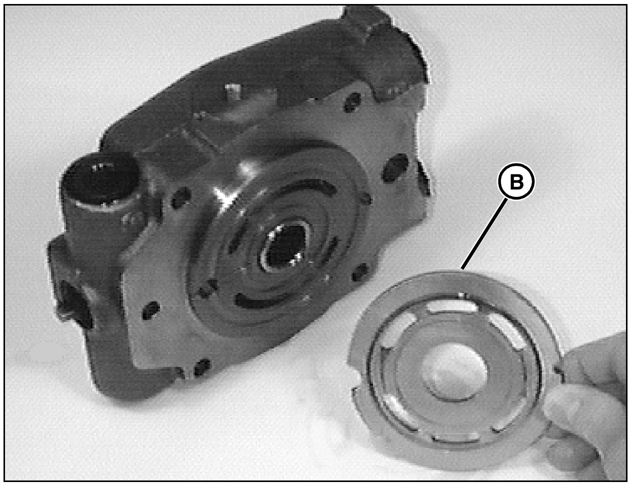
M76203



M76205

1. If the bearing was removed from the backplate, press new one into position as shown. The numbers on the bearing should be positioned toward the inside of the pump housing. Press the bearing in until the race remains above the surface of the backplate according to specifications.

2. Install the roll pin (A) (if removed) that is used to position the valve plate. Allow the pin to protrude from the backplate to specifications.

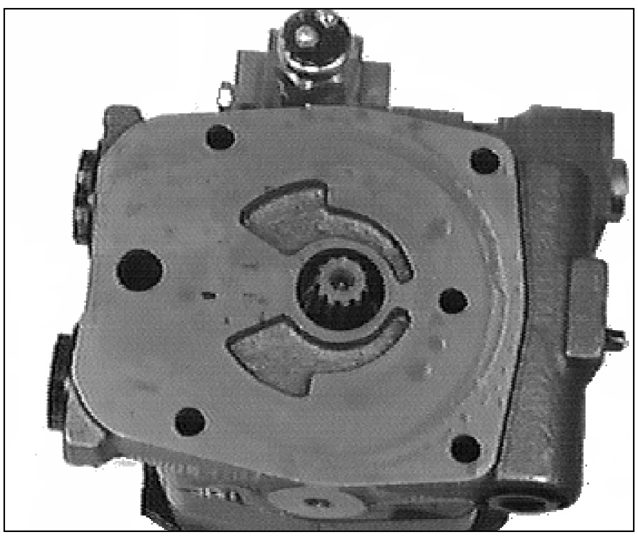


M86012

3. Apply a small amount of clear petroleum jelly to the steel side of valve plate (B) to hold it in place for installation.

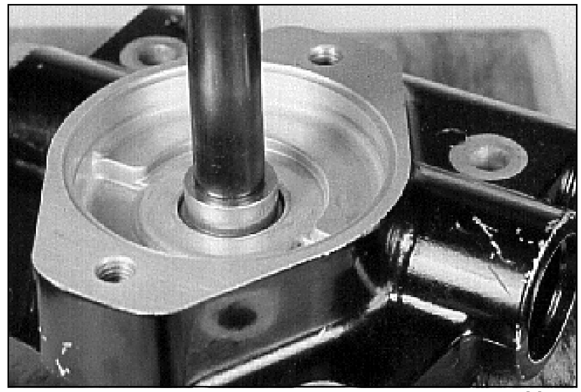
4. Install the valve plate onto the backplate with the steel side facing the backplate and the bronze side facing the inside of the housing.

5. Place a new gasket on the housing.

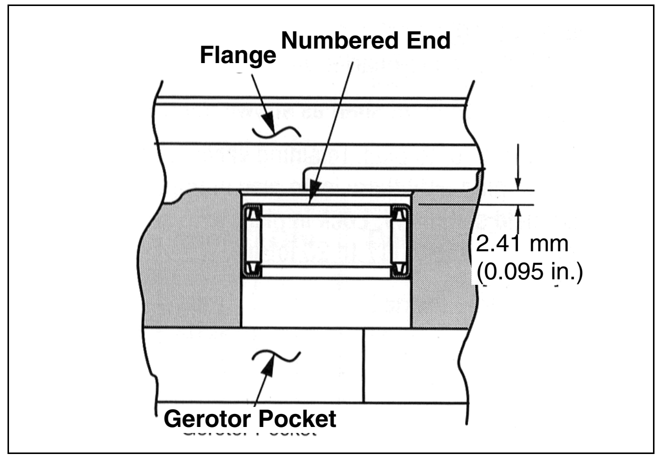


M79115

6. Install the backplate assembly onto the housing assembly, making sure valve plate stays in position. The backplate should rest off of the housing to specifications until it is tightened down. This is due to the spring tension within the rotating assembly.



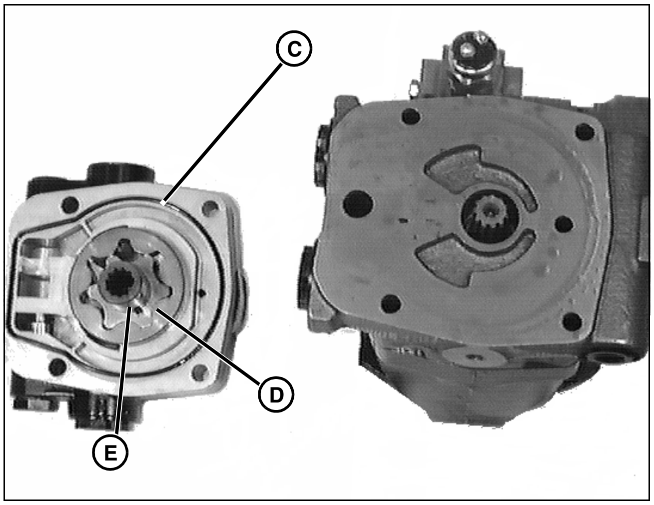
M76207



M76208

7. If necessary, press a new bearing into the gerotor housing. Press the bearing into the housing from the outside inward, with the numbered end of the race facing outward. Press the top of the bearing race until it is positioned to specifications below the top edge of the bore (as shown).

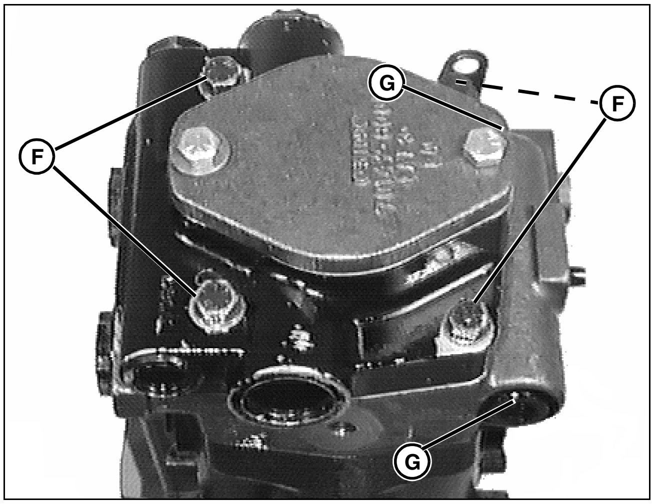
NOTE: Gerotor assembly is not installed on 3235B mowers (S.N. TC3235T020001-) and (S.N. TC3235F020001-)



M79115

8. Install the key and inner gerotor ring (E) onto the shaft. Lubricate the inner gerotor ring.

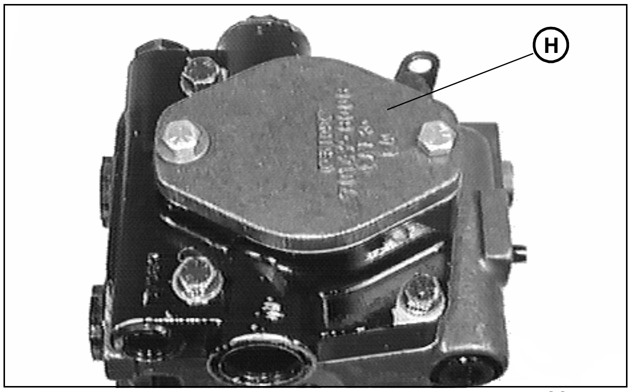
9. Install the O-ring (C) and outer gerotor ring (D) into the gerotor housing. Use petroleum jelly to lubricate and hold the outer gerotor ring and O-ring in place in the housing.



M86011

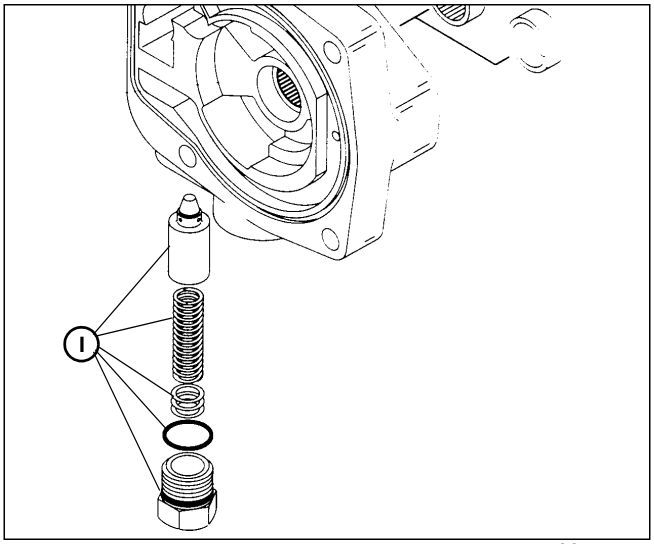
10.Place the gerotor housing over the shaft, meshing the inner and outer gerotor rings. Insert the four cap screws (F) and tighten evenly to specifications.

11.After installing new O-rings, install the main drive pressure relief valves (G) in the same cavities in the backplate from which they were removed. Tighten to specifications.



M86011

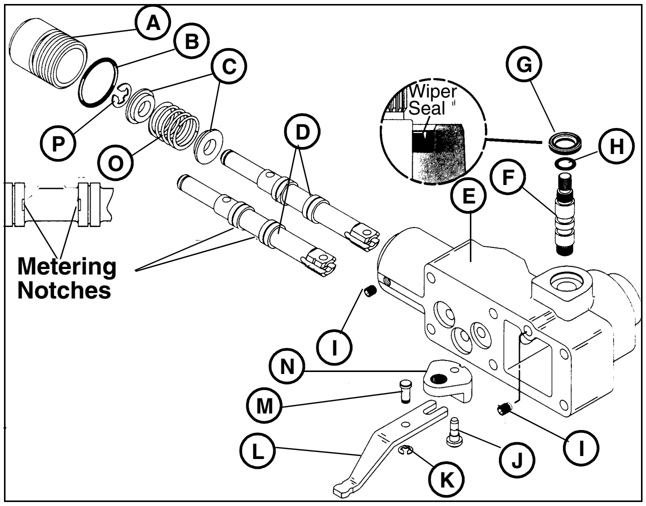
12.Install the flange cover (H).



M79116

13.Install the charge pump adapter assembly (I). Tighten to specifications.

Disassemble Manual Servo Control



M79117

- **A - Plug**
- **B - O-Ring**
- **C - Spring Retainer**
- **D - Valve Spool**
- **E - Control Housing**
- **F - Input Shaft**
- **G - Wiper Seal**
- **H - O-Ring**
- **I - Set Screw**
- **J - Head Pin (press fit)**
- **K - Retaining Ring**
- **L - Feedback Link**
- **M - Dowel Pin**
- **N - Bell Crank**
- **O - Spool Centering Spring**
- **P - Retaining Ring**

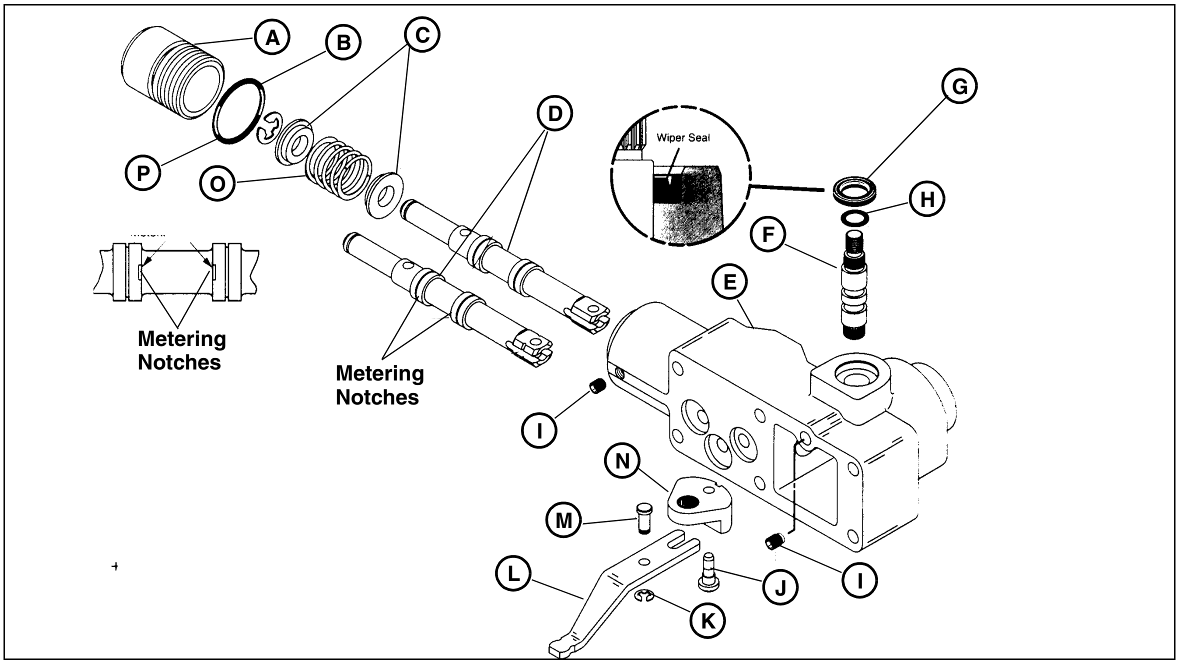
1. Remove wiper seal (G) with a screwdriver. Remove set screw (I) retaining input shaft (F) and remove input shaft from control housing (E).

2. Remove set screw (I) retaining plug (A) in control housing and remove plug.

3. Remove retaining ring (K) from pin retaining feedback link (L) and valve spool (D), and bell crank (N) from control housing.

4. Compress spool centering spring (O) and remove retaining ring (P), spring retainer (C), spool centering spring and second spring retainer (C) from valve spool.

5. Remove O-rings (B and H) from plug and input shaft. Clean all parts and lubricate before reassembly.



M79117

Assemble Manual Servo Control

1. Install one spring retainer (C), spool centering spring (O) and second spring retainer (C) onto valve spool (D). Compress the spool centering spring with retainer and install retaining ring (P) onto valve spool.

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

3. Position bell crank (N) in control housing (E). Slide feedback link (L) into position between clevis on valve spool, aligning holes, and install dowel pin (M), retaining with retaining ring (K).

4. Install new O-ring (H) onto input shaft (F). Hold bell crank (N) in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.

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

6. Install wiper seal (G) on input shaft.

7. Install new O-ring (B) onto plug (A), retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw (I). Tighten set screw to specifications.

Specifications

Needle Bearing Recessed Inside Bore 1.8 mm (1/16 in.)

Cylinder Cap and Gasket (w/ Piston Screw Hole in Center) Mounting Screw Torque . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)

Pump Piston Distance from Edge of Cylinder (Installed) 12.7 mm (0.500 in.)

Outside Jam Nut Torque . . 17.5 ± 1 N•m (155 ± 5 lb-in.)

Cylinder Cap and Gasket Mounting Screw Torque 5.0 ± 0.5 N•m (44 ± 4 lb-in.)

Servo Valve Feedback Rod Mounting Screw Torque 5.0 ± 0.5 N•m (44 ± 4 lb-in.)

Cradle Mounting Screw Torque 36 ± 2 N•m (26 ± 2 lb-ft)

Wear Plate Retaining Screw Torque 1.7 ± 0.1 N•m (15 ± 1 lb-in.)

Gerotor Bearing Position in Bore . . 2.29 mm (0.090 in.)

Roll Pin Protrusion from Backplate 4.39 mm (0.173 in.)

Backplate Assembly Resting Position 1.5 mm (0.06 in.)

Gerotor Bearing Race Position in Bore 2.41 mm (0.095 in.)

Gerotor Housing Cap Screw Torque (4 used) . . . 40 ± 2 N•m (29 ± 2 lb-ft)

Main Drive Pressure Relief Valve Torque . . 143 ± 6 N•m (105 ± 5 lb-ft)

Charge Pump Adapter Assembly Torque 39 ± 2 N•m (29 ± 1 lb-ft)

Manual Servo Control Set Screw Torque . 2-3 N•m (17-25 lb-in.)

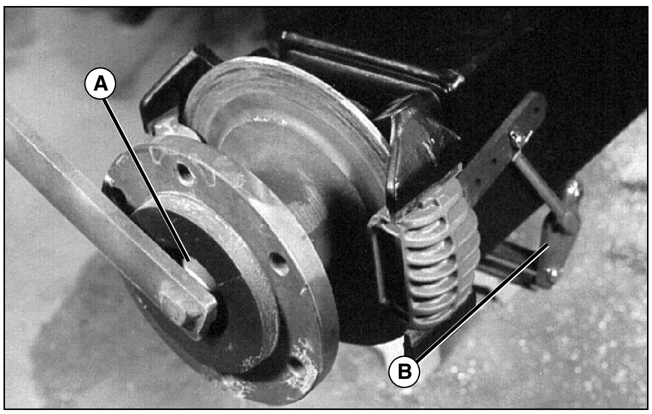
Install Hydrostatic Pump - 3235A and 3235B

1. Installation is performed in reverse order from removal.
2. Be sure that the mounting area on the engine gearbox and the flange area on the pump are clean.
3. Install a new O-ring on the pump flange.

Remove Front Wheel Motor

NOTE: Hydraulic reservoir contains approximately 45 L (12 gallons).

1. Drain hydraulic reservoir.
2. Raise vehicle and install jackstands under the front axle/ reservoir assembly.

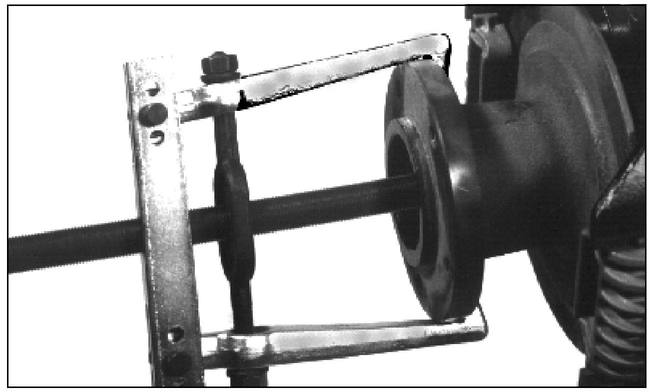


M76519

3. Remove wheel from side of motor removal.
4. Apply parking brake. Remove nut securing disk to wheel motor using a 1-7/16" socket (A).
5. Release parking brake.
6. Remove cotter keys from lower end of brake linkage arms and remove linkage arms from lower linkage pivot (B).

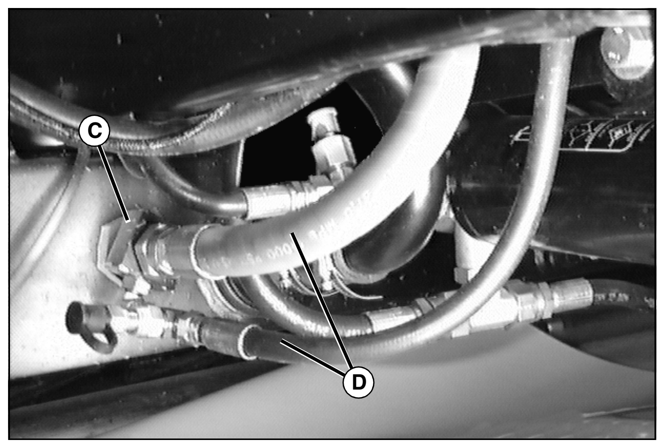
CAUTION: Avoid injury! With tension on disk from puller, disk will release from tapered motor shaft with force. Stand to one side when tapping on puller with hammer.

NOTE: Calipers will be removed with disk.



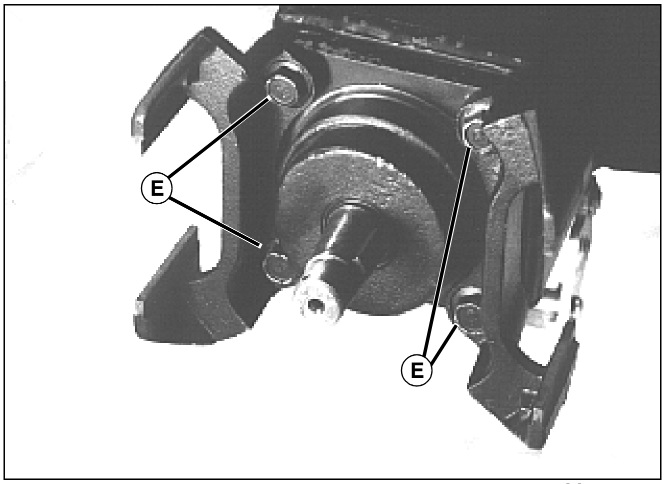
M56621

7. Remove disk from motor shaft using a puller as shown. Apply pressure with puller and tap with hammer.



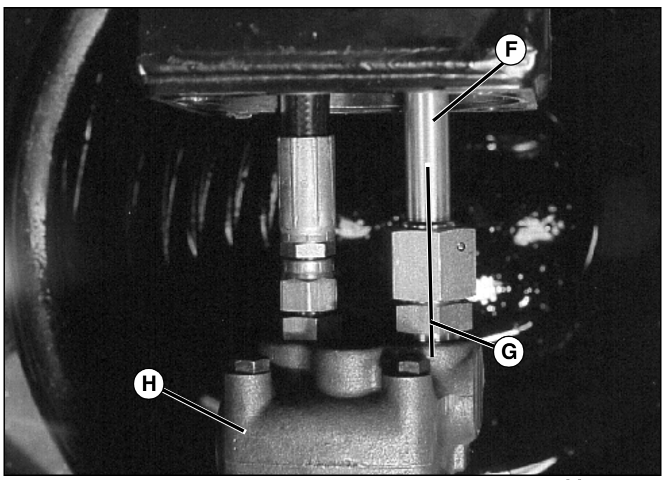
M58756

8. Disconnect hoses (D) from block (C) on back of axle/ reservoir.
9. Loosen jam nut on block.
10. Remove block from reservoir. Block is threaded into another block inside the reservoir.



M56623

11.Remove four cap screws (E) securing motor to front axle/reservoir.



M76520

12.Slide motor (H) out from axle/reservoir.

NOTE: Threaded hole of manifold block on opposite end of hard line must line up with opening in reservoir for reinstallation.

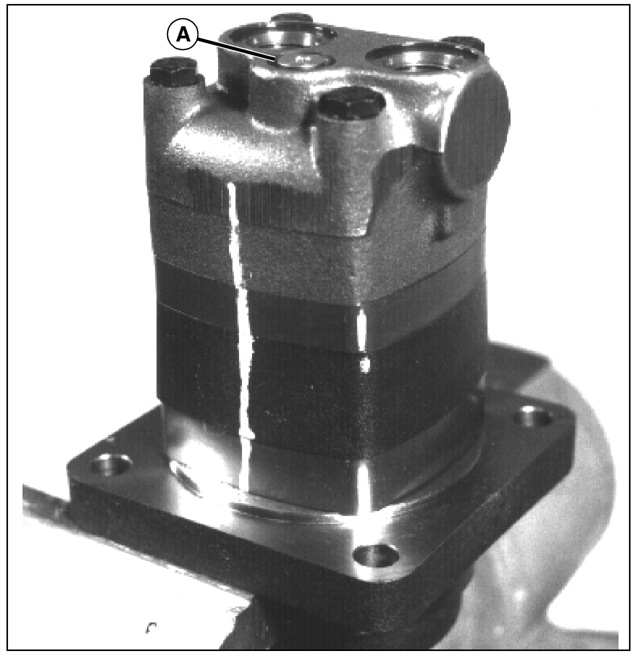
13.Mark an index line (G) before disconnecting hard line (F) from motor to aid in alignment during assembly.

IMPORTANT: Avoid damage! Before disconnecting the lines, clean the port area of the motor and use a wire brush to remove foreign material from the joint areas and burrs that could damage seals when reassembling.

14.Disconnect hydraulic lines from motor and remove motor.

Disassemble Front and Rear Wheel Motor

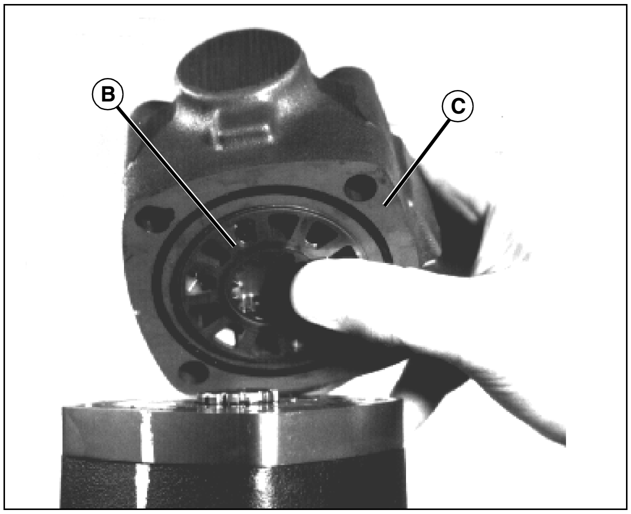
NOTE: Front and rear wheel motors have the same components. The difference between the front and rear wheel motors is the size of the components only.



M56573

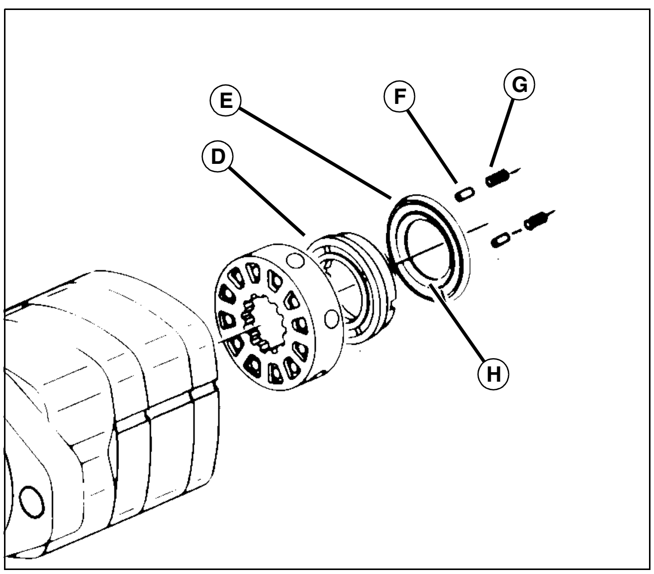
1. Remove fittings from backplate of motor.
2. Remove case drain plug (A) and seal (rear motor only).
3. Place the motor in a vise with output shaft facing down. Use a soft jaw vise or wood between the jaws and avoid excessive clamping pressure. Clamp across the mounting flange of the motor, not the housing.

NOTE: If the valve cannot be removed with the valve housing, be careful not to lose the two pins and springs that may fall from the housing during removal.



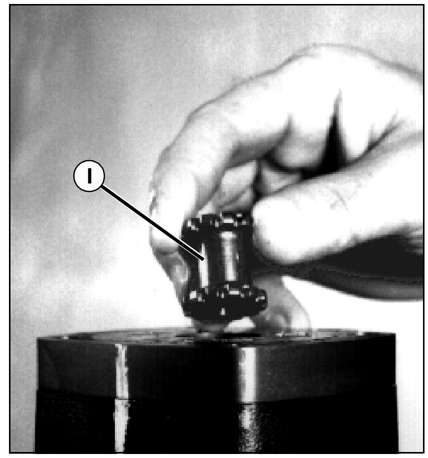
M56574

4. Remove the four cap screws from the valve housing (C). Lift the valve housing just enough to place your finger under the valve (B) and remove the housing with the valve. Place the housing and valve upside down on the bench. Remove valve from housing.



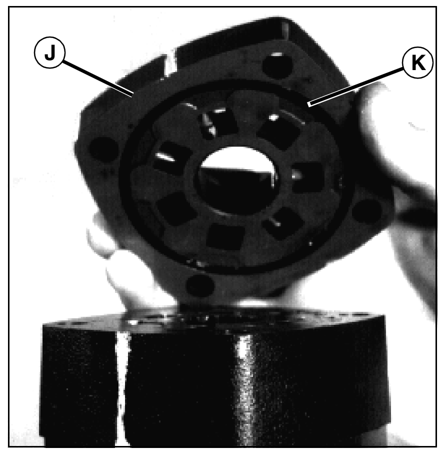
M76529

5. Remove balance ring (D), two pins (F) and springs (G), and inner and outer face seals (H and E).



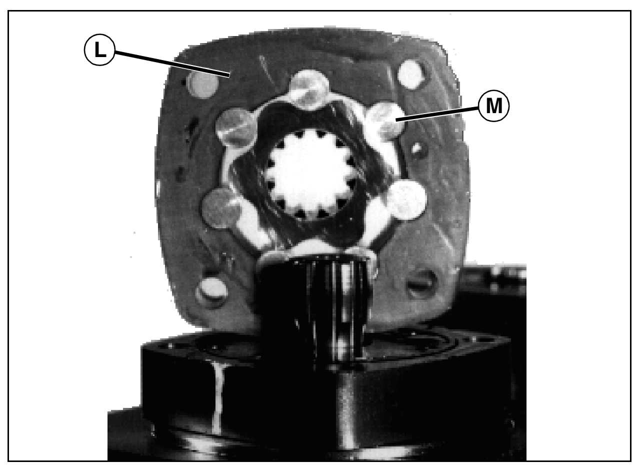
M56575

6. Remove the valve drive (I).



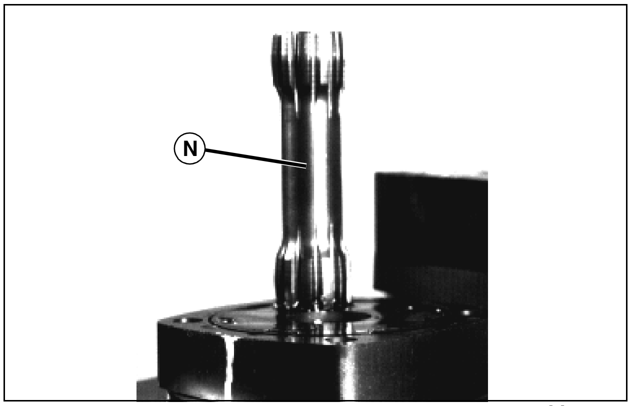
M56576

7. Remove valve plate (J) and seal (K).



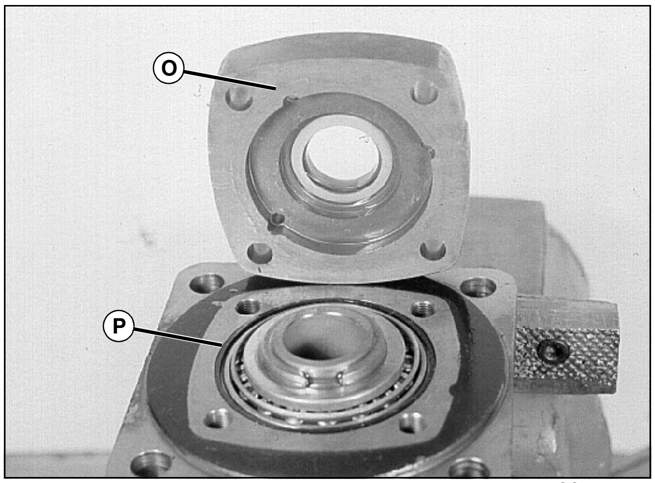
M56577

8. Remove the geroler (L). Be sure to retain the rollers (M) if they are loose.



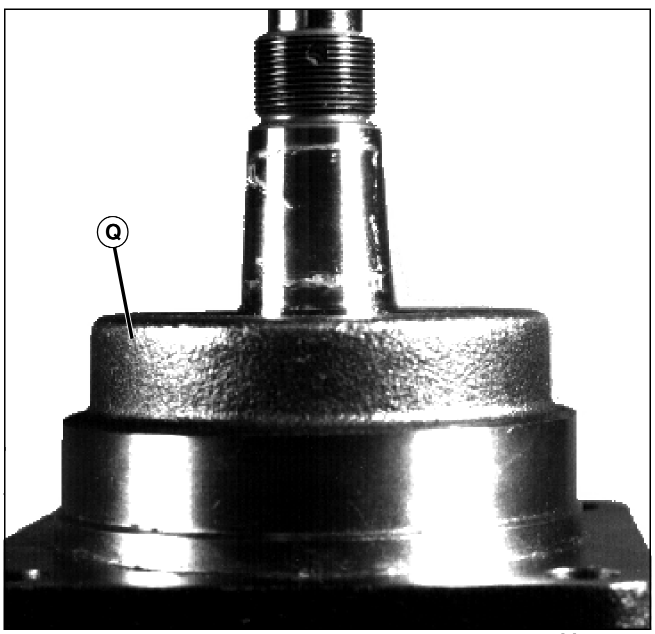
M56578

9. Remove the drive (N).



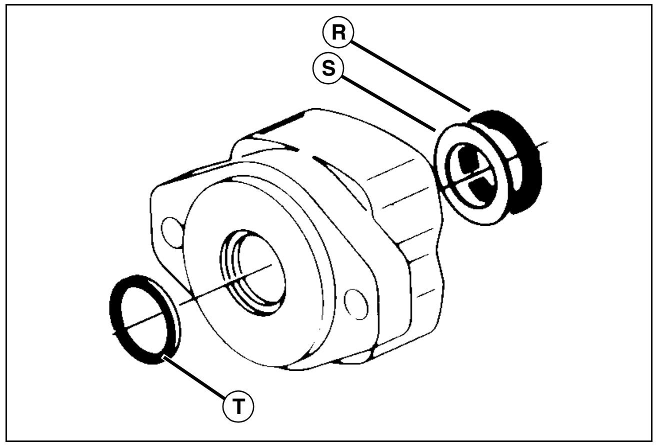
M76525

10.Remove wear plate (O) and seal (P).



M56602

11.Remove drive key and press shaft and bearing assembly from the bearing housing (Q).



M76532

12.Use a small screwdriver and remove the shaft seal (R), backup washer (S) and exclusion seal (T). Be careful not to damage housing bore.

Inspect Front and Rear Wheel Motors

IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection. DO NOT use coarse grit or try to file or grind these parts.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage.

Assemble Front and Rear Wheel Motors

Special or Required Tools

Tool Name	Tool No.	Tool Use
Balance Ring Tool	JDG859	Used to install balance ring.

NOTE: Always use new seals. Lubricate all seals with petroleum jelly prior to installation.

M56583

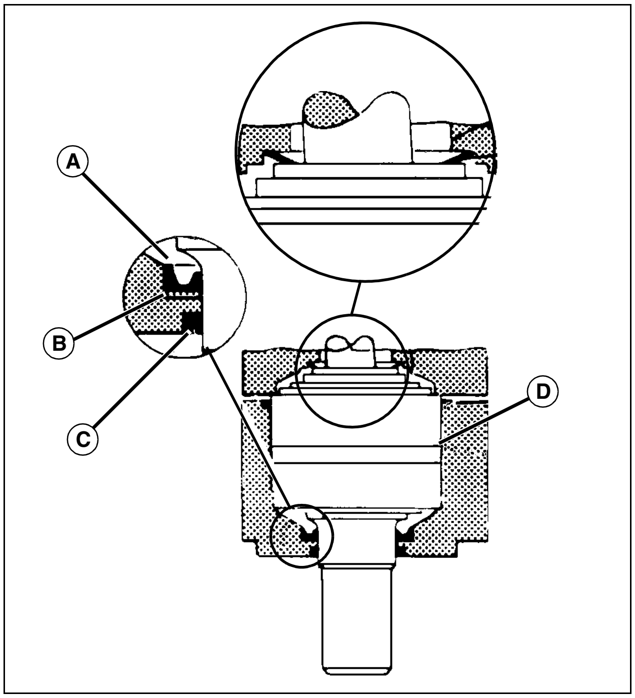
1. Use a press to install exclusion seal (C) in outer bore of bearing housing. Lip of seal must face outward. If a press is not available, use a plastic or rubber hammer. Be careful not to damage or cock seal in bore.

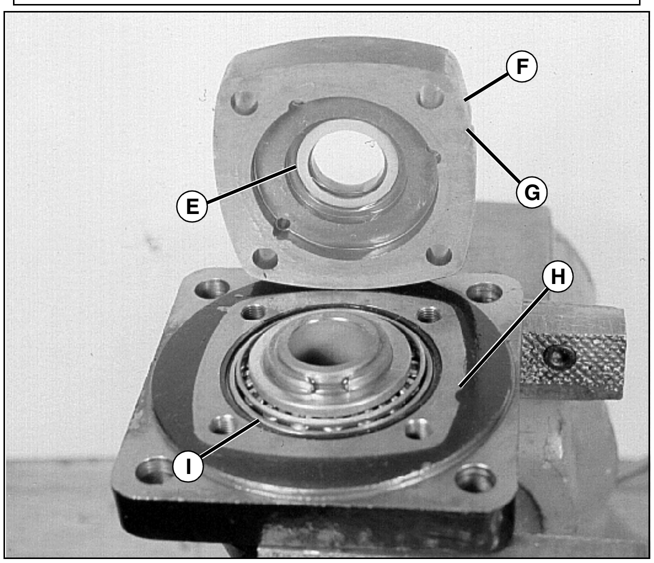
2. Place back-up washer (B) into seal bore.

3. Press shaft seal (A) in housing bore with a suitable seal driver.

4. Apply petroleum jelly to inside diameter of dust and shaft seal.

5. Press bearing assembly (D) into housing. DO NOT distort shaft seal.



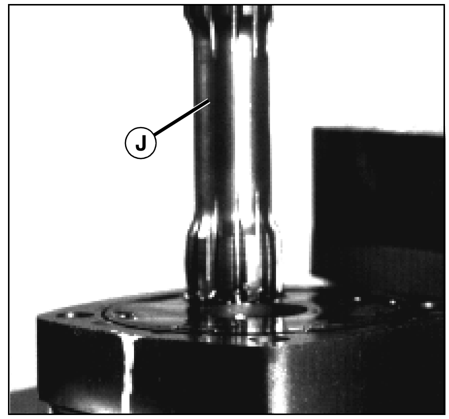


M76525

6. Apply petroleum jelly to diameter seal (I) and install into seal groove.

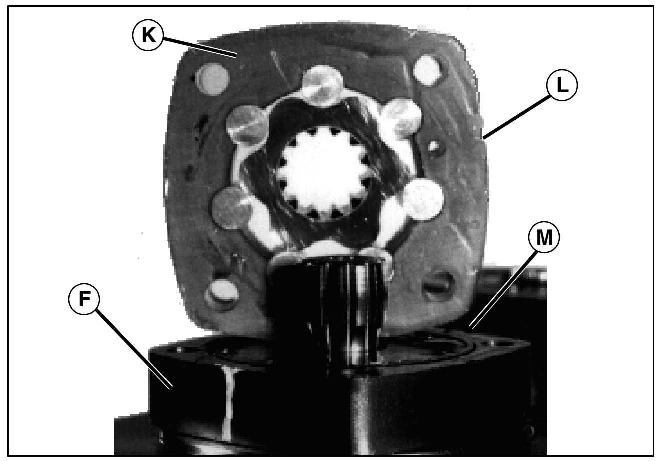
7. Install shaft face seal (E) in wear plate (F). Inner diameter edge of shaft face seal must contact shaft and bearing assembly when assembled.

8. Install wear plate. Align notch (G) in wear plate with housing by looking for matching paint mark (H).



M56578

9. Install drive shaft (J).

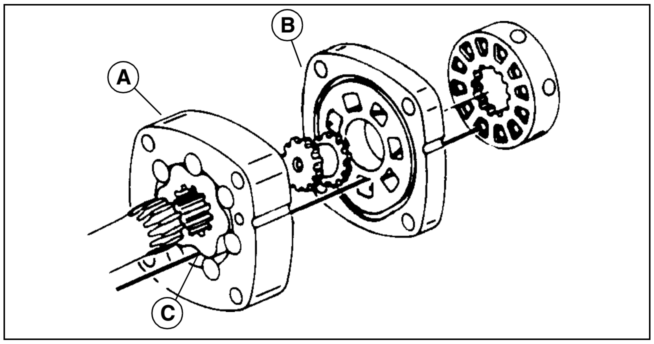


M56577

10.Align the notch (L) on the geroler (K) with the notch (M) on the wear plate (F). Install the geroler against the wear plate. Ensure the rollers stay with the outer ring if loose.

Timing

IMPORTANT: Avoid damage! Installation now involves timing in three steps. Timing determines the direction of rotation of the output shaft. All motors, regardless if left side or right side, will be timed the same way.



M56584

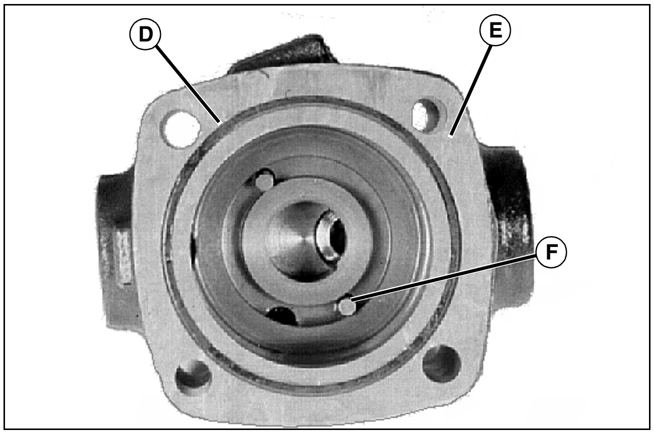
1. **Timing Step #1 -** Locate the largest open pocket (C) in the geroler (A) and mark it on the outside edge of the geroler.

2. Apply a light film of petroleum jelly to the diameter seal. Install seal in groove of valve plate (B).

3. Align the notch on the outside of the valve plate with the notch on the geroler. Place valve plate on geroler.

4. **Timing Step #2 -** Locate the slot opening in the valve plate that is in line with the largest open pocket of the geroler.

5. **Timing Step #3 -** Locate any one of the side openings of the valve. Then align the opening with the open slot of the valve plate that is in line with the largest open pocket of the geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth maximum).

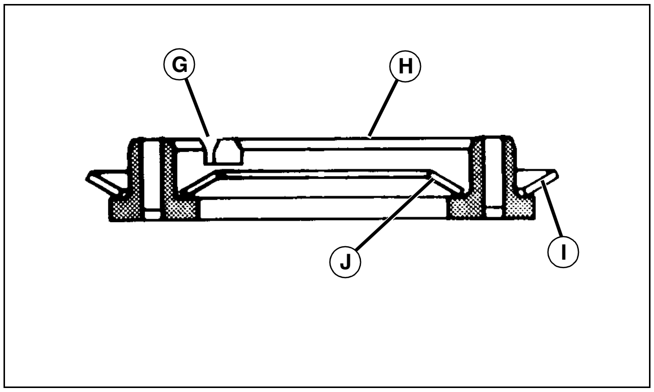


M76527

6. Install two springs and two pins (F) in the holes located in the bore of the valve housing (E).

7. Apply a light film of petroleum jelly to the diameter seal (D) and install seal in valve housing.

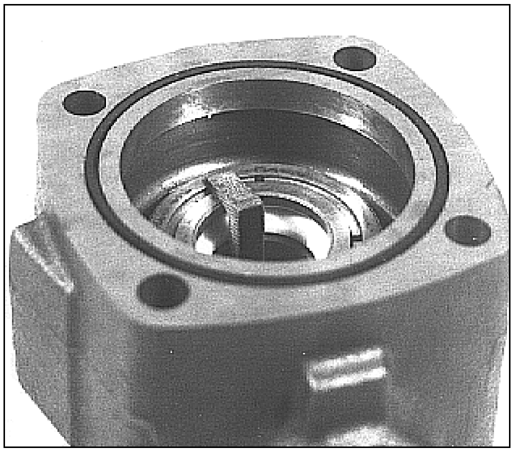
IMPORTANT: Avoid damage! Install face shields in the positions shown or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.



M76533

8. Apply petroleum jelly to inner and outer face seals (J and I) and install seals on balance ring (H) as shown.

9. Align pin notches (G) in balance ring with pins in valve housing.



M56600

10.While holding the balance ring in position with your fingers, insert the foot of the balance ring tool through the port that leads to the center of the valve housing.

M56601

11.Rotate the foot of the tool over the balance ring and gently pull the tool back to hold the balance ring in position.

12.Install the valve housing on the motor, rotate the foot of the tool and remove it from the valve housing port.

13.Check for proper alignment by pushing down on the valve housing. A slight spring action should be felt. If not, repeat steps 9-12.

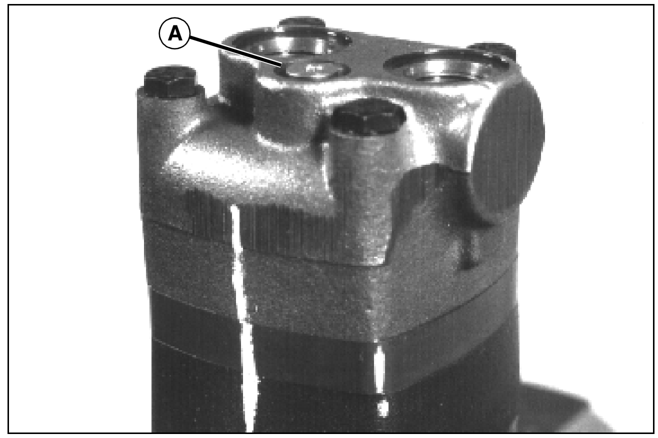
14.Install the tie bolts evenly and tighten to specifications.

Specifications

Motor Housing Cap Screw Torque . . .   50 N•m (37 lb-ft)

Install Front Wheel Motor

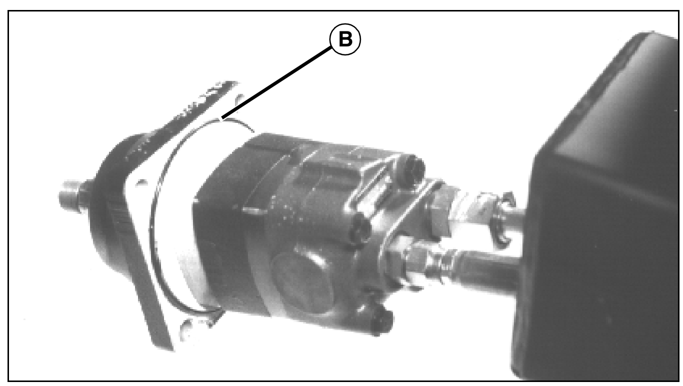
IMPORTANT: Avoid damage! Hydraulic reservoir and associated plumbing should be flushed to remove any contamination before installing wheel motors. This is especially critical following internal failure of wheel motors.



M56573

IMPORTANT: Avoid damage! Make sure that motor does not have a drain plug in the case drain port. If plug is present on unit being rebuilt, remove it. If new unit has a plug, remove it.

See Specifications and Information section before installing O-ring boss fittings and O-ring face seal fittings.



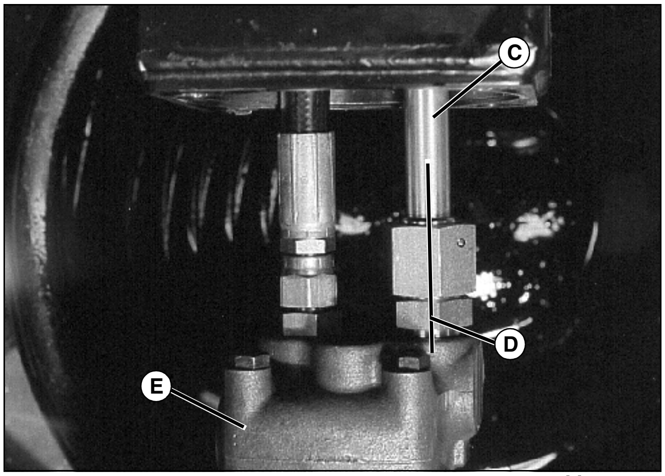
M56622

1. Remove plug (A,) if installed.

2. Lubricate large O-ring (B) with petroleum jelly and install O-ring.

3. Lubricate small O-rings and install on fittings. Install fittings on motor end-head. Tighten fittings to specifications.

4. Lubricate small O-rings with petroleum jelly. Install O-rings; connect hydraulic lines. Tighten the larger line and the smaller line to specifications.

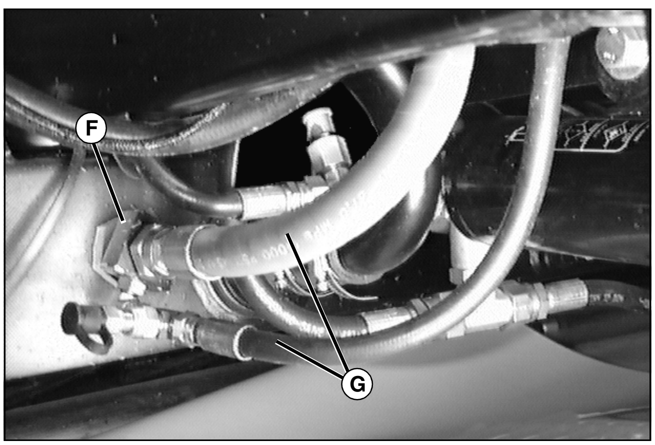


M76520

5. Index line (D) made during removal will aid in alignment of manifold block on opposite end of hard line (C).

NOTE: Threaded hole of manifold block on opposite end of hard line must line up with opening in reservoir for installation of block on rear of reservoir.

6. Position motor (E) into housing. Ensure that the female end of the hard line aligns with opening at rear of axle housing.

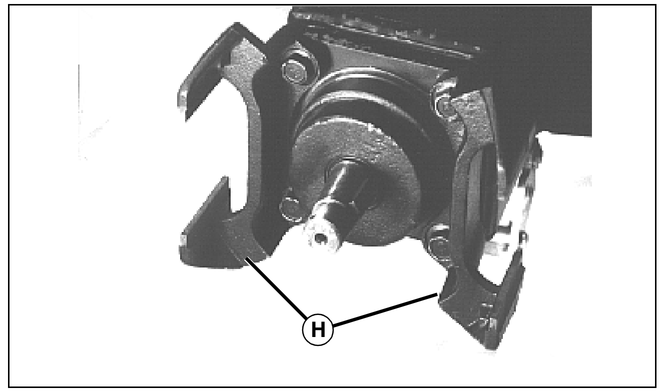


M58756

7. Thread block (F) into manifold block in reservoir which is on the end of hard line from hydrostatic motor. Tighten block to specifications.

8. Tighten jam nut on block to secure block to axle/ reservoir. Tighten until flush plus 1/4 turn.

9. Attach hoses (G) from rear hydrostatic motors and hydrostatic pump to block.



M56623

10.Install caliper mounting brackets (H) and secure with four cap screws. Tighten to specifications. Install key.

11.Position calipers onto disk with arms facing up in relaxed position. Install disk and calipers onto keyed shaft as an assembly.

12.Install linkage arms and cotter pins.

13.Apply parking brake.

14.Install nut and tighten to specifications.

Specifications

Motor Fitting Torque . . . . 46 N•m (34 lb-ft)

Large Hydraulic Line Torque. . . . . 102 N•m (75 lb-ft)

Small Hydraulic Line . . . . 50 N•m (37 lb-ft)

Manifold Block Torque. . . . . 176 N•m (130 lb-ft)

Caliper Mounting Bracket Bolt Torque 140 N•m (105 lb-ft)

Caliper Nut Torque . . . . 190 N•m (140 lb-ft)

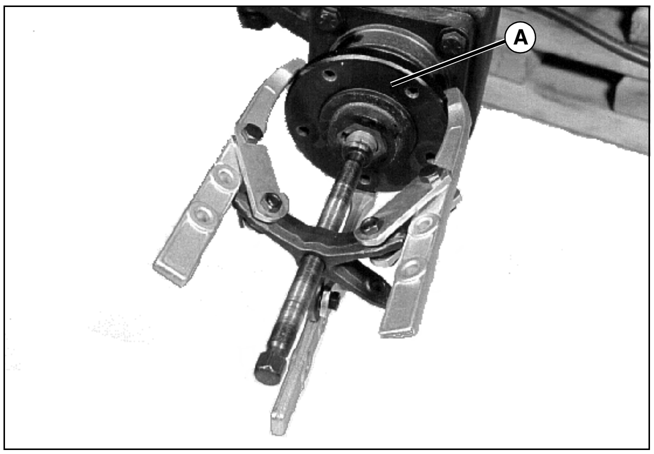
Remove Rear Wheel Motor - Four-Wheel Drive Only

1. Park vehicle on a level surface and lock park brake.
2. Raise rear of vehicle and support safely with jackstands or wood blocks.
3. Remove rear wheel from side of machine requiring motor removal.

NOTE: Pipe wrench is used to prevent disk from rotating when removing nut without air tools.

4. Remove nut from keyed motor shaft with 1-7/16” socket.

CAUTION: Avoid injury! Disk will release from motor shaft with force. Stand out of the way of disk when tapping with hammer.



M76522

5. Remove disk (A) from motor shaft using a three-jaw puller by applying tension on disk and tapping with a hammer.
6. Remove hydraulic lines from motor.
7. Remove four mounting bolts from hydraulic mounting flange.
8. Remove motor from rear axle housing.

Install Rear Wheel Motor - Four-Wheel Drive Only

1. Place hydrostatic motor in rear axle housing.
2. Position motor so the fittings on the backplate of the motor face rear of the machine.
3. Install four bolts through motor mounting flange and into rear axle housing. Tighten to specifications.
4. Install hydraulic lines on motor.
5. Place disk on motor shaft and install nut. Use pipe wrench to keep disk from turning if not using air tools. Tighten to specifications.
6. Install wheel and tire assembly.
7. Start machine and operate motor to determine if motor rotates in the proper direction.

If motor rotates in wrong direction, the hydraulic lines are reversed or timing procedure of the motor is incorrect. See Motor Assembly for proper timing procedure.

Specifications

Rear Axle Housing Bolt Torque (4 used) . 140 N•m (105 lb-ft)

Disc Torque. . . . . 190 N•m (140 lb-ft)

Start-Up Procedure

IMPORTANT: Avoid damage! Follow this procedure to properly purge the hydrostatic drive system before returning the machine to service.

1. Ensure hydraulic reservoir is full.
2. Disconnect fuel shutoff solenoid connector and crank engine for 15 seconds.
3. Reconnect fuel shutoff solenoid connector.
4. With transmission in neutral, start engine and run at slow idle.
5. Operate steering and lift system through several cycles. Slowly operate the machine in forward and reverse to purge the air from the system.
6. Check and replenish the reservoir.
7. Check all connections for leaks and tighten if necessary.
8. Short hour filter changes are recommended for the first two changes after returning the machine back to service. Change the first filter after 3-5 hours of operation and the second after 50 hours.

Table of Contents

Specifications

General Specifications

Triple Pump (Front Gear Set)

Make. . . . . Danfoss
Flow . . . . 16.1 L/min (4.25 gpm)
Required Pressure at Hydro Input . . . . 414-1103 kPa (60 -160 psi)
Relief Valve Setting - 3215, 3215A, 3215B, 3225B and 3235 (In Hydro) . . . . 758-1103 kPa (110-160 psi)
Relief Valve Setting - 3235A and 3235B (In Hydro) . . . . 1310-1861 kPa (190-270 psi)

Reel Pumps

Make. . . . . Danfoss
Flow . . . . (8 gpm)
Type . . . . Gear, Positive Displacement

Reel Motor

Make. . . . . Danfoss
Type . . . . Gear, with case drain flow

Reel Speeds @ 2900 Engine RPM (Engine Not Loaded)

3235/3235A w/22H Reels . . . . 1500 ± 100 rpm
3215, 3215A and 3235, 3235A w/22M Reels . . . . 2500 ± 125 rpm
3215B, 3225B, and 3235B Reels (Standard). . . . . 2800 ± 150 rpm
3215B, 3225B, and 3235B Reels (EPS) . . . . 1600 ± 150 rpm

Front Inboard and Rear Lift Cylinders

Stroke . . . . 152 mm (6 in.)
Compressed Length. . . . . 289 mm (11-3/8 in.)

Front Outer Lift Cylinder

Stroke . . . . 152 mm (6 in.)
Compressed Length. . . . . 1000 mm (39-3/8 in.)

Hydraulic Filter

Type . . . . Spin on
Clogged Filter Bypasses Fluid to Tank At . . . . 344.74 kPa (50 psi)
Filter Bypass Light Comes On At . . . . 275.79 kPa (40 psi)

Test and Adjustment Specifications

Reel Motor System Relief Pressure . . . . 20 684 ± 1380 kPa (3000 ± 200 psi)
Reel Pump (Triple Pump, Middle and Rear Gear Sets) Flow @17237 kPa (2500 PSI) . . . . 24.2 L/min (6.4 gpm)
Reel Motor Case Drain Flow (Maximum) . . . . 3.08 L/min (1 gpm)
Lift System Relief Valve Pressure. . . . . 13 100 ±1380 kPa (1900 ± 200 psi)

Repair Specifications

Lift Valve

Spool Retainer Torque . . . . 28-32 N•m (21-24 b-ft)

Plunger Torque . . . . 47-54 N•m (35-40 lb-ft)

Coil Nut Torque . . . . 2-3 N•m (15-25 lb-ft)

Triple Pump - 3215, 3215A, 3235 and 3235A

Rear Pump Assembly Allen Head Screw (3/8-in. x 1-1/2-in.) Torque . . . . 40-43 N•m (30-32 lb-ft)

Rear Pump Assembly Allen Head Screw (5/16-in. x 3-in.) Torque. . . . . 21-24 N•m (190-210 lb-in.)

Center Pump Assembly Allen Head Screw (3/8-in. x 1-1/4-in.) Torque . . . . 40-43 N•m (30-32 lb-ft)

Front Pump Assembly Allen Head Screw (3/8-in. x 1-1/2-in.) Torque . . . . 40-43 N•m (30-32 lb-ft)

Front Pump Assembly Allen Head Screw (5/16-in. x 4-in.) Torque. . . . . 21-24 N•m (190-210 lb-in.)

Front Pump Assembly Allen Head Screw (5/16-in. x 3-in.) Torque. . . . . 21-24 N•m (190-210 lb-in.)

Triple Pump - 3215B, 3225B and 3235B

Allen Head Screw (3/8-in.) Torque. . . . . 40-43 N•m (30-32 lb-ft)

Allen Head Screw (5/16-in.) Torque. . . . . 21-24 N•m (190-210 lb-in.)

Reel Motor

Reel Motor Housing Screw Torque . . . . 21.5-23.7 N•m (190-210 lb-in.)

Backlapping Valve

Solenoid Coil. . . . . 94.9 N•m (70 lb-ft)

Solenoid Plunger . . . . 27.1-33.9 N•m (20-25 lb-ft)

Flow Control Valve . . . . 61.0-67.8 N•m (45-50 lb-ft)

Pressure Relief Valve . . . . 61.0-67.8 N•m (45-50 lb-ft)

Forward/Reverse Valve . . . . 237.3 N•m (175 lb-ft)

Forward/Reverse Switch . . . . 13.6-20.3 N•m (10-15 lb-ft)

Tools and Materials

Tools

Special or Required Tools

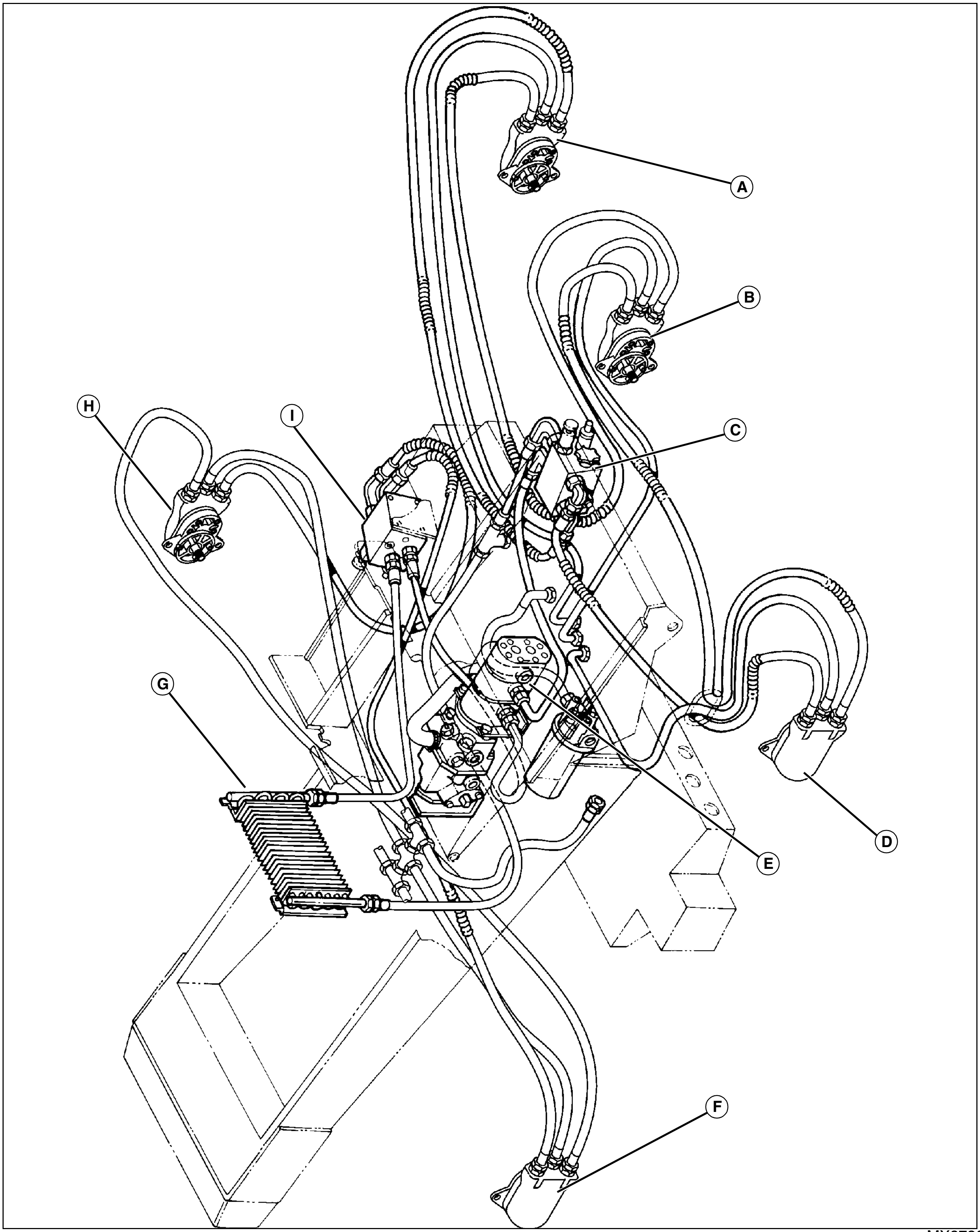
Tool Name	Tool No.	Tool Use
Swivel Tee Fitting	38H1030	Used to test reel motors pressure relief. Used to test lift system relief valve pressure. Part of BM18319 diagnostic Kit.
Hose	AMT846	Used to test reel motors pressure relief. Used to test lift system relief valve pressure. Part of BM18319 diagnostic Kit.
In-Line Hydraulic Tester	D01074AA	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 3/4” F NPT x 1-1/16” F 37° (2)	JT03012	Used to test reel pump flow. Used to measure reel motor case drain.
Hose 34 474 kPa (5000 PSI)	JT03017	Used to test lift system relief valve pressure.
Gauge 20 684 kPa (3000 PSI)	JT03345	Used to test lift system relief valve pressure.
Gauge 70 000 kPa (10,000 PSI)	JT03362	Used to read front reel motor pressure.
Hose 70 000 kPa (10,000 PSI)	JT03364	Used to attach pressure gauge.
120” Hydraulic Test Hoses (2)	JT03377	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-1/16” M 37° x 1-3/16” M ORFS	JT03483	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-3/16” F ORFS x 13/16” M ORFS	JT03484	Used to test reel pump flow. Used to measure reel motor case drain.
0-7000 kPa (0-1000 psi) gauge	JT05471	Used to test optional down pressure valve.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to test reel motor relief pressure. Used to test lift system relief valve pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector 1-1/16” M 37° x 13/16” F ORFS	JT05688	Used to test reel pump flow. Used to measure reel motor case drain.
Quick Disconnect Fitting	MT1531	Used to test reel motors pressure relief. Part of BM18319 diagnostic Kit. Used to test lift system relief valve pressure.
Female Quick Coupler	RE48122	Used to test reel motors relief pressure. Used to test lift system relief valve pressure. Part of BM18319 diagnostic Kit.
Cover	XPD6-285	Used to test reel motors pressure relief. Part of BM18319 diagnostic Kit.
1/2” ID hose 24” long (2)	NA	Used to measure reel motor case drain.

Component Location

Reel Drive Component Location

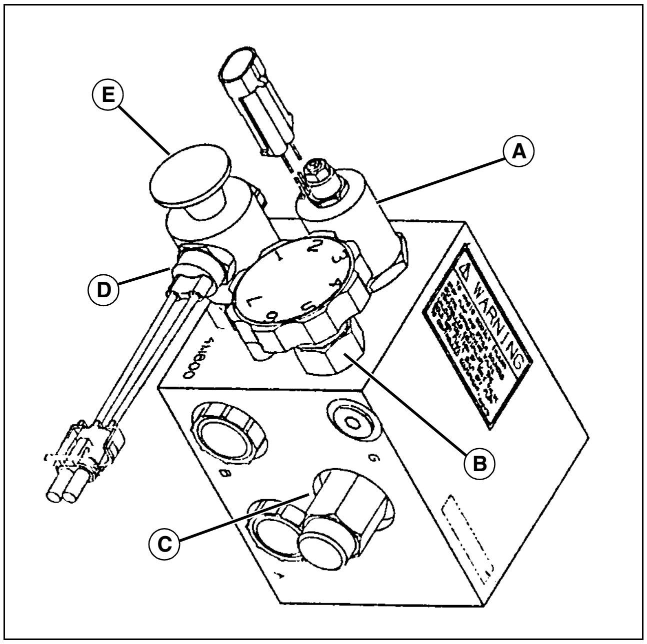


MX2730

HYDRAULICS COMPONENT LOCATION

A - Left Front Reel Motor
B - Center Front Reel Motor
C - Backlapping Valve (Front)
D - Right Front Reel Motor
E - Triple Pump Assembly
F - Right Rear Reel Motor
G - Hydraulic Oil Cooler
H - Left Rear Reel Motor
I - Backlapping Valve (Rear)

Backlapping Valve Assembly

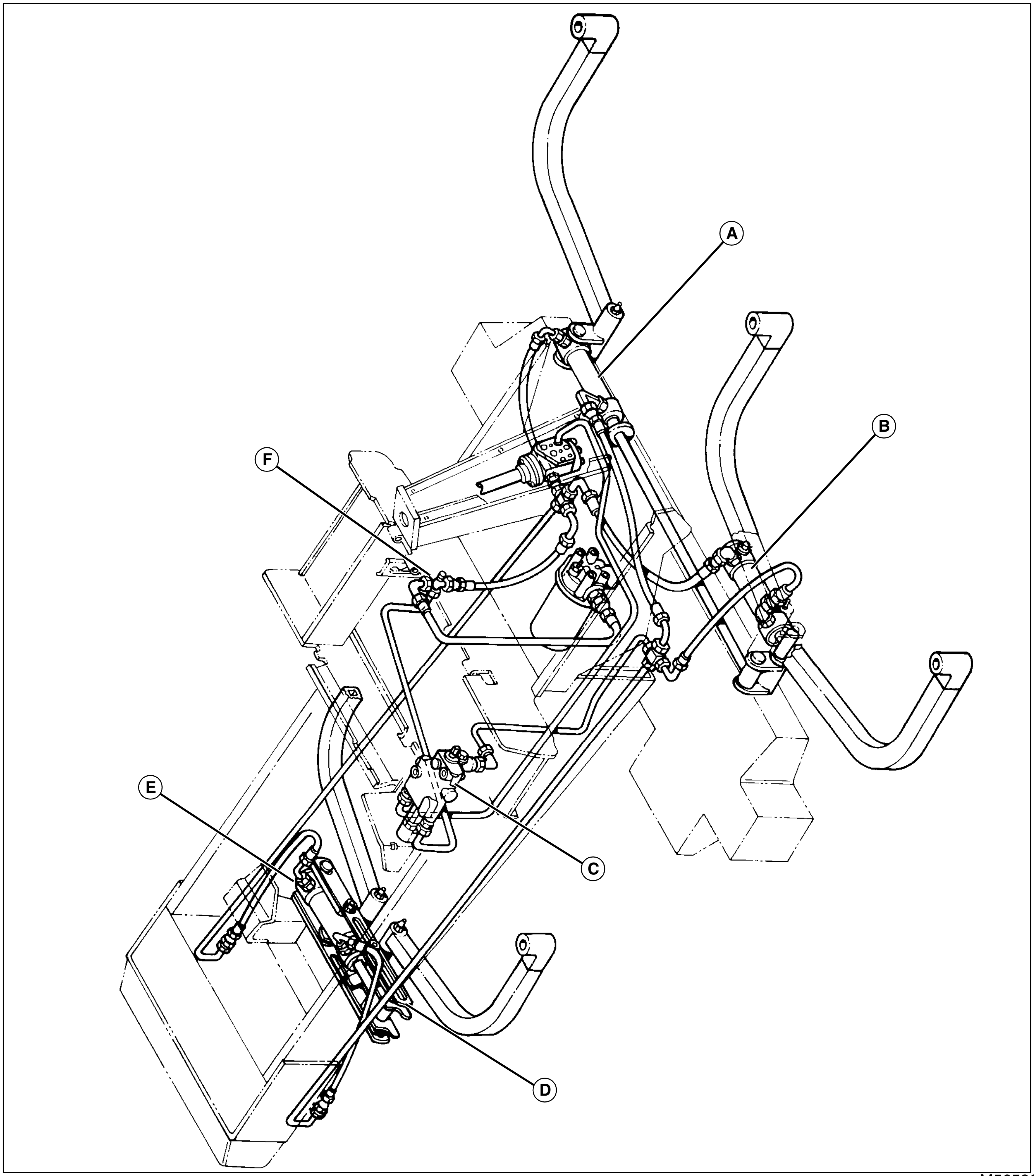


M56667

- **A - Mow Valve**
- **B - Flow Control Valve**
- **C - Logic Element**
- **D - Switch**
- **E - Forward/Reverse Valve**

HYDRAULICS COMPONENT LOCATION

Lift System Component Location

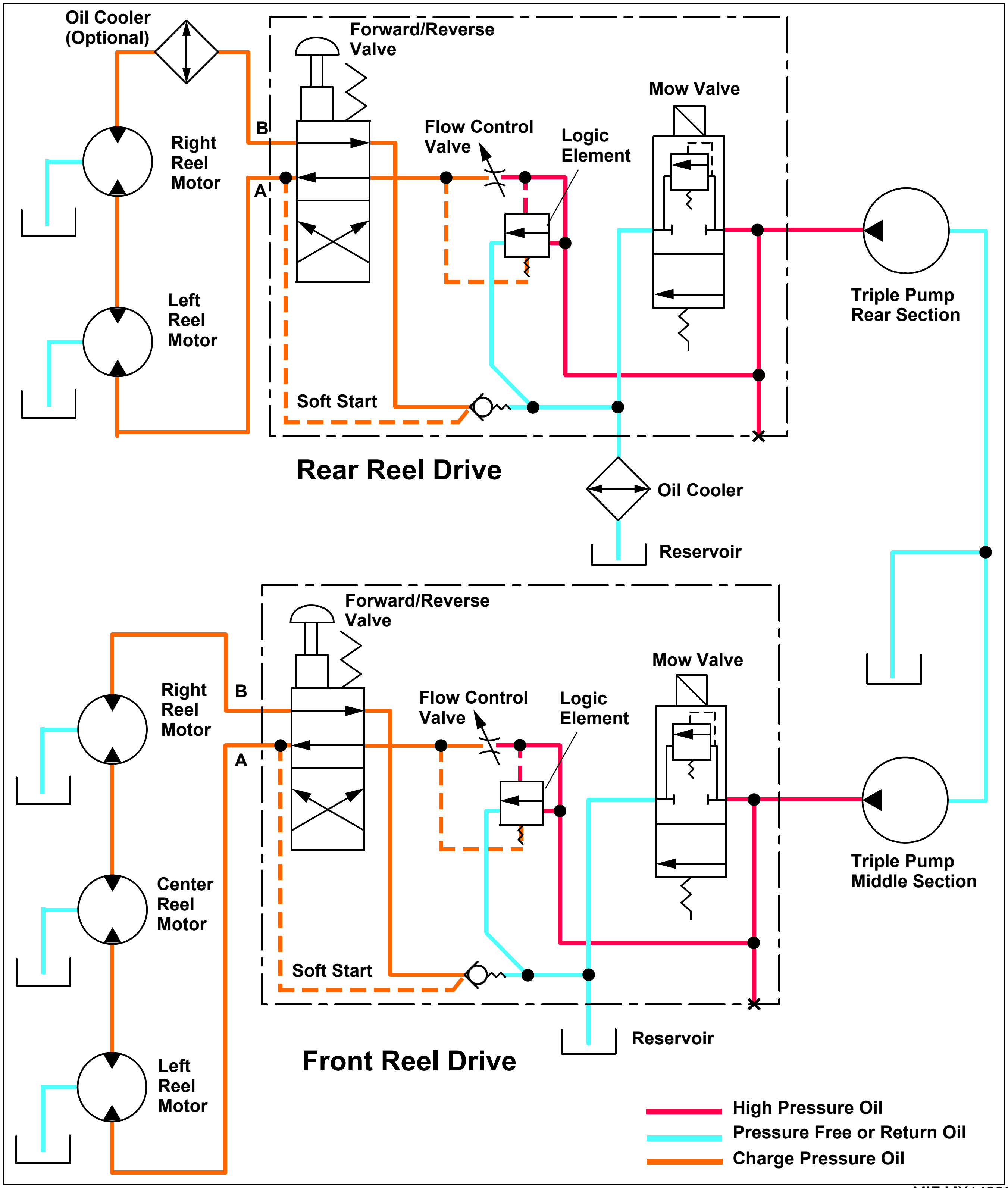


M56590

- **A - Left/Right Wing Lift Cylinder**
- **B - Center Lift Cylinder**
- **C - Lift Valve**
- **D - Lost Motion Linkage**
- **E - Rear Lift Cylinder**
- **F - Optional Down Pressure Valve**

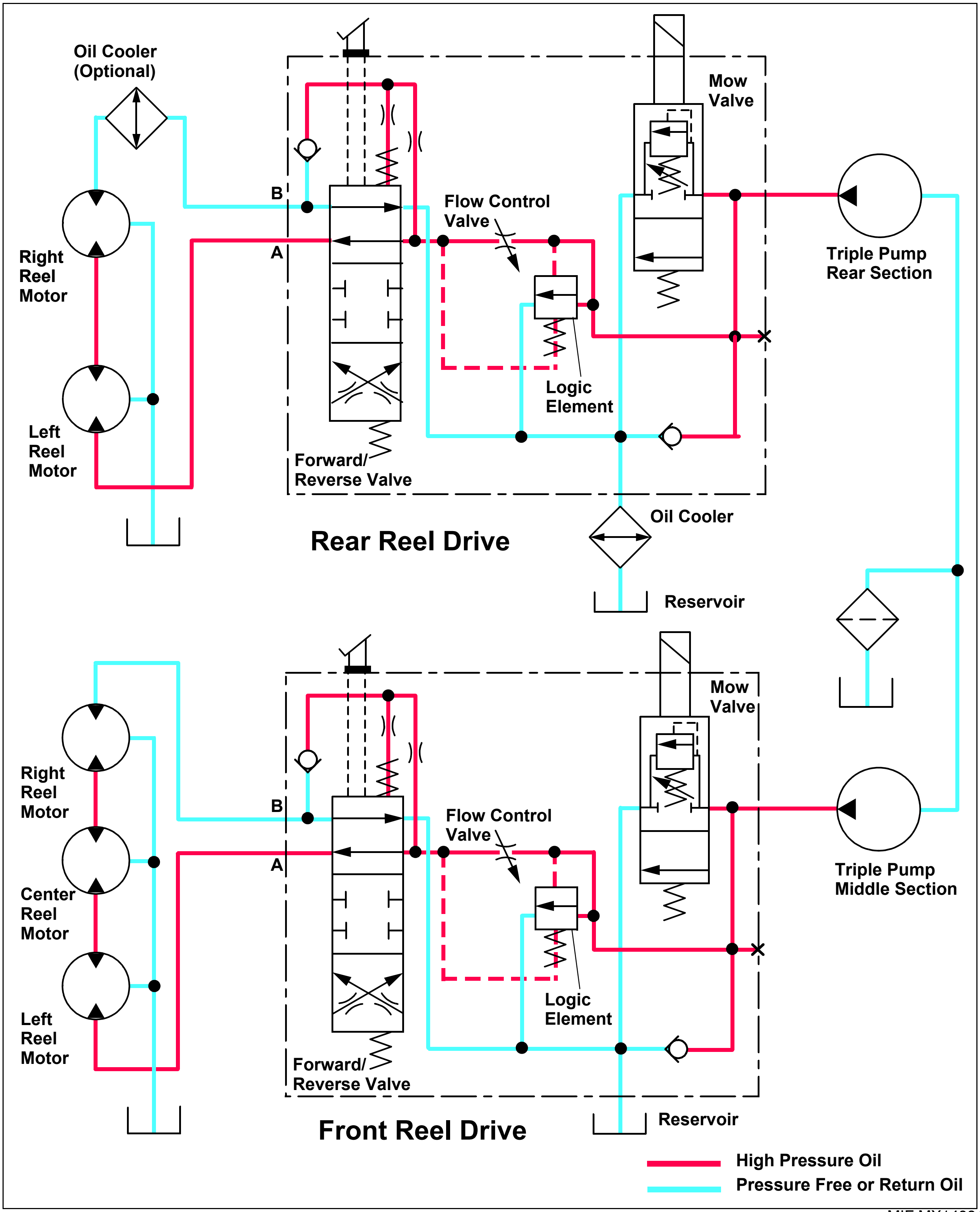
Schematics

Reel Drive Hydraulic Schematic - 3215, 3215A, 3235, 3235A, 3215B (S.N. -TC3215B010278), 3225B (S.N. -TC3225T010032) and 3235B (S.N. -TC3235F010356) (-TC3235T010380)



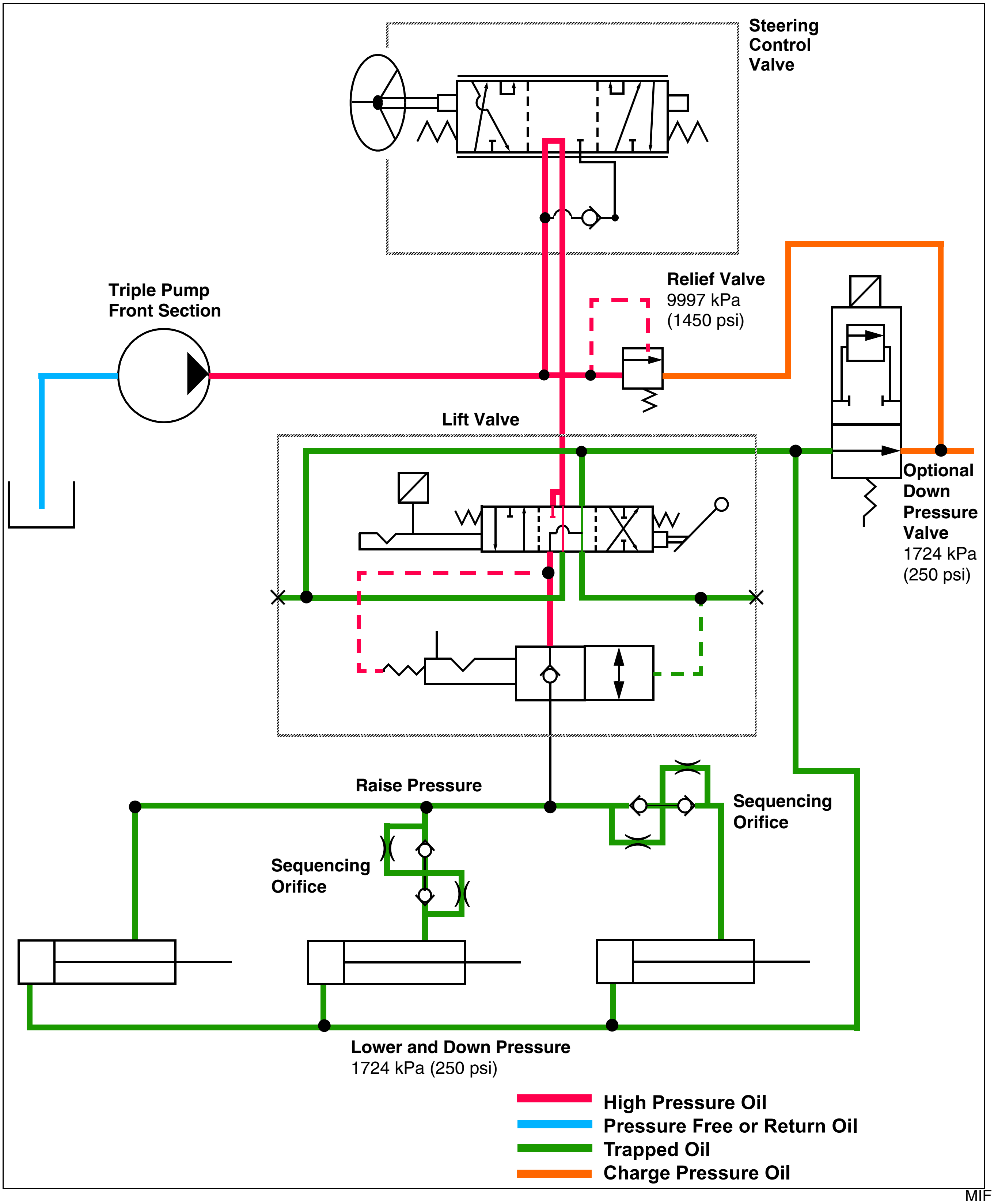
MIF MX14980

Reel Drive Hydraulic Schematic - 3215B (S.N. TC3215B010279-), 3225B (S.N. TC3225T010033-) and 3235B (S.N. TC3235F010357-) (TC3235T010381-)



MIF MX14981

Lift System Hydraulic Schematic



Operation and Diagnostics

Reel Drive System Theory of Operation

System Function

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

Reel Pump

The reel pumps are Danfoss Series YC, positive displacement gear pumps rated at 30.3 L/min (8 gpm). They are part of the triple pump assembly that is mounted to the hydrostatic pump. The rear cutting units are powered by the rear pump section, and the front cutting units are powered by the middle section of the triple pump assembly.

Mow Valve

The mow valve is a solenoid actuated, pressure limiting shuttle valve. It is used to control the flow to the reel motors. The mow valve is energized through the control module during mowing operations. It limits pressure in the reel drive circuit to 20 684 kPa (3,000 psi). The mow valve is contained within the backlapping valve assembly.

Flow Control Valve

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

Forward/Reverse Valve

The forward/reverse valve, located in the backlapping valve assembly, is a manually operated, two-position, push-pull valve that changes fluid flow direction. The knob, when pushed in, directs the fluid flow to the motors for forward cutting. When pulled out, the cutting units will reverse direction for backlapping, and a switch is actuated to allow the engine to run with the operator off the seat and the mow/transport lever in the mow position.

Theory

When the mow solenoid is energized, the pressure limiting part of the mow valve shifts to limit pressure in the mow circuit to a maximum of 20 684 kPa (3,000 psi) at a maximum flow rate of 30.3 L/min (8 gpm).

Pressure and flow are now routed to the flow control valve and logic element. The flow control valve determines the rpm of the reels. Pressure in the reel circuit will vary according to the amount of resistance that the cutting units are generating.

The logic element, a pilot operated dump valve, compares pressure at the inlet and outlet ports of the flow control valve. As the flow is restricted, pressure builds on the input side of the flow control valve to a value higher than that on the output side. This forces the logic element to open and dump excess flow to the tank. As flow returns to the reservoir, pressure to the input side of the flow control valve drops and the logic element closes. The logic element will continue this cycle as needed to equalize pressure on both sides of the flow control valve.

After leaving the flow control valve, fluid enters the forward/reverse valve where it is directed to the forward or reverse side of the reel motors. The forward/reverse valve is spring centered and is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the reel circuit to prevent damage to the cutting units from full pressure start-ups.

After leaving the backlapping valve, flow is directed to the forward or reverse side of the reel motors. The reel motors are connected in series starting with the left front, center, and right front motor.

Lift System Theory of Operation

Function

Provides a means to raise or lower the cutting units for three operating modes:

- Transport
- Mowing
- Service and Backlapping

Triple Pump (Front Gear Set)

The triple pump (front gear set) is a Danfoss model YC direct drive, positive displacement gear pump capable of displacing 16 L/min (4.25 gpm) at 10 342 kPa (1500 psi). The triple pump operates in an “open center series” type hydraulic system consisting of the steering, lift, down pressure (if equipped) and hydrostatic drive systems. Each system has a controlling valve with an open center that allows fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Raise/Lower Valve

The raise/lower valve is a manually operated, spring returned valve with a solenoid that, when energized, will hold the valve in the raise position for three seconds, then release it. This valve has been modified with another valve assembly that is detented to allow fluid to flow in and out of the down side of the lift cylinders when the lever is put in the down position and then released.

Down Pressure Valve (Optional Equipment)

The down pressure valve is used to maintain downward force on the cutting units when mowing. The valve is operated by the rear mow solenoid. Hydraulic pressure is routed through the neutral position of the lift valve and to the down pressure valve. The down pressure valve regulates pressure to the fixed end of the lift cylinder. Pressure is set at the factory to 1724 kPa (250 psi), and can be adjusted to a maximum of 4826 kPa (700 psi). Pressure must be adjusted while the system is pressurized.

Lift System Theory

The lift system receives pressure from the charge pump through the steering valve. The steering valve will take first priority and limited pressure will be available to the lift system during steering operations.

The lift system has two different raised positions which are controlled by the mow/transport lever as follows:

- With the mow/transport lever in the mow position, the raise/lower lever will raise the cutting units slightly to allow for turning the machine during mowing operations.
- With the mow/transport lever in the transport position, the raise/lower lever will raise the cutting units to the full up position for transport or servicing operations.

The lower position is the same for both of the above conditions, and the cutting units will be lowered completely to the ground for cutting or backlapping operations.

The lift valve is solenoid operated (in mow only) and timed to allow lift for three seconds before disengaging. This allows the operator to only tap the lift lever before entering a turn.

The lift system is timed to allow a “clean-up cut” transition off the fairway. As the mower leaves the fairway and the operator moves the raise/lower lever to the raise position, the front cutting units rise first. This allows the rear cutting units to continue cutting until the end of the fairway. Conversely, when the operator is approaching the fairway to begin cutting and moves the raise/lower lever to the lower position, the front cutting units lower first, keeping the rear cutting units raised until they are over the fairway.

Delay of the rear lift arms is done hydraulically when lowering and hydraulically and mechanically when rising. There is a flow restrictor on the rod end of the rear lift cylinder which limits flow and slows the lowering of the rear lift arm. When raising the cutting units, both the front and rear cylinders begin to retract at the same time. Since the rear lift cylinder is mounted on a slotted lost motion link and a flow restrictor limits the flow, the lifting action of the lift arm is delayed.

Reel Drive Troubleshooting

NOTE: The front three cutting units and the rear two cutting units are driven by separate hydraulic systems. Problems that affect both systems are either electrical or lift system related.

Symptom: One Reel Turns Slowly

(1) Is reel-to-bed knife clearance adjusted properly?

Yes - Go to step (2).

No - Adjust reel-to-bed knife clearance to specification. (See "Adjust Reel-to-Bed Knife - 22-In. Standard" on page 402, for standard cutting unit.) (See "Adjust Reel-to-Bed Knife - 22-In. Heavy Duty" on page 406, for heavy duty cutting unit.) (See "Adjust Reel-to-Bed Knife - 2500M" on page 412, for 2500M cutting unit.)

(2) Are cutting unit bearings in good condition?

Yes - Go to step (3).

No - Replace cutting unit bearings

(3) Is reel drive motor operating properly?

No - See "Test Front Reel Motors Case Drain" on page 330. See "Test Rear Reel Motors Case Drain" on page 329.

Symptom: All Reels in One System Are Turning Slowly

(1) Is system relief valve operating properly?

Yes - Go to step (2).

No - Perform reel motors pressure relief test. See "Test Front Reel Motors Pressure Relief" on page 323 for front reels. See "Test Rear Reel Motors Pressure Relief" on page 325 for rear reels.

(2) Is first reel motor in series operating properly?

Yes - Go to step (3).

No - See "Test Front Reel Motors Case Drain" on page 330. See "Test Rear Reel Motors Case Drain" on page 329

(3) Is first cutting unit in series operating properly?

Yes - Go to step (4).

No - Check cutting reel for binding. Adjust or replace worn or damaged parts. See Attachments section for disassembly and inspection procedures.

(4) Is reel drive pump operating properly?

Yes - Go to step (5).

Symptom: All Reels in One System Are Turning Slowly

No - Check pump for wear. See "Test Front Reel Pump Flow" on page 326 for front reels. See "Test Rear Reel Pump Flow" on page 328 for rear reels.

(5) Is flow control valve open fully?

Yes - Go to step (6).

No - Move flow control valve to the fully open position.

(6) Is mow solenoid operating properly?

Yes - Go to step (7).

No - Check if solenoid is energized.

No - Check if solenoid is stuck open.

(7) Is backlapping valve in the down position?

No - Place backlapping valve in the down position.

Symptom: Second and Third Reels Turn Slowly

(1) Is middle cutting unit, reel-to-bed knife clearance adjusted properly?

Yes - Go to step (1).

No - Adjust reel-to-bed knife clearance to specification. (See "Adjust Reel-to-Bed Knife - 22-In. Standard" on page 402, for standard cutting unit.) (See "Adjust Reel-to-Bed Knife - 22-In. Heavy Duty" on page 406, for heavy duty cutting unit.) (See "Adjust Reel-to-Bed Knife - 2500M" on page 412, for 2500M cutting unit.)

(2) Are middle cutting unit bearings operating properly?

No - Replace cutting unit bearings.

Symptom: One Cutting Unit Is Not Turning

(1) Are cutting unit bearings in good working condition?

Yes - Go to step (2).

No - Replace cutting unit bearings

(2) Is reel drive motor operating properly?

Yes - Go to step (3).

No - See "Test Front Reel Motors Case Drain" on page 330 for front reels. See "Test Rear Reel Motors Case Drain" on page 329 for rear reels.

(3) Is coupler between motor and cutting unit in place and in good condition?

Symptom: One Cutting Unit Is Not Turning

No - Repair or replace as necessary.

Symptom: One System Will Not Backlap

(1) Is mow solenoid operating?

Yes - Go to step (2).

No - Check if solenoid valve is stuck open.

(2) Is flow control valve fully open?

Yes - Go to step (3).

No - Move control valve to the fully open position.

(3) Is backlapping valve in the up position?

No - Place backlapping valve in the up position.

Symptom: Pump Noisy

(1) Is hydraulic oil reservoir at proper level?

Yes - Go to step (2).

No - Fill reservoir to proper level with recommended oil.

(2) Is reel drive pump operating properly?

No - Check pump for wear. See "Test Front Reel Pump Flow" on page 326 for front pump. See "Test Rear Reel Pump Flow" on page 328 for rear pump.

Lift System Troubleshooting

Symptom: Front and Rear Lift Arms Will Not Lower

(1) Is lift valve operating properly?

Yes - Go to step (2).

No - Repair or replace lift valve as required.

(2) Is down pressure valve operating properly?

No - Perform down pressure valve test. See "Test Optional Down Pressure Valve" on page 332.

Symptom: Front and Rear Lift Arms Will Not Rise

(1) Is engine speed to specification?

Yes - Go to step (2).

No - perform fast idle adjustment.

(2) Is steering system leakage within specification?

Yes - Go to step (3).

Symptom: Front and Rear Lift Arms Will Not Rise

No - Perform steering system leakage test. See "Test Steering System Leakage" on page 370.

(3) Is lift system free of air?

Yes - Go to step (4).

No - Start engine and cycle lift arms to purge air from system.

(4) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (5).

No - Tighten fittings and replace O-rings as needed.

(5) Is charge pressure within specification?

Yes - Go to step (6).

No - Perform lift system relief valve pressure test. See "Test Lift System Relief Valve Pressure" on page 331

(6) Is lift valve operating properly?

Yes - Go to step (7).

No - Repair or replace as needed.

(7) Is down pressure valve operating properly?

No - Perform down pressure valve test. See "Test Optional Down Pressure Valve" on page 332.

Symptom: Front and Rear Lift Arms Will Not Stay in Raised Position

(1) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (2).

No - Tighten fittings and replace O-rings as needed.

(2) Is lift valve operating properly?

Yes - Go to step (3).

No - Repair or replace lift valve as needed.

(3) Is down pressure valve operating properly?

No - Perform down pressure valve test. See "Test Optional Down Pressure Valve" on page 332.

Symptom: Rear Lift Arms Will Not Rise

(1) Is engine speed to specification?

Yes - Go to step (2).

No - perform fast idle adjustment.

Symptom: Rear Lift Arms Will Not Rise

(2) Is lift system free of air?

Yes - Go to step (3).

No - Start engine and cycle lift arms to purge air from system.

(3) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (4).

No - Tighten fittings and replace O-rings as needed.

(4) Is charge pressure within specification?

Yes - Go to step (5).

No - Perform lift system relief valve pressure test. See “Test Lift System Relief Valve Pressure” on page 331.

(5) Is steering system leakage within specification?

Yes - Go to step (6).

No - Perform steering system leakage test. See “Test Steering System Leakage” on page 370.

(6) Is rear lift cylinder delay orifice free from obstructions?

Yes - Go to step (7).

No - See “Remove and Install Rear Lift Cylinder Flow Restrictor” on page 338.

(7) Is lost motion linkage on rear lift cylinder operating properly?

No - See “Remove and Install Rear Lift Cylinder Lost Motion Linkage” on page 339.

Symptom: Rear Tilt Arms Will Not Lower

(1) Is rear lift cylinder delay orifice free from obstructions?

Yes - Go to step (2).

No - See “Remove and Install Rear Lift Cylinder Flow Restrictor” on page 338.

(2) Is lost motion linkage on rear lift cylinder operating properly?

No - See “Remove and Install Rear Lift Cylinder Lost Motion Linkage” on page 339.

Symptom: Rear Tilt Arms Rise Too High

(1) Is rear lift arm stop in the down position?

No - Move stop into the down position.

Tests and Adjustments

Test Front Reel Motors Pressure Relief

Reason

To ensure that front reel pressure relief valve is operating properly.

Special or Required Tools

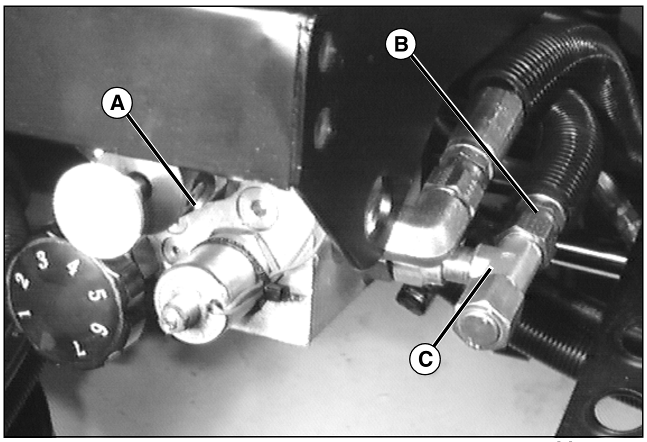
Tool Name	Tool No.	Tool Use
Quick Disconnect Fitting	MT1531	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Swivel T-Fitting	38H1030	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Cover	XPD6-285	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Hose	AMT846	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Female Quick Coupler	RE48122	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Hose 70 000 kPa (10,000 psi)	JT03364	Used to attach pressure gauge.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to read front reel motor pressure.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to attach pressure gauge.

Procedure

> **CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.**

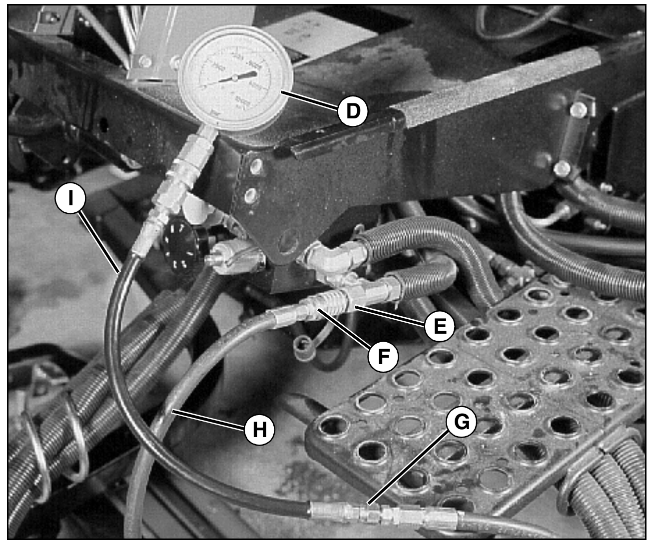
IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.

1. Test is performed by reading system pressure between center section of triple pump and front mow/backlapping valve.



M58750

2. If machine does not have optional test kit installed, 38H1030 T-Fitting (C) will have to be installed into the hydraulic hose (B) from center pump and the front mow/ backlapping valve (A).



M76545

3. MT1531 Quick Disconnect Fitting (E) will allow the test gauge to be easily installed and removed for service.

4. Install JT05486 Connector (G) and RE48122 Female Quick Coupler (F) on ends of AMT846 Hose (H). Connect AMT846 Hose (H) to MT1531 Quick Disconnect Fitting (E) on machine.

5. Install JT03364 Hose (I) to AMT846 Hose (H).

6. Install JT03362 Gauge (D) to JT03364 Hose (I).

7. With cutting units lowered to ground, place wooden block in a cutting reel to stop rotation.

8. Place in backlap mode.

9. Start engine and set throttle to 2000 rpm (min).

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

10.Set mow/transport lever to mow and lift/lower lever to lower.

11.Note reading on gauge.

Results

If relief valve does not meet specifications, adjust relief valve as follows:

NOTE: Counterclockwise rotation of the set screw will decrease pressure relief setting and clockwise rotation will increase pressure relief setting.

- Loosen jam nut and turn set screw with Allen wrench to adjust pressure relief setting while watching gauge.

Specifications

Front Reel Motor System Relief Pressure 20 684 ± 1380 kPa (3000 ± 200 psi)

Test Rear Reel Motors Pressure Relief

Reason

To ensure that rear reel pressure relief valve is operating properly.

Special or Required Tools

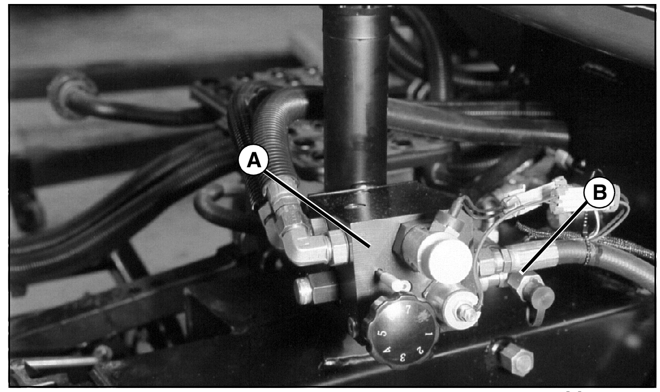
Tool Name	Tool No.	Tool Use
Quick Disconnect Fitting	MT1531	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Swivel T-Fitting	38H1030	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Cover	XPD6-285	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Hose	AMT846	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Female Quick Coupler	RE48122	Used to attach pressure gauge. Part of BM18319 diagnostic Kit.
Hose 70 000 kPa (10,000 psi)	JT03364	Used to attach pressure gauge.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to read front reel motor pressure.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Used to attach pressure gauge.

Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

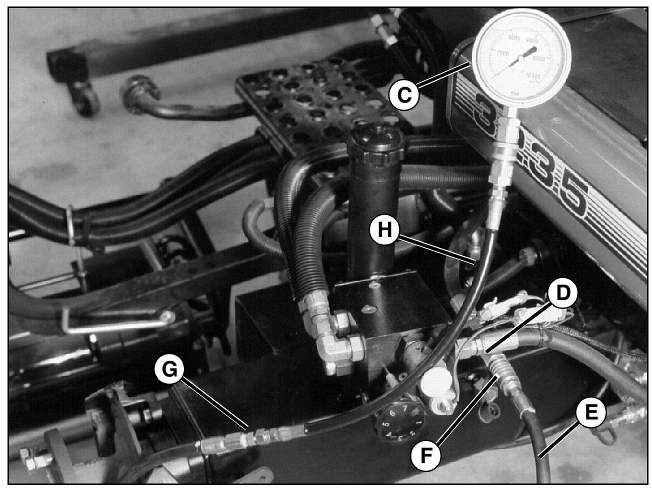
IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.

1. Test is performed by reading system pressure between rear section of triple pump and rear mow/backlapping valve.



M76546

2. If machine does not have optional test kit installed, 38H1030 T-Fitting (B) will have to be installed into the hydraulic hose at the rear mow/backlapping valve (A).



M76547

3. MT1531 Quick Disconnect Fitting (D) will allow the test gauge to be easily installed and removed for service.

4. Install JT05486 Connector (G) and RE48122 Female Quick Coupler (F) on ends of AMT846 Hose (E). Connect AMT846 Hose (E) to MT1531 Quick Disconnect Fitting (D) on machine.

5. Install JT03364 Hose (H) to AMT846 Hose (E).

6. Install JT03362 Gauge (C) to JT03364 Hose (H).

7. With cutting units lowered to ground, place wooden block in a cutting unit to stop rotation.

8. Place in backlap mode.

9. Start engine and set throttle to 2000 rpm (min).

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

10.Set mow/transport lever to mow and lift/lower lever to lower.

11.Note reading on gauge.

Results:

If relief valve does not meet specifications, adjust relief valve as follows:

NOTE: Counterclockwise rotation of the set screw will decrease pressure relief setting and clockwise rotation will increase pressure relief setting.

- Loosen jam nut and turn set screw with Allen wrench to adjust pressure relief setting while watching gauge.

Specifications

Rear Reel Motor System Relief Pressure. 20684 ± 1380 kPa (3000 ± 200 psi)

Test Front Reel Pump Flow

Reason

To determine if middle section of triple pump is worn by testing hydraulic flow at front reel motors.

Special or Required Tools

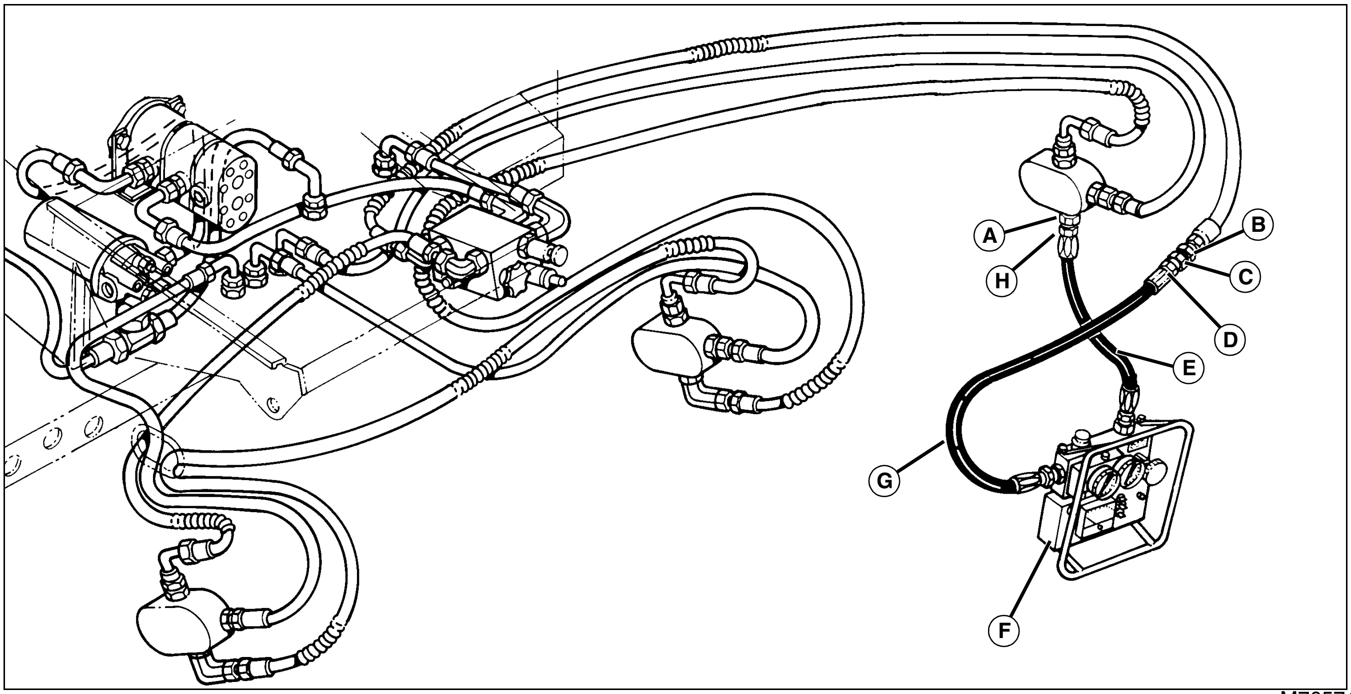
Tool Name	Tool No.	Tool Use
Connector 3/4” F NPT x 1-1/16” F 37° (2)	JT03012	Used to connect hydraulic tester to motor.
Connector 1-1/16” M 37° x 13/16” F ORFS	JT05688	Used to connect hydraulic tester to motor.
Connector 1-1/16” M 37° x 1-3/16” M ORFS	JT03483	Used to connect hydraulic tester to motor.
Connector 1-3/16” F ORFS x 13/16” M ORFS	JT03484	Used to connect hydraulic tester to motor.
In-Line Hydraulic Tester	D01074AA	Used to test hydraulic motor.
120” Hydraulic Test Hoses (2)	JT03377	Used to connect hydraulic tester to motor.

Procedure

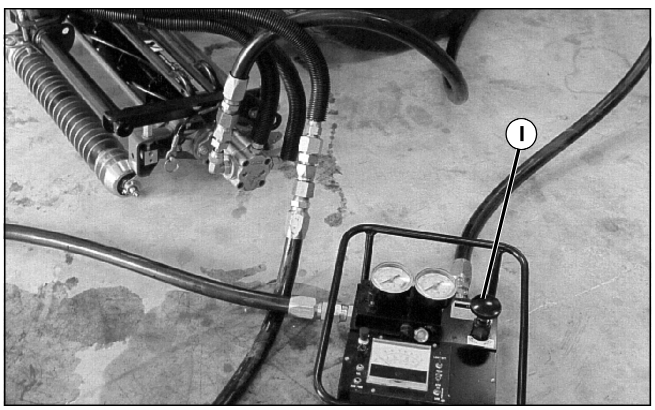
CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, reels lowered, engine off.

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.



M76571



M76572

2. Remove front hose from left front motor. Connect JT03377 Hose (E) to motor using JT03012 Connector (H) and JT05688 Connector (A). Connect another JT03377 Hose (G) to hose from backlap valve using JT03012 Connector (D), JT03483 Connector (C) and JT03484 Connectors (B).

3. Connect JT03377 Hose (G) from backlap valve into inlet port of D01074AA Hydraulic Tester (F). Install hose from reel motor into outlet port.

4. Turn tester control knob (I) out (counterclockwise) completely.

5. Set front backlapping valve to forward (mow) position (knob pushed in).

6. Have a helper technician start machine, run at full throttle and engage reels.

7. Slowly turn tester control knob in (clockwise) until pressure reaches 17 237 kPa (2500 psi). Note flow.

Results

The reel pump pressure should be to specifications. If not, replace or rebuild pump.

Specifications

Front Reel Pump Flow @17 237 kPa (2500 psi). . 24.2 L/min (6.4 gpm)

Test Rear Reel Pump Flow

Reason

To determine if rear section of triple pump is worn by testing hydraulic flow at rear reel motors.

Special or Required Tools

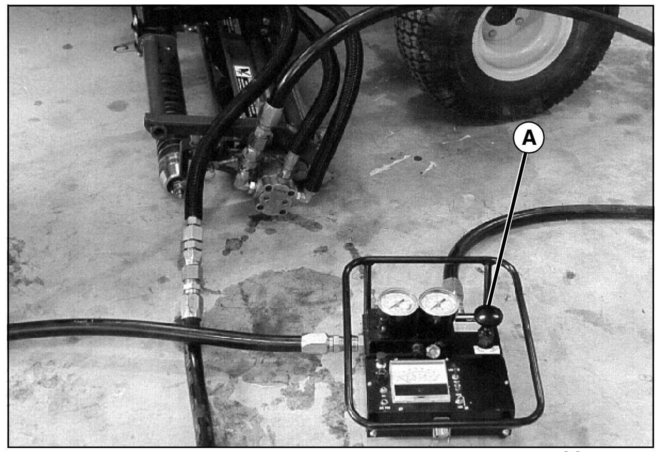
Tool Name	Tool No.	Tool Use
Connector 3/4” F NPT x 1-1/16” F 37° (2)	JT03012	Used to connect hydraulic tester to motor.
Connector 1-1/16” M 37° x 13/16” F ORFS	JT05688	Used to connect hydraulic tester to motor.
Connector 1-1/16” M 37° x 1-3/16” M ORFS	JT03483	Used to connect hydraulic tester to motor.
Connector 1-3/16” F ORFS x 13/16” M ORFS	JT03484	Used to connect hydraulic tester to motor.
In-Line Hydraulic Tester	D01074AA	Used to test hydraulic motor.
120” Hydraulic Test Hoses (2)	JT03377	Used to connect hydraulic tester to motor.

Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, reels lowered, engine off.

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.



M76573

2. Remove front hose from left rear motor. Connect JT03377 Hose to motor using JT03012 and JT05688 Connectors. Connect another JT03377 Hose to hose from backlap valve using JT03012, JT03483 and JT03484 Connectors.

3. Connect JT03377 Hose from backlap valve into inlet port of D01074AA Hydraulic Tester. Install hose from reel motor into outlet port.

4. Turn tester control knob (A) out (counterclockwise) completely.

5. Set rear backlapping valve to forward (mow) position (knob pushed in).

6. Have a helper technician start machine, run at full throttle and engage reels.

7. Slowly turn tester control knob in (clockwise) until pressure reaches specifications. Note flow.

Specifications

Rear Reel Pump Flow @17 237 kPa (2500 psi) . . 24.2 L/min (6.4 gpm)

Test Rear Reel Motors Case Drain

Reason

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

Special or Required Tools

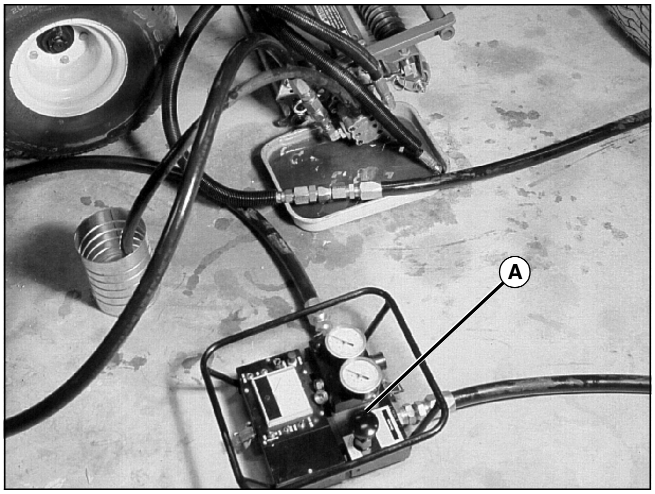
Tool Name	Tool No.	Tool Use
Connector 3/4” F NPT x 1-1/16” F 37° (2)	JT03012	Used to measure hydraulic oil quantity from case drain.
Connector 1-1/16” M 37° x 13/16” F ORFS	JT05688	Used to measure hydraulic oil quantity from case drain
Connector 1-1/16” M 37° x 1-3/16” M ORFS	JT03483	Used to measure hydraulic oil quantity from case drain
Connector 1-3/16” F ORFS x 13/16” M ORFS	JT03484	Used to measure hydraulic oil quantity from case drain
1/2” ID hose 24” long (2)	NA	Used to measure hydraulic oil quantity from case drain
In-Line Hydraulic Tester	D01074AA	Used to measure hydraulic oil quantity from case drain
120” Hydraulic Test Hoses (2)	JT03377	Used to measure hydraulic oil quantity from case drain

Procedure

NOTE: Case drain from both rear reel motors can be tested simultaneously with hydraulic tester connected to right rear reel motor.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

1. Park machine on level surface, reels lowered, engine off.



M76574

2. Place drain pan under right rear reel motor. Clean hydraulic hose fittings and remove rear hose from motor.

3. Connect JT03377 Hose to motor using JT03012 and JT05688 Connectors. Connect another JT03377 Hose to hose removed from rear of reel motor using JT03012, JT03483 and JT03484 Connectors.

4. Connect JT03377 Hose from rear of motor to inlet port of D01074AA Hydraulic Tester. Connect JT03377 Hose connected to reel motor hose previously removed, to outlet port of hydraulic tester.

5. Remove center case drain hose from left and right reel motors and place in drain pans.

6. Place a 1/2” ID hose on center port fitting of both rear reel motors and place other end into a clean container.

7. Turn tester control knob (A) out (counterclockwise) completely.

8. Set rear backlapping valve to forward (mow) position (knob pushed in).

9. Have a helper technician start machine, run at full throttle and engage reels.

10.Turn tester control knob in (clockwise) until pressure reaches 17 237 kPa (2500 psi). Hold for 15 seconds.

11.Turn out control knob and stop engine.

12.Measure amount of oil in each container.

13.Multiply volume of oil in each container by 4 to arrive at amount of case drain in one minute.

Results

The reel motor case drain from either motor should not exceed specifications. If case drain exceeds specifications, rebuild or replace motors.

Specifications

Rear Reel Motor Case Drain
(Maximum) . . . . 3.08 L/min (1 gpm)

Test Front Reel Motors Case Drain

Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector 3/4” F NPT x 1-1/16” F 37° (2)	JT03012	Used to measure hydraulic oil quantity from case drain.
Connector 1-1/16” M 37° x 13/16” F ORFS	JT05688	Used to measure hydraulic oil quantity from case drain
Connector 1-1/16” M 37° x 1-3/16” M ORFS	JT03483	Used to measure hydraulic oil quantity from case drain
Connector 1-3/16” F ORFS x 13/16” M ORFS	JT03484	Used to measure hydraulic oil quantity from case drain
1/2” ID hose 24” long (2)	NA	Used to measure hydraulic oil quantity from case drain
In-Line Hydraulic Tester	D01074AA	Used to measure hydraulic oil quantity from case drain
120” Hydraulic Test Hoses (2)	JT03377	Used to measure hydraulic oil quantity from case drain

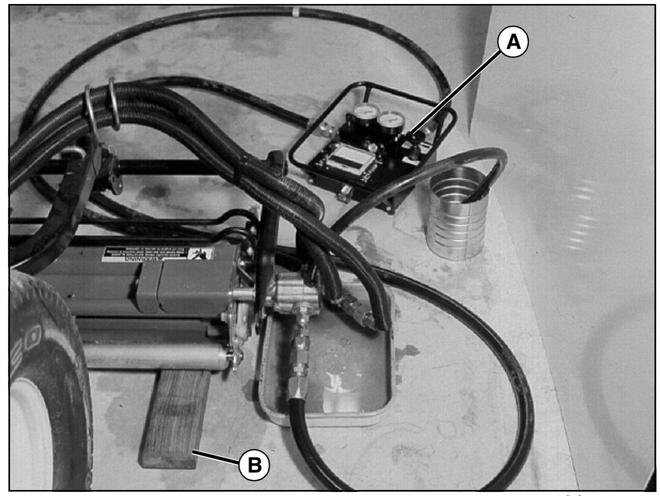
Procedure

NOTE: Case drain from all three front reel motors can be tested simultaneously with hydraulic tester connected to right front reel motor.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

1. Park machine on level surface, reels lowered, engine off.



M76575

2. Place drain pan under right front reel motor. Clean hydraulic hose fittings and remove rear hose from motor. Raise reel and place block of wood (B) under rear roller to connect tester hoses to reel motor.

3. Connect JT03377 Hose to motor using JT03012 and JT05688 Connectors. Connect another JT03377 Hose to hose removed from rear of reel motor using JT03012, JT03483 and JT03484 Connectors.

4. Connect JT03377 Hose from rear of motor to inlet port of D01074AA Hydraulic Tester. Connect JT03377 Hose connected to reel motor hose previously removed, to outlet port of hydraulic tester.

5. Remove center case drain hose from all three front reel motors and place each in a drain pan.

6. Place a 1/2” ID hose on center port fitting of each reel motor and place other ends into a clean container.

7. Turn tester control knob (A) fully counterclockwise.

8. Set rear backlapping valve to forward (mow) position (knob pushed in).

9. Have an assistant start machine, run at full throttle and engage reels.

10. Turn tester control knob in (clockwise) until pressure reaches specifications. Hold for 15 seconds.

11. Turn out control knob and stop engine.

12. Measure amount of oil in each container. Multiply volume of oil in each container by 4 to arrive at amount of case drain in one minute.

Results

The reel motor case drain from any motor should not exceed specifications. If case drain exceeds specifications, rebuild or replace motors.

Specifications

Reel Motor Case Drain. . . . . 3.08 L/min (1 gpm)

Test Lift System Relief Valve Pressure

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids. If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Connect pressure gauge for steering and lift system relief valve pressure test.
T-Fitting	38H1030	Connect pressure gauge for steering and lift system relief valve pressure test.
Hose	AMT846	Connect pressure gauge for steering and lift system relief valve pressure test.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.

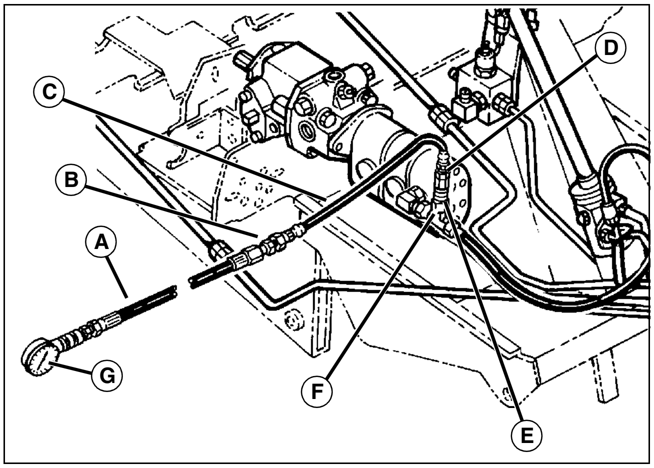
Special or Required Tools

Tool Name	Tool No.	Tool Use
Gauge 20 684 kPa (3000 psi)	JT03345	Check steering and lift system relief valve setting.
Hose 34 474 kPa (5000 psi)	JT03017	Connect pressure gauge for steering and lift system relief valve pressure test.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

2. Deplete system pressure by operating the lift system.



MIF M76550

3. Disconnect the charge pump pressure hose and install 38H1030 T-Fitting (F) and MT1531 Adapter (E) on T-fitting.

4. Install JT05486 Connector (B) and RE48122 Female Quick Coupler (D) on ends of AMT846 Hose (C) and install AMT846 Hose on MT1531 Adapter (E).

5. Install JT03017 Hose (A) and JT03345 Gauge 20 684 kPa (3000 psi) (G) to AMT846 Hose (C).

6. Start engine and set the throttle to fast idle.

7. Raise the lift arms and hold the lift lever in the full raise position and record the pressure reading.

Results

- Pressure should be within specifications. If pressure is not within specification, replace relief valve.

Lift System Relief Valve Pressure . . 13 100 ± 1380 kPa (1900 ± 200 psi)

Test Optional Down Pressure Valve

Reason

To adjust the optional down pressure valve to set downward force on lift system and cutting units.

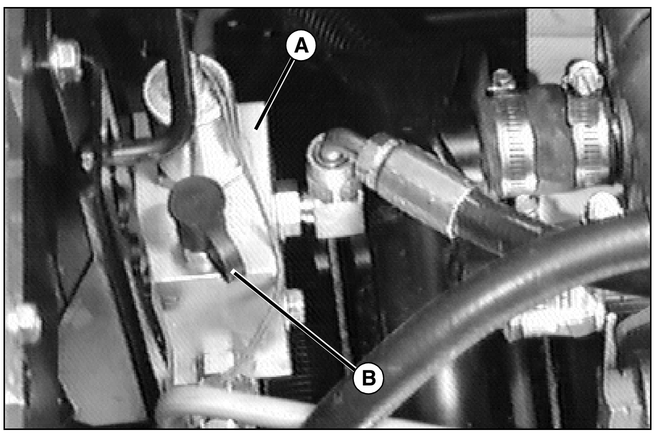
Special or Required Tools

Tool Name	Tool No.	Tool Use
0-7000 kPa (0-1000 psi) Gauge	JT05471	Used to test optional down pressure valve.

Procedure

1. Park machine on level surface, lock park brake, lower cutting units to ground, engine off.

2. Test is performed by reading system pressure at down pressure valve. A test connector is located on the top of the valve block.



M58745

3. If machine does not have optional test kit installed, a test fitting (B) will have to be installed into the top of the down pressure valve block (A). A quick disconnect fitting will allow the test gauge to be easily installed and removed for service.

4. Install JT05471 0-7000 kPa (0-1000 psi) Test Pressure Gauge to the test fitting.

> **CAUTION: Avoid injury! Do not use a test pressure gauge rated lower than recommended. Do not move steering wheel while test is in progress.**

5. Start engine.
6. Unlock park brake.
7. Set mow/transport switch to MOW.
8. Set raise/lower lever to LOWER position.
9. Move throttle to full forward (full throttle) position.
10. Note reading on gauge.
11. Stop engine.

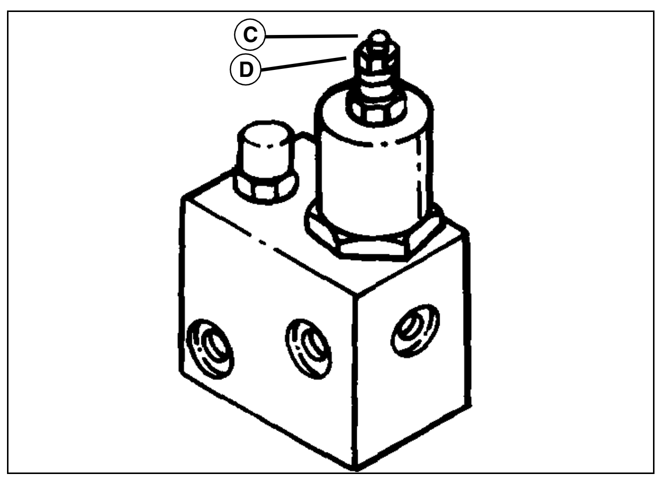
Adjusting Down Pressure Force

Use the chart below to determine pressure setting needed to achieve the required down force.

> **IMPORTANT: Avoid damage! Adding down force to cutting unit will decrease mower traction. Do not exceed 4826 kPa (700 psi) at the down pressure valve.**

Pressure Reading at Down Pressure Valve	Down Force at Cutting Unit
1379 kPa (200 psi)	93 N (21 lb)
2068 kPa (300 psi)	142 N (32 lb)
2758 kPa (400 psi)	187 N (42 lb)
3447 kPa (500 psi)	236 N (53 lb)
4137 kPa (600 psi)	285 N (64 lb)
4826 kPa (700 psi)	334 N (75 lb)

> **IMPORTANT: Avoid damage! All pressure adjustments must be made with the engine running and the reel drive system at normal operating pressure (mow solenoid energized).**



MIF M56671

1. Loosen lock nut (D) on top of down pressure solenoid plunger.

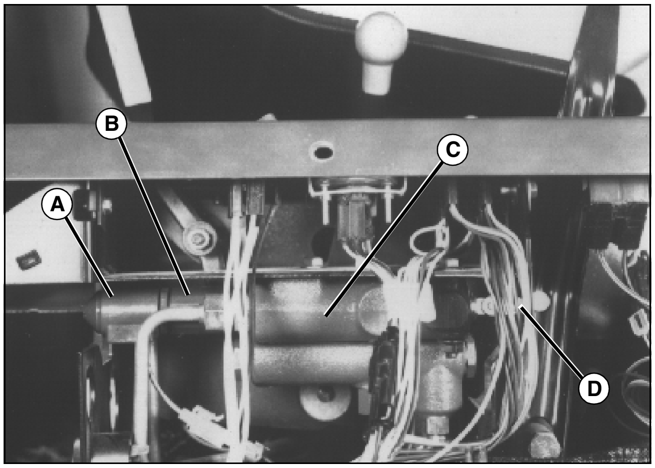
2. Follow steps 1-10 from Test Optional Down Pressure Valve section to determine current pressure setting.

3. Turn pressure set screw (C) while watching pressure gauge.

Repair

Remove Lift Valve

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

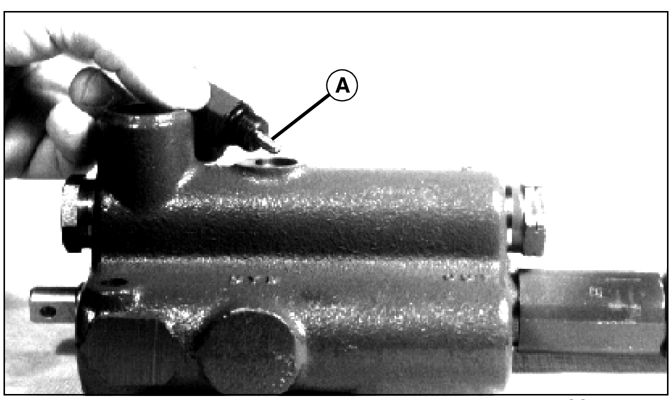


M56612

1. Remove front and side console panels to gain access to lift valve.
2. Remove coil (A) and plunger (B) assembly from lift valve (C).
3. Disconnect hydraulic lines at lift valve.
4. Remove link (D) connecting the lift valve to the handle.
5. Remove two bolts securing lift valve to instrument cluster frame.

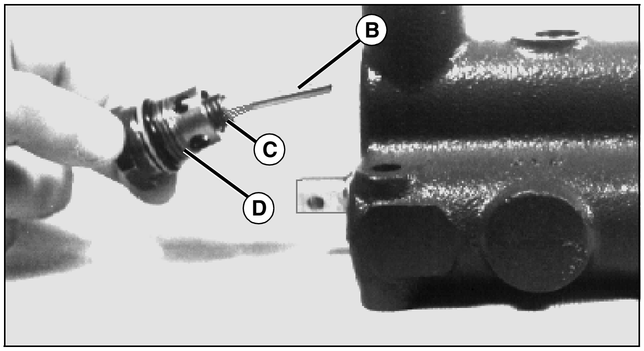
Disassemble Lift Valve

NOTE: Remove fittings, plug all ports and wash valve assembly with a suitable solvent before disassembly.



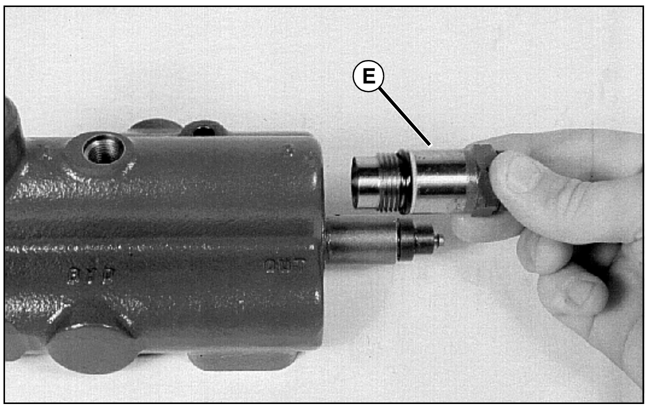
M56657

1. Remove detent ball and spring (A).



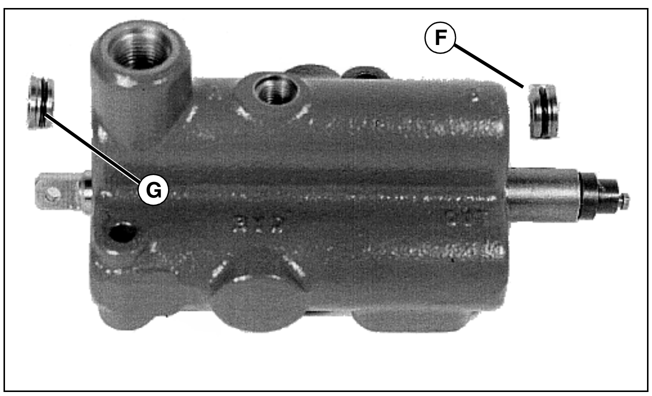
M56652

2. Remove return plunger (B), spring (C) and cap (D).



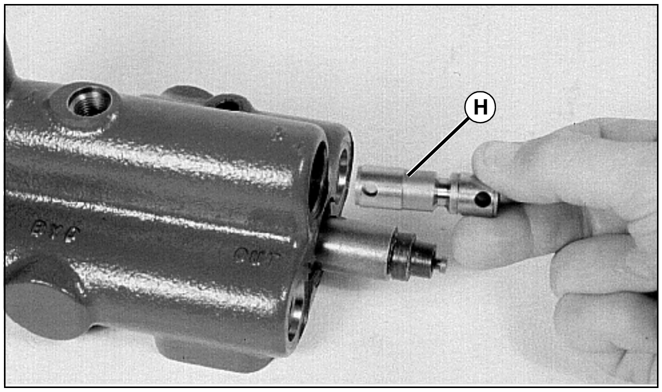
M76556

3. Remove spool retainer (E).



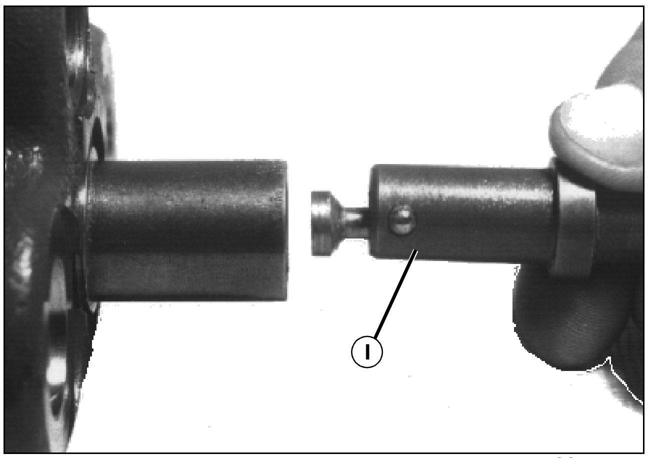
M76555

4. Remove spool end caps (F and G).



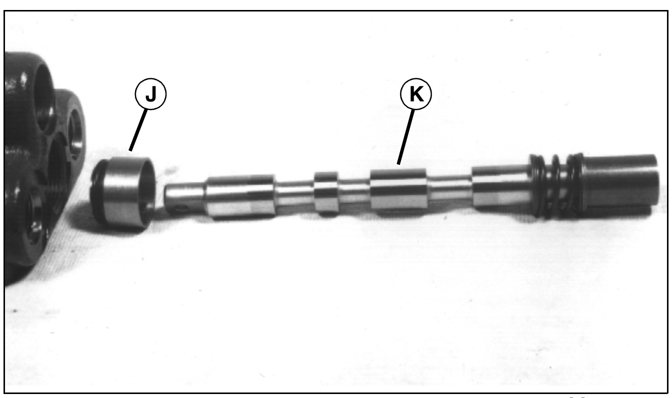
M76554

5. Remove spool (H).



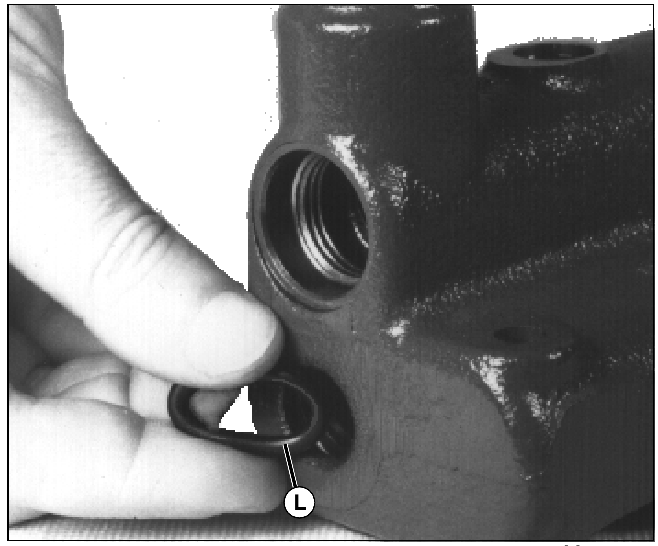
M56649

6. Remove detent assembly (I). DO NOT lose balls.



M56646

7. Remove spool (K) and cup (J).

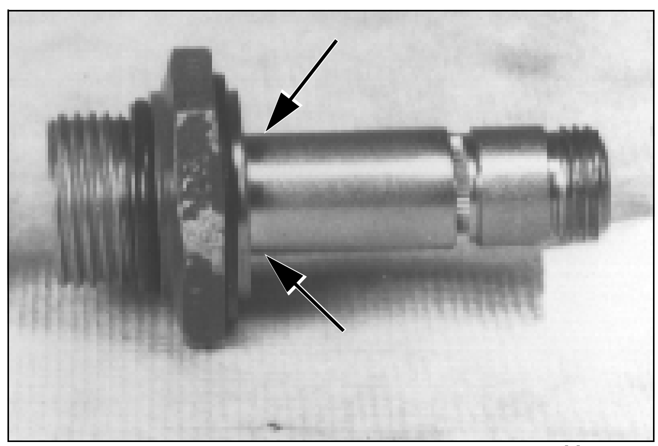


M56648

8. Remove O-ring (L) from lift valve housing.

Inspect Lift Valve

- Clean all parts with a suitable solvent. Clean bores with a brush hone and solvent.
- Inspect bores in valve housing for scoring.
- Inspect spools for scoring, fretting and straightness.
- Check all springs for breakage.
- Replace all seals and O-rings.

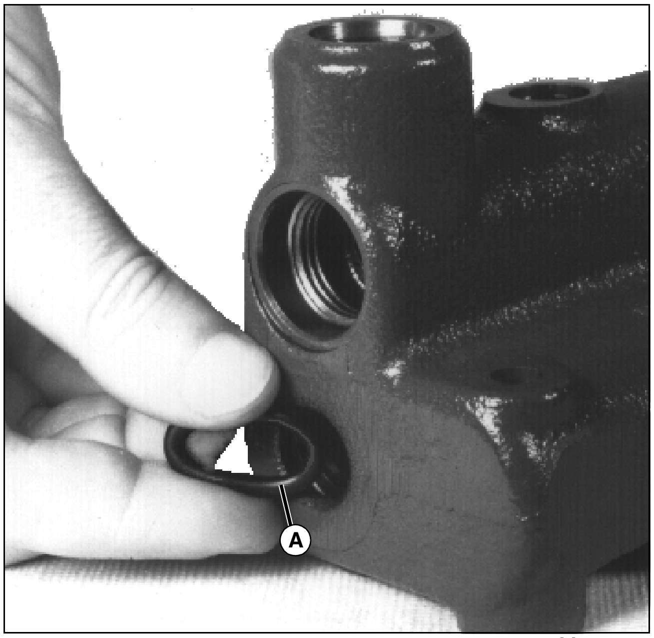


M56656

- Inspect shaft near the nut for signs of stretching or breakage. Replace if necessary.
- If any parts other than the solenoid assembly and seals or O-rings are worn, the valve assembly must be replaced.

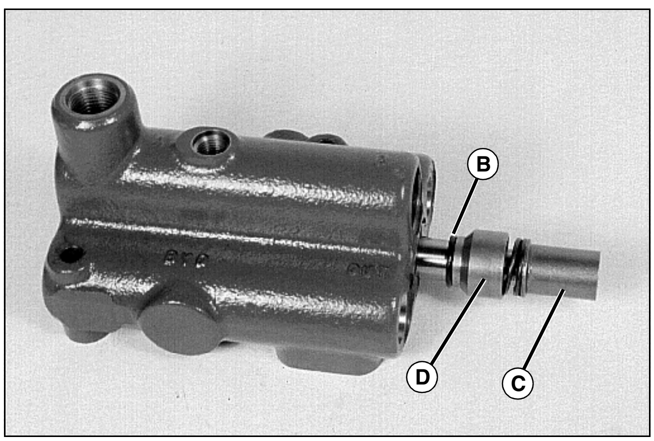
Assemble Lift Valve

IMPORTANT: Avoid damage! Use plenty of fresh hydraulic oil to lubricate parts during assembly.



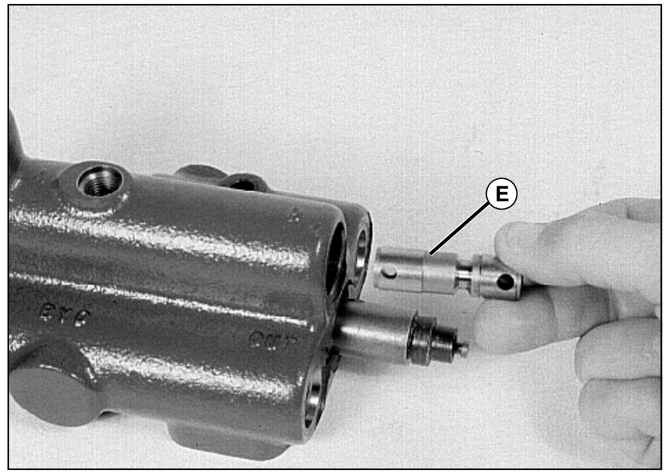
M56648

1. Lubricate and install O-ring (A) into cavity of housing.



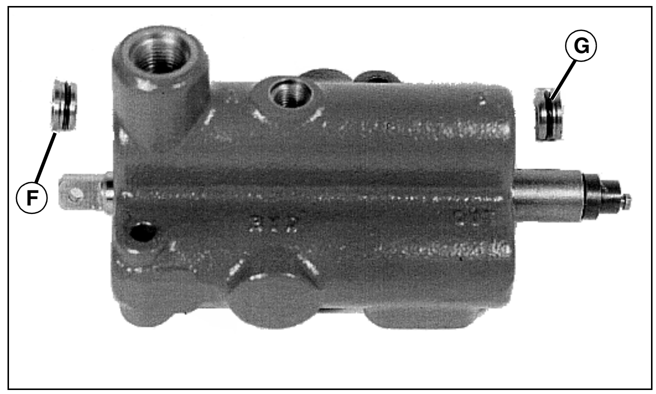
M76553

2. Lubricate and install O-ring (B) on cup (D). Slide cup onto spool (C) and install spool into housing.



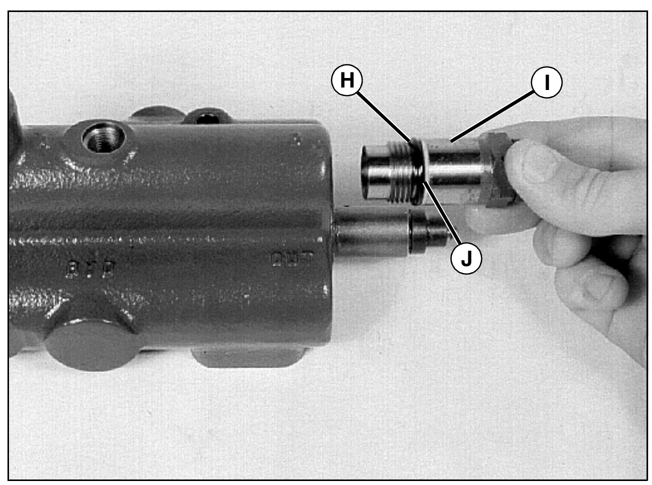
M76554

3. Lubricate and install spool (E).



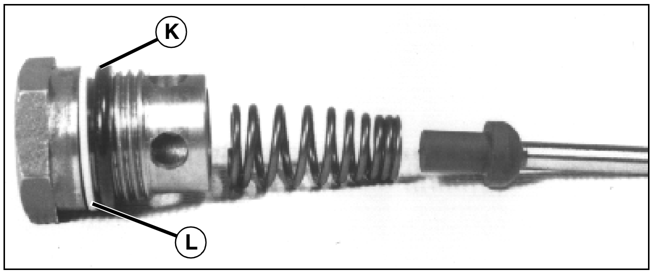
M76555

4. Lubricate and install O-rings on spool caps (F and G). Install spool caps.



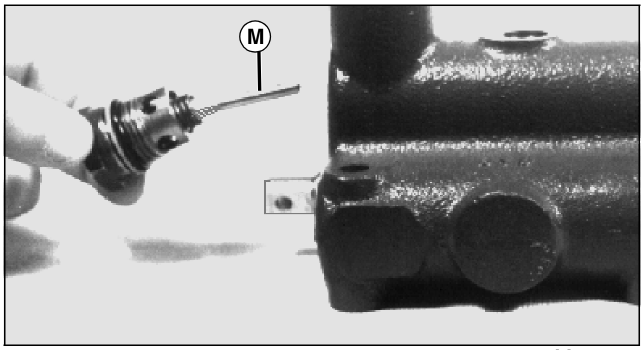
M76556

5. Lubricate and install seal (J) and O-ring (H). Install spool retainer (I).



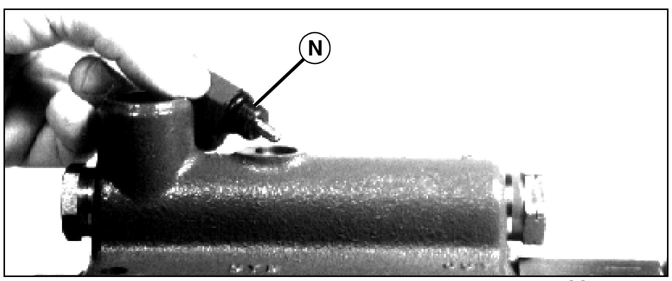
M56650

6. Lubricate and install seal (L) and O-ring (K). Assemble return plunger as shown.



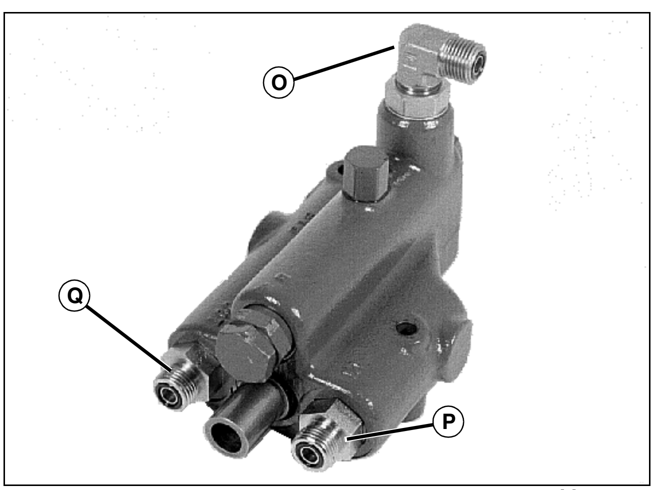
M56652

7. Install return plunger (M).



M56657

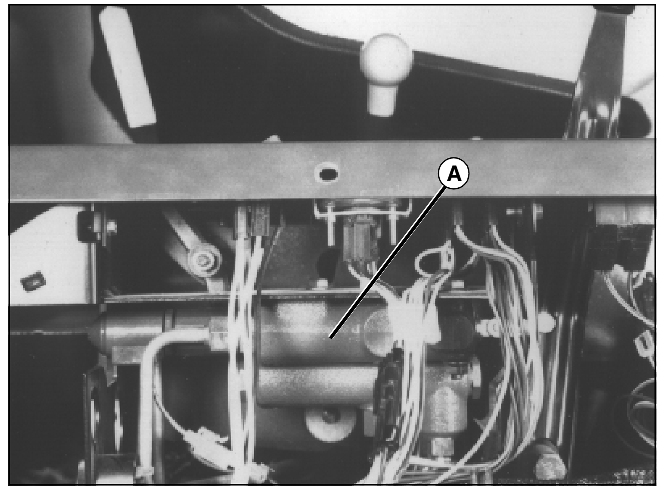
8. Assemble and install detent (N).



M76558

9. Install new O-rings on fittings (O, P and Q) and install fittings in lift valve housing.

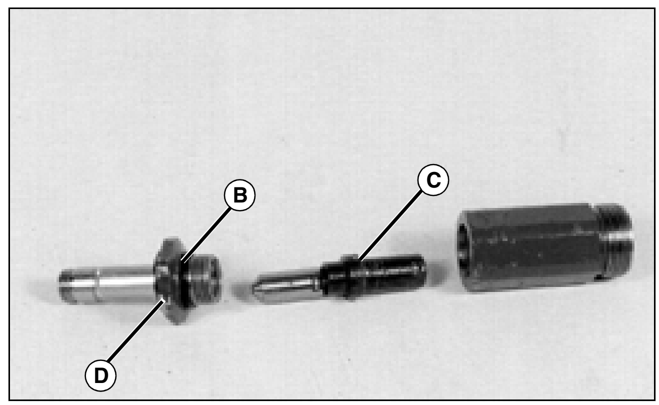
Install Lift Valve



M56612

1. Place lift valve (B) in machine and loosely install two bolts securing lift valve to instrument cluster frame. DO NOT tighten at this time.

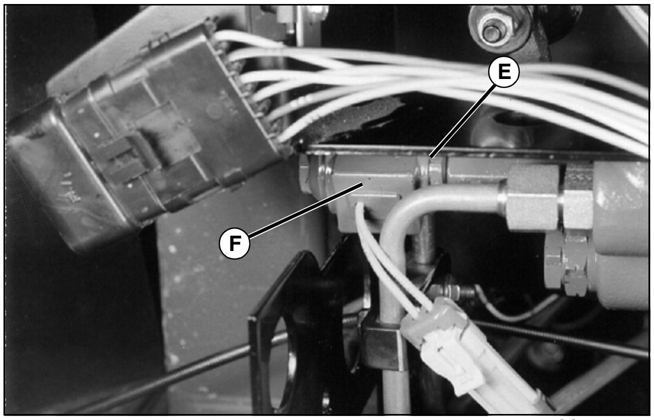
2. Connect hydraulic lines at lift valve.



M76559

3. Slide plunger (C) over detent assembly. Make sure balls are in place. Grease will help hold them in place.

4. Install O-ring (B) on spool retainer (D) and assemble spool retainer and plunger assembly on bench. Tighten spool retainer to specifications.



M76560

5. Install plunger assembly (E) on lift valve. Tighten plunger to specifications.

6. Install coil (F) over plunger assembly. Tighten coil nut to specifications. DO NOT overtighten.

7. Assemble link and switch actuator connecting the lift valve to the handle.

8. Install front and side console panel.

9. Start machine and cycle lift cylinders to purge air from system.

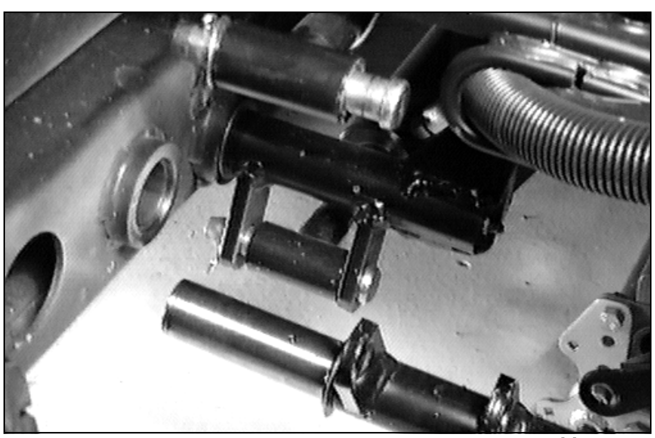
Specifications

Spool Retainer Torque	**28-32 N•m (21-24 b-ft)**
Plunger Torque	**47-54 N•m (35-40 lb-ft)**
Coil Nut Torque	**2-3 N•m (15-25 lb-ft)**

Remove Lift Arm

1. Remove cutting units from lift arm being serviced.

2. Remove hydraulic hoses from hose support on top of lift arm by unwinding from support spiral.



M57767

3. Remove hydraulic cylinder attachment pin from lift arm yoke. Secure cylinder to frame with wire to keep work area clear.

NOTE: Newer model fairway mowers use a retaining pin and washer to retain the lift arm shaft, instead of a cap screw and washer.

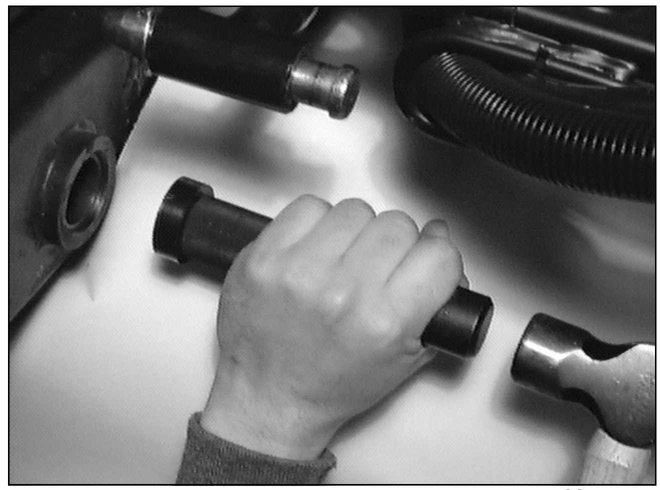
4. Remove retaining cap screw and washer or retaining pin and washer from back side of lift arm pivot.

5. Remove lift arm shaft from frame pivot bushing.

NOTE: As lift arm is pulled from frame, rear O-ring and washer may drop off of end of frame bushing.

Remove Lift Arm Bushing

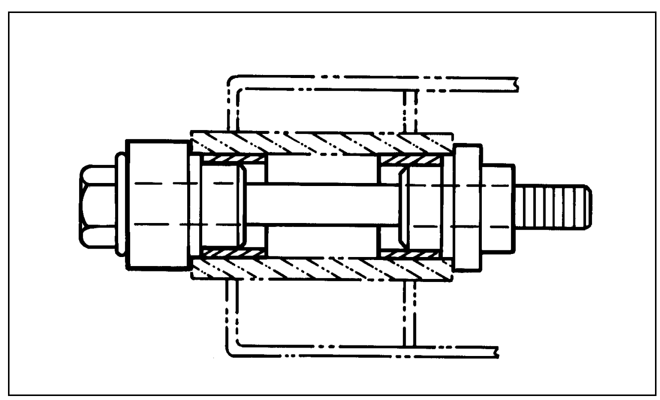
1. Remove lift arm. (See Remove Lift Arm.)



M57766

2. Using 1-5/8" bearing driver, drive front and rear bushing out back of lift arm mounting tube.

Install Lift Arm Bushing



MIF M57769

1. Place bushing on threaded end of JDG892 installation tool and place on back of lift arm frame tube. Place front bushing on front half of tool and thread bolt from front to rear of tool.

2. Tighten bolt on tool to pull bushings into frame tube. Tool will set correct depth for proper O-ring clearance.

Install Lift Arm

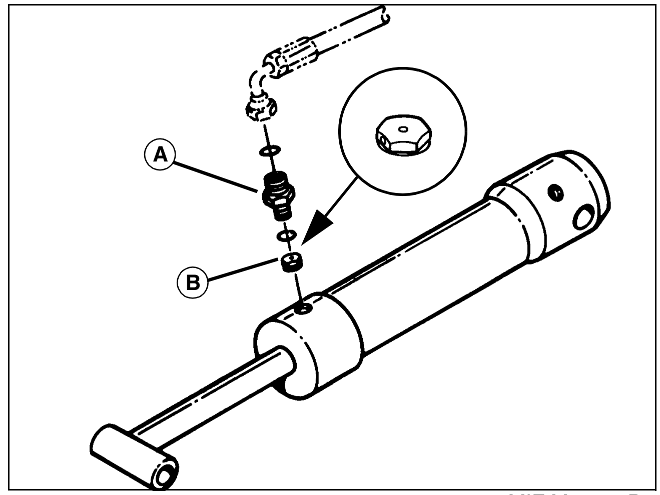
1. Clean old grease from lift arm and frame tube.
2. Inspect bushings for wear. Replace if necessary.
3. Place washer and O-ring on lift arm pivot shaft.
4. Insert lift arm pivot shaft into frame tube.
5. Install O-ring and washer on back of pivot shaft.
6. Install washer and cap screw on end of lift arm pivot shaft. Tighten to specifications.

Remove and Install Lift Cylinder

1. Remove hydraulic hoses.
2. Remove cotter keys and washers at end of hydraulic cylinder mounting pins.
3. Remove mounting pins and cylinders.
4. Install cylinder on machine with rod end to the right side of machine. Rear cylinder will require lost motion linkage to be configured during cylinder installation. (See Remove and Install Rear Lift Cylinder Lost Motion Linkage.)
5. Install mounting pins, washers and cotter keys.
6. Install flow restrictor in port on rod end of cylinder. (See Remove and Install Rear Lift Cylinder Flow Restrictor or see Remove and Install Front Lift Cylinder Flow Restrictor.)
7. Install new O-rings on fittings and install in cylinder ports. Attach hydraulic lines to fittings.
8. Grease mounting pins at grease fittings.
9. Start machine and cycle lift cylinders to purge air from system.

Remove and Install Rear Lift Cylinder Flow Restrictor

1. Remove hydraulic hose to rod end of rear lift cylinder.

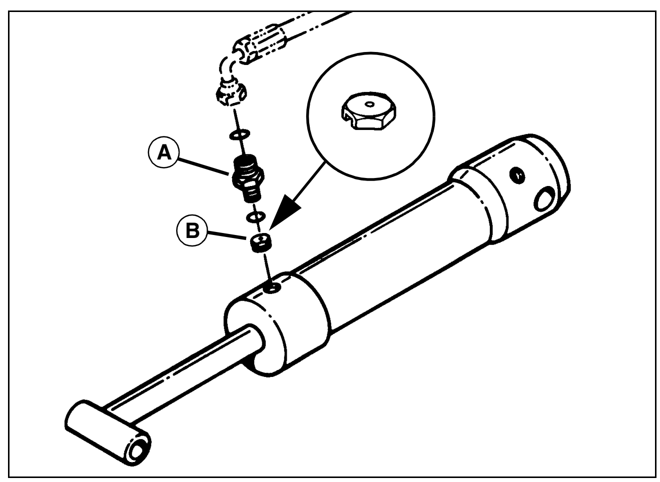


MIF M58761B

2. Remove fitting (A) from hydraulic cylinder.
3. Remove flow restrictor (B) from under fitting.
4. The flow restrictor is installed with the round end of the body inserted into the cylinder first.

Remove and Install Front Center Lift Cylinder Flow Restrictor

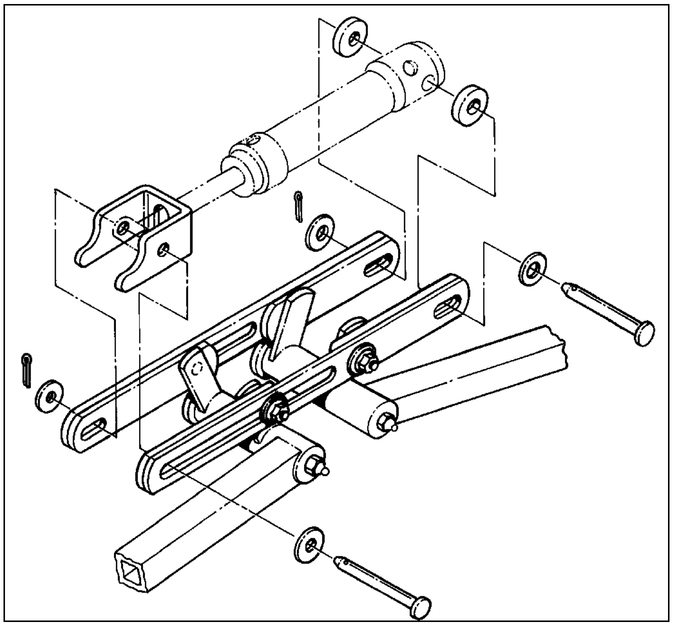
1. Remove hydraulic hose to rod end of front lift cylinder.



MIF M58761A

2. Remove fitting (A) from hydraulic cylinder.
3. Remove flow restrictor (B) from under fitting.
4. The flow restrictor is installed with the slot of the restrictor inserted into the cylinder first.

Remove and Install Rear Lift Cylinder Lost Motion Linkage



MIF M57770

1. Remove rear lift cylinder and hydraulic hoses (See Remove and Install Lift Cylinder.)

2. Remove four nuts and washers holding lost motion linkage to lift arms.

3. Inspect link arms for wear or bending.

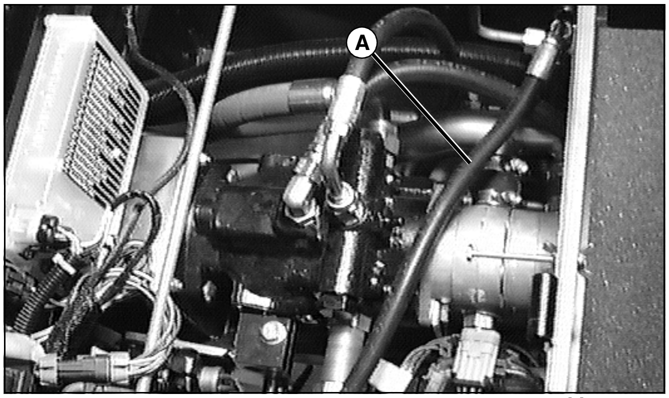
Remove Triple Pump

NOTE: Removal of the triple pump is similar for all models; 3215 is shown.

1. Park vehicle on a level surface, reels lowered, park brake locked, engine off. Block wheels to prevent inadvertent movement of the machine.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

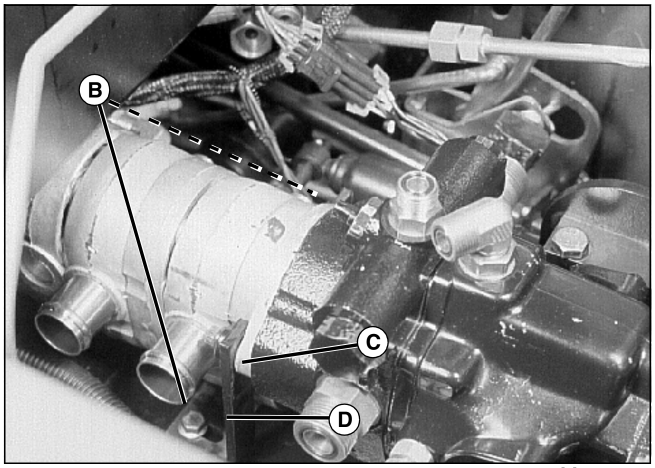
2. Disconnect battery and remove seat.



M56614

3. Disconnect hydraulic hose (A) from oil filter to cross fitting or down pressure valve (if equipped).

4. Mark for reinstallation and disconnect all hydraulic lines connected to the triple pump assembly.

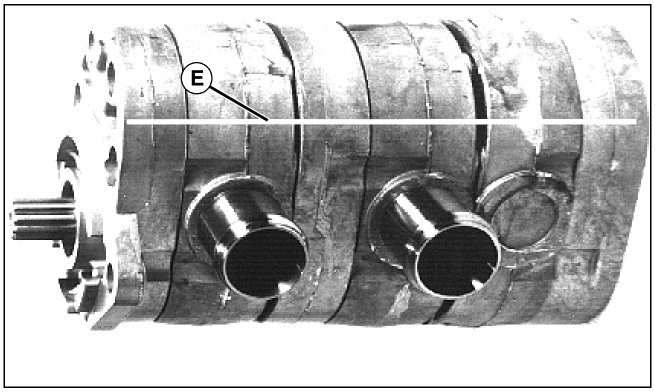


M76523

5. Remove the two cap screws (B) that secure triple pump mounting bracket (D) to frame.

6. Remove two cap screws from mounting flange (C) to separate triple pump assembly from hydrostatic pump.

7. Remove triple pump from machine. Do not lose shaft coupler.



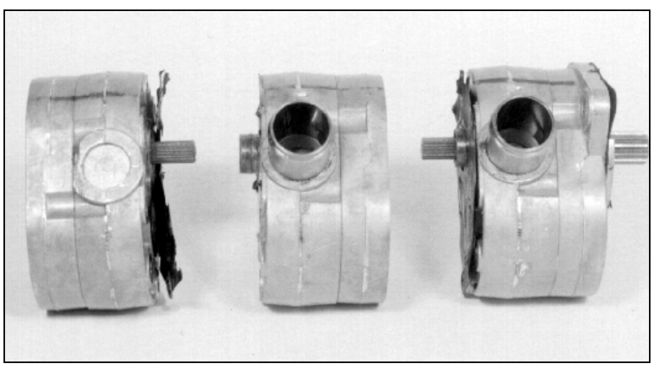
M56593

8. Mark (E) pump housing with solvent resistant marker or paint to guide reassembly.

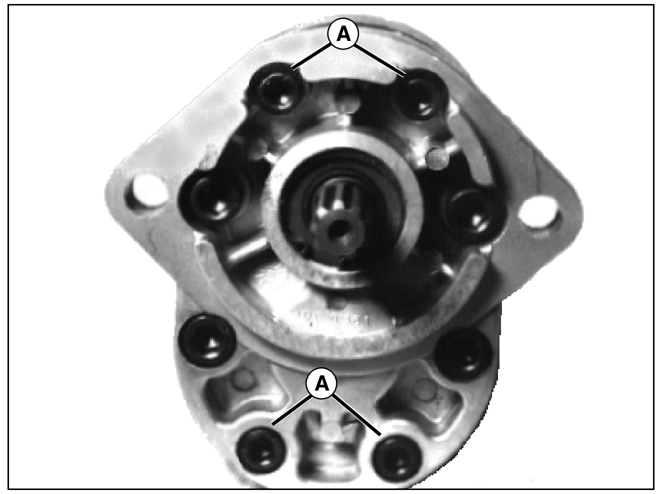
Disassemble Triple Pump - 3215, 3235, 3215A and 3235A

CAUTION: Avoid injury! Extreme caution must be used when using a vise to avoid distorting any parts.

NOTE: The triple pump assembly will be treated as three separate pumps once they are separated. After the disassembly and inspection, they will be reassembled into one unit.



M76487



M56647

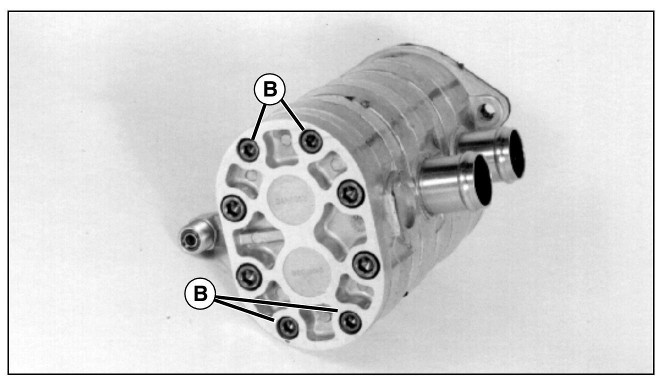
1. Remove four 5/16” Allen head screws (A) that hold front section of triple pump to center section.

CAUTION: Avoid injury! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

IMPORTANT: Avoid damage! DO NOT intermix parts between pumps. Keep parts for individual pumps separated for reassembly.

2. Separate front pump from center pump. Set aside front section of triple pump for disassembly after remaining pumps are separated.

3. Remove splined shaft from front section.



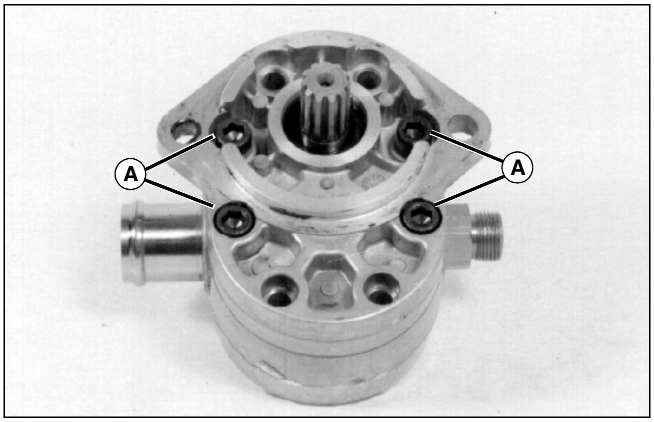
M76486

4. Remove four 5/16” Allen head screws (B) that hold rear section of triple pump to center section.

5. Separate rear pump from center pump. Set aside front section of triple pump for disassembly.

6. Remove splined shaft from rear section.

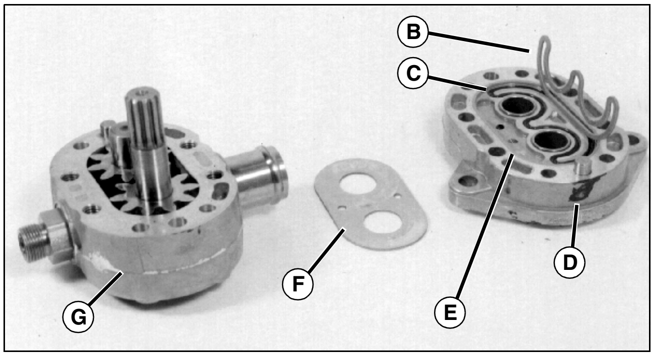
Front Pump Disassembly



M76493

1. Remove four 3/8” Allen head screws (A) that hold end plate and pump body together.

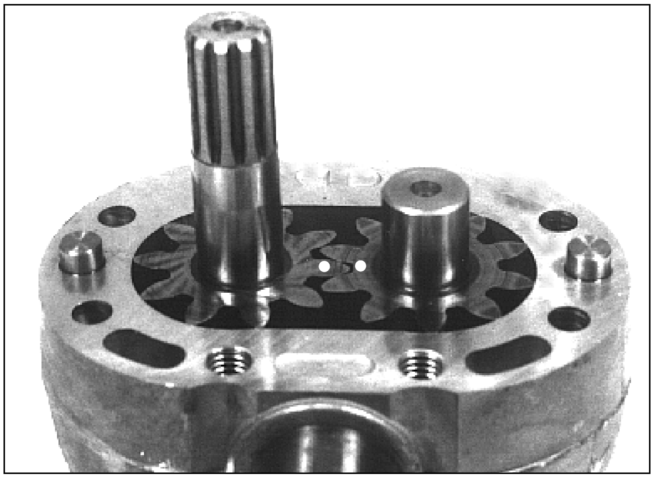
NOTE: While separating end plate from pump body the seal will hold the drive shaft in end plate. Slight pressure will allow end plate to be removed without taking gear with end plate. DO NOT remove the gears from pump body at this time.



M76494

2. Separate end plate (D) from pump body (G).

3. Remove and discard the seals (B, C and E) and wear plate (F).

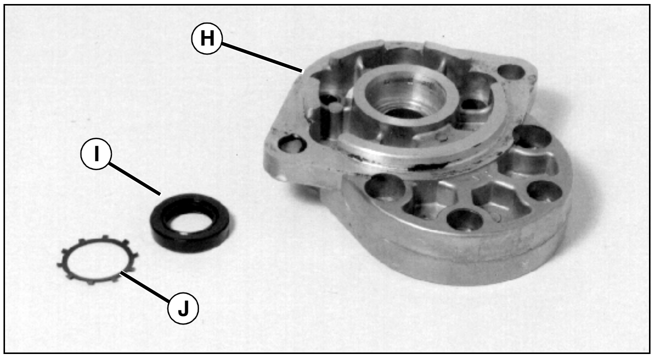


M56597

4. Mark the mating teeth of the gears for assembly.

5. Remove gears from pump body.

6. Inspect housing and shaft bushings for scratches, scoring or fretting.

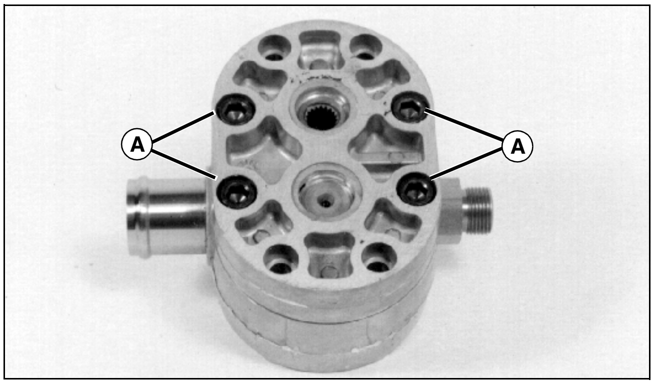


M76488

7. Remove retaining ring (or snap ring) (J) from end plate (H).

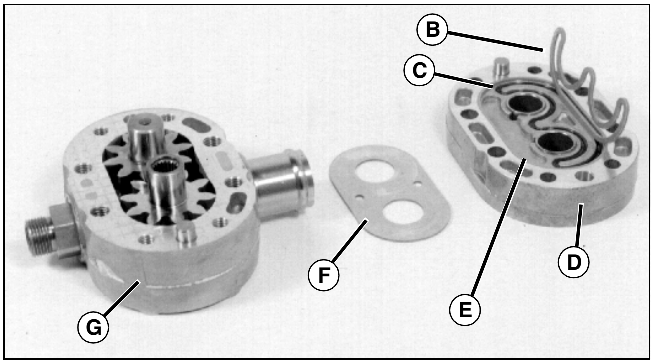
8. Use a screwdriver to carefully remove the shaft seal (I) from end plate. Discard seal and retaining ring.

Center Pump Disassembly



M76491

1. Remove four 3/8” Allen head screws (A) that hold end plate and pump body together.



M76492

2. Separate end plate (D) from pump body (G).

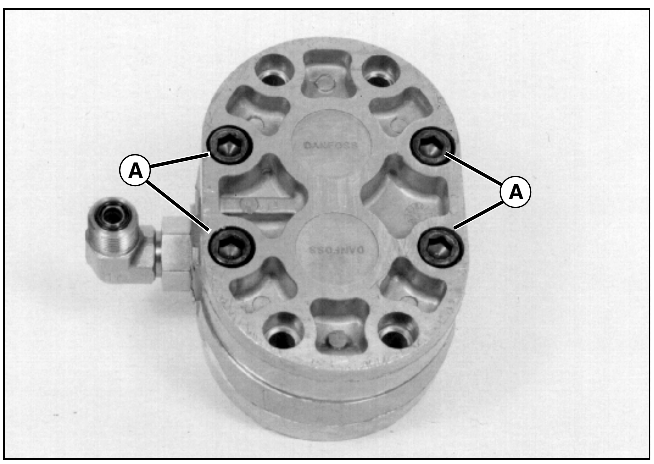
3. Remove and discard the seals (B, C and E) and wear plate (F).

4. Mark the mating teeth of the gears for assembly.

5. Remove gears from pump body.

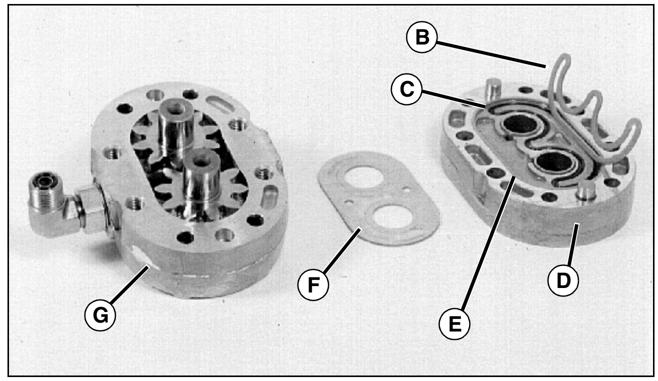
6. Inspect housing and shaft bushings for scratches, scoring or fretting.

Rear Pump Disassembly



M76489

1. Remove four 3/8" Allen head screws (A) that hold end plate and pump body together.



M76490

2. Separate end plate (D) from pump body (G).

3. Remove and discard the seals (B, C and E) and wear plate (F).

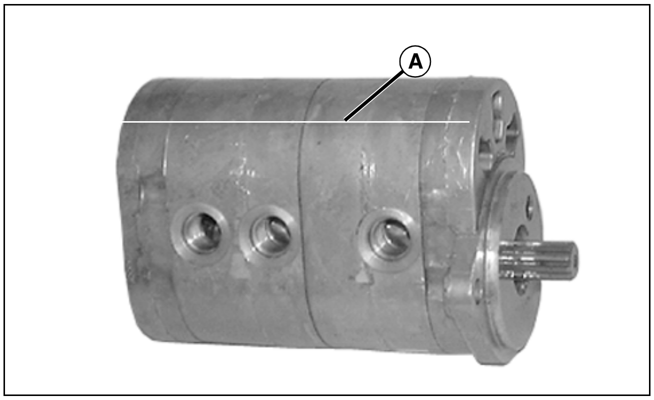
4. Mark the mating teeth of the gears for assembly.

5. Remove gears from pump body.

6. Inspect housing and shaft bushings for scratches, scoring or fretting.

Disassemble Triple Pump - 3215B, 3225B, and 3235B

CAUTION: Avoid injury! Extreme caution must be used when using a vise to avoid distorting any parts.

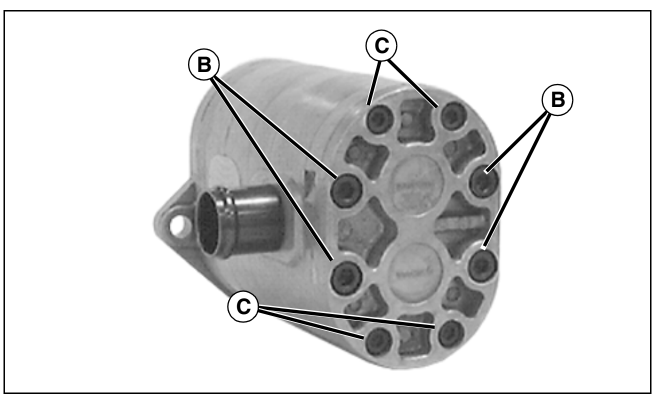


MX2704

1. Place a mark (A) on pump housing to guide reassembly. Make sure the mark extends across all sections of the pump housing.

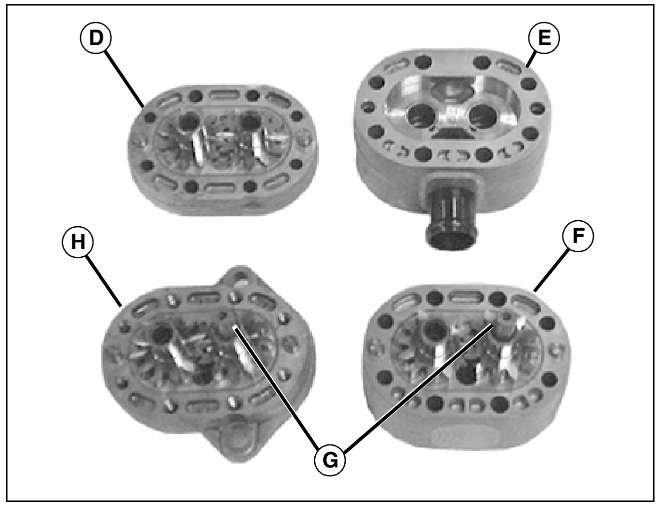
CAUTION: Avoid injury! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

IMPORTANT: Avoid damage! DO NOT intermix parts between pumps. Keep parts for individual pumps separated for reassembly.



MX2705

2. Remove four 3/8-in. Allen head screws (B) and washers and four 5/16-in. Allen head screws (C) and washers that hold pump sections together.

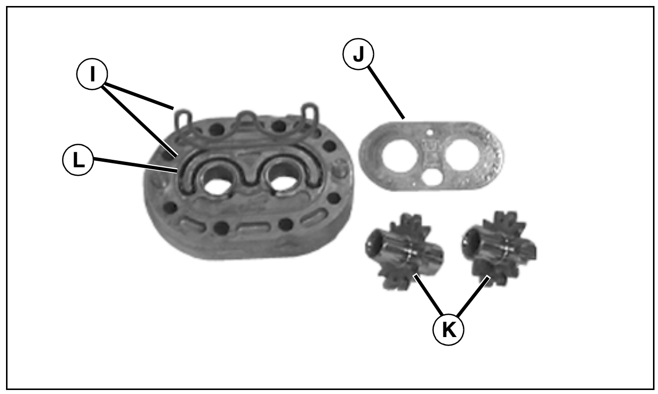


MX2706

3. Carefully separate the rear end plate (D), rear/middle pump body (E), front pump body (F), shaft couplers (G) and front end plate (H) as shown.

4. Remove shaft couplers.

Rear End Plate and Front Pump Body



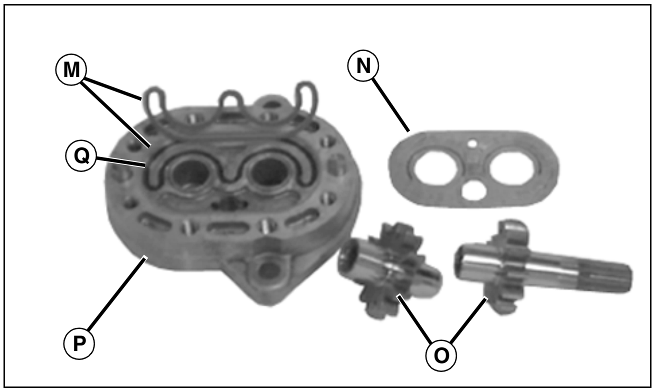
MX2707

Picture Note: Rear end plate is shown. Front body is similar.

5. Remove gears (K), wear plate (J) and seals (I and L) from end plate or pump body.

6. Discard wear plate and seals.

Front End Plate

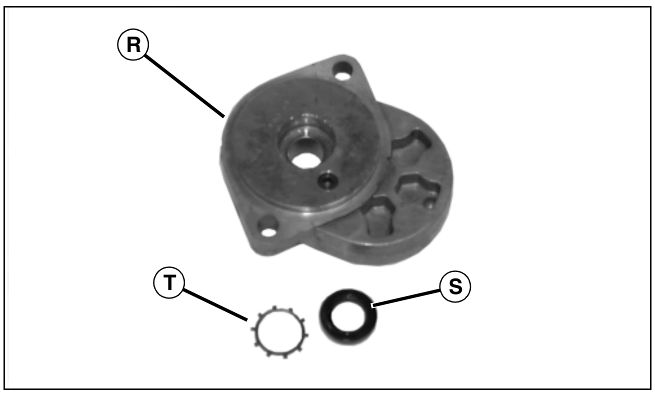


MX2708

7. Remove gears (O), wear plate (N) and seals (M and Q) from front end plate (P).

8. Discard wear plate and seals.

Shaft Seal



MX2709

9. Remove retaining ring (T) from front pump section.

10.Use a screwdriver to carefully remove the shaft seal (S) from the front pump section (R). Discard the shaft seal.

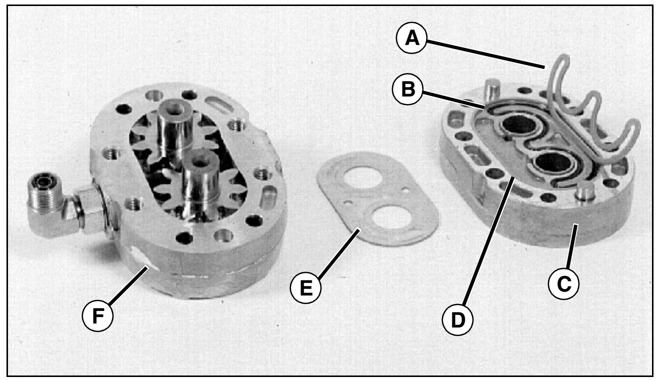
Assemble Triple Pump - 3215, 3235, 3215A, and 3235A

CAUTION: Avoid injury! Extreme caution must be used when using a vise to avoid distorting any parts.

NOTE: Always use new wear plates, gaskets, and seals when rebuilding hydraulic components.

Clean all components of old gasket material and debris with suitable solvent and blow dry.

Rear Pump Assembly



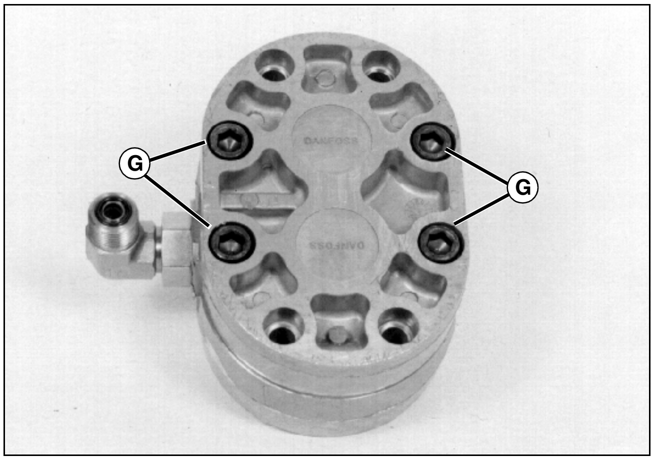
M76490

1. Install gears in pump body. Alignment marks should line up when properly installed.

2. Install three new seals in end plate (C). One blue O-ring seal (D), one black seal (B) and one blue seal (A). Ensure black and blue seals are in proper order in end plate.

3. Install new wear plate (E) over seals in end plate. Bronze side of wear plate should face gears.

4. Assemble end plate to pump body (F). Dowel pins should aid in alignment.



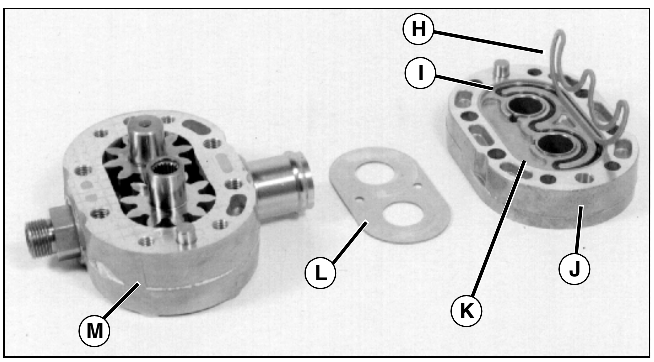
M76489

5. Install four 3/8” x 1-1/2” Allen head screws (G) and washers that hold end plate and pump body together.

6. Tighten bolts to specifications.

7. Rotate drive shaft to be sure pump is not binding.

Center Pump Assembly



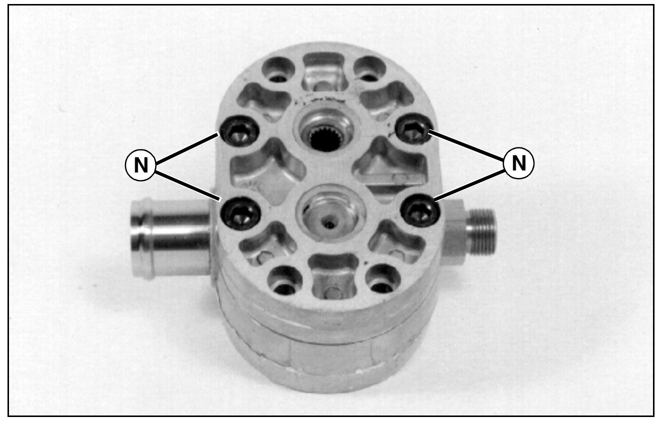
M76492

1. Install gears in pump body. Alignment marks should line up when properly installed.

2. Install three new seals in end plate. One blue O-ring seal (K), one black seal (I) and one blue seal (H). Ensure black and blue seals are in proper order in end plate.

3. Install new wear plate (L) over seals in end plate. Bronze side of wear plate should face gears.

4. Assemble end plate (J) to pump body (M). Dowel pins should aid in alignment.



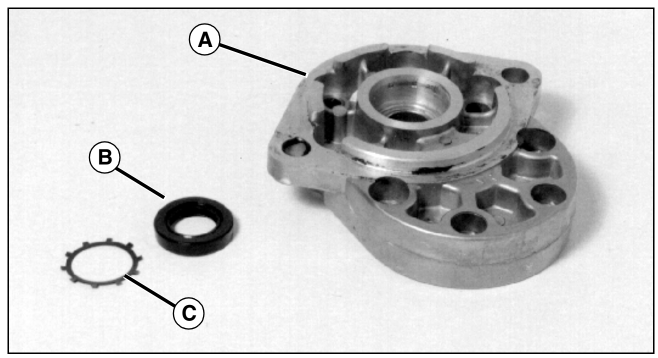
M76491

5. Install four 3/8” x 1-1/4” Allen head screws (no washers) (N) that hold end plate and pump body together.

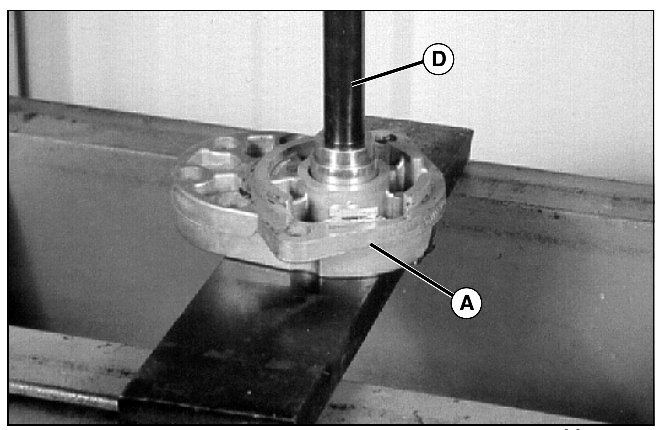
6. Tighten bolts to specifications.

7. Rotate drive shaft to be sure pump is not binding.

Front Pump Assembly



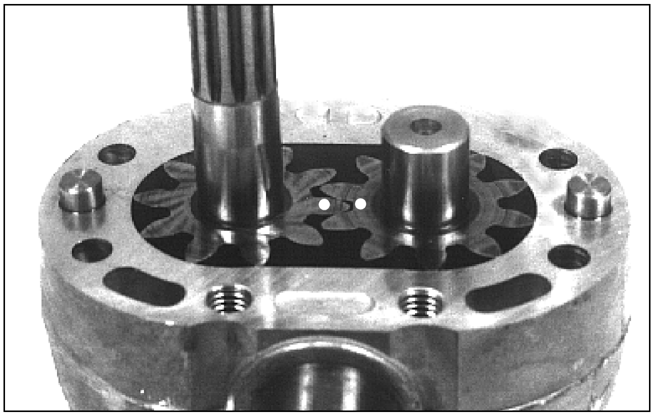
M76488



M76524

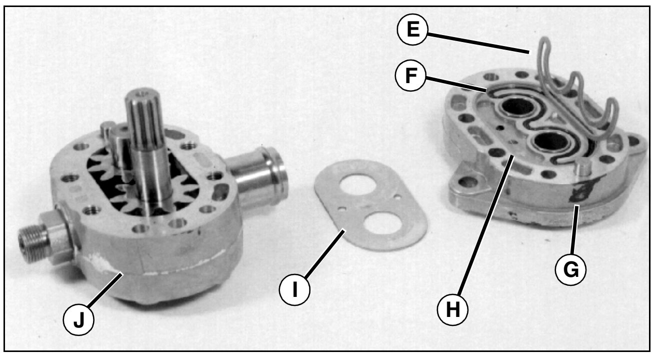
1. Install new shaft seal (B) in end plate (A) using suitable seal driver (D). Lubricate inner seal lip with grease.

2. Install retaining ring (or snap ring) (C) in end plate (A) with curved tabs of retaining ring out.



M56597

3. Install gears in pump body. Alignment marks should line up when properly installed.

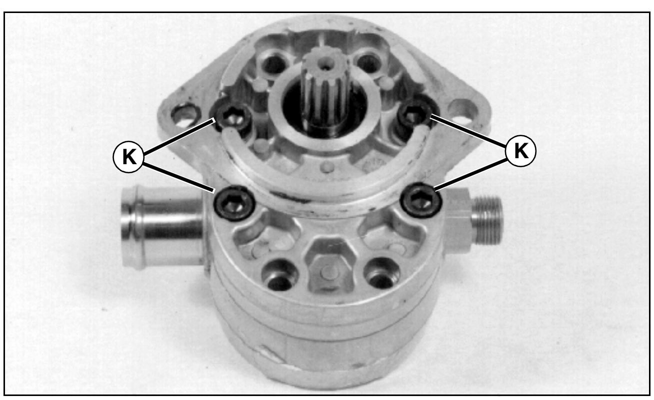


M76494

4. Install three new seals in end plate. One blue O-ring seal (H), one black seal (F) and one blue seal (E). Ensure black and blue seals are in proper order in end plate.

5. Install new wear plate (I) over seals in end plate. Bronze side of wear plate should face gears.

6. Assemble end plate (G) to pump body (J). Dowel pins should aid in alignment.

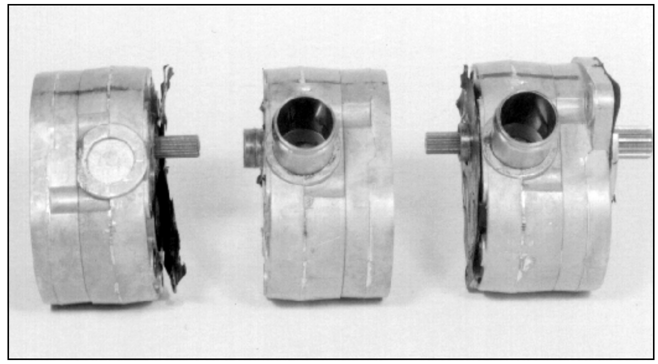


M76493

7. Install four 3/8” x 1-1/2” Allen head screws (K) and washers that hold end plate and pump body together.

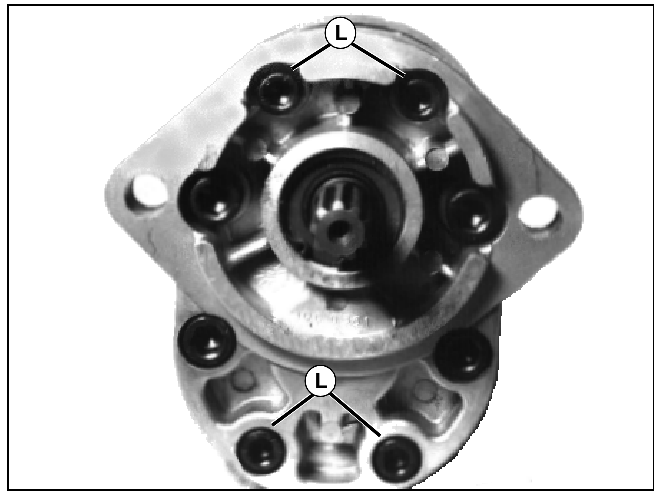
8. Tighten bolts to specifications.

9. Rotate drive shaft to be sure pump is not binding.



M76487

10.Install splined shafts in rear pump and front pump.



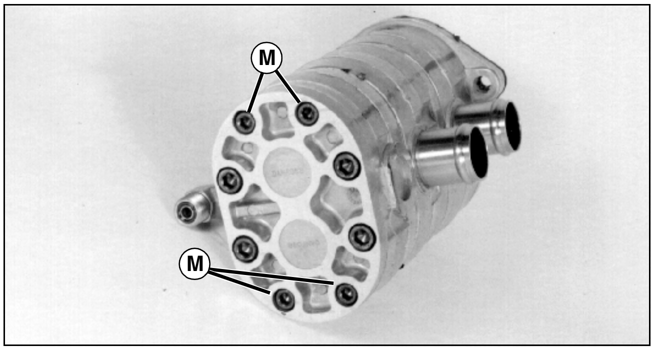
M56647

11.Use a new gasket between pump sections.

12.Assemble front pump section to center pump section. Rotate drive shaft to align splines.

13.Install four 5/16” x 4” Allen head screws (L) and washers that hold front section of triple pump to center section.

14.Tighten bolts to specification.



M76486

15.Use a new gasket between pump sections.

16.Assemble rear pump section to center pump section. Rotate drive shaft to align splines.

17.Install four 5/16" x 3" Allen head screws (M) and washers that hold rear section of triple pump to center section.

18.Tighten bolts to specification.

Specifications

Rear Pump Assembly Allen Head Screw (3/8-in. x 1-1/2-in.) Torque . . . . . 40-43 N•m (30-32 lb-ft)

Rear Pump Assembly Allen Head Screw (5/16-in. x 3-in.) Torque. . . . . 21-24 N•m (190-210 lb-in.)

Center Pump Assembly Allen Head Screw (3/8-in. x 1-1/4-in.) Torque . . . . 40-43 N•m (30-32 lb-ft).

Front Pump Assembly Allen Head Screw (3/8-in. x 1-1/2-in.) Torque . . . . . 40-43 N•m (30-32 lb-ft)

Front Pump Assembly Allen Head Screw (5/16-in. x 4-in. Torque . . . . . 21-24 N•m (190-210 lb-in.)

Front Pump Assembly Allen Head Screw (5/16-in. x 3-in. Torque . . . . . 21-24 N•m (190-210 lb-in.)

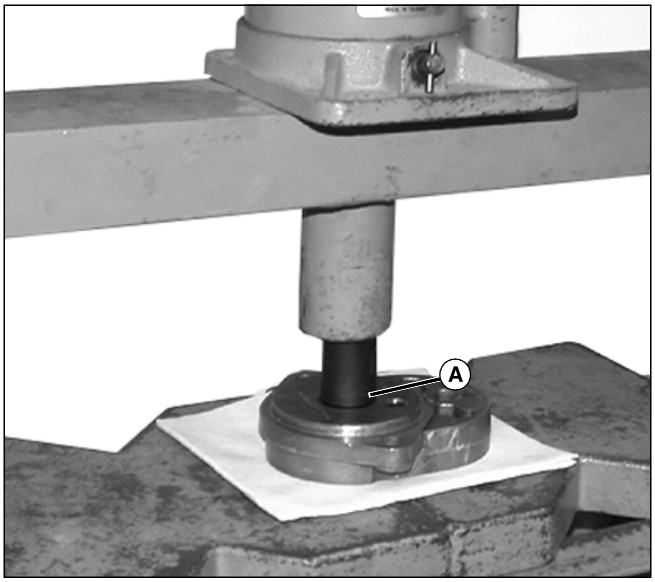
Assemble Triple Pump - 3215B, 3225B, and 3235B

CAUTION: Avoid injury! Extreme caution must be used when using a vise to avoid distorting any parts.

NOTE: Always use new wear plates, gaskets, and seals when rebuilding hydraulic components.

Clean all components of old gasket material and debris with suitable solvent and blow dry.

Front End Plate

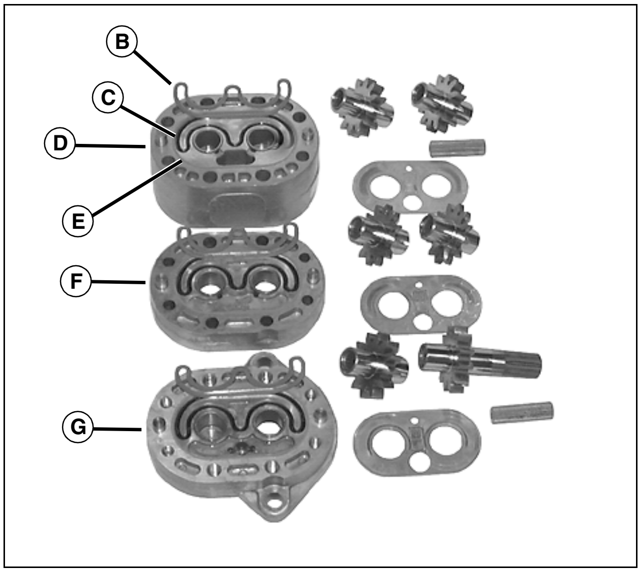


MX2710

IMPORTANT: Avoid damage! Place a cloth or other soft materlal under the end plate to protect the machined surfaces.

1. When installing shaft, lips of shaft seal (A) should be facing in. Use a seal driver and press to install shaft seal.

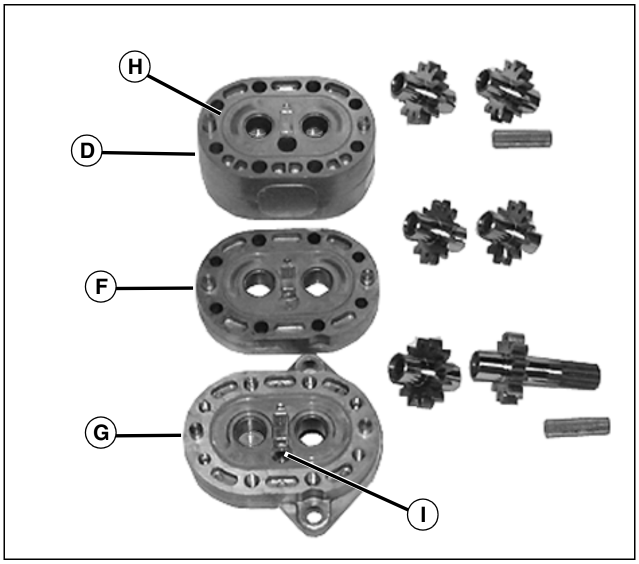
2. Lubricate inner lip of seal with grease.



MX2711

3. Install black seal (C) and then blue seal (B) in channel in front end plate (G), rear end plate (F) and front pump body (D).

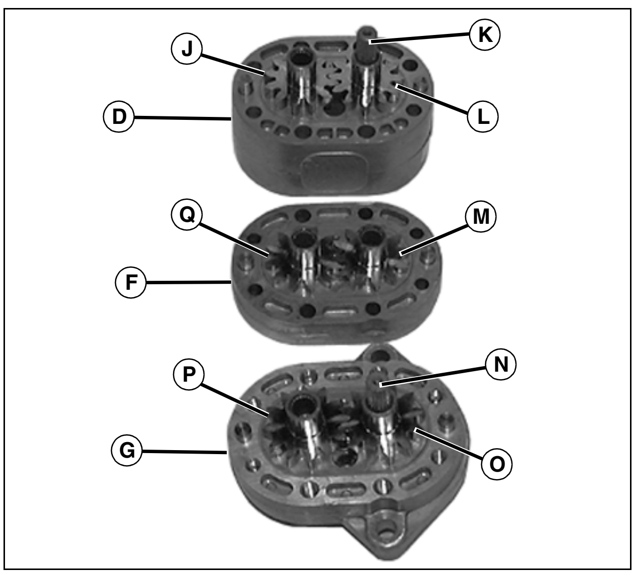
4. Install large blue seal (E) in front end plate, rear end plate and front pump body.



MX2712

5. Install wear plate (H) in front end plate (G), rear end plate (F) and front pump body (D). Ensure bronze side faces up and large hole (I) is over the oil inlet passage.

IMPORTANT: Avoid damage! Make sure bronze side of wear plates are facing the gears.



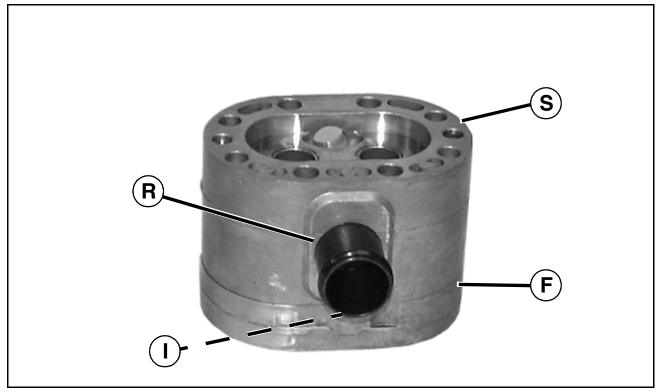
MX2713

6. Install idler gear (P) and drive gear with input drive shaft (O) in front end plate (G).

7. Install idler gear (M) and drive gear (Q) in rear end plate (F).

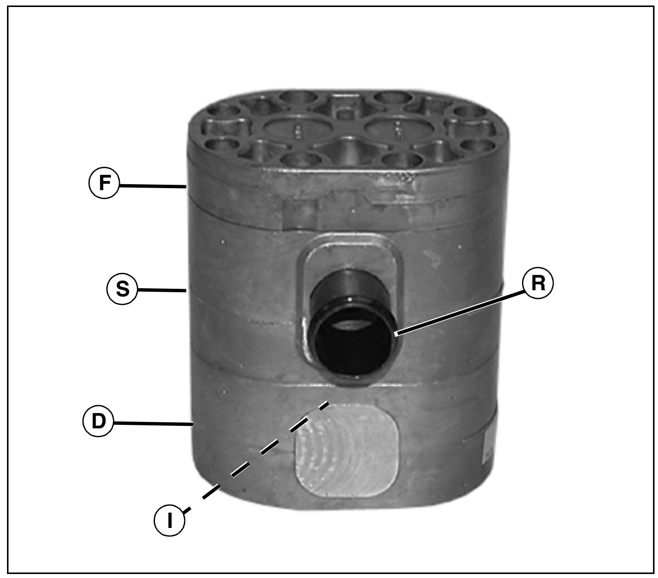
8. Install idler gear (J) and drive gear (L) in front pump body (D).

9. Install shaft couplers (K and N) in drive gear of front end plate (G) and front pump body (D).



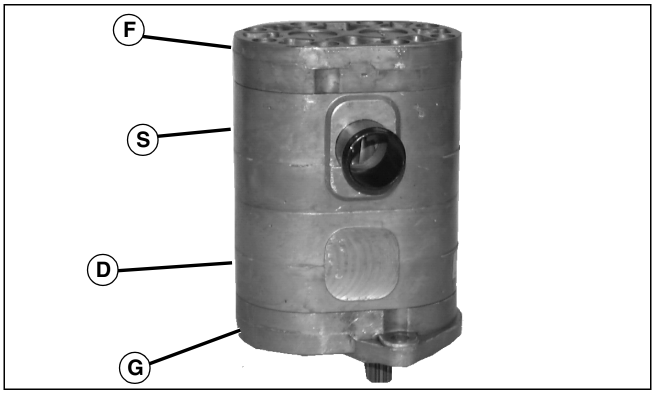
MX2714

10.Install rear/middle pump body (S) on rear end plate (F). Oil inlet (R) should be on the same side as the large hole (I) in wear plate.



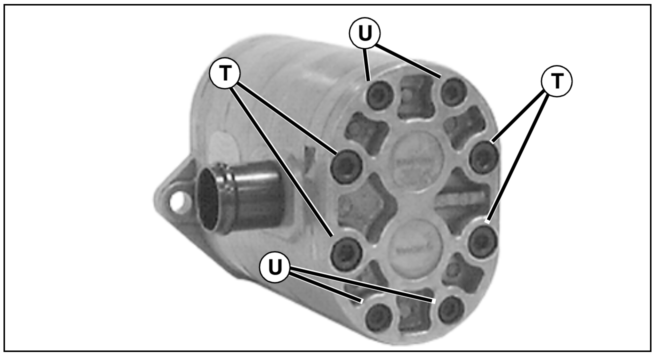
MX2715

11.Turn over rear/middle pump body (S) and rear end plate (F) and install on front pump body (D). Oil inlet (R) should be on the same side as the large hole (I) in wear plate.



MX2716

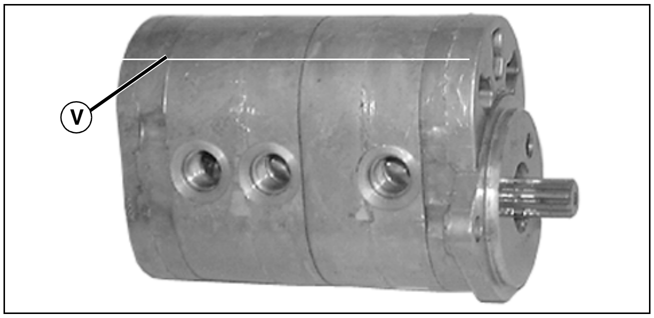
12.Install assembled sections (rear end plate (F), rear/ middle pump body (S) and front pump body (D) on front end plate (G).



MX2705

13.Install four 3/8-in. Allen head screws (T) and washers and tighten to specifications.

14.Install four 5/16-in. Allen head screws (U) and tighten to specifications.



MX2704

15.If assembly is correct, the mark (V) that was made on the side of the pump housing prior to disassembly should be continuous across the housing with no gaps. If not, make corrections.

Specifications

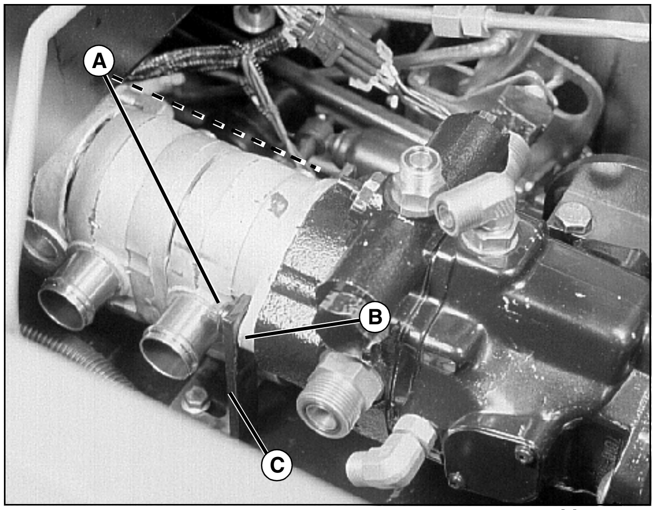
Allen Head Screw (3/8-in.) Torque 40-43 N•m (30-32 lb-ft)

Allen Head Screw (5/16-in.) Torque. 21-24 N•m (190-210 lb-in.)

Install Triple Pump

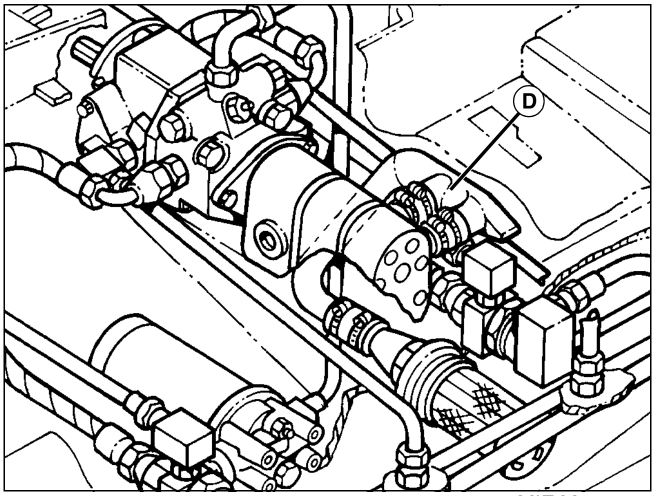
NOTE: Installation is similar for all models; 3215 is shown.

1. Install coupler onto hydrostatic pump shaft.
2. Add Loctite Superflex™ No. 598 to both sides of gasket.
3. Place gasket on triple pump assembly mount flange.



M76523

4. Place triple pump mounting bracket (C) in place.
5. Fit triple pump drive shaft into coupler on hydrostatic pump drive shaft.
6. Install two cap screws (A) through mounting bracket (C), triple pump mounting flange (B), then into hydrostatic pump.
7. Install three high-pressure hoses on right side of triple pump.



MIF M56547

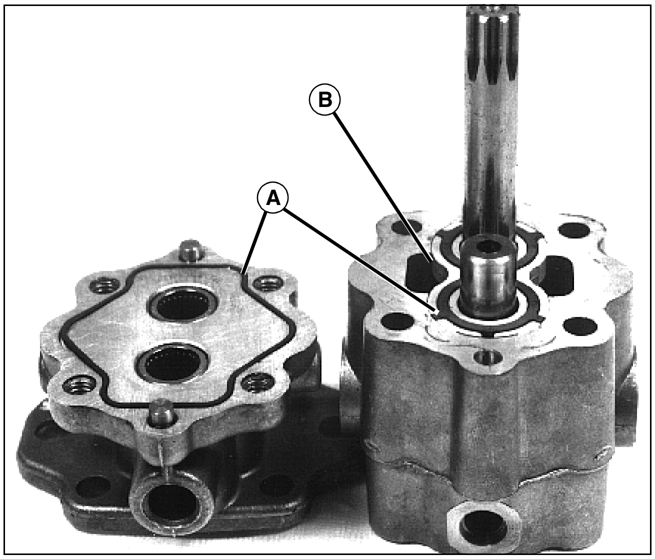
8. Install pump intake line (D) on reservoir and left side of triple pump.

Repair Reel Motor - Medium Duty (YB Series)

Disassembly

IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

Be careful not to drop any parts or disengage gear mesh when separating assemblies.

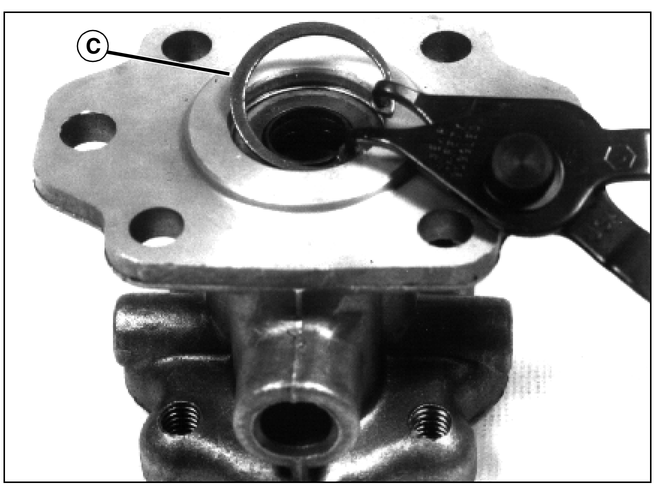


M56603

1. Remove four Allen head screws and separate the two pump halves.

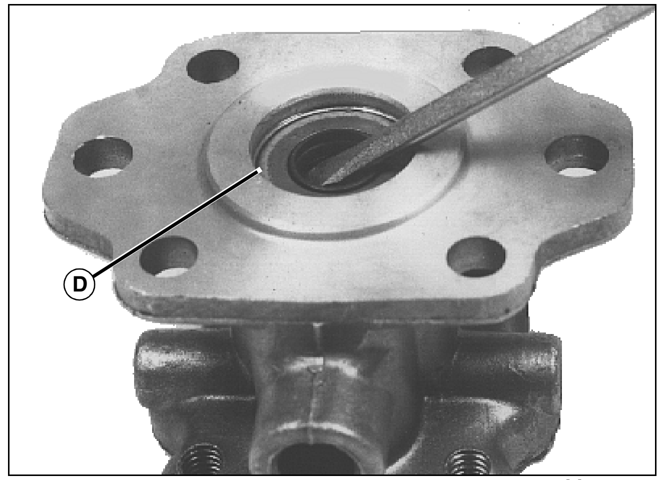
2. Remove wear plate (B) and seals (A).

3. Mark mating teeth of pump gears and remove from housing.



M56605

4. Remove retaining ring (C) from shaft seal.



M56604

5. Remove shaft seal (D).

Inspection

1. Inspect bore area for scoring, burrs, fretting or uneven wear patterns. Replace pump assembly if worn.

2. Inspect pump gears and shafts for excessive wear. Replace pump assembly if worn.

3. Inspect wear plate for scoring.

Assembly

1. Clean all parts with suitable solvent and blow dry.

2. Install new shaft seal and lubricate lip. Secure with external snap ring.

3. Install pump gears with alignment marks lined up.

4. Lubricate wear plate and install with new seal on top.

5. Install new O-ring on housing and install housing on pump body.

6. Loosely install four 5/16” Allen head screws. Rotate pump shaft to check for binding.

7. Tighten 5/16” Allen head screws to specifications.

Specifications

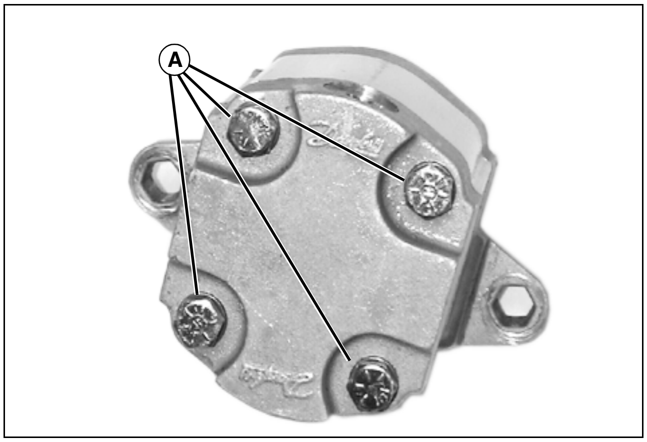
Allen Head Screw (5/16-in.) Torque 21.5-23.7 N•m (190-210 lb-in.)

Repair Reel Motor - Medium Duty (2500M)

Disassembly

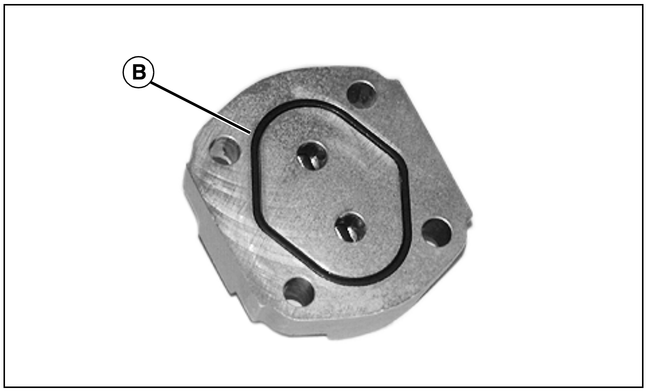
1. Thoroughly clean and dry outside of motor.

> **IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on input shaft will separate components without burring.**
>
> **Be careful not to drop any parts or disengage gear mesh when separating assemblies.**



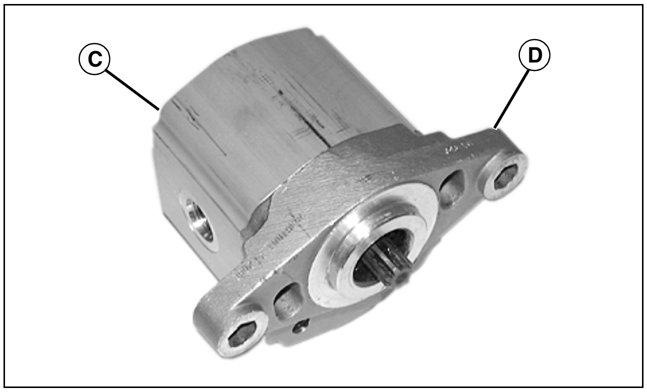
M84877

2. Place motor in a soft-jaw vise using just enough pressure to prevent the motor from turning when removing cap screws.
3. Remove four cap screws (A).
4. Remove end cover.



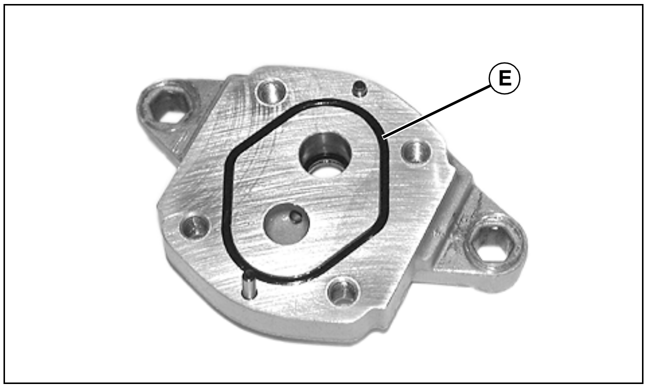
M84878

5. Remove O-ring (B) from end cover.



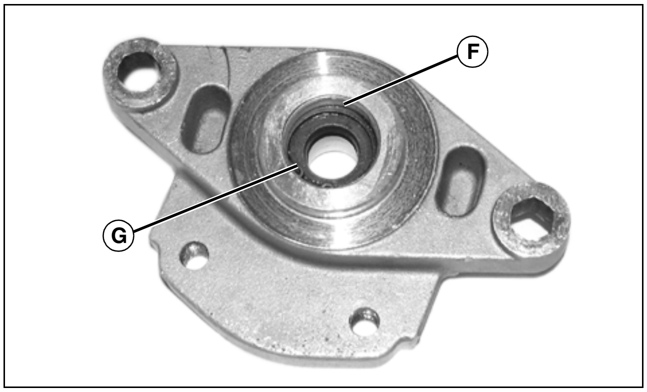
M84879

6. Separate front end cover (D) from main body (C).



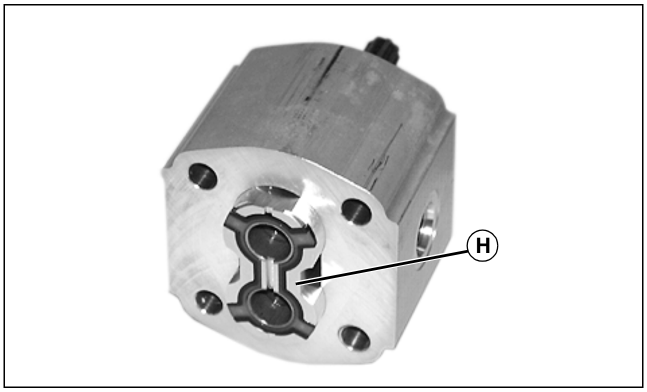
M84880

7. Remove O-ring (E) from front end cover.



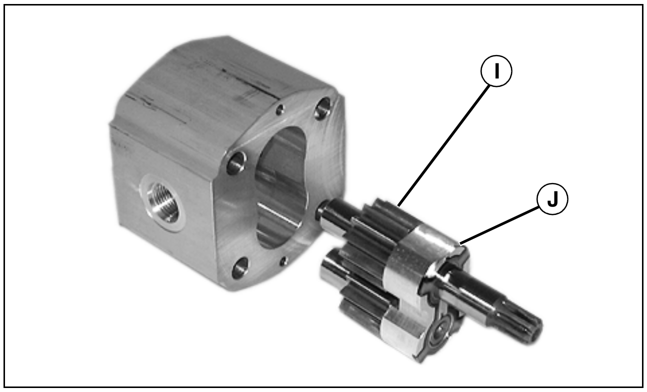
M84881

8. Remove retaining ring (F).
9. Remove seal (G).



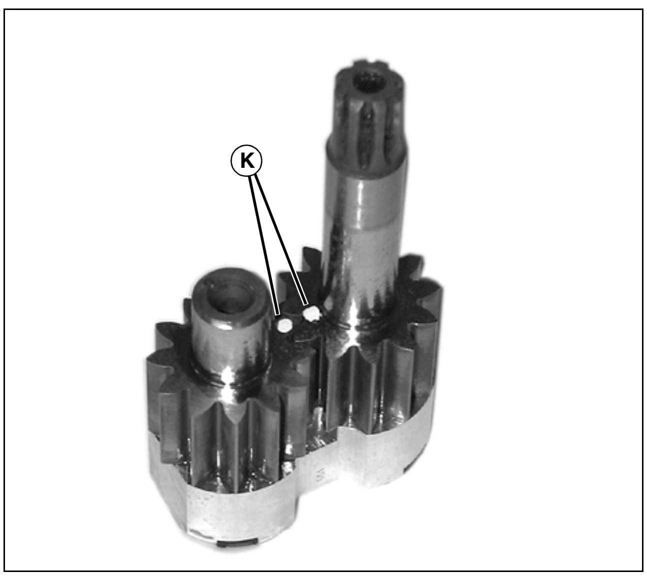
M84882

10.Remove rear wear block assembly (H).



M84883

11.Remove front block assembly (J) and gear set (I).



M84885

12.Place alignment marks (K) on gear mating teeth and remove gears from wear block assembly.

M84886

13.Inspect housing bore (L) for signs of damage.

CAUTION: Avoid injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

IMPORTANT: Avoid damage! Absolute cleanliness is essential when working on reel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

14.Clean all metal parts with solvent and blow dry with compressed air.

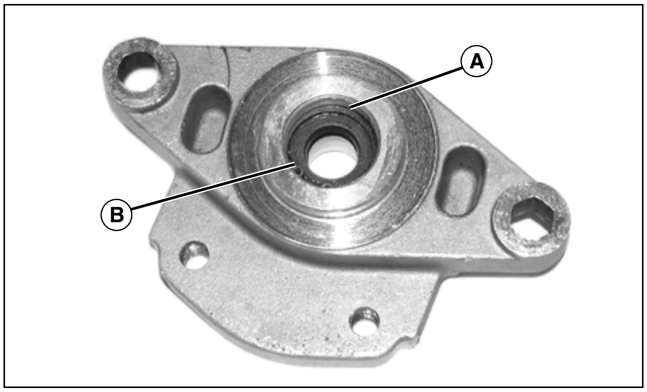
15.Inspect all parts for damage, nicks or unusual wear. Replace entire reel moor assembly if any parts other than seal rings, seals or outer bearing are worn or damaged.

Assembly

IMPORTANT: Avoid damage! Always use new O-rings and seals. Used or damaged O-rings and seals will leak.

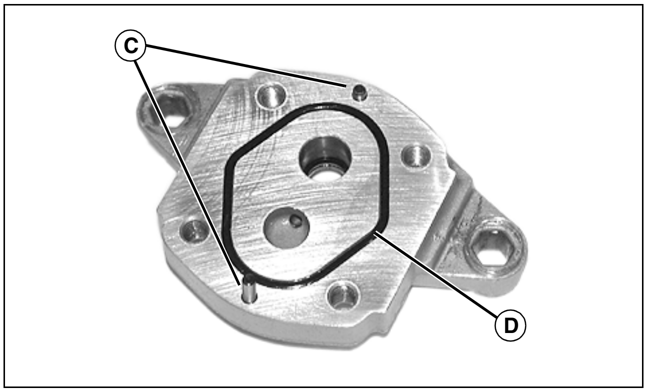
NOTE: Lubricate all seals and O-rings with petroleum jelly during assembly.

Apply a light coat of clean hydraulic oil to all internal parts when assembling the reel motor.



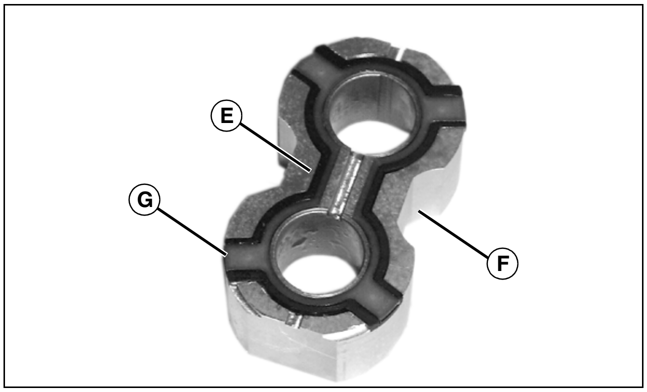
M84881

1. Apply multi-purpose grease to lips of seal (B).
2. Install a new seal parallel to the bore and seat tight against shoulder of bore.
3. Install retaining ring (A).



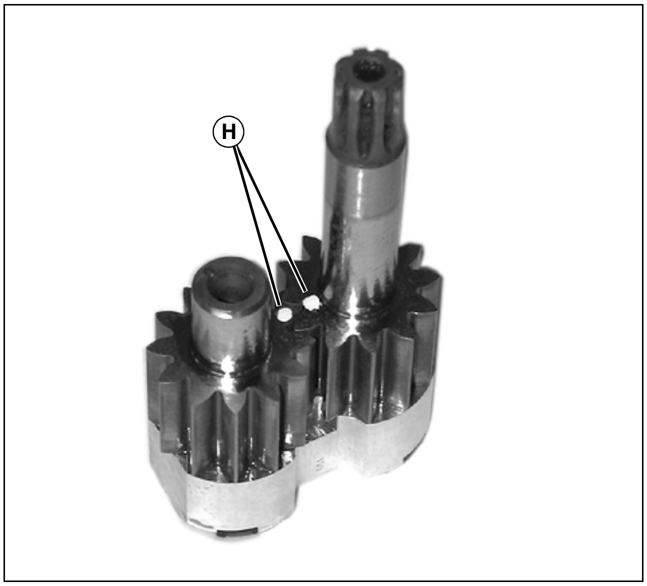
M84880

4. Install new O-ring (D).
5. Install alignment pins (C), if removed.



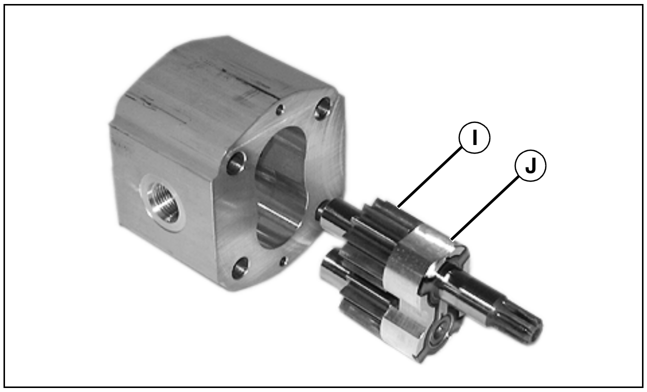
M84884

6. Install new seals (E) and spreaders (G) in wear block (F).



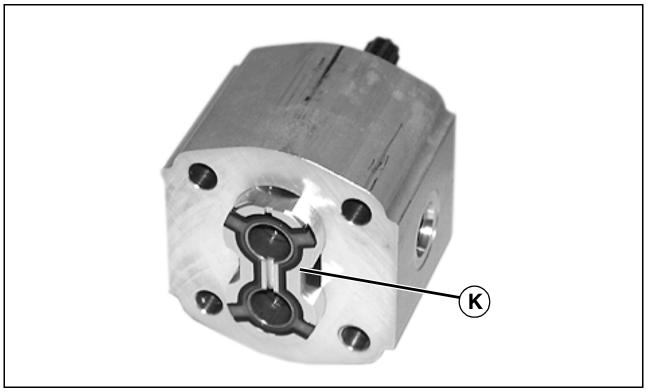
M84885

7. Align marks (H) and install gears in wear block.



M84883

8. Apply a light coat of clean hydraulic oil to wear block (J) and gear assembly (I).
9. Install front wear block/gear set assembly in housing.

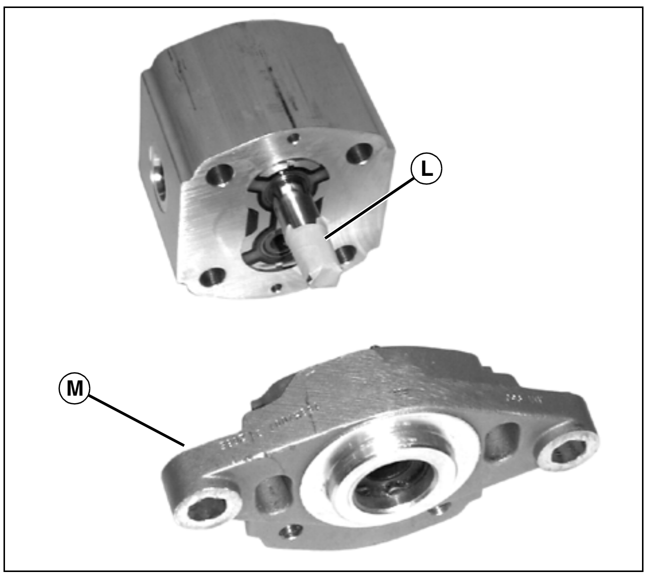


M84882

10.Apply a light coat of clean hydraulic oil to wear block/ gear set assembly.

11.Install rear wear block/gear set assembly (K) in housing.

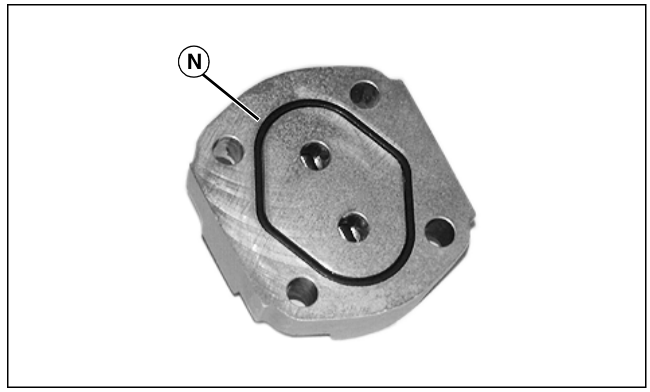
NOTE: The repair kit may include a plastic sleeve to cover the input shaft in order to prevent damage to the seal.



M98191

12.Cover the splines of the input shaft with tape (L) (or sleeve included with the repair kit) to prevent damaging the seal during installation.

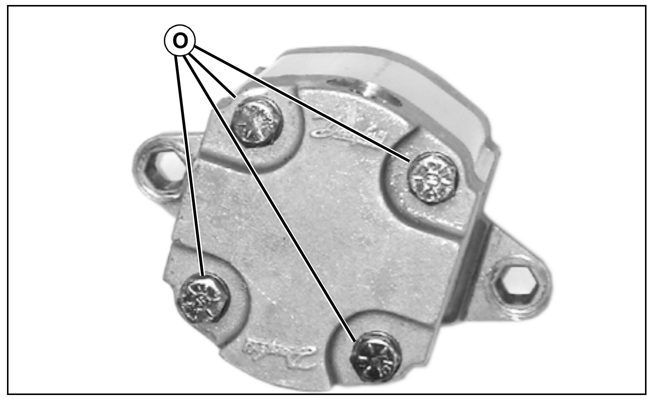
13.Install front cover (M).



M84878

14.Install new O-ring (N) in rear cover.

15.Install rear cover.



M84877

16.Install cap screws (O) (hand tight).

17.Rotate input shaft to verify that all parts are mating smoothly.

18.Tighten cap screws in an alternating pattern to specifications.

Specifications

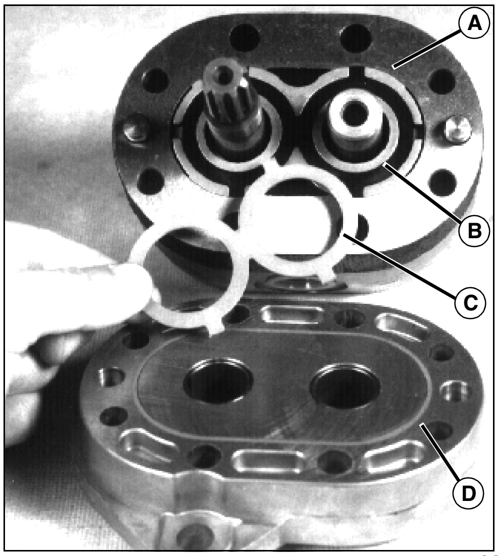
Reel Motor (2500M) Cap Screw Torque 45 N•m (33 lb-ft)

Repair Reel Motor - Heavy Duty (YC Series)

Disassembly

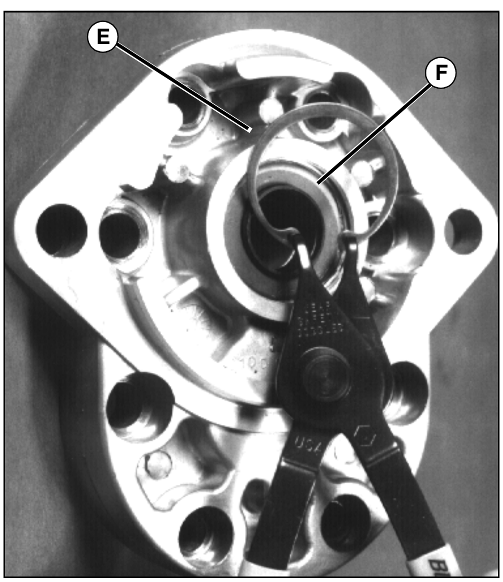
IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

Be careful not to drop any parts or disengage gear mesh when separating assemblies.



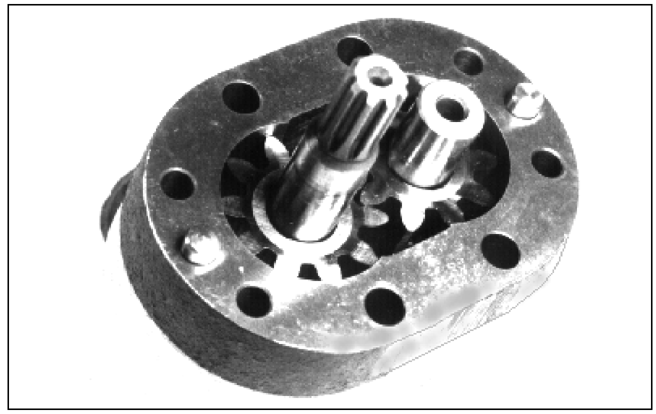
M56571

1. Remove eight Allen head screws and cover from gear housing.
2. Remove seals (B, C and D) and wear plate (A).

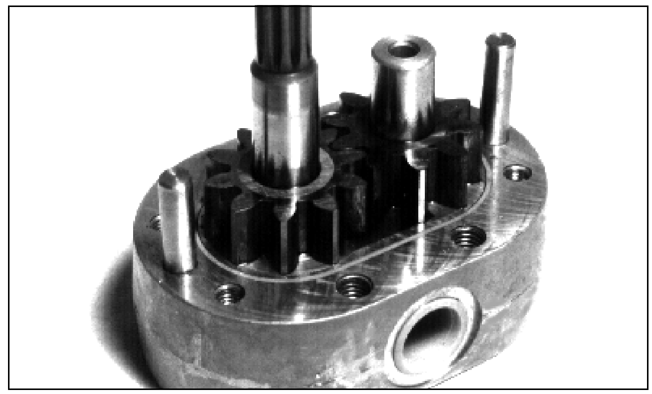


M56645

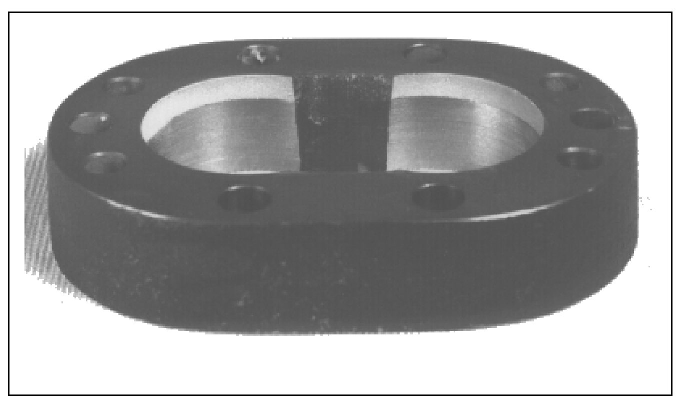
3. Remove internal snap ring (E) from shaft seal.
4. Remove shaft seal (F) using a two-jaw puller.


M56569

5. Remove center bore section. Do not disturb gears.


M56570

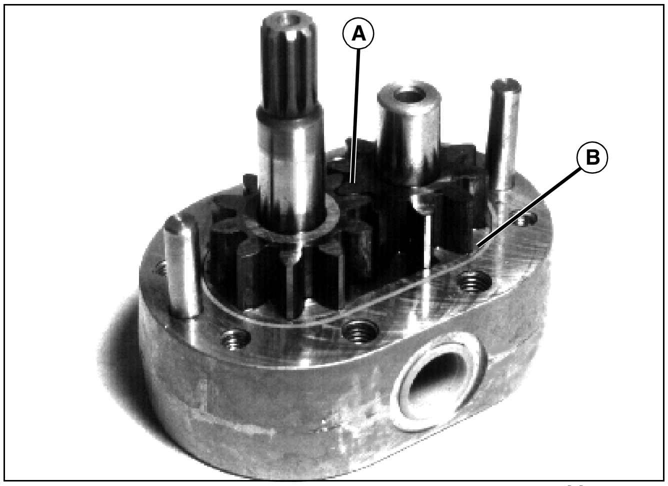
6. Mark mating teeth of pump gears for assembly.
7. Remove gears. Inspect for scoring, burrs, fretting or uneven wear patterns. Replace pump assembly if gears are worn.


M56641

8. Inspect bore area for scoring, burrs, fretting or uneven wear patterns. Replace pump assembly if worn.

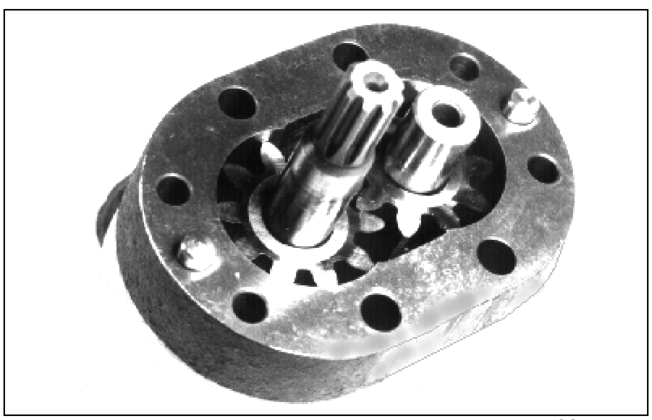
Assembly

1. Clean all parts with suitable solvent. Blow dry.



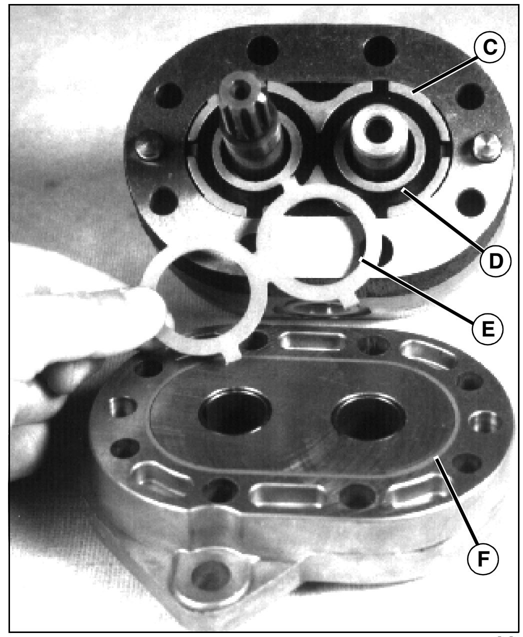
M56570

2. Install gears. Be sure gear teeth are matched to alignment marks (A).
3. Install dowel pins if removed.
4. Install O-ring seal (B).



M56569

5. Install center bore section.

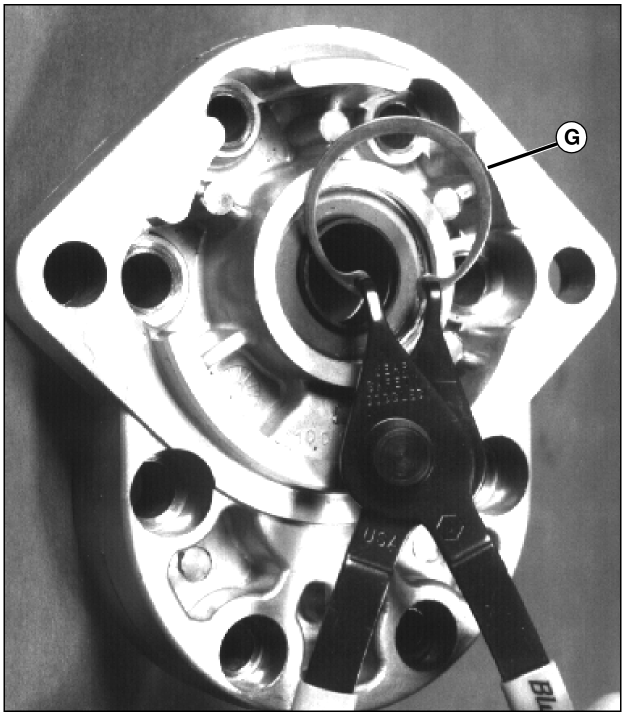


M56571

6. Install wear plate (C) and seals (D, E and F).

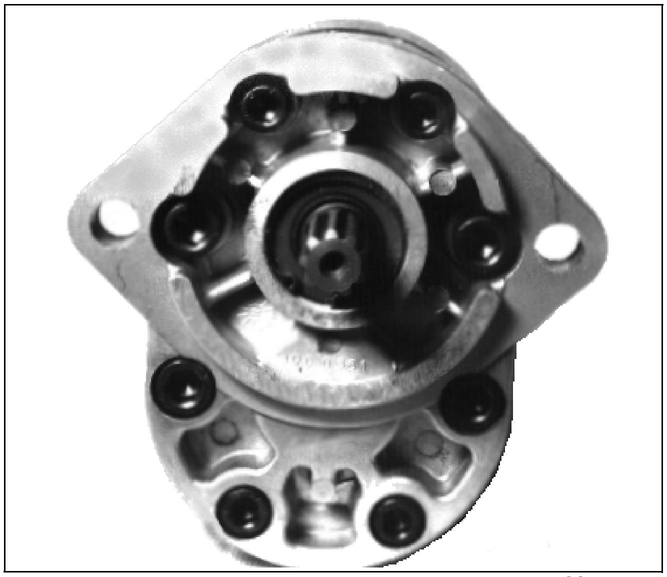
M56640

7. Press in shaft seal (metal side facing out) using a suitable seal driver.



M56645

8. Install snap ring (G). Make sure sharp edge of ring faces out.



M56647

9. Install eight 5/16” Allen head screws and tighten evenly to specifications.

Specifications

Allen Head Screw (5/16-in.) Torque. 21.5-23.7 N•m (190-210 lb-in.)

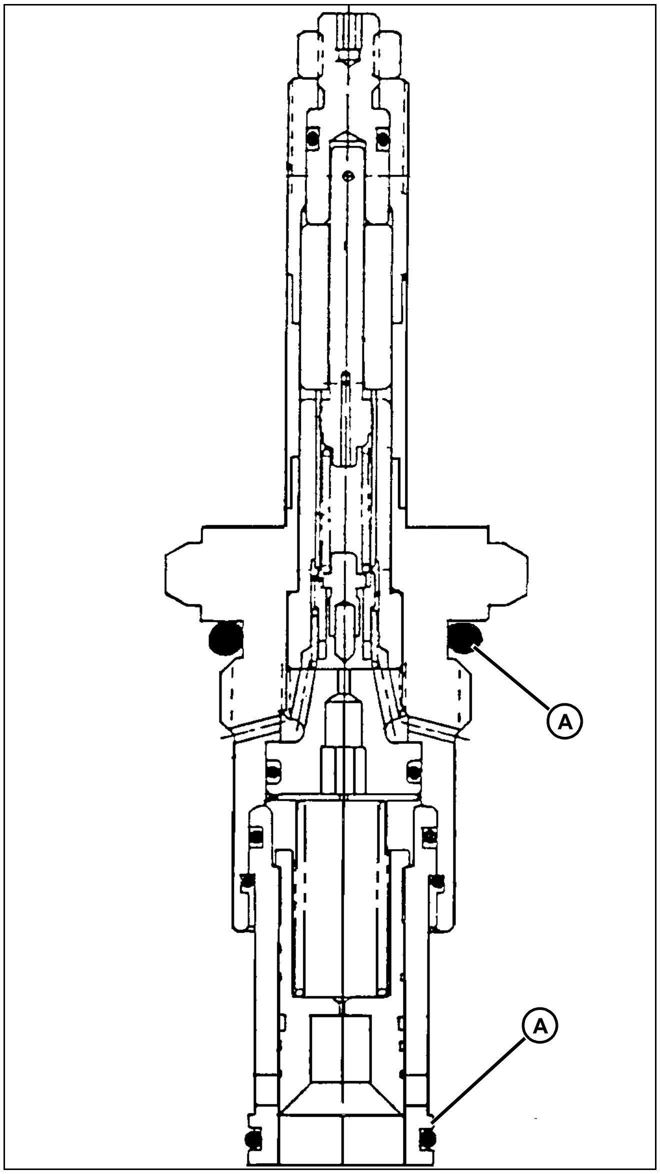
Backlapping Valve

Removal

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

Disassembly and Reassembly

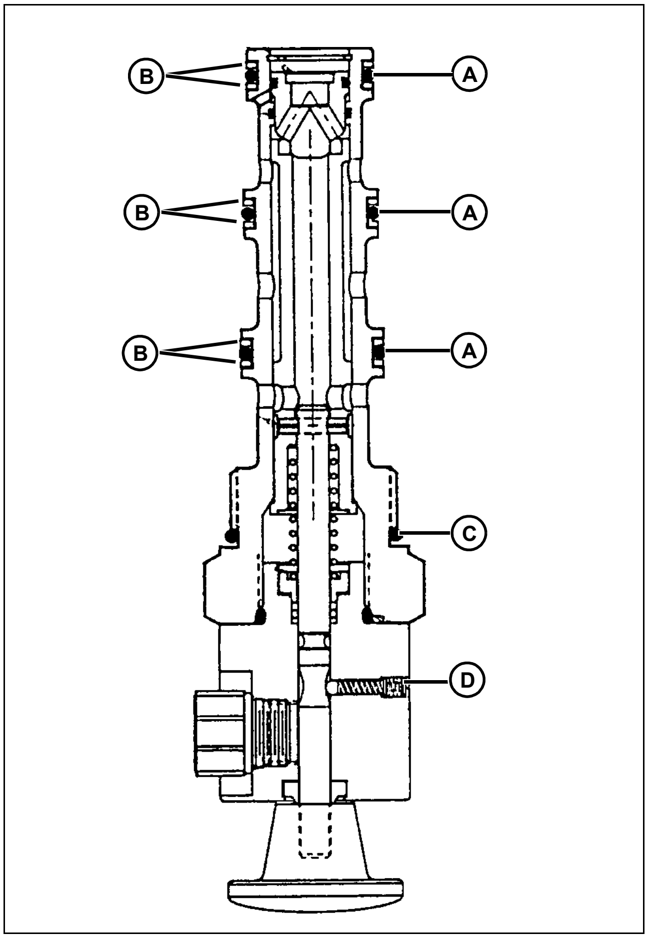
1. The valve body is a single machined block. The valves may be removed and inspected for wear, and seals replaced. The following diagrams show seal placement:



MIF M56666

Picture Note: Mow Valve Solenoid Plunger Shown.

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



MIF M56665

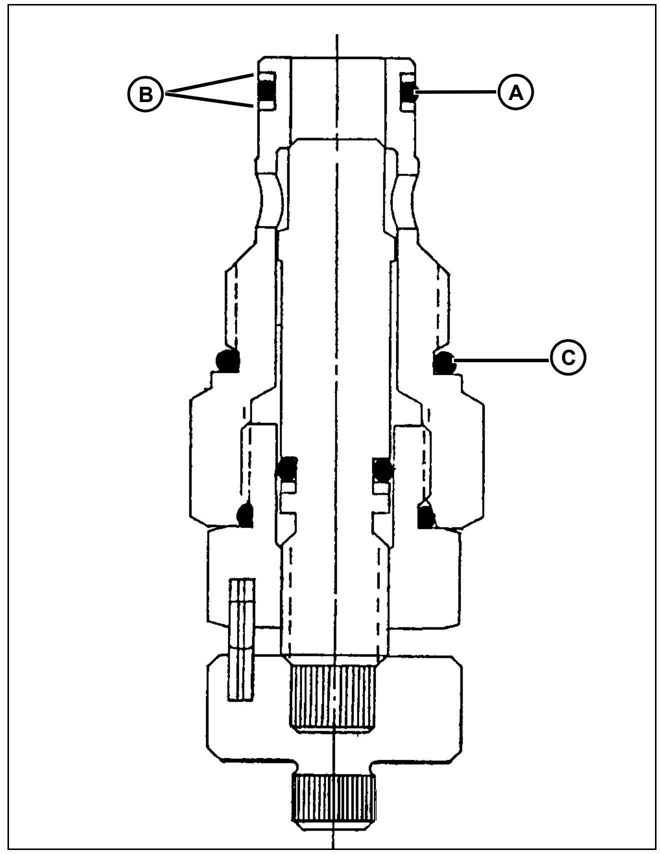
Picture Note: Forward/Reverse Valve Shown.

3. Ensure O-rings (A) are installed between back-up washers (B). Install O-ring (C). Lubricate O-rings and back-up washers before installing valve.

4. Install detent ball and spring (D). Secure with Allen head retainer.

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

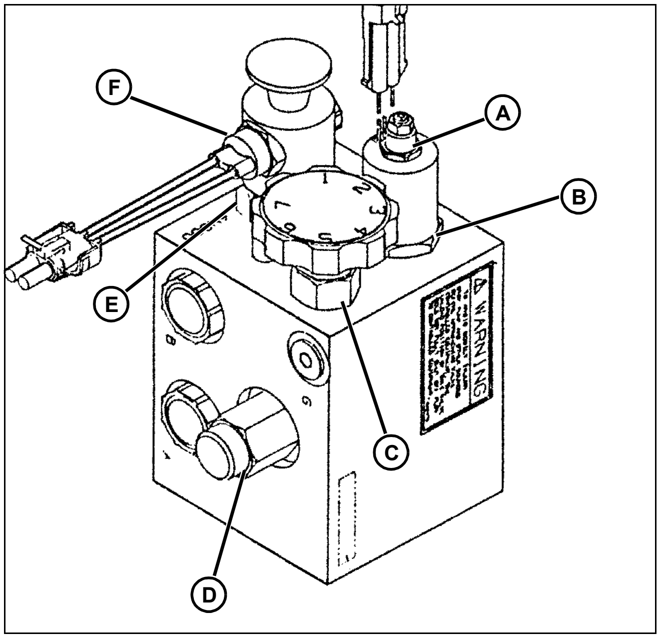
5. Adjust detent tension with system under pressure. Proper tension is achieved when the forward/reverse knob stays IN with the system pressurized.



MIF M56664

Picture Note: Flow Control Valve Shown.

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



MIF M56667A

A - Solenoid Coil
B - Solenoid Plunger
C - Flow Control Valve
D - Pressure Relief Valve
E - Forward/ Reverse Valve
F - Forward/ Reverse Switch

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

Specifications

Solenoid Coil	**94.9 N•m (70 lb-ft)**
Solenoid Plunger	**27.1-33.9 N•m (20-25 lb-ft)**
Flow Control Valve	**61.0-67.8 N•m (45-50 lb-ft)**
Pressure Relief Valve	**61.0-67.8 N•m (45-50 lb-ft)**
Forward/Reverse Valve	**237.3 N•m (175 lb-ft)**
Forward/Reverse Switch	**13.6-20.3 N•m (10-15 lb-ft)**

Table of Contents

STEERING SPECIFICATIONS

Specifications

General Specifications

Steering Control Unit

Make. . . . . Eaton

Type . . . . Char-Lynn® 2 Series

Maximum Operating Pressure. . . . . 6895 kPa (1000 psi)

Maximum Back Pressure . . . . 1034 kPa (150 psi)

Maximum Operating Temperature . . . . 93°C (200°F)

Maximum Flow . . . . 15 L/min (4 gpm)

Maximum Differential Temperature (Between Steering Unit and System Temperature) . . . . 28°C (50°F

Test and Adjustment Specifications

Steering and Lift System Relief Valve Pressure . . . . 13 100 ± 1380 kPa (1900 ± 200 psi)

Repair Specifications

Steering Column-to-SCU Cap Screw Torque . . . . 16-18 N•m (140-160 lb-in.)

SCU Relief Valve Plug Torque . . . . 17 N•m (150 lb-in.)

Tools and Materials

Tools

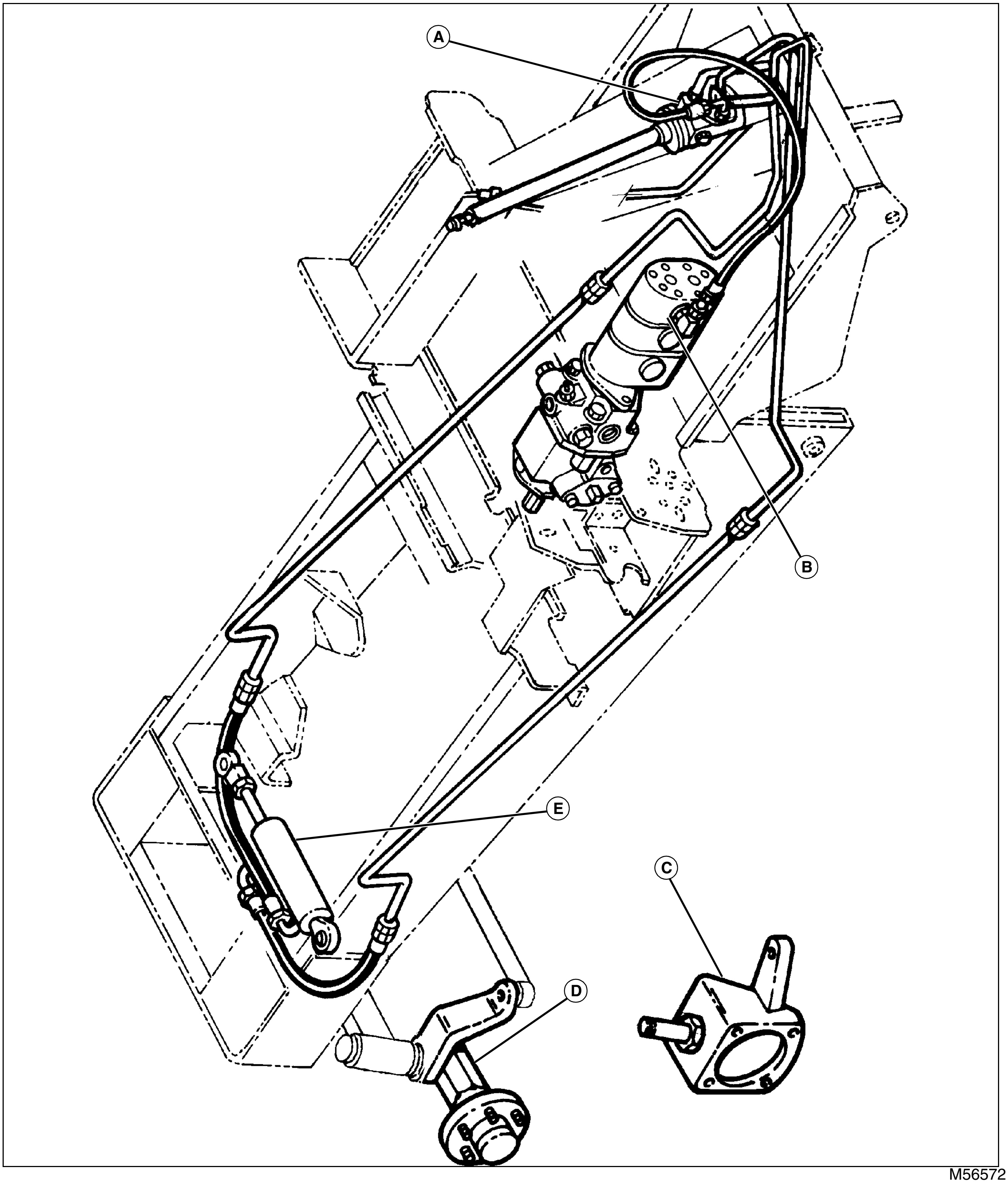
Special or Required Tools

Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Connect pressure gauge for steering and lift system relief valve pressure test.
T-Fitting	38H1030	Connect pressure gauge for steering and lift system relief valve pressure test.
Hose	AMT846	Connect pressure gauge for steering and lift system relief valve pressure test.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.
Gauge 20 684 kPa (3000 psi)	JT03345	Check steering and lift system relief valve setting.
Hose 34 474 kPa (5000 psi)	JT03017	Connect pressure gauge for steering and lift system relief valve pressure test.

STEERING COMPONENT LOCATION

Component Location

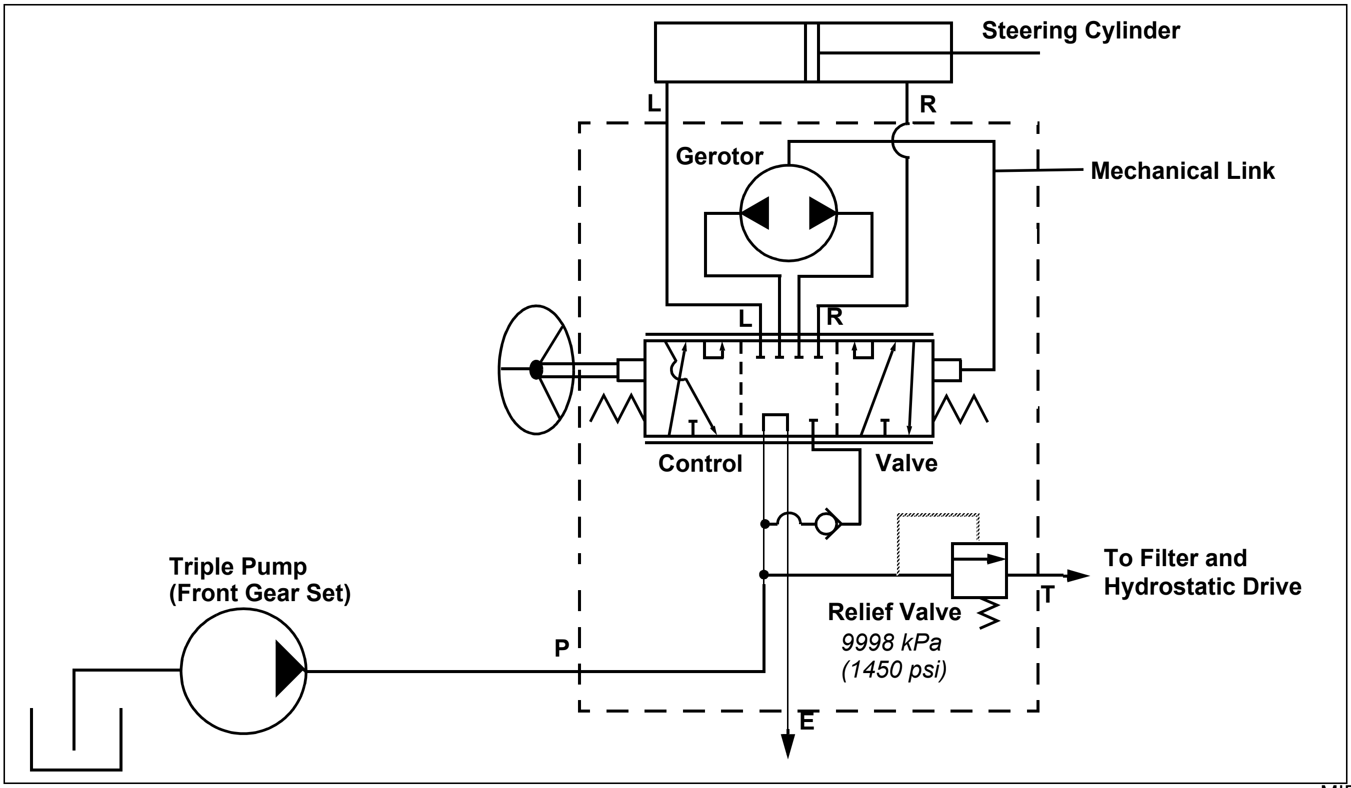
Steering Components



A - Steering Control Unit
B - Triple Pump (Front Gear Set)
C - 4-Wheel Drive Motor Housing
D - 2-Wheel Drive Stub Axle
E - Steering Cylinder

Theory of Operation

Steering System



MIF

Port Identification

Port P . . . . Inlet pressure

Port T . . . . To reservoir

Port E . . . . To lift system and hydrostatic drive

Port L . . . . Left turn

Port R . . . . Right turn

Function

Provides power assisted steering and manual steering if hydraulic pressure is lost.

Triple Pump (Front Gear Set)

The triple pump (front gear set) is the forward pump of the triple pump assembly. The triple pump (front gear set) provides make-up fluid to the steering mechanism.

Steering Control Unit (SCU)

The steering control unit is a Char-Lynn® Mini-Series 291 Steering Control Unit manufactured by Eaton Corp. This unit operates in an “Open Center Series” type hydraulic system which allows hydraulic flow through a open center port when the valve is in the center position. This allows operation of other equipment such as lift, down pressure (if equipped) and hydrostatic drive systems. Each system, except the hydrostatic drive, has a controlling valve with an open center that directs fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Theory

Charge pressure flows to a three-position, spring centered control valve inside the Steering Control Unit (SCU). When the control valve is in neutral, oil flows through the open center of the valve and is available for lift operation, the down pressure system and to charge the hydrostatic drive system. When a turn is initiated, fluid flows to either the left or right side of the steering actuator to position the mechanical steering linkage and wheels for a left or right turn. When the steering wheel is held in any position, except full left or full right, the control valve returns to neutral by centering springs and the fluid is available for use downstream in the circuit. If the steering wheel is held in the full left or full right position, the charge pump pressure will build until the pressure reaches the steering valve internal relief valve setting of 9825 kPa (1450 psi).

Manual steering is available during vehicle towing or in the event charge pressure is lost to the SCU. A mechanical link inside the SCU connects the gerotor to the steering wheel. The gerotor is a manual pump that is driven by the operator when he turns the steering wheel delivering fluid under pressure to actuate the steering cylinder.

Diagnostics

Steering System Troubleshooting

Symptom: Steering Wanders

(1) Are tires of proper type and inflated to proper pressure?

Yes - Go to step (2).

No - Replace tire with tires of proper type. Inflate tire(s) to proper pressure.

(2) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (3).

No - Purge air from system. Check suction line to charge pump for air leaks.

(3) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (4).

No - Tighten hydraulic fittings.

(4) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (5).

No - Replace parts as needed.

(5) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (6).

No - Repair or replace parts as necessary.

(6) Perform steering system leakage test. See "Test Steering System Leakage" on page 370. Is test within specifications?

No - Perform steering valve leakage test. See "Test Steering Control Unit (SCU) Leakage" on page 370. Follow results of test.

Symptom: Steering Shimmy

(1) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (2).

No - Replace parts as needed.

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

Symptom: Steering Shimmy

(3) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (4).

No - Tighten hydraulic fittings.

(4) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (5).

No - Purge air from system. Check suction line to charge pump for air leaks.

(5) Check hydraulic fluid. Is fluid free of contamination?

No - Remove contaminated fluid, flush system and find source of contamination.

Symptom: Sluggish Steering Response

(1) Is engine rpm within operating range?

Yes - Go to step (2).

No - Adjust slow and/or fast idle speed. See adjustment in engine section.

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

(3) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (4).

No - Tighten hydraulic fittings.

(4) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (5).

No - Purge air from system. Check suction line to charge pump for air leaks.

(5) Check hydraulic fluid. Is fluid free of contamination?

Yes - Go to step (6).

No - Remove contaminated fluid, flush system and find source of contamination.

(6) Is hydraulic filter clean and free from restrictions?

Yes - Go to step (7).

No - Replace filter as needed.

Symptom: Sluggish Steering Response

(7) Are hydraulic lines and oil cooler free from any restrictions?

Yes - Go to step (8).

No - Clear lines or cooler of restrictions. Replace parts as needed.

(8) Perform steering system leakage test. See "Test Steering System Leakage" on page 370. Is test within specifications?

No - Perform steering valve leakage test. See "Test Steering Control Unit (SCU) Leakage" on page 370. Follow results of test.

Symptom: Excessive Steering Wheel Free-Play

(1) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (2).

No - Repair or replace parts as necessary.

(2) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (3).

No - Purge air from system. Check suction line to charge pump for air leaks.

(3) Is steering valve mounted securely?

Yes - Go to step (4).

No - Secure steering valve.

(4) Disassemble and inspect steering control unit. See "Disassemble Steering Control Unit (SCU)" on page 373. Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Symptom: High Steering Effort in One Direction

(1) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (2).

No - Replace parts as needed.

(2) Perform steering system leakage test. See "Test Steering System Leakage" on page 370. Is test within specifications?

Yes - Go to step (3).

Symptom: High Steering Effort in One Direction

No - Perform steering valve leakage test. See "Test Steering Control Unit (SCU) Leakage" on page 370. Follow results of test.

(3) Disassemble and inspect steering control unit. See "Disassemble Steering Control Unit (SCU)" on page 373. Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Symptom: High Steering Effort in Both Directions

(1) Are tires of proper type and inflated to proper pressure?

Yes - Go to step (2).

No - Replace tire with tires of proper type. Inflate tire(s) to proper pressure.

(2) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (3).

No - Replace parts as needed.

(3) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (4).

No - Repair or replace parts as necessary.

(4) Is hydraulic filter clean and free from restrictions?

Yes - Go to step (5).

No - Replace filter as needed.

(5) Test triple pump (front gear set). Is there sufficient hydraulic fluid flow?

Yes - Go to step (6).

No - Repair or replace pump as necessary.

(6) Perform steering system leakage test. See "Test Steering System Leakage" on page 370. Is test within specifications?

Yes - Go to step (7).

No - Perform steering valve leakage test. See "Test Steering Control Unit (SCU) Leakage" on page 370. Follow results of test.

Symptom: High Steering Effort in Both Directions

(7) Disassemble and inspect steering control unit. See "Disassemble Steering Control Unit (SCU)" on page 373. Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Symptom: Steering Cylinder Will Not Fully Extend or Retract

(1) Is engine rpm within operating range?

Yes - Go to step (2).

No - Adjust slow and/or fast idle speed. See adjustment in engine section.

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

(3) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (4).

No - Purge air from system. Check suction line to charge pump for air leaks.

(4) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (5).

No - Tighten hydraulic fittings.

(5) Is steering rod free of damage, not bent?

Yes - Go to step (6).

No - Replace steering cylinder.

(6) Test triple pump (front gear set). Is there sufficient hydraulic fluid flow?

Yes - Go to step (7).

No - Repair or replace pump as necessary.

(7) Perform steering system leakage test. See "Test Steering System Leakage" on page 370. Is test within specifications?

Yes - Go to step (8).

No - Perform steering valve leakage test. See "Test Steering Control Unit (SCU) Leakage" on page 370. Follow results of test.

Symptom: Steering Cylinder Will Not Fully Extend or Retract

(8) Disassemble and inspect steering control unit. See "Disassemble Steering Control Unit (SCU)" on page 373. Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Symptom: Wheels Continue to Turn After Steering Wheel Is Stopped

(1) Disassemble and inspect steering control unit. See "Disassemble Steering Control Unit (SCU)" on page 373. Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Tests and Adjustments

Test Steering System Leakage

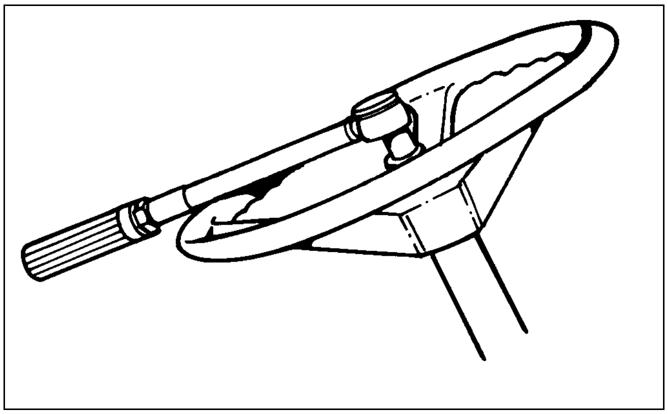
Reason

To check hydraulic steering system for internal leakage.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

2. Start engine and set throttle to slow idle.



M46864

3. With steering wheel at maximum right turn position, use a torque wrench to apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.

4. Repeat step 2 with steering wheel at a maximum left turn position.

Results

- If rotations per minute exceed 6, perform the steering control unit (SCU) leakage test to isolate the SCU from the steering cylinder.

Test Steering Control Unit (SCU) Leakage

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids. If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Reason

The steering system leakage test should be performed first to verify internal steering system leakage. See “Test Steering System Leakage” on page 370.

This procedure isolates steering system leakage between the SCU and the steering cylinder.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

IMPORTANT: Avoid damage! Cap or plug all openings to avoid contamination.

2. Disconnect and cap the lines at the steering cylinder.

3. Start engine and set throttle to slow idle.

4. With steering wheel at a maximum right turn position, apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.

5. Repeat step 2 with the steering wheel at a maximum left turn position.

Results

- If rotations/min exceed 6, repair the SCU.
- If rotations/min are less than 6, replace the steering cylinder.

Test Steering and Lift System Relief Valve Pressure

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids. If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

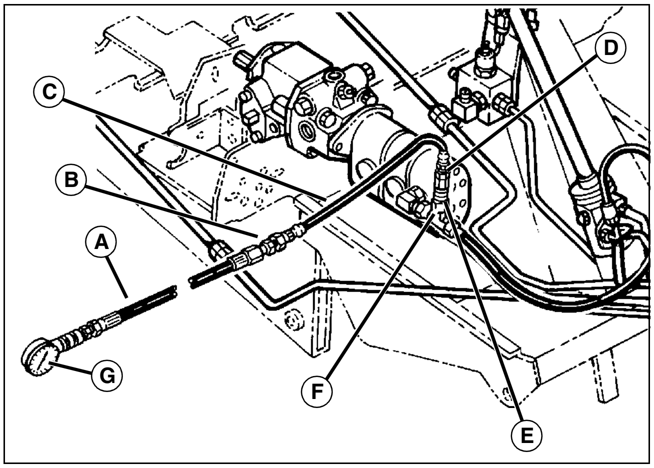
Tool Name	Tool No.	Tool Use
Male Quick Coupler Adapter	MT1531	Connect pressure gauge for steering and lift system relief valve pressure test.
T-Fitting	38H1030	Connect pressure gauge for steering and lift system relief valve pressure test.
Hose	AMT846	Connect pressure gauge for steering and lift system relief valve pressure test.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Gauge 20 684 kPa (3000 psi)	JT03345	Check steering and lift system relief valve setting.
Hose 34 474 kPa (5000 psi)	JT03017	Connect pressure gauge for steering and lift system relief valve pressure test.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).
2. Deplete system pressure by operating the lift system.



MIF M76550

3. Disconnect the charge pump pressure hose and install 38H1030 T-Fitting (F) and MT1531 Adapter (E) on T-fitting.
4. Install JT05486 Connector (B) and RE48122 Female Quick Coupler (D) on ends of AMT846 Hose (C) and install AMT846 Hose on MT1531 Adapter (E).
5. Install JT03017 Hose (A) and JT03345 Gauge 20 684 kPa (3000 psi) (G) to AMT846 Hose (C).
6. Start engine and set the throttle to fast idle.
7. Raise the lift arms and hold the lift lever in the full raise position and record the pressure reading.

Results

- Pressure should be within specifications. If pressure is not within specification, replace relief valve.

Specifications

Steering and Lift System Relief Valve Pressure 13 100 ± 1380 kPa (1900 ± 200 psi)

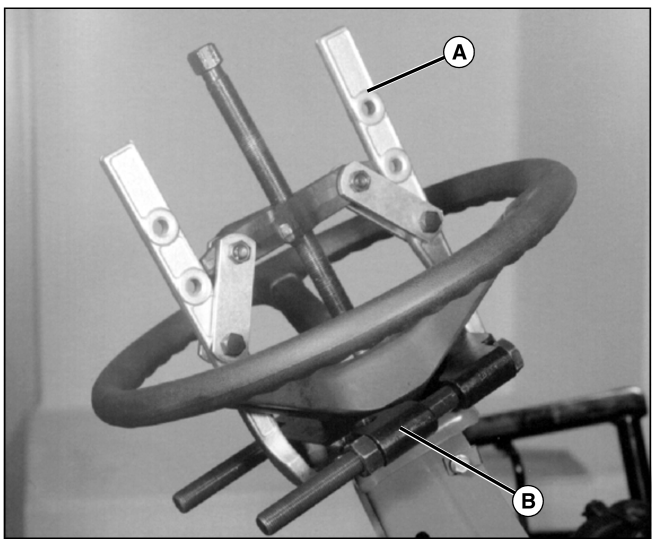
Repair

Remove Steering Control Unit (SCU)

IMPORTANT: Avoid damage! Cleanliness is extremely important when repairing the hydraulic SCU. Before disconnecting the hydraulic lines, clean the port area of the SCU to avoid getting contaminants into SCU and hydraulic system.

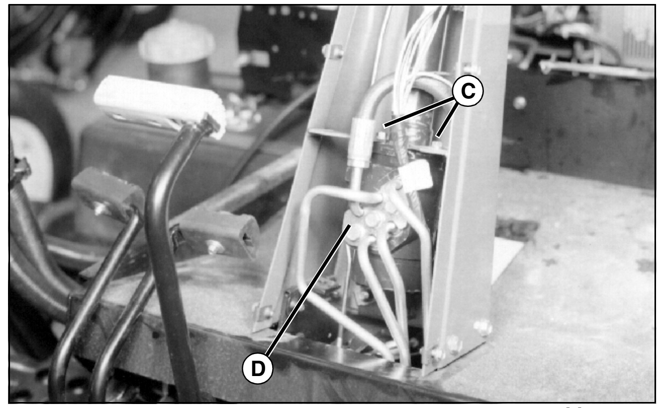
1. Remove steering wheel center cap.
2. Remove steering wheel retaining nut.

NOTE: Normally, slight upward pressure on the steering wheel combined with light taps on the steering wheel shaft will disengage steering wheel and shaft splines. DO NOT damage steering wheel shaft. If steering wheel does not disengage from shaft with slight taps, continue with following steps.



M76501

3. Install bearing separator (B) between steering wheel and top of steering column.
4. Use two-jaw puller (A) to apply pulling pressure to bearing separator. Steering wheel splines should disengage with minimal pressure from puller.
5. Remove the steering column front cover to gain access to the steering control unit.



M76510

6. Remove three mounting bolts (C) that hold hydraulic line retainer (D) on SCU. Remove retainer.

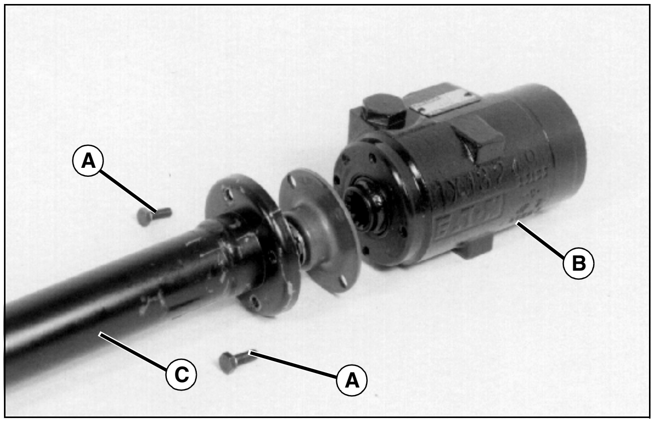
IMPORTANT: Avoid damage! Cap or plug all openings to avoid contamination.

NOTE: A pry bar may be necessary to remove hydraulic lines from SCU. DO NOT use excessive force to remove lines. Use back and forth motion while carefully prying on line to remove from SCU.

7. Remove hydraulic lines from SCU. Cap or plug hydraulic lines and SCU ports.
8. Remove two mounting bolts from SCU.
9. Remove hydraulic line hose clamp from underside of foot platform to aid in removal of SCU from steering column.
10. Lower SCU and depress brake pedal to gain enough clearance for top of shaft to clear top of steering column.
11. Remove SCU from machine.

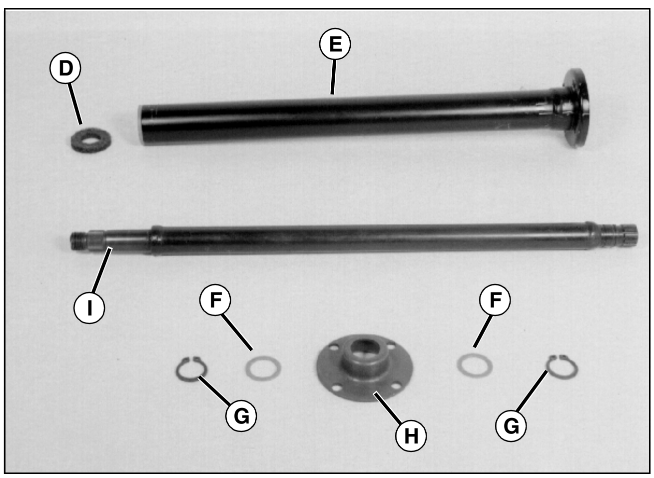
Disassemble Steering Control Unit (SCU)

IMPORTANT: Avoid damage! Drain SCU of hydraulic fluid. Plug all ports and clean the exterior of the SCU thoroughly. Protect the machined surfaces during the repair procedure. Always use new seals when reassembling hydraulic SCU. A complete seal kit is available from your parts catalog.



M76511

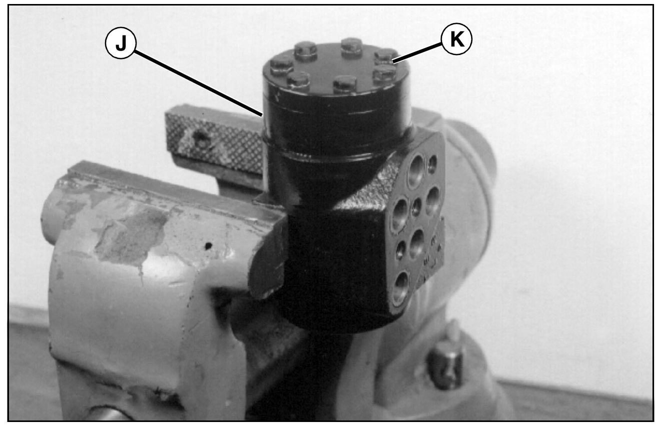
1. Remove two cap screws (A) that attach steering column (C) to SCU (B).



M76512

2. Remove foam washer (D) and slide inner shaft (I) from outer shaft (E).

3. Remove both snap rings (G), washers (F) and guide (H) from inner shaft.

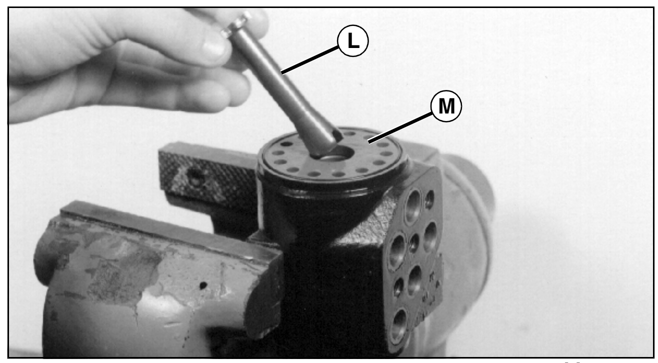


M76513

4. Clamp the housing in a vise. Use just enough clamping force to hold the housing secure.

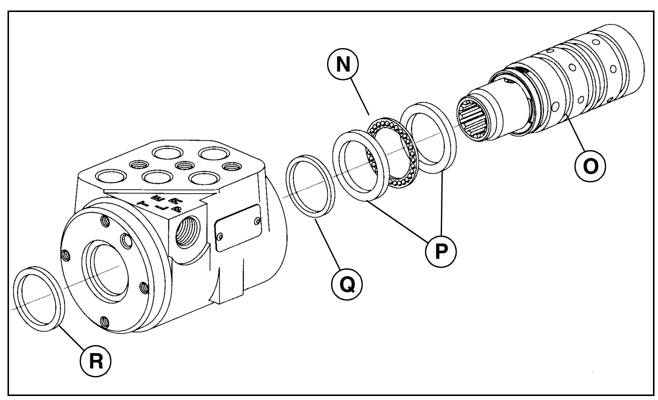
5. Remove the seven cap screws and end cap (K).

6. Remove gerotor assembly (J) and spacer.



M76514

7. Remove mechanical link (L) and wear plate (M).



MIF M46865

8. Push up from splined end to remove the spool and sleeve (O) from the housing.

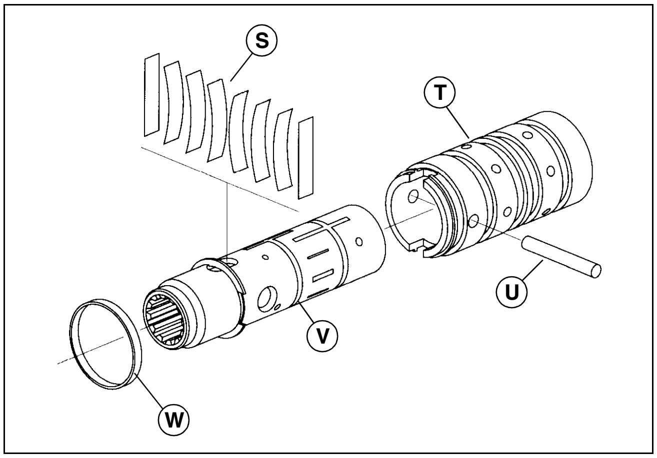
9. Remove the thrust bearing (N) and bearing races (P).

10.Remove the quad seal Q).

IMPORTANT: Avoid damage! DO NOT damage the dust seal seat when removing the dust seal.

11.Using a small blade screwdriver, carefully pry the dust seal from the housing.

IMPORTANT: Avoid damage! Centering springs are under tension and are not serviceable individually. DO NOT LOSE centering springs.



MIF M56586

12.Remove pin (U) that holds the spool (V) and sleeve (T) together.

13.Carefully slide the spool out of the sleeve. The springs (S) and retaining ring (W) will stay with the spool when it is removed.

CAUTION: Avoid injury! The centering springs are under tension; Remove the retaining ring carefully. DO NOT LOSE centering springs.

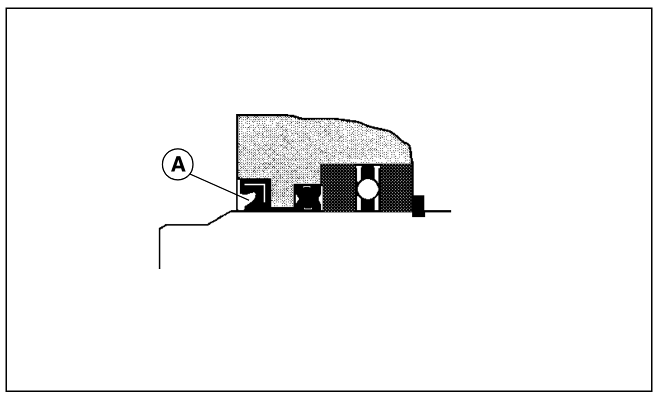
14.Remove the retaining ring and springs.

Assemble Steering Control Unit (SCU)

IMPORTANT: Avoid damage! Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with compressed air. DO NOT dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

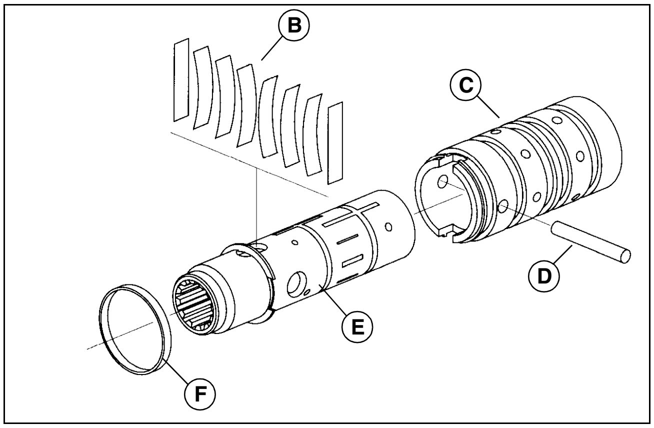
NOTE: Always use new seals when reassembling the hydraulic steering control unit. During reassembly, lubricate the new seals with petroleum jelly. Also lubricate the machined surfaces and bearings with clean hydraulic fluid.

1. Install the quad seal:
   - Put one of the bearing races and sleeve into the housing.
   - Together, the housing and bearing race create a groove into which the quad seal will be installed.
   - Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.
   - Fit the quad seal into its seat through the input end of the housing. Ensure the seal is not twisted.
   - Remove the sleeve and bearing race.



M56588

2. Lubricate and install the dust seal (A) using a seal driver. Orient the seal as shown above.



MIF M56586

3. Install the centering springs (B) in the spool. It is best to install the two flat pieces first. Next install the curved pieces, three at a time.

4. Fit the retaining ring (F) over the centering springs.

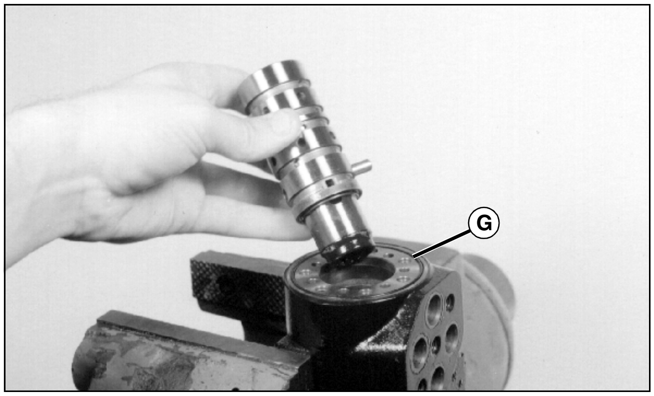
5. Apply a light coat of clean hydraulic fluid to the spool (E) and slide it into the sleeve (C). Ensure the centering springs fit into the notches in the sleeve.

6. Install the pin (D).

7. Apply a light coat of petroleum jelly to the inner edge of the dust and quad seals.

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races.

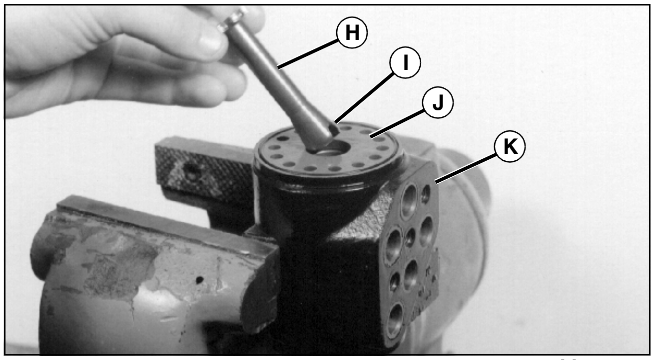
IMPORTANT: Avoid damage! DO NOT damage the dust or quad seals while installing spool and sleeve assembly. Slight back and forth rotation while installing spool and sleeve will help to prevent damage to seals.



M76515

9. Apply a light coat of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing. Be sure pin is installed in spool and sleeve before installing in housing.

10.Lubricate and install a new O-ring seal (G) in the groove in the housing.



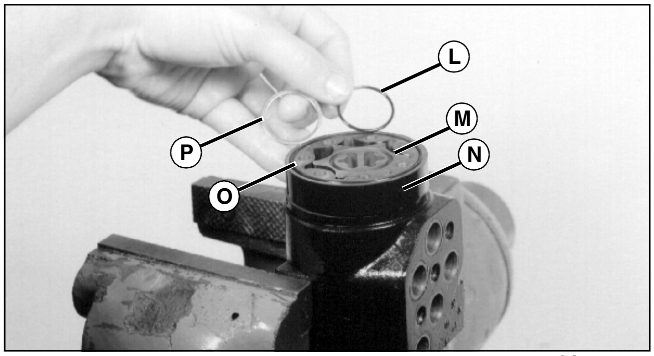
M76514

Picture Note: The Holes in the Wear Plate Are Symmetrical.

11.Install the wear plate (J) and align the holes in the wear plate with the threaded holes in the housing (K).

12.Install the mechanical link (H). Ensure the slot (I) in the drive engages the pin.

13.Lubricate and install a new O-ring seal in the groove of the wear plate.

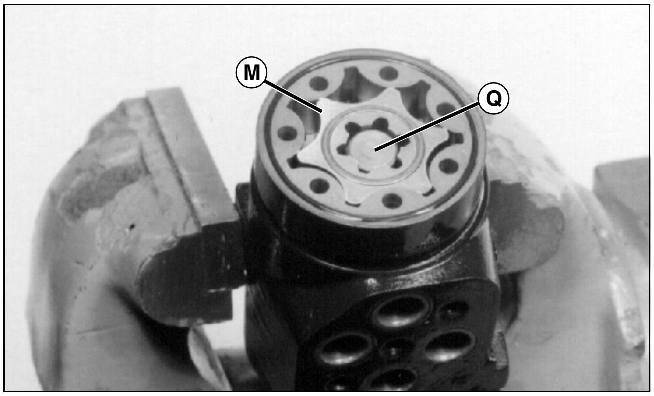


M76516

14.Install the gerotor ring (N) and gerotor star (M) and align screw holes of gerotor ring with screw holes of wear plate. Gerotor star female splines should engage mechanical link male splines.

15.Lubricate and install a new O-ring (O) in the groove of the gerotor ring.

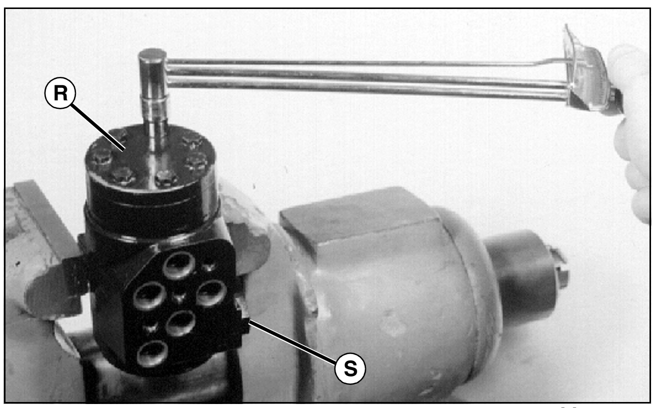
16.Lubricate and install a new O-ring (L) and seal ring (P) in the groove of the gerotor star.



M76517

17.Install the spacer (Q) into the gerotor star (M).

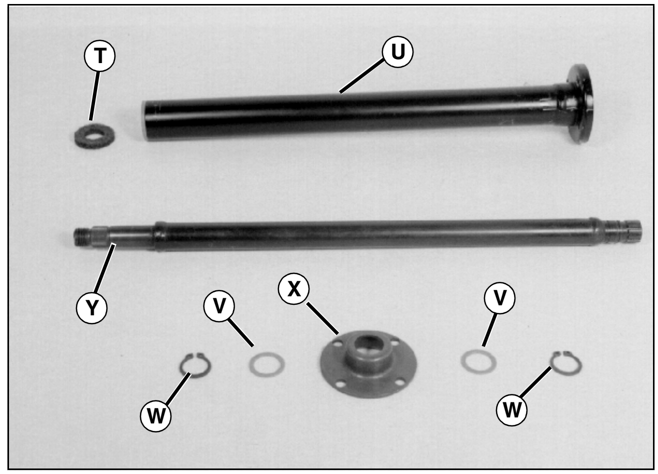
IMPORTANT: Avoid damage! If spacer is not flush or below surface of gerotor star, STOP. Mechanical link is not engaged correctly with the pin through spool and sleeve. Correct problem before continuing assembly.



M76518

18.Install the end cap (R) and seven cap screws. Tighten the cap screws, in a crisscross pattern, to specifications.

19.Install the relief valve and plug (S). Use a new O-ring and tighten the plug to specification.

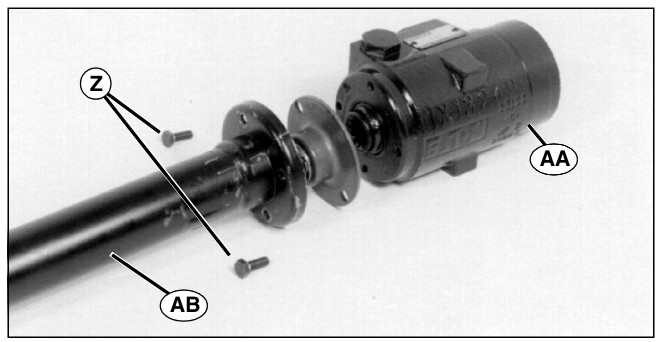


M76512

20.Install snap rings (W), washers (V) and guide (X) on inner shaft (Y) and slide inner shaft into outer shaft (U).

21.Place foam washer (T) on top of inner shaft.

NOTE: Steering column-to-SCU cap screws should be installed at 6 and 12 o'clock positions when facing open ports of SCU.



M76511

22.Place steering column assembly (AB) on SCU (AA) and install cap screws (Z). Tighten cap screws to specification.

Specifications

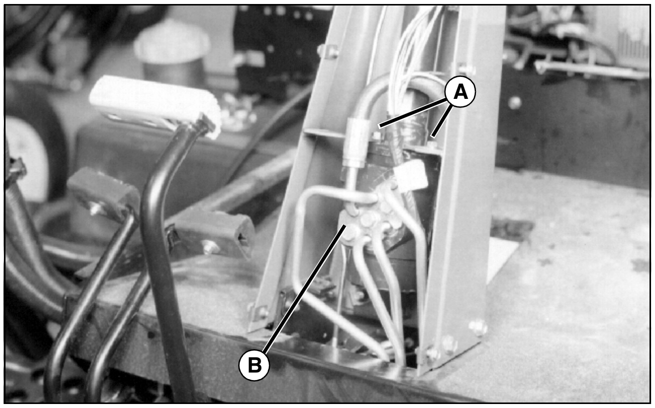
Steering Column-to-SCU Cap Screw Torque. 16-18 N•m (140-160 lb-in.)

SCU Relief Valve Plug Torque . . . . . 17 N•m (150 lb-in.)

Install Steering Control Unit (SCU)

1. Depress brake pedal and place SCU in steering column housing of machine.

2. Slide steering column upward through opening in top of steering column housing.



M76510

3. Install mounting bolts (A) in SCU.

IMPORTANT: Avoid damage! Be careful not to damage O-rings and backup rings when installing hydraulic lines.

4. Replace O-rings and backup rings on hydraulic lines and install hydraulic lines in SCU. Slight taps from a soft-faced mallet will help to get lines in SCU.

5. Place hydraulic line retainer (B) on SCU and install three mounting cap screws.

6. Install hydraulic line hose clamp and cross “T” support at underside of foot platform.

7. Install steering wheel.

8. Start machine and cycle steering wheel and reel lift system.

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other high-pressure 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 source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

9. Check for leaks.

10. Install steering column front cover.

Table of Contents

BRAKES SPECIFICATIONS

Specifications

General

Brake Type . . . . **Mechanical**

Rotor Diameter (Nominal) . . . . **203.835 mm (8.025 in.)**

Rotor Thickness (New). . . . . **4.775 mm (0.188 in.)**

Rotor Minimum Thickness. . . . . **3.6 mm (0.140 in.)**

Rotor Run-Out. . . . . **0.635 mm (0.025 in.)**

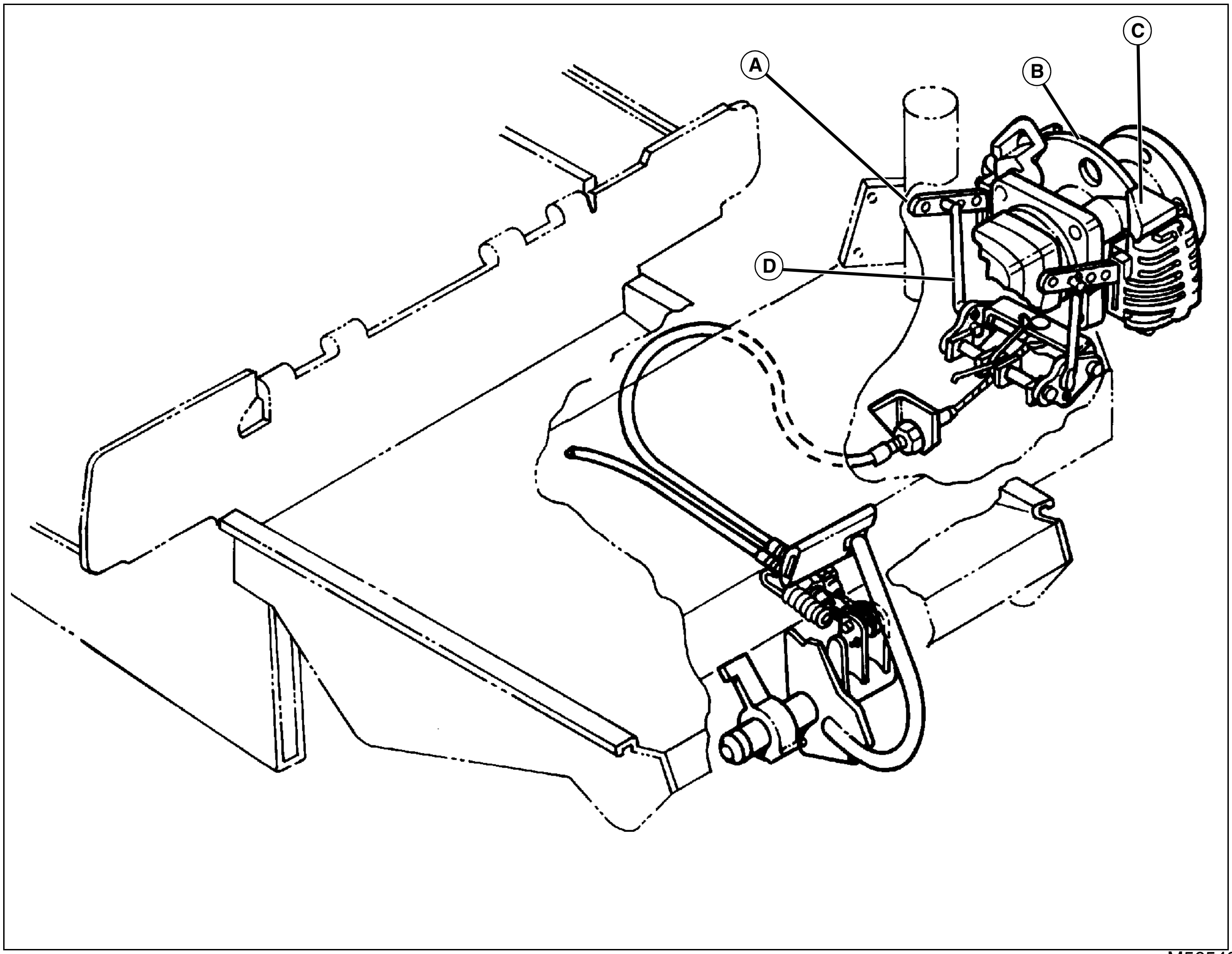
Pad Thickness, Usable. . . . . **3.429 mm (0.135 in.)**

Torque Specifications

Rotor Nut Torque . . . . **90 N•m (140 lb-ft)**

Theory of Operation

Brake System



M56548

Function

The park brake is used to prevent movement when the mower is not in use and to assist in stopping the mower while on a slope. The brake is not used to stop the mower on level ground. Primary braking is accomplished by the back pressure in the hydrostatic transmission.

Brake interlock switches stop the engine if operator attempts to move the unit with the brake engaged or leaves the seat without engaging the brake. The switch also prevents the reels from rotating if the brake is engaged.

Theory

When the brake pedal is depressed, the link rod (D) pushes the caliper link (A), which in turn causes the brake caliper (C) to force the brake pads against the rotor (B). This prevents the unit from moving. Operating the brake pedal or park brake lock also operates the brake interlock switches which will stop the engine and/or the reels under certain circumstances.

The brake is locked on by moving the park brake lever to the bottom of the slot and fully depressing the brake pedal. It is unlocked by pushing and holding the pedal down while returning the lever to the top of the slot. When the park brake lever is engaged, the brakes will remain engaged until the lever is disengaged. Without the lever engaged, the brakes will be engaged only while the pedal is being pushed.

Diagnostics

Brake System Troubleshooting

Symptom: Park Brake Does Not Hold

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 384.

No - Repair or replace linkage as required.

(2) Are pads and rotors clean with no excessive wear or damage?

Yes - Go to step (3).

No - Replace pads.

No - Cut or replace rotors.

(3) Are calipers functioning properly?

No - Repair or replace as required.

Symptom: Excessive Brake Wear

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 384.

No - Repair or replace linkage as required.

(2) Are calipers functioning properly, not binding or damaged?

Yes - Go to step (3).

No - Repair or replace as required.

(3) Are rotor machined surfaces smooth and free of excessive wear or damage?

No - Cut or replace rotors.

Symptom: Brakes Do Not Release

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 384.

No - Repair or replace linkage as required.

(2) Are calipers functioning properly, not binding or damaged?

Symptom: Brakes Do Not Release

No - Repair or replace as required.

Symptom: Brake Pedal Does Not Return

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 384.

No - Repair or replace linkage as required.

(2) Are calipers functioning properly, not binding or damaged?

Yes - Go to step (3).

No - Repair or replace as required.

(3) Is the brake pedal return spring functioning properly, not broken?

No - Replace brake pedal return spring.

Symptom: Brakes Noisy

(1) Are pads and rotors clean with no excessive wear or damage?

Yes - Go to step (2).

No - Replace pads.

No - Cut or replace rotors.

(2) Are calipers functioning properly, not binding or damaged?

No - Repair or replace as required.

Tests and Adjustments

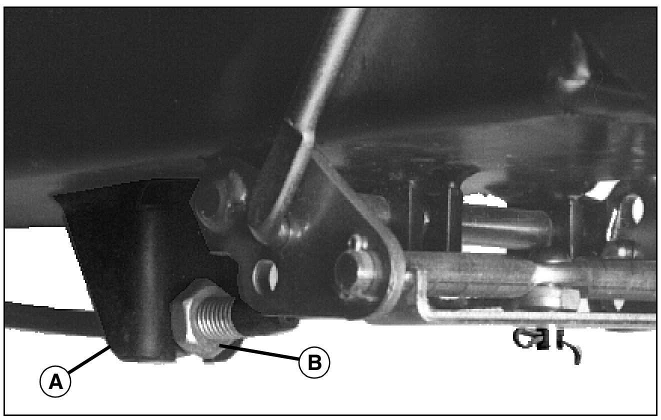
Adjust Brakes

Reason

Allow full activation of the brakes without creating brake drag.

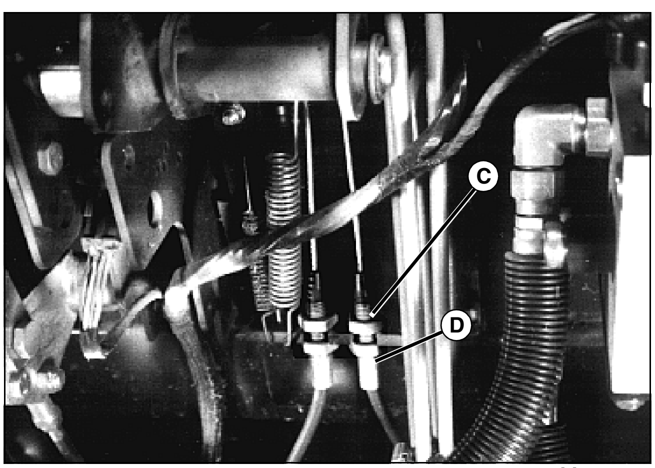
Procedure

1. Park machine on level surface and turn engine off.
2. Block rear wheels and release park brake lock.
3. Use jack stands to support the front wheels off the ground.



M56629

4. Loosen jam nut (B).
5. Tighten coupler nut (A) while rotating wheel until brake pads begin to contact rotor. Loosen coupler until brake releases. Tighten jam nut.
6. Repeat on other wheel.



M58782

7. Additional adjustment is available at the pedal end of the cable.
8. Loosen jam nut (C) and adjust coupler nut (D).

Results

- Brakes should fully engage with pedal depressed and disengage while the brake pedal is released, preventing the brake pads from dragging on the rotors.

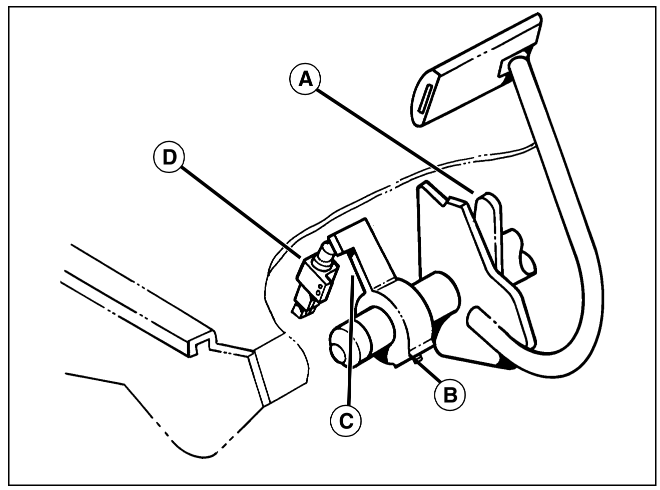
Adjust Brake Pedal Switch

Reason

To allow proper operation of the brake interlock circuit. See electrical section for start and/or run circuit operation and diagnosis.

Procedure

1. Release park brake lock lever. Make sure brake is completely off.



M57768

2. Loosen brake switch lever adjustment set screw (B).
3. Rotate brake switch lever (C) until brake switch (D) is completely depressed.
4. Tighten brake switch lever adjustment set screw.
5. Set park brake lock lever (A).
6. Engage park brake. Be sure brake switch is not in contact with brake switch lever.

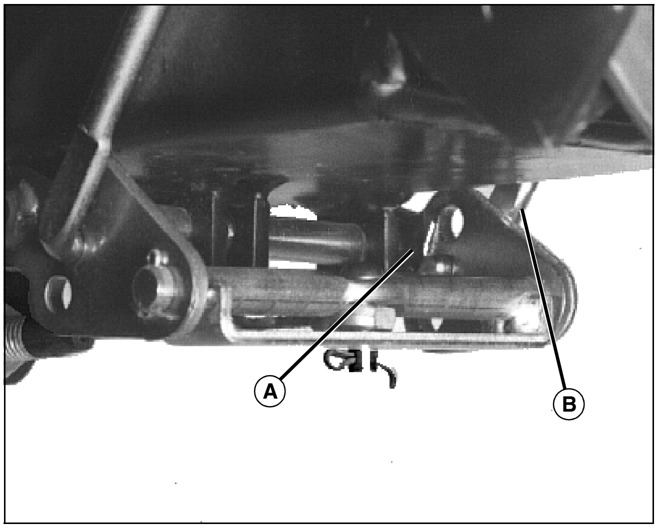
Results

- Engine should start and run under normal operating conditions.

Repair

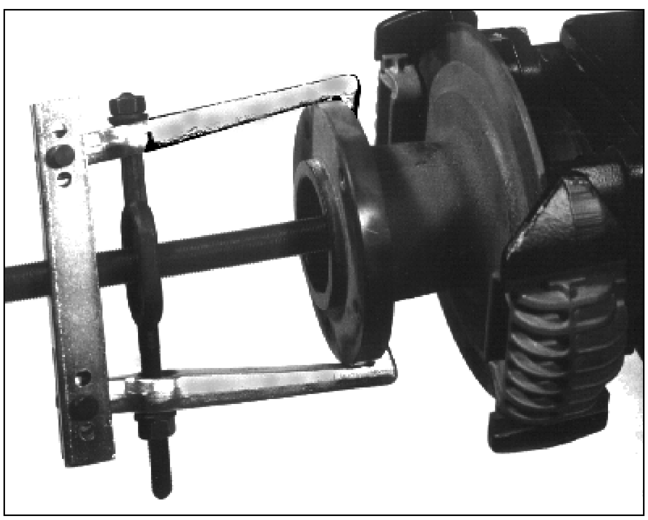
Replace Brake Pad

1. Remove wheel and tire.
2. Release park brake, if applied.



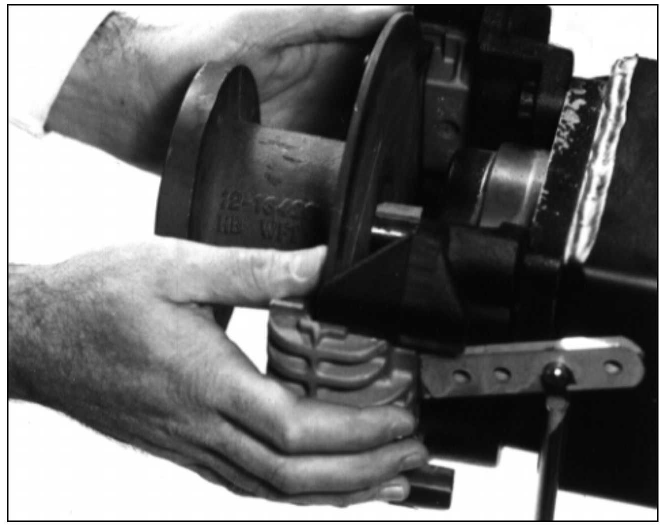
M56629

3. Remove cotter pin (A) from each linkage rod (B).



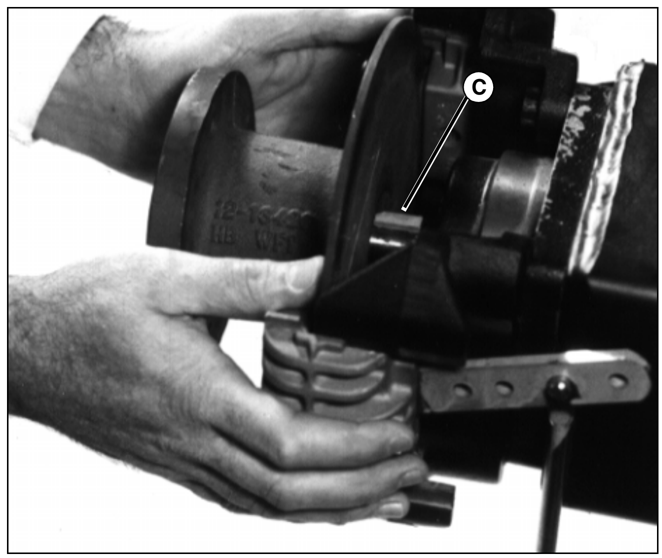
M56621

4. Remove nut securing rotor to wheel motor.
5. Use a puller as shown to remove rotor.



M56632

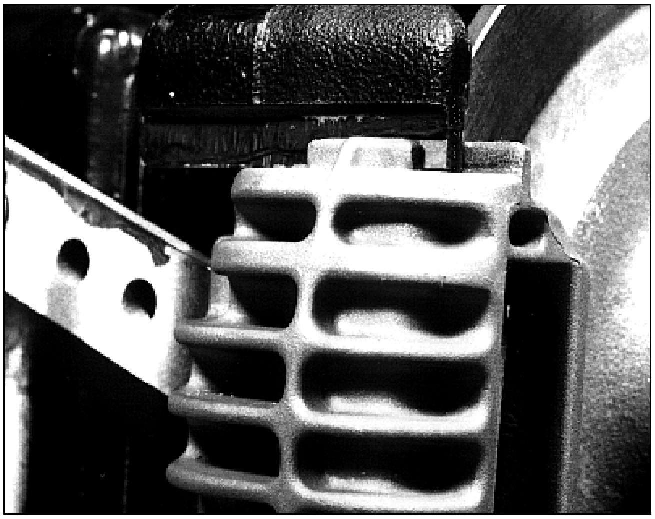
6. Slide rotor and calipers from wheel motor.
7. Replace pads.



M56632

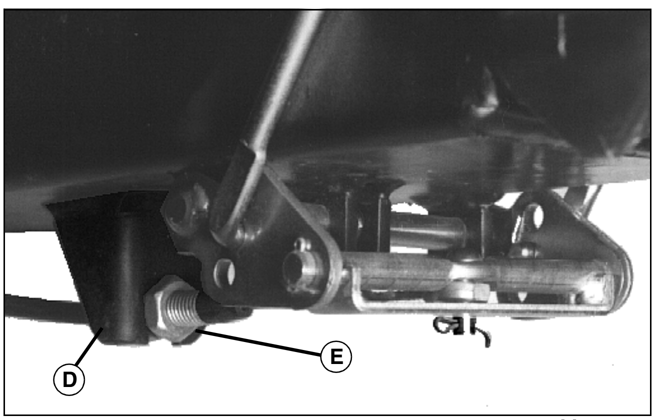
8. Install key (C) into slot of wheel motor shaft. Position the calipers onto the rotor and slide the assembly onto the wheel motor shaft.

IMPORTANT: Avoid damage! Make sure caliper assemblies are positioned on sliders as shown below.

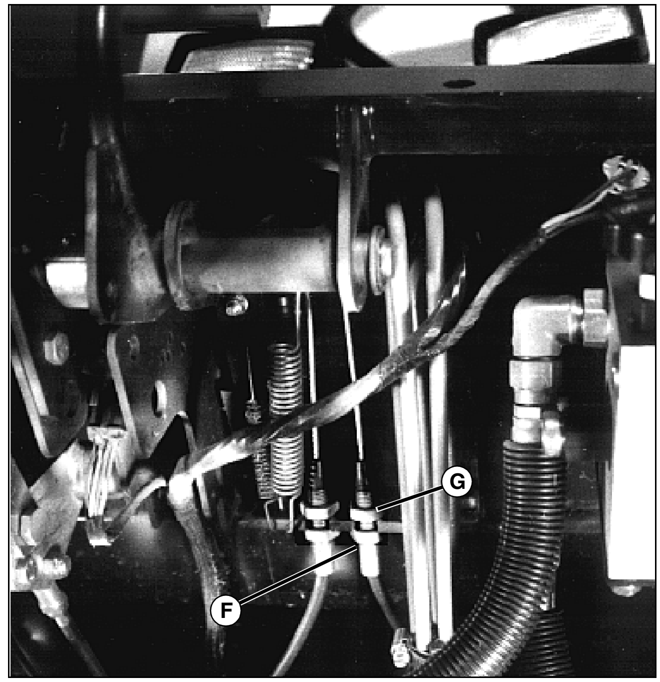


M56624

9. Install nut securing rotor to wheel motor shaft. Torque to specifications.

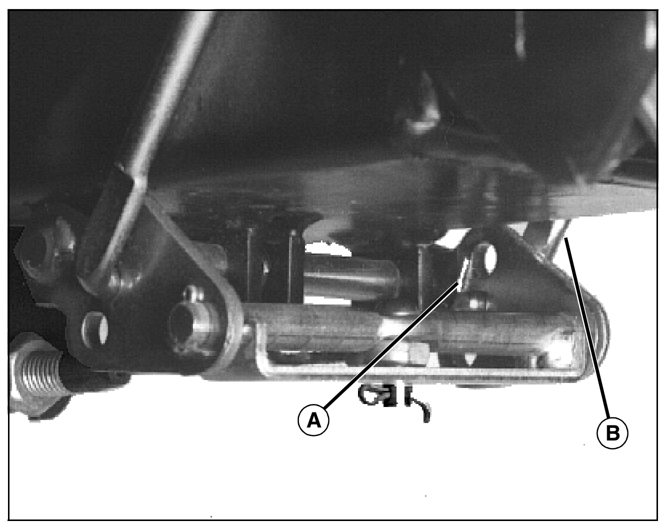


M56629



M58782

10.Loosen jam nut (E) and back off coupler nut (D) at wheel assembly, or loosen jam nut (G) and back off coupler nut (F) at brake pedal assembly to loosen brake cable.



M56629

11.Install linkage rod (B) and secure with cotter pin (A) on each side of assembly.

12.Install wheel and tire assembly.

13.Adjust brakes. See “Adjust Brakes” on page 384.

Specifications

Rotor Nut Torque . . . . 90 N•m (140 lb-ft)

Table of Contents

Specifications

Cutting Units

There are three models (22-In. Standard, 22-In. Heavy Duty and 2500M) of cutting units. Refer to the ID tag on the cutting unit for the model number when servicing.

General Specifications - 22-In. Standard and 22-In. Heavy Duty

Make	**John Deere**
Size	**55.9 cm (22 in.)**
Backlapping	**On machine variable speed**
Clip Ratio	**See Theory of Operation (Performance Variables)**
Front Rollers	**Choice of smooth, grooved or spiral**
Reel Diameter	**12.7 cm (5 in.)**
Bed Knife Adjustment	**Reel-to-bed knife**
Height-of-Cut	**2.4 to 19 mm (3/32 to 3/4 in.)**
Number of Blades (Standard)	**9 (greens)**
Number of Blades (Optional)	**5 (fairways)**
Cutting Unit Drive	**Hydraulic**
Bed Knife Standard	**3 mm (1/8 in.)**
Bed Knife Tournament	**2.38 mm (3/32 in.)**
Bed Knife Fairway	**6.5 mm (1/4 in.)**

Repair Specifications - 22-In. Standard and 22-In. Heavy Duty

Bed Knife Grinding Specification

Bed Knife Top Surface	**5° relief angle**
Front Surface	**5° relief angle**
Reel	**Spin grind with 20° relief angle**

Bed Knife/Support (22-In. Standard)

Bed Knife Mounting Screws	**9 N•m (7 lb-ft)**
Bed Knife Support Mounting Bolts (Lower)	**47 N•m (35 lb-ft)**
Bed Knife Support Mounting Bolts (Upper)	**81 N•m (60 lb-ft)**

Reel Mounting (22-In. Standard)

Pivot Arm-to-Frame	**47 N•m (35 lb-ft)**

Bed Knife and Support (22-In. Heavy Duty)

Bed Knife Mounting Screws (Dry)	**35-45 N•m (26-34 lb-ft)**
Bed Knife Mounting Screws (Lubricated)	**24-36 N•m (18-27 lb-in.)**

Reel Mounting (22-In. Heavy Duty)

Reel-to-Pivot Arm	**68 N•m (50 lb-ft)**
Pivot Arm-to-Frame (Forward)	**47 N•m (35 lb-ft)**
Pivot Arm-to-Frame (Rear)	**81 N•m (60 lb-ft)**

Roller

Shaft Lock Nut Torque (Heavy Duty Cutting Units) . . . . . 0.34-0.79 N•m (3-7 lb-in.)

Reel/Bed Knife (22-In. Standard)

Out-of-Round (Smile) . . . . . 0.051 mm (0.002 in.) maximum

Clearance . . . . . 0.000-0.025 mm (0.000-0.001 in.)

Reel/Bed Knife (22-In. Heavy Duty)

Out-of-Round (Smile) . . . . . 0.10 mm (0.004 in.) maximum

Clearance . . . . . 0.000-0.051 mm (0.000-0.002 in.)

Adjustment Specifications - 2500M

Bed Knife-to-Cutting Reel Clearance . . . . . 0.025 mm (0.001 in.)

Front Roller Out-of-Parallel (Maximum) . . . . . 0.050 mm (0.005 in.)

Cutting Shield-to-Cutting Reel Clearance (Maximum) . . . . . 1 mm (0.04 in.)

Repair Specifications - 2500M

Bed Knife Screw Torque . . . . . 6.5 N•m (58 lb-in.)

Bed Knife Shoulder Screw Torque . . . . . 55 N•m (40 lb-ft)

FTC Shaft Retaining Nut Torque . . . . . 47 N•m (35 lb-ft)

Vertical Cutting Unit Shaft Runout (Maximum) . . . . . 0.50 mm (0.020 in.)

Tools and Materials

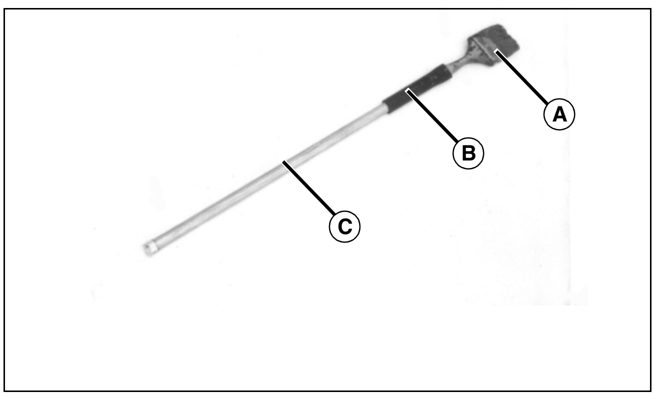
Special or Essential Tools

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bearing Installer	JDG243	Used to install bearings.
Bearing Installer	JDG506	Used to install bearings.
Roller Bearing Puller	JDG795	Used to remove bearings from rollers.
Height-of-Cut Gauge Bar	NA	Used to adjust cutting height.
Bench Plate	NA	Used to adjust front roller.

Dealer Fabricated Tools



E32285

•Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

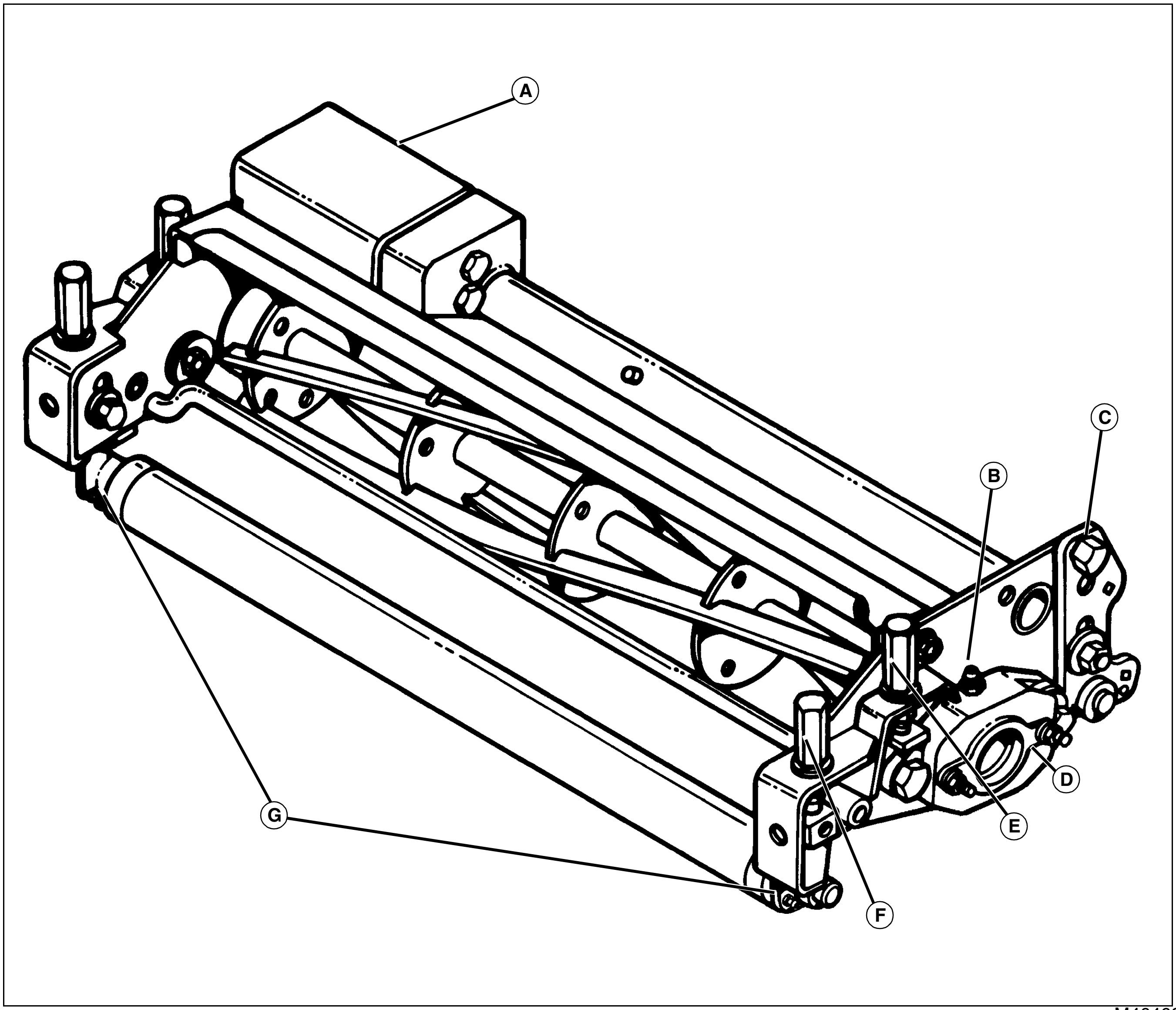
Other Materials

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reels.

Component Location

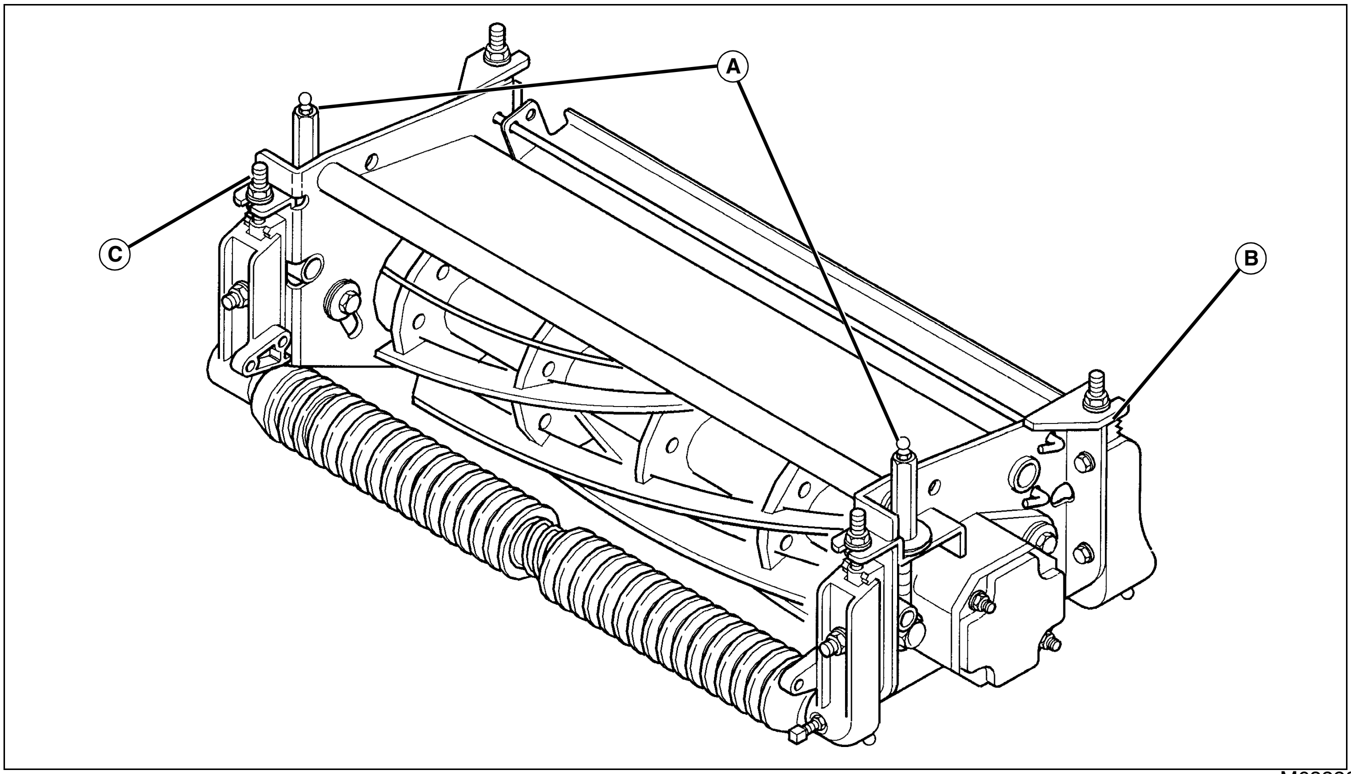
22-In. Standard Cutting Unit



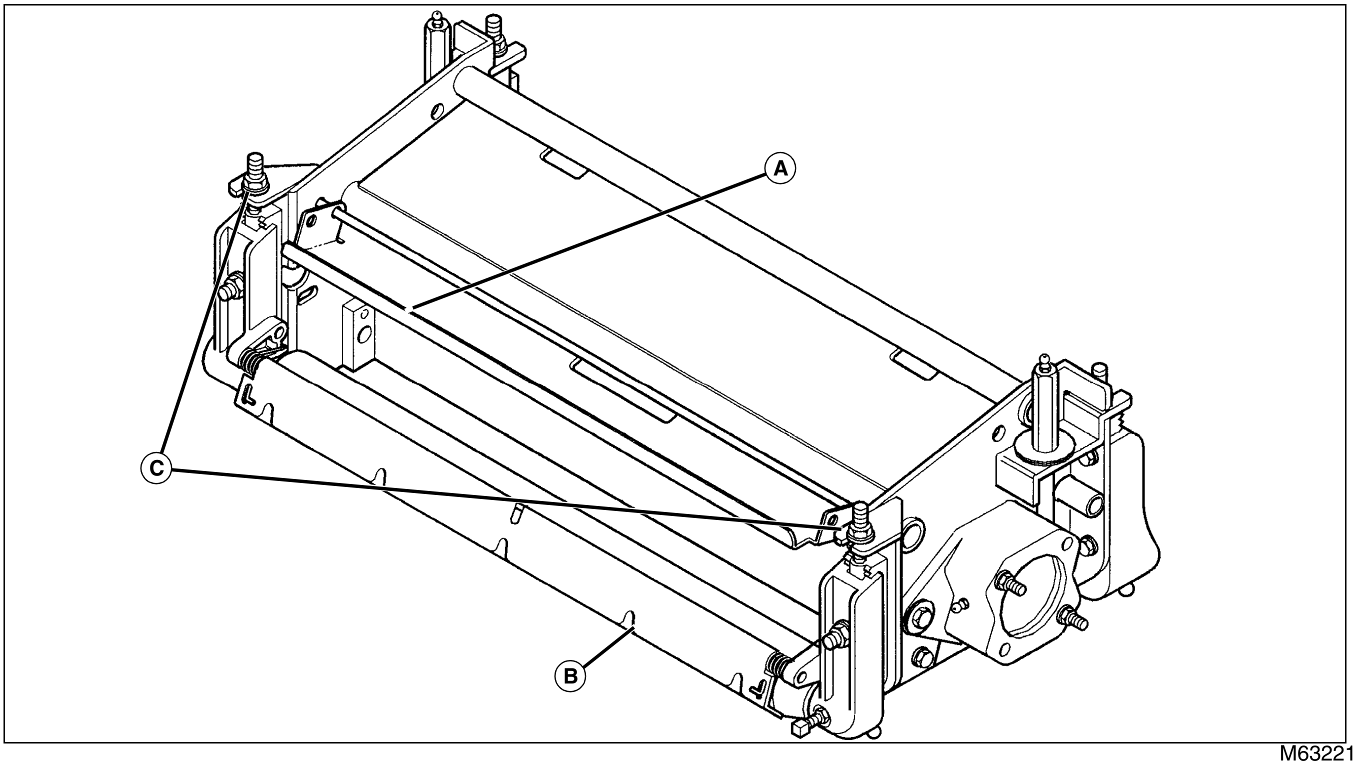
M46460

A - Counterweight
B - Grease Fitting
C - Eccentric
D - Pivot Arm
E - Reel-to-Bed Knife Adjustment
F - Front Roller Height of Cut Adjustment
G - Grease Fittings (Smooth Rollers Only)

22-In. Heavy Duty Cutting Unit

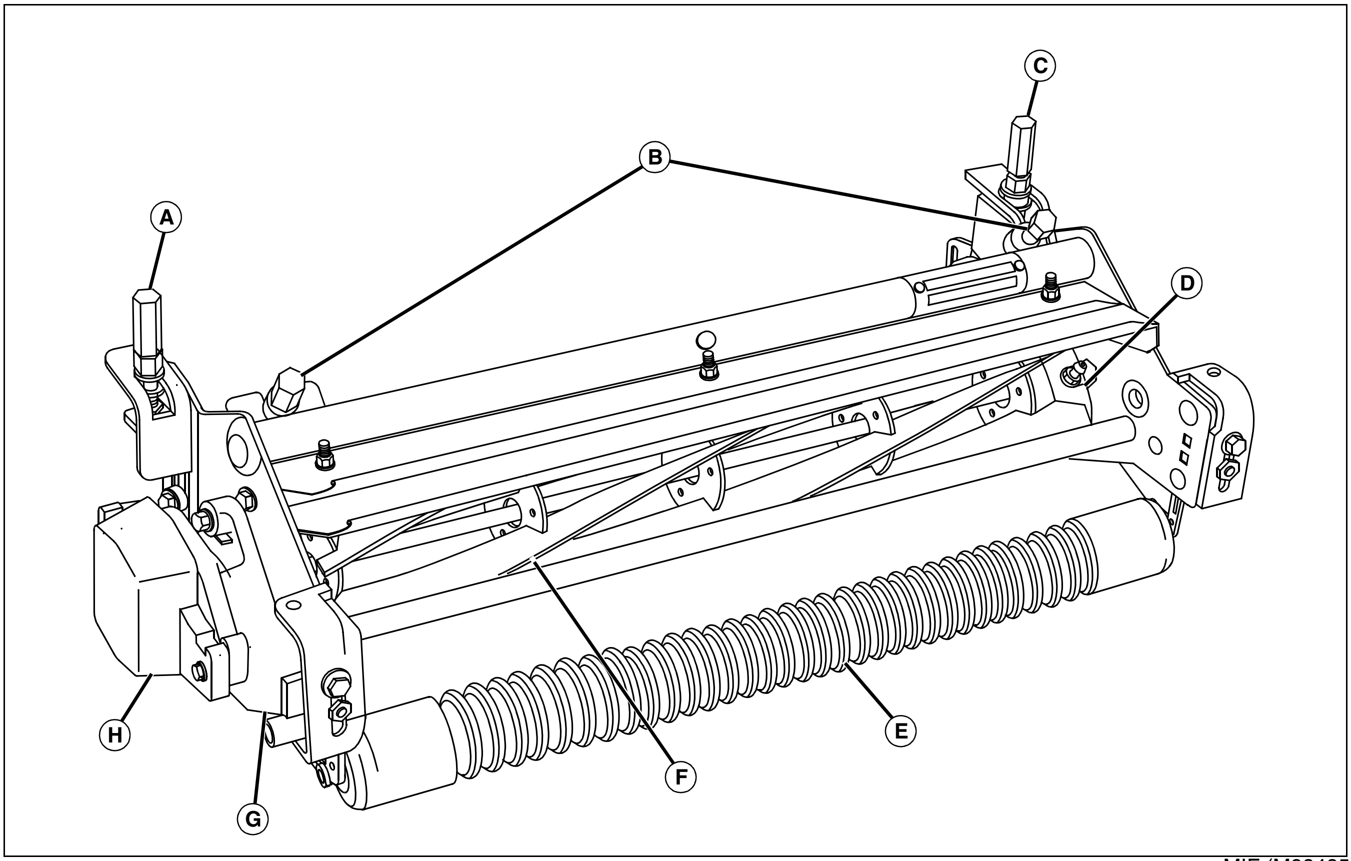


A - Reel-to-Bed Knife Clearance Adjustment
B - Ratchet Teeth
C - Front Roller HOC Adjustment



A - Rear Deflector
B - Rear Roller Scraper
C - Rear Roller HOC Adjustment

2500M Cutting Unit

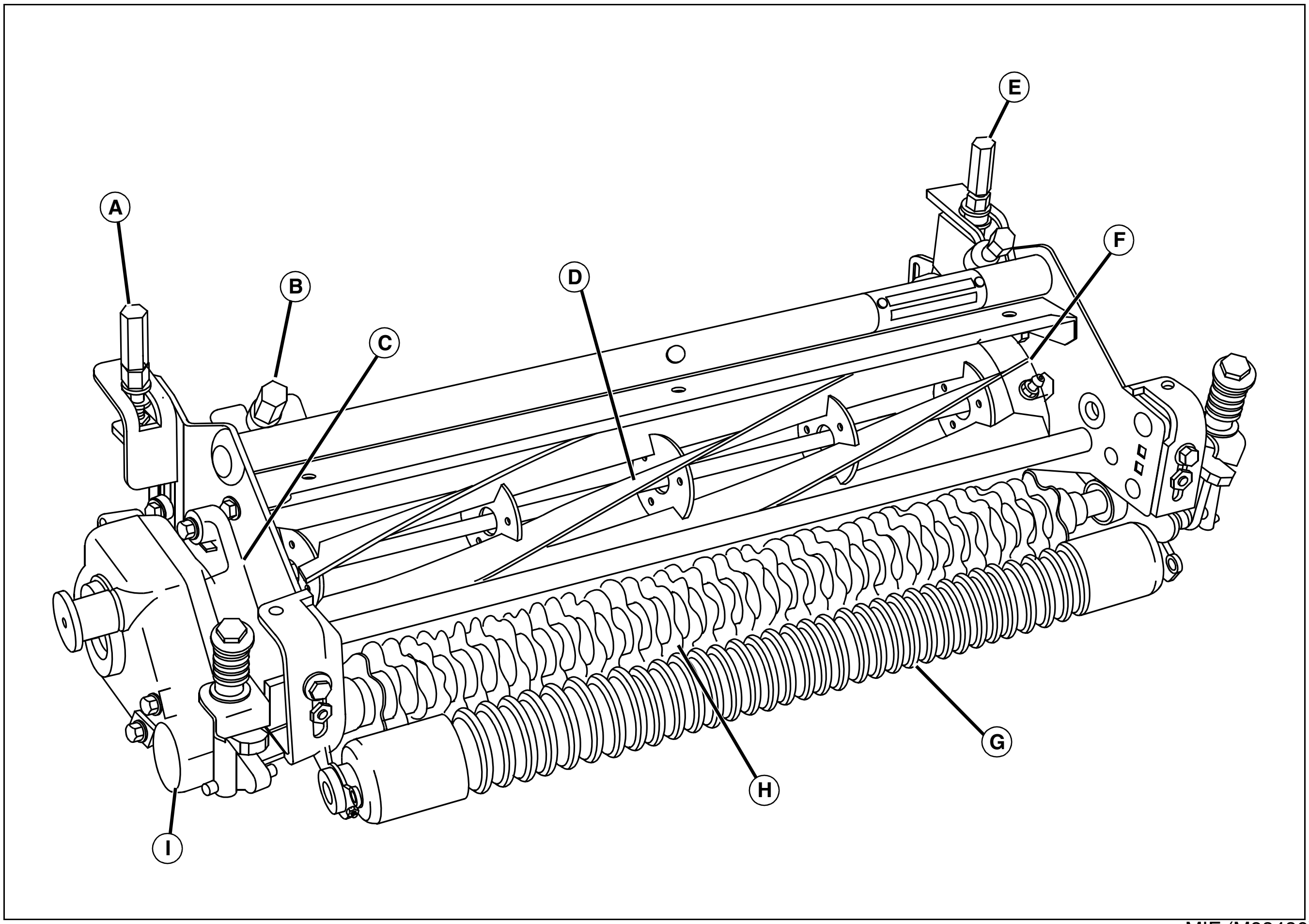


MIF (M98485)

A - Rear Roller Height Adjuster
B - Bed Knife Adjusters
C - Rear Roller Height Adjuster
D - Bearing Housing
E - Front Roller
F - Reel
G - Bearing Housing
H - Counterweight

2500M with Fairway Tender Conditioner (FTC)

NOTE: 2500M cutting unit shown with fairway tender conditioner. 22-in. standard and 22-in. heavy duty cutting units with fairway tender conditioner are similar.

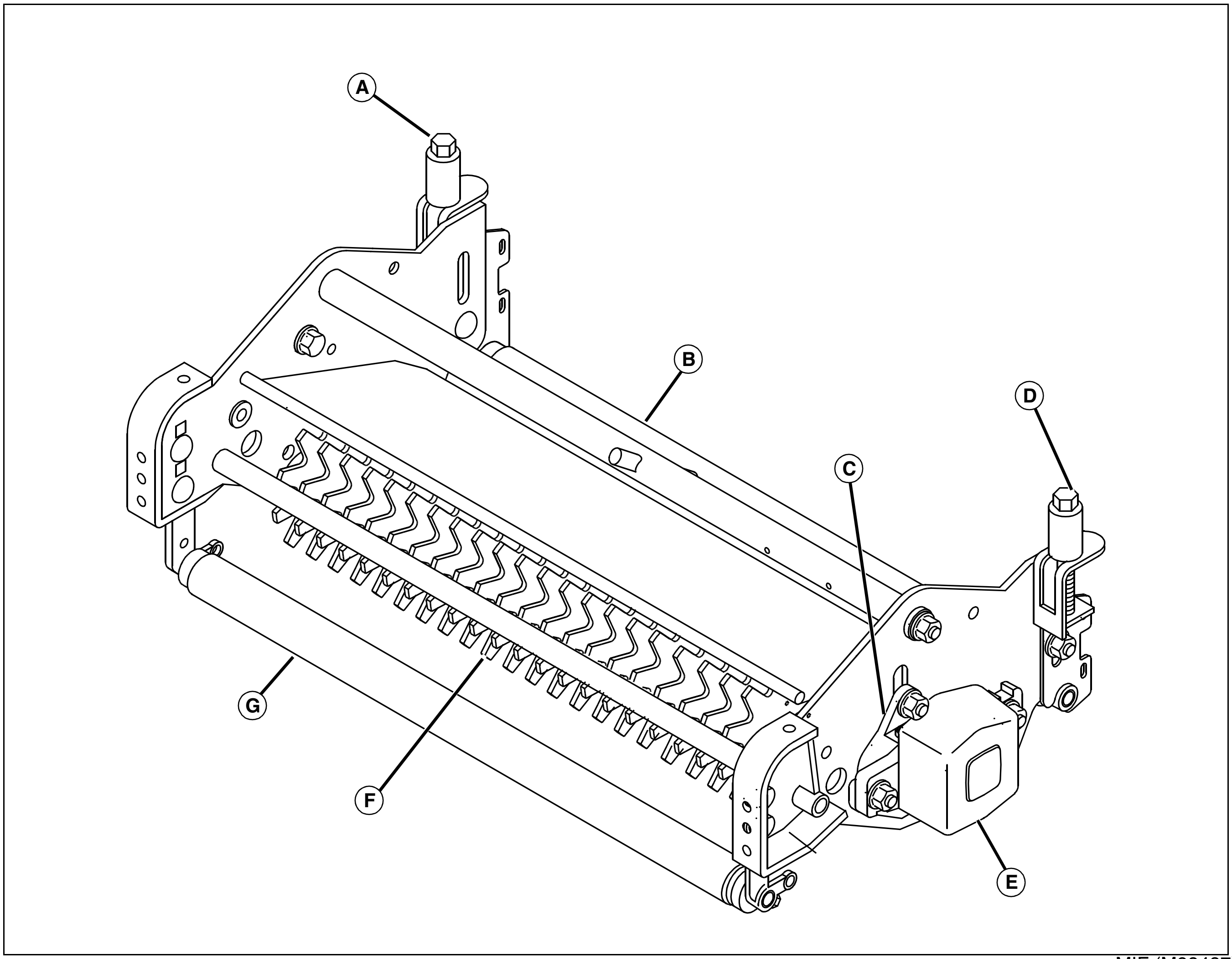


MIF (M98486)

A - Rear Roller Height Adjuster
B - Bed Knife Adjuster
C - Bearing Housing
D - Reel
E - Rear Roller Height Adjuster
F - Bearing Housing
G - Front Roller
H - FTC Shaft Assembly
I - FTC Gear Case

2500M Vertical Cutting Unit

NOTE: 2500M cutting unit shown with vertical cutting unit. 22-in. standard and 22-in. heavy duty vertical cutting units are similar.



MIF (M98487)

A - Rear Roller Height Adjuster
B - Rear Roller
C - Bearing Housing
D - Rear Roller Height Adjuster
E - Counterweight
F - Vertical Blades
G - Front Roller

Theory of Operation

Reel and Bed Knife Grinding

Reel and Bed Knife Relationship

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

Close examination of the reel-to-bed knife relationship reveals two square edges passing one another with approximately 0.051 mm (0.002 in.) clearance. There are several reasons why this clearance is necessary.

- When the reel is allowed to contact the bed knife, the square (sharp) edges of the reel and bed knife will roll over, becoming dull.
- Contact between the reel and bed knife generates heat. Heat generated through this contact will distort the shape of the bed knife. Distortion causes the bed knife to draw closer to the reel, resulting in more rollover of the cutting surfaces and more heat generated in the bed knife.
- Drag produced by an improperly adjusted cutting unit may result in an unacceptable clip ratio, undue strain on drive mechanisms and premature wear of the cutting unit.

Reasons for Grinding

- To restore the cylindrical shape of a reel that has become cone-shaped due to improper adjustment of the reel-to-bed knife clearance or worn reel bearings.
- To restore the edge when the grass is not being cut across the entire length of the bed knife, evidenced by streaks of grass left after the mower has passed, usually the result of nicked blades caused by hitting foreign objects in the grass.
- To restore the edge when the lack of frequent backlapping allowed the edge to be rounded beyond the capability of the backlapping procedure to restore the edge.
- To restore the edge when the reel-to-bed knife clearance has been improperly adjusted (reel contacting bed knife).

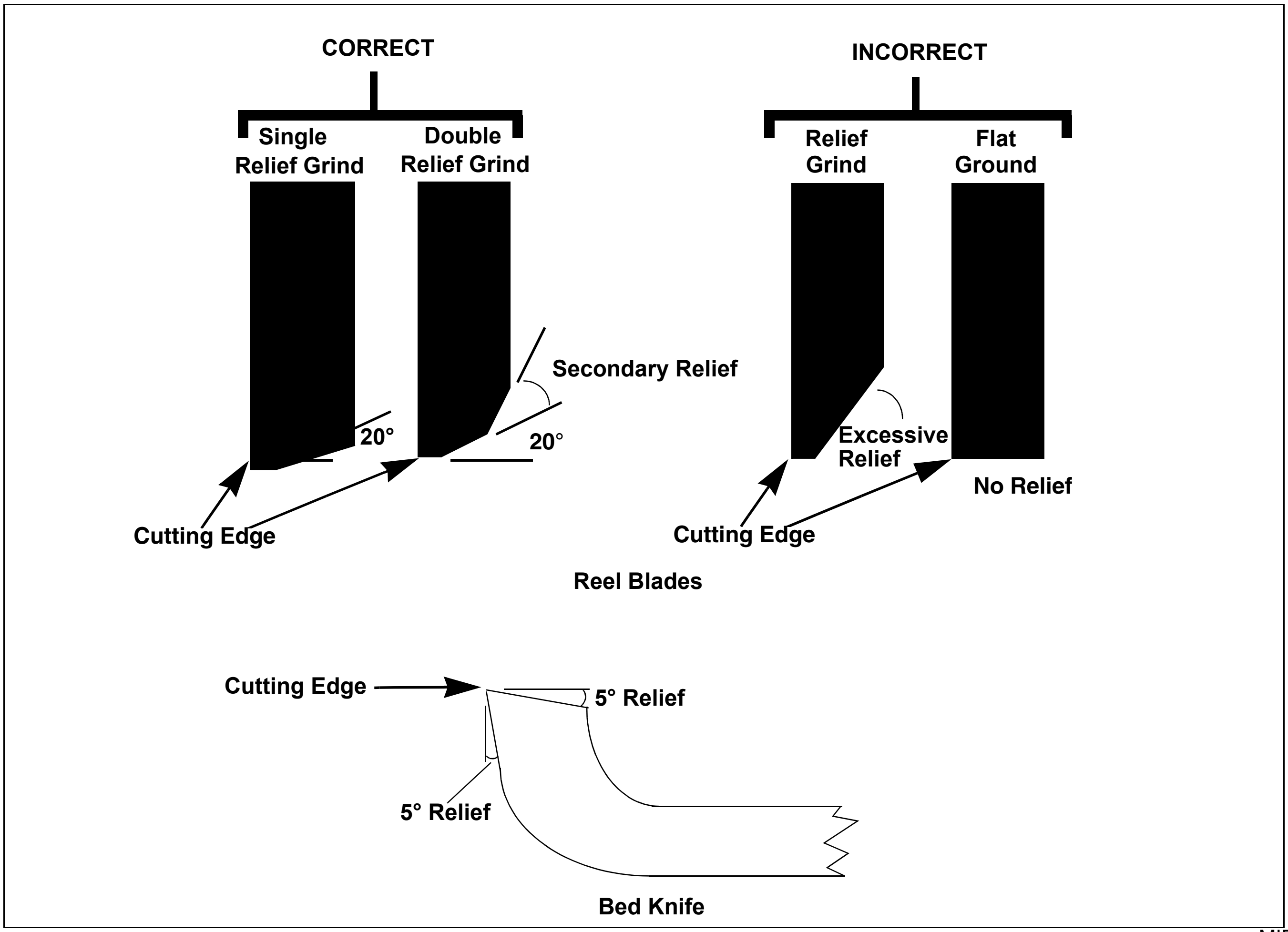
Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass towards the bed knife where it is sheared by the cutting edges as they pass one another.

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

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

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

Relief Grinding



MIF

John Deere recommends relief grinding the reels before spingrinding for the following reasons:

- Reduces blade contact area, results in less friction, requiring less horsepower to drive the reels.
- Ensures longer wear life.
- Less time is required to backlap.
- Reduces pulling and tearing of the grass as the unit gets dull by use.
- Provides an area for backlapping compound to be trapped to more effectively backlap reels.
- Relief grinding removes metal from the trailing edge of the blade forming an angle (relief angle) to reduce the contact area of the cutting edges.
- Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is 0.025-0.052 mm (0.001-0.002 in.) out of round.

Backlapping

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

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

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

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

Vertical Cutting Unit

The vertical cutting unit is a dedicated cutting unit used to de-thatch fairways, greens and tees prior to topdressing. This tends to promote vertical growth for better consistency of play on the golf course.

The vertical blades are positioned in a helix pattern and are placed 3/4 in. apart as shipped from the factory. Spacing is accomplished by placing three 1/4 in. spacers together between each blade. If a closer spacing is desired, spacers can be removed and blades added.

The helix pattern in the cutters is formed by indexing the center hexagonal cut one additional flat.

Normal rotational direction for the reel is forward; however, for very aggressive cutting, the reel should be operated in the reverse direction. This will prevent the cutting blades from pulling the machine and will provide a more desirable cutting action.

To operate the reel in reverse, the hydraulic hoses must be reversed at the reel motors.

Rollers

Smooth Roller

The roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. A smooth roller is generally used on the rear of a cutting unit to establish the cutting height range. (Under certain circumstances, grooved rollers are used on the rear.) A front roller used in conjunction with a rear roller is needed to achieve more exact cutting heights under 25 mm (1 in.).

Grooved Roller

The grooved roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. The main advantage in using a grooved roller rather than a smooth one comes when cutting long grass that is very wet. Grass that is wet will tend to stay down rather than spring up after the roller passes. Grooved rollers will not bend the grass over, allowing it to be cut rather than passed over.

Along with advantages come disadvantages. Because of the reduced contact area inherent with a grooved roller, the roller may penetrate deeper into the soil (especially in wet conditions), lowering the effective cutting height and possibly scalping the turf. Serious consideration should be given to mowing fairways or greens with a grooved roller attached, especially when the turf is very wet.

Spiral Roller

The 3-in. diameter spiral-grooved front roller with spiral end-caps allows more grass to stand up along the entire width of the cutting unit, providing a better quality of cut. This roller is also self-cleaning, reduces material buildup on the ends, and improves the overall appearance of the finished cut.

Performance Variables

Three performance variables that affect the quality of cut are:

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

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

To apply performance variables to a formula we need to understand three terms:

Shear Point - A single point of cutting contact between the cutting unit and the turf. Due to the reel mower design, there is an infinite number of shear points across the bed knife.

Clip Ratio (CR) - The forward distance traveled between successive cutting contacts at any one shear point.

Cutting Height (CH) - The distance above the soil line that grasses are clipped.

The most uniform cut occurs when the Clip Ratio (CR) equals the Cutting Height (CH). If CR is 20% greater than CH, marcelling (a wavy, rib-like appearance) can occur. CR should be within 20% of CH. Therefore, a CH of 13 mm (0.50 in.) requires a CR of 10-15 mm (0.40-0.60 in.). If CH is 20% greater than CR, the rotating blades create a fanning effect that blows the grass down without cutting it.

CR is controlled by the performance variables (the number of blades on the reel, ground speed and reel speed). In most cases, only two of these performance variables (the number of blades on the reel and/or the vehicle ground speed) are changeable for a given cutting height.

Since the number of blades on the reel, the reel speed, the cutting height and the clip ratio (since CR must equal CH) are known, the formula to calculate optimum vehicle ground speed (mph) is:

mph = (reel rpm) x (CR) x (No. of blades) ÷ 1056

Example:

Using:

- 3215/3235 Lightweight Fairway Mower at a tested reel speed of 2100 rpm
- 9-blade reel on a 22-in. cutting unit
- CH = 0.14 (therefore, CR = 0.14)

Optimum vehicle ground speed (mph) is:

(2100) x (0.14) x (9) ÷ 1056 = 2.5 mph

NOTE: To measure vehicle ground speed (mph):

• Measure off an 88-ft distance and record the length of time (in seconds) it takes to travel that distance.

• Vehicle ground speed equals 60 divided by that time.

Diagnostics

Attachments Troubleshooting

Symptom: Marcelling

(1) Is the ground speed correct?

Yes - Go to step (2).

No - Increase or decrease ground speed as necessary. (See “Performance Variables” on page 399.)

(2) Is engine rpm correct (not too low)?

Yes - Go to step (3).

No - Increase engine speed to specification. (See operator's manual.)

(3) Are the reel and bed knife sharp?

Yes - Go to step (4).

No - Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure - 22-In. Standard” on page 402, for standard cutting unit.) (See “Backlapping Procedure - 22-In. Heavy Duty” on page 407, for heavy duty cutting unit.) (See “Backlapping Procedure - 2500M” on page 413, for 2500M cutting unit.)

(4) Is the correct number of reel blades being used for desired clip ratio (CR)?

Symptom: Marcelling

No - Install reel with correct number of blades. (See “Performance Variables” on page 399.)

Symptom: Streaking

(1) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes - Go to step (2).

No - Perform reel-to-bed knife adjustment. (See “Adjust Reel-to-Bed Knife - 22-In. Standard” on page 402, for standard cutting unit.) (See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 406, for heavy duty cutting unit.) (See “Adjust Reel-to-Bed Knife - 2500M” on page 412, for 2500M cutting unit.)

(2) Are the reel and bed knife in good condition (no nicks, uneven wear, or distortions)?

No - Grind reel and bed knife. (See “Reel and Bed Knife Grinding” on page 397.)

Symptom: Height-of-Cut (HOC) Changes

(1) Is the grass dry enough for proper cutting (not too wet)?

Yes - Go to step (2).

No - Allow sufficient time for grass to dry before cutting.

(2) Is the roller clean (no grass or dirt collecting on the roller)?

Yes - Go to step (3).

No - Install scraper or power brush on roller.

(3) Is the condition of the soil good (not rough or changing)?

Yes - Go to step (4).

No - Use a smooth roller.

(4) Is the cutting unit floating properly?

Yes - Go to step (5).

No - See operator's manual.

(5) Are the roller clamp bolts tight?

Yes - Go to step (6).

Symptom: Height-of-Cut (HOC) Changes

No - Perform height-of-cut (HOC) Adjustment. (See "Adjust Height-of-Cut (HOC) - 22-In. Standard" on page 404, for standard cutting unit.) (See "Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty" on page 408, for heavy duty cutting unit.) (See "Adjust Height-of-Cut Range - 2500M" on page 415, for 2500M cutting unit.)

(6) Are the rollers concentric (not out-of-round)?

Yes - Go to step (7).

No - Replace roller. (See procedure in this section.)

(7) Are the roller bearings in good condition (not worn)?

No - Replace roller bearings. (See procedure in this section.)

Symptom: Poor Quality of Cut

(1) Is the grass at an acceptable height (not too high)?

Yes - Go to step (2).

No - Mow grass more frequently.

(2) Are the reel and bed knife sharp?

Yes - Go to step (3).

No - Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure - 22-In. Standard" on page 402, for standard cutting unit.) (See "Backlapping Procedure - 22-In. Heavy Duty" on page 407, for heavy duty cutting unit.) (See "Backlapping Procedure - 2500M" on page 413, for 2500M cutting unit.)

(3) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No - Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife - 22-In. Standard" on page 402, for standard cutting unit.) (See "Adjust Reel-to-Bed Knife - 22-In. Heavy Duty" on page 406, for heavy duty cutting unit.) (See "Adjust Reel-to-Bed Knife - 2500M" on page 412, for 2500M cutting unit.)

Symptom: Reel Does Not Rotate

(1) Is the machine operating properly?

Yes - Go to step (2).

No - See machine operator's manual.

(2) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Symptom: Reel Does Not Rotate

Yes - Go to step (3).

No - Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife - 22-In. Standard" on page 402, for standard cutting unit.) (See "Adjust Reel-to-Bed Knife - 22-In. Heavy Duty" on page 406, for heavy duty cutting unit.) (See "Adjust Reel-to-Bed Knife - 2500M" on page 412, for 2500M cutting unit.)

(3) Are the roller bearings in good condition (not worn or seized)?

No - Replace roller bearings.

Symptom: Unit Not Cutting

(1) Is the grass dry and height of the grass not too excessive?

Yes - Go to step (2).

No - Allow sufficient time for grass to dry and mow more frequently.

(2) Are the engine and ground speeds correct?

Yes - Go to step (3).

No - Adjust engine speed to specification. (See operator's manual.) Adjust ground speed to conditions. (See "Performance Variables" on page 399.)

(3) Is the correct number of blades used for conditions?

Yes - Go to step (4).

No - Install reel with correct number of blades. (See "Performance Variables" on page 399.)

(4) Are the reel and bed knife sharp?

Yes - Go to step (5).

No - Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure - 22-In. Standard" on page 402, for standard cutting unit.) (See "Backlapping Procedure - 22-In. Heavy Duty" on page 407, for heavy duty cutting unit.) (See "Backlapping Procedure - 2500M" on page 413, for 2500M cutting unit.)

(5) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No - Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife - 22-In. Standard" on page 402, for standard cutting unit.) (See "Adjust Reel-to-Bed Knife - 22-In. Heavy Duty" on page 406, for heavy duty cutting unit.) (See "Adjust Reel-to-Bed Knife - 2500M" on page 412, for 2500M cutting unit.)

Tests and Adjustments

Backlapping and Bed Knife-to-Reel

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

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

Adjust Reel-to-Bed Knife - 22-In. Standard

Reason

To maintain reel-to-bed knife clearance for clean, consistent cutting.

Procedure

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

NOTE: Each flat on the adjustment nut represents 0.025 mm (0.001 in.) movement of the reel. The lower nut will lower the reel when turned counterclockwise and the upper nut will raise the reel when turned clockwise (as viewed from the top of the unit looking down).

1. Adjust ends of reel to set drag with a 0.025 mm (0.001 in.) feeler gauge.

2. Now inspect the entire length of the bed knife with a 0.051 mm (0.002 in.) feeler gauge. It should not go in anywhere. If the clearance exceeds 0.051 mm (0.002 in.), grind the reel and bed knife to eliminate the "smile" in the bed knife or the out-of-round condition of the reel.

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

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

3. Slowly rotate the reel backwards, watching for contact between the reel and bed knife at the center of the bed knife. If contact is made, grind the reel and bed knife to eliminate the "frown" in the bed knife or the out-of-round condition of the reel.

Results

When properly adjusted and sharpened, each reel blade should cut a piece of paper held at 90° to the top surface of the bed knife along the entire length of the bed knife.

Specifications

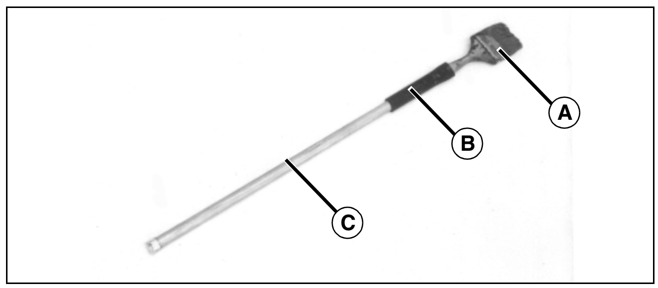
Reel-to-Bed Knife Clearance - 22-In. Standard . . . 0.025 mm (0.001 in.)

Backlapping Procedure - 22-In. Standard

Reason

To provide a consistent cutting action and prolong reel life.

Dealer Fabricated Tools



E32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Other Material

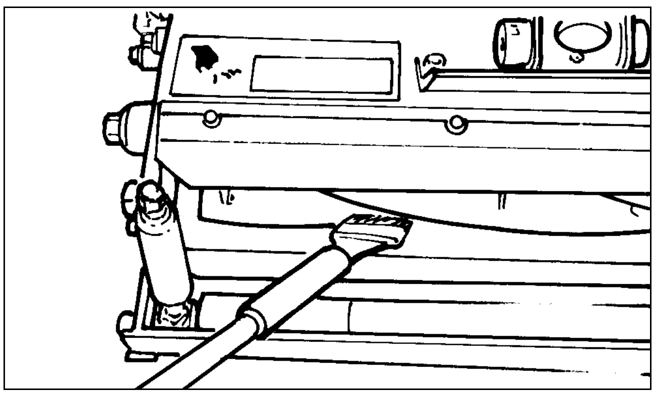
Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reel.

Procedure

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

Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

1. Put machine in the backlapping mode. Adjust machine speed to rotate reel at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.



M56482

2. Apply 120-grit compound to the rotating reel evenly from one side to the other and back again with a long-handled brush.

3. Allow the reel to spin until quiet. If desired, follow with a 220-grit compound to achieve a "tournament grade" finish.

CAUTION: Avoid injury! Never use pressure washers or steam cleaners to rinse the abrasives from the cutting unit. The abrasives may be forced past the seals and damage the bearings.

IMPORTANT: Avoid damage! Never operate cutting unit in the forward direction until abrasive compounds are removed from the cutting unit. The abrasive compound will dull the cutting edges.

4. Rinse the lapping compound off the cutting unit with water and repeat the adjustment procedure before returning the unit to service.

5. Add a relief, if needed, to the leading edge of the knife to prevent the edge from "catching" the reel and curling it up.

6. Check reel-to-bed knife clearance. See “Adjust Reel-to-Bed Knife - 22-In. Standard” on page 402.

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut (HOC) - 22-In. Standard

Reason

To set desired cutting height.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to adjust cutting height.

Procedure

NOTE: The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another. When mowing fairways it is best to set the height-of-cut 0.0508-1.016 mm (0.020-0.040 in.) higher for the initial cut and lower it as needed after a test cut.

Adjust Rear Roller Height HOC

		Standard Roll Bracket (AET11306) Height-of-Cut								**Low HOC Kit (BM16277) Height-of-Cut**			
		2-Inch Roll Forward		**2-Inch Roll Rear**		**3-Inch Roll Forward**		**3-Inch Roll Rear**		**3-Inch Roll Forward**		**3-Inch Roll Rear**	
Rear Roller Bracket Hole	**Rear Roller Frame Hole**	**MIN[1]**	**MAX[2]**	**MIN[1]**	**MAX[2]**	**MIN[1]**	**MAX[2]**	**MIN[1]**	**MAX[2]**	**MIN[1]**	**MAX[2]**	**MIN[1]**	**MAX[2]**
Top	Top	6.7 (0.264)	15.10 (0.594)	8 (0.315)	18.8 (0.740)	11.8 (0.464)	20.2 (0.795)	14.2 (0.559)	25 (0.964)	6.5 (0.256)	13.7 (0.539)	8.8 (0.268)	15.6 (0.614)
Bottom	Bottom	11.2 (0.441)	19.6 (0.772)	11.8 (0.464)	22.7 (0.893)	16.2 (0.638)	24.6 (0.969)	18 (0.709)	28.8 (0.984)	10.6 (0.417)	18.1 (0.713)	10.9 (0.429)	19.6 (0.772)
Top	Middle	15.7 (0.618)	24.1 (0.949)	15.7 (0.618)	26.5 (1.043)	20.7 (0.815)	29 (1.141)	21.8 (0.858)	32.6 (1.283)	15 (0.590)	22.5 (0.886)	14.9 (0.587)	23.6 (0.929)

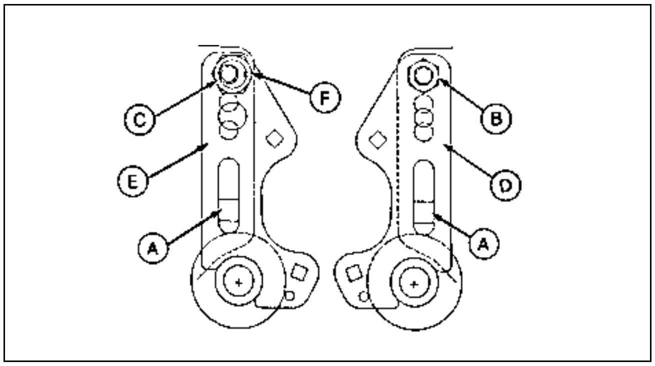
mm
(inches)

1. Measured with a new bed knife

2. Measured with a worn bed knife

Use the table above to ensure the rear roller mounting brackets are positioned correctly for the front roller HOC range desired. Perform Rear Roller HOC Range procedure to change the (HOC) range (if needed) before performing Rear Roller/Bed Knife adjustment.

Rear Roller HOC Range



E33982

1. Loosen lower rear roller support bolts (A) and remove upper bolt (B) and eccentric (C).

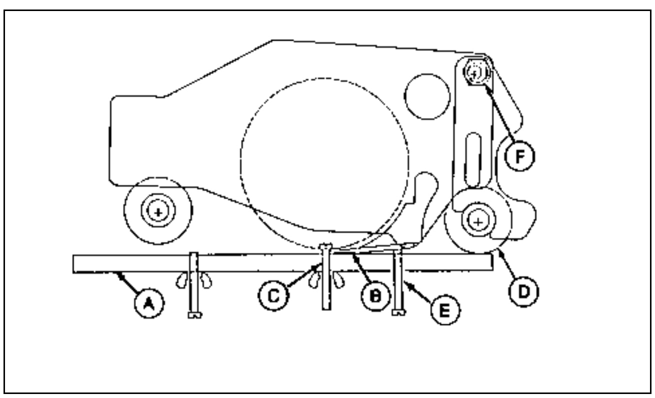
2. Align the upper holes in the roller support with the proper hole in the frame side plate (A).

3. Install bolt (B) and nut on the right side (D) and tighten.

4. Install the eccentric (C) and nut on the left side (E). DO NOT tighten at this time. Ensure the index mark (F) on the eccentric faces the rear of the cutting unit.

Adjust Rear Roller/Bed Knife

NOTE: It may be necessary to raise the front roller height to allow enough room for the gauge bar to be installed.



E33983

1. Set center gauge screw (C) to desired height-of-cut. Position the gauge bar (A) approximately 51 mm (2 in.) from the right end (fixed end of roller) of the bed knife (B).

2. Hook the center gauge screw (C) on the cutting edge of the bed knife and hold the end of the bar flat against the rear roller (D).

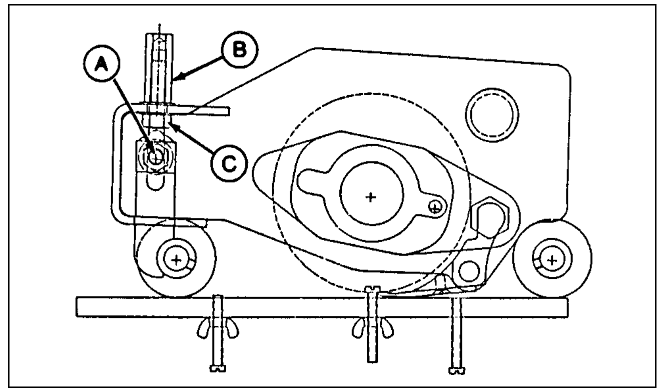
3. Turn the rear gauge screw (E) in until it just makes contact with the bed knife. Tighten the wing nut to lock the position of the screw (E).

4. Move the gauge bar (A) to approximately 51 mm (2 in.) from the left end of the bed knife.

5. Use the eccentric bolt (F) to adjust the roller up or down until the rear gauge screw (E) just makes contact with the bed knife.

6. Tighten all rear roller support hardware and recheck with the gauge bar to ensure the roller has not moved.

7. Ensure the rear gauge screw is backed out and will not contact the bed knife.



E33987

8. Loosen the front roller clamp bolts (A) 1/4 to 1/2 turn.

NOTE: It may be necessary to adjust the front roller height to allow enough room for the gauge bar to be installed.

9. Position the gauge bar 51 mm (2 in.) from either end of the bed knife.

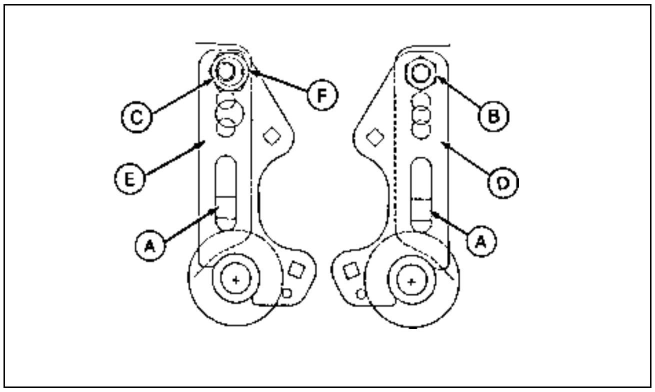
10.Hook the center gauge screw on the cutting edge of the bed knife and hold the end of the bar flat against the rear roller.

IMPORTANT: Avoid damage! Alternate turns of the adjustment nuts equally on both sides to prevent binding the adjustment mechanism.

NOTE: One flat on the adjustment nut equals 0.25 mm (0.010 in.) of roller movement. Turning the upper adjustment nut (B) clockwise raises the roller and turning the lower adjustment nut (C) counterclockwise lowers the roller. Remember to loosen the opposite nut to allow movement of the adjustment nut.

The roller should just touch the gauge bar; forcing the roller against the gauge bar will bend it and raise the HOC.

11.While holding the roller mounting brackets against the rear of the frame guide slots, use the adjustment nuts to bring the roller down to the gauge bar.



E33982

12.After the adjustment is made, tighten the clamp bolts (A) and tighten the opposite nut of the one used for adjustment.

13.Use the gauge bar to ensure the roller has not moved after tightening the clamp bolts and adjuster nuts.

Results

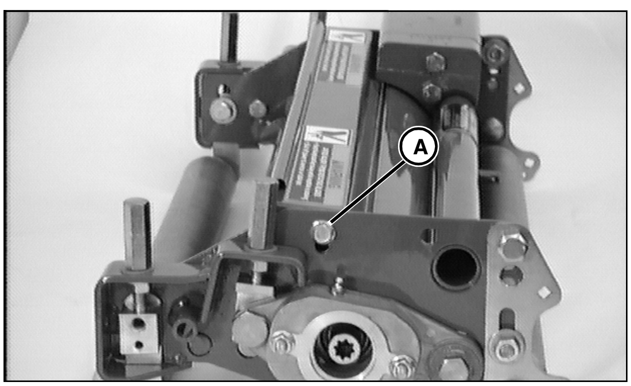
Height-of-Cut should be adjusted to desired level, consistently across cutting unit.

Adjust Cutting Unit Shield - 22-In. Standard

Reason

Keeping the shield close to the blades improves the performance of the grass catcher in most conditions.

Procedure



M73875

1. Loosen bolt (A) on each side of cutting unit and set clearance between shield and reel blades to specification.
2. Tighten bolt (A) on each side.

Results

Proper clearance between shield and cutting blades will result in greater grass catching performance.

Specifications

Cutting Unit Shield Clearance - 22-In. Standard . 1 mm (0.04 in.)

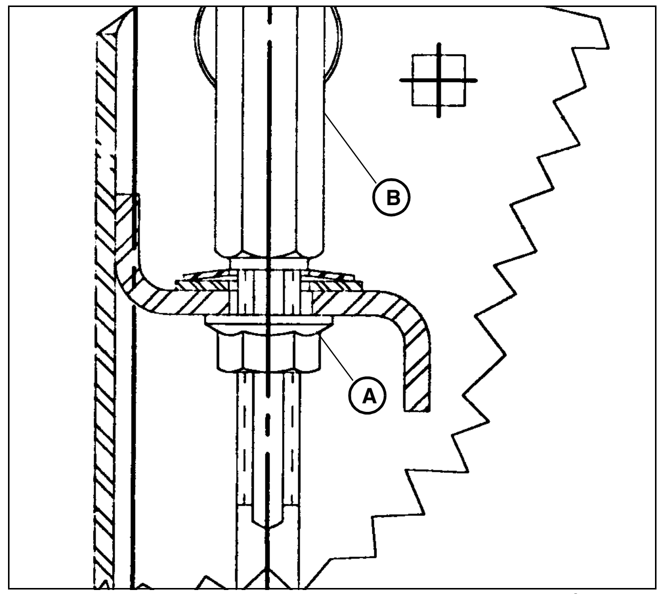
Adjust Reel-to-Bed Knife - 22-In. Heavy Duty

Reason

To maintain reel-to-bed knife clearance for clean, consistent cutting.

Procedure

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



A46505

1. Turn adjustment nut (A) counterclockwise (as viewed from the top of the cutting unit looking down) to lower the reel and turn the upper adjustment nut (B) clockwise to raise the reel.
2. Rotate adjustment nuts until reel is touching bed knife. Then adjust reel away to achieve a reel-to-bed knife clearance of 0.051 mm (0.002 in.).
3. Now try to insert a 0.1 mm (0.004 in.) feeler gauge along the entire length of the bed knife. It should not go in anywhere. If the clearance exceeds 0.10 mm (0.004 in.) grind the reel and/or bed knife.

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

4. Slowly rotate the reel backwards, watching for contact between the reel and bed knife at the center of the bed knife. If contact is made, grind the reel and bed knife to eliminate the "frown" in the bed knife or the out-of-round condition of the reel.

Results

When properly adjusted and sharpened, each reel blade should cut a piece of paper held at 90° to the top surface of the bed knife along the entire length of the bed knife.

Specifications

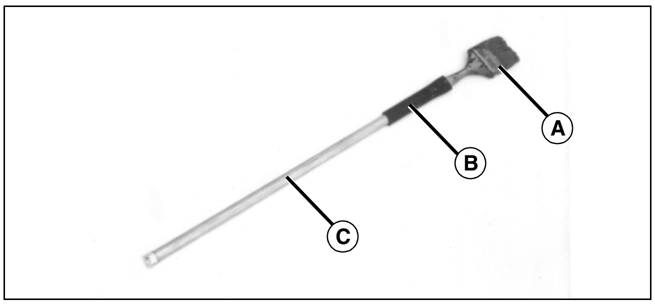
Reel-to-Bed Knife Clearance - 22-In. Heavy Duty   0.051 mm (0.002 in.)

Backlapping Procedure - 22-In. Heavy Duty

Reason

To provide a consistent cutting action and prolong reel life.

Dealer Fabricated Tools



E32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Other Material

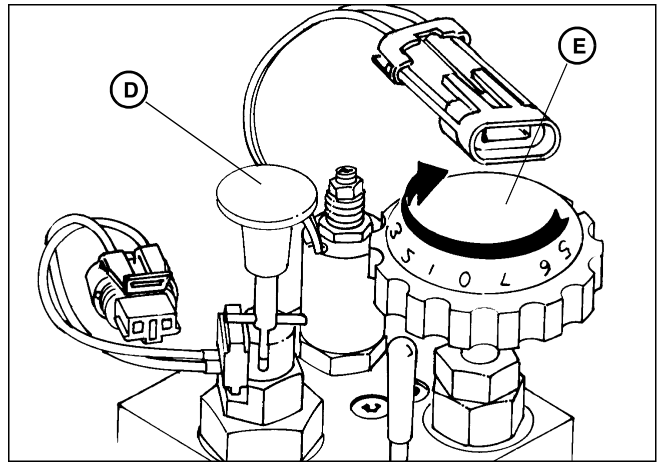
Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reel.

Procedure

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

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

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

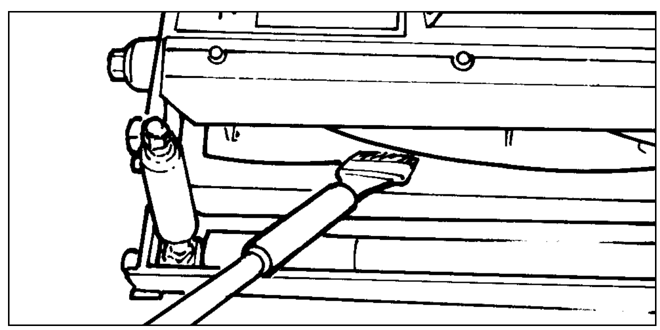


M56504

2. Locate the backlapping valve on the front of the operators platform for the front three reels, and on the back side, below the left fender for the rear two reels. Pull up and rotate the forward/reverse knob (D) to align it with the notch on the valve block.

3. Engage the PTO. (The reels should now be rotating in the reverse direction.)

4. Using the flow control knob (E), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.



M56482

5. Apply 60- to 80-grit compound for units with extended service time, and 120-grit compound for new, newly ground reels or when applied on a weekly basis, to the rotating reel evenly from one side to the other and back again with a long-handled brush.

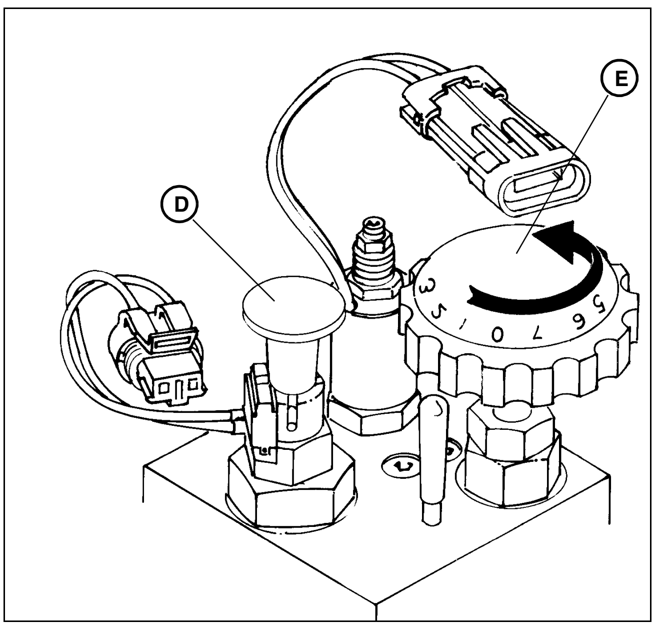
6. Allow the reel to spin until quiet. If desired, follow with a 220-grit compound to achieve a smoother finish.

CAUTION: Avoid injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running. Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

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

7. Rinse the lapping compound off the cutting unit with water and repeat reel-to-bed knife adjustment before returning the unit back to service.



M56503

8. Disengage PTO switch and shut off the engine. Turn the flow control knob (E) fully counterclockwise.

9. Rotate forward/reverse knob (D) to allow the pin to engage the slot.

10. Check reel-to-bed knife clearance. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 406.

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty

Reason

To set desired cutting height.

Special or Required Tools

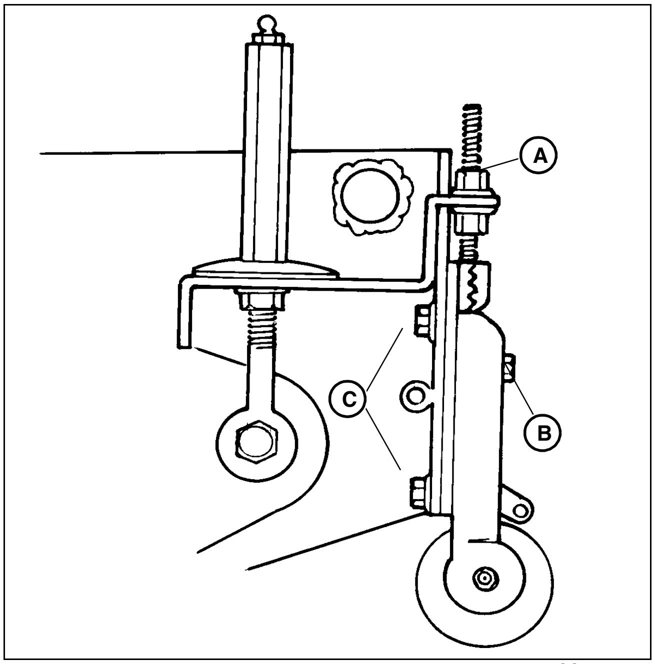
Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to adjust cutting height.

Procedure

CAUTION: Avoid injury! Do not service or adjust cutting units while the engine is running. Disengage PTO and shut off engine prior to making any adjustments. Always wear protective gloves when working on or near the reel or bed knife.

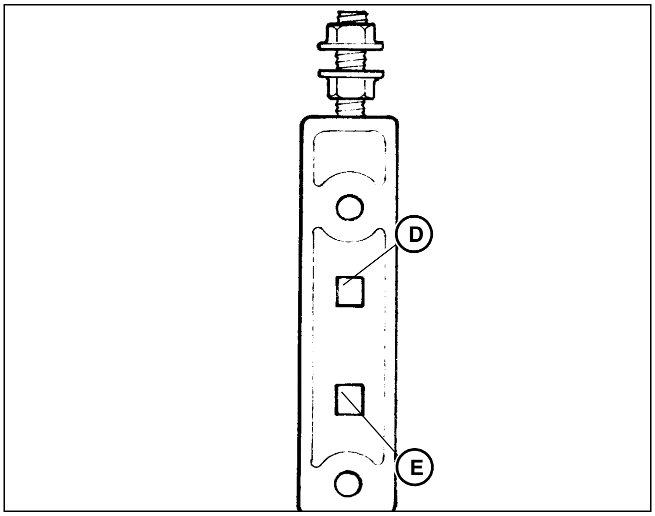
Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

IMPORTANT: Avoid damage! The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another. When grass length exceeds 38 mm (1-1/2 in.), floating units may not provide a quality cut; operate cutting units in fixed position only.



M46876

1. Loosen nut (A). Remove nut and washer (B) and two bolts (C) (per side) and position the carriage bolt for the cutting height range.



M46861

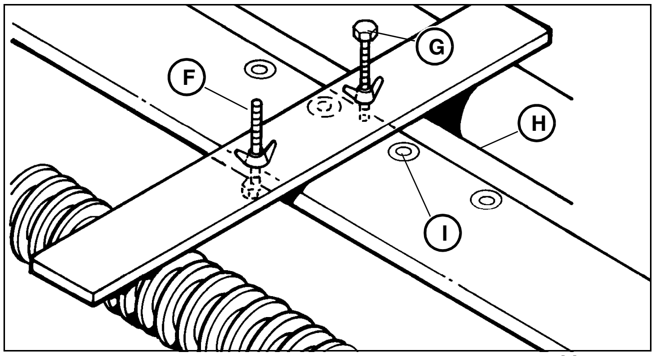
2. For cutting heights of 9.5-41 mm (3/8-1-5/8 in.), position carriage bolt into the upper square opening (D). For cutting heights of 38-90 mm (1-1/2-3-1/2 in.), position carriage bolt into the lower square opening (E).

IMPORTANT: Avoid damage! Ensure the rear bolt (G) on the gauge bar rests on the bed knife support. Ensure it does not rest on a bed knife mounting bolt (I).

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

Ensure the rear bolt on the gauge bar rests on the bed knife support, and not on a bed knife mounting bolt.

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



M56471

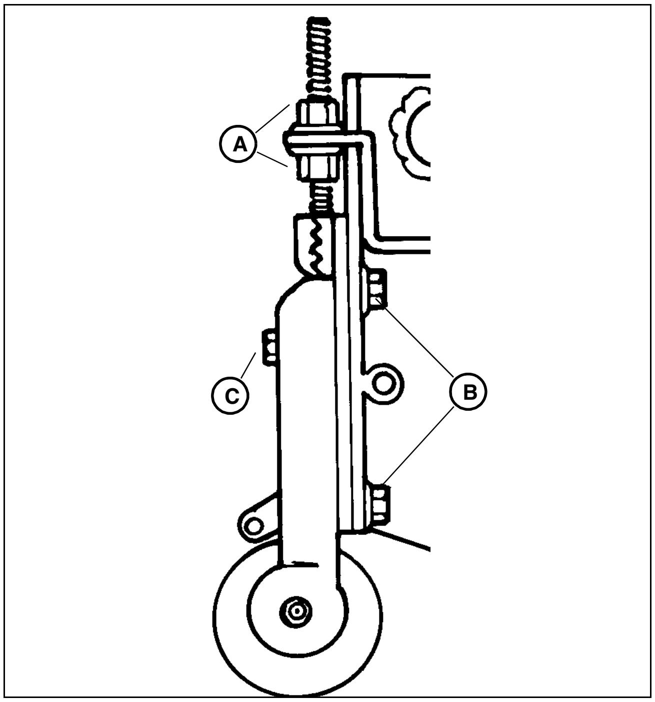
Picture Note: Cutting Unit Shown Upside Down for Clarity.

3. Adjust gauge bar for desired height-of-cut and install on cutting unit (see note above). Ensure the head of the bolt (F) rests on the lip of the bed knife.

4. Adjust rear bolt (G) until the gauge bar is parallel to the bed knife.

Adjust Rear Roller Height

IMPORTANT: Avoid damage! To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller. Each tooth on the adjustment mechanism equals 3.2 mm (1/8 in.).

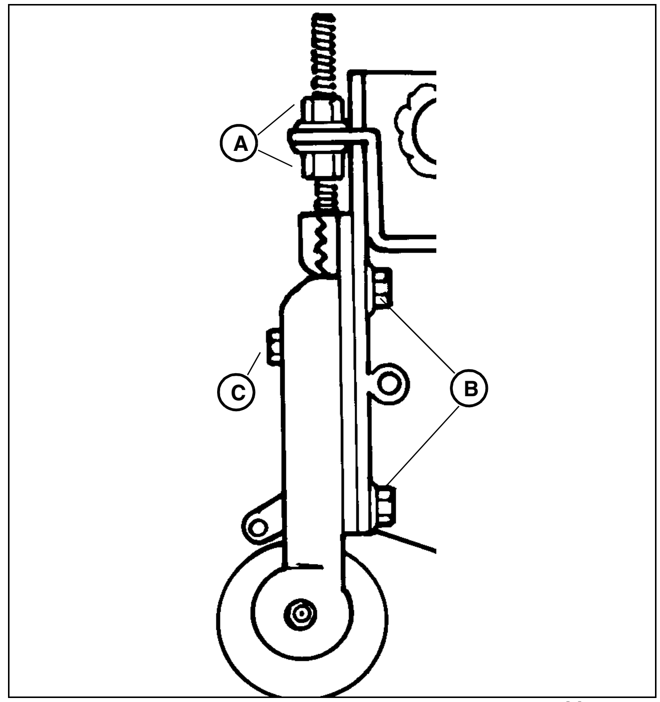


M56472

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

Adjust Front Roller Height

NOTE: To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller. Each tooth on the adjustment mechanism equals 3.2 mm (1/8 in.).



M56472

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

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Adjust Depth-of-Cut - Vertical Cutting Unit (22-In. Heavy Duty)

Reason

To set the desired cutting depth.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to set desired cutting height.

Procedure

CAUTION: Avoid injury! Always wear gloves when handling the reel or cutting blades. Rotating one reel by hand may cause other reels to rotate. If a reel is rotated, be sure no other person is near the other units. Serious personal injury can result from contact with the sharp cutting edges of the blades.

IMPORTANT: Avoid damage! Measure the usable blade length of the cutting blades. If the usable blade length is less than the desired cutting depth, replace the cutting blades before continuing.

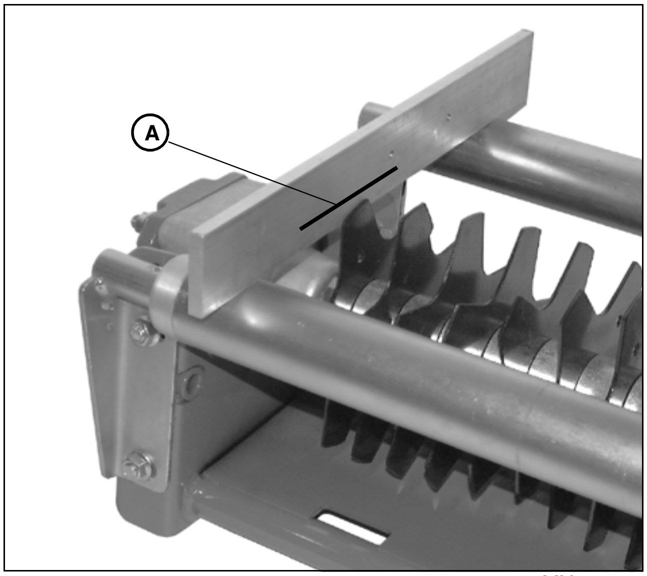
1. Mark the desired cutting depth on a gauge bar.

2. Place the gauge bar across the front and rear rollers approximately two inches in from the end of the rollers.

NOTE: When checking cutting depth of blade against mark on gauge bar, rotate reel back and forth to ensure blade travel does not extend beyond mark on gauge bar.

If desired depth cannot be achieved with roller adjustment, adjust pivot arms to raise or lower the cutting blades.

If blade wear is beyond adjustment, move rear roller adjuster bolts to top holes.



MX18308

3. Adjust front roller height to bring leading edge of cutting blade even with mark (A) on gauge bar.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Specifications

Vertical Cutting Unit Flap Adjustment . . 13 mm (1/2 in.)

Adjust Reel-to-Bed Knife - 2500M

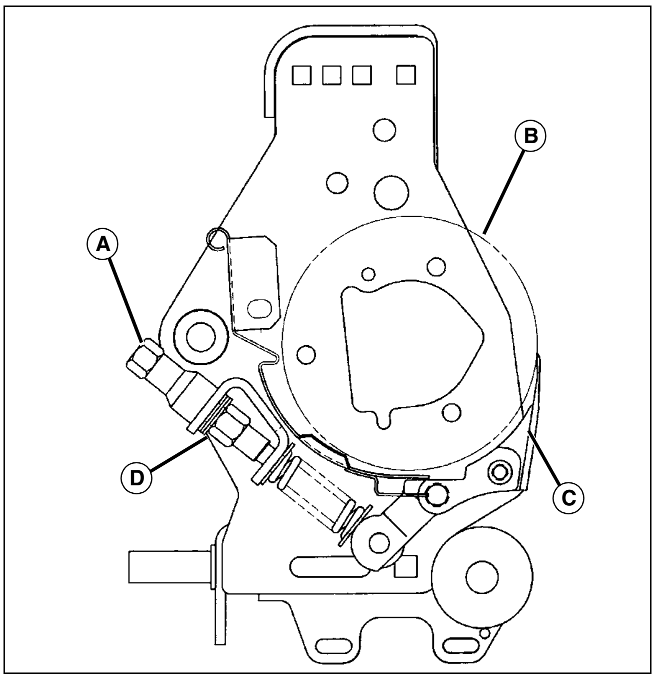
Reason

To maintain reel-to-bed knife clearance for clean, consistent cutting.

Procedure

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

1. Remove cutting units from mower.



M84842

2. Place cutting unit on a stable working surface with the front roller facing up.

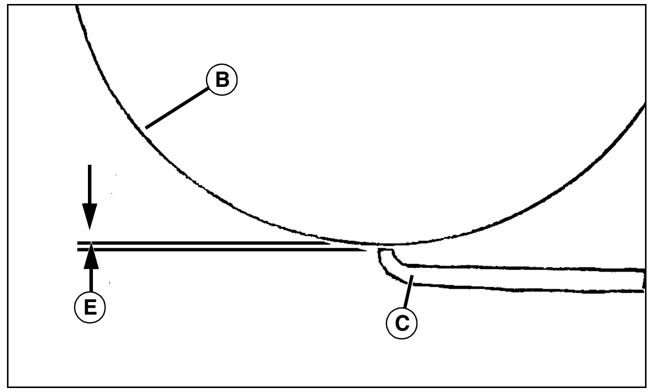
3. Loosen jam nut (D) on both sides of the cutting unit.

IMPORTANT: Avoid damage! Both sides of the bed knife must be adjusted evenly in small increments. DO NOT turn each bed knife adjuster more than one flat at a time.

4. Turn both bed knife adjusters (A) counterclockwise (alternating from one side to the other) until the bed knife (C) is tight against the cutting reel (B).

5. Slowly turn both bed knife adjusters clockwise (alternating from one side to the other) until the bed knife begins to pull away from the cutting reel. At this time the cutting reel should rotate freely.

NOTE: Make sure that when making the final adjustment, the bed knife is moving away from cutting reel.



E35559

6. Using a feeler gauge, turn both bed knife adjusters clockwise (alternating from one side to the other) until bed knife-to-cutting reel clearance (E) is set to specifications.

7. Tighten jam nuts.

IMPORTANT: Avoid damage! Always rotate the cutting wheel backwards to prevent damaging or dulling the cutting edges of the reel and/or bed knife.

8. Slowly rotate the cutting reel backwards and check the gap at several points along the entire length of the bed knife using a 0.050 mm (0.002 in.) feeler gauge. The feeler gauge should not pass between the bed knife and cutting reel at any point.

Results

- **If the gap is 0.050 mm (0.002 in.) or greater at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “smile” in the bed knife or the out-of-round condition of the reel.
- **If there is contact at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “frown” in the bed knife or the out-of-round condition of the reel.

Specifications

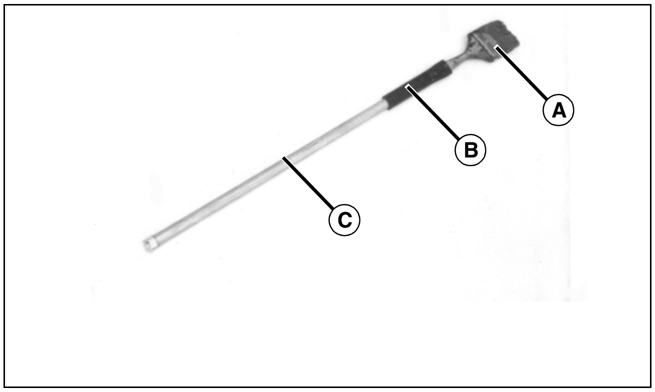
Reel-to-Bed Knife Clearance - 2500M 0.025 mm (0.001 in.)

Backlapping Procedure - 2500M

Reason

To provide a consistent cutting action and prolong reel life.

Dealer Fabricated Tools



E32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reel.

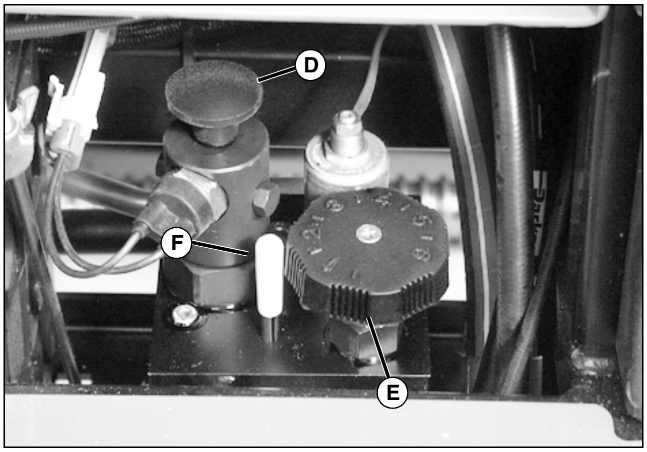
Procedure

CAUTION: Avoid injury! Disengage the FAIRWAY TENDER CONDITIONER before backlapping. Severe personal injury may result from rotating blades.

NOTE: Perform reel-to-bed knife adjustment before performing backlapping procedure.

1. Park machine on a level surface.
2. Lower cutting units to the ground.
3. Move mow/transport lever to TRANSPORT position.
4. Turn key switch to STOP position.
5. Engage park brake.
6. Start engine.
7. Move throttle lever to a position between slow idle and half-throttle position.

NOTE: The operator must be off the seat to perform backlapping procedure.



M84846

8. Adjust reel speed by turning the speed control knob (E) clockwise until the indicator (F) is aligned between “1” and “3”.

NOTE: The forward/reverse control knob must be pulled up completely past the first detent for the backlapping valve to function properly.

9. Engage the backlapping valve by pulling the forward/ reverse knob (D) UP until a “click” is heard.

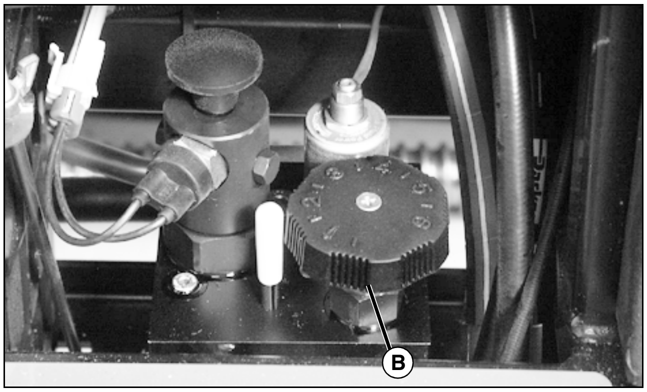
CAUTION: Avoid injury! Avoid injury from rotating blades. keep hands and feet away from blades while machine is running. Never allow more than one person at a time to work on any one cutting unit.Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result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

Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

10.Move mow/transport lever to MOW position.

11.Move lift/lower lever forward to LOWER position. Release lever when cutting reels begin to rotate backward.

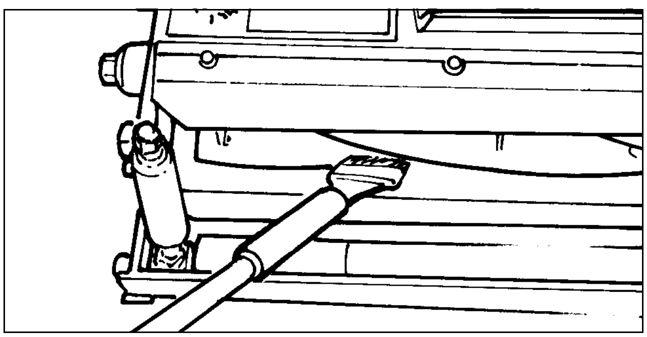
NOTE: Turn speed control knob clockwise to decrease speed.



M84846

12.Adjust reel speed by turning the speed control knob (B). Reels must be turning slowly enough so that sharpening compound will not be thrown from reel.

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



M56482

13.Using a long-handled brush (see Dealer Fabricated Tools), apply sharpening compound to the rotating reel evenly from one side to the other and back again. Use 60- to 80-grit compound for units with extended service time and 120-grit compound for new, newly ground reels or when applied on a weekly basis.

14.Allow the reel to spin until quiet. If desired, follow with a 120-grit compound to achieve a smoother finish.

CAUTION: Avoid injury! DO NOT attempt to disengage the cutting units using the speed control knob. This is not a shut-off valve. Reels may turn if engine is running.

15.Periodically disengage the cutting units by moving mow/transport lever to TRANSPORT position.

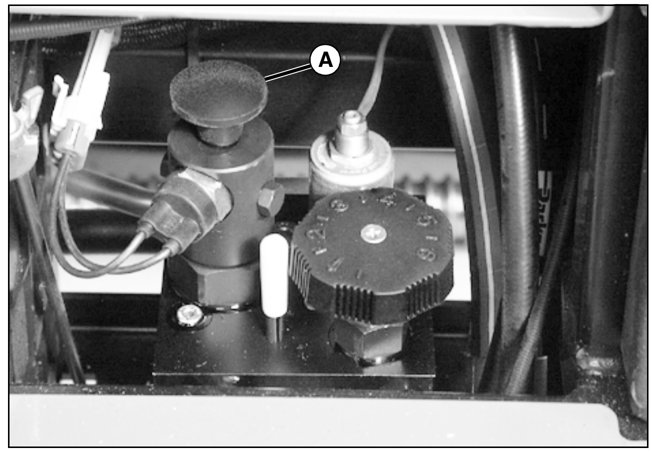
16.Turn key switch to STOP position.

17.Check for uniform clearance across the entire bed knife. If clearance is not uniform, repeat backlapping procedure.

18.Rinse the lapping compound completely off the cutting unit with water while running the reels in reverse.

19.Move mow/transport lever to TRANSPORT position.

20.Turn key switch to STOP position.



M84846

21.Push forward/reverse knob (A) down.

22.Adjust cutting reel speed. (See procedure in Owner's Manual.)

23.Check reel-to-bed knife clearance. See "Adjust Reel-to-Bed Knife - 2500M" on page 412.

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut Range - 2500M

Reason

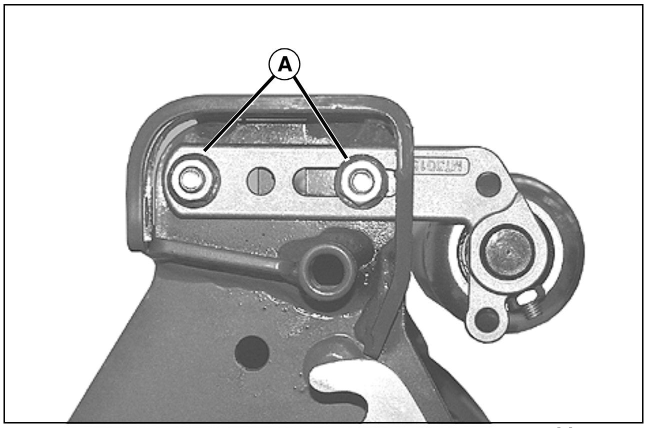
To set front roller range for proper height-of-cut position.

Procedure

1. Remove cutting units from mower.

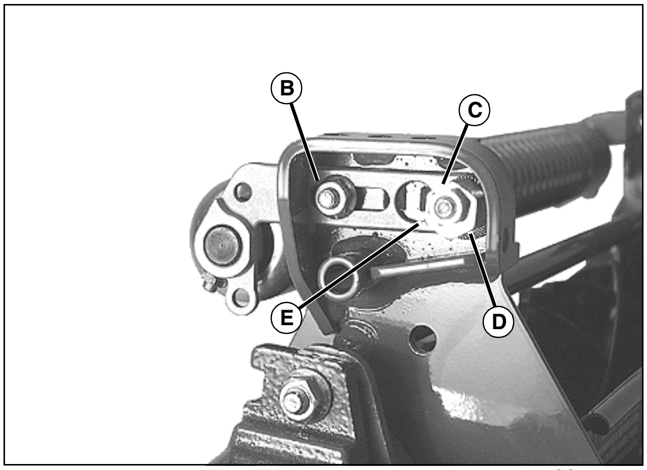
2. Place cutting unit on a stable working surface with the front roller facing up.

NOTE: The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another.



M84841

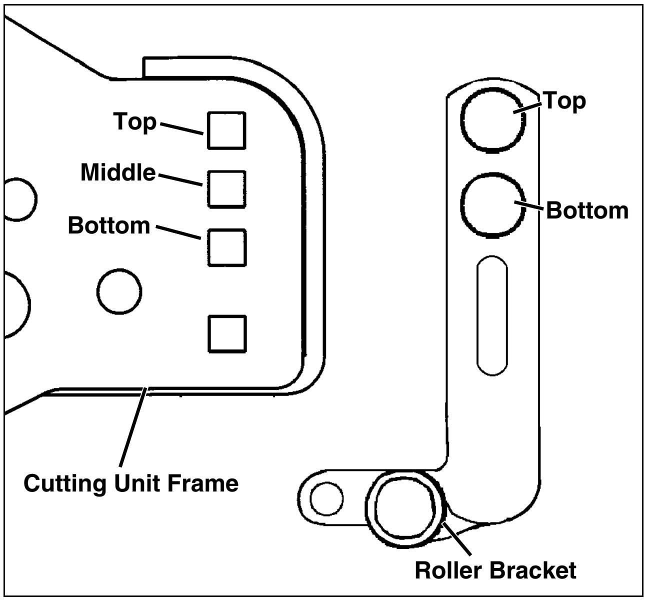
3. Remove two flanged nuts and carriage bolts (A).



M84828

4. Remove lower flanged nut and carriage bolt (B).

5. Remove eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.

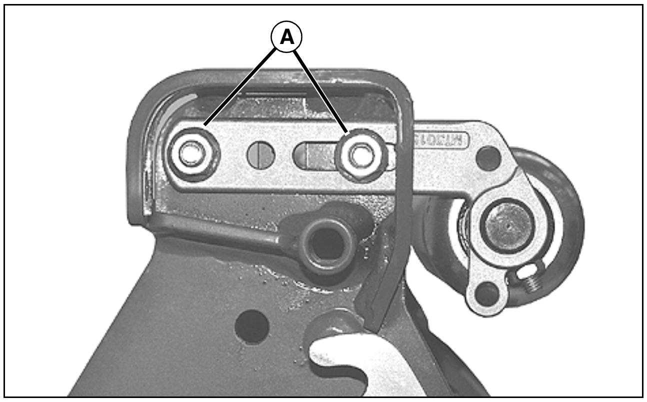


M84845

6. Reposition roller bracket to holes in cutting unit frame to the desire cutting height range (see chart).

Height of Cut	Roller Bracket Hole	Cutting Unit Frame Hole
0-9.53 mm (0-3/8 in.)	Top	Top
6.35-15.88 mm (1/4-5/8 in.)	Bottom	Bottom
12.70-22.23 mm (1/2-7/8 in.)	Top	Middle
0-6.53 mm[1] (0-1/4 in.)	Bottom	Middle

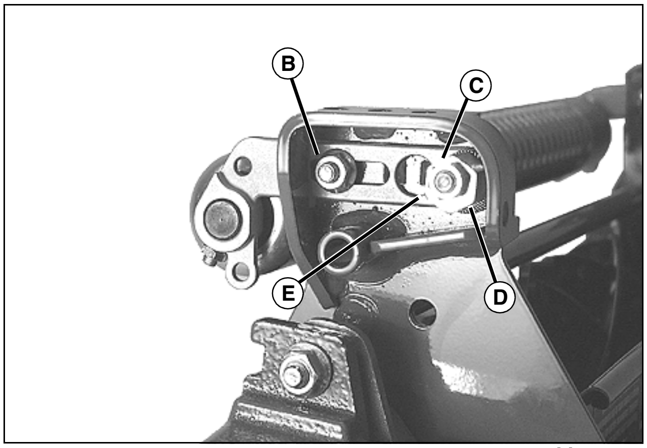
1. This setting is used when the diameter of the cutting reel has worn down to 120 mm (4.7 in.) or less.



M84841

7. Install two flanged nuts and carriage bolts (A).

8. Tighten nuts.



M84828

9. Install lower flanged nut and carriage bolt (B).

10.Install eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.

11.Adjust front roller. (See “Adjust Front Roller - 2500M” on page 416.

Results

Front roller range positioned for proper height-of-cut adjustment.

Adjust Front Roller - 2500M

Reason

To ensure that the front roller is parallel with the bed knife.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bench Plate	NA	Used to adjust front roller.
Height-of-Cut Gauge Bar	NA	Used to adjust front roller.

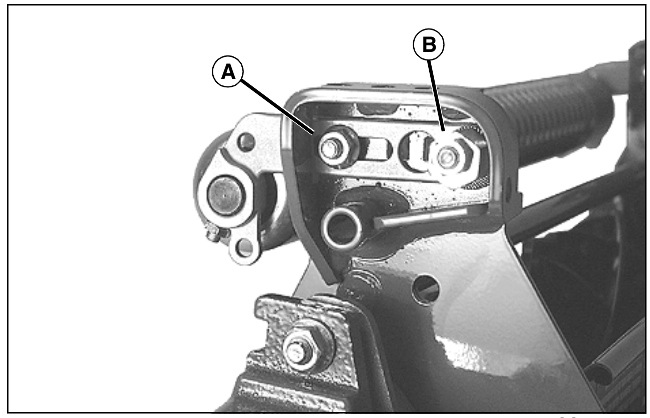
Procedure

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

NOTE: The bed knife-to reel clearance should be adjusted before performing the following procedure.

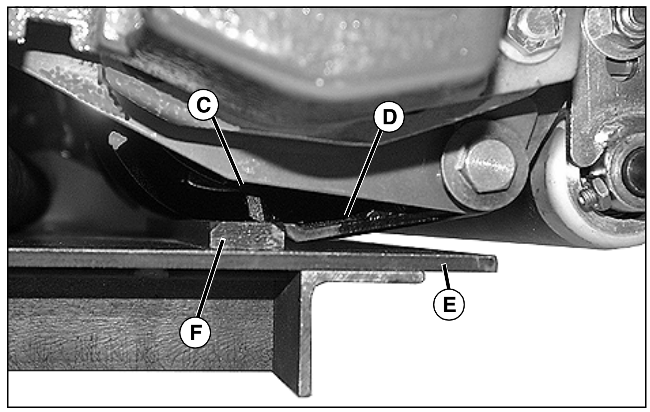
Bench Plate Procedure

1. Place cutting unit on a stable working surface with the front roller facing up.



M84828

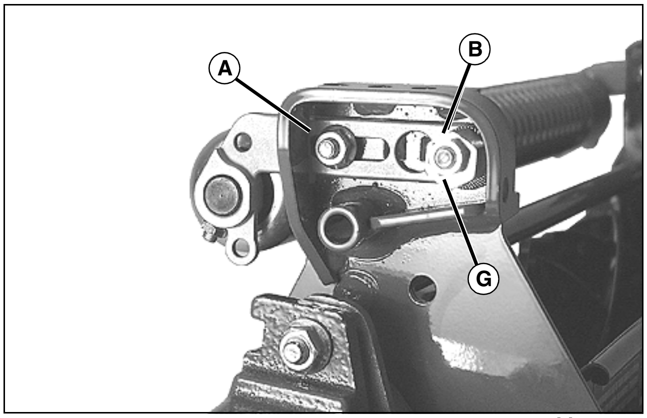
2. Loosen flanged nut (A) on left roller bracket.
3. Loosen eccentric lock nut (B).



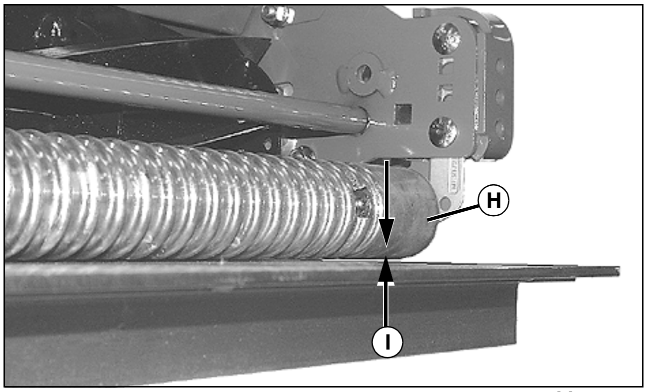
M84829

4. Set bench plate (E) on a level surface.

5. Set cutting unit on top of bench plate. The bed knife (D) must rest firmly against the plate stop (F), with the cutting reel blade (C) on top of plate stop.



M84828



M84830

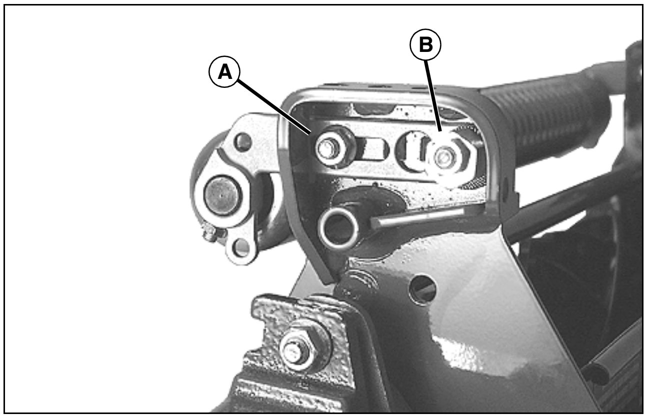
6. Rotate eccentric adjuster (G) until the front roller (H) sits flat and parallel with the bench plate. The gap (I) should not exceed 0.050 mm (0.005 in.).

7. Tighten left roller lower flanged nut (A).

8. Tighten eccentric lock nut (B).

Height-of-Cut Gauge Bar Procedure

1. Place cutting unit on a stable working surface with the front roller facing up.

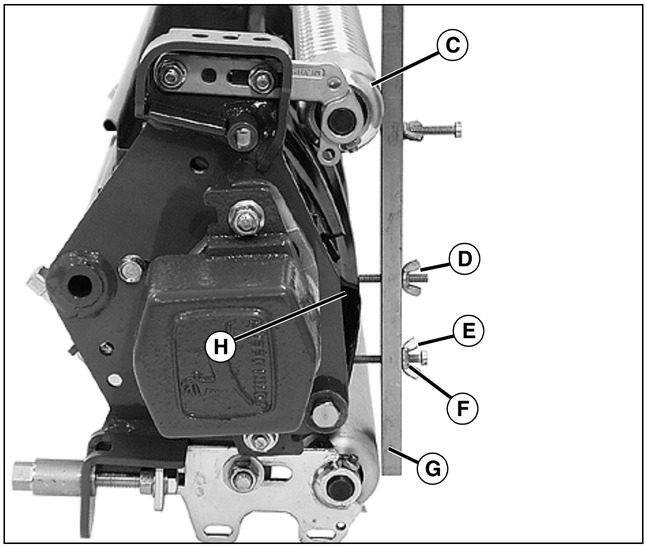


M84828

2. Loosen lower flanged nut (A) on left roller bracket.

3. Loosen eccentric lock nut (B).

NOTE: The height-of-cut gauge bar should not contact the bottom of the rear roller.



M84831

4. Rest the height-of-cut gauge bar (G) approximately 51 mm (2.0 in.) from the right end of bed knife (H).

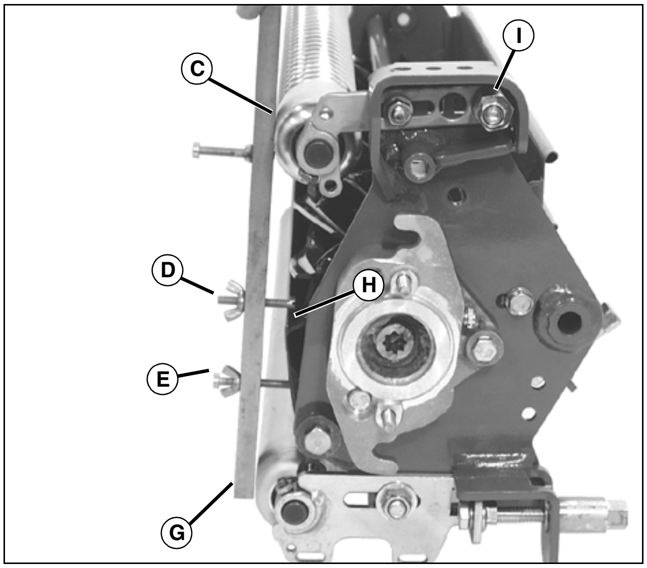
5. Hook the center gauge screw head (D) on the edge of the bed knife. Hold end of gauge bar against the bottom of the front roller (C).

6. Loosen wing nut (F).

7. Turn lower gauge screw (E) clockwise until the top of screw makes contact with the flat edge of bed knife.

8. Tighten wing nut (F).

NOTE: The height-of-cut bar should not contact the bottom of the rear roller.

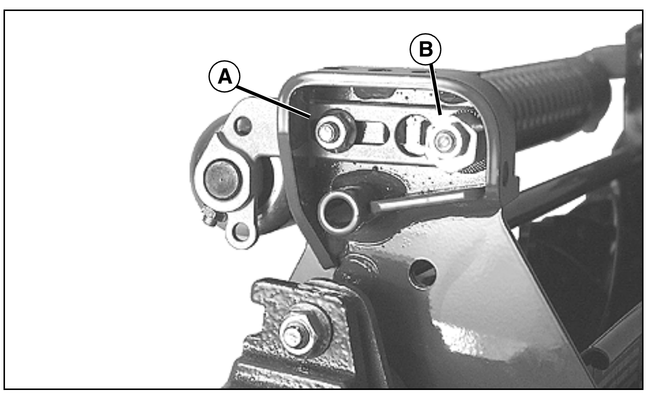


M84832

9. Rest the height-of-cut gauge bar (G) approximately 51 mm (2.0 in.) from the left end of the bed knife (H).

10.Hook the center gauge screw head (D) on the edge of the bed knife. Hold end of gauge bar against the bottom of the front roller (C).

11.Rotate eccentric adjuster (I) until the top of lower gauge screw (E) makes contact with the bed knife.



M84828

12.Tighten left roller lower flanged nut (A).

13.Tighten eccentric lock nut (B).

14.Check adjustment using height-of-cut bar.

15.Adjust cutting height. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 418.)

Results

Front roller positioned for proper height-of-cut adjustment.

Adjust Height-of-Cut (HOC) - 2500M

Reason

To set desired cutting height.

Special or Required Tools

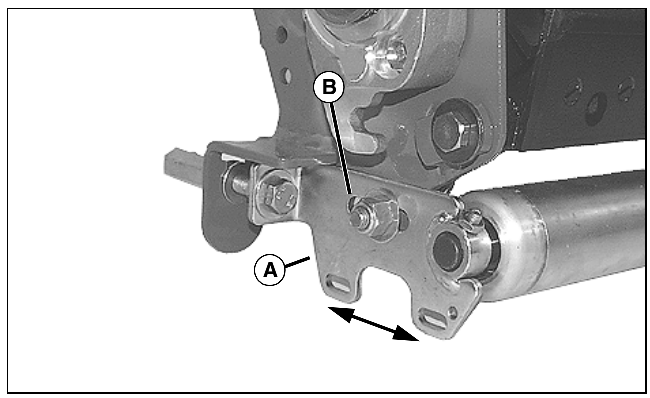
Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to set desired cutting height.

Procedure

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

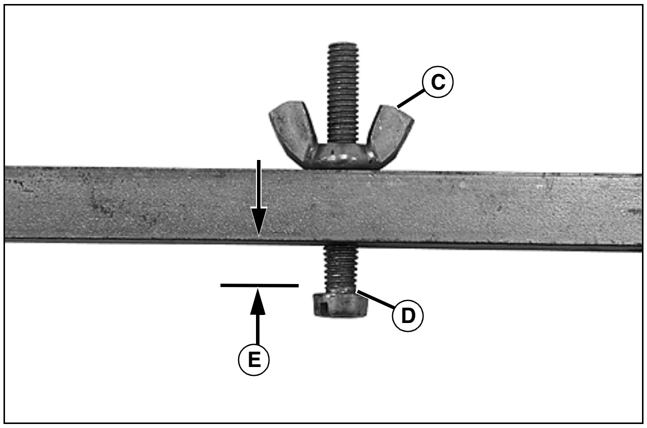
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M98489

3. Loosen lock nut (B) on each side of the cutting unit, just enough to allow the height-of-cut bracket (A) to slide.

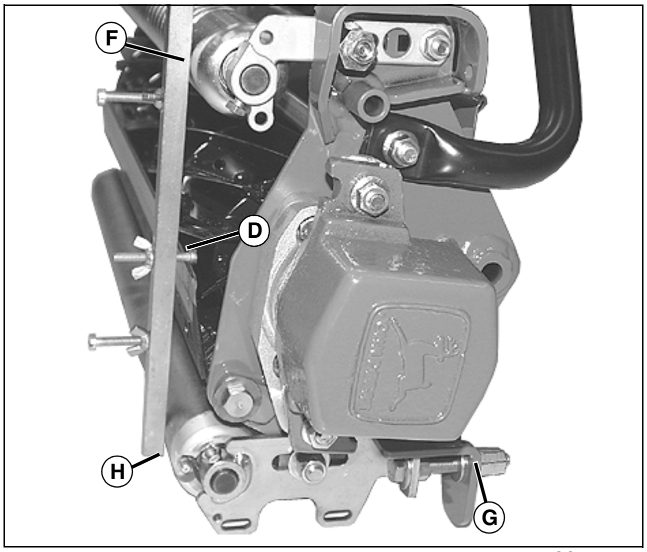


M84833

4. Adjust the center adjustment bolt head (D) on the height-of-cut gauge bar to the desired cutting height (E).

NOTE: DO NOT allow the adjustment bolt to turn while turning the wing nut.

5. Hold the adjustment bolt and turn the wing nut (C) until it sets firmly against the bar.

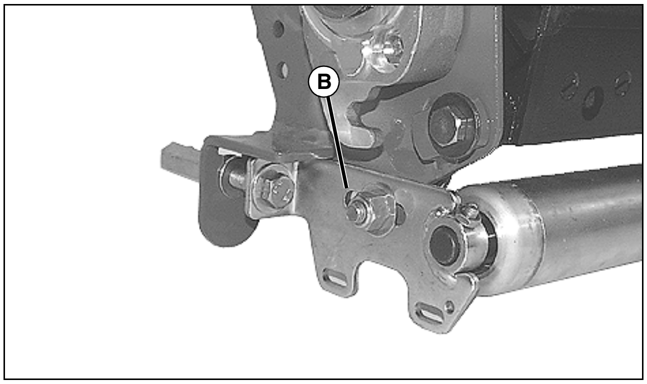


M84834

6. Rest height-of-cut gauge bar against the front roller (F), approximately 51 mm (2.0 in.) from the end of the bed knife. Rest the inside of the bolt head (D) against the edge of the bed knife.

7. Turn tower adjuster (G) until the rear roller (H) makes contact with the height-of-cut gauge bar. Repeat for other side.

8. Check adjustment on both sides of cutting unit using height-of-cut gauge bar. Repeat adjustment as needed.



M98489

9. Tighten lock nut (B) on each side of the cutting unit.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Adjust Fairway Tender Conditioner (FTC) - 2500M

Reason

To set the desired cutting height.

Special or Required Tools

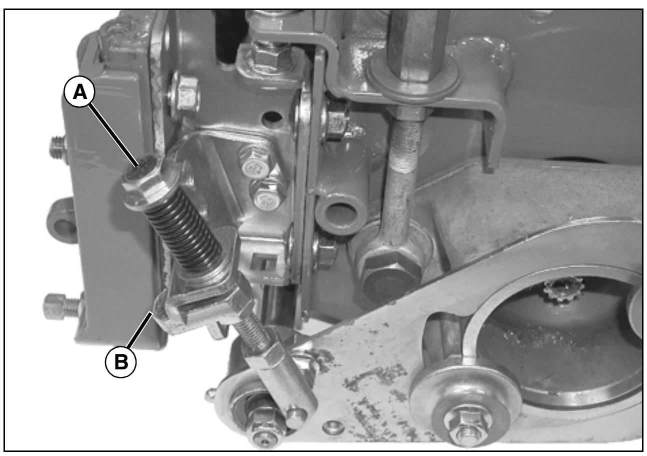
Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to set desired cutting height.

Procedure

NOTE: Height-of-cut must be adjusted before adjusting the fairway tender conditioner.

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

1. Remove cutting units from mower.
2. Place cutting unit on a stable working surface.

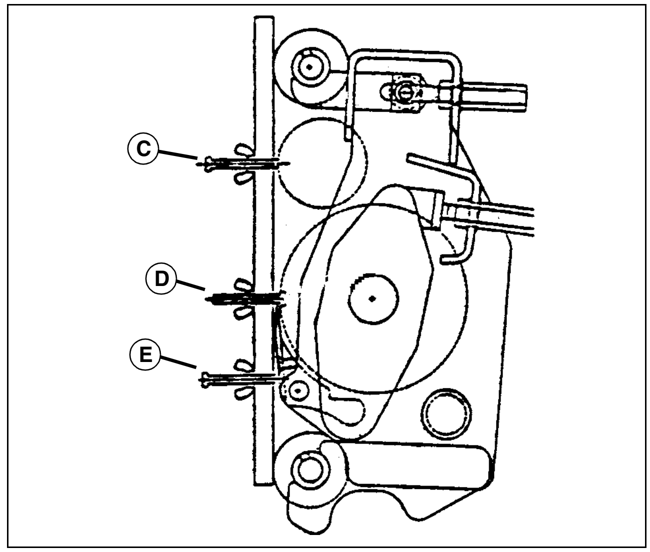


MX18310

Picture Note: Operating Position Shown

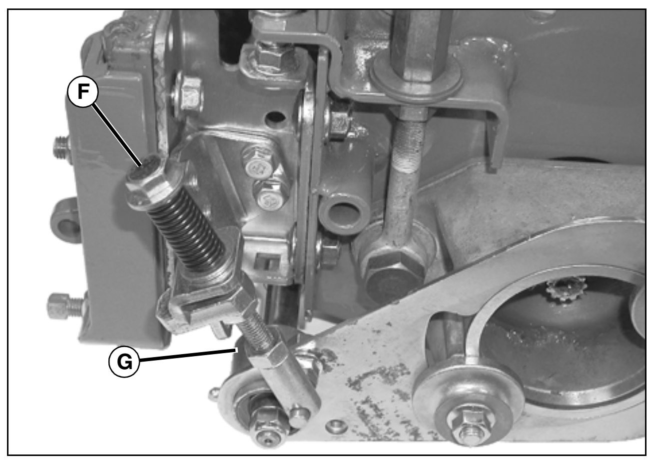
3. Press down on FTC adjuster bolts (A) and swing adjuster stops (B) toward the front of the cutting unit on both ends of the cutting unit (engaged position).

NOTE: Measure the usable blade length of the cutting blades. If the usable blade length is less than the desired cutting depth, replace the cutting blades before continuing.



M44324

4. Set FTC adjustment screw (C) on the gauge bar to desired height.
5. Loosen adjustment screw (E), if needed, to allow the gauge bar to rest against the rollers.
6. Place the depth gauge on cutting unit. Hook the underside of height-of-cut screw head (D) on bed knife. The ends should rest firmly on the front and rear rollers.



MX18310

Picture Note: Operating Position Shown

7. Loosen adjuster lock nut (G) on both ends of the cutting unit.
8. Turn adjuster bolt (F) to raise or lower FTC roller. Alternate from end to end until the teeth touch the screw on the gauge bar.
9. Tighten adjuster lock nuts.
10. Remove gauge bar.

Results

FTC cutting height should be set to desired level, consistently across cutting unit.

Adjust Cutting Shield - 2500M

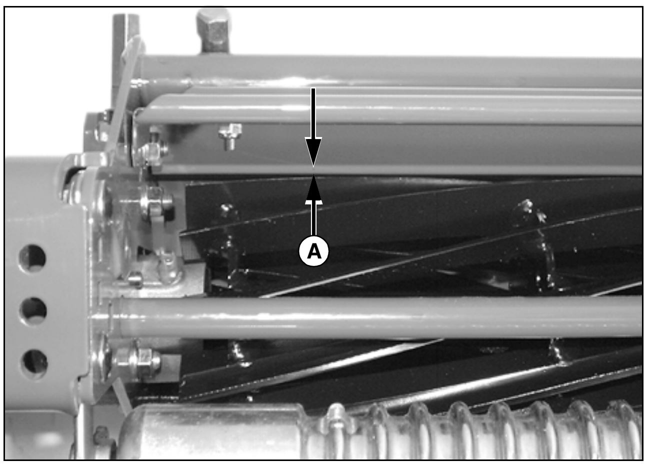
Reason

Correct adjustment of the cutting shield improves the performance of the grass catcher.

Procedure

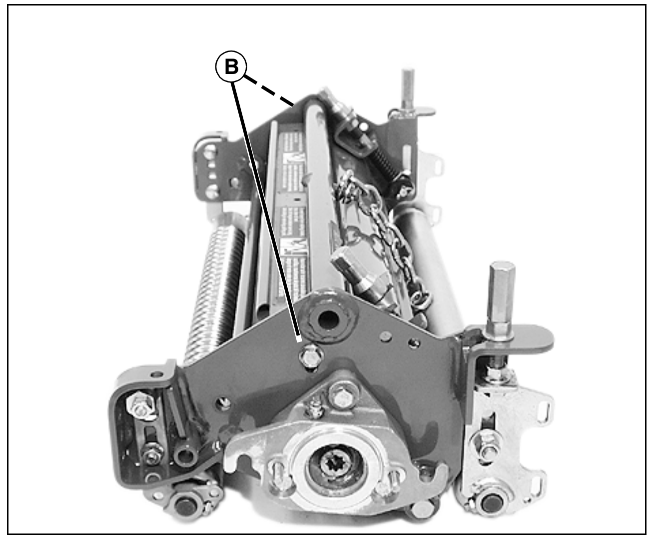
CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.
2. Place cutting unit on a stable working surface.



M84844

3. Check the clearance (A) between the bottom of the cutting shield and the cutting blades. Gap should be at specifications. If the clearance is not correct, adjust as follows.



M84848

4. Loosen cap screws and lock nuts (B) on both sides of cutting unit.
5. Raise or lower shield until correct clearance is obtained.
6. Tighten bolts and lock nuts.

Results

Proper clearance between shield and cutting blades will result in greater grass catching performance.

Specifications

Cutting Unit Shield Clearance - 2500M . 1 mm (0.04 in.)

Adjust Depth-of-Cut - Vertical Cutting Units (2500M)

Reason

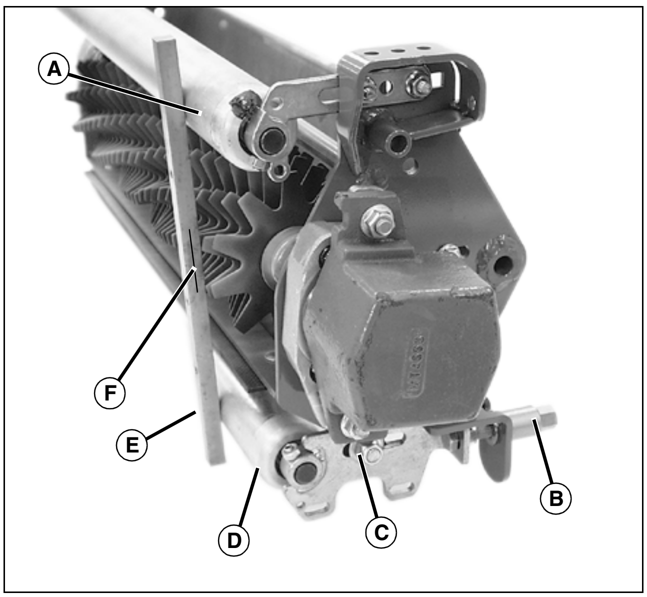
To set the desired cutting depth.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	NA	Used to set desired cutting height.

Procedure

1. Remove cutting units from mower.
2. Place cutting unit on a stable working surface with the front roller facing up.



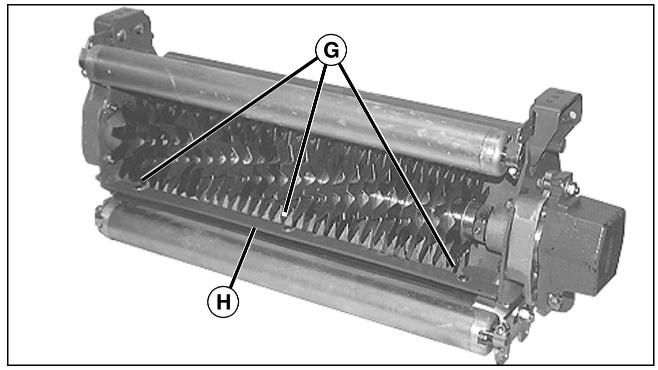
M98504

3. Mark the desired cutting depth (F) on the gauge bar (E).
4. Place gauge bar across the front and rear rollers (A and D) approximately 50 mm (2 in.) in from the end of the rollers.
5. Loosen the lock nut (C) on each side of the cutting unit.
6. Turn each tower adjuster (B) until the leading edge of the vertical cutting unit blade aligns with the cutting depth on the gauge bar.
7. Rotate the cutting reel back and forth to ensure the tips of the cutting blade do not extend past the mark on the gauge bar.
8. Repeat steps 4-7 on the other side of the cutting reel.
9. Tighten lock nuts.

NOTE: Adjustment of flap height will depend on turf conditions.

On short turf, lower flap to prevent material from flying out the rear of the cutting unit.

On turf with a lot of thatch, raise flap to allow the removed thatch to exit out the rear of the cutting unit.



M98561

10.Loosen three carriage bolts and hex nuts (G).

11.Adjust flap (H) from the bottom of the rollers to specifications.

12.Tighten hardware.

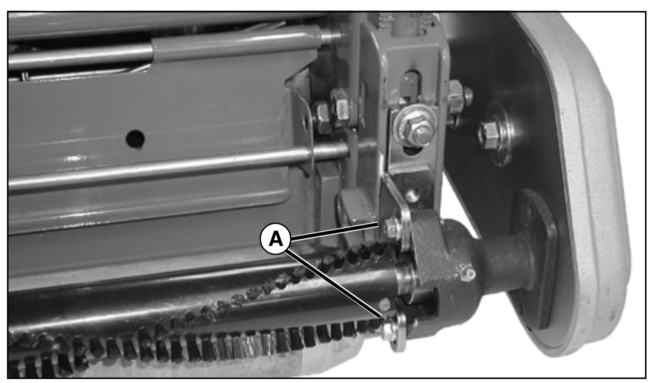
Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Specifications

Vertical Cutting Unit Flap Adjustment . . 13 mm (1/2 in.)

Adjust Power Brush



MX18343

Picture Note: Heavy Duty Shown

1. Loosen cap screws (A) on both sides of cutting unit.
2. Move brush up or down to achieve specification.
3. Tighten cap screws (A) on both sides of cutting unit.

Specification

Brush-to-Roller Clearance. . . . . . .   0-1 mm (0-0.031 in.)

Repair

Prepare Cutting Units for Service

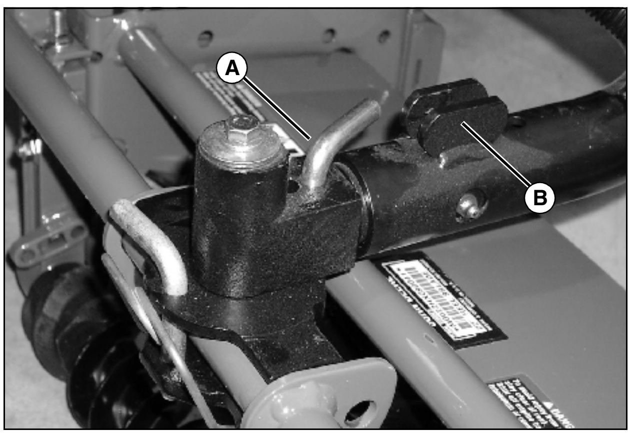
Rotate for Service™ (RFS)

CAUTION: Avoid injury! Always use the mower's hydraulic system to rotate the units. DO NOT attempt to rotate units manually. Keep others away from mower during RFS operation to prevent injury.

1. Set parking brake.

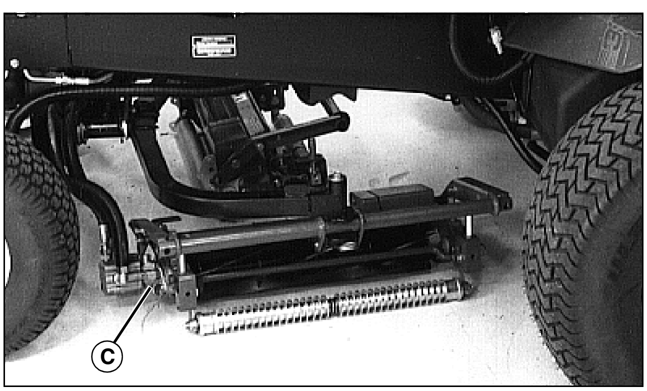
CAUTION: Avoid injury! Units must be on the ground when releasing the spring levers. DO NOT release spring levers with units raised, to prevent injury.

2. Lower units to the ground and stop engine.
3. Rear cutting units:



M57569

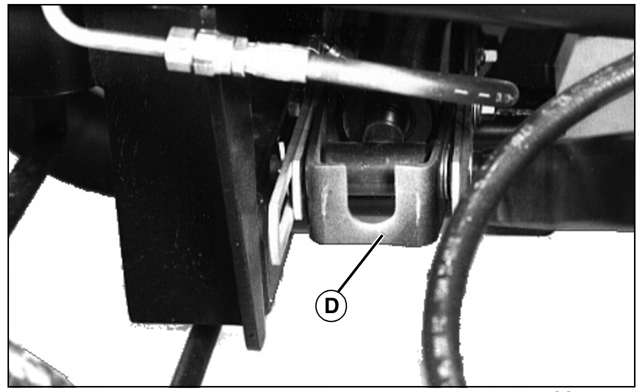
a. Pull out pin (A) and re-insert the pin with the short leg in the hole and the long leg in the channel (B).



M57558A

b. Turn the cutting unit (C) outward.

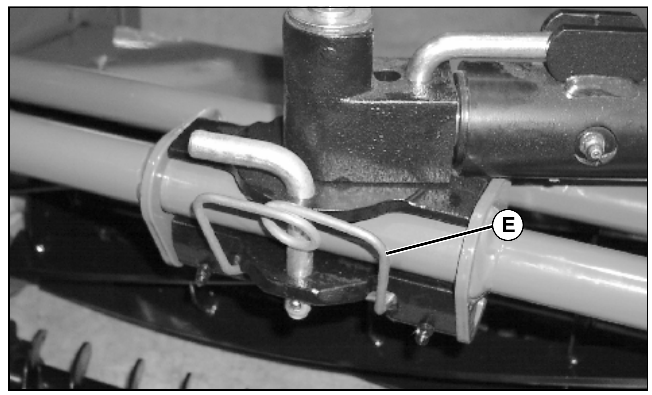
c. Repeat for second rear cutting unit.



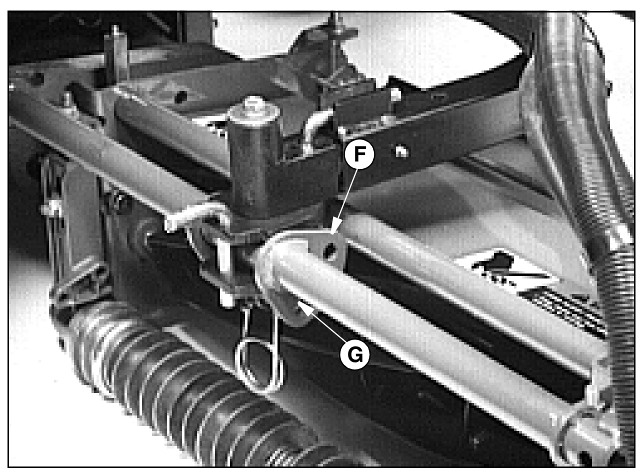
M57560

Picture Note: U-shaped rear lift arm stop shown rotated away from rear lift arm cylinder.

d. Rotate the U-shaped rear lift arm stop (D) away from the rear lift arm cylinder.



4. Push down spring (E) on each cutting unit until spring locks into lower detent.

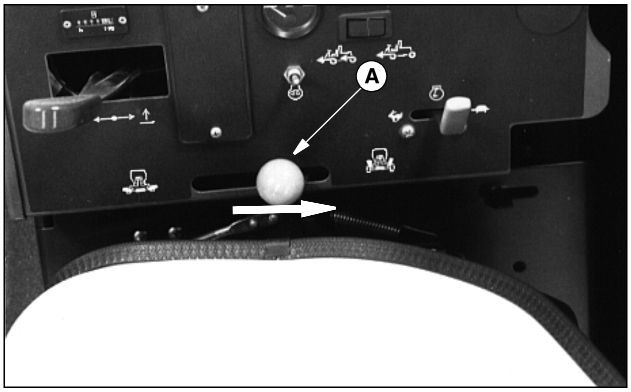


M57569

5. The unique spring design has two settings: The bottom hole (G) locks the cutting units in the normal operating position. The top hole (F) locks the cutting unit in rotate forward position to present the blades.

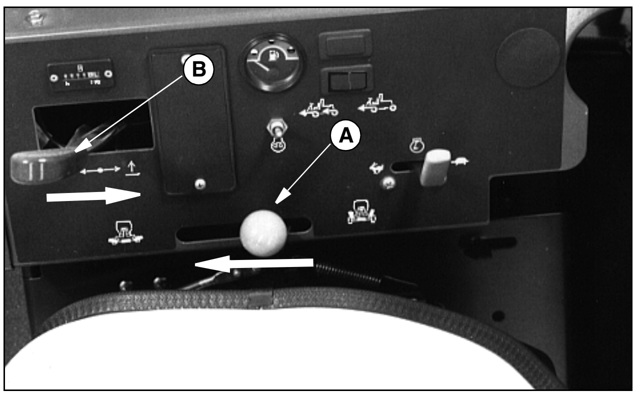
Prepare Cutting Units for Service

1. Prepare cutting units using the RFS™ system.



M57517

2. With the mow/transport lever (A) pulled back to TRANSPORT, start the engine while in the seat.

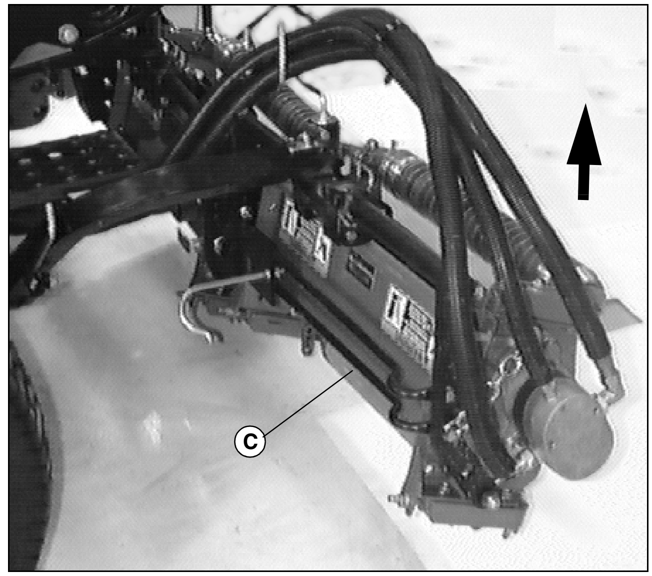


M57517

3. Move the mow/transport lever (A) forward into MOW and pull back the black lift lever (B) to raise the cutting units to the mow lift height.

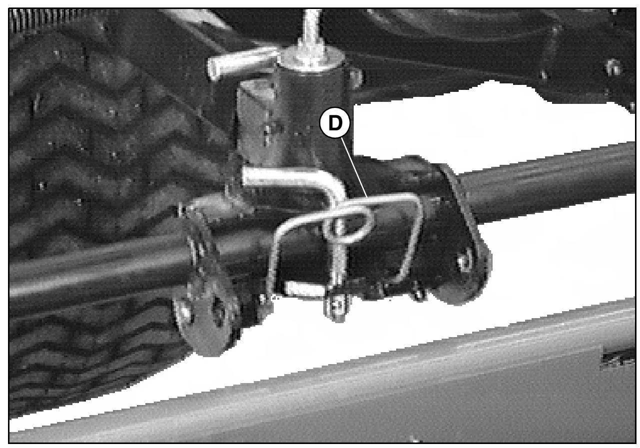
4. Move the mow/transport lever (A) back to the TRANSPORT position.

5. Set the park brake and shut off the engine.



M85472

6. The cutting units are pointing up (C) because the retaining pins are not in place.

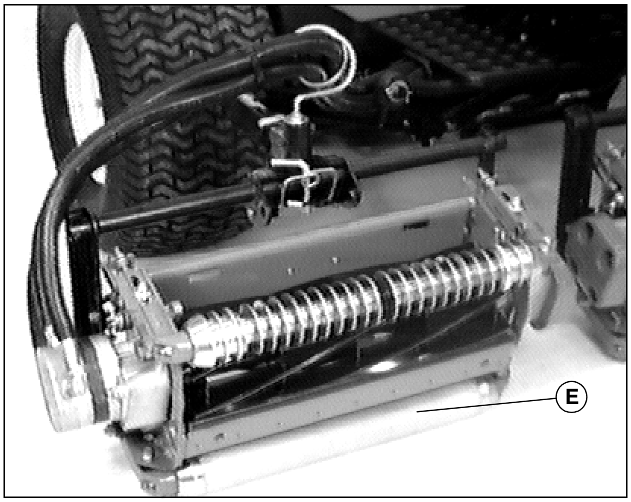


M85475

7. Pull the spring lever (D) back up to the normal position. Then, pull the cutting unit up by the front roller so the pins align with the service lock hole and lock the cutting unit in place.

NOTE: Lock the rear cutting units in place facing the side.

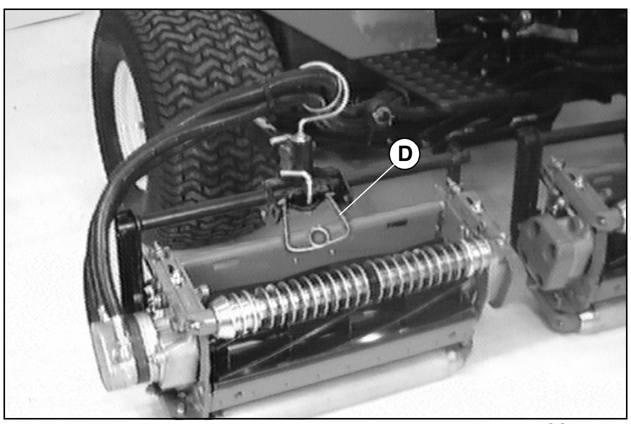
8. Restart the machine.



M85478

9. Lower the cutting units so the back roller (E) is on the floor. This stabilizes the cutting units and takes the load off the lock pins. The cutting units are now ready for servicing.

CAUTION: Avoid injury! Rear rollers must be on the ground when releasing spring levers. DO NOT release spring levers with the units lifted.

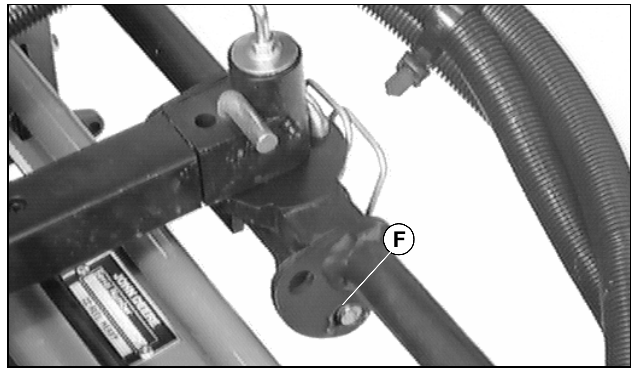


M85474

10.When finished servicing the cutting units, release the spring levers (D) on all five units.

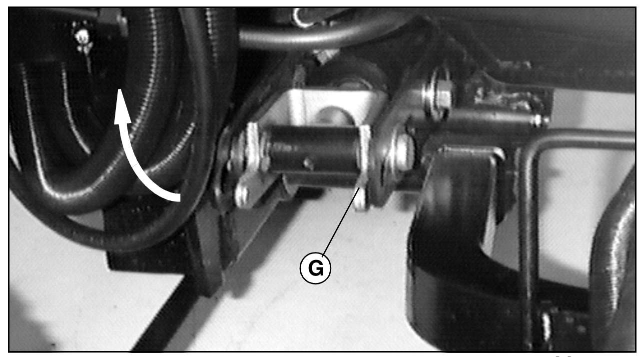
11.Start the machine and pull the lift lever back to raise the cutting units, causing them to hang in their normal free positions.

12.Push the lift lever forward to lower them back down.



M85471

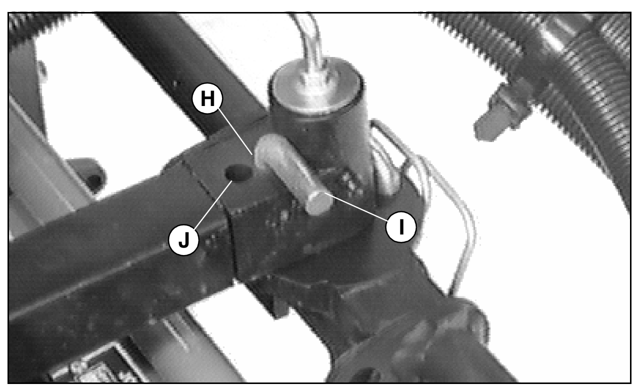
13.Shut off the engine and put the spring levers back up on each cutting unit. Jiggle them to make sure the pins lock in place (F).



M85468

14.Turn the rear cutting units to face forward again. Replace their retaining pins with the long leg in one of the holes. Place the U-shaped rear lift arm stop (G) back into place.

The RFS system allows a choice of fixed steer and normal steer cutting unit mowing options, as well as a transport position.



M85471

IMPORTANT: Avoid damage! DO NOT install pin in channel except for servicing the rear units.

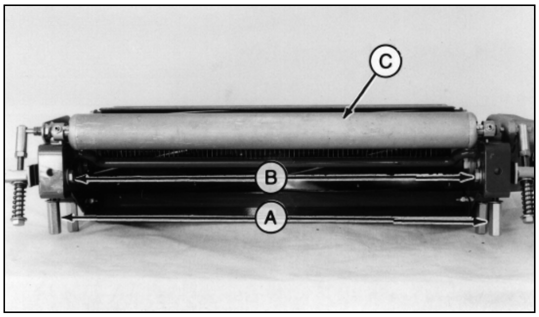
Fixed steer cutting unit position is where the longer leg of pin (I) is inserted into the front hole (H).

Normal steer is where pin (I) is inserted into rear hole (J).

Remove Front Roller - 22-In. Standard

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

1. Remove cutting unit from the tractor. If the cutting unit is not removed from the tractor, rest the cutting unit on wood blocks.

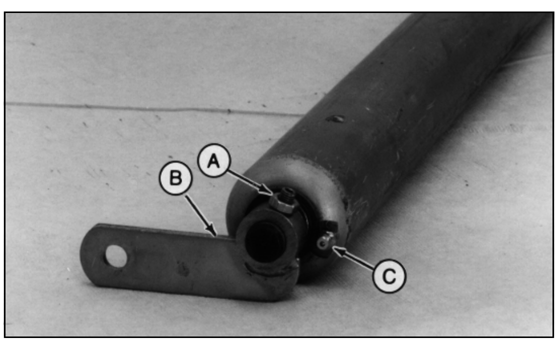


M46712

2. Loosen height-of-cut adjusting nuts (A).
3. Make note of washers and remove cap screws and washers (B).
4. Remove front roller with brackets (C).

Remove Roller Bracket - 22-In. Standard

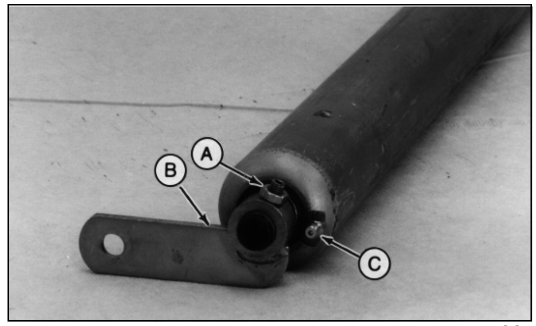
NOTE: Smooth and machine-grooved rollers have identical disassembly and assembly procedures.



M46713

1. Loosen jam nuts (A) and remove set screws.
2. Remove brackets (B) from bearing shafts. It may be necessary to press the bearing shaft from the bracket if corroded.
3. Remove grease fittings (C).

Install Roller Bracket - 22-In. Standard



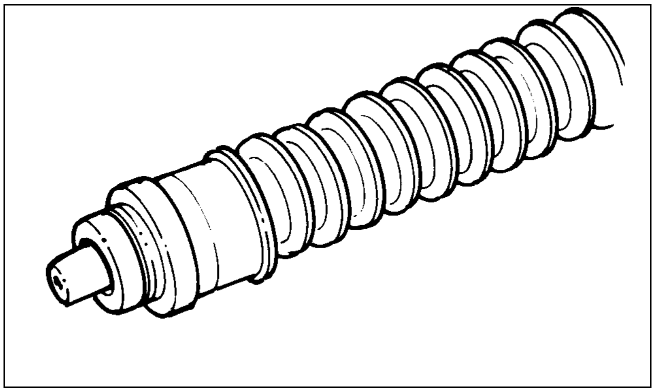
M46713

1. Install grease fittings (C).
2. Position brackets (B) on roller as shown. Install set screws and jam nuts (A). DO NOT tighten.

Disassemble Roller - 22-In. Standard

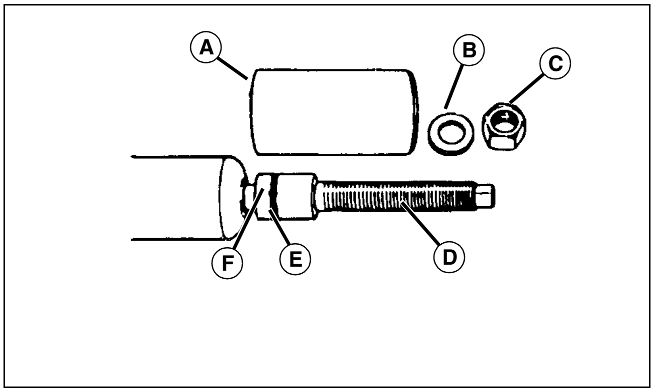
1. Secure roller in a vise. Remove grease fittings (smooth rollers only).

CAUTION: Avoid injury! Wear approved eye protection when using this tool.



M46904

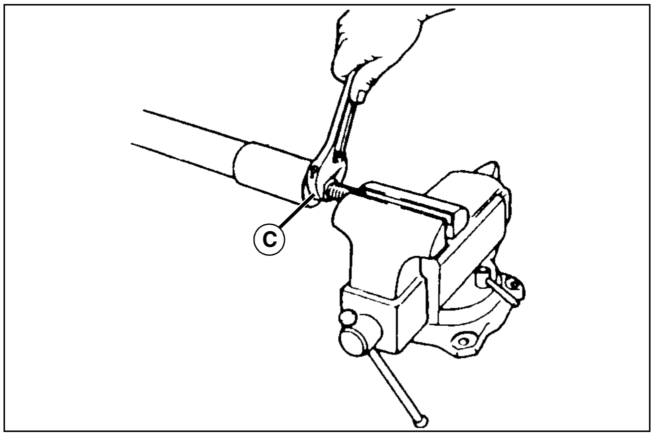
2. Use JDG795 Roller Bearing Puller to remove end bearings.



M76567

3. Attach the threaded puller (D) to the bearing in the roller by inserting the pin (F) through the hole in the bearing shaft and puller. Slide the O-ring (E) over the pin to keep the pin in position.

4. Slide the roller sleeve (A) over the threaded puller with the concave end of the roller sleeve against the end of the roller. Install the flat washer (B) and nut (C) on the threaded puller.



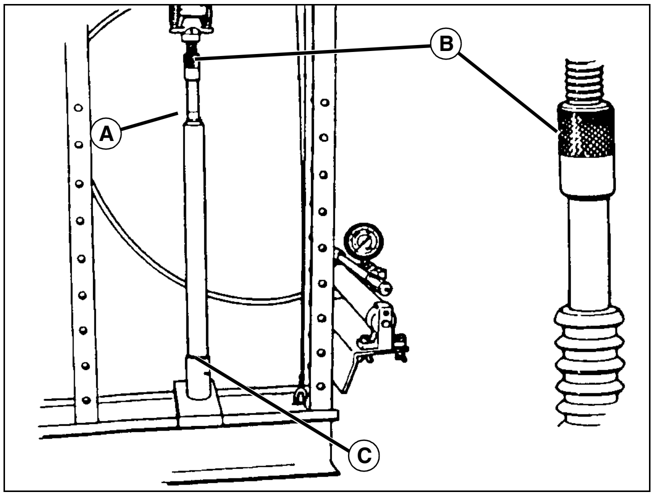
M76568

5. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn the nut (C) clockwise until the bearing is removed from the roller.

Assemble Roller - 22-In. Standard

IMPORTANT: Avoid damage! Press on the outside race of the bearing when installing the bearing in the roller. DO NOT press on the center shaft of the bearing because it will cause the bearing to set and become tight.

1. Clean roller end cap and bearing shaft with crocus cloth. Pack bearings with grease.

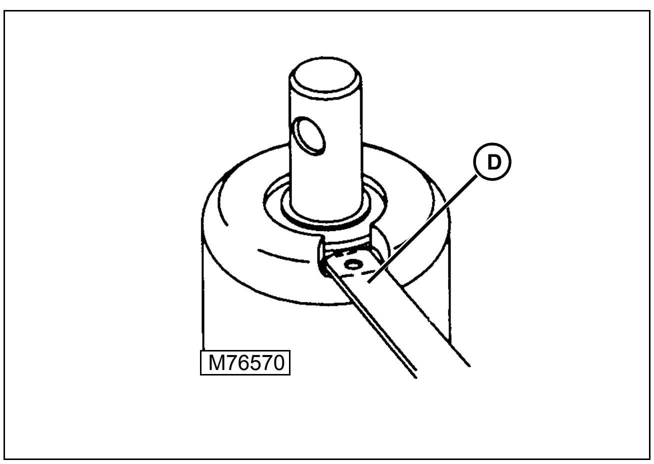


M76569

2. Position the roller in a press using the roller sleeve (C) to hold the roller while installing the new bearing (A) in the other end.

3. Position the bearing installer (JD243 or JDG506) (B) over the new bearing in the top end of the roller.

Smooth Roller



M76569

1. Place a 0.89 mm (0.035 in.) feeler gauge (D) in the slot where the grease fitting was located.

2. Press the bearing into the roller until the top of the outside bearing race is flush with the top of the feeler gauge.

Grooved Roller

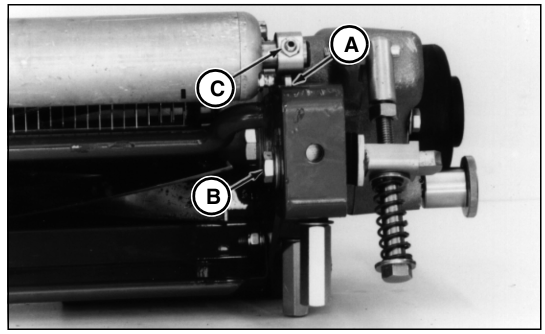
1. Press the bearing into the roller until the top of the outside bearing race is flush with the end of the roller.

2. Apply grease to lip of seal and install with seal lip facing the bearing.

3. Install opposite seal.

4. Install grease fittings and lubricate. (DO NOT over-lubricate; a small amount of grease is fine.)

Install Front Roller - 22-In. Standard



M46714

1. Insert bracket ends through frame slots (A).

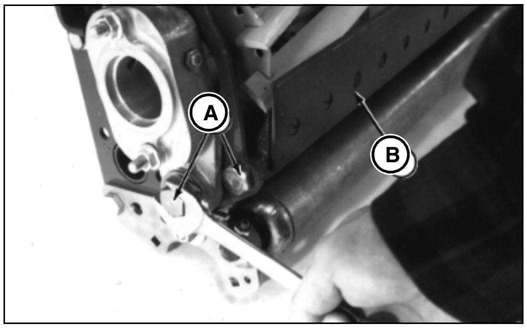
2. Apply NEVER-SEEZ® to the threads of the clamp bolts (B) and install.

3. Center the roller between the mounting brackets and tighten the set screws and jam nuts (C).

4. See “Adjust Height-of-Cut (HOC) - 22-In. Standard” on page 404.

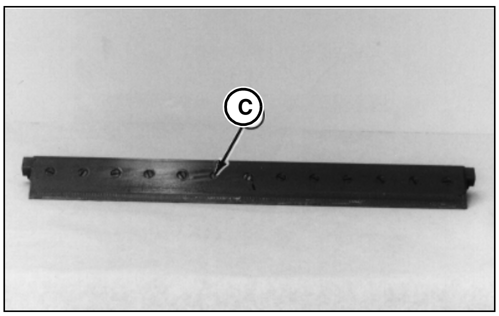
Remove Bed Knife/Support - 22-In. Standard

1. Loosen the lower reel adjuster nuts and turn the top adjuster nuts clockwise to obtain maximum clearance between the reel and the bed knife.



E33996

2. Remove four bed knife support mounting bolts (A) and remove the bed knife and support (B).



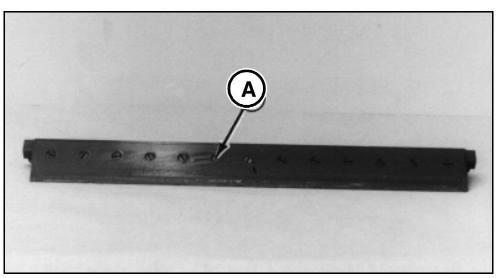
M46715

3. Using an impact driver, remove the bed knife mounting screws (C) and discard the mounting screws.

Install Bed Knife/Support - 22-In. Standard

1. Use a scraper and a wire brush to remove scale and rust from the bed knife mounting surface.

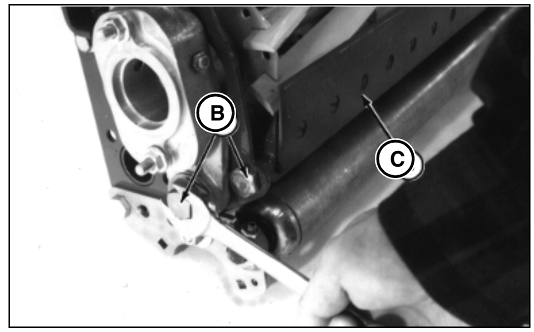
2. Check the bed knife mounting surface with a straightedge for distortion. Straighten or replace as necessary.



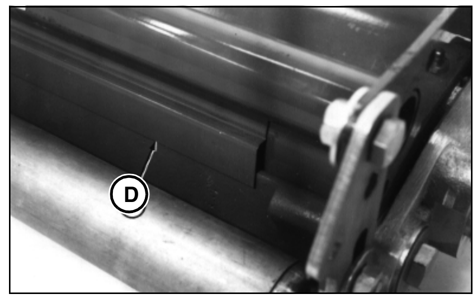
M46715

3. Position the bed knife on the bed knife support. Secure with new bed knife mounting screws (A) starting with the center screw and working toward the ends of the bed knife, alternating from side to side. Tighten screws to specifications.

4. Clean the bed knife support mounting bolt threads and clean the bolt shoulders with crocus cloth. Apply NEVER-SEEZ® to the threads and shoulders.



E33996



E33997

5. Position the bed knife support (C) in the frame and rear shield locator (D). Secure with four mounting bolts (B). Tighten the upper and lower mounting bolts to specifications.

6. See “Adjust Reel-to-Bed Knife - 22-In. Standard” on page 402.

Specifications

Bed Knife Mounting Screw Torque. . . . . 9 N•m (7 lb-ft).

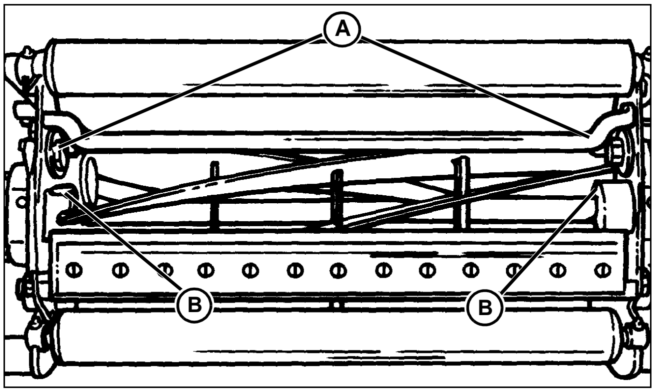
Upper Mounting Bolt Torque. . . . . 81 N•m (60 lb-ft)

Lower Mounting Bolt Torque. . . . . 47 N•m (35 lb-ft)

Remove Reel - 22-In. Standard

CAUTION: Avoid injury! Always wear protective gloves when handling reels. Serious personal injury can result from contact with the sharp cutting edges of the reel.

1. Remove FTC (if equipped). See "Remove Bed Knife/ Support - 22-In. Standard" on page 429 before continuing this procedure.



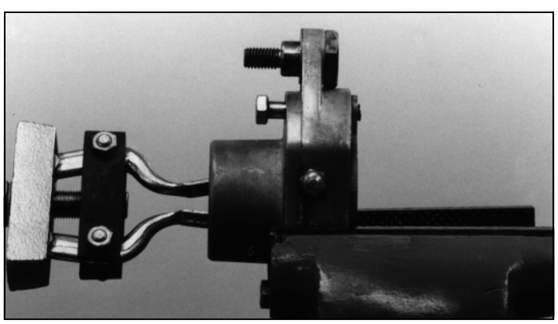
M46887

2. Remove remaining shouldered nuts and eight Belleville washers (A) securing left and right side pivot arm (B) to frame.

3. Remove pivot arms and carefully remove reel from frame.

Disassemble and Inspect Pivot Arm - 22-In. Standard

NOTE: Left and right positions are determined by standing at rear of unit and looking forward.



M46717

1. Remove seals, tapered roller bearings and washer (left side only) from pivot arms.

2. Clean bearings and pivot arms with solvent.

IMPORTANT: Avoid damage! Always replace bearings and bearing cups as a set.

3. Inspect bearings and bearing cups for scoring, pitting or bluing from overheating.

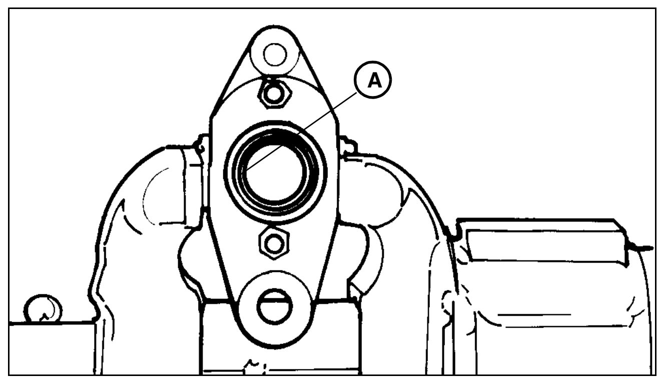
4. Inspect reel bearing surfaces and seal contact surfaces for corrosion. Use crocus cloth to smooth and polish the surface for better sealing.

5. Inspect splined shaft (motor side) of reel for wear.

NOTE: If the splines on one side of the reel shaft are worn, the splines on the opposite side can be utilized by simply transferring the cutting unit to the other side of the mower.

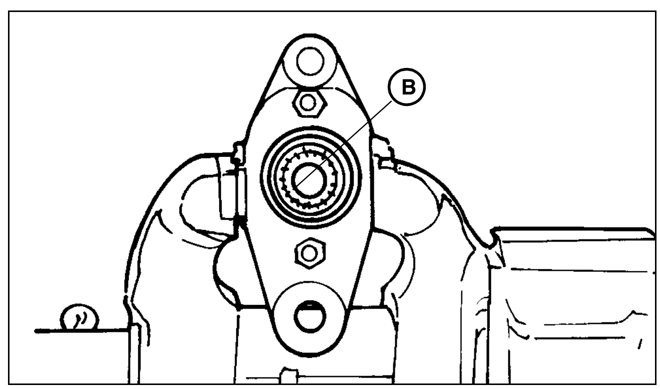
Assemble Pivot Arm - 22-In. Standard

NOTE: Left and right positions are determined by standing at rear of unit and looking forward.



M46899

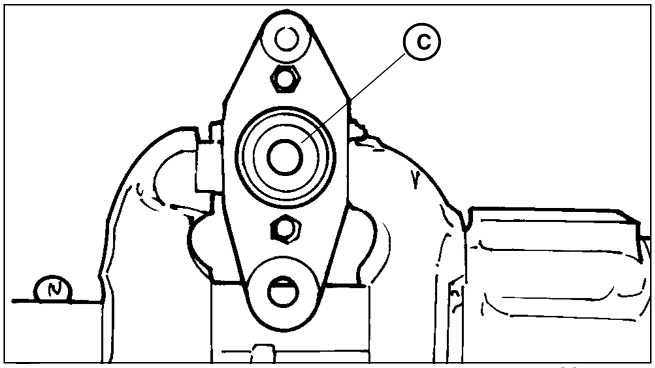
1. Install the bearing cups (A) using a suitable driver or a press (tapered end facing outside of case).



M46900

2. Pack bearings (B) with John Deere special purpose golf and turf cutting unit grease and position in bearing cups.

3. Install keyed washer (left side only).



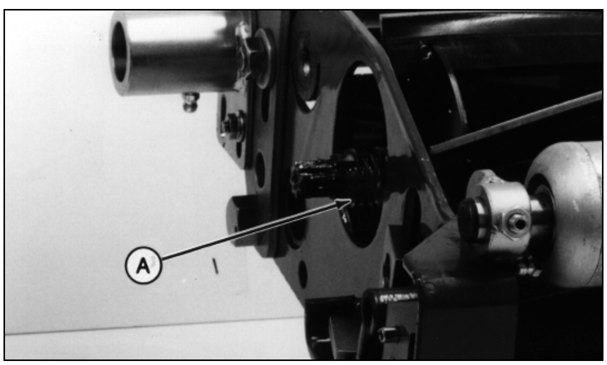
M46901

4. Install grease seals (C) flush with end of case. Apply grease to lip of seal.

Install Reel - 22-In. Standard

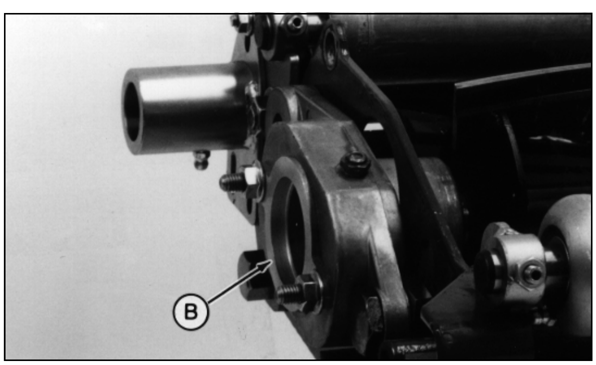
CAUTION: Avoid injury! Always wear protective gloves when handling reels. Serious personal injury can result from contact with the sharp cutting edges of the reel.

1. Position reel in frame assembly (reel shaft end with keyway must be used on the left side).



M46721

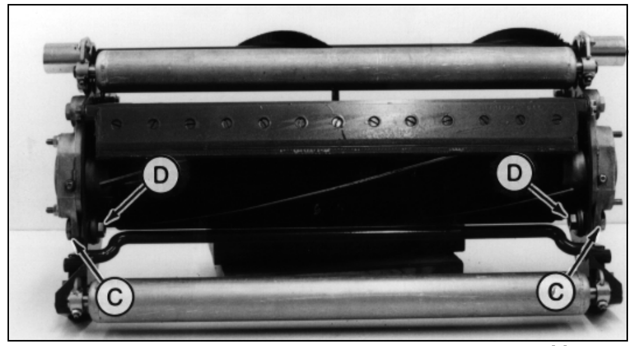
2. Install wave spring (A) on left end of shaft.



M46722

3. Slide left pivot arm (B) onto reel shaft. Ensure key washer engages slot on shaft.

4. Slide right pivot arm onto reel shaft.



M46723

5. Install shoulder bolts (C) through adjusters and secure with four spring washers (per side) and shoulder nuts (D). After bed knife is installed, tighten nuts (D) to specification.

6. See “Install Bed Knife/Support - 22-In. Standard” on page 429.

Specifications

Bed knife Nuts . . . . 47 N•m (35 lb-ft)

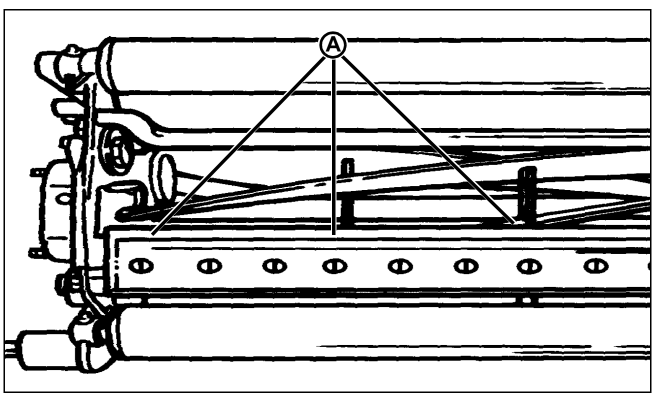
Inspect Reel and Bed Knife - 22-In. Standard

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

1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge for nicks, gouges or distortion. Ensure the cutting edge land does not exceed more than 3/4 of the blade thickness. See “Reel and Bed Knife Grinding” on page 397 to restore the relief angle and cutting edge before continuing with this procedure.

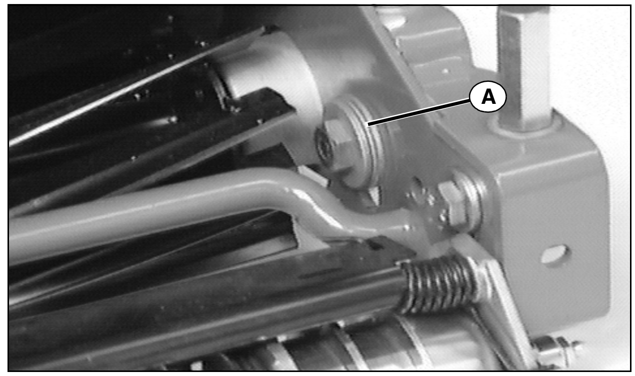


M46887

4. Inspect the bed knife cutting edge (A) for nicks, gouges or distortion. Inspect leading edge of bed knife for relief to prevent catching of knife. A small relief or dub needs to be added after several backlappings.

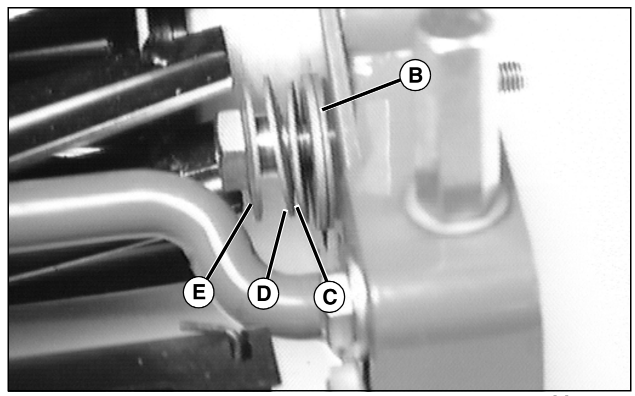
5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge starts curling upward.

Install Reel Adjustment Washers - 22-In. Standard



M85452

NOTE: It is NOT necessary to remove reel adjustment hardware (A) to adjust reel-to-bed knife clearance.



M85453

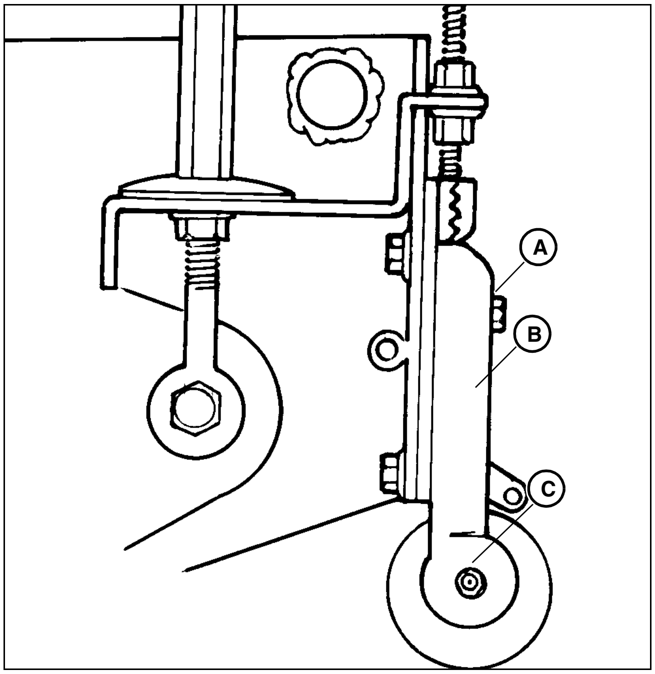
1. Install flat washer (B) onto bolt.

2. Install one spring washer (C) onto bolt with cupped side toward flat washer.

3. Install one spring washer (D) with cupped side out and install last spring washer (E) with cupped side in. The cupped sides of (D) and (E) should face each other.

4. Install adjuster nut and tighten. DO NOT overtighten.

Remove Front Roller - 22-In. Heavy Duty



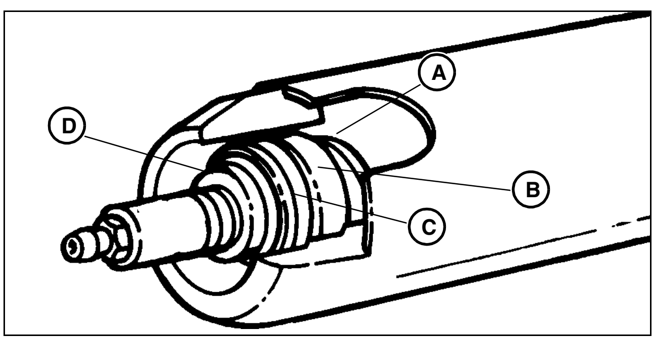
M46876

1. Remove the two cap screws (A) securing the roller adjustment brackets to the cutter frame. Remove roller with brackets from cutting unit.

2. Loosen lock nut and set screw (left side only). Slide the roller adjustment brackets (B) off the roller.

3. Remove grease fittings (C).

Disassemble and Inspect Roller - 22-In. Heavy Duty



M46888

1. Remove lock nuts from each end of the roller.

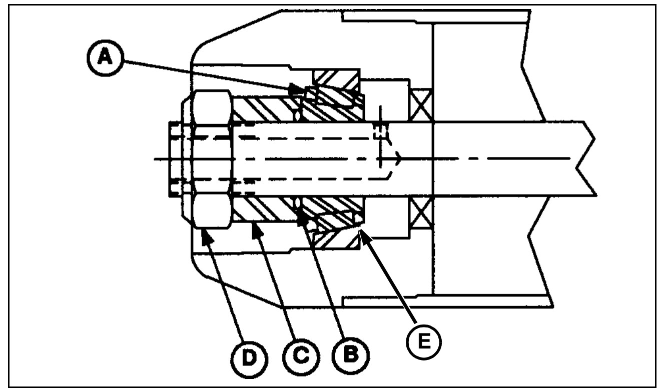
2. Press roller shaft out of roller.

3. Remove seals (C) (A, smooth roller only), spacer (D) and bearings (B). Clean bearings and end caps with a suitable solvent.

4. Inspect bearings and bearing cups for pitting, scoring and bluing from overheating. Replace bearings and bearing cups as necessary.

Assemble Roller - 22-In. Heavy Duty

1. Install bearing cup.



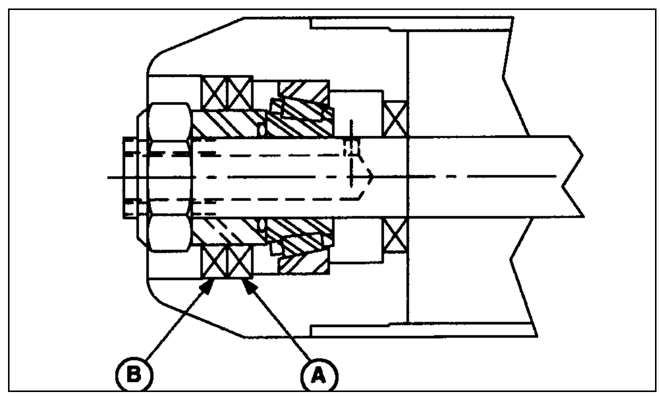
E35821

2. Pack bearing (A) with grease and install into bearing cup.

3. Apply grease to seal lip and install seal (E) with lip of seal facing out.

4. Lubricate O-ring (B) and install next to bearing.

5. Slide spacer (C) over shaft with O-ring groove facing bearing and install shaft.



E35823

6. Apply grease to lips of seals (A and B) and install with seal lips facing away from bearing.

7. Repeat steps 1 through 5 on opposite end.

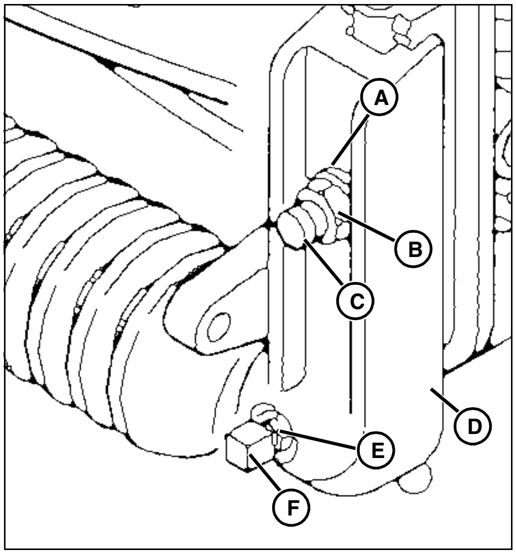
8. Install self-locking nut (D) on each end and tighten until snug. Back off slightly and retighten to specifications.

9. Install grease fittings and lubricate.

Specifications

Self-Locking Nut Torque . . . . 0.34-0.79 N•m (3-7 lb-in.)

Install Roller - 22-In. Heavy Duty



M56473

1. Slide adjustment brackets (D) onto roller shaft (bracket with set screw on left side).

2. Secure each bracket to frame with cap screw (C), nut (B) and washer (A).

3. Center the roller between the brackets and tighten set screw (F). Tighten jam nut (E).

4. See “Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty” on page 408.

Remove Bed Knife/Support - 22-In. Heavy Duty

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

1. Raise reel away from bed knife approx. 10 mm (3/8 in.).

2. Remove six cap screws (3 each side) securing bed knife support to cutter frame.

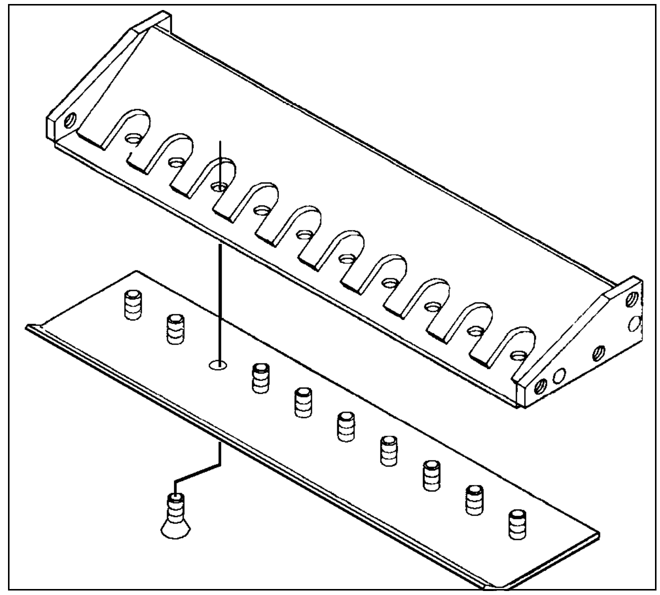
3. Carefully remove bed knife support from cutter frame.

4. Remove ten hex head cap screws and nuts securing bed knife to support.

5. Remove dirt and corrosion from bed knife mounting surface.

6. Inspect support for straightness. Repair or replace if necessary.

Install Bed Knife/Support - 22-In. Heavy Duty



M63222

1. Position the bed knife on the bed knife support and secure with new mounting hardware (install the outer screws first to position the bed knife). Starting with the center hex screw and working your way toward the ends of the bed knife, alternating from side to side, torque the bolts in two steps to specifications.

2. Grind bed knife after securing it to the support and before installing in cutting unit frame.

3. Clean the bed knife support mounting bolt threads. and clean the bolt shoulders with crocus cloth. Apply NEVER-SEEZ® to the threads and shoulders.

4. Position the bed knife and bed knife support in the cutting unit frame and secure with six mounting bolts. Tighten bolts to specifications.

5. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 406.

6. See “Backlapping Procedure - 22-In. Heavy Duty” on page 407.

7. See “Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty” on page 408.

Specifications

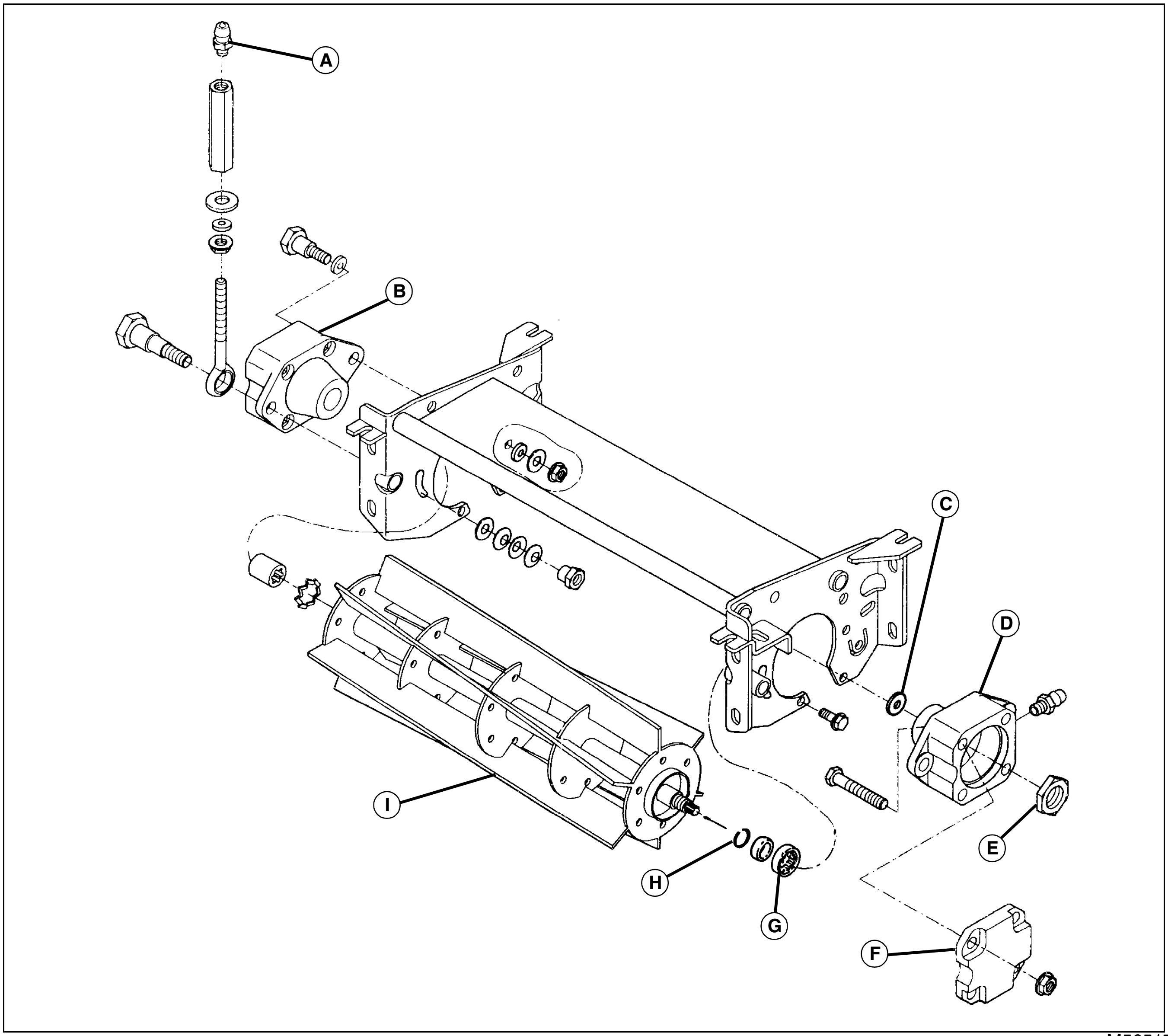
Hex Screw Torque (Dry). . . . . . . 35-45 N•m (26-34 lb-ft)

Hex Screw Torque (Lubricated) 24-36 N•m (18-27 lb-ft)

Bed Knife/ Support Mounting Bolt Torque. . 63 N•m (46 lb-ft)

Remove Reel - 22-In. Heavy Duty

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



M56517

1. See “Remove Bed Knife/Support - 22-In. Heavy Duty” on page 434 prior to performing this procedure.

2. Loosen reel-to-bed knife adjustment nut (A) on each side of reel.

3. Remove end cover (F).

4. Remove one retaining nut (E), washer (C) and tapered roller bearing (G) from each end of the reel.

5. Remove one snap ring (H) from the right end of the reel.

6. Remove nuts, washers and shoulder bolts securing the pivot arms (B and D) to the cutter frame.

7. Remove the pivot arms. Remove reel (I).

Disassemble and Inspect Pivot Arm - 22-In. Heavy Duty

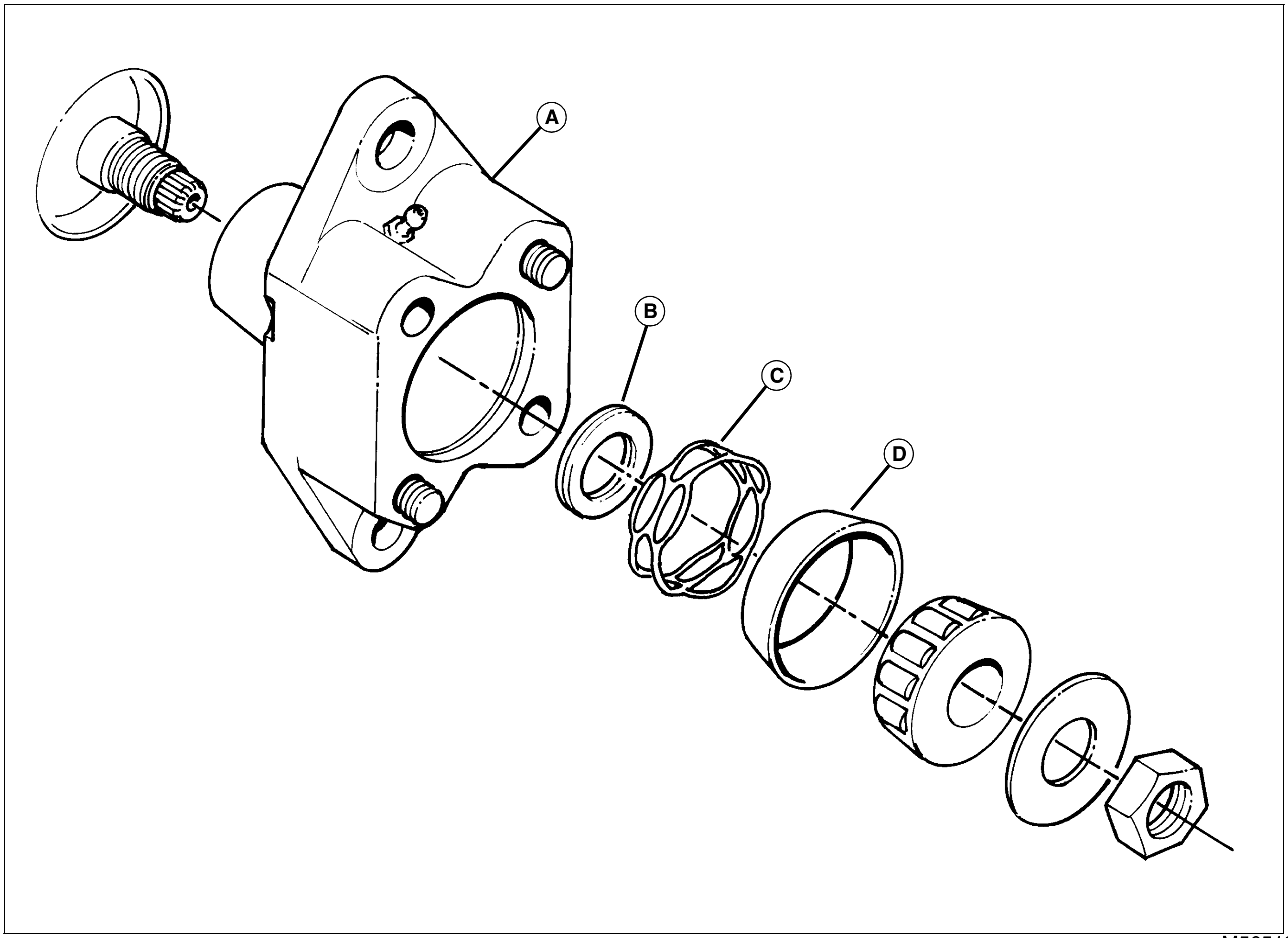
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove bearing cup, wave spring and seal from the right side.
2. Clean parts in a suitable solvent.

IMPORTANT: Avoid damage! Always replace bearing cone and bearing cup as a set.

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

Assemble Pivot Arm - 22-In. Heavy Duty



M56518

1. Install seal (B) flush with pivot arm housing.

NOTE: Left side housing uses an internal snap ring instead of a wave spring.

2. Install wave spring (C) on right side only.
3. Install bearing cup (D).

Install Reel - 22-In. Heavy Duty

1. Position reel in frame. Apply grease to lip of seal and slide pivot arm over reel shaft.

2. Install shoulder bolts through adjustment link, pivot arm and cutter frame. Install spring washers and shoulder nuts. DO NOT tighten. Repeat on opposite side.

3. Position shoulder bolt through pivot arm and cutter frame. Secure with washer and nut. DO NOT tighten. Repeat on opposite side.

4. Pack bearings with grease and slide over shaft and into bearing cup (one each side). Install washers and nuts. DO NOT tighten.

5. After bed knife is installed, tighten reel attachment nuts to specifications.

6. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 406.

Specifications

Reel Attachment Nut Torque. . . . 68 N•m (50 lb-ft) min.

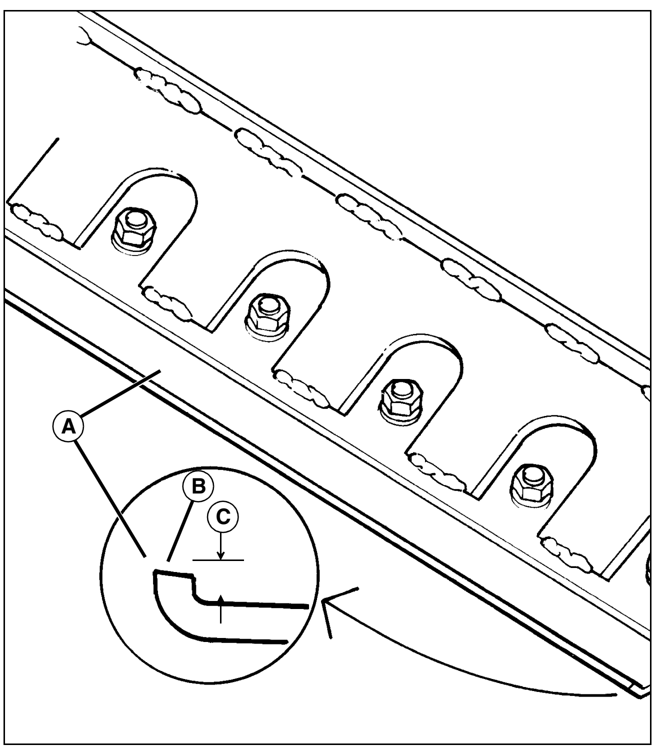
Inspect Reel and Bed Knife - 22-In. Heavy Duty

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

1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge for nicks, gouges or distortion. Ensure the cutting edge land does not exceed more than 3/4 of the blade thickness. See “Reel and Bed Knife Grinding” on page 397 to restore the relief angle and cutting edge before continuing with this procedure.



M56519

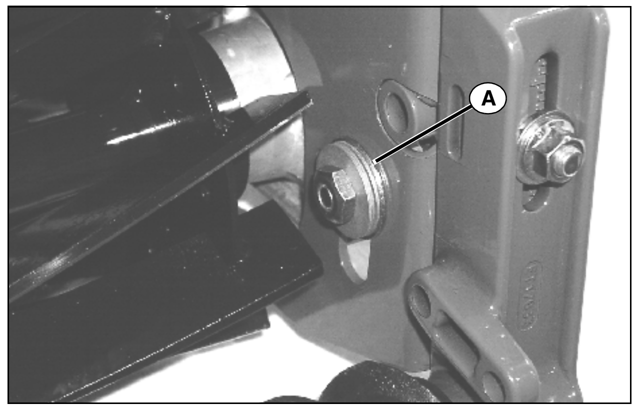
4. Inspect the bed knife cutting edge (A) for nicks, gouges or distortion.

5. Inspect the bed knife for uneven wear (indicated by uneven land (B) width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge-to-mounting surface distance (C) is less than specification.

Specifications

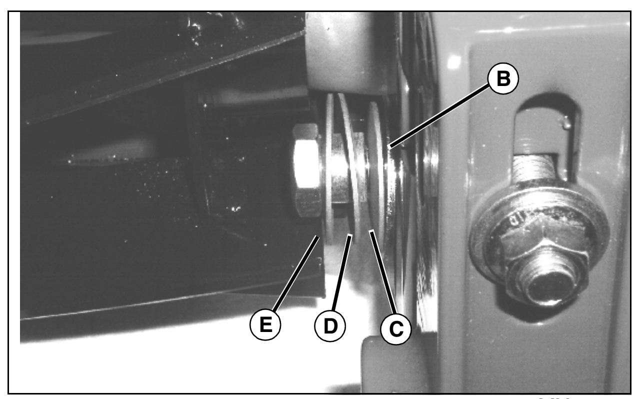
Bed knife Cutting Edge-to-Mounting Surface Distance . 1.45 mm (0.057 in.)

Install Reel Adjustment Washers - 22-In. Heavy Duty



MX18019

NOTE: It is NOT necessary to remove reel adjustment hardware (A) to adjust reel-to-bed knife clearance.



MX18018

1. Install flat washer (B) onto bolt.

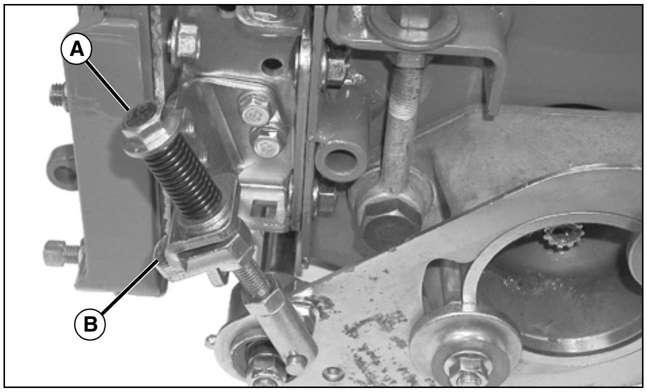
2. Install one spring washer (C) onto bolt with cupped side toward flat washer.

3. Install one spring washer (D) with cupped side out and install last spring washer (E) with cupped side in. The cupped sides of (D) and (E) should face each other.

4. Install adjuster nut and tighten. DO NOT overtighten.

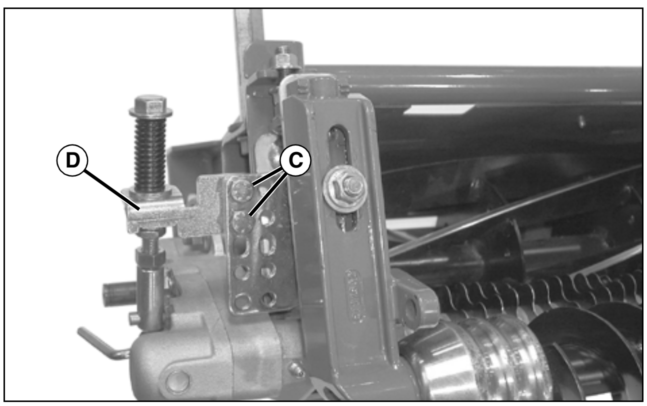
Remove Fairway Tender Conditioner - 22-In. Heavy Duty

1. Remove brush if equipped. (See “Remove Power Brush - 22-In. Heavy Duty” on page 444.)



MX18310

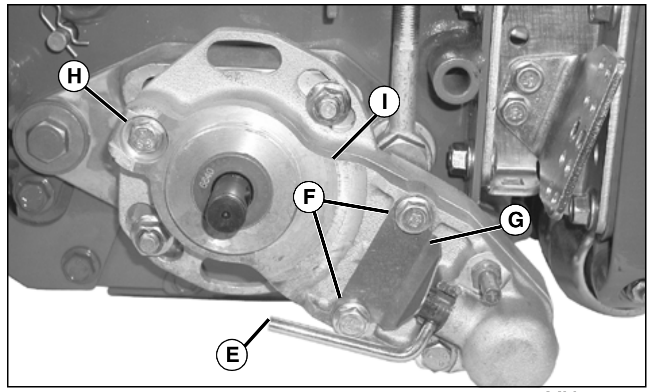
2. Press down on FTC adjuster bolt (A) and swing adjuster stop (B) toward the rear of the cutting unit (disengaged position). Repeat on other end of cutting unit.



MX18320

3. Remove cap screws (C) from both sides of cutting unit.

4. Remove adjuster bracket assembly (D) from both sides of cutting unit.



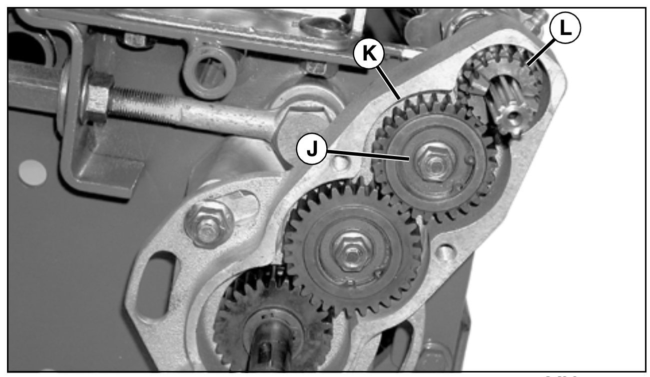
MX18323

5. Turn lever (E) to OFF position.

6. Remove two M8 hex flange bolts (F) and engagement spring (G).

7. Remove one M8 hex bolt (H).

8. Remove FTC gearcase cover (I).

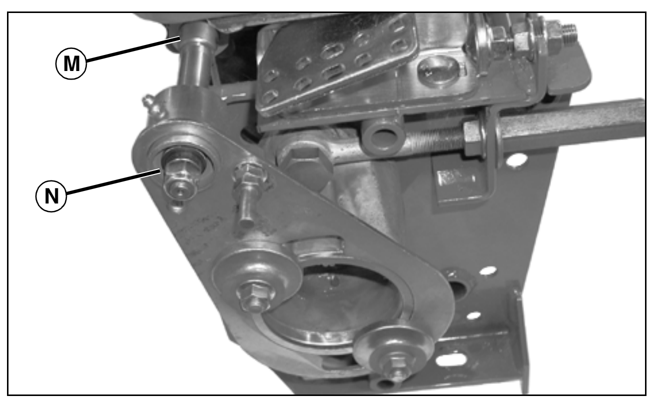


MX18325

9. Remove nut and shoulder bolt (J).

10. Remove idler gear (K) from gear case housing.

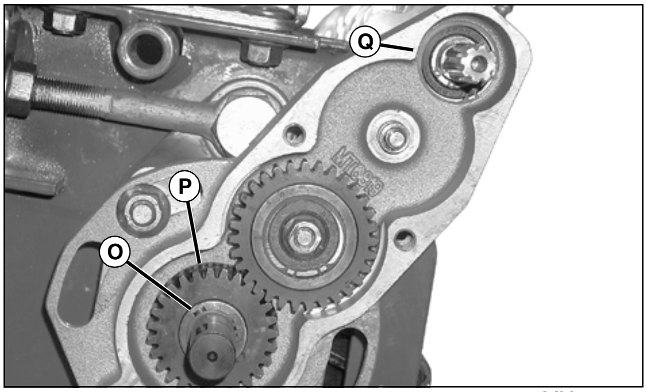
11. Remove gear assembly (L) from splined shaft.



MX18326

12. Hold shaft, using wrench on flats (M).

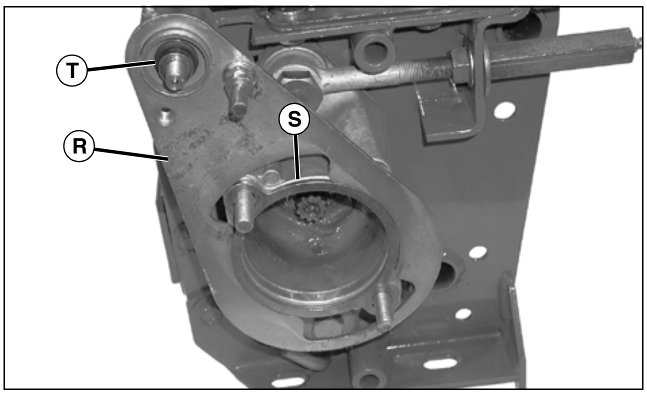
13. Remove nut (N) from conditioner shaft.



MX18328

14.Remove snap ring (O) and gear (P).

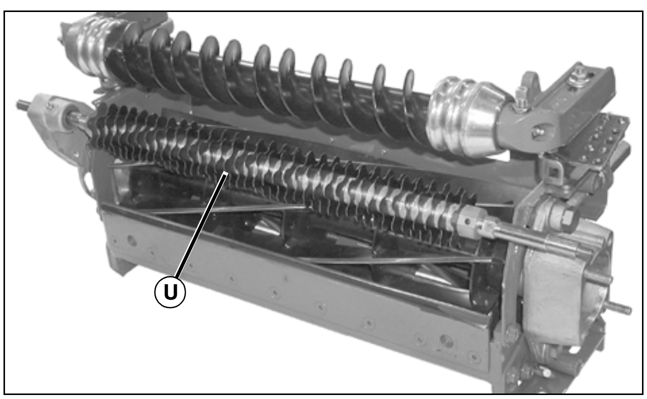
15.Remove snap ring (Q) from conditioner shaft.



MX18327

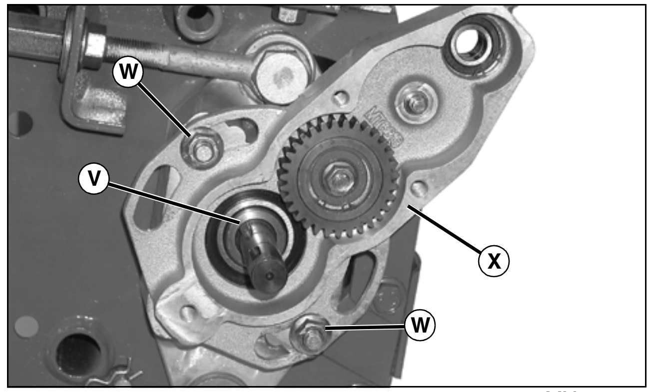
16.Remove bracket (R) and ring (S).

17.Remove spacer (T).



MX18335

18.Remove roll conditioner assembly (U).



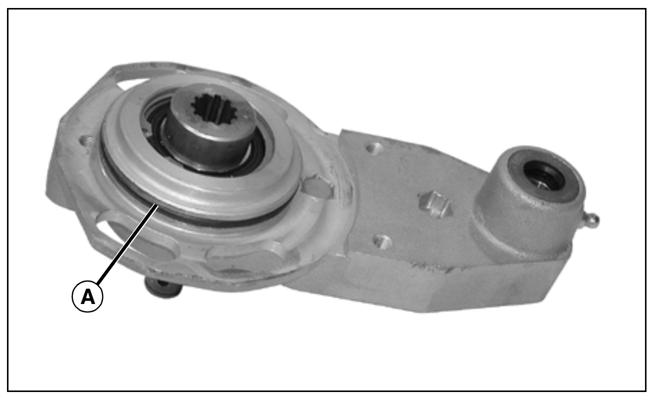
MX18329

19.Remove key (V) from shaft.

20.Remove flange nuts (W) and gear housing (X).

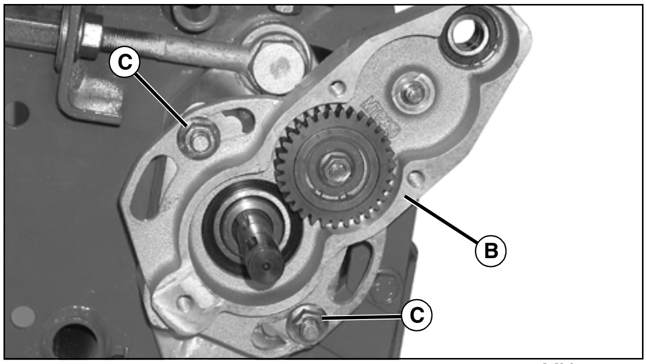
Install Fairway Tender Conditioner - 22-In. Heavy Duty

NOTE: The following procedure shows FTC unit mounted on right-hand side of cutting unit. The procedure for units mounted on the left side is the same.



MX18340

1. Lightly grease and install O-ring (A) on the back of the gearcase.

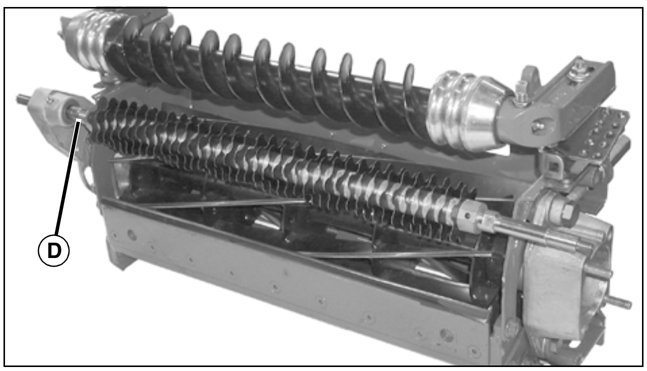


MX18329

2. Install gearcase (B) onto the reel bearing housing.

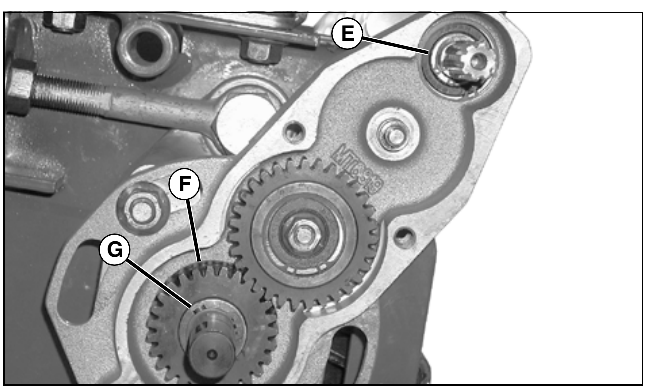
3. Install lock nuts (C). Do not overtighten nuts; be sure gearcase will pivot freely.

NOTE: There are two bearings and one washer at the front of each housing. If the washer is not centered in the housing, the shaft will not fit through both bearings. To hold washers in position, lubricate each housing grease fitting with a shot of JD Special Purpose HD water resistant grease, then center the washer.



MX18335

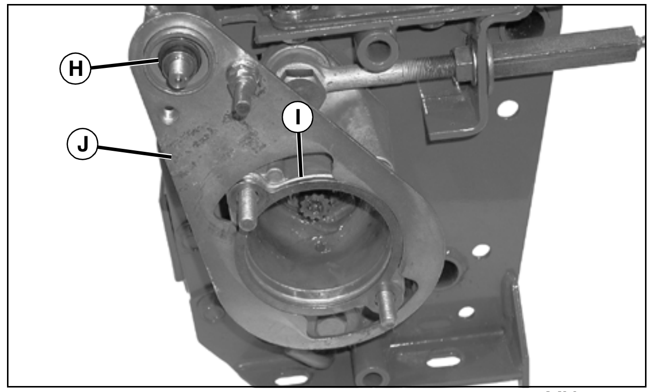
4. Slide the splined end of the roll conditioner shaft (D) into the bearing of the gearcase assembly.



MX18328

5. Install snap ring (E) to secure shaft.

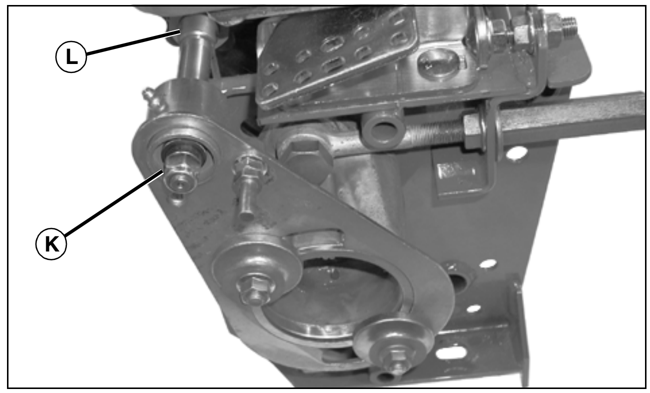
6. Install drive gear (F) with higher raised pad toward bearing and snap ring (G).



MX18327

7. Install spacer (H).

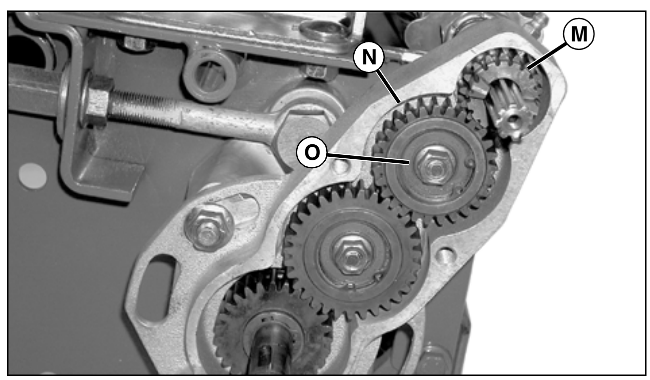
8. Install ring (I) and side bracket (J).



MX18326

9. Install M10 lock nut (K) onto threaded shaft. Hold shaft using a wrench on flats (L).

10.Tighten lock nut (K) so the conditioner shaft has no play in the reel bearing housing. The shoulder of the shaft should be tight against the bearings.

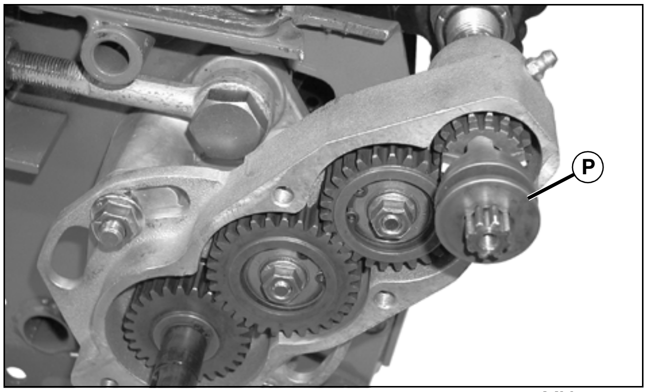


MX18325

11.Install gear assembly (M) onto splined shaft.

12.Install shoulder bolt with O-ring into gearcase.

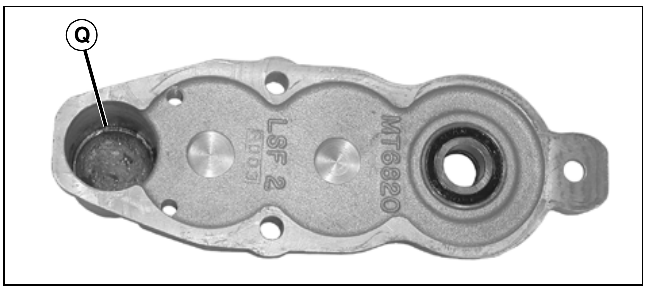
13.Install idler gear (N) and secure with M8 lock nut (O).



MX18341

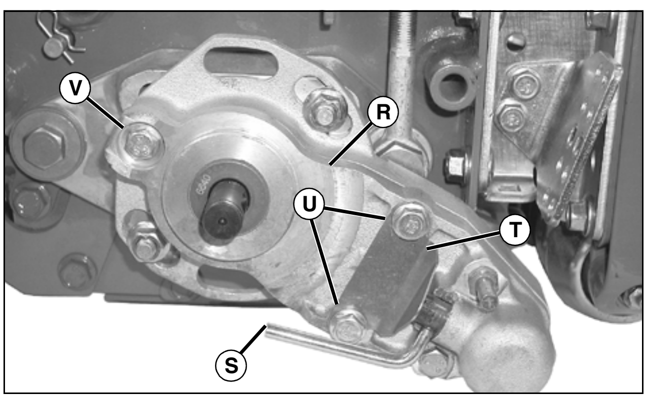
14.Install the engagement shift collar (P).

15.Grease the drive shaft end and fill openings around gears with cornhead grease.



MX18342

16.Apply cornhead grease into cover area between the seal and bearing, and into the engagement hole. Apply cornhead grease into the cast boss (Q) on the cover.



MX18323

17.Install gasket and gearcase cover (R).

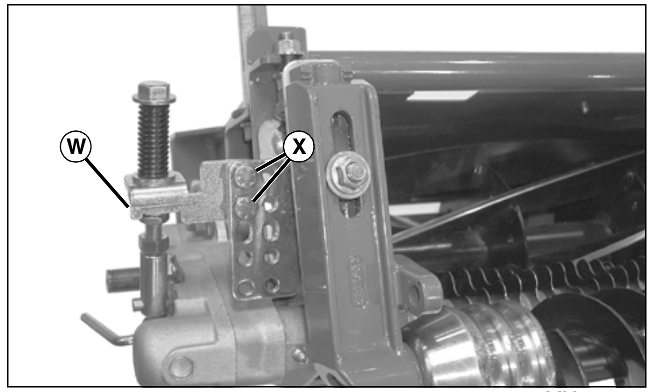
NOTE: Coat O-ring with grease to assist in installation.

18.Install engagement handle (S) with O-ring into gearcase cover. Eccentric on handle must fit into groove in shift collar.

19.Install engagement spring (T) using two M8 x 35 cap screws (U).

20.Install one M8 x 25 cap screw (V).

21.Be sure engagement handle turns freely.



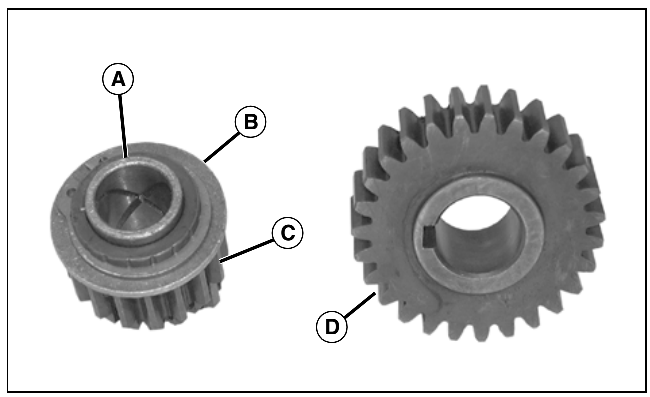
MX18320

22.Install adjuster bracket assembly (W) and cap screws and nuts (X) to both sides of cutting unit.

23.Install brush if equipped. (See “Install Power Brush - 22-In. Heavy Duty” on page 446.)

Disassemble and Inspect FTC - 22-In. Heavy Duty

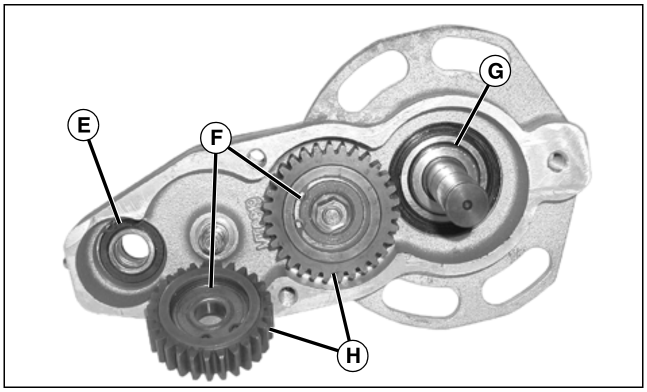
FTC Housing



MX18337

1. Inspect bushing (A) and washer (B) for signs of wear or damage. Replace as needed.

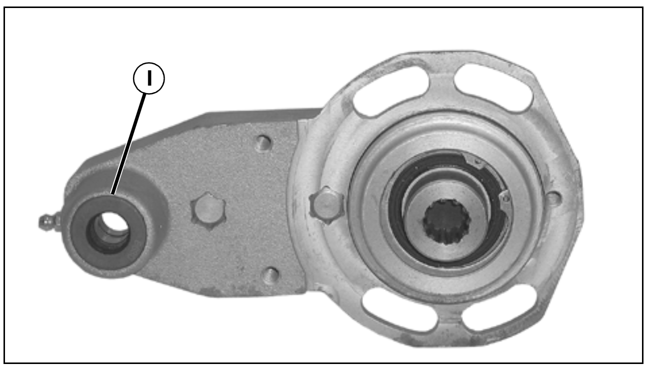
2. Inspect reel gear (C) and drive gear (D) for signs of wear or damage. Replace as needed.



MX18331

3. Inspect reel shaft bearing (E), idler gear bearings (F), and driveshaft bearing (G) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

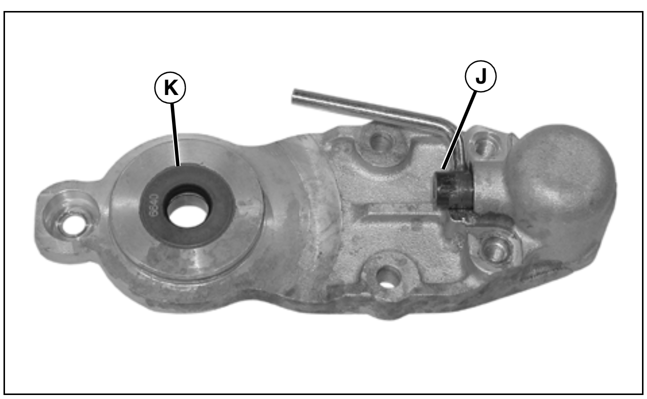
4. Inspect gears (H) for signs of wear or damage. Replace as needed.



MX18330

5. Inspect reel shaft seal (I) for signs of wear or damage. Replace as needed.

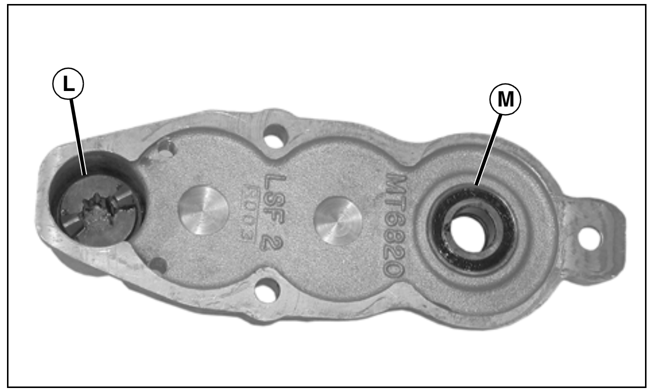
NOTE: Removing engagement pawl will cause engagement cog to fall out of housing.



MX18338

6. Remove engagement pawl by pulling shaft (J) straight out of housing.

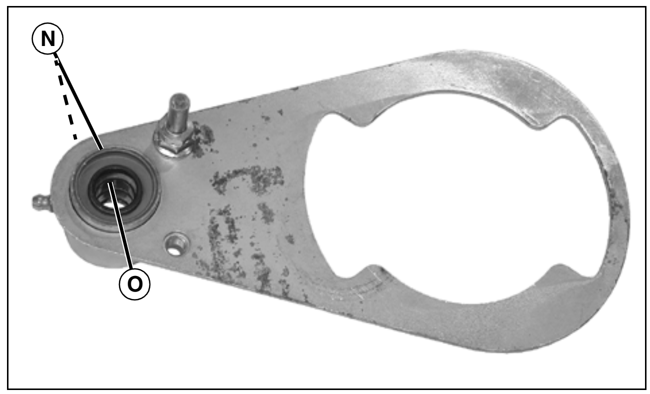
7. Inspect seal (K) for wear or damage. Replace as needed.



MX18339

8. Remove engagement cog (L) from housing. Inspect cog for wear or damage. Replace as needed.

9. Inspect bearing (M) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

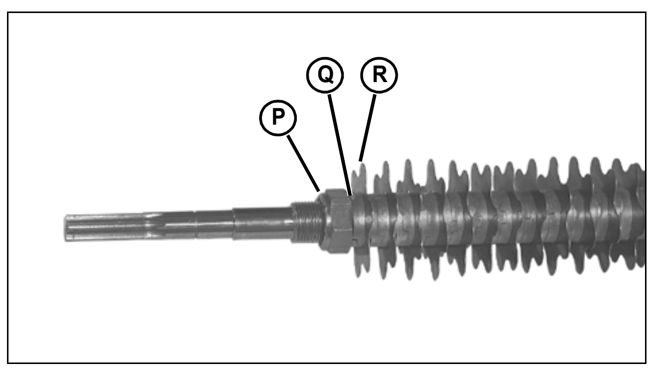


MX18334

10.Inspect seals (N) on both sides of bearing for wear or damage. Replace as needed.

11.Inspect bearing (O) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

FTC Shaft Assembly

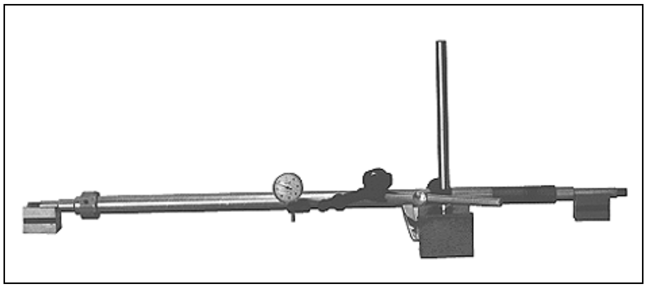


MX18332

1. Remove lock nut (P).

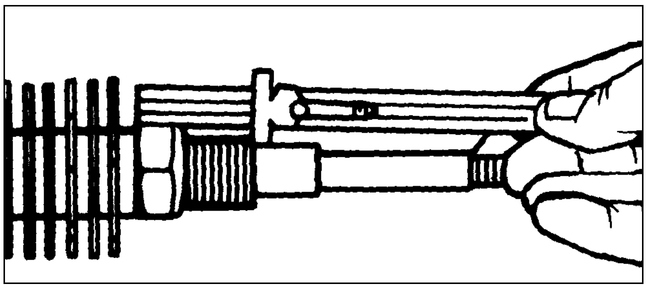
2. Remove index rings (Q) and blades (R).

3. Inspect blades for excessive wear and broken, cracked, or distorted cutting teeth. Replace parts as needed.



M46725

4. Remove debris and/or corrosion from shaft and place on V-blocks. Check runout at center of the shaft. Runout should not exceed 1.4 mm (0.0625 in.). Straighten or replace shaft as necessary.



M46886

5. Install index rings and blades on shaft, rotating occasionally to align blades and index rings. Install all spacers and blades until approximately 38 mm (1.50 in.) of exposed shaft is left.

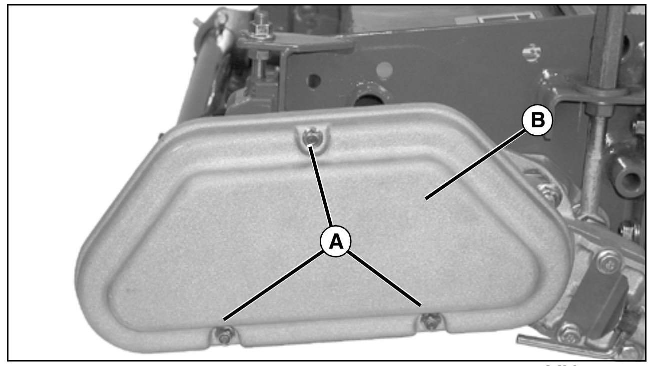
6. Stand shaft on end and shake it slightly to ensure blades and index rings are aligned.

7. Install locking nut and tighten to specification.

Specifications

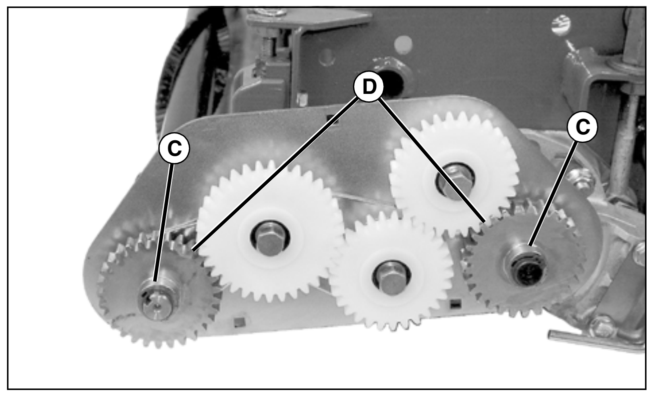
Locking Nut Torque . . . . 47 N•m (35 lb-ft)

Remove Power Brush - 22-In. Heavy Duty



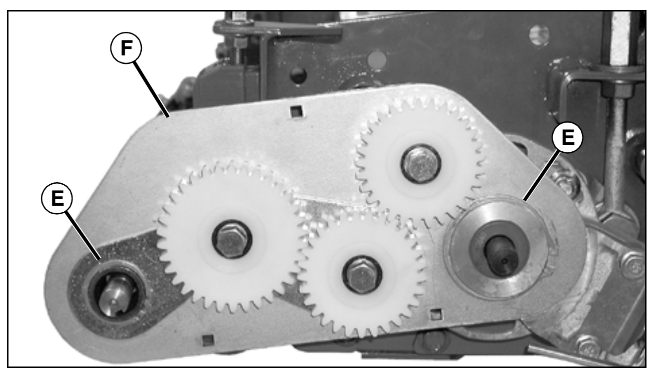
MX18311

1. Remove three nuts and carriage bolts (A).
2. Remove cover (B) and gasket.



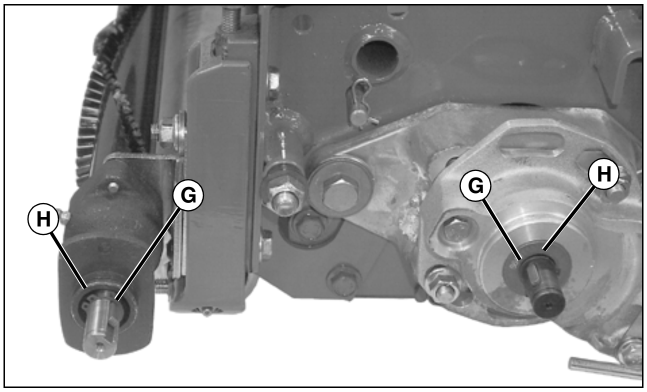
MX18312

3. Remove snap rings (C).
4. Remove gears (D).



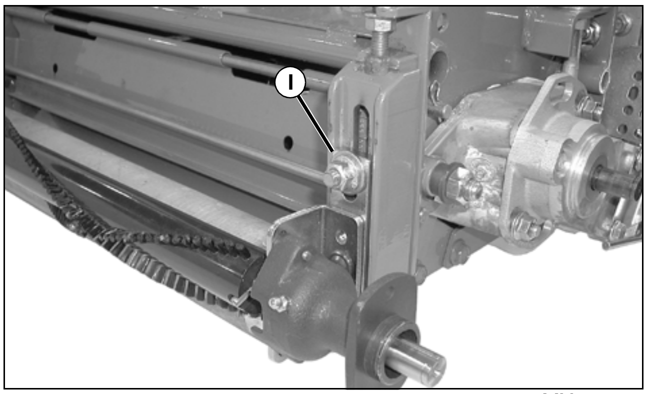
MX18314

5. Remove snap rings (E) and gear plate (F).



MX18313

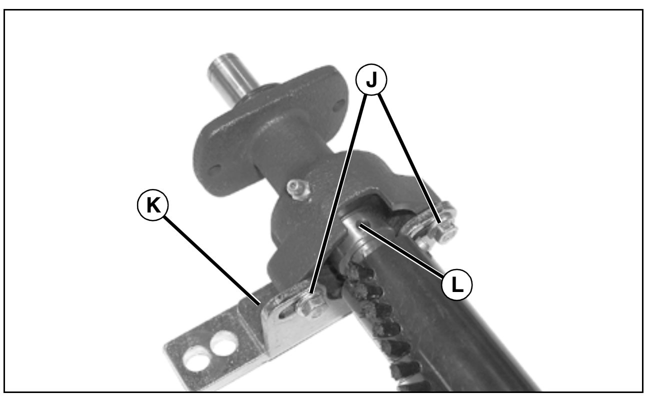
6. Remove keys (G) from shafts. Remove snap rings (H).



MX18315

7. Remove nut and washer (I) from bracket on both sides of cutting unit.

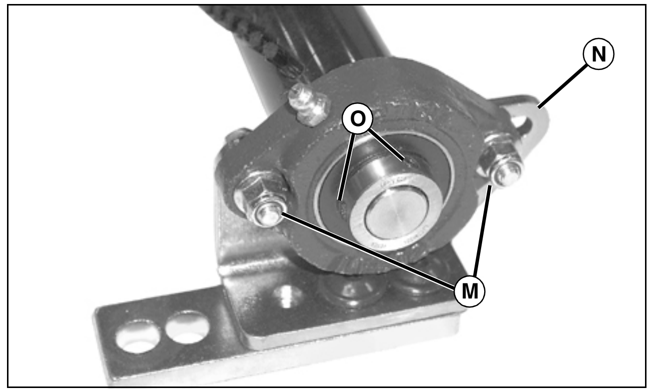
8. Remove brush assembly.



MX18316

9. Remove cap screws (J) and mount bracket (K).

10.Loosen two set screws (L) and slide drive housing off shaft.

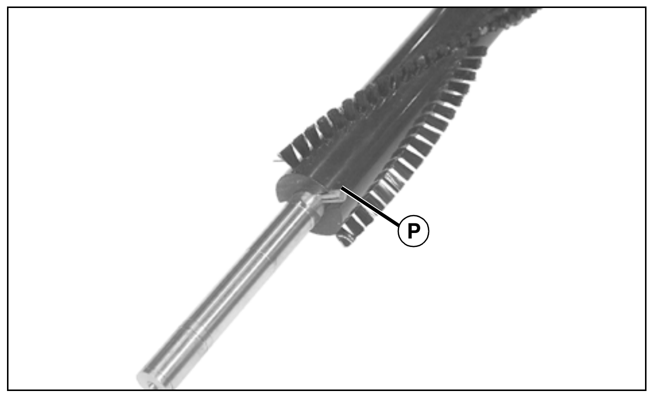


MX18317

11.Remove cap screws and nuts (M).

12.Remove mount bracket (N).

13.Loosen two set screws (O) and remove ball bearing with flange from shaft.

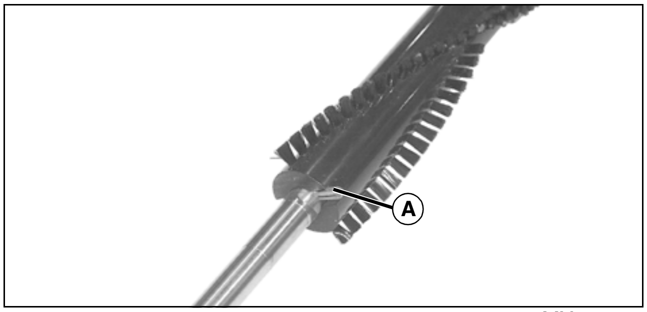


MX18318

14.Drive spring pin (P) from shaft using a punch.

15.Remove brush from shaft.

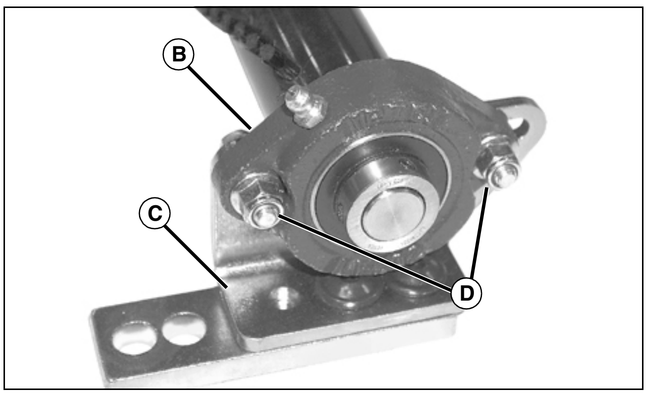
Install Power Brush - 22-In. Heavy Duty



MX18318

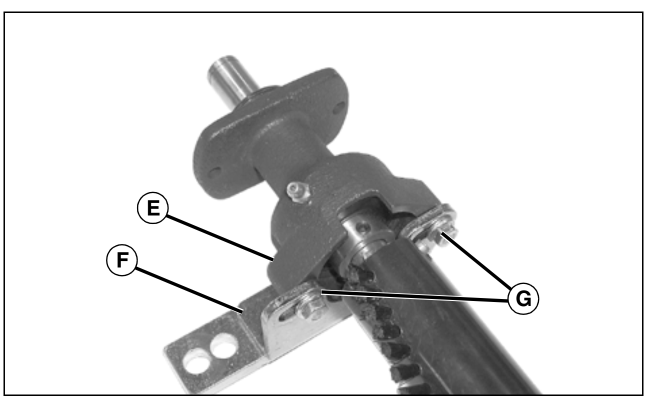
1. Install brush on shaft.
2. Install spring pin (A) to secure brush.

NOTE: The grease fittings will be more accessible for service it the housing and bearing are installed with the fittings to the rear of the unit.



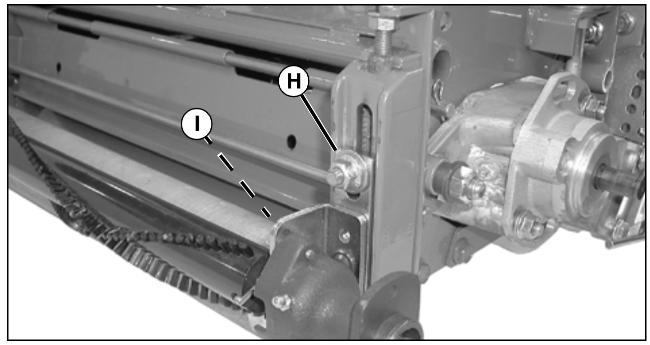
MX18317

3. Install ball bearing with flange (B) to short shaft end of brush. Do not tighten set screws at this time.
4. Loosely fasten the ball bearing with flange (B) to mount bracket (C) using two M6 x 25 bolts and two lock nuts (D).



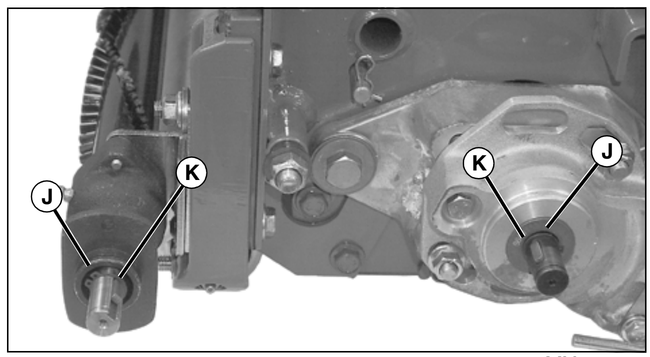
MX18316

5. Install brush drive housing (E) on long end of brush. Do not tighten set screws at this time.
6. Loosely fasten the brush drive housing (E) to mount bracket (F) using two M6 x 25 flange bolts (G).



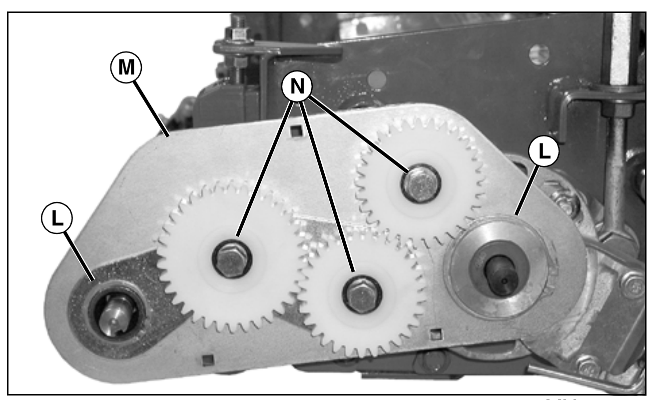
MX18315

7. Install brush assembly to cutting unit.
8. Install nut and washer (H) on bracket on both sides of cutting unit.
9. Adjust the brush to the roller with a clearance of 0-1 mm (0-0.031 in.) by raising or lowering brush and tighten cap screws and nuts (I) on both sides of cutting unit.
10.Position the brush between the housings so that the short end of the shaft is flush with the cast bearing. Apply thread locking compound and tighten the set screws in both bearings.



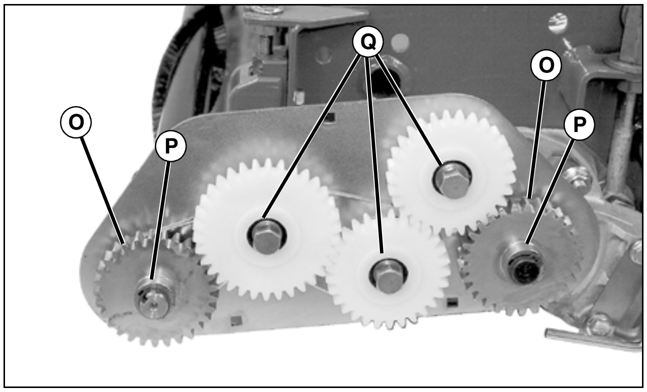
MX18313

11.Install snap rings (J) and keys (K) on shafts.



MX18314

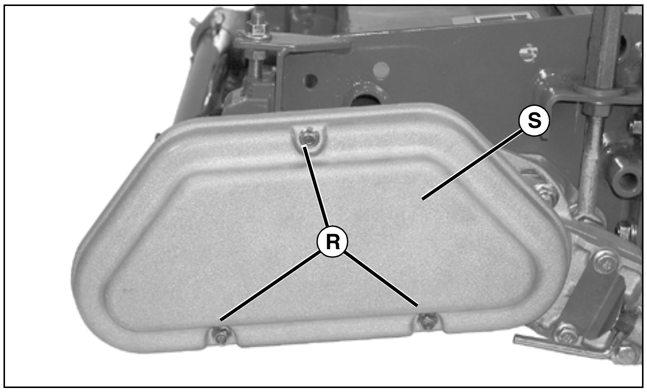
12.Loosen gear shaft bolts (N) before installing plate.
13.Install gear plate (M) and snap rings (L).



MX18312

14.Install gears (O) and snap rings (P).

15.Tighten gear shaft bolts (Q).

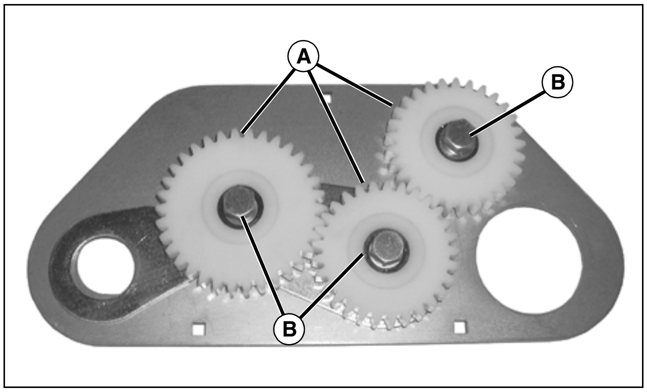


MX18311

16.Install gasket and cover (S).

17.Install three carriage bolts and lock nuts (R).

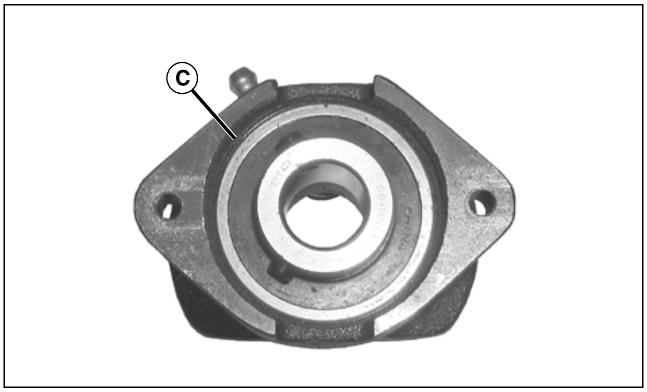
Disassemble and Inspect Power Brush - 22-In. Heavy Duty



MX18319

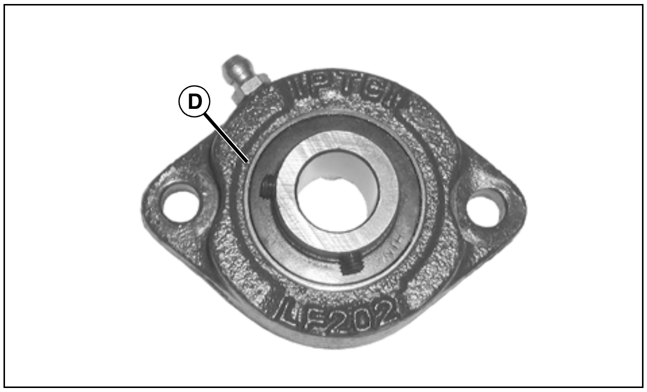
1. Inspect gears (A) for signs of wear or damage. Replace if needed.

2. Inspect bearings (B) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18321

3. Inspect bearing (C) for free movement and excessive play. Replace bearing if it has excessive play or is noisy..



MX18322

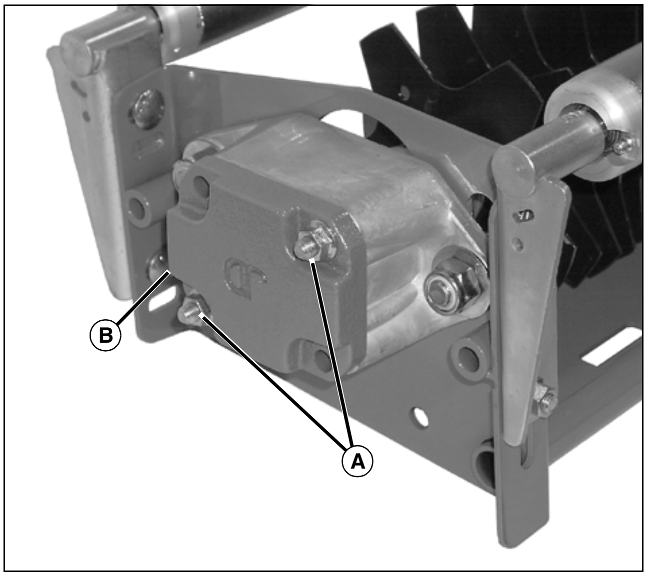
4. Inspect bearings (D) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

Remove Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)

CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.

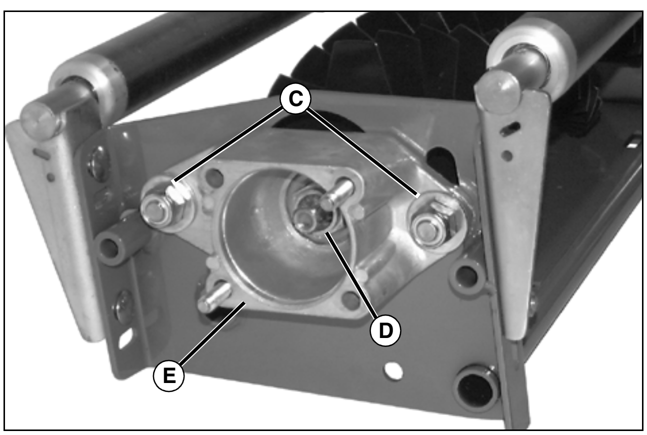
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



MX18301

3. Loosen flange nuts (A).

4. Remove weight (B).

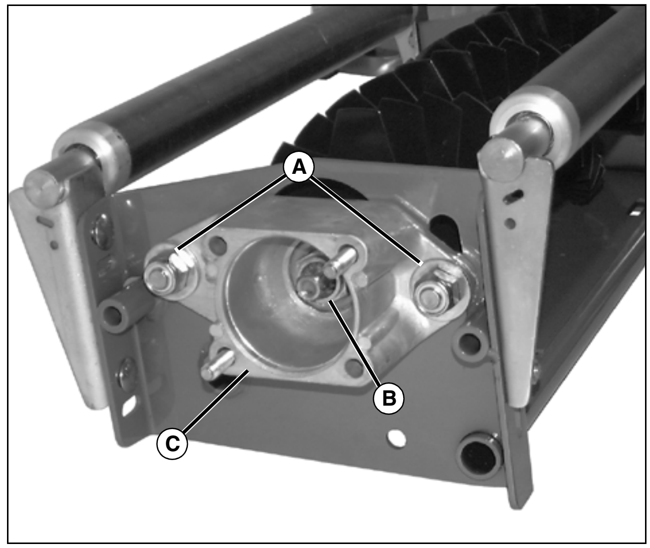


MX18296

5. Remove nut (D), two nuts and cap screws (C) and pivot arm (E) from both sides of cutting unit.

6. Remove reel assembly.

Install Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)

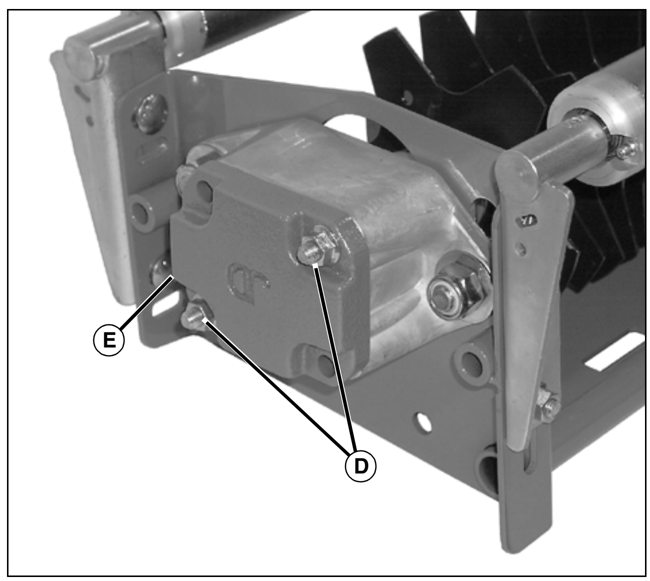


MX18296

1. Place cutting unit into housing.

2. Install pivot arm assembly (C), nut (B) and cap screws and nuts (C) on each side of cutting unit. (See "Assemble Pivot Arm - 22-In. Heavy Duty" on page 437.)

3. Grease both pivot arms with proper grease. (See "Grease - North America" on page 22.)(See "Grease - Europe" on page 23.)



MX18301

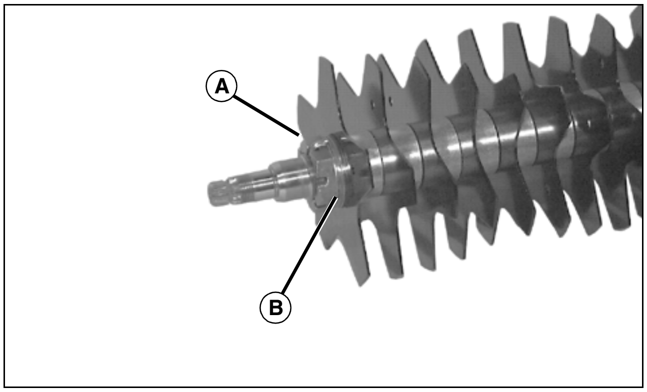
4. Install weight (E).

5. Tighten flange nuts (D).

6. See "Adjust Depth-of-Cut - Vertical Cutting Unit (22-In. Heavy Duty)" on page 411.

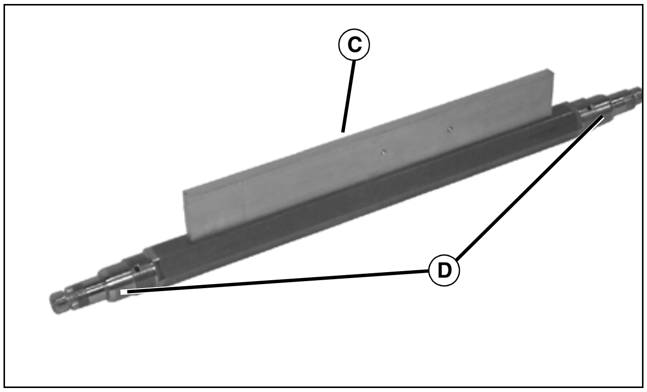
Disassemble and Inspect Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)

CAUTION: Avoid injury! Always wear gloves when handling reel or cutting blades. Serious personal injury can result from contact with sharp cutting edges.



MX18299

1. Remove cotter pin and nut (A), washers (B) and cutting blades and spacers from reel shaft.



MX18298

2. Using a straightedge (C), check several sides of hex shaft for straightness. Shaft runout should not exceed 0.50 mm (0.020 in.).

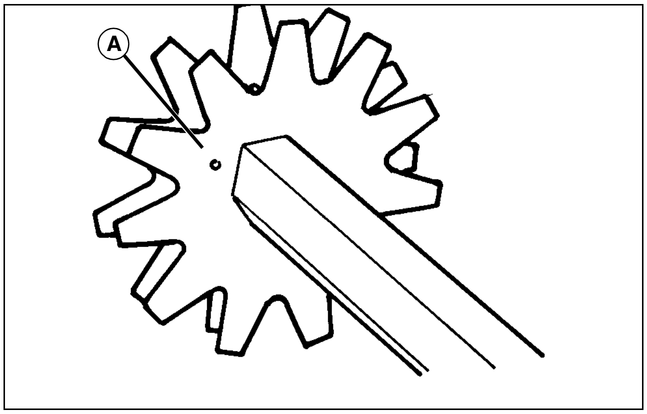
3. Inspect machined surfaces (D) of shaft for wear or damage. Replace shaft if needed.

Assemble Reel - Vertical Cutting Unit (22-In. Heavy Duty)

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

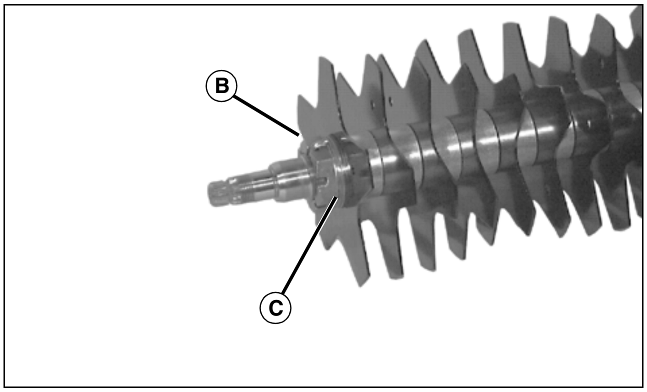
1. Install nut and cotter pin and washers on one end.

NOTE: Fewer spacers and more blades can be used if desired.



M46882

2. Assemble blades and spacers starting with a blade against the washers. Ensure that the index hole (A) of the next blade is placed on the next flat counterclockwise on the shaft as shown. This will establish the proper helix pattern.

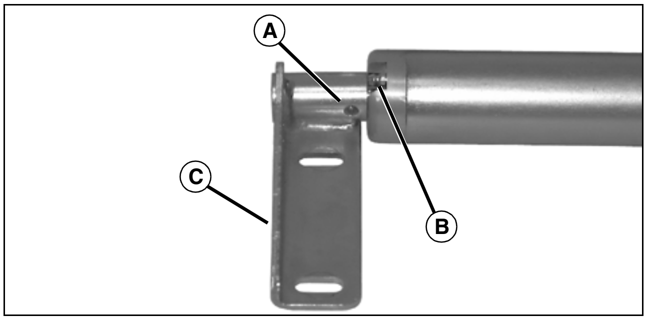


MX18299

3. After the last cutting blade is installed, install washers (C) and nut (B). Tighten nut until a slight deflection of cutting blade on opposite side of shaft is observed, then tighten nut until cotter pin can be installed.

Replace Roller Bearing - Vertical Cutting Unit (22-In. Heavy Duty)

NOTE: This procedure applies to both smooth and grooved rollers.



MX18324

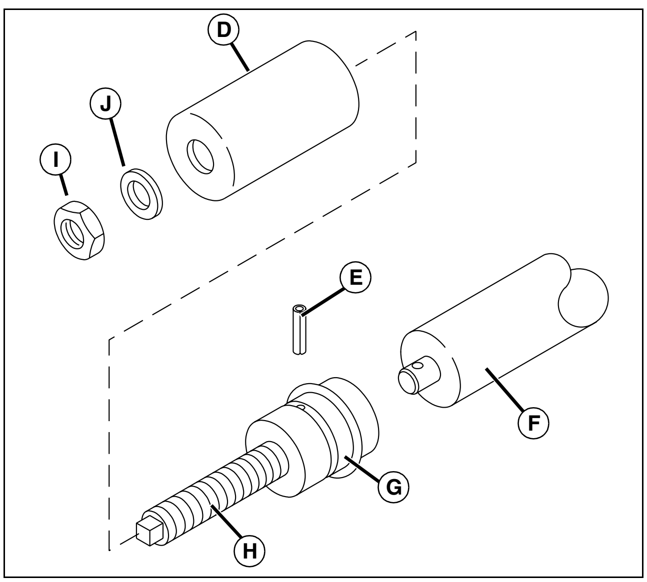
Picture Note: Smooth Roller Shown

1. Remove spring pin (A).

NOTE: It may be necessary to press the bearing shaft from the bracket.

2. Remove bracket (C) from bearing shaft.
3. Remove grease fitting (B) (smooth rollers only).

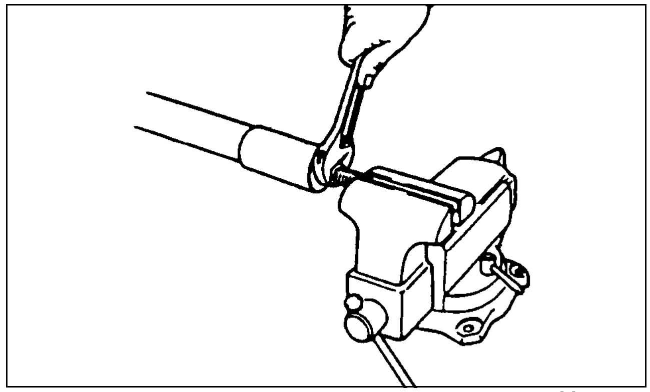
CAUTION: Avoid injury! Wear approved eye protection when using JDG795 Roller Bearing Puller.



M83583

4. Attach threaded puller (H) to the bearing by inserting the pin (E) through the hole in the bearing shaft and puller. Slide the O-ring (G) over the pin to keep it in position.

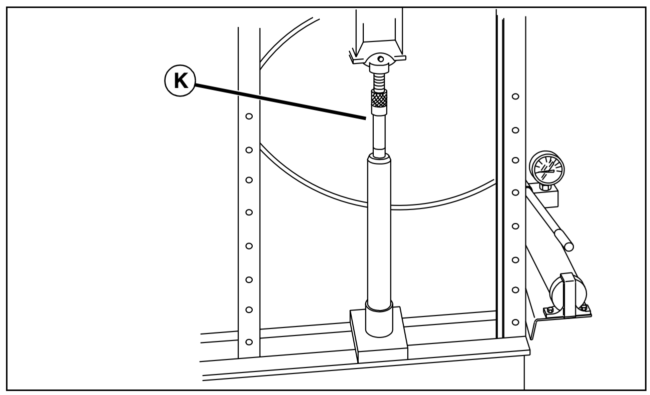
5. Slide roller sleeve (D) over the threaded puller with the concave end of the roller sleeve against the end of the roller (F). Install flat washer (J) and nut (I) on threaded puller.



M83584

6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

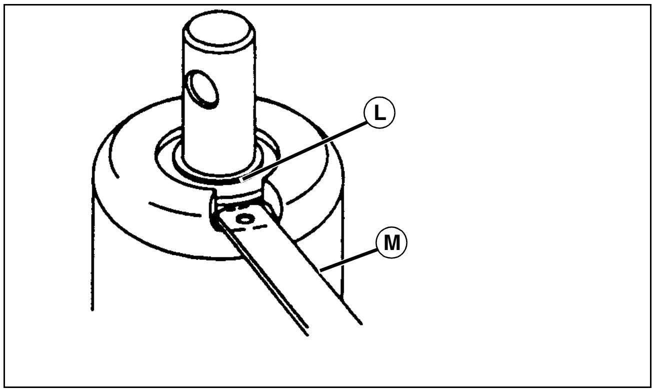
IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outisde of bearing race.



M83586

7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.

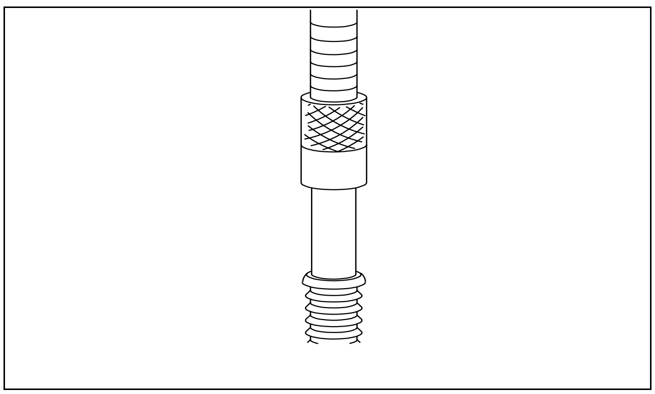
8. Position JD243 or JD506 Bearing Installer (K) over the new bearing in the top end of the roller.



M83585

9. Smooth Rollers: Place a 0.89 mm (0.035 in.) feeler gauge (M) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (L) is flush with the top of the feeler gauge.

10.Install the grease fitting.



M83587

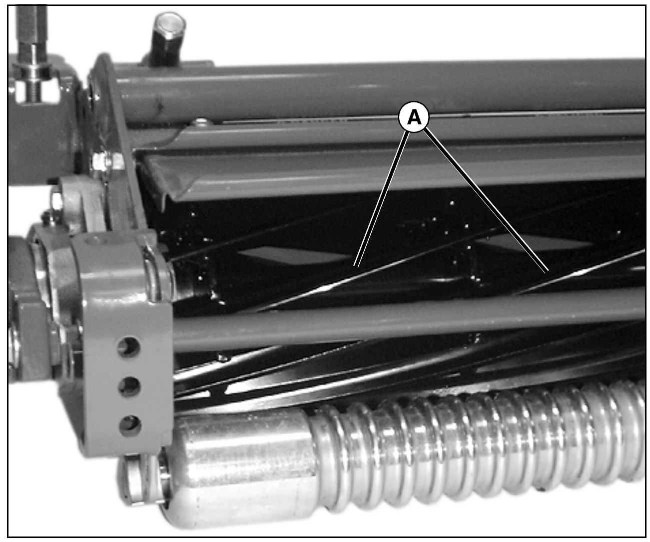
11.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.

Inspect Reel and Bed Knife - 2500M

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

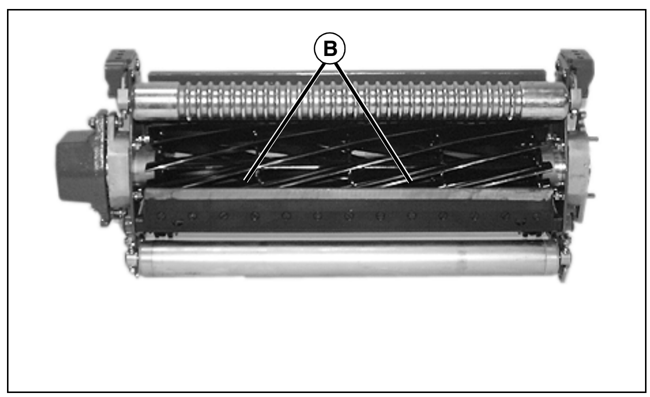
1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.



M84825

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge (A) for nicks, gouges or distortion. Ensure the cutting edge land does not exceed more than 3/4 of the blade thickness. See "Reel and Bed Knife Grinding" on page 397 to restore the relief angle and cutting edge before continuing with this procedure.



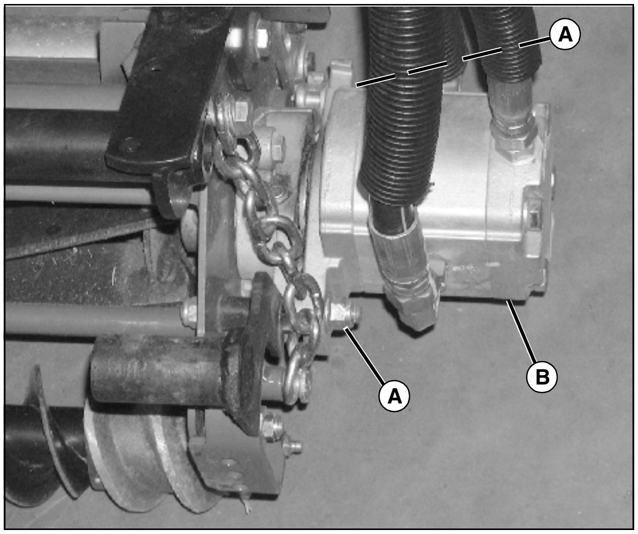
M84823

4. Inspect the bed knife cutting edge (B) for nicks, gouges or distortion.

5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge extends below 1.45 mm (0.057 in.) from the mounting surface.

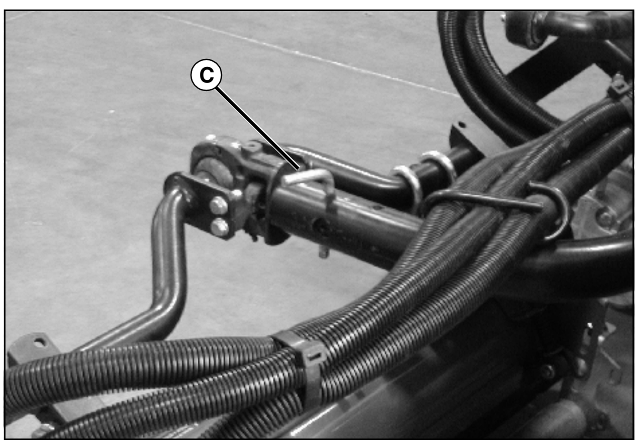
Remove and Install Cutting Unit - 2500M

1. Park machine on a level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Engage park brake.



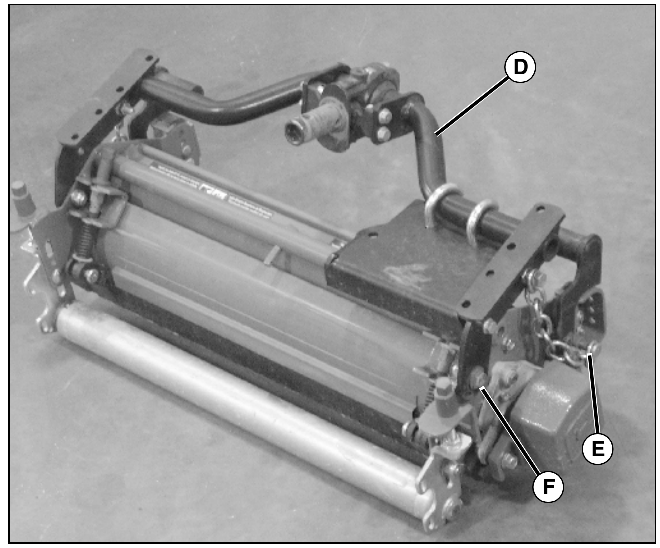
MX18371

5. Loosen reel motor mounting cap screws (A).
6. Remove the reel motor (B).



M84610

7. Remove retaining pin (C) and remove cutting unit from machine.



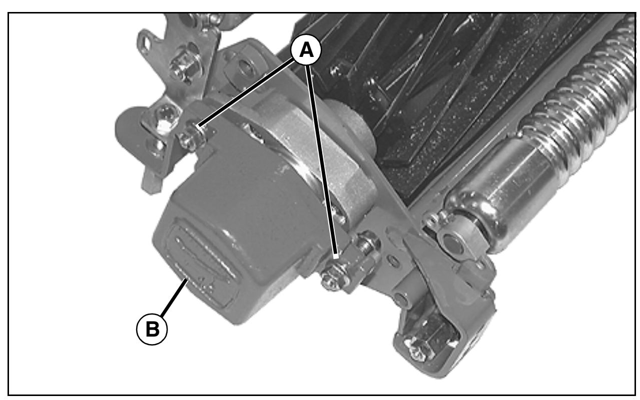
M84822

8. If cutting unit is to be repaired, remove ring and pin (E) and cap screw and nut (F) from both sides of cutting unit.
9. Remove yoke (D).

Installation is done in reverse order of removal.

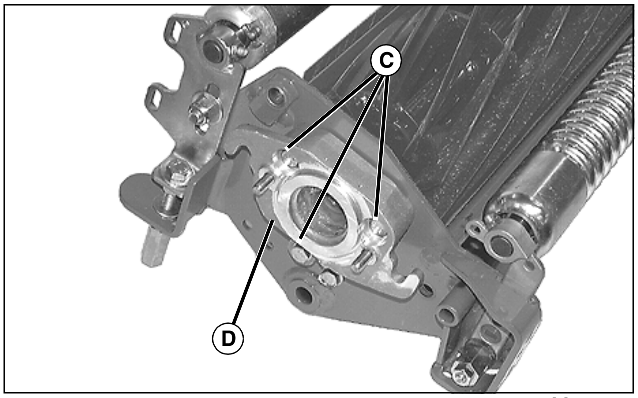
Remove Reel - 2500M

1. Remove cutting units from mower.
2. Remove fairway tender conditioner (if equipped). (See “Remove Fairway Tender Conditioner - 2500M” on page 460.)
3. Remove bed knife. (See “Remove Bed Knife - 2500M” on page 455.)
4. Place cutting unit upside-down on a stable working surface (rollers facing up).



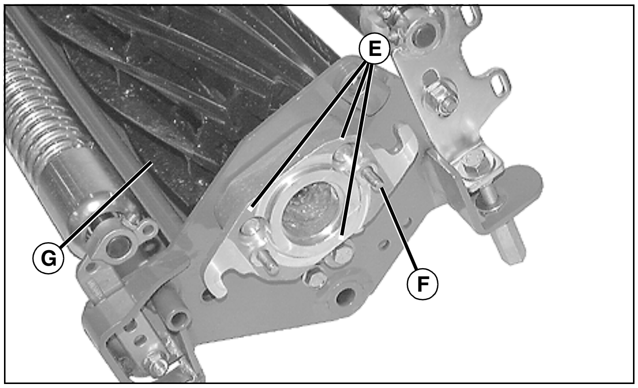
M98791

5. Loosen flange nuts (A).
6. Remove weight assembly (B).



M98798

7. Remove three cap screws and flange nuts (C).
8. Remove bearing housing (D).

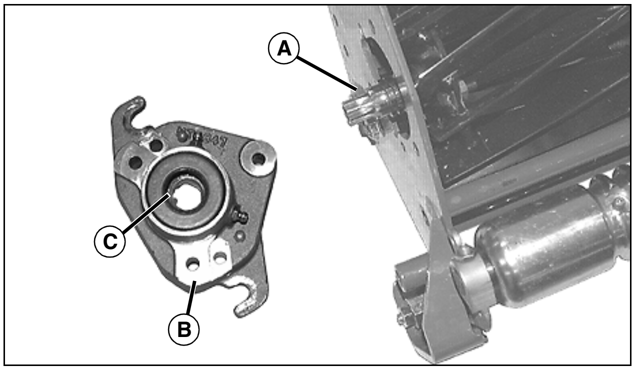


M98799

9. Remove three cap screws and nuts (E).
10. Remove bearing housing (F).
11. Remove reel (G).

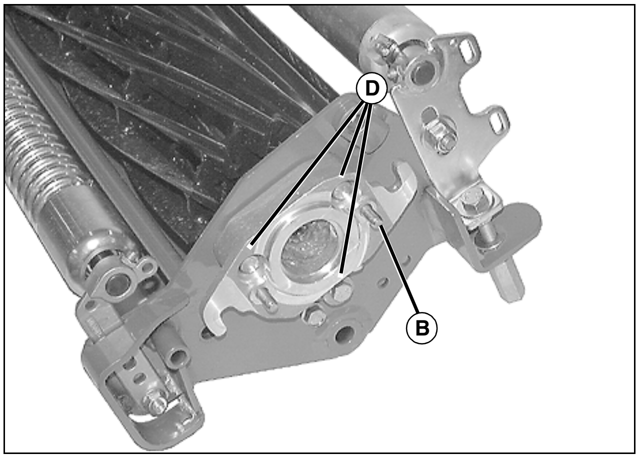
Install Reel - 2500M

1. Install reel assembly in housing with the shaft end with the keyway on the left side of the frame.



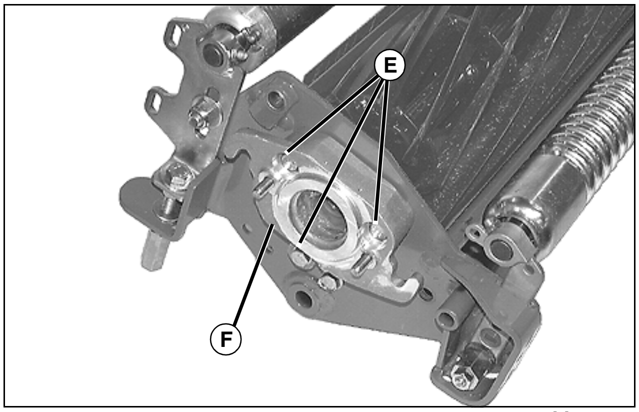
M98800

2. Align the tab (C) on the keyed washer with the keyway (A) on the reel shaft.
3. Install the bearing housing (B).



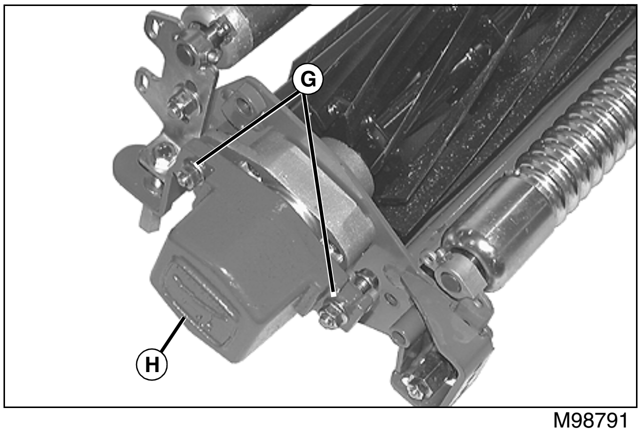
M98799

4. Install three cap screws and nuts (D) retaining bearing housing (B).



M98798

5. Install bearing housing (F).
6. Install three cap screws and nuts (E).

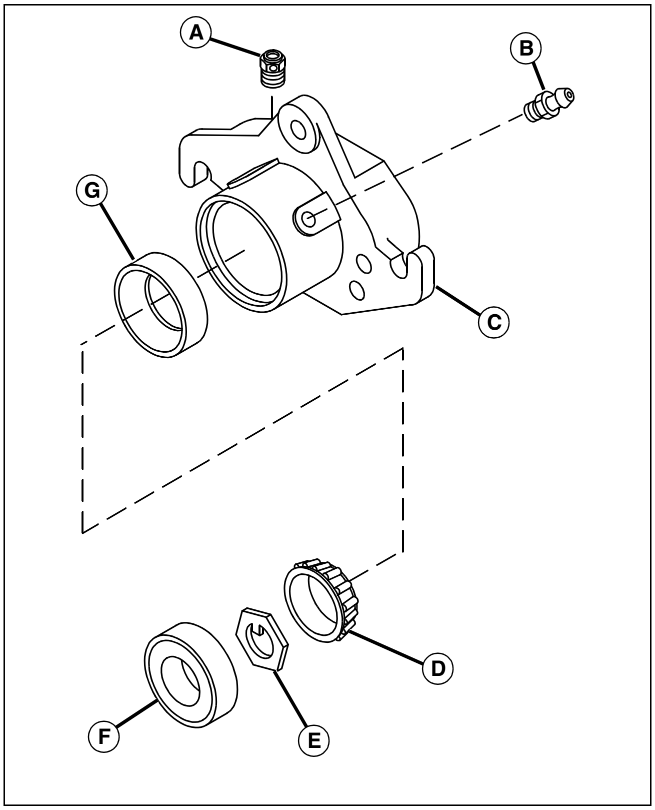


M98791

7. Install weight assembly (H) with flange nuts (G).
8. Adjust bed knife-to-reel clearance. (See “Adjust Reel-to-Bed Knife - 2500M” on page 412.)

Disassemble and Inspect Bearing Housing - 2500M

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Remove seal (F), keyed washer (E) (left side only), tapered roller bearing (D), bearing cup (G), breather (A) and grease fitting (B) from each housing (C).

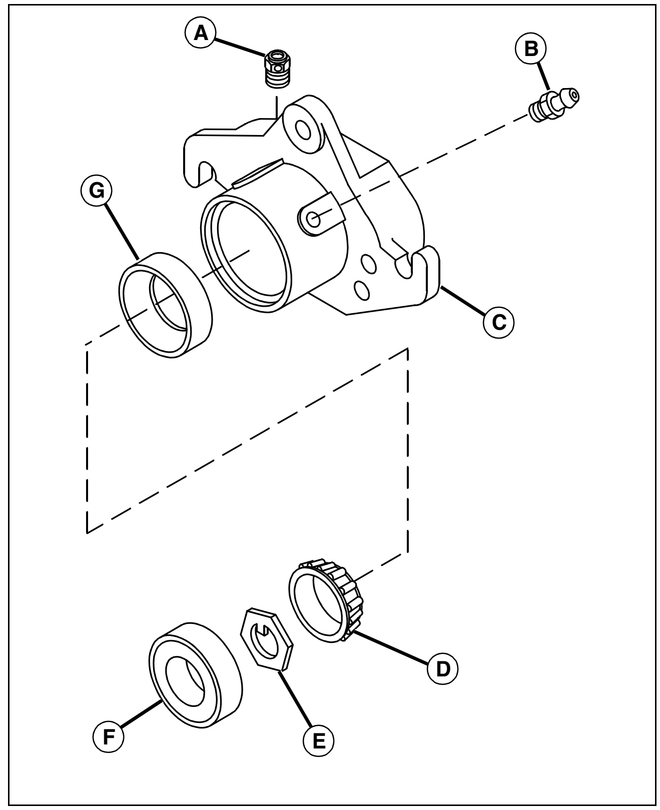
2. Clean bearings and housing with solvent.

IMPORTANT: Avoid damage! Always replace bearings and bearing cups as a set.

3. Inspect bearings and bearing cups for scoring, pitting or bluing from overheating. Replace as needed.

Assemble Bearing Housing - 2500M

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Install bearing cups (G) into housing (C) using a suitable driver or a press (tapered end facing the outside of the housing).

2. Pack tapered roller bearings (D) with John Deere special purpose golf and turf cutting unit grease and position in the bearing cups.

3. Install keyed washer (E) (left side only).

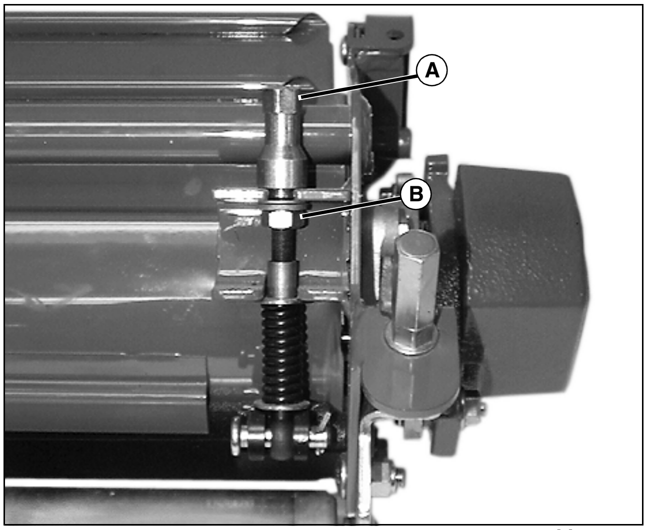
4. Install seal (F) flush with the face of the housing. Apply John Deere special purpose golf and turf cutting unit grease to the seal lips.

5. Install breather (A) and grease fitting (B).

Remove Bed Knife - 2500M

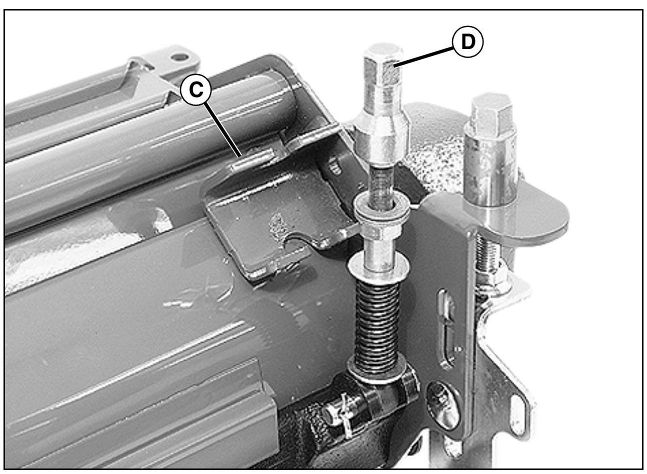
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.
2. Place cutting unit on a stable working surface.



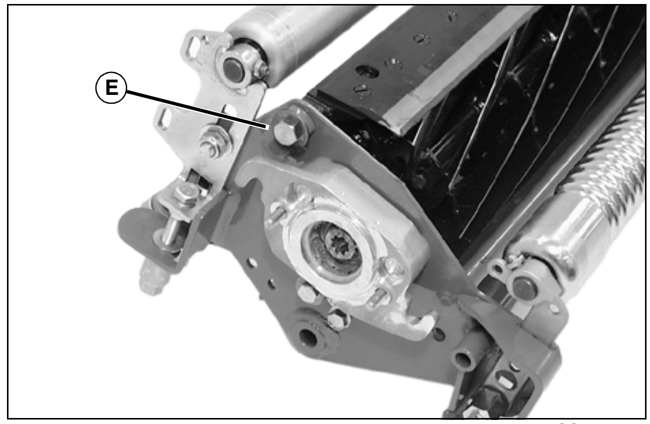
M84843

3. Rotate jam nut ((B) on each adjuster assembly counterclockwise until springs are completely compressed.
4. Loosen each adjuster (A).



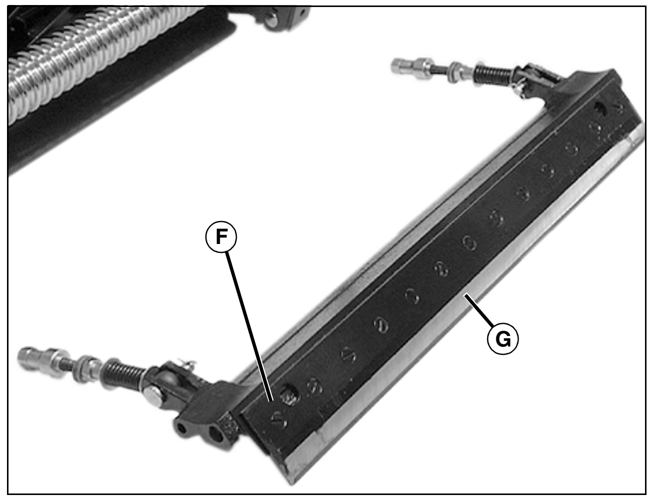
M84853

5. Rotate both adjuster assemblies (D) away from reel housing brackets (C).



M84852

6. Turn the cutting unit over (bed knife facing up).
7. Remove shoulder bolt (E) from both sides of cutting unit.



M84851

8. Slide bed knife (G) out of the cutting unit housing.
9. Remove debris and corrosion from bottom surface of bed knife support.

IMPORTANT: Avoid damage! DO NOT reuse bed knife screws if bed knife is removed.

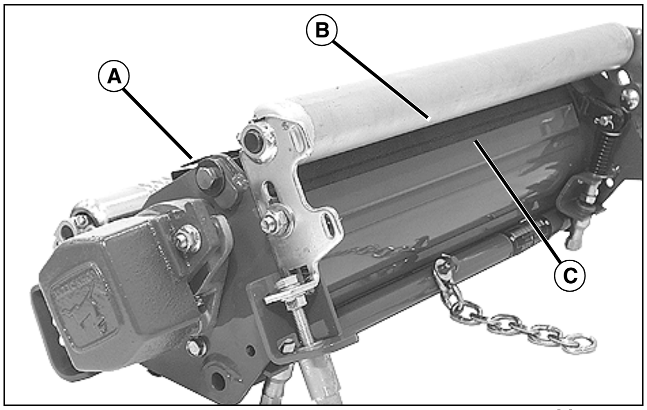
10. Remove and discard thirteen bed knife mounting screws (F).
11. Remove and discard bed knife.
12. Install bed knife using new screws. Starting at the center screw, alternately tighten the bed knife screws working toward both ends of the bed knife. Tighten screws to specifications.
13. Place shoe/bed knife in a suitable grinder. Grind until nicks are removed from the entire top surface of the bed knife lip. (See “Reel and Bed Knife Grinding” on page 397.)

Specifications

Bed Knife Mounting Screw Torque. . . 7 N•m (62 lb-in.)

Install Bed Knife - 2500M

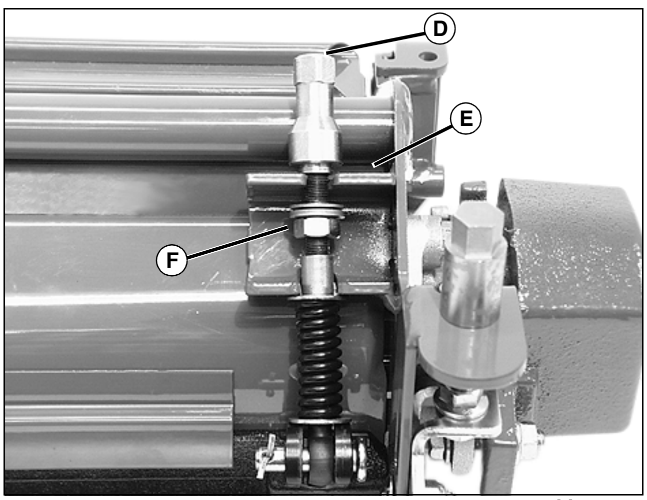
1. Place cutting unit on a stable working surface with the bottom of the cutting unit facing up.



M98491

2. Slide bed knife/shoe assembly (B) into position inside locator shoe (C).

3. Install both shoulder bolts (A) and tighten to specification.



M84854

4. Turn the cutting unit over.

5. Install adjuster assembly (D) in housing bracket (E) on both sides of cutting unit.

6. Turn adjuster jam nut (F) on each adjuster assembly clockwise until the jam nut is midway up the exposed threads.

7. Adjust bed knife-to-reel clearance. (See “Adjust Reel-to-Bed Knife - 2500M” on page 412.)

8. Adjust cutting height. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 418.)

9. Backlap reel. (See Backlapping Procedure.)

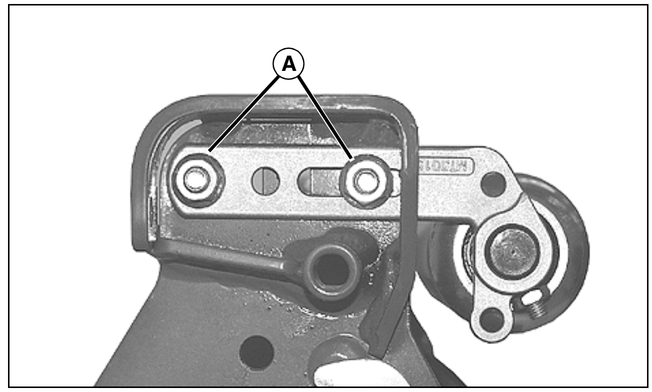
Specifications

Shoulder Bolt Torque . . . . 5 N•m (40 lb-ft)

Remove and Install Front Roller - 2500M

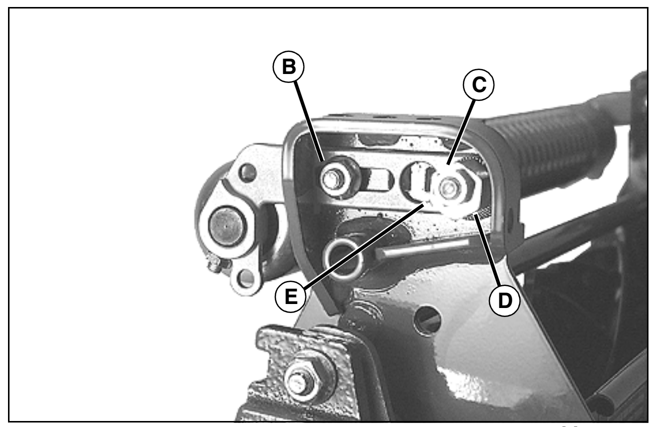
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M84841

3. Remove two flanged nuts and carriage bolts (A).



M84828

4. Remove lower flanged nut and carriage bolt (B).

5. Remove eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.

6. Remove roller and bracket assembly.

Installation is done in the reverse order of removal.

NOTE: Roller brackets are offset. For standard use, the bracket should be installed on the roller with the offset to the rear of the cutting unit.

If Fairway Tender Conditioner (FTC) is installed, the bracket should be installed on the roller with the offset to the front of the cutting unit.

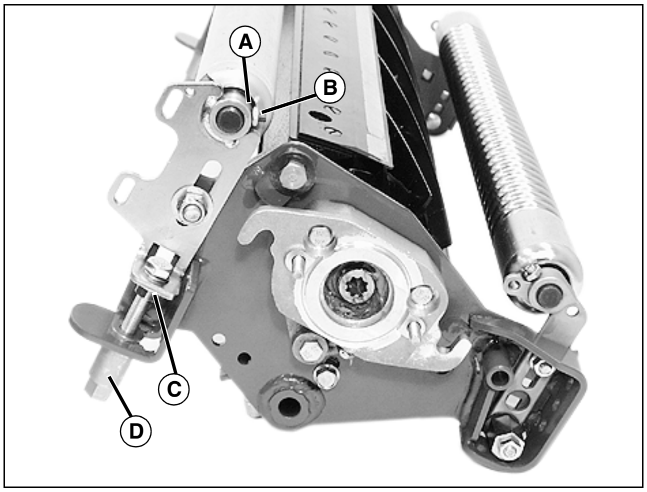
Install roller bracket with the larger holes and adjustment slot on the left side of the cutting unit, in the direction of travel.

•Adjust roller height. (See “Adjust Front Roller - 2500M” on page 416.)

Remove Rear Roller - 2500M

1. Remove cutting units from mower.

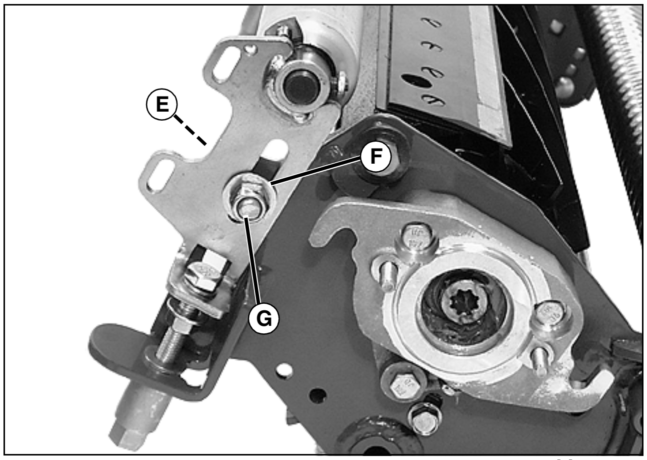
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M84849

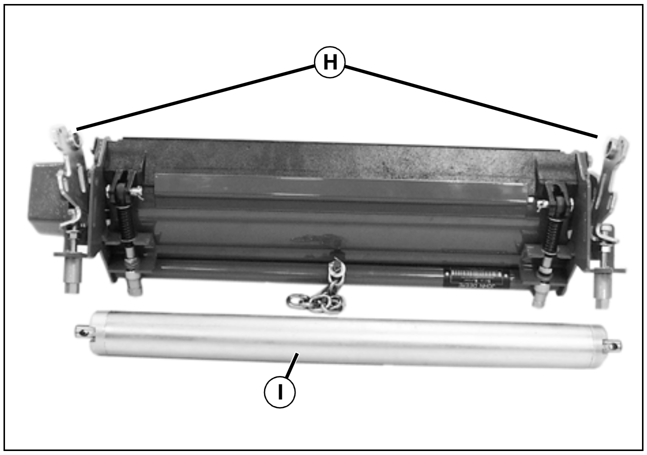
3. Loosen jam nut (A) and set screw (B) on both sides of cutting unit.

4. Loosen jam nut (C) on adjuster tower (D) from both sides of cutting unit.



M98490

5. Remove carriage bolt (E), flat washer (F) and lock nut (G) from both sides of cutting unit.

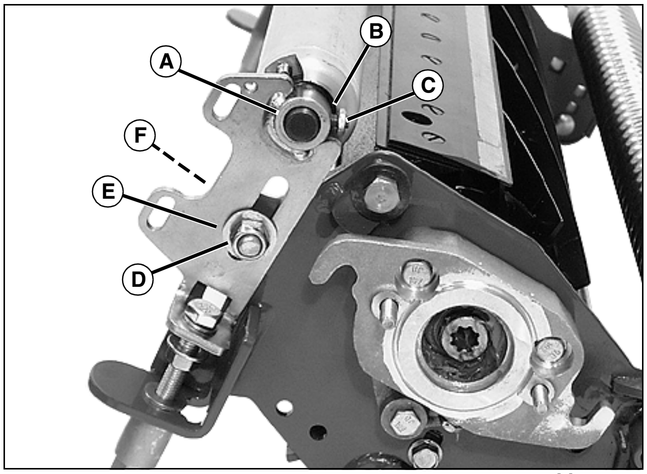


M84850

6. Move height-of-cut brackets (H) away from bearing spindle shaft ends.

7. Remove rear roller (I).

Install Rear Roller - 2500M



M98490

NOTE: DO NOT tighten roller shaft set screws and jam nuts at this time.

1. Install roller bearing spindle shaft (A) into height-of-cut bracket on both sides of cutting unit.

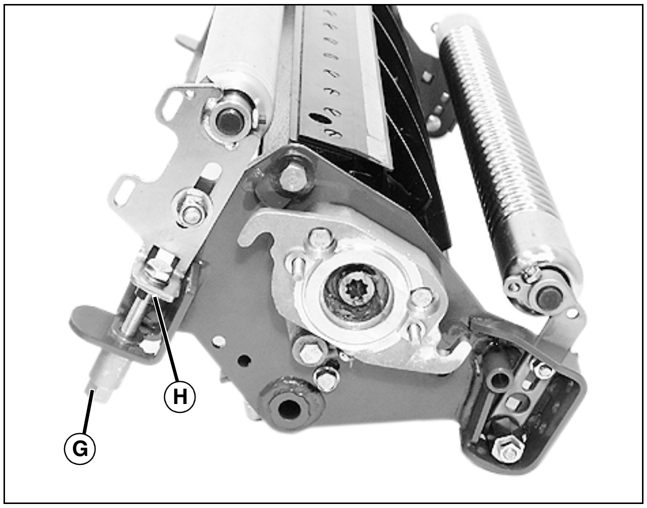
NOTE: Install carriage bolts with the flat washer and nut on the outside of the cutting unit.

2. Attach height-of-cut brackets to cutting unit frame using carriage bolt (F), flat washer (E) and lock nut (D) on both sides of cutting unit.

NOTE: DO NOT install set screws into holes in roller spindle shafts.

3. Center rear roller between height-of-cut brackets.

4. Tighten set screws (C) and jam nuts (B) on both sides of cutting unit.



M84849

5. Loosen bracket lock nuts approximately 1/4 turn (on both sides of cutting unit.

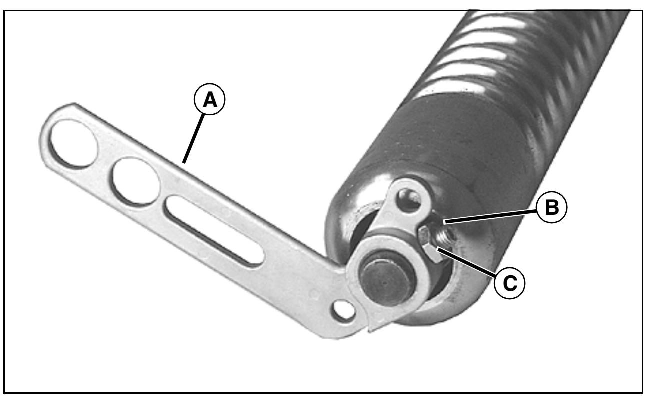
6. Tighten jam nut (H) on adjuster tower (G) on both sides of cutting unit.

7. Tighten bracket lock nuts (both sides of cutting unit).

8. Adjust height-of-cut. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 418.)

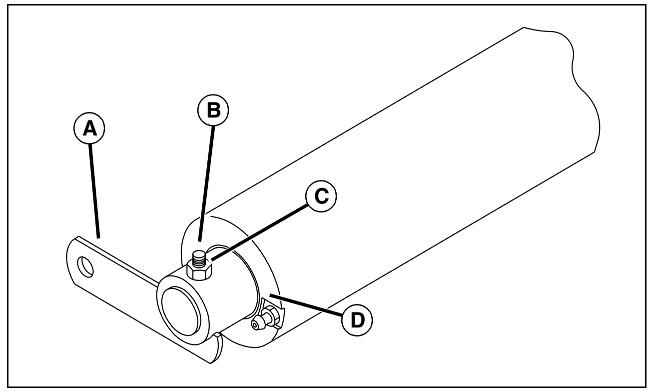
Disassemble and Assembly Roller - 2500M

NOTE: This procedure applies to both smooth and grooved rollers.



M84840

Picture Note: Grooved Roller Shown



M83582

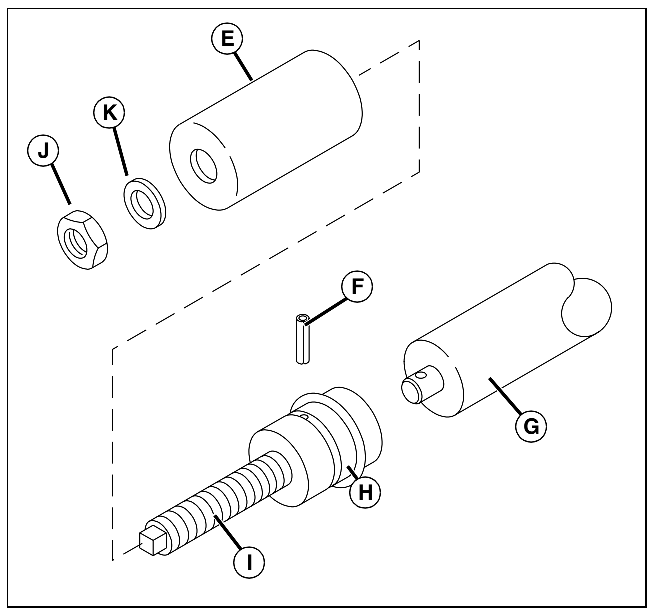
Picture Note: Smooth Roller

1. Loosen jam nut (C) and remove set screw (B).

NOTE: It may be necessary to press the bearing shaft from the bracket.

2. Remove brackets (A) from bearing shafts.
3. Remove grease fitting (D) (smooth rollers only).

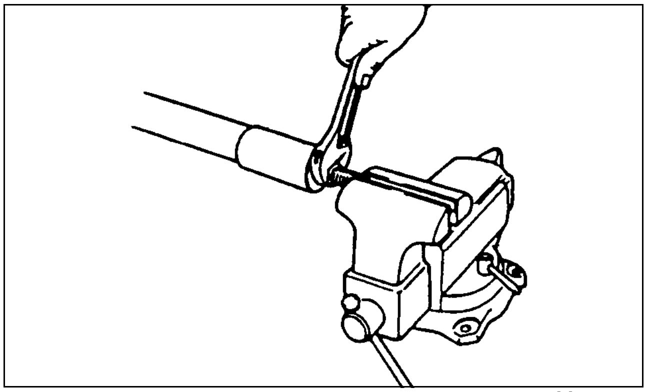
CAUTION: Avoid injury! Wear approved eye protection when using JDG795 Roller Bearing Puller.



M83583

4. Attach threaded puller (I) to the bearing by inserting the pin (F) through the hole in the bearing shaft and puller. Slide the O-ring (H) over the pin to keep it in position.

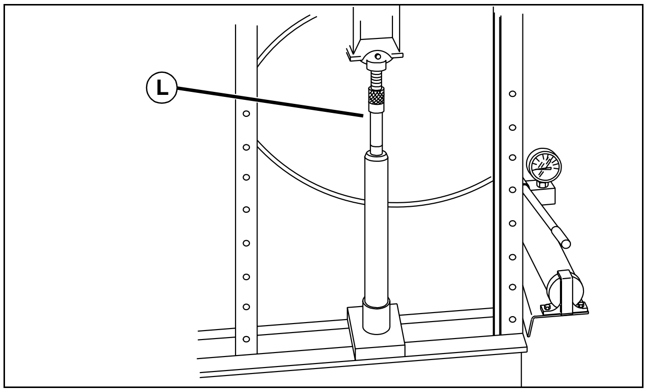
5. Slide roller sleeve (E) over the threaded puller with the concave end of the roller sleeve against the end of the roller (G). Install flat washer (K) and nut (J) on threaded puller.



M83584

6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

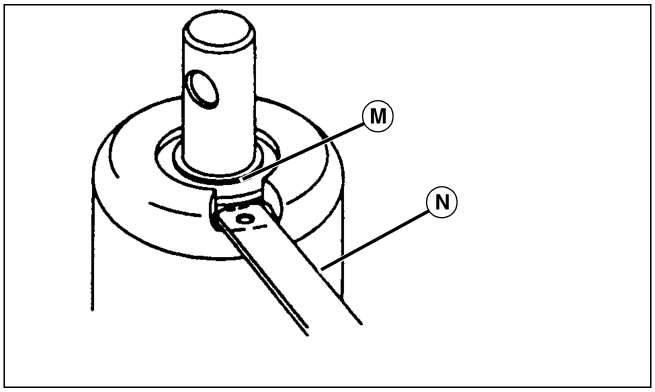
IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outside of the bearing race.



M83586

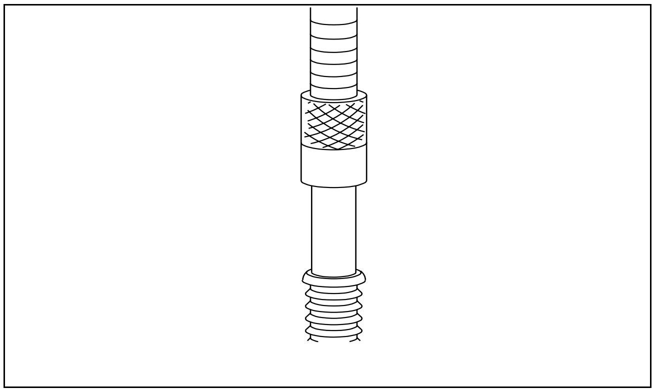
7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.

8. Position JD243 or JD506 Bearing Installer (L) over the new bearing in the top end of the roller.



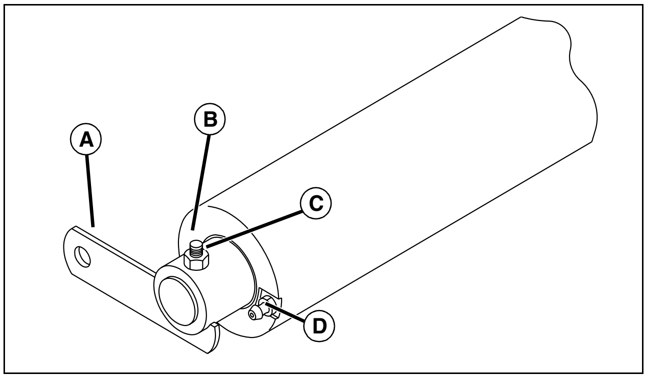
M83585

9. Smooth Rollers Only: Place an 0.89 mm (0.035 in.) feeler gauge (N) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (M) is flush with the top of the feeler gauge.



M83587

10.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.



M83582

Picture Note: Smooth Roller Shown

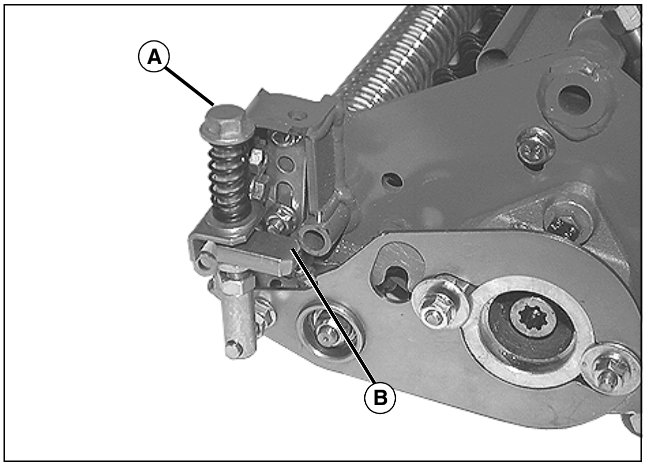
11.Install bracket (A) on both sides of roller.

12.Install set screw (B) and jam nut (C) on both sides of roller.

13.Install grease fitting (D) (smooth rollers only) on both sides of roller.

Remove Fairway Tender Conditioner - 2500M

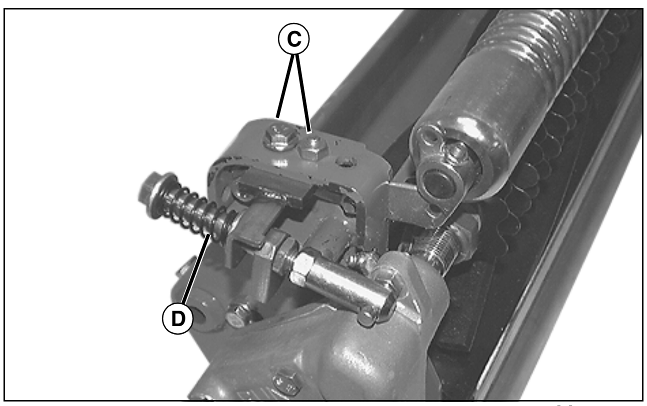
NOTE: The following procedures show FTC unit mounted on right-hand side of the cutting unit. The procedure for units mounted on the left side are the same.



M98560

Picture Note: FTC - Disengaged Position

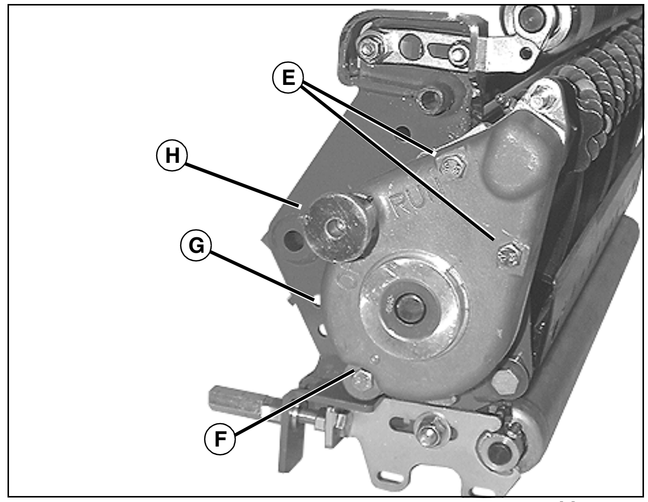
1. Press down on FTC adjuster bolt (A) and swing adjuster stop (B) toward the rear of the cutting unit (disengaged position). Repeat on other end of cutting unit.



M98565

2. Remove cap screws and nuts (C) from both sides of cutting unit.

3. Remove adjustment bracket assembly (D) from both sides of cutting unit.



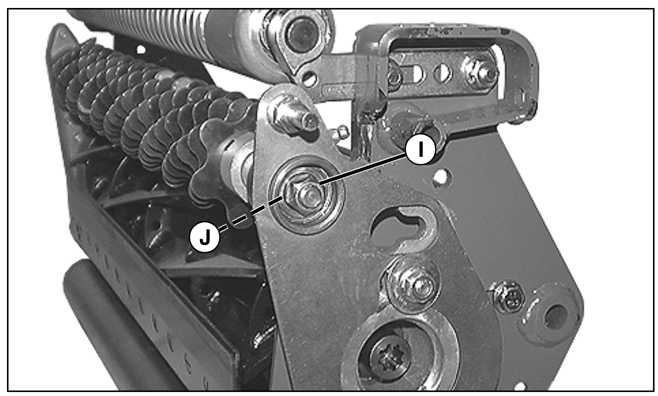
M98562

4. Move knob (H) to OFF position.

5. Remove two M8 x 50 hex-flange bolts (E) and one M8 x 30 hex bolt (F).

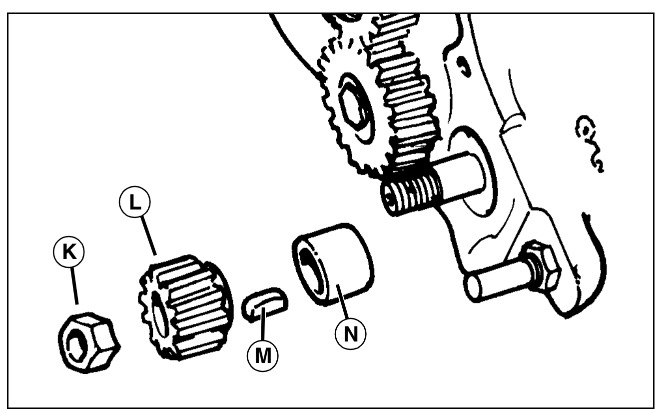
6. Remove FTC cover (G) and gasket.

NOTE: Hold gears on opposite side of cutting unit while loosening nut.



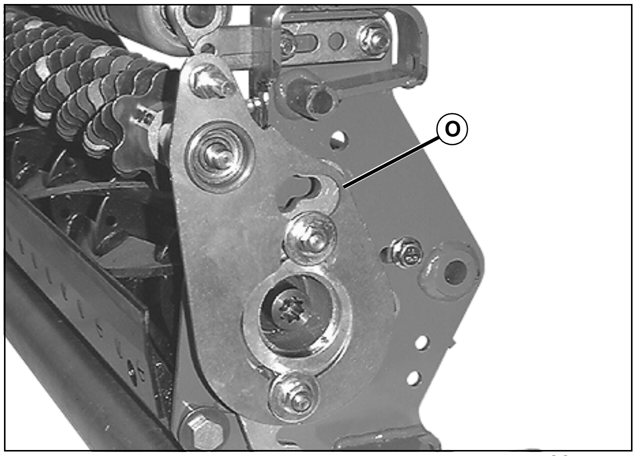
M98564

7. Remove nut (I) and spacer (J).



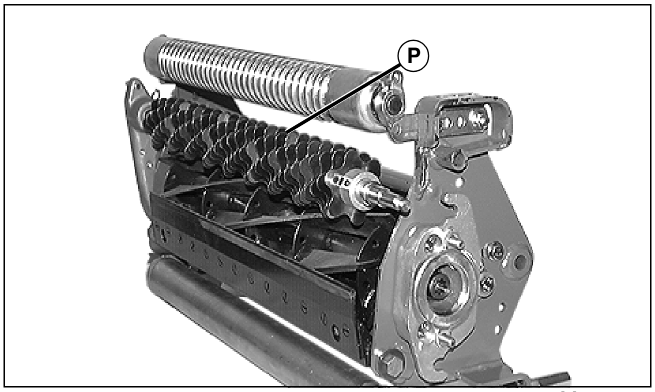
M46877

8. Remove nut (K), gear (L), key (M) and spacer (N).



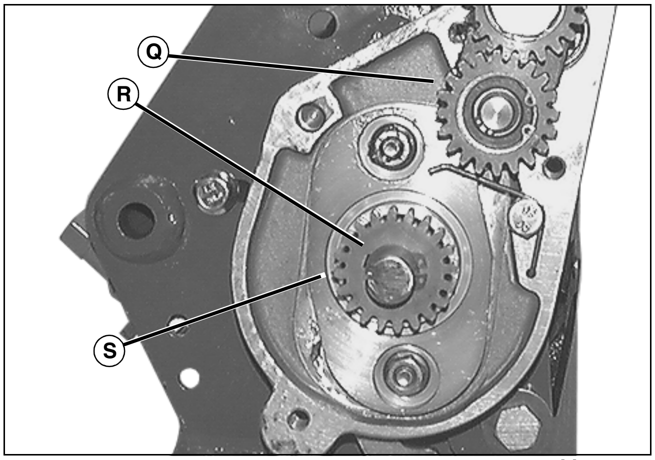
M98567

9. Remove bracket (O).



M98568

10.Remove FTC assembly (P).

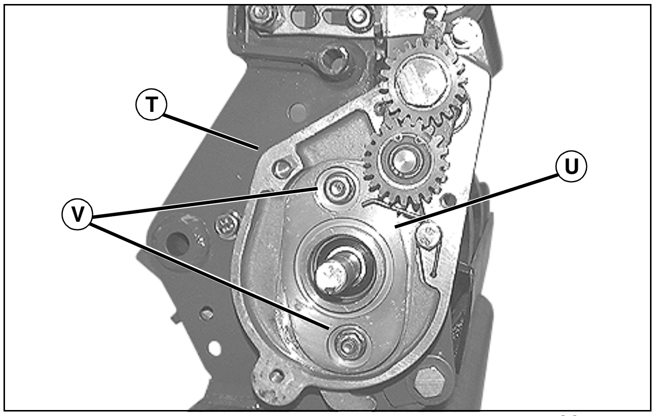


M98569

11.Swing idler gear bracket (Q) away from main drive gear.

12.Remove retaining ring (R).

13.Remove gear (S).



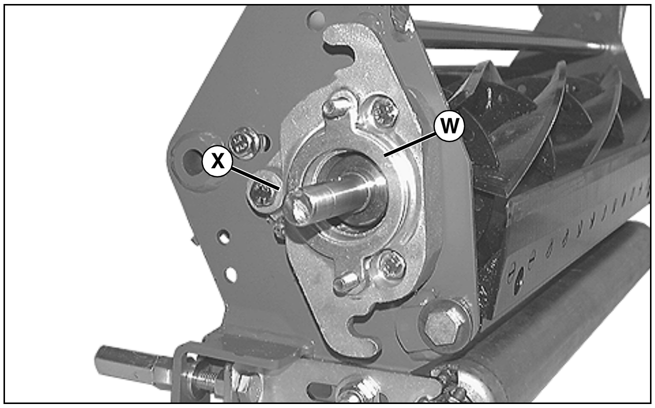
M98570

14.Remove two nuts (V).

NOTE: Spacer ring and shaft may come off with housings.

15.Remove bearing housing assembly (U).

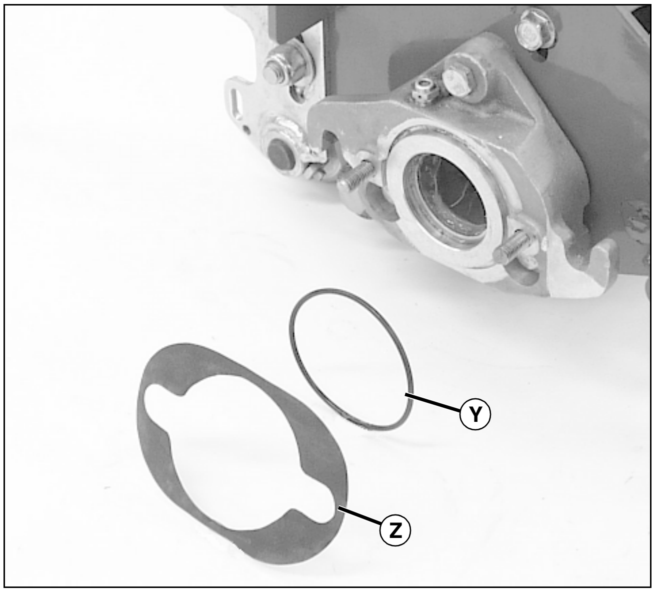
16.Remove FTC housing (T).



M98591

17.Remove spacer ring (W).

18.Remove shaft (X).

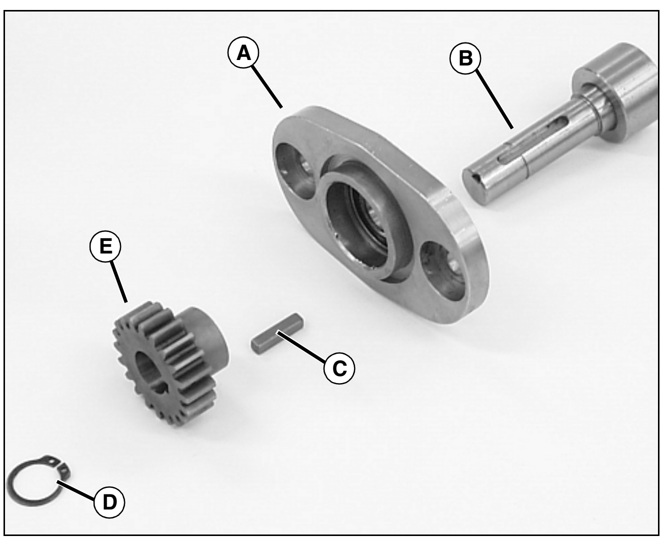


M98066

19.Remove gasket (Z) and O-ring (Y).

Install Fairway Tender Conditioner - 2500M

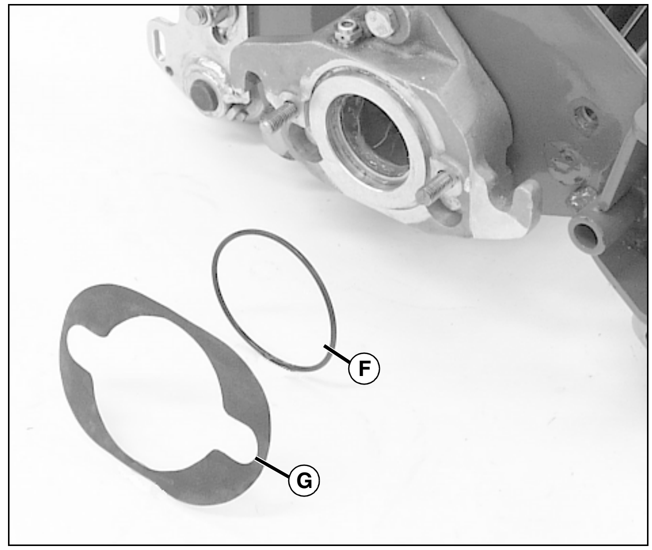
The following procedures show FTC unit mounted on right-hand side of the cutting unit. The procedure for units mounted on the left side is the same.



M98065

NOTE: If a rear roller brush kit is installed with the FTC, use the long, double key-slot drive shaft supplied with the brush kit.

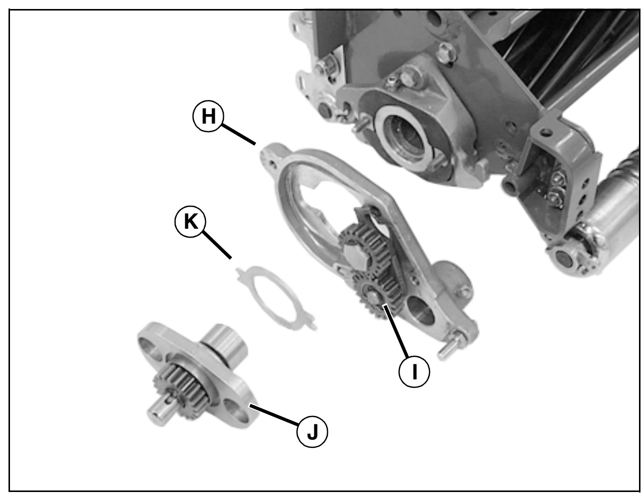
1. Install the drive shaft (B) into bearing housing (A).
2. Install square key (C) into drive shaft key slot.
3. Install main drive gear (E) on drive shaft.
4. Install snap ring (D).



M98066

5. Install O-ring (F) into groove in reel bearing housing.
6. Install gasket (G) over the bolts and O-ring.

NOTE: Slots in spacer ring must align with bolts projecting from reel bearing housing. If not assembled correctly, the FTC height cannot be adjusted.



M99034

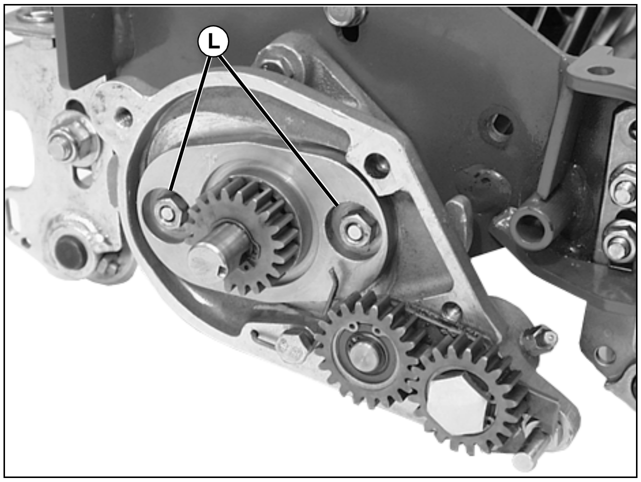
7. Position spacer ring (K) onto gear drive assembly (J).

NOTE: Apply John Deere Corn Head Grease to the drive shaft end before installing the shaft onto the reel drive housing. (See Specifications and Information section.)

8. Rotate the idler gear bracket (I) away from the opening to gain clearance for installing the gear drive assembly (H).

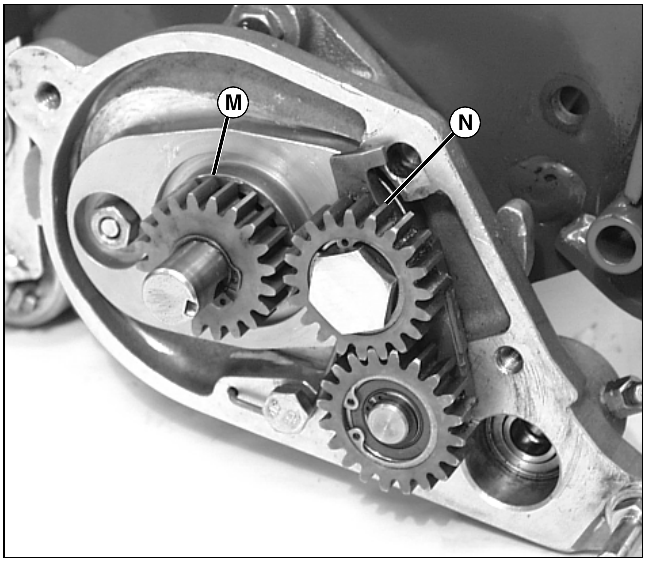
9. Install drive gear assembly with spacer ring into gear case assembly.

NOTE: Make sure that the torsion spring is positioned in front of the gear drive assembly bearing end cap.



M98088

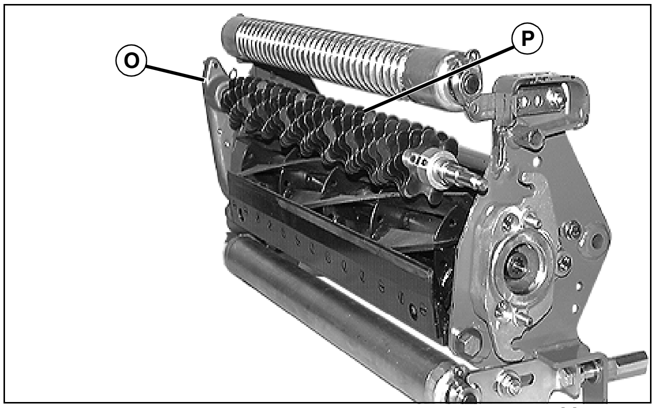
10.Secure the drive gear assembly using two hex lock nuts (L).



M98089

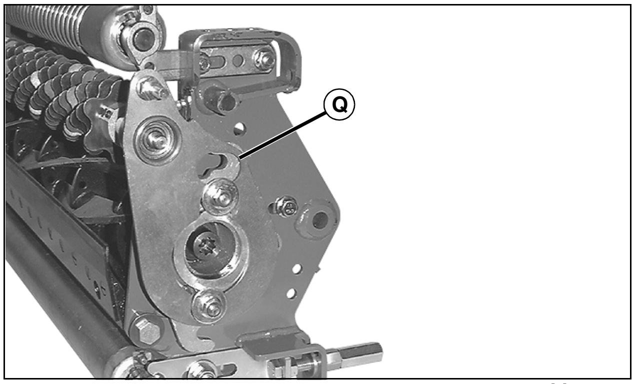
11.Rotate idler gear bracket (N) down to engage the main drive gear (M).

NOTE: There are two bearings and one washer in each arm bearing housing. If the washer is not centered in the housing, the shaft will not fit through both bearings. To hold the washers in position, lubricate each housing lubrication fitting using John Deere Special Purpose HD Water Resistant Grease, then center the washers. (See Specifications and Information section.)



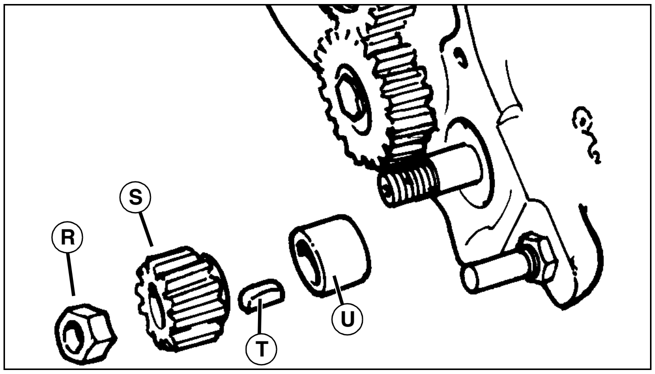
M98568

12.Slide the keyway end of the reel assembly (P) into the bearings in the FTC housing (O).



M98567

13.Install the bracket (Q).



M46877

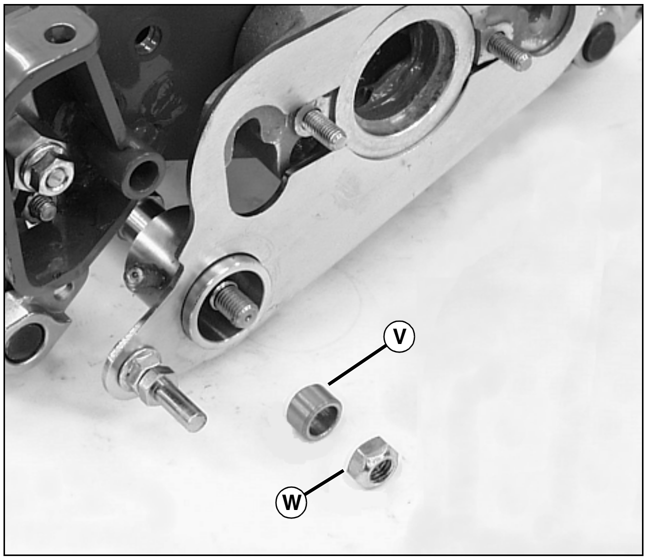
14.Slide large spacer (U) onto the FTC shaft (gear case assembly side).

15.Install key (T) in keyway slot.

16.Install gear (S) onto shaft.

NOTE: Tighten lock nut until there is no play of the conditioner shaft in the reel bearing housing. The shoulder of the shaft should be tight against the bearing.

17.Install and tighten the lock nut (R).

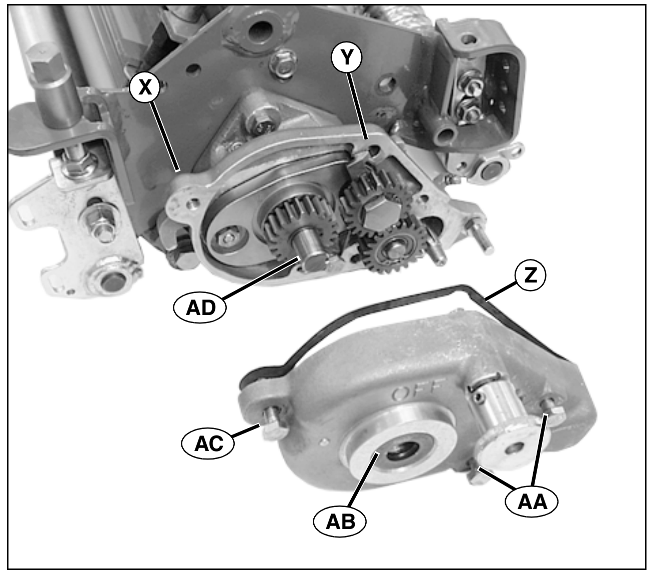


M98092

18.Install spacer (V) on conditioner shaft (bracket side).

NOTE: When properly tightened, the shoulder of the shaft and spacer should be against the bearings.

19.Install and tighten lock nut (W) against spacer.



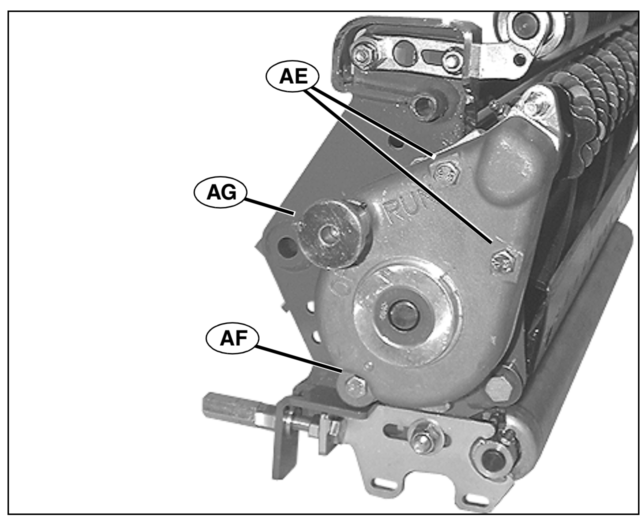
M99035

20.Fill gear case cover with approximately 240 mL (8 oz) of John Deere Corn Head Grease. (See Specifications and Information section.)

21.Apply a light coat of John Deere Corn Head Grease to the end of the drive shaft (AD).

22.Apply a light coat of John Deere Corn Head Grease to the area between the seal (AB) and bearing and to the engagement hole (Y).

23.Install a new gasket (Z) and gear case cover on the gear case assembly (X). Secure the cover using two M8 x 50 hex-flange bolts (AA) and one M8 x 30 hex bolt (AC). DO NOT tighten bolts at this time.

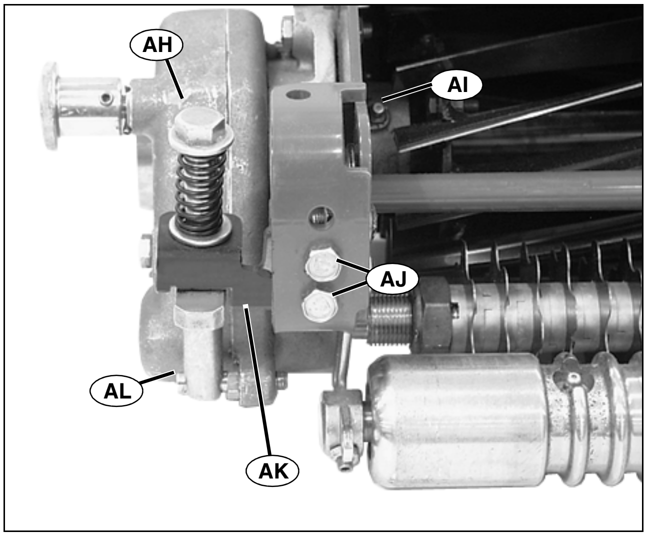


M98562

24.Turn engagement knob (AG) past the OFF position.

25.Tighten the M8 x 30 hex bolt (AF) first, then tighten the two M8 x 50 hex-flange bolts (AE).

26.Check engagement knob for free movement. If the knob does not move freely, remove and reinstall the cover.



M99036

27.Install adjuster assembly (AH) on the mounting bracket stud (AL).

NOTE: The alignment of the stop bracket and mounting holes used will determine the height of cut.

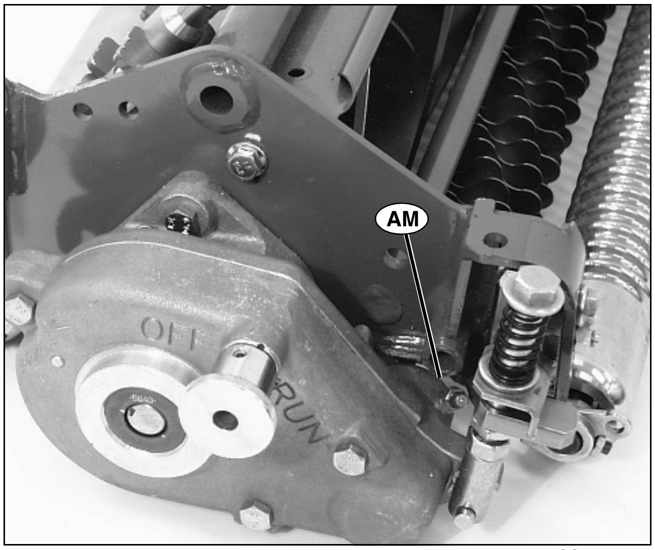
28.Secure the stop bracket (AK) to the cutting unit frame using two cap screws (AJ).

Height of Cut	Cutting Unit Frame Hole
0-12.70 mm (0-1/2 in.)	Top two holes
9.53-15.88 mm (3/8-5/8 in.)	Bottom two holes

29.Apply John Deere Corn Head Grease to the lubrication fittings (AJ) until grease begins to escape from the roller bearing vent plug.

30.Repeat steps 28 and 30 for adjuster assembly on the other side of the cutting unit.

31.Press down on the adjuster assembly bolt and swing the adjuster stop toward the front of the cutting unit on both sides of the cutting unit (engaged position).

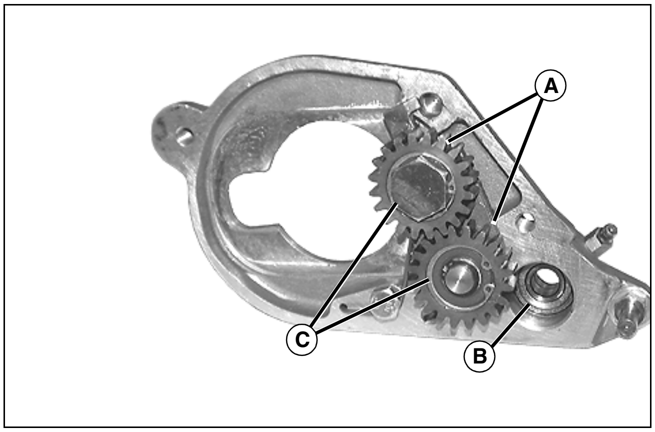


M97456

32.Apply John Deere Special Purpose HD Water Resistance Grease to the lubrication fittings (AM).

Disassemble and Inspect Fairway Tender Conditioner - 2500M

FTC Housing

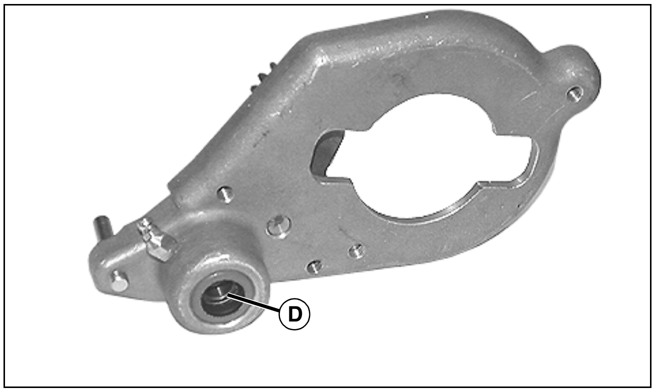


M98593

1. Inspect gears (A) for signs of wear or damage. Replace as needed.

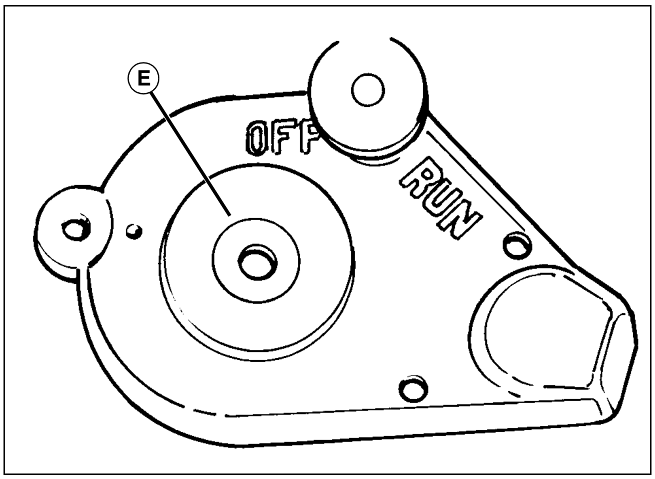
2. Inspect gear bearings (C) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.

3. Inspect reel shaft bearing (B) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



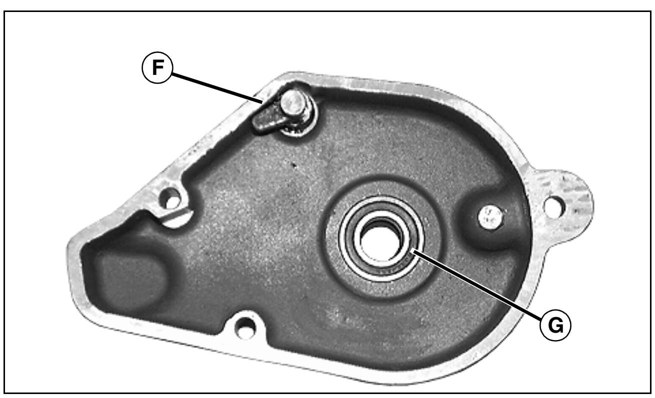
M98594

4. Inspect seal (D) for wear or damage. Replace bearing if it has excessive play or if it is noisy.



M46903

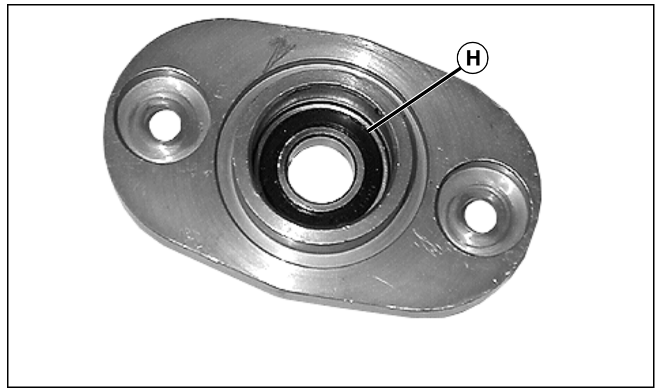
5. Inspect seal (E) in cover for wear or distortion. Replace seal as needed.



M98563

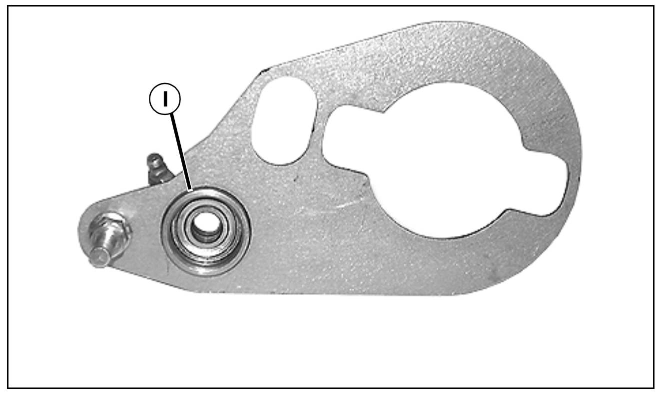
6. Inspect bearing (G) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.

7. Inspect engagement pawl and spring (F) for wear or damage. Replace as needed.



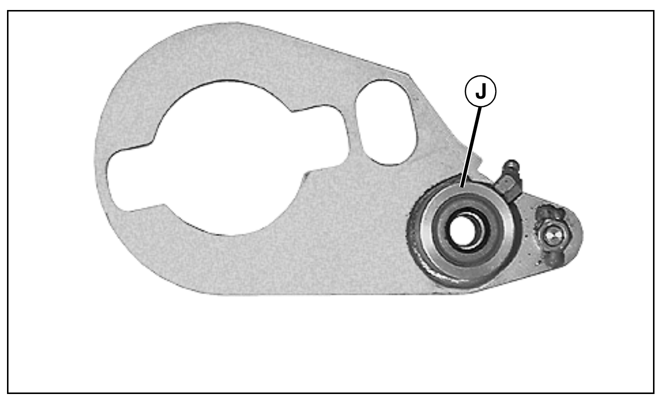
M98592

8. Inspect bearing (H) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



M98599

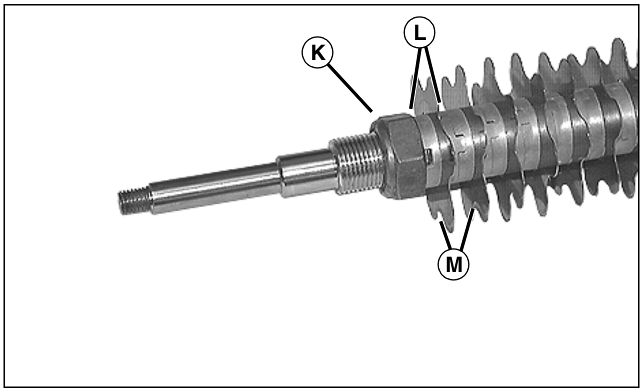
9. Inspect bearing (I) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



M98600

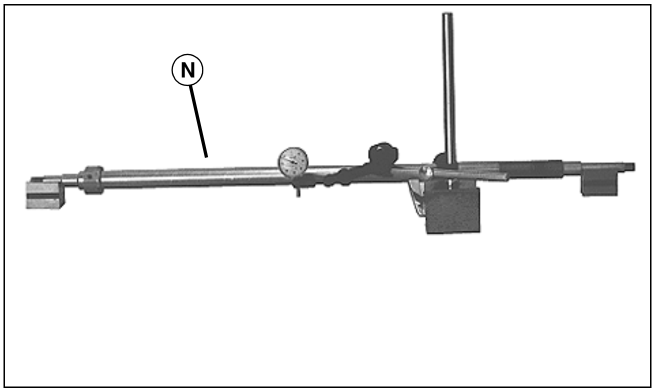
10.Inspect seal (J) in plate for wear or damage. Replace seal as needed.

FTC Shaft Assembly



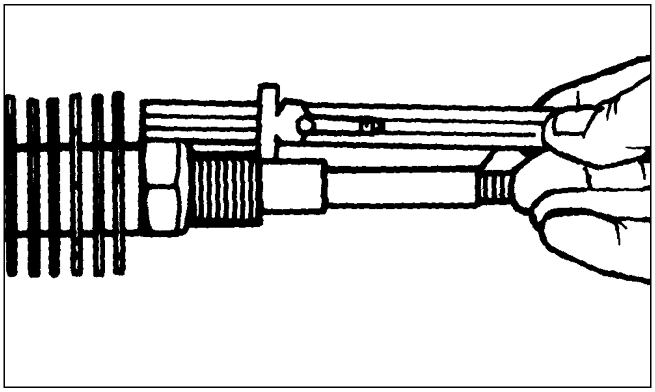
M98566

1. Remove lock nut (K).
2. Remove blades (M) and index rings (L).
3. Inspect blades for excessive wear and broken, cracked or distorted cutting teeth. Replace parts as needed.



M46725

4. Remove debris and/or corrosion from shaft (N) and place on V-blocks. Check runout at the center of the shaft. Runout should not exceed 1.4 mm (0.0625 in.). Straighten or replace shaft as needed.



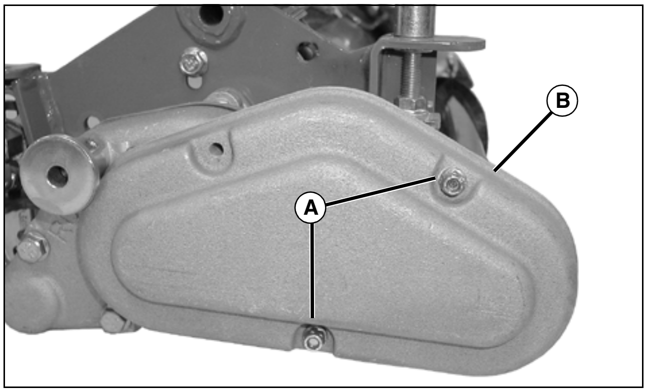
M46886

5. Install index rings and blades on shaft, rotating occasionally to align blades and index rings. Install all spacers and blades until approximately 38 mm (1.50 in.) of exposed thread is left.
6. Stand the shaft on end and shake it slightly to ensure the blades and index rings are aligned.
7. Install locking nut and tighten to specifications.

Specifications

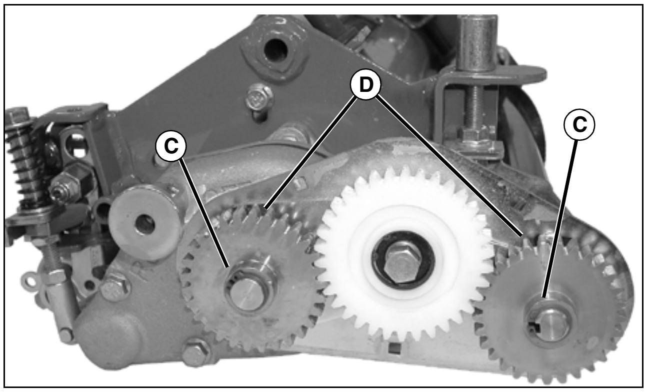
Locking Nut Torque . . . . 47 N•m (35 lb-ft)

Remove Power Brush - 2500M



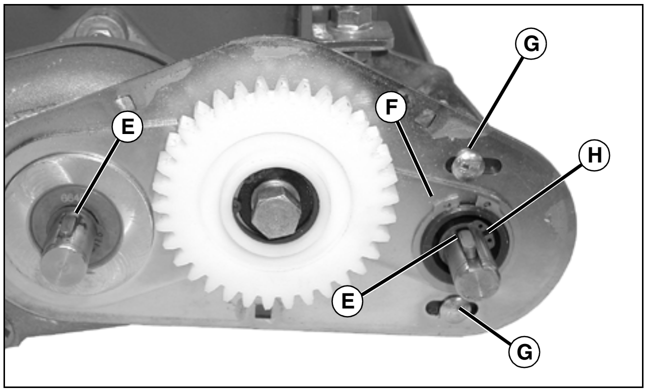
MX18345

1. Remove two carriage bolts and lock nuts (A).
2. Remove cover (B) and gasket.



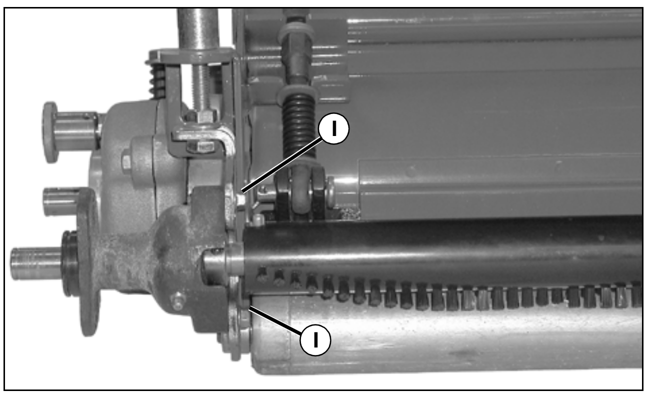
MX18346

3. Remove snap rings (C).
4. Remove gears (D).



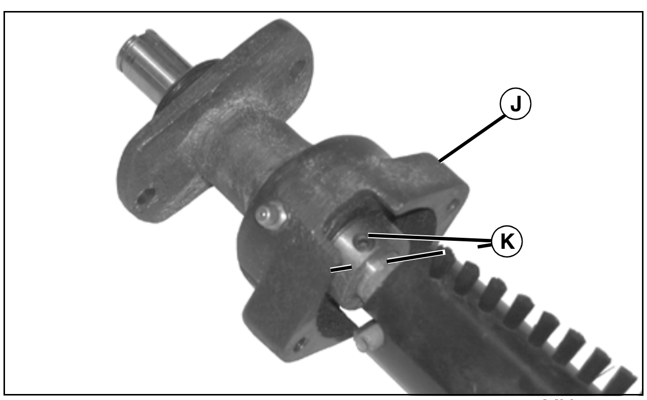
MX18347

5. Remove keys (E) and snap ring (H).
6. Remove two carriage bolts (G) and nuts.
7. Remove snap ring (F).
8. Remove gear plate from cutting unit with attached idler gear.



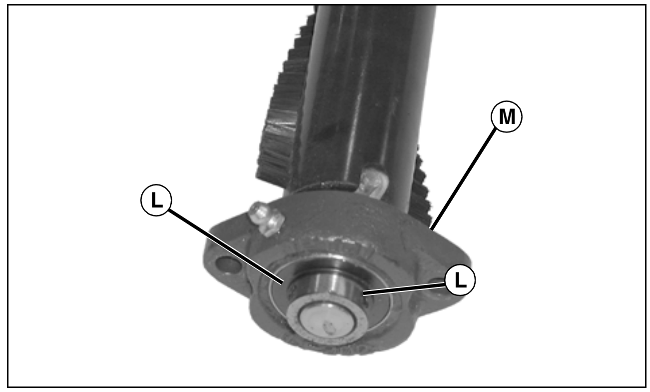
MX18348

9. Remove both cap screws (I) and remove two cap screws and nuts from opposite side of brush. Remove assembly from cutting unit.



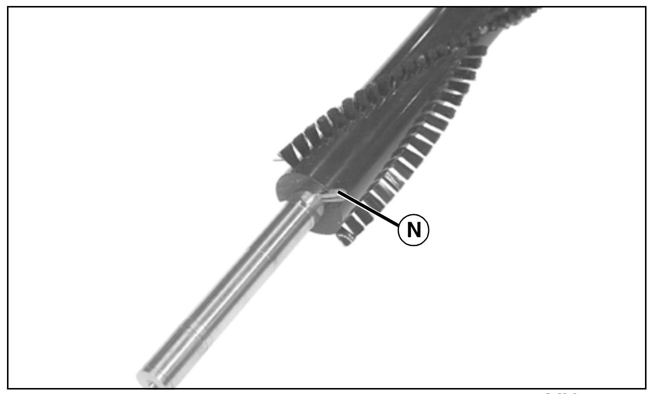
MX18349

10. Remove two set screws (K) and slide off drive housing (J).



MX18350

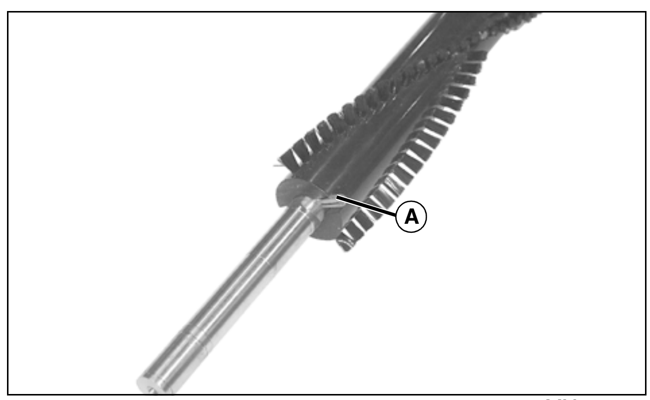
11. Loosen two set screws (L) and slide off bearing flange (M).



MX18318

12. Drive spring pin (N) from shaft using a punch.
13. Remove brush from shaft.

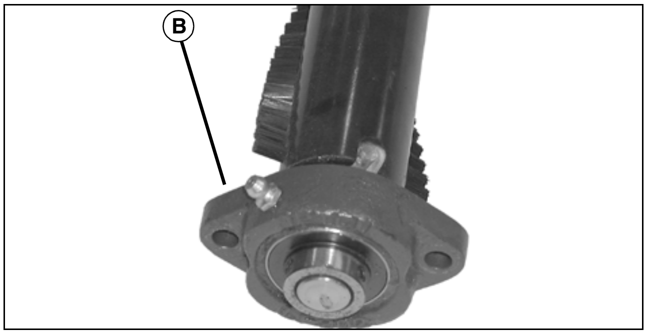
Install Power Brush - 2500M



MX18318

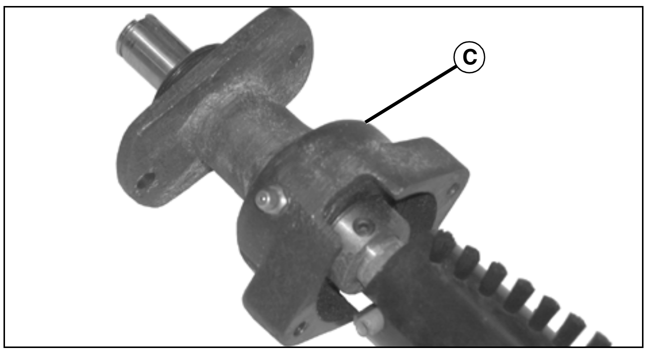
1. Install brush on shaft.
2. Install spring pin (A) to secure brush.

NOTE: The grease fittings will be more accessible for service if the drive housing and bearing flange are installed with the fittings to the rear of the unit.



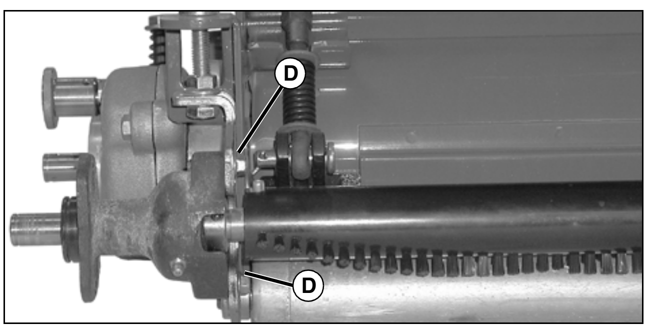
MX18350

3. Install bearing flange (B) to short shaft end of brush. Do not tighten set screws at this time.



MX18349

4. Install brush drive housing (C) on long end of brush. Do not tighten set screws at this time.



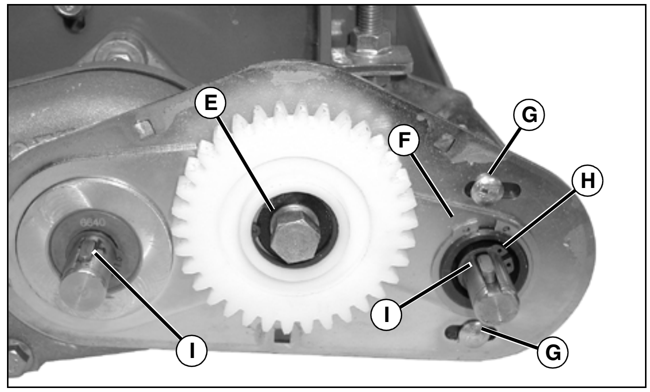
MX18348

5. Install brush assembly to cutting unit.

6. Install both cap screws (D) and two cap screws and nuts on opposite side of cutting unit, securing each bracket on cutting unit.

7. Adjust the brush to the roller with a clearance of 0-1 mm (0-0.031 in.) by raising or lowering brush. Tighten cap screws on both sides of cutting unit.

8. Position the brush between the housings so that the short end of the shaft is flush with the cast bearing. Apply thread locking compound and tighten the set screws in both bearings.



MX18347

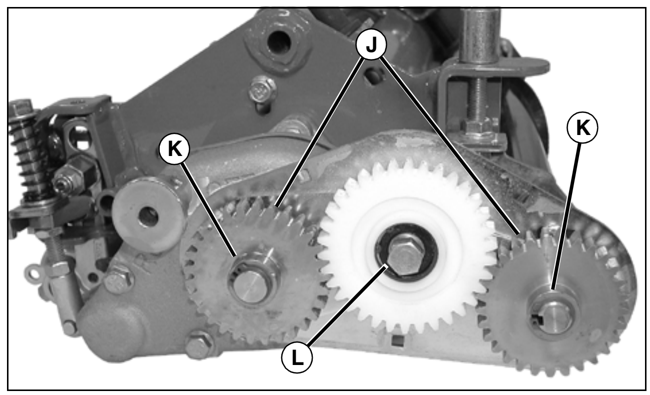
9. Loosen gear shaft bolt (E) before installing plate.

10. Install gear plate and snap ring (F).

11. Install two carriage bolts and nuts (G).

12. Install snap ring (H) on brush shaft.

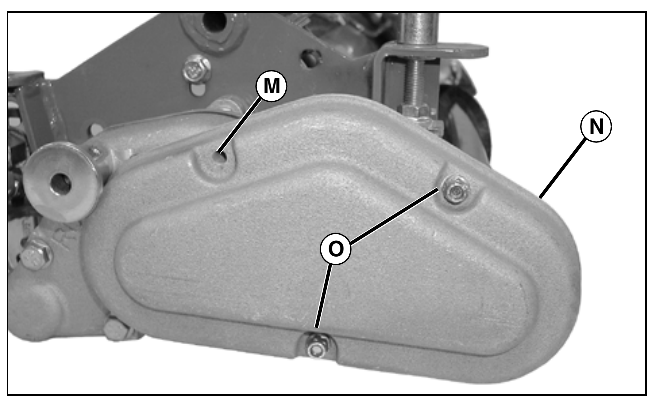
13. Install keys (I).



MX18346

14. Install gears (J) and snap rings (K).

15. Tighten gear shaft bolt (L).

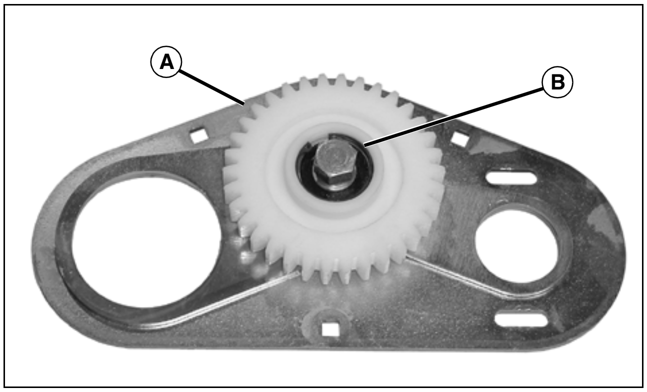


MX18345

16. Install gasket and cover (N).

17. Install two carriage bolts and lock nuts (O). Hole (M) is not used.

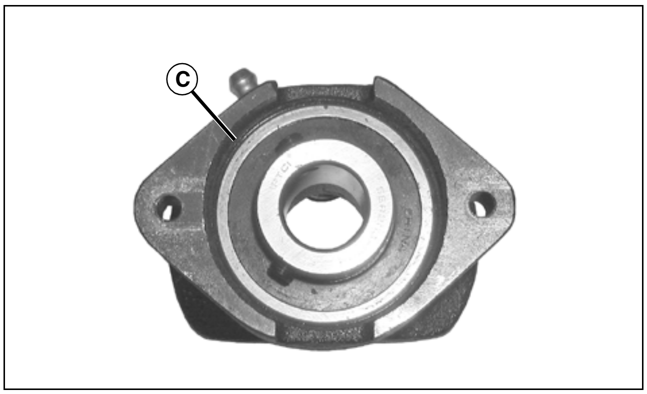
Disassemble and Inspect Power Brush - 2500M



MX18351

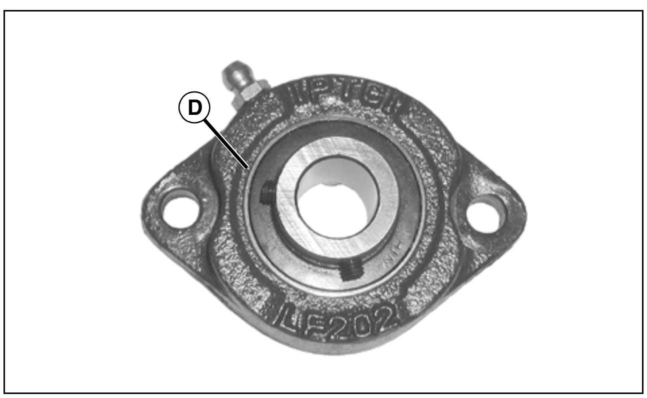
1. Inspect gear (A) for signs of wear or damage. Replace if needed.

2. Inspect bearing (B) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18321

3. Inspect bearing (C) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18322

4. Inspect bearings (D) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

Remove and Install Vertical Cutting Unit - 2500M

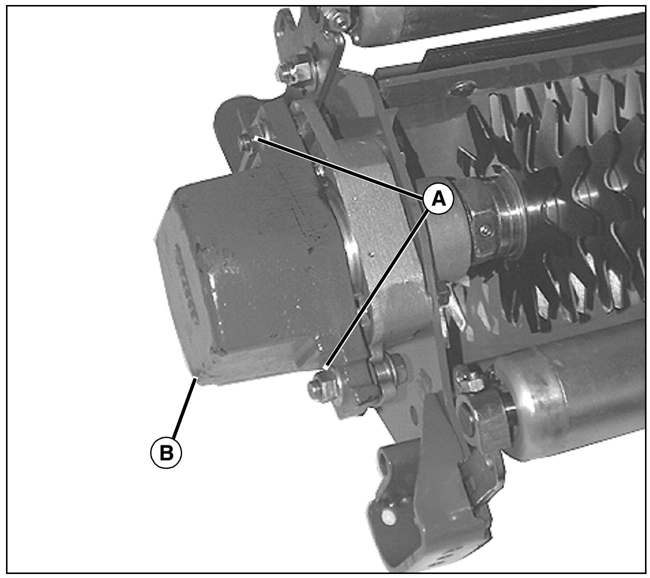
NOTE: Vertical cutting units are removed and installed in the same manner as reel mowers. (See "Remove and Install Cutting Unit - 2500M" on page 452.)

Remove Reel Assembly - Vertical Cutting Unit (2500M)

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

1. Remove cutting units from mower.

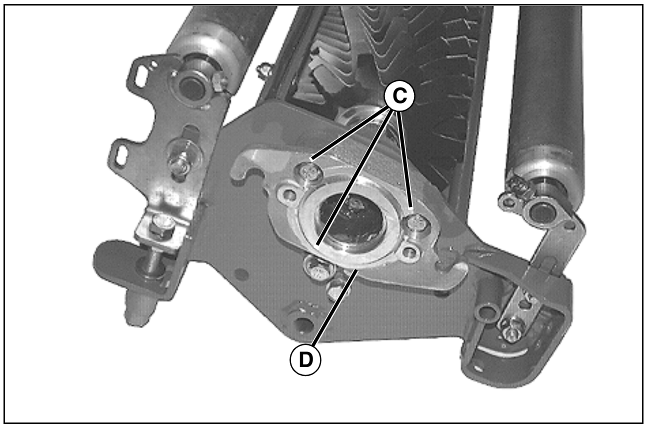
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M98492

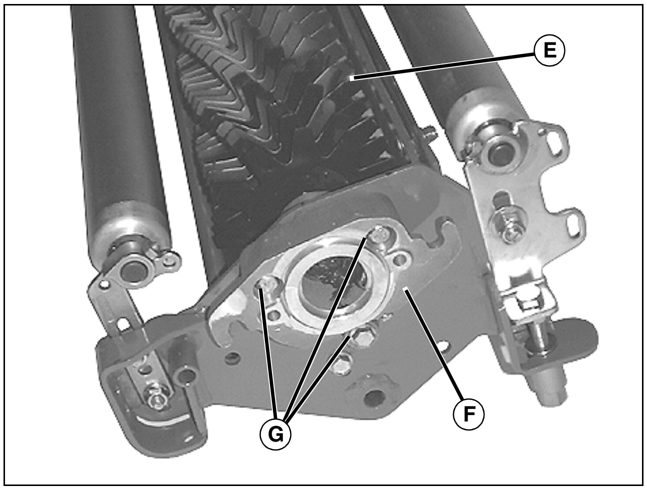
3. Loosen flange nuts (A).

4. Remove weight assembly (B).



M98493

5. Remove three cap screws and nuts (C).
6. Remove bearing housing (D).



M98494

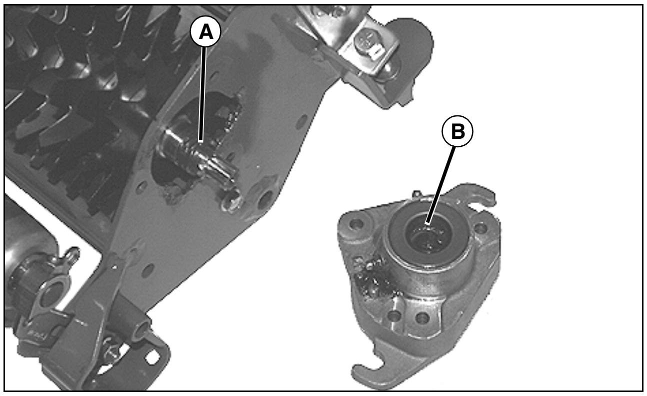
7. Remove three cap screws and nuts (G).
8. Remove reel assembly (E).

NOTE: Remove bearing housing only if repair is required.

9. Remove bearing housing (F).

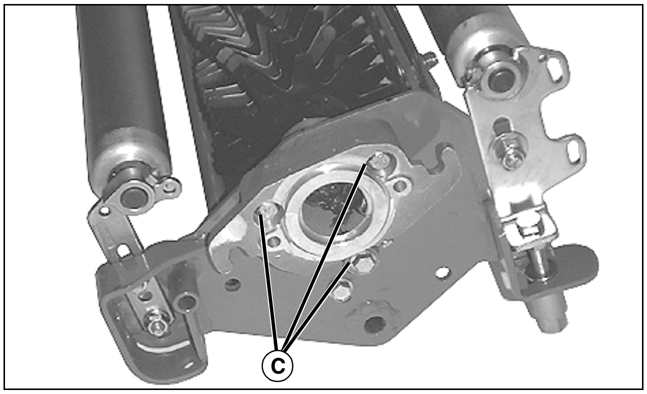
Install Reel Assembly - Vertical Cutting Unit (2500M)

1. Install reel assembly in housing with the shaft end with the keyway on the left side of the frame.



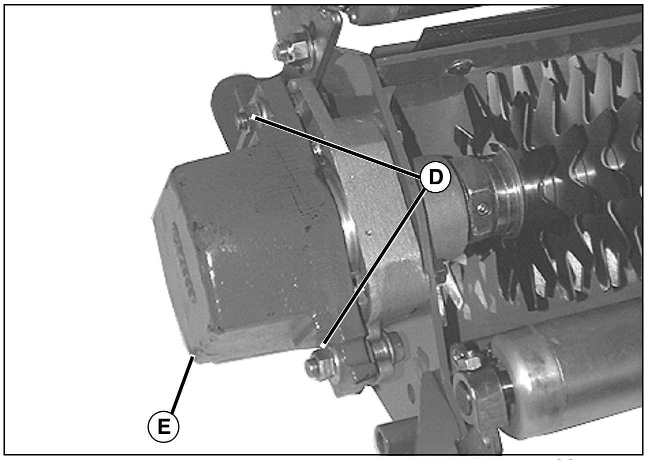
M98495

2. Align the tab (B) on the keyed washer with the keyway (A) on the reel shaft.
3. Install the bearing housing.



M98494

4. Install three cap screws and nuts (C).

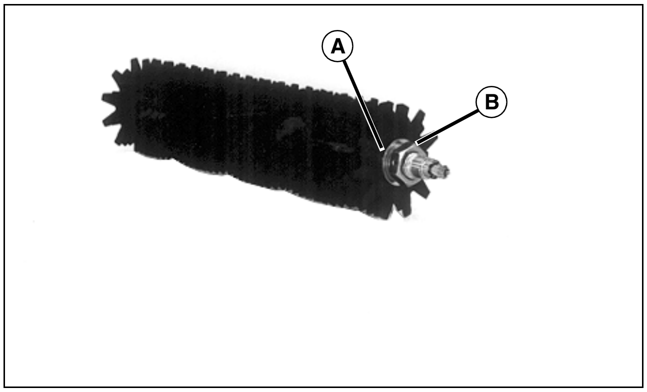


M98492

5. Install weight assembly (E).
6. Tighten flange nuts (D).

Disassemble and Inspect Reel Assembly - Vertical Cutting Unit (2500M)

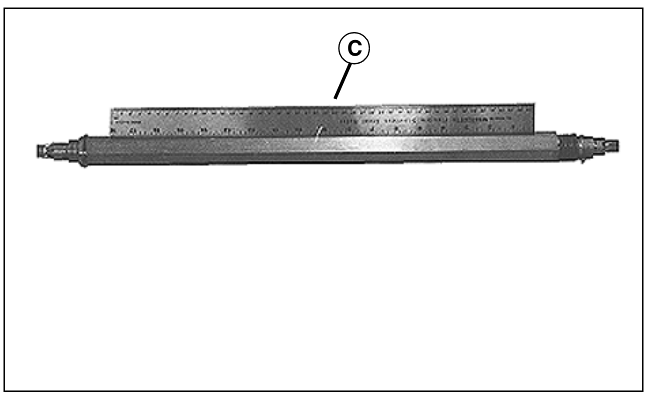
CAUTION: Avoid injury! Always wear gloves when handling reel or cutting blades. Serious personal injury can result from contact with sharp cutting edges.



M46740

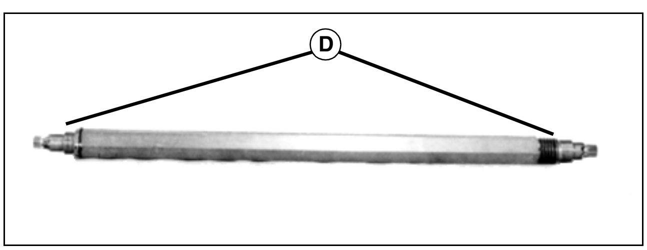
1. Remove set screw (A).

2. Remove nut (B) and remove cutting blades and spacers from reel shaft.



M46741

3. Using a straightedge (C), check shaft for straightness. Shaft runout should not exceed 0.50 mm (0.020 in.).

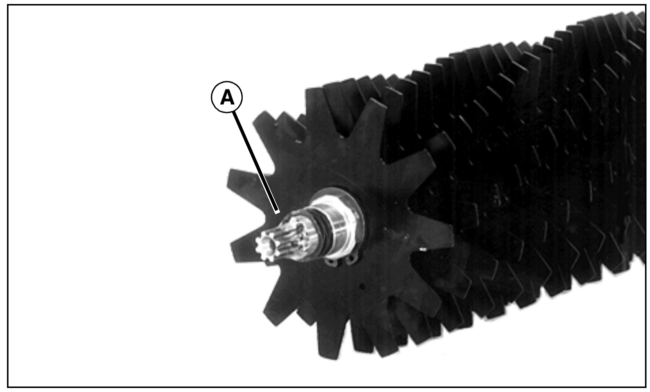


M46742

4. Inspect machined surfaces (D) of shaft for wear or damage. Replace shaft if needed.

Assemble Reel - Vertical Cutting Unit (2500M)

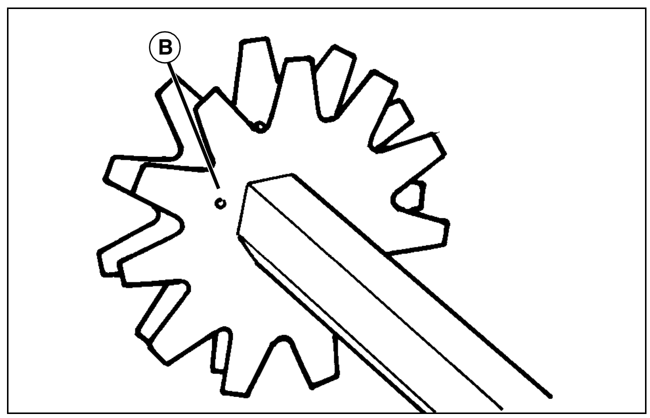
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.



M46743

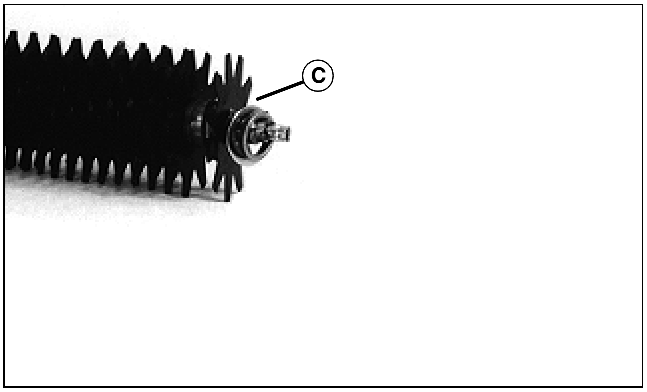
1. Install snap ring (A) in groove on shaft. (Sharp edge of snap ring facing away from the blades.)

NOTE: The cutting unit is shipped with three 6 mm (0.25 in.) spacers between each cutting blade. Fewer spacers and more blades can be used if desired.



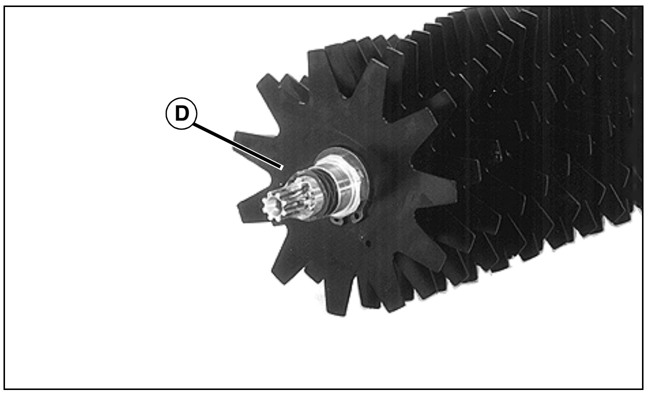
M46882

2. Assemble blades and spacers starting with a blade against the snap ring. Ensure that the index hole (B) of the next blade is placed on the next flat counterclockwise on the shaft as shown. This will establish the proper helix pattern.



M46745

3. After the last cutting blade is installed, install a washer, spacer (C) and nut. Tighten nut until a slight deflection of the cutting blade, next to the snap ring, is observed.

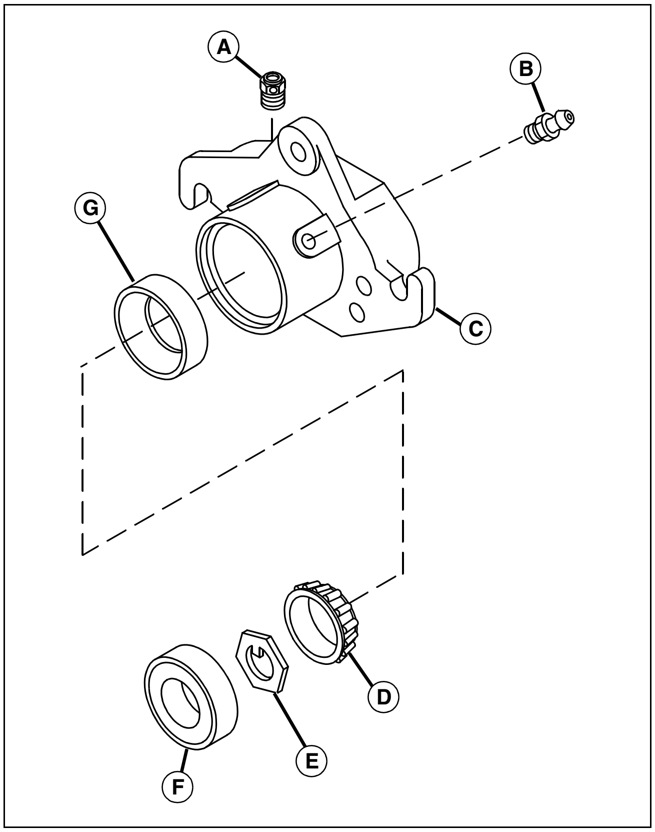


M46746

4. Install set screw (D).

Disassemble and Inspect Bearing Housing - Vertical Cutting Unit (2500M)

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Remove seal (F), tapered roller bearing (D), keyed washer (E) (left side only) and bearing cup (G) from bearing housing (C).

2. Remove grease fitting (B) and breather (A).

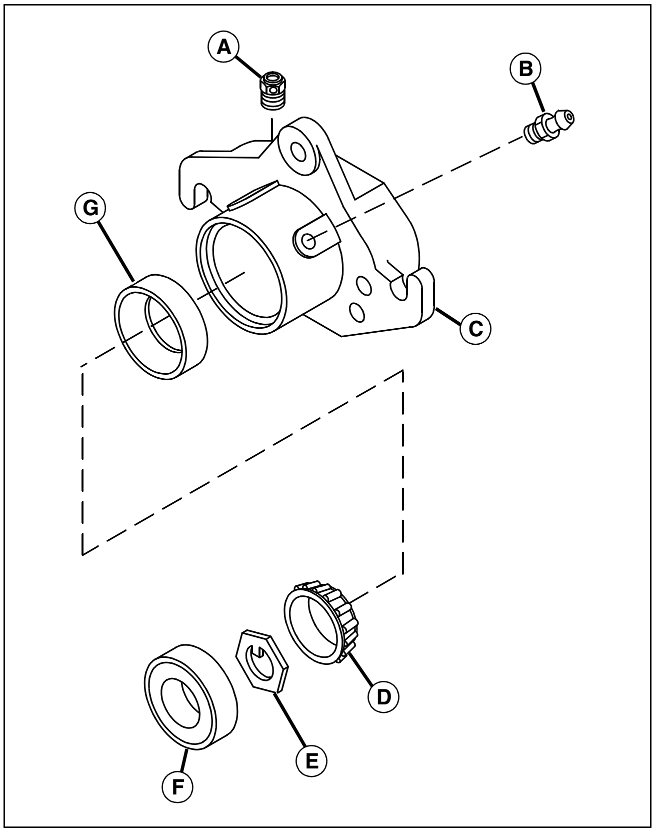
3. Clean bearings and housing with solvent.

IMPORTANT: Avoid damage! Always replace bearings and bearing cups as a set.

4. Inspect bearings and bearing cups for scoring, pitting or bluing from overheating. Replace as needed.

Assemble Bearing Housing - Vertical Cutting Unit (2500M)

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Install bearing cup (G) into housing (C) using a suitable driver or a press (tapered end facing the outside of the housing).

2. Pack bearing (D) with John Deere special purpose golf and turf cutting unit grease and position in the bearing cups.

3. Install keyed washer (E) (left side only).

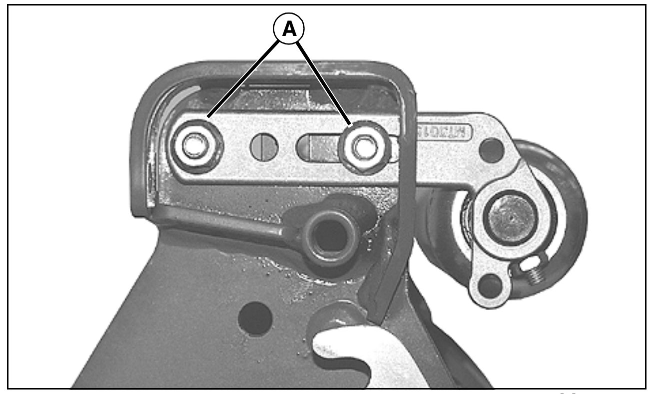
4. Install breather (A) and grease fitting (B).

5. Install seal (F) flush with the face of the housing. Apply John Deere special purpose golf and turf cutting unit grease to the seal lips.

Remove and Install Front Roller - Vertical Cutting Unit (2500M)

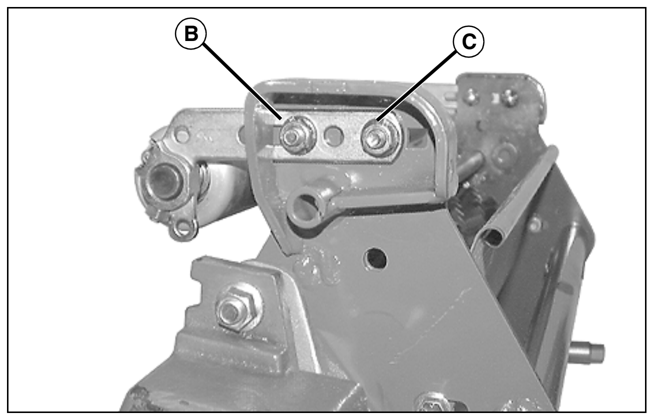
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M84841

3. Remove two flanged nuts and carriage bolts (A).



M98841

4. Remove lower flanged nut and carriage bolt (B) from both sides.

5. Remove nut, serrated washer and carriage bolt (C) from both sides.

6. Remove roller and bracket assembly.

Installation is done in the reverse order of removal.

NOTE: DO NOT install set screws into the holes in the roller bearing shafts.

Roller brackets are offset. For standard use, the bracket should be installed on the roller with the offset to the rear of the cutting unit.

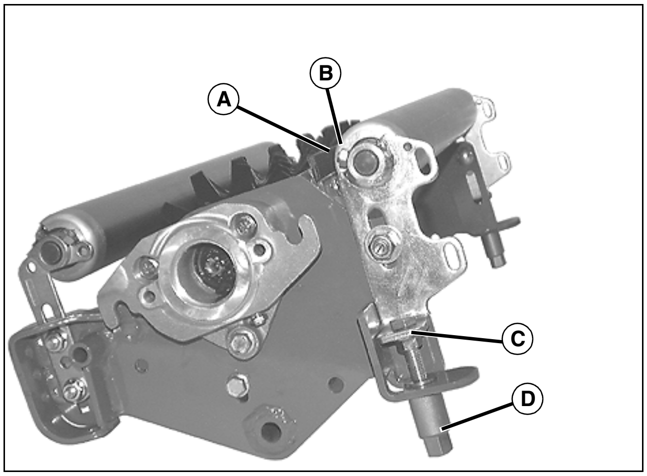
Install roller bracket with the larger holes and adjustment slot on the left side of the cutting unit, in the direction of travel.

• Adjust roller height. (See “Adjust Front Roller - 2500M” on page 416.)

Remove Rear Roller - Vertical Cutting Unit (2500M)

1. Remove cutting units from mower.

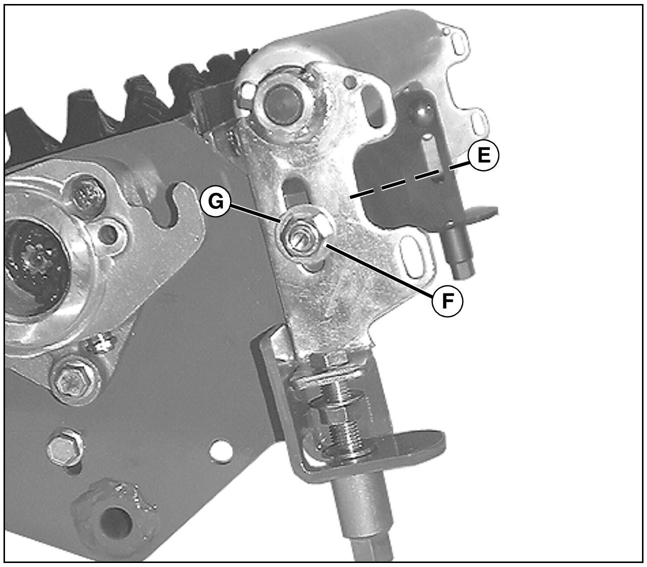
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M98842

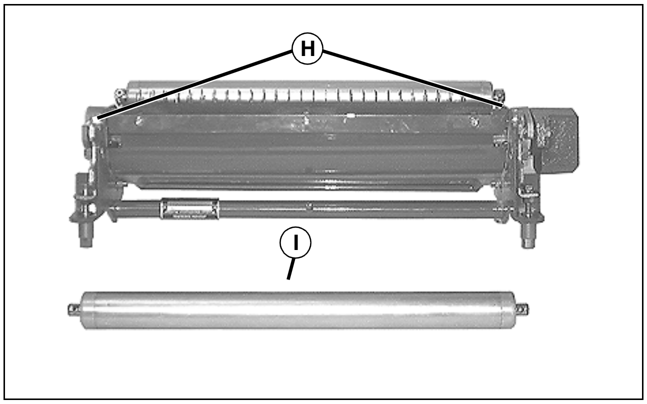
3. Loosen jam nut (B) and set screw (A) on both sides of cutting unit.

4. Loosen jam nut (C) on adjuster tower (D) on both sides of cutting unit.



M98843

5. Remove carriage bolt (E), flat washer (F) and lock nut (G) on both sides of cutting unit.

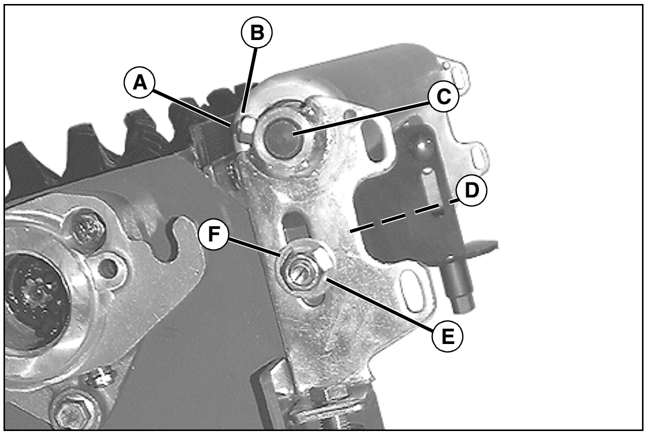


M98844

6. Move height-of-cut brackets (H) away from bearing spindle shaft ends.

7. Remove rear roller (I).

Install Rear Roller - Vertical Cutting Unit (2500M)



M98843

NOTE: DO NOT tighten roller shaft set screws and jam nuts at this time.

1. Install roller bearing spindle shaft (C) into height-of-cut brackets on both sides of machine.

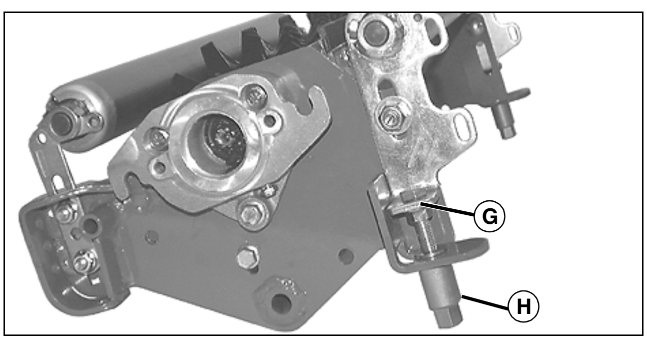
NOTE: Install carriage bolts with the flat washer and nut on the outside of the cutting unit.

2. Attach height-of-cut bracket to cutting unit frame using carriage bolt (D), flat washer (E) and lock nut (F) on both sides of cutting unit.

NOTE: DO NOT install set screws into holes in roller spindle shafts.

3. Center rear roller between height-of-cut brackets.

4. Tighten set screw (A) and jam nut (B) on both sides of cutting unit.



M98842

5. Loosen bracket lock nuts approximately 1/4 turn (both sides of cutting unit).

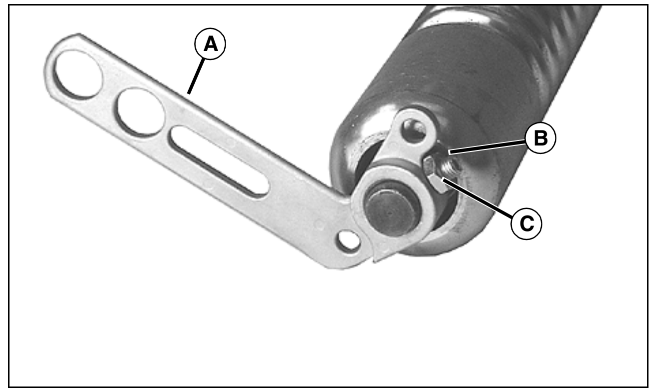
6. Tighten jam nut (G) on adjuster tower (H) on both sides of cutting unit.

7. Tighten bracket lock nuts (both sides of cutting unit).

8. Adjust cutting depth. (See “Adjust Depth-of-Cut - Vertical Cutting Units (2500M)” on page 422.)

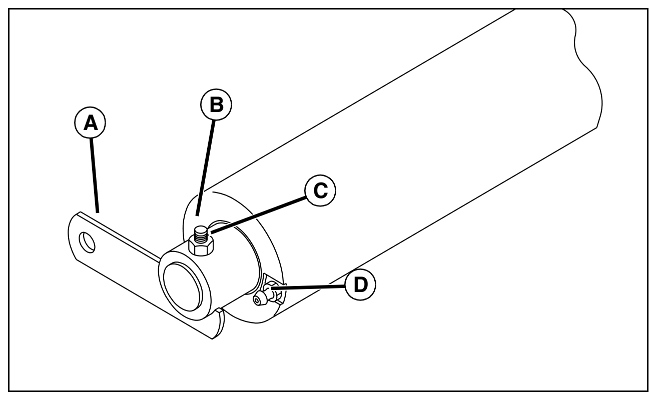
Replace Roller Bearing - Vertical Cutting Unit (2500M)

NOTE: This procedure applies to both smooth and grooved rollers.



M84840

Picture Note: Grooved Roller Shown



M83582

Picture Note: Smooth Roller Shown

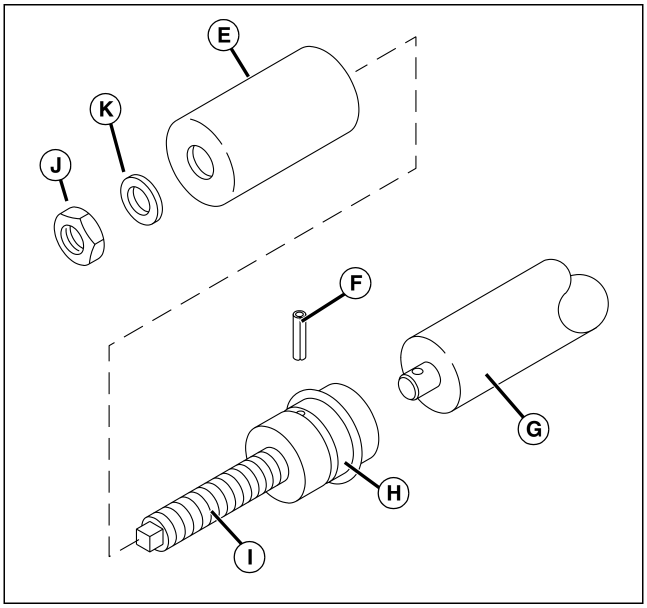
1. Loosen jam nut (C) and remove set screw (B).

NOTE: It may be necessary to press the bearing shaft from the bracket.

2. Remove bracket (A) from bearing shaft.

3. Remove grease fitting (D) (smooth rollers only).

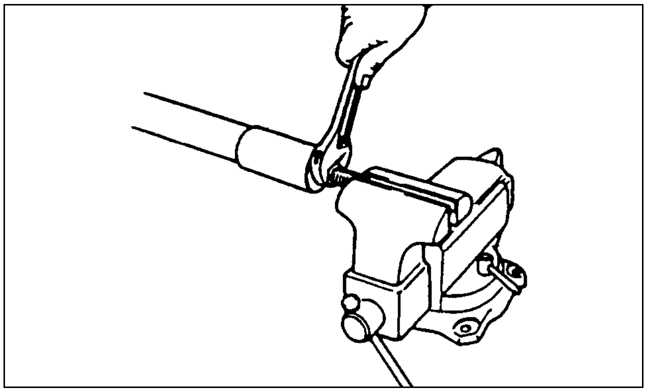
CAUTION: Avoid injury! Wear approved eye protection when using roller bearing puller.



M83583

4. Attach threaded puller (I) to the bearing by inserting the pin (F) through the hole in the bearing shaft and puller. Slide the O-ring (H) over the pin to keep it in position.

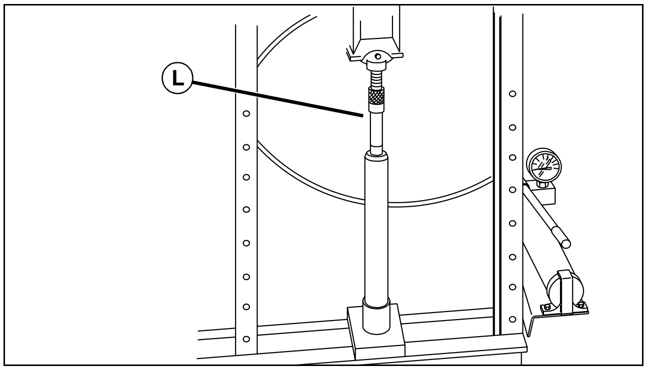
5. Slide roller sleeve (E) over the threaded puller with the concave end of the roller sleeve against the end of the roller (G). Install flat washer (K) and nut (J) on threaded puller.



M83584

6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

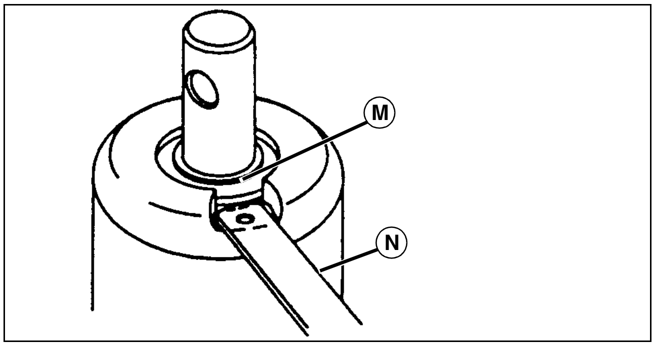
IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outisde of bearing race.



M83586

7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.

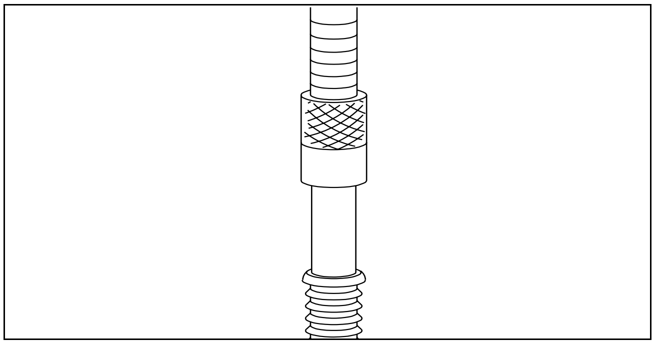
8. Position JD243 or JD506 Bearing Installer (L) over the new bearing in the top end of the roller.



M83585

9. Smooth Rollers: Place a 0.89 mm (0.035 in.) feeler gauge (N) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (M) is flush with the top of the feeler gauge.

10.Install the grease fitting.



M83587

11.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.

INDEX

Numerics

INDEX

D

INDEX

M

O

P

R

S

INDEX

T

V

W