425, 445, and 455
Lawn and Garden Tractors

TECHNICAL
MANUAL

John Deere
Worldwide Commercial and
Consumer Equipment Division

TM1517 (Sep99)
Replaces TM1517 (15Sep96)

Litho in U.S.A

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

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

- Table of Contents
- General Diagnostic Information
- Specifications
- Electrical Wiring Harness Legend
- Component Location
- System Schematic
- Wiring Harness
- Troubleshooting Chart
- Theory of Operation
- Diagnostics
- Tests and Adjustments
- Repair

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

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

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

Safety

Specifications and Information

Engine

Diesel Engine

Electrical

Hydrostatic Power Train

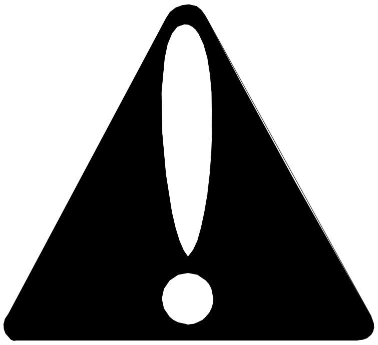
Steering

Brakes

Hydraulics

Miscellaneous

RECOGNIZE SAFETY INFORMATION



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

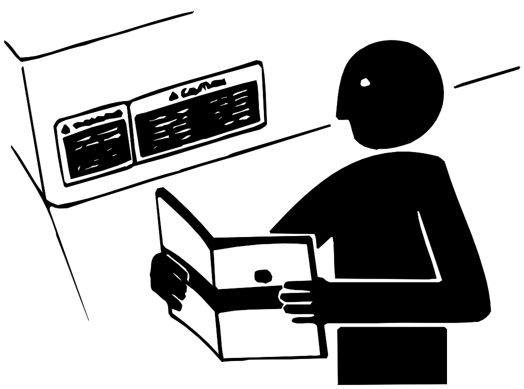
Follow recommended precautions and safe servicing practices.

Understand Signal Words

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

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

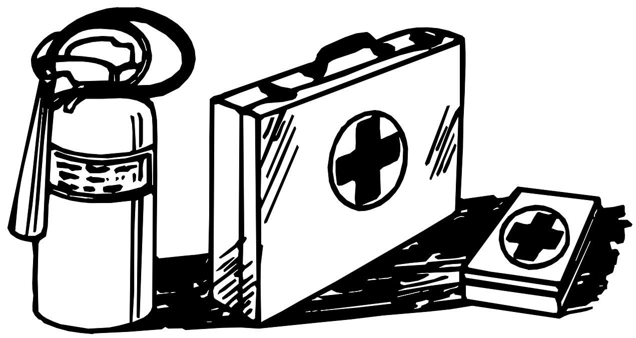
REPLACE SAFETY SIGNS



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

HANDLE FLUIDS SAFELY—AVOID FIRES

Be Prepared for Emergencies



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

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

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

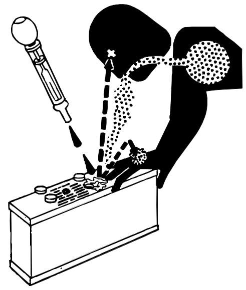
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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

USE CARE IN HANDLING AND SERVICING BATTERIES



Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object across the posts. Use a 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:**

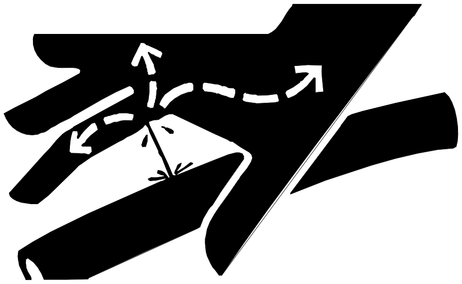
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10—15 minutes.
4. Get medical attention immediately.

- **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



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

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

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

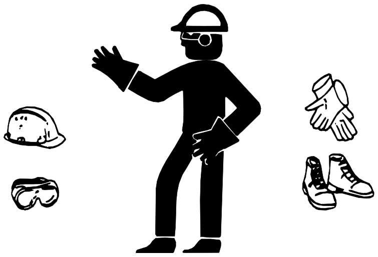
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

Avoid Heating Near Pressurized Fluid Lines

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

USE SAFE SERVICE PROCEDURES

Wear Protective Clothing

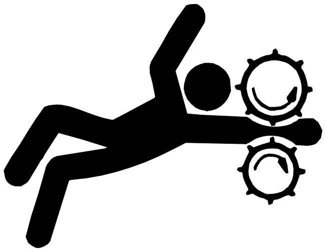


Wear close fitting clothing and safety equipment appropriate to the job.

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

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

Service Machines Safely



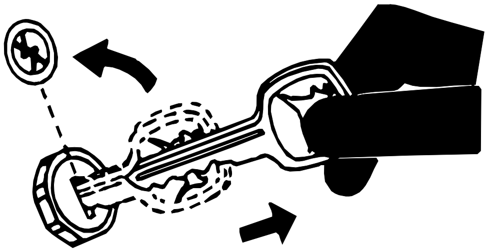
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

Use Proper Tools

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

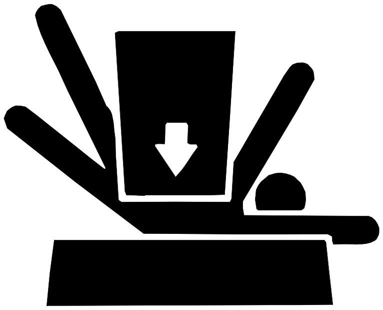
Park Machine Safely



Before working on the machine:

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

Support Machine Properly and Use Proper Lifting Equipment



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

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

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

Work in Clean Area

Before starting a job:

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

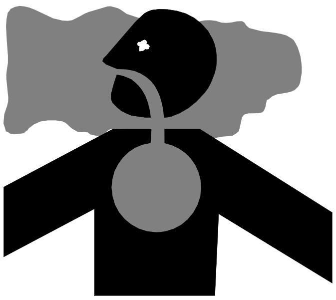
Using High—Pressure Washers

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

Illuminate Work Area Safely

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

Work in Ventilated Area



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

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

WARNING: California Proposition 65 Warning

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

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

Remove Paint Before Welding or Heating

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

Avoid Harmful Asbestos Dust

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

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

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

SERVICE TIRES SAFELY

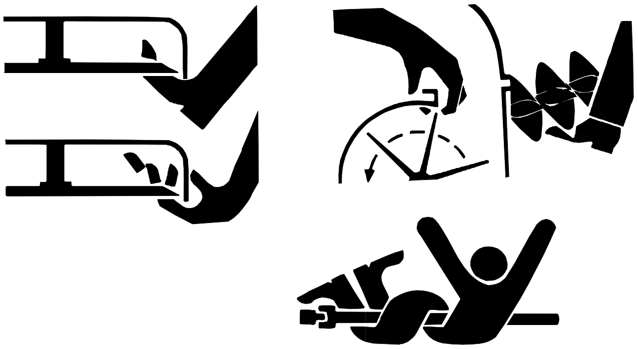
Explosive separation of a tire and rim parts can cause serious injury or death.

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

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

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

AVOID INJURY FROM ROTATING BLADES, AUGERS AND PTO SHAFTS



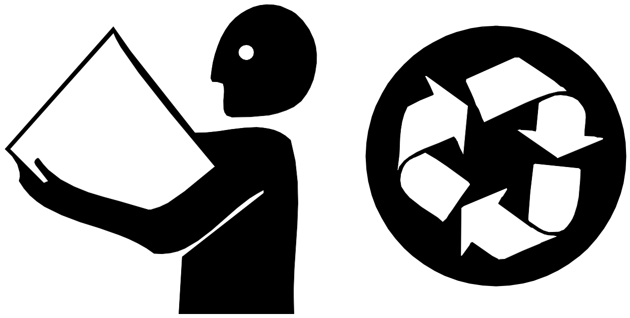
Keep hands and feet away while machine is running. Shut off power to service, lubricate, or remove mower blades, augers, or PTO shafts.

SERVICE COOLING SYSTEM SAFELY

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

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

HANDLE CHEMICAL PRODUCTS SAFELY



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

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

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment 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

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

CONTENTS

SPECIFICATIONS AND INFORMATION

GENERAL VEHICLE SPECIFICATIONS

TORQUE VALUES, NON-STANDARD FASTENERS

All torque specifications are subject to final verication.

NOTE: Torques listed in this GROUP apply ONLY to "special" and/or NON-STANDARD fasteners. Unless otherwise specified, STANDARD fasteners should be torqued per "TORQUE VALUES, STANDARD METRIC METRIC FASTENER" or 'TORQUE VALUES, STANDARD INCH FASTENER".

GASOLINE ENGINE

Engine Mounting Cap Screws . . . . 80 N•m (60 lb-ft)
Valve Clearance Adjusting Nut . . . . 9 N•m (79 lb-in.)
Carburetor Mounting Nuts . . . . 17 N•m (12 lb-ft)
Intake Manifold Cap Screw (Final) . . . . 6 N•m (53 lb-in.)
Pressure Relief Plug . . . . 15 N•m (133 lb-in.)
Thermostat Housing Cap Screws . . . . 6 N•m (53 lb-in.)
Rocker Arm Adjuster Screw Lock Nut . . . . 9 N•m (79 lb-in.)
Cylinder Head Cap Screw (Final) . . . . 21 N•m (186 lb-in.)
Spark Plug . . . . 20 N•m (177 lb-in.)
Crankcase Cover Cap Screw . . . . 21 N•m (186 lb-in.)
Crankcase Drain Plug . . . . 23 N•m (204 lb-in.)
Connecting Rod Cap Screw . . . . 21 N•m (186 lb-in.)
Coolant Pump Cap Screw . . . . 8 N•m (70 lb-in.)
Crankcase Cover Cap Screw . . . . 23 N•m (17 lb-ft)
Oil Pump Cover Cap Screw . . . . 7.8 N•m (69 lb-in.)
Ignition Coil Cap Screws . . . . 9.8 N•m (87 lb-in.)
Starting Motor Mounting Cap Screw . . . . 15.3 N•m (135 lb-in.)
Governor Arm Nut . . . . 7.8 N•m (69 lb-in.)

Flywheel:

Flywheel Nut . . . . 108 N•m (80 lb-ft)
Flywheel Sheave . . . . 15 N•m (130 lb-ft)
Fan Belt Drive Sheave Screw . . . . 15 N•m (133 lb-in.)

Carburetor—425:

Throttle Shaft Retaining Screw . . . . 2 N•m (17 lb-in.)
Drain Screw . . . . 1.2 N•m (10 lb-in.)
Choke and Throttle Valve Screw . . . . 0.88 N•m (7.8 lb-in.)
Solenoid Valve Torque . . . . 9.8 N•m (87 lb-in.)
Main Jet and Main Air Jet Torque . . . . 1.0 N•m (8.9 lb-in.)
Air Horn Mounting Screws . . . . 2.9 N•m (26 lb-ft)

Throttle Body—445:

Throttle Shaft Retaining Screw . . . . 2.0 N•m (17 lb-ft)
Throttle Plate Screws . . . . 2.0 N•m (17 lb-ft)
Mounting Stud Nuts Torque . . . . 17 N•m (12 lb-ft)

DIESEL ENGINE

Muffler-to-Manifold Nuts	28 N•m (20 lb-in.)
Thermostat Housing Cap Screw	9 N•m (78 lb-in.)
Nozzle Torque	50 N•m (37 lb-ft)
Piston and Connecting Rod Cap Screw	23 N•m (97 lb-in.)
Seal Case-to-Block Cap Screw	11 N•m (96 lb-in.)
Oil Pan-to-Seal Case Cap Screw	9 N•m (78 lb-in.)
Crankshaft Main Bearing Cap Screw	54 N•m (40 lb-ft)
Camshaft Mounting Cap Screw.	11 N•m (96 lb-in.)
Intake Manifold Cap Screws	11 N•m (96 lb-in.)
Exhaust Manifold Cap Screw/Nut	11 N•m (96 lb-in.)
Rocker Arm Cover Special Screw	18 N•m (160 lb-in.)
Rocker Arm Assembly Mounting Cap Screw and Nut	26 N•m (19 lb-ft)
Cylinder Head Cap Screws (Final)	34 N•m (25 lb-ft.)
Oil Pump Mounting Cap Screw	25 N•m (18 lb-ft)
Flywheel Cap Screws	83 N•m (61 lb-ft)
Flywheel Plate Mounting Cap Screw.	49 N•m (36 lb-ft)

Cooling System:

Coolant Pump Mounting Cap Screws	26 N•m (19 lb-ft)
Cooling Fan Mounting Cap Screw	11 N•m (96 lb-in.)
Coolant Pump Plate-to-Housing Screw.	9 N•m (78 lb-in.)

Fuel Injection:

Pump Mounting Nut	20 N•m (180 lb-in.)
Pump Camshaft Bearing Retaining Screw	20 N•m (180 lb-in.)
Mounting Nut	40 N•m (30 lb-ft)
Nozzle Fitting	40 N•m (30 lb-ft)

Oil Pan and Strainer:

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

Timing Gear Cover and Housing:

Fan Mounting Cap Screw	11 N•m (96 lb-in.)
Cover Mounting Cap Screw	9 N•m (78 lb-in.)
Crankshaft Pulley Cap Screw	115 N•m (85 lb-ft)
Aluminum Housing-to-Block	9 N•m (78 lb-in.)
Cast Iron Housing-to-Block	11 N•m (96 lb-in.)

Alternators:

Flywheel Assembly-to-Coil Plate Assembly Nut (KoKosan 20A).	27 N•m (20 lb-ft)
Retainer-to-Front Frame Screw (Nippeondenso 40A)	2 N•m (16 lb-in.)
Sheave Nut (Nippeondenso 40A)	69 N•m (51 lb-ft)

POWER TRAIN, HYDROSTATIC

Control Arm Cap Screw	73 N•m (54 lb-ft)
Axle Housing Cap Screws Torque	54 N•m (40 lb-ft)
King Pin Cap Screws Torque	54 N•m (40 lb-ft)
Transaxle to Frame Mounting Cap Screws	88 N•m (65 lb-ft)
Differential Bolts	78—98 N•m (58—72 lb-ft)

PTO:

Solenoid Armature	22 N•m (195 lb-in.)
Solenoid Nut	4.9 N•m (43 lb-in.)
Output Shaft Retaining Cap Screws	27 N•m (20 lb-ft)
Shifter Shaft Cap Screw	25 N•m (18 lb-ft)
Ball Switches	34 N•m (25 lb-ft)

Charge Pump Cap Screws:

Short Cap Screws Torque	25 N•m (18 lb-ft)
Long Cap Screw Torque	39 N•m (29 lb-ft)

Hydrostatic Center Valve Block:

Directional Control Valves	35 N•m (26 lb-ft)
Bottom Suction Plug	50 N•m (37 lb-ft)
Implement Relief Valve Plug	25 N•m (18 lb-ft)
Mounting Cap Screws	39 N•m (29 lb-ft)

STEERING

Steering Wheel Nut	38 N•m (28 lb-ft)
Steering Valve End Cover Cap Screw	17 N•m (150 lb-in.)
Check Ball Plug	17 N•m (150 lb-in.)
Front Axle Pivot Cap Screw and Lock Nut	68 N•m (50 lb-ft)
Tie Rod Lock Nut	61 N•m (45 lb-ft)
Rear Steering Linkage Lock Nut	170 N•m (125 lb-ft)
Adjusting Nut Jam Nuts	68 N•m (50 lb-ft)
Rear Steering Side Pivots Pivot Lock Nut	108 N•m (80 lb-ft)
Mounting Cap Screw and Nut	84 N•m (62 lb-ft)
Rear Axle Pivot Bracket Cap Screws	91 N•m (67 lb-ft)
Pivot Nut	67—83 N•m (49—61 lb-ft)
Ball Joint Castellated Nut	45—57 N•m (33—42 lb-ft)

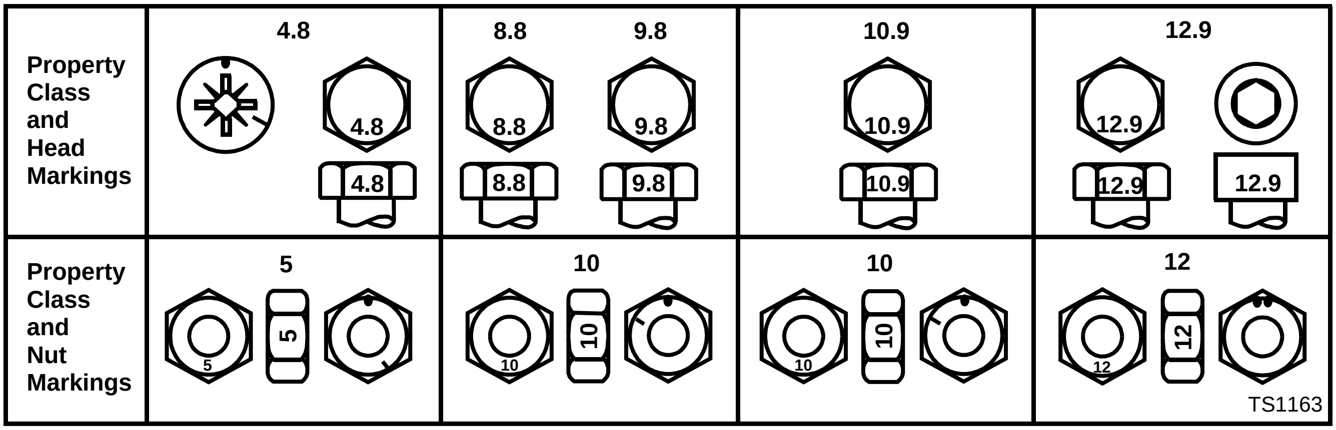
BRAKES

Transaxle Brake Cover Cap Screws Used Transaxle Case	25 N•m (18 lb-ft)
New Transaxle Case	30 N•m (22 lb-ft)
Brake Switch Striker	12 N•m (108 lb-in.)

HYDRAULICS

Return Spring Bonnet Retaining Screw	2.7—4 N•m (24—36 lb-in.)
Return Spring Caps Retaining Screw	2.7—4 N•m (24—36 lb-in.)
Detent Ball Retaining Screw	2.7—4 N•m (24—36 lb-in.)
Work Port Cap	34—40.7 N•m (25—30 lb-ft)
Lift Check Valves Cap Screw	20—27 N•m (15—20 lb-ft)

METRIC FASTENER TORQUE VALUES



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

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

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

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

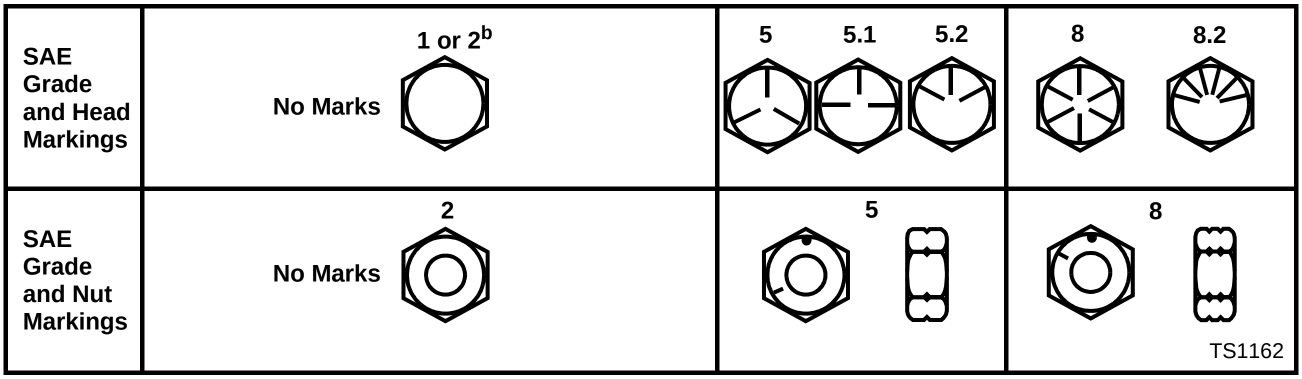
When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

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

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

Reference: JDS—G200.

INCH FASTENER TORQUE VALUES



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

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

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

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

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

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

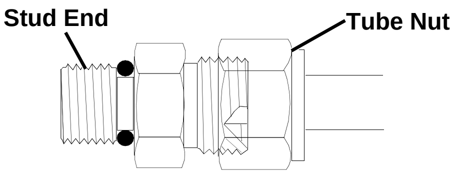
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

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

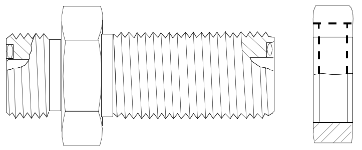
Reference: JDS—G200.

O-RING SEAL SERVICE RECOMMENDATIONS

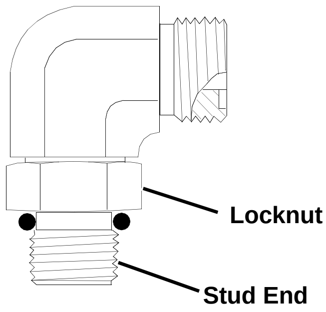
FACE SEAL FITTINGS WITH INCH STUD ENDS TORQUE



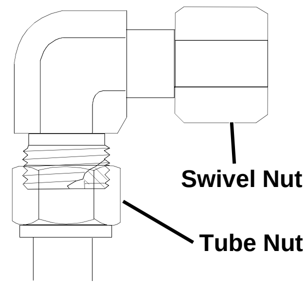
Stud Straight and Tube Nut



Bulkhead Union and Bulkhead Lucknut



90 Adjustable Stud Elbow

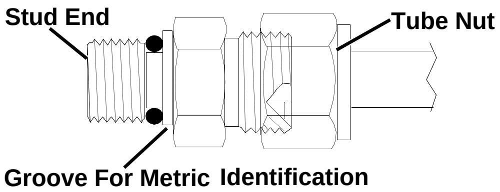


90 Swivel Elbow and Tube Nut

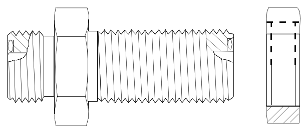
Nominal Tube O.D./Hose I.D.				Face Seal Tube/Hose End					O-ring Stud Ends		
Metric Tube O.D.	Inch Tube O.D.			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76		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

NOTE: Torque tolerance is +15 / –20%.

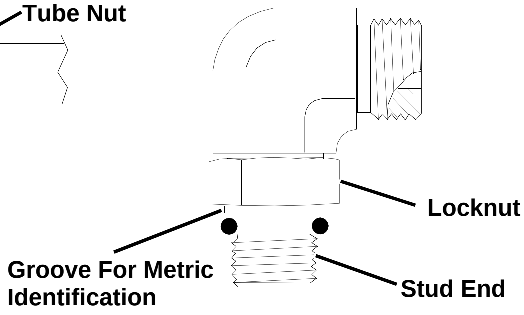
FACE SEAL FITTINGS WITH METRIC STUD ENDS TORQUE



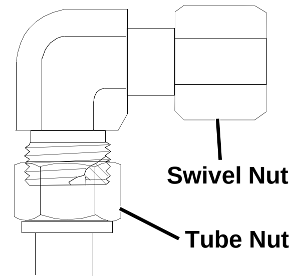
Stud Straight and Tube Nut



Bulkhead Union and Bulkhead Lucknut



90 Adjustable Stud Elbow

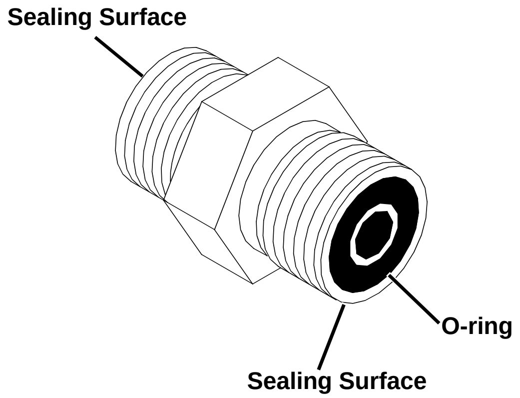


90 Swivel Elbow and Tube Nut

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

NOTE: Torque tolerance is +15 / –20%.

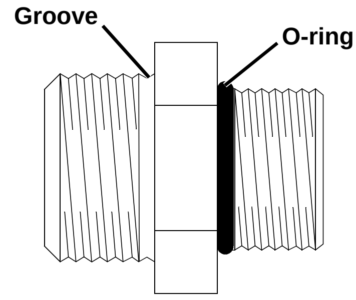
O-RING FACE SEAL FITTINGS



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

O-RING BOSS FITTINGS

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



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

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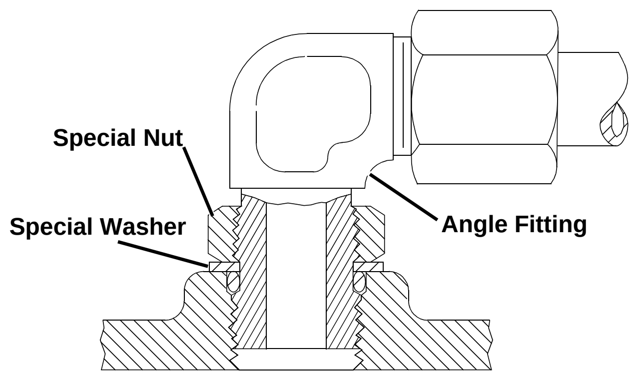


3. For angle fittings, loosen special nut and push special washer against threads so O-ring can be installed into the groove of fitting.
4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.
5. To position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

STRAIGHT FITTING OR SPECIAL NUT TORQUES

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

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

METRIC FASTENER TORQUE VALUE—GRADE 7 (SPECIAL)

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

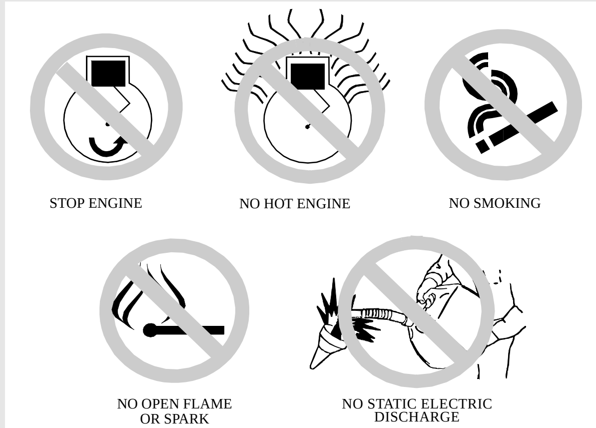
GASOLINE
4–CYCLE ENGINES

c CAUTION

Gasoline is HIGHLY FLAMMABLE, handle it with care.

DO NOT refuel machine while:

- **indoors, always fill gas tank outdoors;**
- **machine is near an open flame or sparks;**
- **engine is running, STOP engine;**
- **engine is hot, allow it to cool sufficiently first;**
- **smoking.**



Help prevent fires:

- **fill gas tank to bottom of filler neck only;**
- **be sure fill cap is tight after fueling;**
- **clean up any gas spills IMMEDIATELY;**
- **keep machine clean and in good repair–free of excess grease, oil, debris, and faulty or damaged parts;**
- **any storage of machines with gas left in tank should be 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.**

To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:

- **ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.**

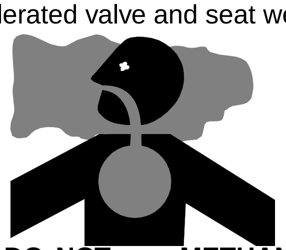
To avoid engine damage:

- DO NOT mix oil with gasoline;
- **ONLY use clean, fresh unleaded gasoline with an octane rating (anti-knock index) of 87 or higher**;
- fill gas tank at the end of each day's operation to help prevent condensation from forming inside a partially filled tank;
- keep up with specified service intervals.

Use of alternative oxygenated, gasohol blended, unleaded gasoline is acceptable as long as:

- the ethyl or grain alcohol blends DO NOT exceed 10% by volume or
- methyl tertiary butyl ether (MTBE) blends DO NOT exceed 15% by volume

RFG (reformulated) gasoline is acceptable for all tractors designed for use of regular unleaded fuel. Older tractors (that were designed for leaded fuel) may see some accelerated valve and seat wear.



IMPORTANT: DO NOT use METHANOL gasolines because METHANOL is harmful to the environment and to your health.

c WARNING

<u>California Proposition 65 Warning:</u> Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

GASOLINE STORAGE

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

Keep gasoline stored in a safe, protected area. Storage of gasoline in a clean, properly marked **("UNLEADED GASOLINE") POLYETHYLENE PLASTIC container WITHOUT** any metal screen or filter is recommended. **DO NOT** use de-icers to attempt to remove water from gasoline or depend on fuel filters to remove water from gasoline. Use a water separator installed in the storage tank outlet. **BE SURE** to properly discard unstable or contaminated gasoline. When storing unit or gasoline, it is recommended that you add **John Deere Gasoline Conditioner and Stabilizer (TY15977)** or an equivalent to the gasoline. **BE SURE** to follow directions on container and to properly discard empty container.

DIESEL FUEL

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

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

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

- Cetane Number 40 (minimum)

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

- Cold Filter Plugging Point (CFPP)

  The air temperature at which diesel fuel **begins to cloud or jell** — at least 5°C (9°F) below the expected low air temperature range.

- Sulfur Content of 0.05%

  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 0.05%, reduce the service interval** for engine oil and filter by **50%**.

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

WARNING

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

DIESEL FUEL LUBRICITY

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

DIESEL FUEL STORAGE

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

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

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

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

ENGINE OIL SPECIFICATIONS

4–CYCLE DIESEL ENGINE OIL

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

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

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

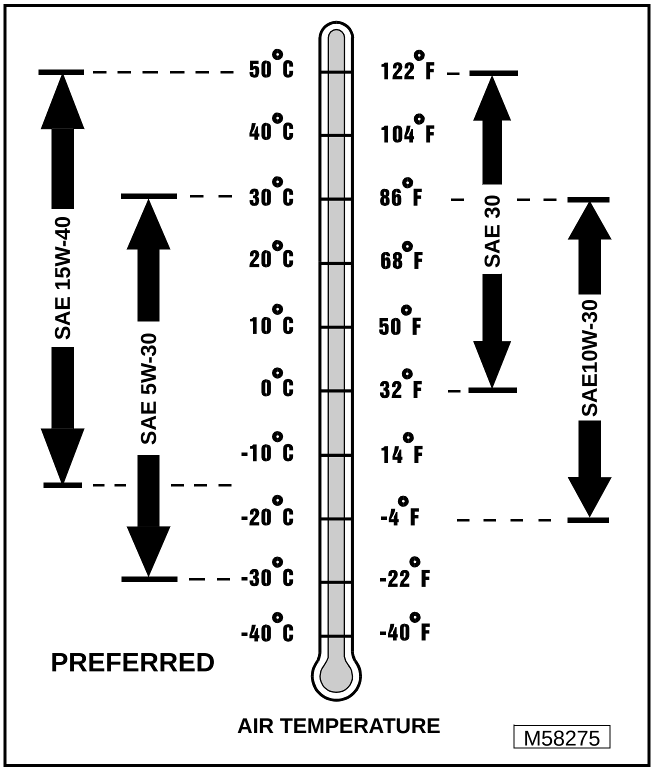
The following John Deere oils are **also recommended**, based on their specified temperature range:

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

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



4–CYCLE GASOLINE ENGINE OIL

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

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

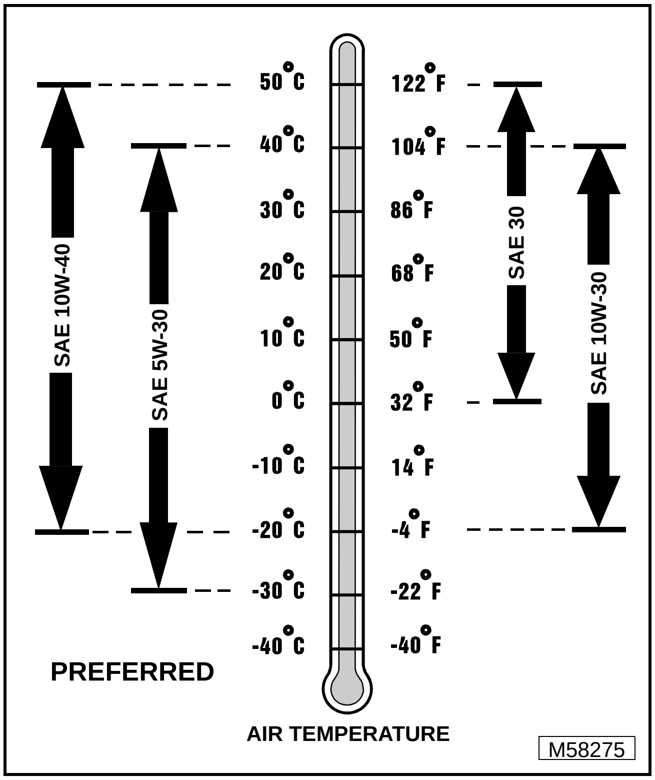
- **PLUS–4®—SAE 10W-40**;
- **TORQ–GARD SUPREME®—SAE 5W-30**.

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 10W-40—API Service Classifications SG or higher;
- SAE 5W-30—API Service Classification SG or higher;
- SAE 10W-30—API Service Classifications SG or higher;
- SAE 30—API Service Classification SC or higher.



BREAK-IN ENGINE OIL—DIESEL

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

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

- **BREAK–IN ENGINE OIL**.

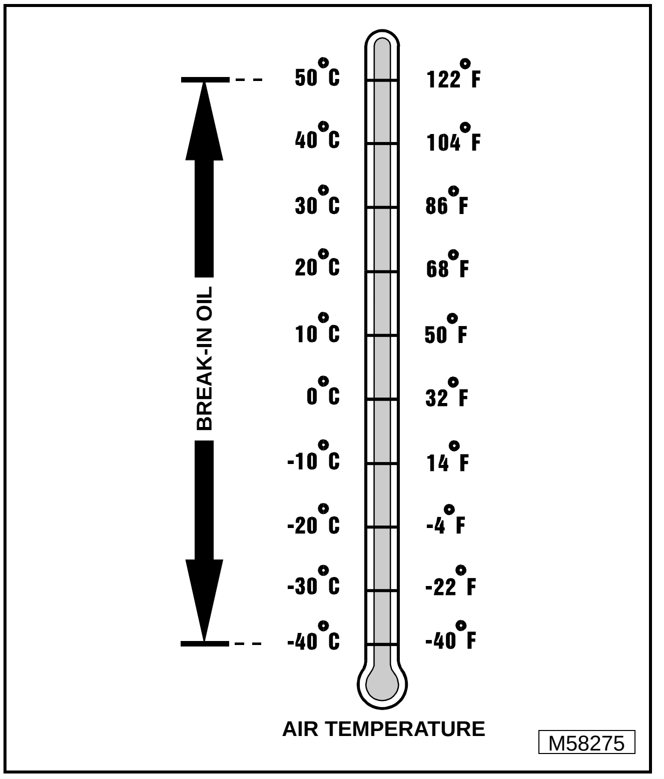
John Deere BREAK–IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions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

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

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

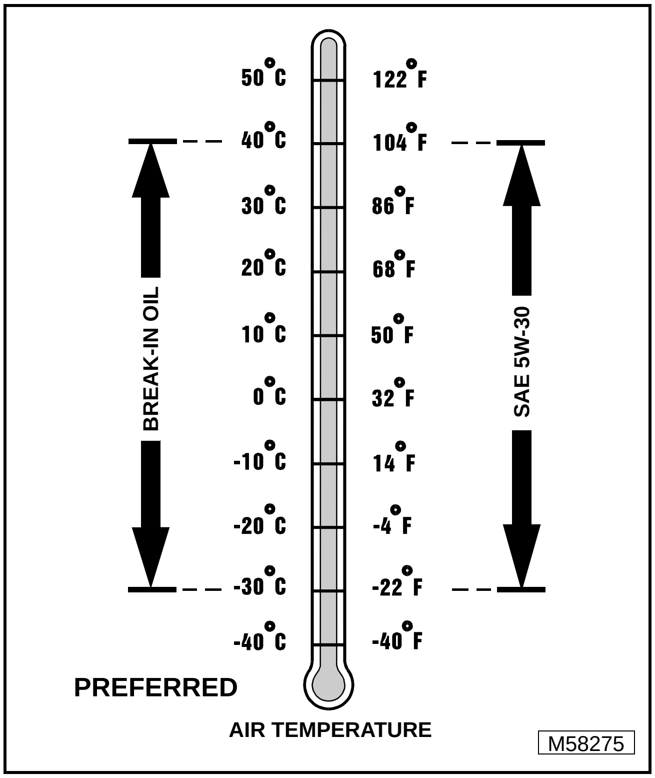
- API Service Classification CE or higher.

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



BREAK-IN ENGINE OIL—4-CYCLE GASOLINE

IMPORTANT: ONLY use a quality break-in oil in rebuilt or remanufactured engines for the first 5 hours (maximum) of operation. DO NOT use oils with heavier viscosity weights than SAE 5W-30 or oils meeting specifications API SG or SH, 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.

The following John Deere oil is **also recommended**:

- **TORQ–GARD SUPREME®—SAE 5W-30.**

If the above recommended John Deere oils are not available, use a break-in engine oil meeting the following specification during the first 5 hours (maximum) of operation:

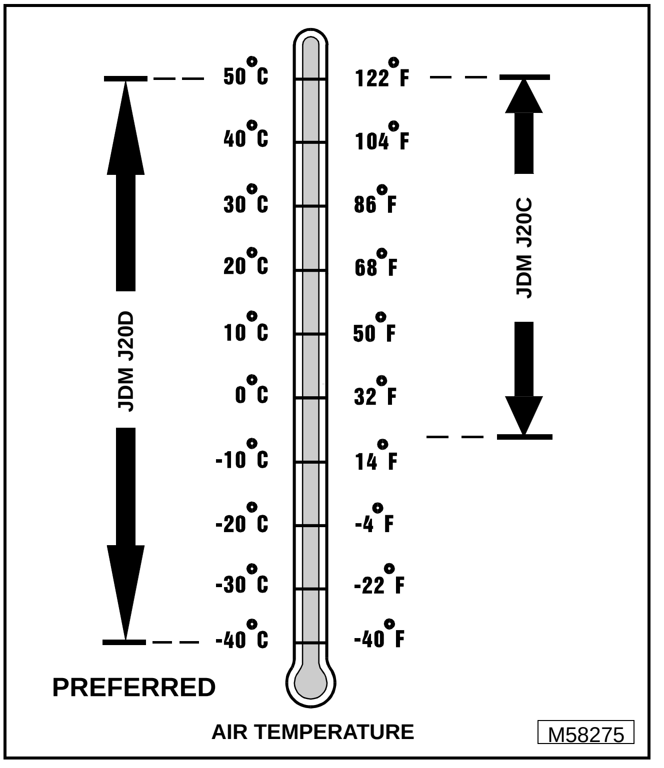
- SAE 5W-30—API Service Classification SE or higher.

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

HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL

HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL

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



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

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

- **LOW VISCOSITY HY–GARD®—JDM J20D**.

The following John Deere oil is **also recommended** if above preferred oil is not available:

- **HY–GARD®—JDM J20C.**

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

- John Deere Standard JDM J20D;
- John Deere Standard JDM J20C.

GEAR CASE OIL SPECIFICATIONS

GEAR CASE OIL

Use the appropriate oil viscosity based on the air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature gear case failure.

IMPORTANT: ONLY use a quality oil in this gear case. DO NOT mix any other oils in this gear case. DO NOT use BIO–HY–GARD® in this gear case.

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

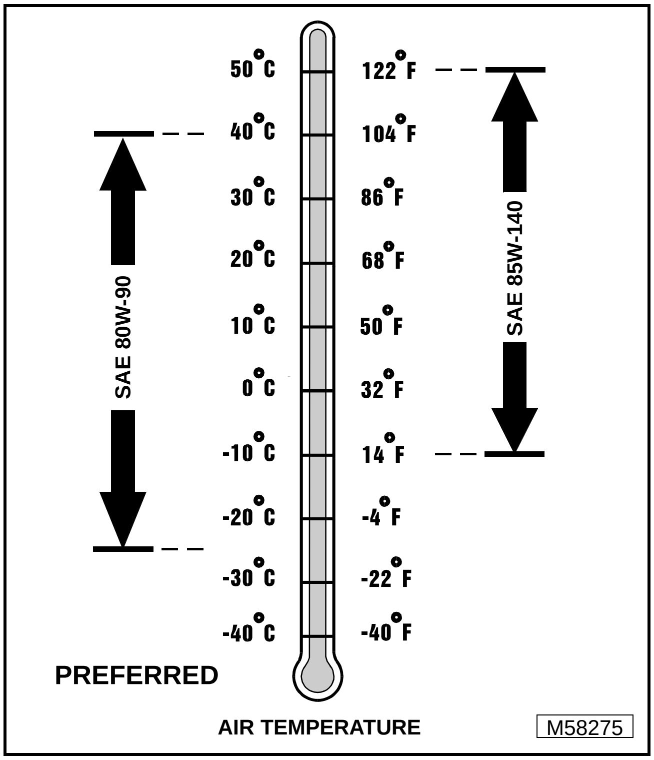
- **GL-5 GEAR LUBRICANT®—SAE 80W-90.**

The following John Deere gear case oil is **also recommended** if above preferred oil is not available:

- **GL-5 GEAR LUBRICANT®—SAE 85W-140.**

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

- API Service Classification GL–5.



GEAR TRANSMISSION GREASE SPECIFICATIONS

GEAR TRANSMISSION GREASE

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

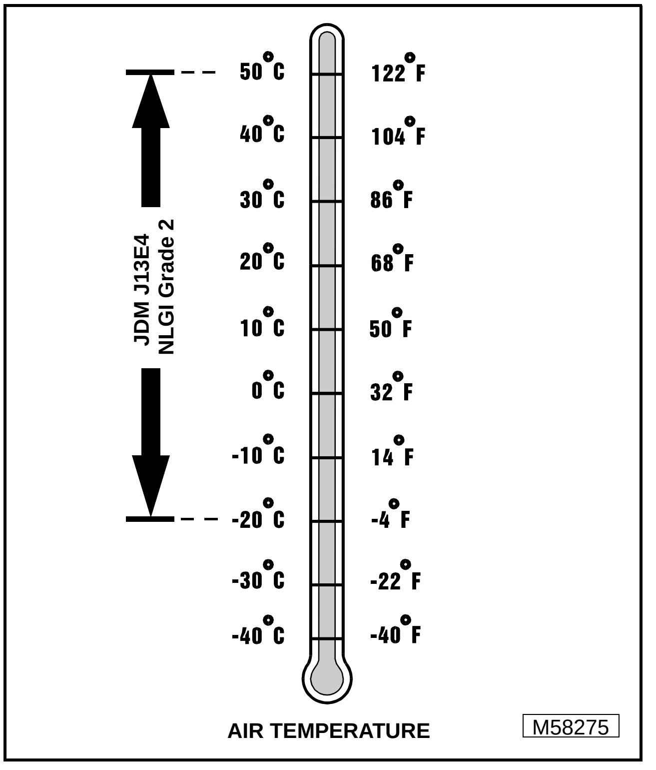
IMPORTANT: ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO–GREASE in this transmission.

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

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

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



ALTERNATIVE LUBRICANTS

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, unless otherwise stated on lubricant label.

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

LUBRICANT STORAGE

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

MIXING OF LUBRICANTS

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

OIL FILTERS

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

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

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

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

- ASTB Tested In Accordance With SAE J806.

COOLANT SPECIFICATIONS

DIESEL AND GASOLINE ENGINE COOLANT

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 available use any Automobile and Light Duty Engine Service **<u>ethylene glycol base coolant</u>**, meeting the following specification:

- ASTM D3306 (JDM H24C1).

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

IMPORTANT: To prevent engine damage, DO NOT use pure 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, Maximum	340 ppm (20 grns/gal)
Total Hardness, Max.	170 ppm (10 grns/gal)
Chloride (as Cl), Max.	40 ppm (2.5 grns/gal)
Sulfate (as SO_4), Max.	100 ppm (5.8 grns/gal)

Mix 50 percent 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 -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 AND GASOLINE ENGINE COOLANT DRAIN INTERVAL

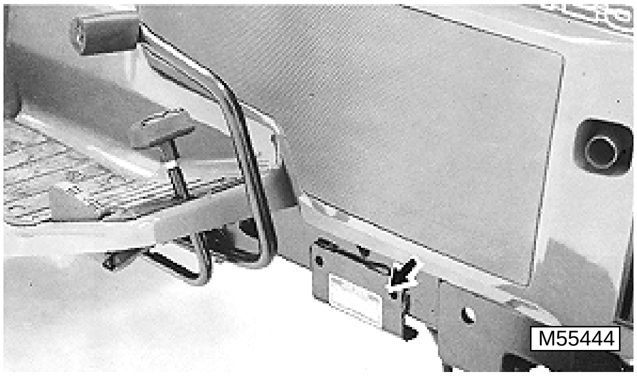
When using **John Deere Pre-Diluted (TY16036)** Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every **36 months or 3,000 hours** of operation, whichever comes first.

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

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

SERIAL NUMBER LOCATIONS

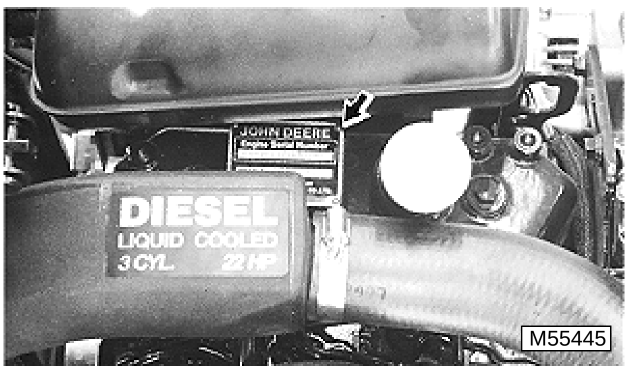
PRODUCT SERIAL NUMBER



M55444

The 13-digit product identification number is located on the right-hand side frame, just below engine compartment.

DIESEL ENGINE SERIAL NUMBER LOCATION

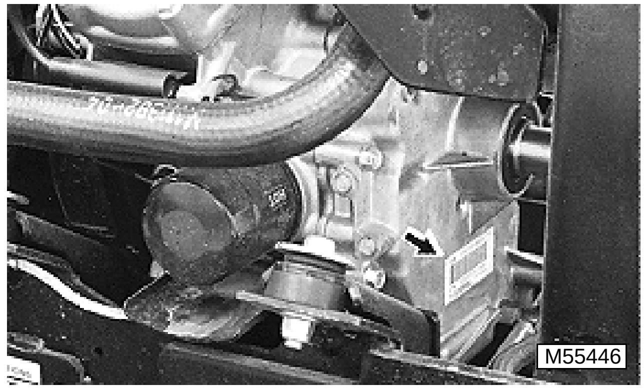


M55445

The engine serial number is located on valve cover. The model number will designate the engine type.

415 Export Model Number . . . . 3TN66-UJ2 or 3007D002
455 Export (Early) Model Number 3TNA72-UJ2
455 Export (Late) Model Number 3TNA72C-UJ2
455 Export (Homologated) Model Number 3TNA72C-UJ2E

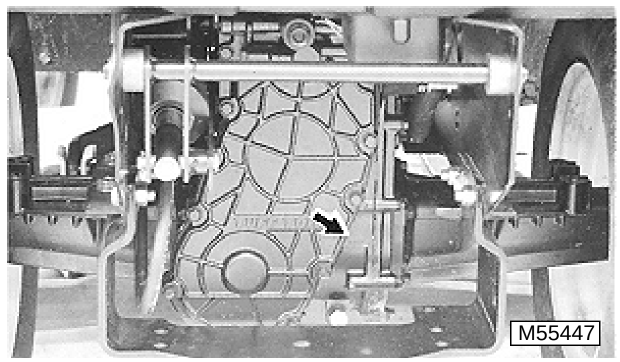
GASOLINE ENGINE SERIAL NUMBER LOCATION



M55446

Engine serial number is located on the front of the engine.

TRANSAXLE SERIAL NUMBER LOCATION



M55447

The transaxle serial number plate is located on right-hand flat surface under the operator's platform.

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ENGINE—FD620D, K SERIES

SPECIFICATIONS

TEST AND ADJUSTMENT SPECIFICATIONS

Engine

Oil Pressure Sensor Activates	98 kPa (14.2 psi)
Oil Pressure While Cranking (Minimum)	28 kPa (4 psi)
Oil Pressure	138—272 kPa (20—40 psi)
Oil Filter Bypass Valve Opening Pressure	78.5—117.5 kPa (11.4—17.1 psi)
Cylinder Compression Pressure (Minimum)	1171 kPa (170 psi)
Maximum Compression Pressure Variation Between Cylinders	97 kPa (14 psi)
Crankcase Vacuum (Minimum)	25 mm (1 in.) water
Intake and Exhaust Valve Clearance (Cold)	0.25 mm (0.01 in.)
Intake and Exhaust Valve Adjustment Interval	300 hrs
Valve Clearance Adjusting Nut Torque	9 N•m (79 lb-in.)

Fuel/Air System

Fuel Pump	
Minimum Flow—425	300 mL (10 oz) in 10 seconds
Minimum Pressure (Carburetor—425)	10 kPa (1.5 psi)
Minimum Pressure (Fuel Injection—445)	172—186 kPa (25—27 psi)
Carburetor	
SLOW Idle Mixture Screw Initial Setting	1 turn counterclockwise after lightly seating
SLOW Idle Stop Screw Setting	50 rpm less than throttle control arm SLOW idle stop screw setting
Throttle Lever Friction Disks	18—35 N (4—8 lb force)
Throttle Cable	
Throttle Control Arm SLOW Idle Stop Screw Setting	1500 ± 100 rpm
Throttle Control Arm FAST Idle Stop Screw Setting	3600 ± 100 rpm
Air Restriction Indicator	(optional)
Fuel Tank	
Check Valve Opening Pressure (Maximum)	3 kPa (0.4 psi)

Cooling System

Radiator	
Maximum Test Pressure	117 kPa (17 psi)
Minimum Hold Pressure	90 kPa (13 psi)
Radiator Cap	
Opening Pressure	83–96 kPa (12–14 psi)
Minimum Pressure	76 kPa (11 psi)
Thermostat	
Begin-to-Open Temperature	63—66°C (145—150°F)
Full-Open Temperature	80°C (176°F)
Full-Closed Temperature	63—66°C (145—150°F)
Fan Belt	
Fan Belt Tension	12—19 mm (0.472—0.748 in.) deflection with 245—391 N (55—88 lb force) applied force

REPAIR SPECIFICATIONS

Engine

Mounting Bolts Torque	80 N•m (60 lb-ft)
Drive Shaft Coupler Screws Torque	40 N•m (30 bl-ft)

Carburetor—425

Throttle Shaft Retaining Screw Torque	2.0 N•m (17 lb-in.)
Drain Screw Torque	1.2 N•m (10 lb-in.)
Choke and Throttle Plate Screws Torque	0.88 N•m (7.8 lb-in.)
Solenoid Valve Torque	9.8 N•m (87 lb-in.)
Main Jet and Main Air Jet Torque	1.0 N•m (8.9 lb-in.)
Air Horn Mounting Screws Torque	2.9 N•m (26 lb-ft)

Throttle Body—445

Throttle Shaft Retaining Screw Torque	2.0 N•m (17 lb-in.)
Throttle Plate Screws Torque	0.88 N•m (7.8 lb-in.)
Mounting Stud Nuts Torque	17 N•m (12 lb-ft)

Plain Bearings

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

Crankcase

Oil Capacity	1.5 L (3.2 pt)
Cover Cap Screw Torque	21 N•m (186 lb-in.)
Drain Plug Torque	23 N•m (204 lb-in.)
Breather Reed Valve Clearance	0.2 mm (0.008 in.)

Fuel System

Carburetor Mounting Nuts Torque	17 N•m (12 lb-ft)

Intake Manifold

Cap Screw Torque	6 N•m (53 lb-in.)
Pressure Relief Plug Torque	15 N•m 133 lb-in.)

Cylinder Head and Valves

Valve Clearance	0.25 mm (0.010 in.)

Rocker Arm

Minimum Shaft OD	11.95 mm (0.470 in.)
Maximum Bearing ID	12.07 mm (0.475 in.)
Adjuster Screw Lock Nut Torque	9 N•m (79 lb-in.)
Push Rod Maximum Bend	0.80 mm (0.031 in.)

REPAIR SPECIFICATIONS—(continued)

Valves and Springs

Valve Clearance at 16—27°C (60—80°F)	0.25 mm (0.010 in.)
Spring Free Length	29.70 mm (1.170 in.)
Minimum Valve Stem OD	
Intake	5.94 mm (0.234 in.)
Exhaust	5.92 mm (0.233 in.)
Maximum Valve Guide ID	6.05 mm (0.238 in.)
Maximum Valve Stem Bend	0.03 mm (0.001 in.)
Standard Valve Seating Surface	0.80 mm (0.031 in.)
Valve Seating Width Tolerance	0.50—1.10 mm (0.020—0.043 in.)
Valve Seat and Face Angle	45°
Minimum Valve Margin	0.60 mm (0.024 in.)
Valve Narrowing Angle	30°

Push Rods

Maximum Run-Out	0.8 mm (0.03 in.)

Cylinder Head

Cylinder Head Flatness	0.06 mm (0.002 in.)
Cap Screw Torque in Sequence (Lubricated)	
Initial Torque	13 N•m (115 lb-in.)
Final Torque	21 N•m (186 lb-in.)
Spark Plug Torque	25 N•m (221 lb-in.)

Flywheel

Flywheel Nut Torque	108 N•m (80 lb-ft)
Flywheel Sheave Torque	15 N•m (130 lb-in.)
Fan Belt Tension Adjustment	
Increase	Remove shim(s)
Decrease	Add shim(s)
Fan Belt Drive Sheave Screw Torque	15 N•m (133 lb-in.)

Camshaft

Bearing Journals OD (Minimum)	15.91 mm (0.626 in.)
Minimum Lobe OD (Intake)	25.21 mm (0.993 in.)
Minimum Lobe OD (Exhaust)	25.46 mm (1.002 in.)
Minimum Fuel Pump Lobe	19.50 mm (0.760 in.)
Maximum Cover and Crankcase Bearing ID	16.07 mm (0.633 in.)

REPAIR SPECIFICATIONS—(continued)

Piston

Maximum Top Ring Groove Clearance	0.15 mm (0.006 in.)
Maximum Second Ring Groove Clearance	0.12 mm (0.005 in.)
Maximum Oil Ring Groove Clearance	Not measured
Maximum Ring End Gap	1.20 mm (0.050 in.)
Minimum Pin O.D	16.98 mm (0.668 in.)
Maximum Pin Bore ID	17.04 mm (0.671 in.)
Distance from Bottom of Piston Skirt to Measure Piston OD	11 mm (0.433 in.)
Piston OD	75.935—75.950 mm (2.989—2.990 in.)
Piston-to-Cylinder Bore Clearance	0.030—0.170 mm (0.00118—0.00670 in.)

Connecting Rod

Maximum Crankshaft Bearing ID	34.06 mm (1.341 in.)
Maximum Piston Pin Bearing ID	17.05 mm (0.671 in.)
End-Cap Screw Torque	21 N•m (186 lb-in.)

Crankshaft

Minimum Bearing Journal OD	33.91 mm (1.335 in.)
Minimum Connecting Rod Journal	33.93 mm (1.336 in.)
Maximum T.I.R. (Bend)	0.05 mm (0.002 in.)

Crankshaft Plain Bearings

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

Cylinder Bore

Standard ID	75.98—76.00 mm (2.994—2.995 in.)
Maximum ID	76.07 mm (2.997 in.)

Cylinder Block Reboring

Oversize Diameter 0.50 mm	76.46—76.48 mm (3.012—3.013 in.)

REPAIR SPECIFICATIONS—(continued)

Oil Pump

Cover Cap Screws Torque . . . . 7.8 N•m (69 lb-in.)
Minimum Rotor Shaft OD. . . . . 10.92 mm (0.430 in.)
Maximum Rotor Shaft Bearing ID . . . . 11.07 mm (0.436 in.)
Minimum Outer Rotor OD . . . . 40.43 mm (1.592 in.)
Maximum Outer Rotor Bearing ID . . . . 40.80 mm (1.606 in.)
Minimum Relief Valve Spring Free Length . . . . 19.50 mm (0.770 in.)
Maximum Inner and Outer Rotor Clearance . . . . 0.3 mm (0.012 in.)
Maximum Pump Housing Depth . . . . 10.230 mm (0.403 in.)
Maximum Outer Rotor Thickness. . . . . 9.830 mm (0.3870 in.)

Coolant Pump

Minimum Shaft OD. . . . . 9.94 mm (0.391 in.)
Maximum Pump and Crankcase Housing Bore ID. . . . . 10.09 mm (0.397 in.)
Cap Screw Torque . . . . 9—11 N•m (79—96 lb-in.)
Crankcase Cover Cap Screw Torque . . . . 23—28 N•m (17—20 lb-ft)

Over-flow Reservoir

Mounting Cap Screw Torque . . . . 4 N•m (31 lb-in.)

Governor

Governor Arm Nut Torque . . . . 7.88 N•m (69 lb-in.)
Shaft Oil Seal . . . . 1.0 mm (0.004 in.) below crankcase surface

Charging System

Capacity . . . . 20 amps
Unregulated Stator Output . . . . 26 VAC @ 3000 rpm
Regulated Stator Output . . . . 15 VDC @ 3000 rpm

Injector

Resistance at 20°C (68°F) . . . . 13.8 ohms

Ignition System

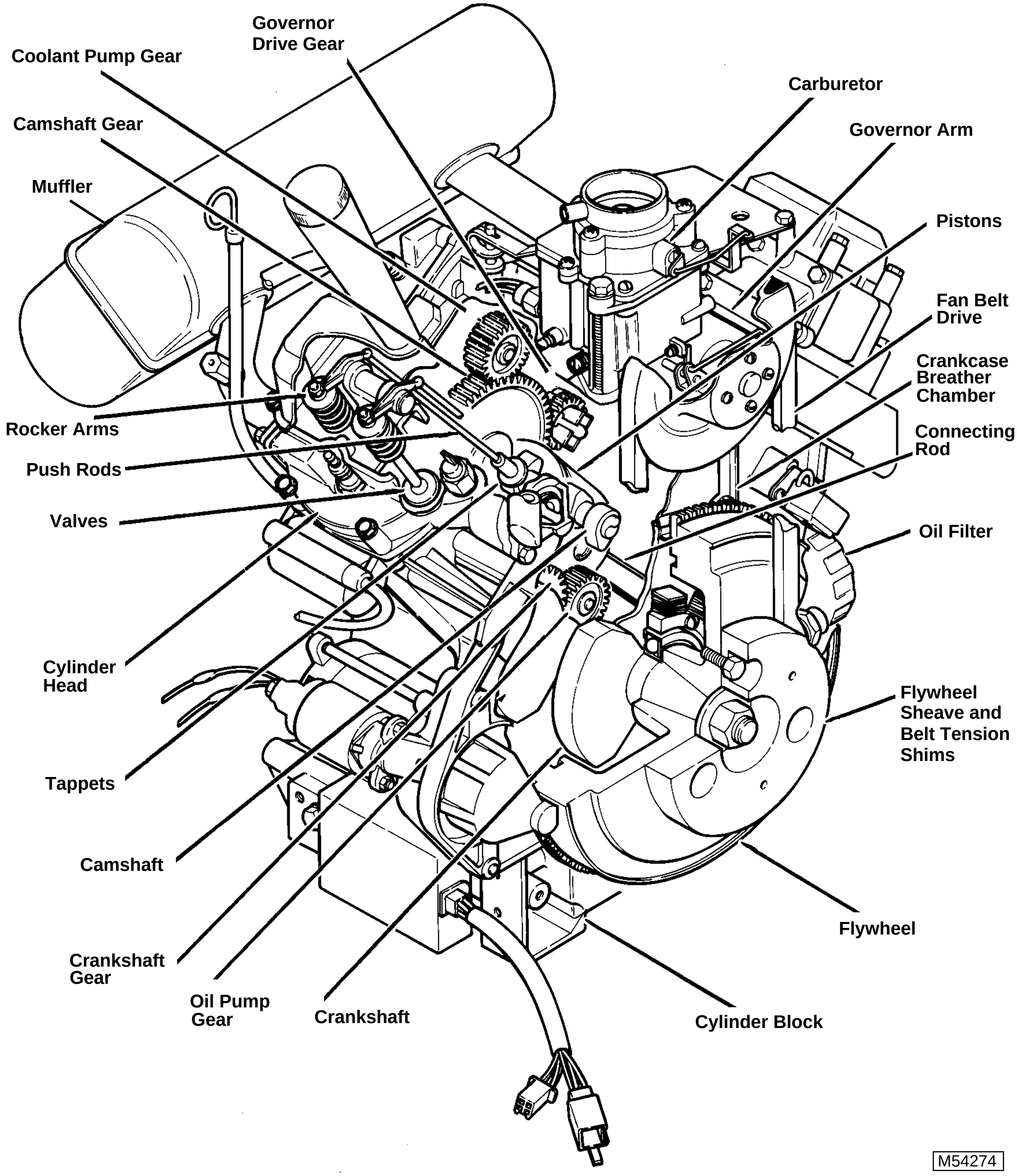
Pulser Output . . . . 0.1—1.0 VAC

Electric Starter

Minimum Brush Length . . . . 6 mm (0.240 in.)
Maximum No Load Starter Draw . . . . 30 amps at 6000 rpm (min)

COMPONENT LOCATION

ENGINE—FD620D



Cutaway—FD620D

THEORY OF OPERATION

COOLING SYSTEM OPERATION

Function:

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

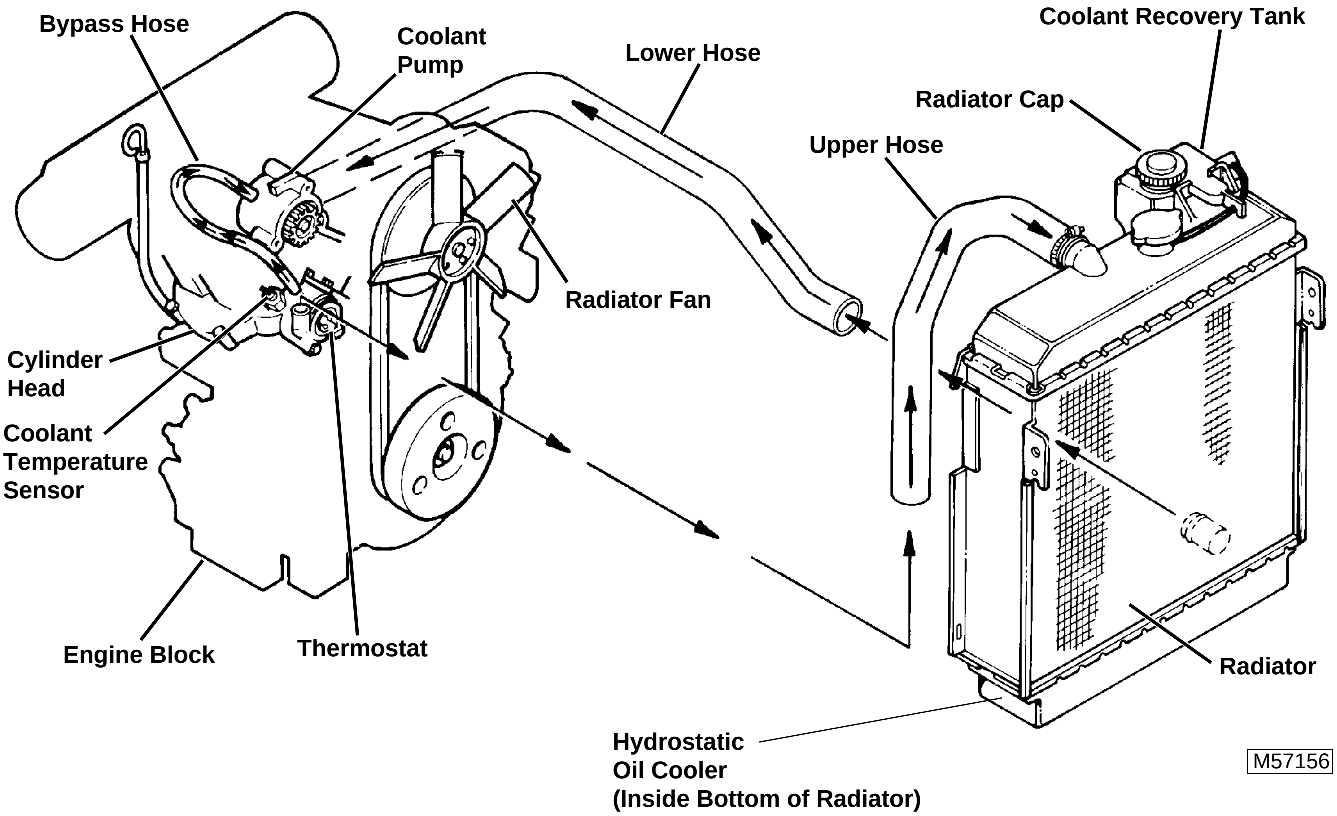
System Operation:

The impeller-type coolant pump draws coolant from the bottom of the radiator when the thermostat is open or from the bypass when the thermostat is closed. Coolant from the water pump flows to the water jackets in block, up through cylinder heads, intake manifold, past the coolant temperature sensor and thermostat.

When the engine temperature is below approximately 66°C (150°F), the thermostat is closed and coolant is directed back to the water pump through bypass hose to be recirculated. This allows the engine to warm up to operating temperature quickly.

When the engine temperature is approximately 66°C (150°F), the thermostat begins to open and is fully open at 80°C (176°F). Coolant from the water jackets and cylinder heads now flow through the thermostat to the radiator, which is cooled by the radiator fan. The fan is driven by a belt off the crankshaft pulley.

The radiator cap maintains a constant pressure of 90 kPa (13 psi) inside the radiator which actually raises the boiling point of the coolant. The radiator cap contains a pressure valve and a vacuum valve. When the coolant is hot and pressure is above 90 kPa (13 psi), the pressure valve opens allowing some coolant to flow to the recovery tank. After the engine is stopped, the coolant cools and the pressure inside the radiator decreases. The pressure difference between the radiator and recovery tank forces the vacuum valve open and some coolant from the recovery tank flows back to the radiator.



CARBURETED ENGINE FUEL AND AIR SYSTEM OPERATION—425

Function:

The fuel system supplies pressurized fuel to the carburetor for combustion. The air intake system filters air needed for combustion.

System Operation:

An electric fuel pump mounted inside the fuel tank provides pressurized fuel to the carburetor. The fuel pump uses the fuel for lubrication and cooling. The fuel pump draws fuel through the fuel pump filter. Low pressure fuel from the fuel pump flows through the fuel shut-off valve and in-line fuel filter to the carburetor. Fuel pressure is maintained at the carburetor inlet needle until the float allows more fuel in the bowl. The fuel tank relief/check valve prevents gas fumes from escaping into the air for emission control. When the fuel tank starts to create a vacuum, the check valve opens and allows air into the tank, but closes for air trying to escape from the tank. The tank will pressurize up to 3 kPa (0.4 psi) before the relief valve opens and allows the air pressure out. The fuel tank cap is NOT vented (carburetor vent solenoid only).

IMPORTANT: Model (S.N. —033626) use a carburetor vent solenoid. Model (S.N. 033627—) use a fuel shut-off solenoid. System operation remains the same expect for the following differences. Lower, upper and inlet vent hoses are removed. Air restriction indicator is removed. Fuel shut-off solenoid shuts off the main jet not atmospheric pressure (vacuum), which eliminates the need for vent hoses. Fuel cap is vented instead of vent hoses with fuel tank relief/check valve.

The carburetor vent solenoid connects both sides of the carburetor venturi through lower and upper vent hoses when the solenoid is de-energized. In this condition, no vacuum is present in the carburetor to draw fuel out of the main nozzle, so the fuel flow is stopped very quickly. The ignition delay module is used with the carburetor vent/fuel shut-off solenoid to prevent backfire. The ignition delay module allows the spark plugs to fire for one additional second after the key switch is turned off to burn any remaining fuel in the cylinder. When the key switch is turned off, the carburetor vent/fuel shut-off solenoid is de-energized. When the key switch is turned on, the carburetor vent solenoid closes the venturi vent tubes, so a vacuum can be created for fuel flow.

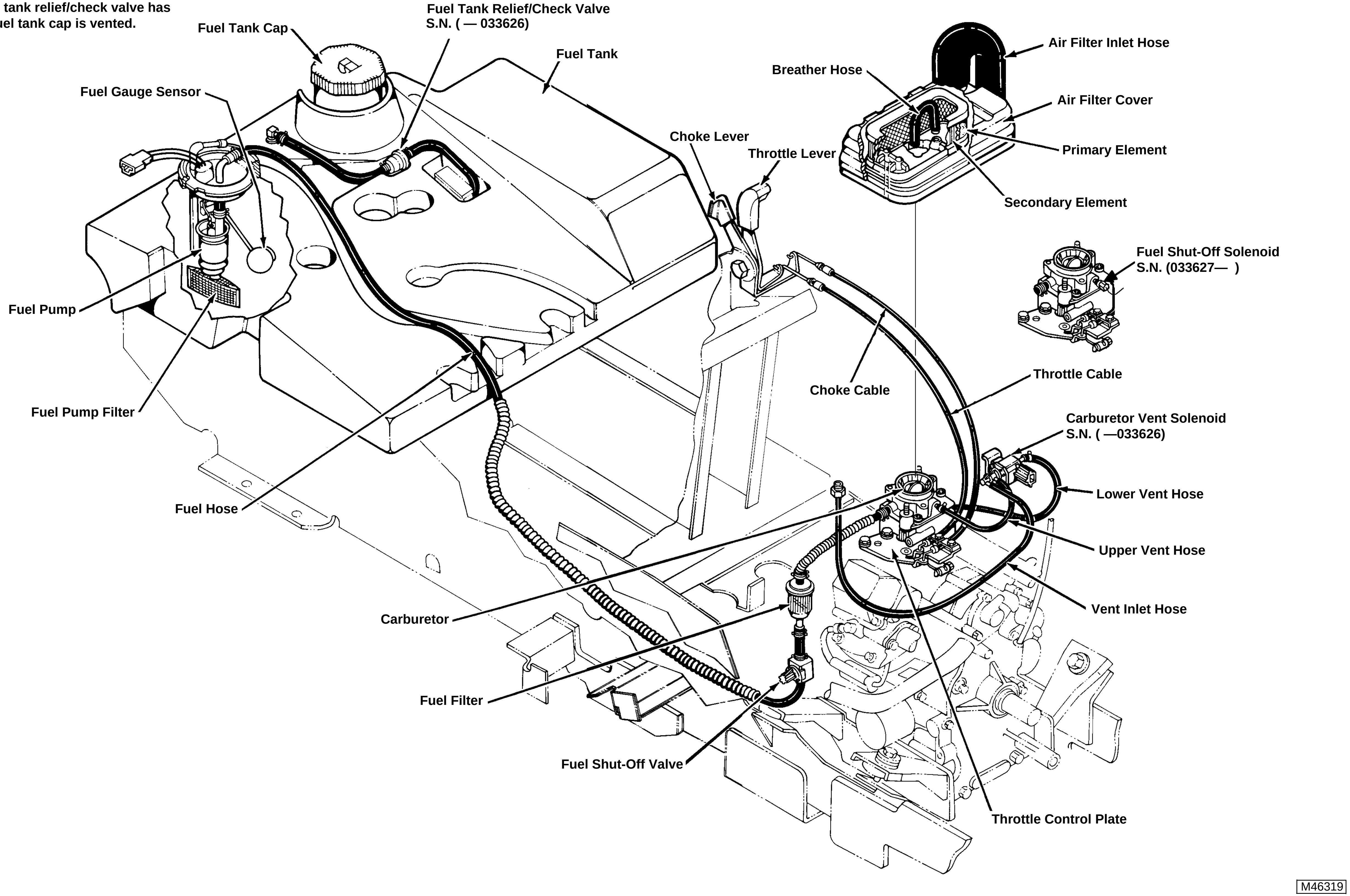
Air enters the air filter through the side panel screen and air filter inlet hose. The primary and secondary elements filter the air before entering the carburetor. The breather hose vents crankcase fumes into the carburetor for burning to decrease emissions. An air restriction indicator alerts the operator when the filters need servicing. The air restriction indicator senses the amount of vacuum in the intake system.

NOTE: Air restriction indicators are removed for model (S.N. 033627—).

A small amount of air restriction is always present due to some restriction of air movement through the filter elements. The vacuum increases as the filter elements become plugged. The indicator moves to the highest vacuum rating and holds that position until the operator resets it. An air intake leak will prevent the air restriction from operating properly.

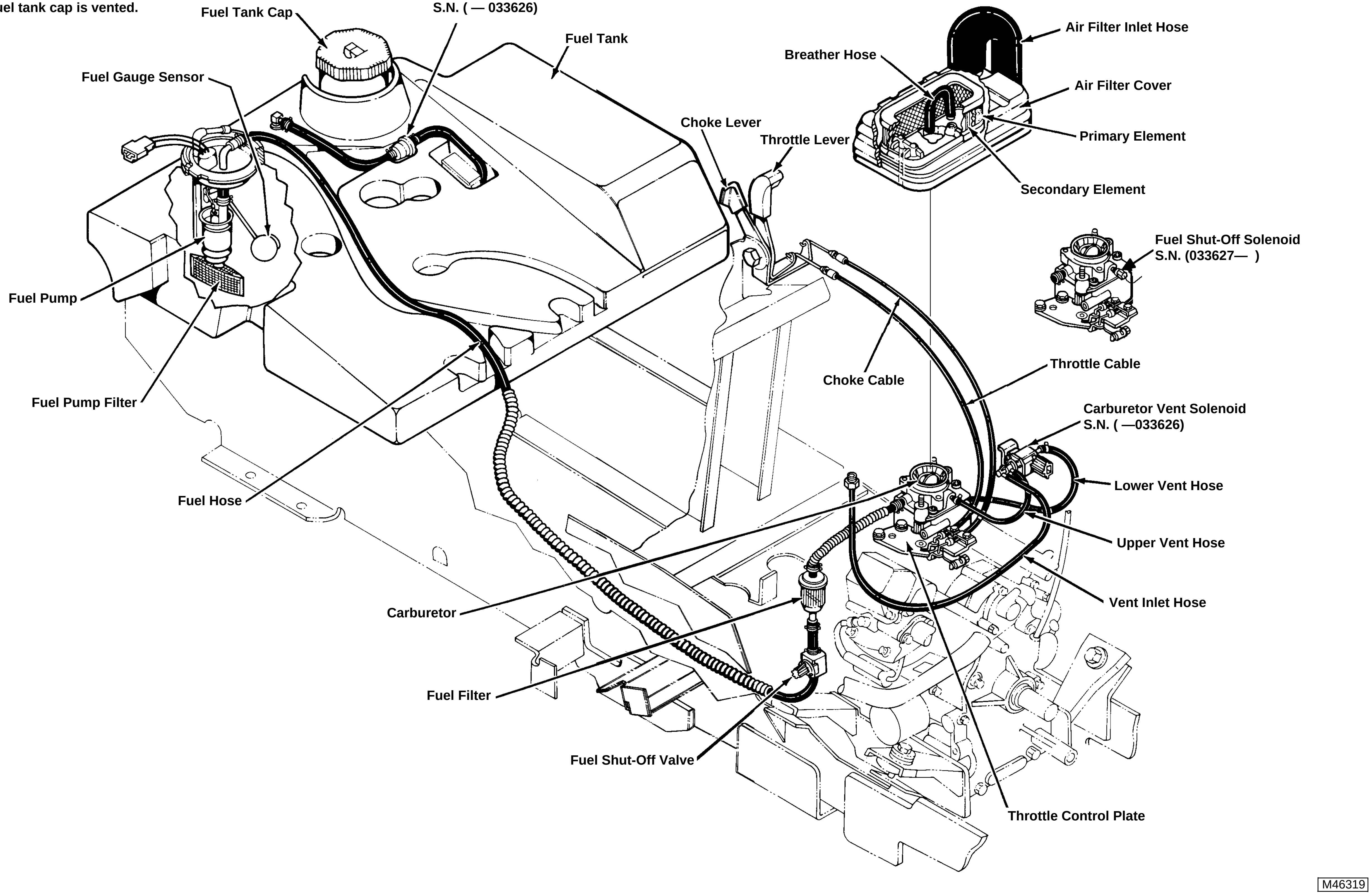
CARBURETED ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION—425

Important: Model S.N. (033627—) have fuel shut-off solenoid instead of carburetor vent solenoid and vent hoses. Air restiction indicator and fuel tank relief/check valve has been removed. Fuel tank cap is vented.



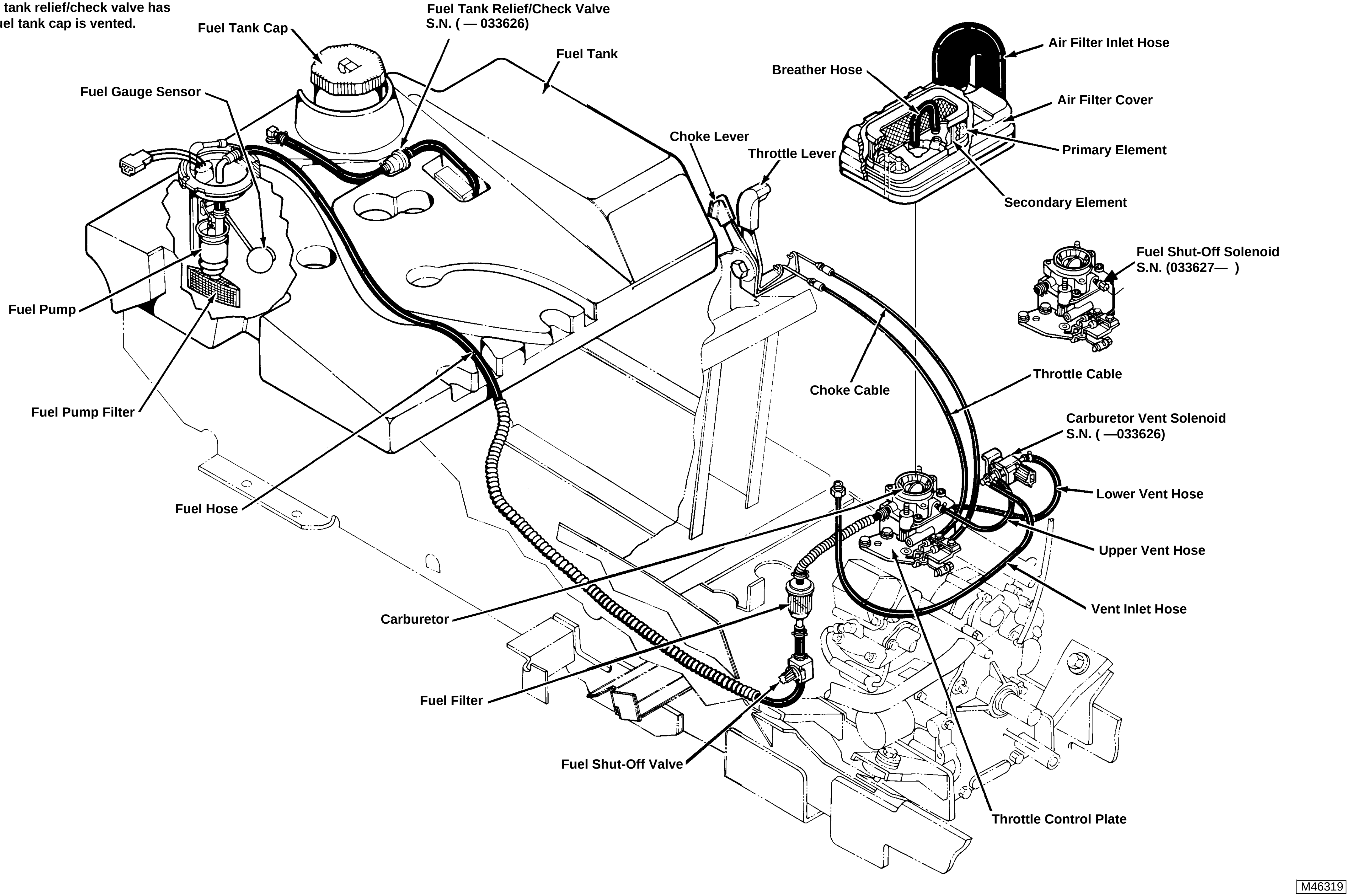
CARBURETED ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION—425

Important: Model S.N. (033627—) have fuel shut-off solenoid instead of carburetor vent solenoid and vent hoses. Air restiction indicator and fuel tank relief/check valve has been removed. Fuel tank cap is vented.

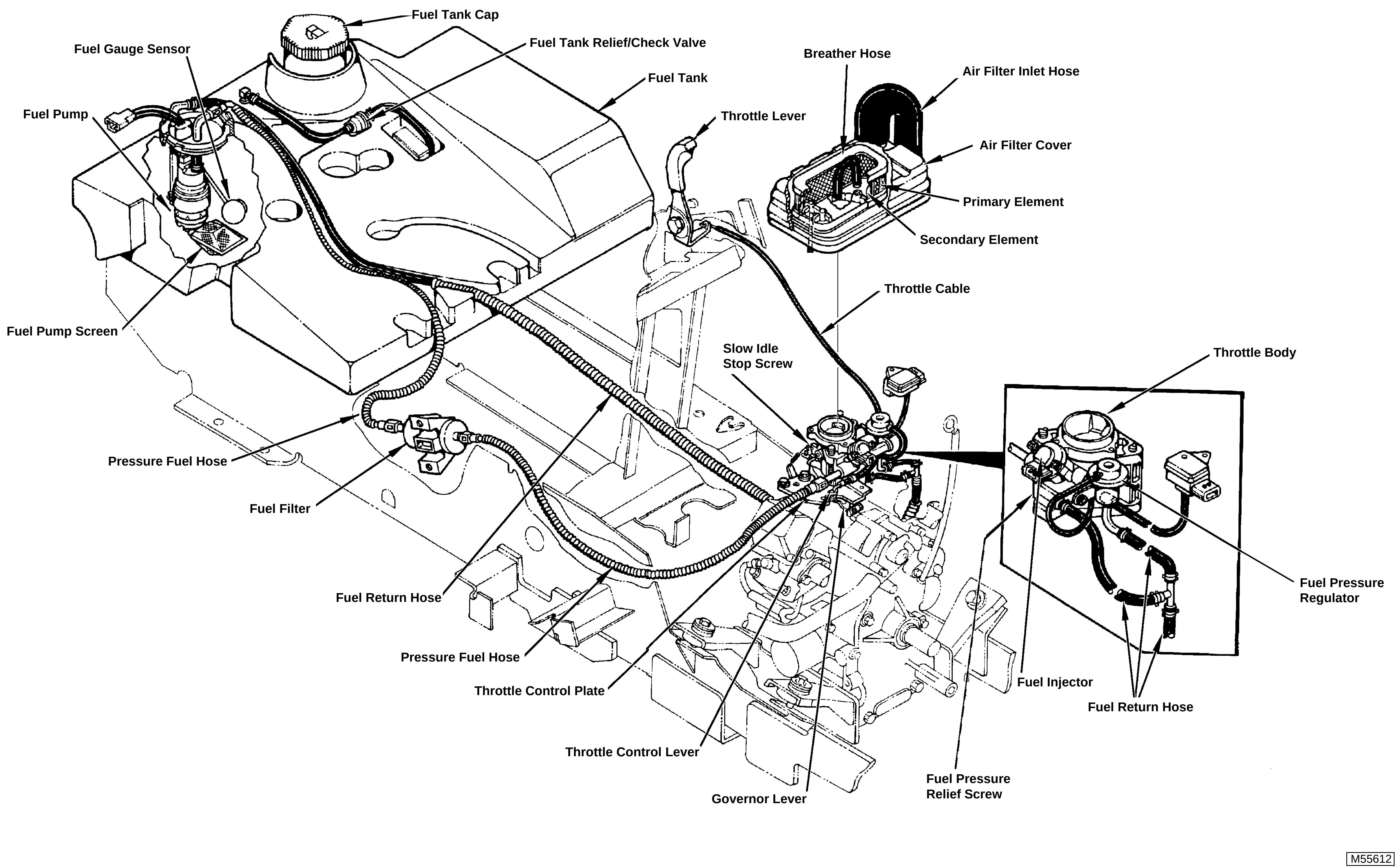


CARBURETED ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION—425

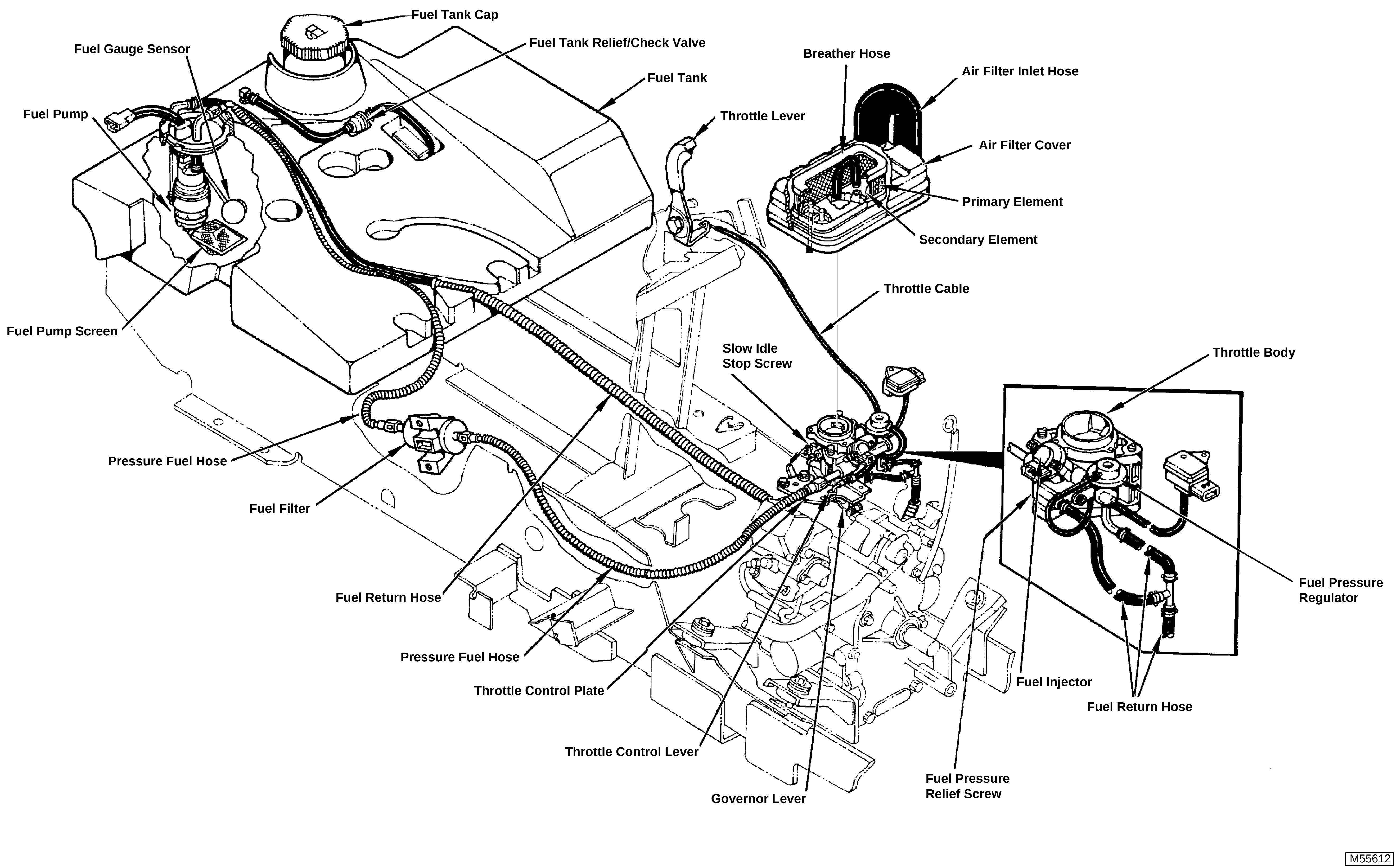
Important: Model S.N. (033627—) have fuel shut-off solenoid instead of carburetor vent solenoid and vent hoses. Air restiction indicator and fuel tank relief/check valve has been removed. Fuel tank cap is vented.



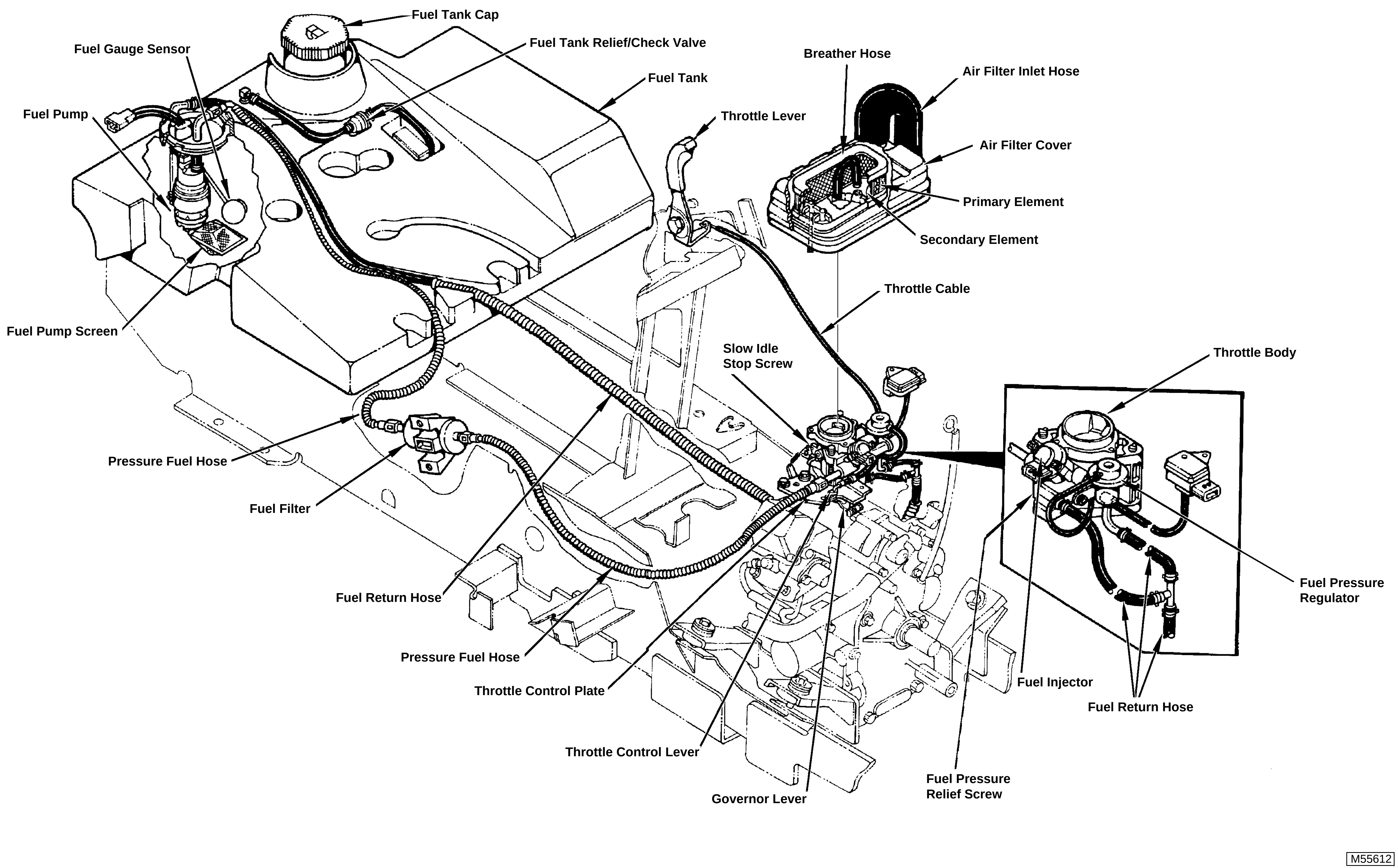
FUEL INJECTION AND AIR SYSTEM COMPONENTS AND OPERATION—445



FUEL INJECTION AND AIR SYSTEM COMPONENTS AND OPERATION—445



FUEL INJECTION AND AIR SYSTEM COMPONENTS AND OPERATION—445



FUEL INJECTION AIR SYSTEM COMPONENTS AND OPERATION—445

Function:

The fuel injection system supplies pressurized fuel to the fuel injector for combustion. The air intake system filters air needed for combustion.

System Operation:

An electric fuel pump mounted inside the fuel tank provides pressurized fuel to the fuel injector. The fuel pump uses the fuel for lubrication and cooling.The fuel pump and fuel injector are controlled by the fuel injection module computer. The computer monitors engine operating and environmental conditions to calculate the amount of fuel to inject. The fuel pump draws fuel through the fuel pump screen. High pressure fuel from the fuel pump flows through the in-line fuel filter to the fuel injector and fuel pressure regulator. The fuel injector is a solenoid operated type valve with single point injection. Fuel is injected into the throttle body when the solenoid is energized by the computer. Fuel pressure is controlled by the fuel pressure regulator. The regulator is an overflow type regulator that maintains fuel pressure at the fuel injector at a constant 175 kPa (25 psi). Excess fuel flows through the regulator valve and fuel return hose to the fuel tank. The fuel tank relief/check valve prevents gas fumes from escaping into the air for emission control. When the fuel tank starts to create a vacuum, the check valve opens and allows air into the tank, but closes for air trying to escape from the tank. The tank will pressurize up to 3 kPa (0.4 psi) before the relief valve opens and allows the air pressure out. The fuel tank cap is NOT vented.

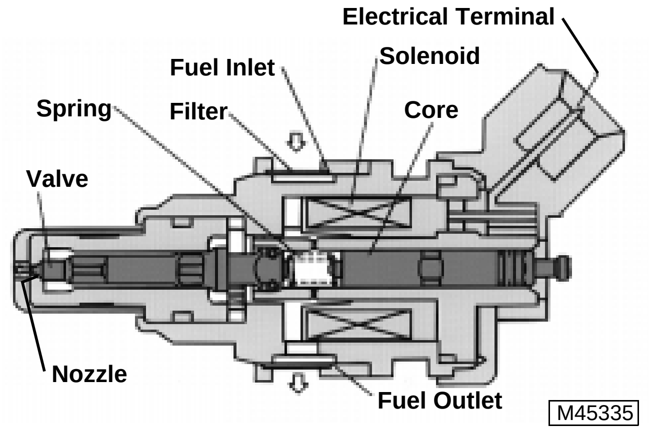
The throttle control lever, which is connected to the throttle lever and the governor lever, controls engine rpm. The governor lever is connected to the throttle valve inside the throttle body. Slow idle is adjusted by turning the slow idle stop screw and fast idle is adjusted by moving the throttle control plate.

Air enters the air filter through the side panel screen and air filter inlet hose. The primary and secondary elements filter the air before entering the throttle body. The breather hose vents crankcase fumes into the throttle body for burning to decrease emissions. An air restriction indicator alerts the operator when the filters need servicing. The air restriction indicator senses the amount of vacuum in the intake system. A small amount is always present due to some restriction of air movement through the filter elements. The vacuum increases as the filter elements become plugged. The indicator moves to the highest vacuum rating and holds that position until the operator resets it. An air intake leak will prevent the air restriction indicator from operating properly.

FUEL INJECTOR OPERATION—445

Function:

Injects fuel into the throttle body at the correct time and duration.



System Operation:

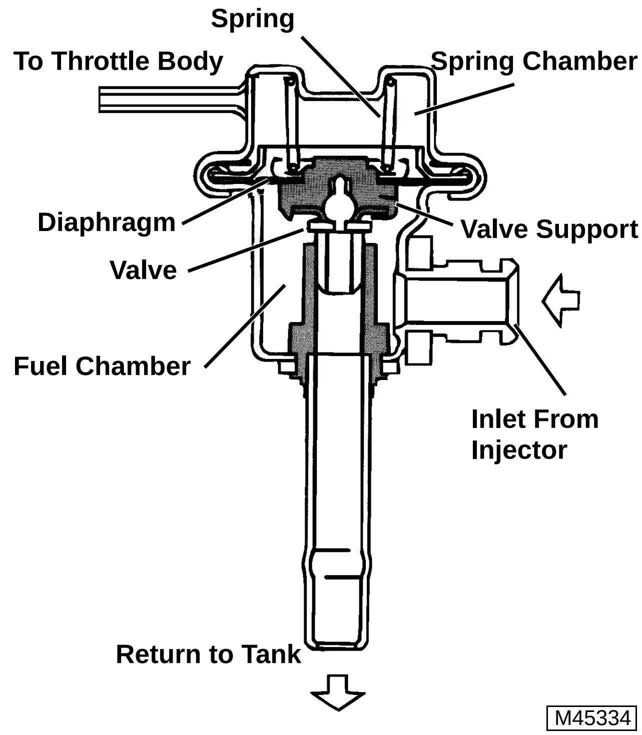
The fuel injector is a solenoid operated type valve with single point injection. Fuel is injected into the throttle body when the solenoid is energized by the computer. The amount of fuel injected depends on the length of time the injector valve is open and on fuel pressure.

High pressure fuel from the fuel pump flows through filter to the inlet passage. High pressure fuel also flows out the outlet passage to the pressure regulator. The pressure regulator maintains the correct fuel pressure needed for injection. When the solenoid is energized, the solenoid core pulls the valve open against spring tension. High pressure fuel is injected in the throttle body through the nozzle. After a precise amount of fuel is injected, the computer de-energizes the solenoid. Spring tension closes valve quickly to prevent additional leakage.

FUEL PRESSURE REGULATOR OPERATION—445

Function:

Maintains a constant differential in pressure between fuel pressure at the injector and air pressure in the throttle body. Therefore, the amount of fuel injected is determined by the opening time of the injector.



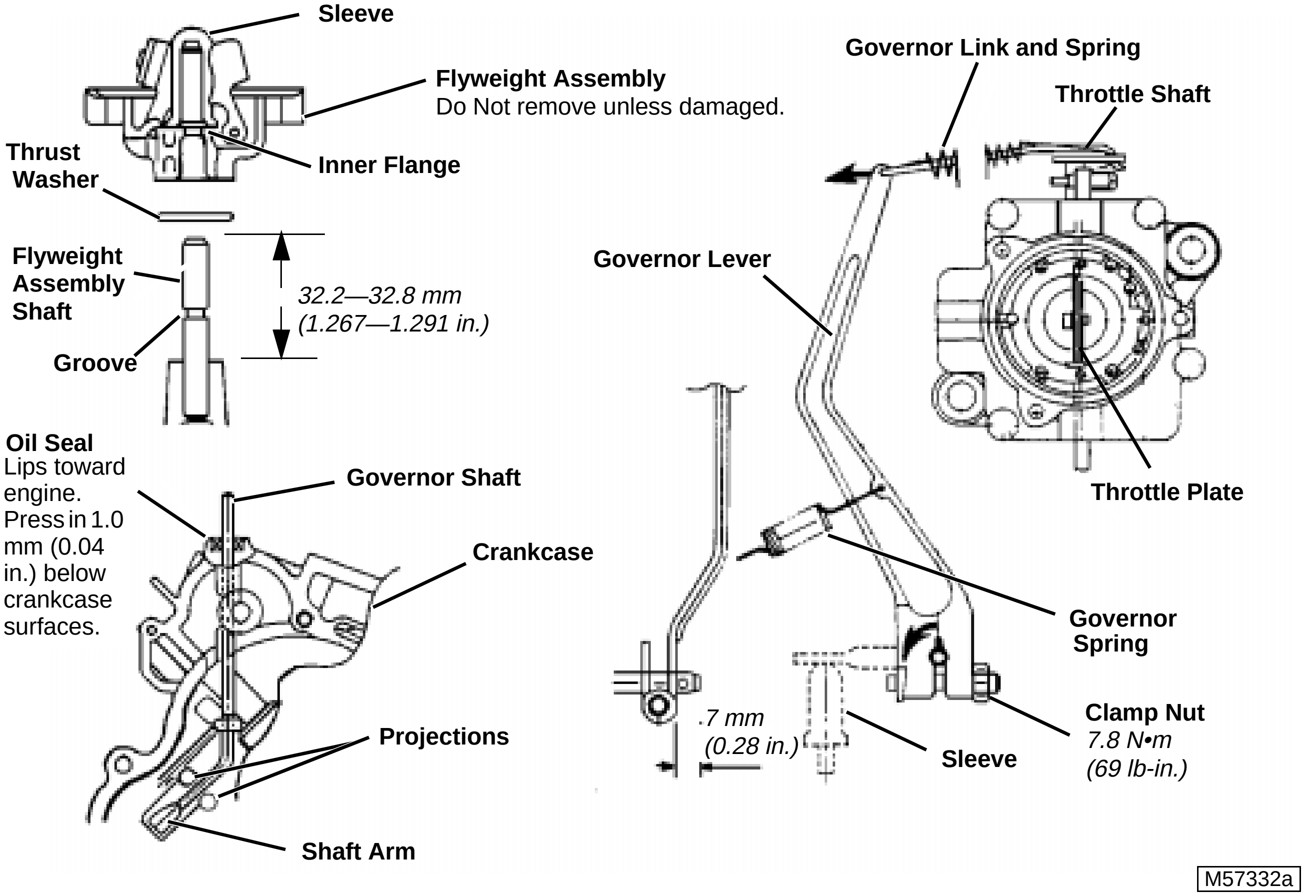
System Operation:

The pressure regulator is an overflow type regulator. The spring chamber is connected to the throttle body to insure that they are operating at the same air pressure. High pressure fuel from the injector flows to the pressure regulator inlet and fills the fuel chamber. A hose from the vacuum inlet is connected to the intake manifold. This allows the air pressure in the spring chamber and intake manifold to be equal.

When intake manifold vacuum increases, the spring chamber vacuum also increases and overcomes spring tension allowing the diaphragm to move upward. With the valve connected to the diaphragm, the valve moves upward and allows more fuel to flow out the outlet and return to the fuel tank. This lowers the fuel pressure. As intake manifold vacuum decreases, the spring chamber vacuum decreases and the spring returns the diaphragm to the original position. The valve restricts fuel flow to return and fuel pressure increases.

GOVERNOR OPERATION

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

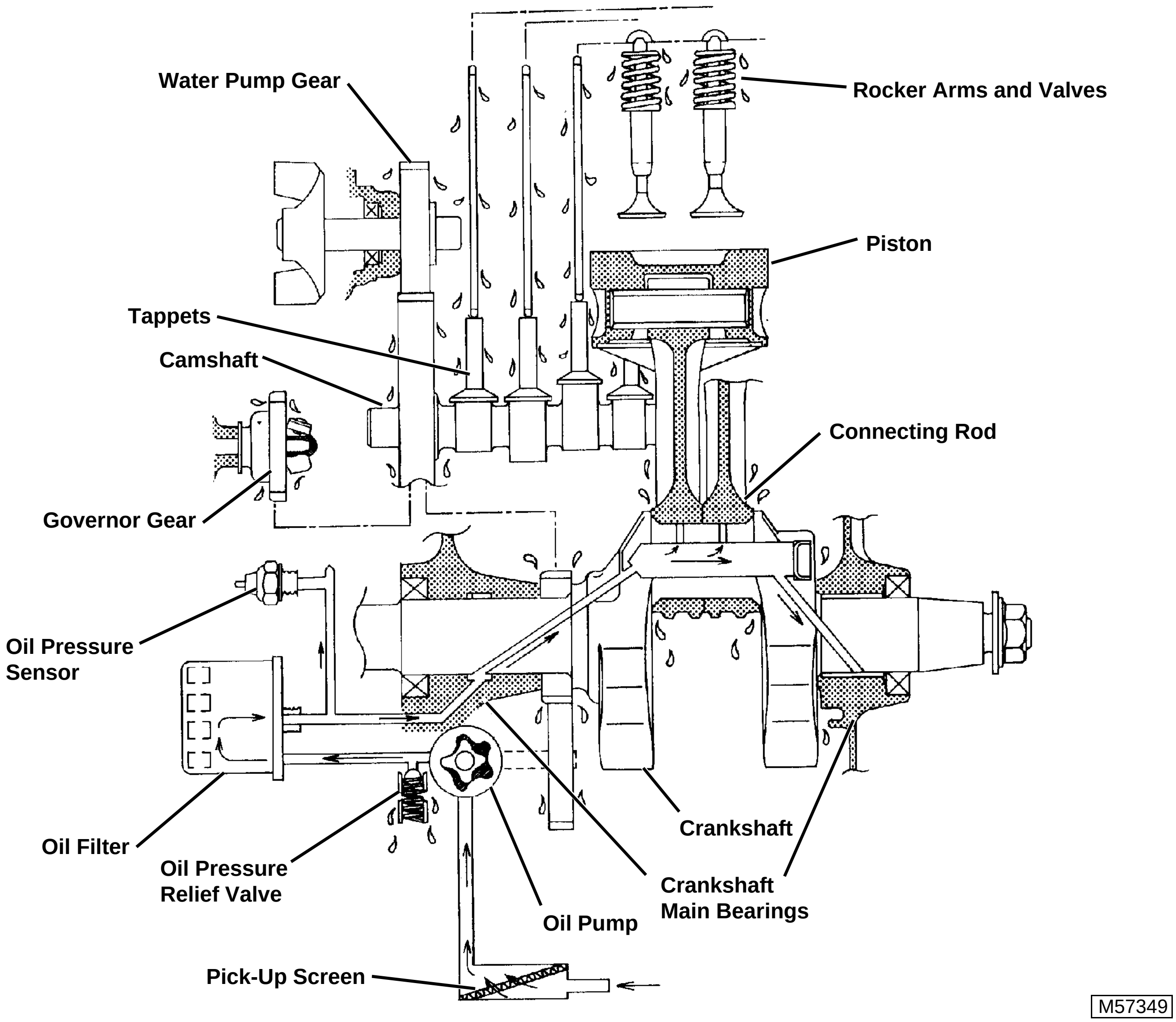


System Operation:

The governor controls engine speed. Governed engine speed is a balance between governor spring tension, set by the throttle control, and actual engine speed, countered by centrifugal force of the governor flyweights. As tension is applied to governor spring, governor linkage opens carburetor throttle shaft and plate, increasing engine rpm. As engine speed increases, flyweight assembly (driven by the crankshaft gear) pushes on governor arm, rotating governor shaft and lever, moving throttle shaft, closing throttle plate slightly and reducing rpm to governed operating speed. If a heavy load is encountered, engine speed drops, as does the governor assembly speed. Flyweights retract and allow shaft arm to move governor shaft and lever in opposite direction to open throttle plate and allow more air into venturi to draw in more fuel until engine peak operating speed is recovered. Springs provide a smooth yet responsive transitional control.

IMPORTANT: Flyweight assembly shaft is pressed into crankcase cover and is not serviceable. Therefore, if it is damaged or pulled loose, the crankcase cover MUST BE replaced.

LUBRICATION SYSTEM OPERATION



System Operation

A positive displacement gerotor pump is used to pressurize the lubrication system. The lubrication system is protected by an oil pressure relief valve, low oil pressure switch, and an oil filter with bypass.

The oil pump draws oil from the sump through screen. Pressure oil from the pump flows to the oil pressure relief valve. If oil pressure exceeds 296 kPa (43 psi), the relief valve opens allowing oil to return to sump. Relief valve is not adjustable.

Pressure oil from the relief valve flows to the oil filter. The filter contains a bypass valve which opens if the element becomes plugged to insure engine lubrication.

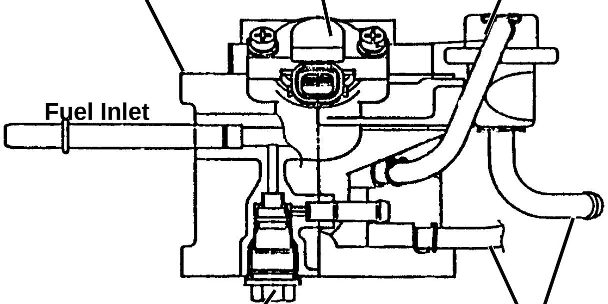
An oil pressure switch mounted above the oil filter turns on a warning light if oil pressure is below 28 kPa (4 psi). Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (PTO side).

Drilled passages in the crankshaft distribute oil from the main bearing to the connecting rod journals and crankshaft main bearing (flywheel side). A drilled passage in the connecting rods allows oil from the connecting rod journal to lubricate the piston and cylinder walls.

THROTTLE BODY OPERATION—445

Function:

Injects and atomizes the fuel into the intake air for the proper combustion.



System Operation:

An electric fuel pump, controlled by the computer, supplies fuel to the inlet of the throttle body to the injector. The fuel pressure regulator holds the fuel under pressure in the injector. The computer receives signals from the throttle sensor and other sensors then controls the time the injector is open. The injector injects the atomized fuel into the throat of the throttle body.

Excess fuel not used by the injector flows through the pressure regulator back to the fuel tank.

The FD620 has an extra passage in the throttle body that allows for a means to relieve the fuel pressure in the fuel lines before any work is done on the system.

TROUBLESHOOTING—425 CARBURETED ENGINES

NOTE: See Electrical Section for fuel injection chart.

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

TROUBLESHOOTING—425 CARBURETED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Coolant leakage.	Engine overheats.
Plugged oil ring groove.											
Check spark—see Electrical Section.											
Incorrect oil viscosity.											
Carburetor flange loose or leaking at gasket.											
Carburetor body and throttle shaft worn.											
Intake valve burned or sticking.											
Excessive engine load.											
Fan belt slippage.											
Defective radiator hose or clamp.											
Broken or missing fan shroud.											
Defective radiator.											
Cracked or porous casting.											
Loose stud bolts and cap screw.											
Engine overheating.											
Damaged water pump seals.											
Improperly installed gasket.											
Improper or defective radiator cap.											

TROUBLESHOOTING—425 CARBURETED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Engine rpm low or engine stalls.
Battery weak or discharged.	●									●
Drain-back in breather chamber plugged.							●			
Oil leakage along governor shaft.			●							
Defective oil seal.			●							
Weak or faulty spark plug.	●	●	●	●	●	●				
Faulty high tension leads.	●	●	●	●	●	●				
Faulty ignition module.	●	●	●	●	●	●			●	
Faulty ignition coil.	●	●	●	●	●	●				
Faulty pulser coil.	●	●	●	●	●	●		●		
Contaminated fuel or faulty fuel supply system.	●	●	●						●	
Fuel shut-off solenoid not allowing fuel into main jet.	●									
Defective fuel pump.	●	●	●	●						
Air being drawn in through a hole in the fuel line(s).	●	●	●					●		

TROUBLESHOOTING—425 CARBURETED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Coolant leakage.
Fuel shut-off valve closed (In-line valve).	●									
Clogged fuel line or filter.	●	●	●	●						
Fuel tank vent line clogged.	●	●	●	●						
Vapor lock.		●	●							
Improper use of choke.	●					●				
Air filter restricted.	●	●				●				
Defective breather valve.		●					●			
Float level too high.	●					●				
Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.	●	●				●	●			
Cylinder head loose.	●	●				●		●		●

TROUBLESHOOTING—425 CARBURETED ENGINES

Problem or Symptom / Check or Solution	Engine is sluggish.	Black smoky Exhaust.	Runs worse when warm.	Spark plug fouled black.	Runs better without air cleaner.	Engine will not start, plug wet.	Spark plug burned white.	Engine speed unstable (surging).	Loss of power.	Engine overheats.	Engine is hard to start when cold.
Mixture too rich.											
Mixture too lean.											
Check and clean air cleaner.											
Clean under engine shrouding.											
Adjust Idle mixture and check engine performance.											
Choke is not completely open Adjust.											
Inlet needle and seat leaking.											
Choke is not completely shut Adjust.											
Clean Carburetor.											
Check spark plug gap and spark. See Electrical Section.											
Water pump nylon impeller.											

TROUBLESHOOTING—445 FUEL INJECTED ENGINES

See Electrical Section for fuel injection chart.

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

TROUBLESHOOTING—445 FUEL INJECTED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Coolant leakage.	Engine overheats.
Plugged oil ring groove.											
Check spark—See Electrical Section.											
Incorrect oil viscosity.											
Throttle body flange loose or leaking at gasket.											
Throttle body and throttle shaft worn.											
Intake valve burned or sticking.											
Excessive engine load.											
Fan belt slippage.											
Defective radiator hose or clamp.											
Broken or missing fan shroud.											
Defective radiator.											
Cracked or porous casting.											
Loose stud bolts and cap screw.											
Engine overheating.											
Damaged water pump seals.											
Improperly installed gasket.											
Improper or defective radiator cap.											

TROUBLESHOOTING—445 FUEL INJECTED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Engine rpm low or engine stalls.
Battery weak or discharged.	●									●
Drain-back in breather chamber plugged.							●			
Oil leakage along governor shaft.			●							
Defective oil seal.			●							
Weak or faulty spark plug.	●	●	●	●	●	●				
Faulty high tension leads.	●	●	●	●	●	●				
Faulty fuel injection module.	●	●	●	●	●	●			●	
Faulty ignition coil.	●	●	●	●	●	●				
Faulty pulser coil.	●	●	●	●	●	●		●		
Contaminated fuel or faulty fuel supply system.	●	●	●						●	
Fuel shut-off solenoid not allowing fuel into fuel injectior.	●									
Defective fuel pump.	●	●	●	●						
Air being drawn in through a hole in the fuel line(s).	●	●	●					●		

TROUBLESHOOTING—445 FUEL INJECTED ENGINES (continued)

Problem or Symptom / Check or Solution	Engine cranks but will not start.	Loss of power.	Engine runs erratically.	Engine misses at high rpm.	Engine misses at low rpm.	Excessive fuel consumption.	Excessive oil consumption.	Engine backfires.	Engine knocks.	Coolant leakage.
Fuel shut-off valve closed (In-line valve).	●									
Clogged fuel line or filter.	●	●	●	●						
Fuel tank vent line clogged.	●	●	●	●						
Vapor lock.		●	●							
Improper use of choke.	●					●				
Air filter restricted.	●	●				●				
Defective breather valve.		●					●			
Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.	●	●				●	●			
Cylinder head loose.	●	●				●		●		●

TROUBLESHOOTING—445 FUEL INJECTED ENGINES

Problem or Symptom / Check or Solution	Engine is sluggish.	Black smoky Exhaust.	Runs worse when warm.	Spark plug fouled black.	Runs better without air cleaner.	Engine will not start, plug wet.	Spark plug burned white.	Engine speed unstable (surging).	Loss of power.	Engine overheats.	Engine is hard to start when cold.
Mixture too rich.											
Mixture too lean.											
Check and clean air cleaner.											
Clean under engine shrouding.											
Check spark plug gap and spark See Electrical Section.											
Water pump nylon impeller .											

DIAGNOSIS—425

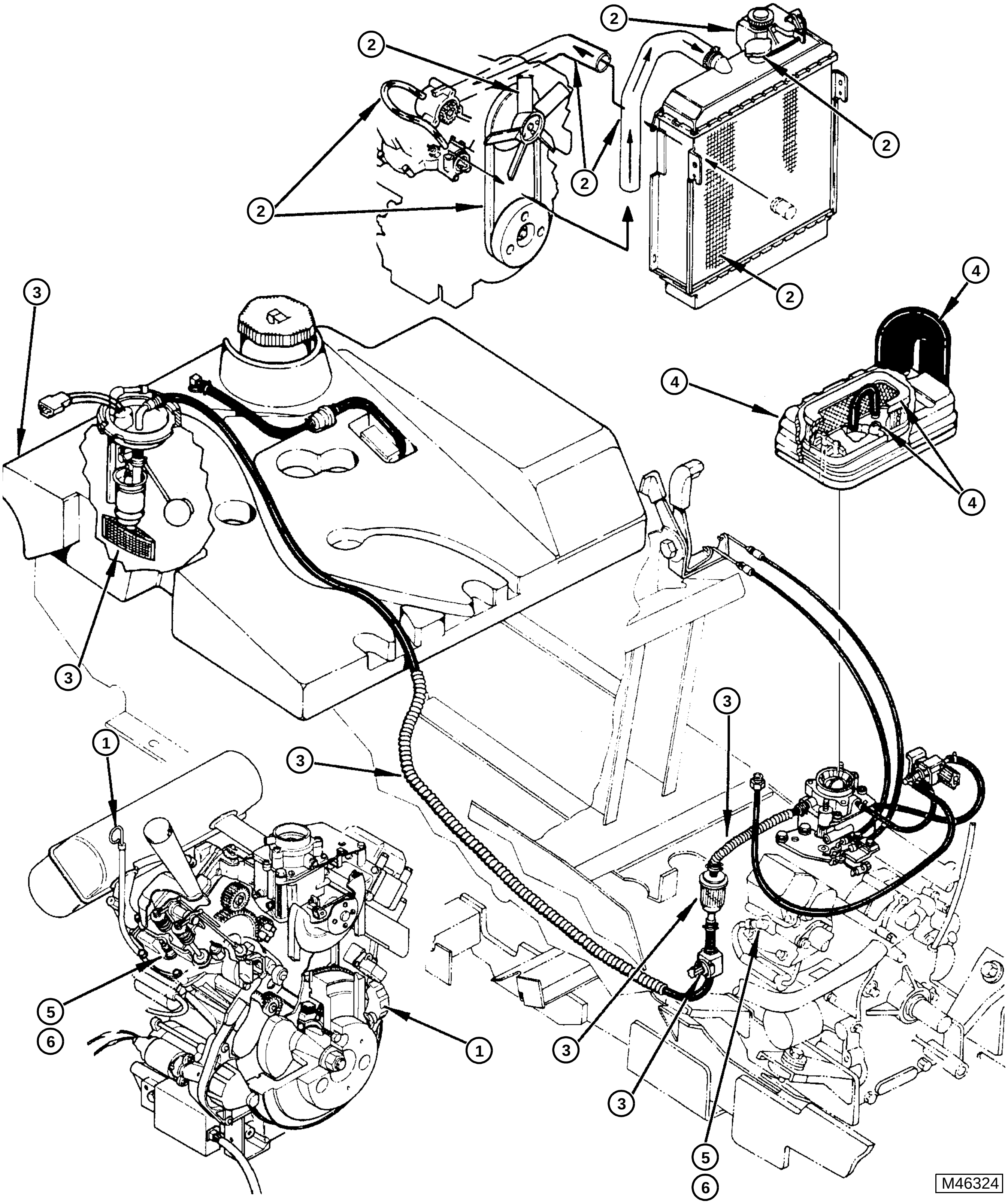
ENGINE SYSTEM DIAGNOSIS—425 CARBURETED ENGINES

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- PTO switch off.
- Key switch off.
- Spark plug connected to D-05351ST Spark Tester.

Test/Check Point	Normal	If Not Normal
1. Engine dipstick and exterior engine surface—ENGINE OIL DIPSTICK. See engine oil dipstick in this section.	Oil level between "L" and "H" marks. Oil not burnt, or contaminated with metal particles or coolant. (A small amount of fuel is acceptable.) No external leakage, filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold. Change oil filter.
2. Coolant tank and radiator—cooling system check.	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top. Coolant not contaminated with oil or fuel or discolored brown. Radiator/screen free of debris. Hoses not cracked or leaking, clamps and radiator cap tight. Fan belt tight, not glazed or cracked. Fan blades not damaged or warped.	Add proper coolant mix. Drain and flush system. Check for source of contamination. Clean or replace hoses. Pressure test radiator and cap. Replace and adjust belt tension. Replace fan.
3. Fuel tank, pump, lines, filters and shutoff valve—fuel system check.	Fuel level correct, not contaminated or stale smelling, no water in fuel. Fuel pump filter and in-line filter free of debris. Fuel shutoff valve in on position. Fuel hoses not cracked or leaking. Fuel hose clamps tight. Fuel tank does not have vacuum.	Drain and clean fuel tank. Add fresh fuel. Replace filters. Move to on position Replace or tighten. Replace fuel tank check valve.
4. Air filter, side screen.	Side panel air intake screen free of debris. Air filter hose not cracked, clamps tight. Primary and secondary elements not plugged. Air filter housing sealed, no dirt tracking inside filter element.	Clean intake screen. Replace and tighten clamps. Replace elements or housing. Replace air restriction indicator.
5. Spark plug (key switch in start position).	Steady blue spark. Engine must crank.	If spark is weak (yellow) or no spark, install new spark plug and test again. If still weak or no spark, see IGNITION CIRCUIT DIAGNOSIS—425 in ELECTRICAL section. See CRANKING CIRCUIT DIAGNOSIS. in the ELECTRICAL section.
6. Spark plug (key switch off).	Plug dry.	Check carburetor inlet needle for debris, choke, and mixture adjustment.

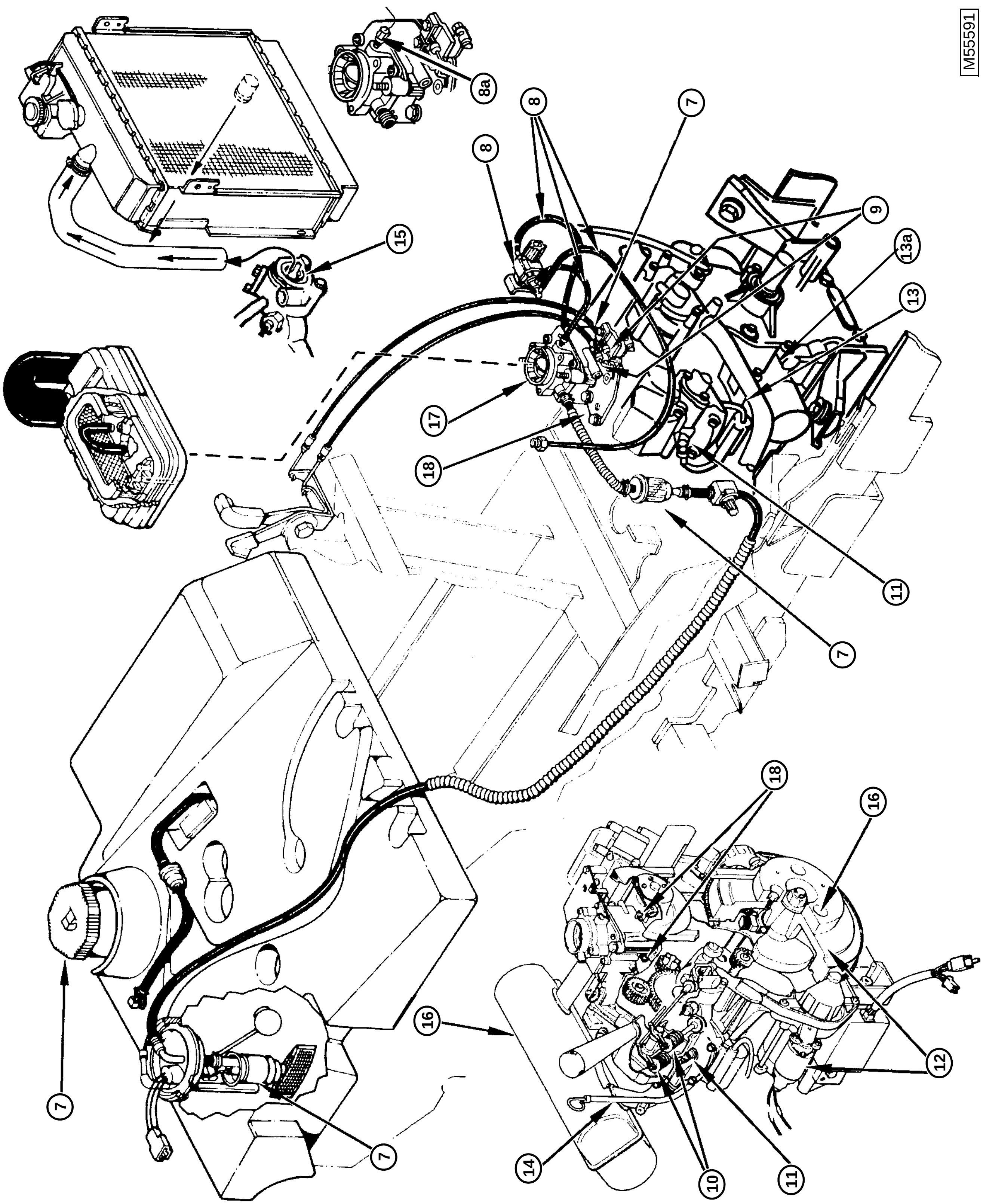
ENGINE SYSTEM TEST POINTS—425 CARBURETED ENGINES



ENGINE SYSTEM DIAGNOSIS—425 CARBURETED ENGINES (continued)

Test/Check Point	Normal	If Not Normal
7. Carburetor—fuel filter, fuel pump, and carburetor bowl drain screw (key switch on).	Fuel level increases in filter. Fuel pump operating—listen for humming sound near fuel tank cap. Fuel present in float bowl when screw is opened.	See FUEL PUMP AND FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS in the ELECTRICAL section. Test fuel pump pressure and flow. Check carburetor for debris.
8. Carburetor vent solenoid (S.N. —033626). 8a. Fuel shut-off solenoid (S.N. 033627—).	Solenoid must “click” when key is turned on. Vent hoses not cracked, and clamps tight. Solenoid must “click” when key is turned on.	See FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT DIAGNOSIS in the ELECTRICAL section. Replace hoses and clamp. See FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT DIAGNOSIS in the ELECTRICAL section.
9. Carburetor choke, governor linkage, and mixture screw (key off).	Linkage not binding and adjusted correctly.	Repair, replace or adjust linkage and mixture screw.
10. Intake and exhaust valves.	Cold engine valve clearance of 0.25 mm (0.010 in.). Valves not sticking.	Adjust—See Valve Clearance Adjustment. Check valve guides and stems.
11. Spark plug hole (key switch start).	Minimum compression of 1171 kPa (170 psi) with a 97 kPa (14 psi) maximum difference between cylinders.	Perform compression test.
12. Flywheel and starter.	Minimum cranking rpm—300 rpm.	Check starter amp draw.

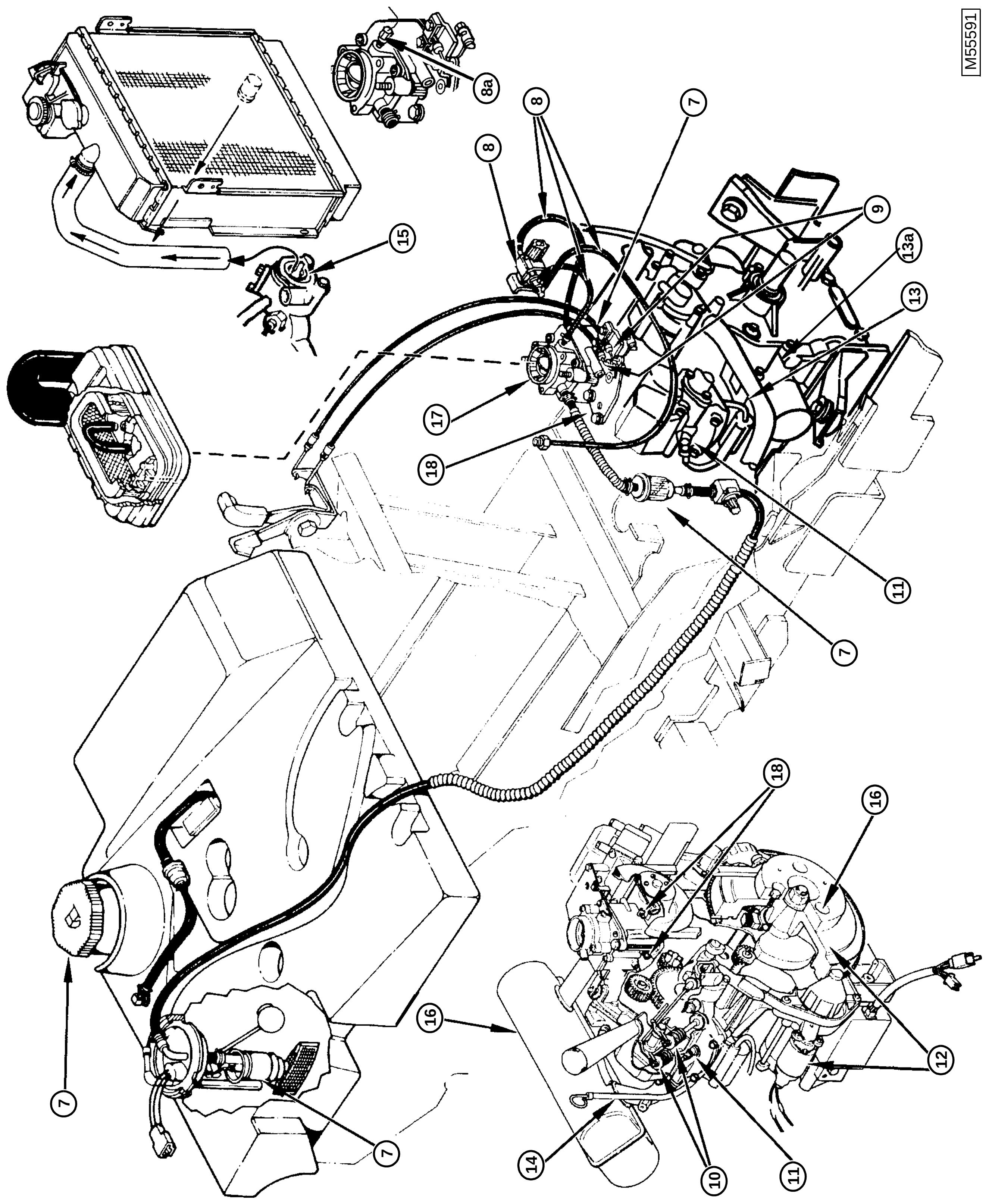
ENGINE SYSTEM TEST POINTS—425 CARBURETED ENGINES (continued)



ENGINE SYSTEM DIAGNOSIS—425 CARBURETED ENGINES (continued)

Test/Check Point	Normal	If Not Normal
13. Oil pressure switch port (on engines with test ports). 13a. Oil filter base (on machines without test ports).	Minimum oil pressure at 3600 rpm—276 kPa (40 psi). Oil pressure at slow and fast idle—138—272 kPa (20—40 psi).	See ENGINE OIL PRESSURE TEST. (Engines Without Oil Pressure Switch Ports) See ENGINE OIL PRESSURE TEST. (Engines Without Oil Pressure Switch Ports)
14. Dipstick tube.	Minimum crankcase vacuum—25 mm (1 in.) water at 3600 rpm.	See CRANKCASE VACUUM TEST.
15. Thermostat.	Clean from corrosion, rust, or debris. Opening temperature—66°C (150°F).	Replace thermostat.
16. Internal components, muffler, and driveshaft.	Wear within limits, all hardware tight, not bent or vibrating.	Repair or replace components.
17. Carburetor internal inspection (key off).	Needle valve, passages, and jets free from varnish or debris. Main jet correct for elevation.	Clean or replace carburetor. Replace jet with correct size.
18. Carburetor (engine running).	Slow idle at 1500 ± 100 rpm. Fast idle at 3600 ± 100 rpm.	Adjust slow idle mixture screw and slow idle rpm. Adjust fast idle.

ENGINE SYSTEM TEST POINTS—425 CARBURETED ENGINES (continued)



DIAGNOSIS—425

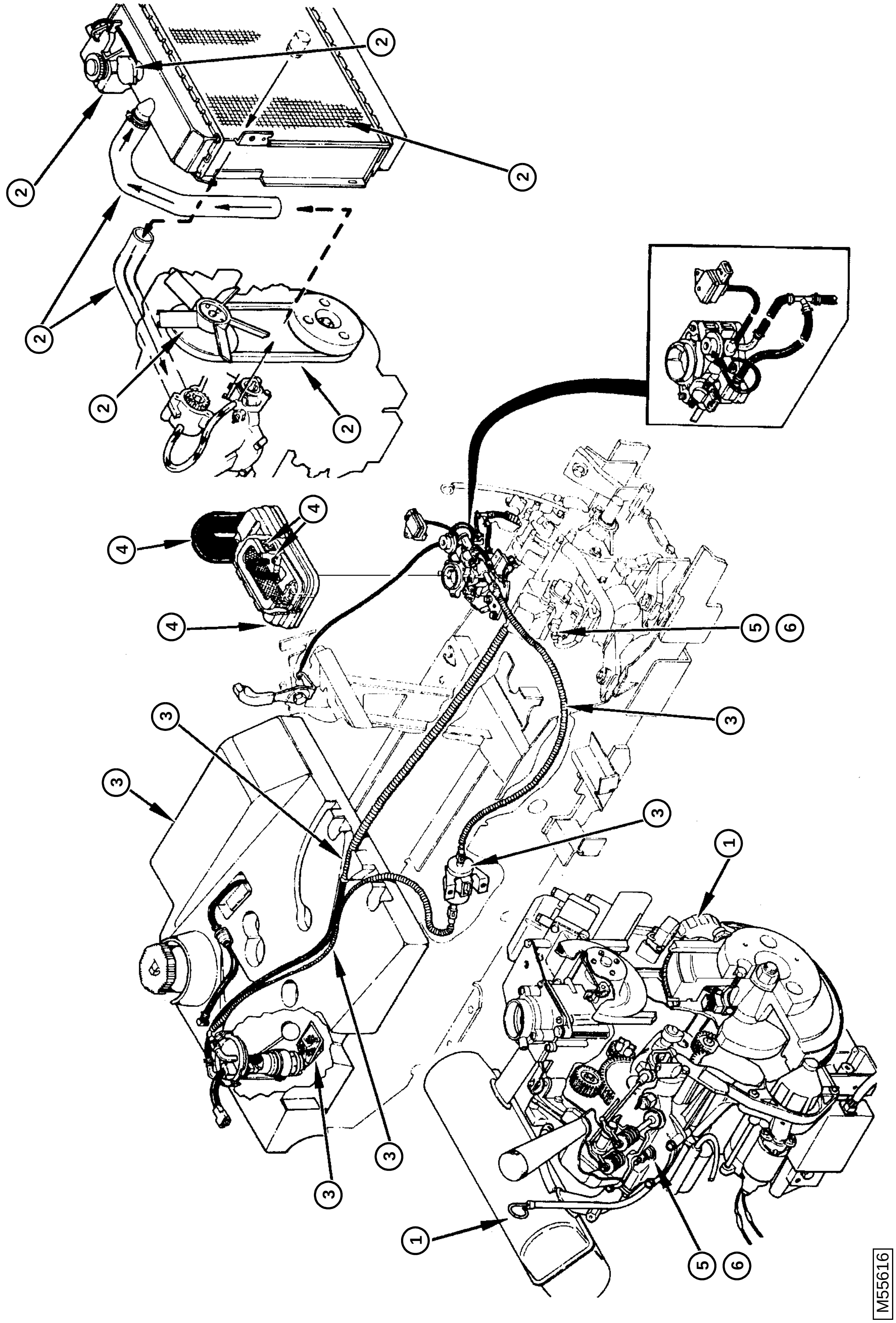
ENGINE SYSTEM DIAGNOSIS—445 FUEL INJECTED ENGINES

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- PTO switch off.
- Key switch off.
- Spark plug connected to D-05351ST Spark Tester.

Test/Check Point	Normal	If Not Normal
1. Engine dipstick and exterior engine surface—engine oil check. SEE ENGINE OIL DIPSTICK.	Oil level between "L" and "H" marks. Oil not burnt, or contaminated with metal particles or coolant. (A small amount of fuel is acceptable.) No external leakage, filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold. Change oil filter.
2. Coolant tank and radiator—cooling system check.	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top. Coolant not contaminated with oil or fuel or discolored brown. Radiator/screen free of debris. Hoses not cracked or leaking, clamps and radiator cap tight. Fan belt tight, not glazed or cracked. Fan blades not damaged or warped.	Add proper coolant mix. Drain and flush system. Check for source of contamination. Clean or replace hoses. Pressure test radiator and cap. Replace and adjust belt tension. Replace fan.
3. Fuel tank, pump, lines, filters and shutoff valve—fuel system check.	Fuel level correct, not contaminated or stale smelling, no water in fuel. Fuel pump filter and in-line filter free of debris. Fuel shutoff valve in on position. Fuel hoses not cracked or leaking. Fuel hose clamps tight. Fuel tank does not have vacuum.	Drain and clean fuel tank. Add fresh fuel. Replace filters. Move to on position Replace or tighten. Replace fuel tank check valve.
4. Air filter, side screen.	Side panel air intake screen free of debris. Air filter hose not cracked, clamps tight. Primary and secondary elements not plugged. Air filter housing sealed, no dirt tracking inside filter element.	Clean intake screen. Replace and tighten clamps. Replace elements or housing. Replace air restriction indicator.
5. Spark plug (key switch in start position).	Steady blue spark. Engine must crank.	If spark is weak (yellow) or no spark, install new spark plug and test again. If still weak or no spark, see IGNITION CIRCUIT DIAGNOSIS—425 in ELECTRICAL section. See CRANKING CIRCUIT DIAGNOSIS. in the ELECTRICAL section.
6. Spark plug (key switch off).	Plug dry.	Check fuel injector needle for debris and test fuel injector operation.

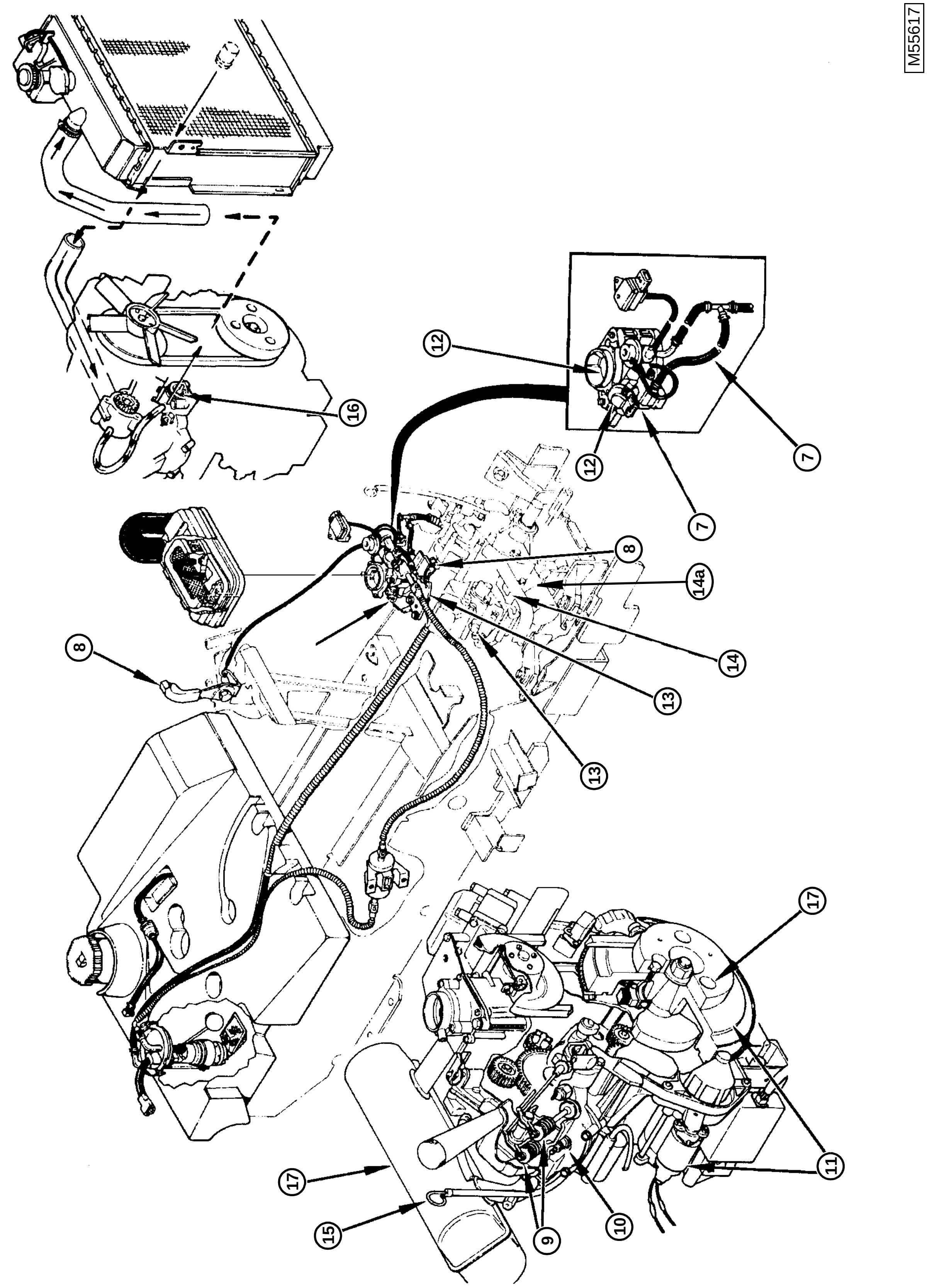
ENGINE SYSTEM TEST POINTS—445 FUEL INJECTED ENGINES



ENGINE SYSTEM DIAGNOSIS—445 FUEL INJECTED ENGINES (continued)

Test/Check Point	Normal	If Not Normal
7. Fuel Injection—pressure relief screw of throttle body (key switch on).	Fuel pump operating for 2 seconds —listen for humming sound near fuel tank cap. Fuel present in throttle body. Passage when screw is opened—fuel will flow through throttle body return hose.	See FUEL INJECTOR AND FUEL PUMP CIRCUIT DIAGNOSIS—445 in the ELECTRICAL section. Test fuel pump pressure and flow. Check fuel injector screen for debris and test fuel pump pressure and flow.
8. Fuel Injection—throttle lever, throttle control lever, and governor lever (key off).	Linkage not binding and adjusted correctly.	Repair, replace or adjust linkage.
9. Intake and exhaust valves.	Cold engine valve clearance of 0.25 mm (0.010 in.). Valves not sticking.	Adjust—See VALVE CLEARANCE ADJUSTMENT. Check valve guides and stems.
10. Spark plug hole (key switch start).	Minimum compression of 1171 kPa (170 psi) with a 97 kPa (14 psi) maximum difference between cylinders.	Perform compression test.
11. Flywheel and starter.	Minimum cranking rpm—300 rpm.	Check starter amp draw.
12. Fuel injector and throttle body valve plate wet (with key switch in start for 5 seconds, then off, then remove air filter cover).	Throttle body valve plate fuel.	Dry or can't tell if wet—check Fuel Injector Circuit Test Points.
13. Throttle body (engine running).	Slow idle at 1500 ± 100 rpm. Fast idle at 3600 ± 100 rpm.	Adjust slow idle stop screw. Adjust fast idle.

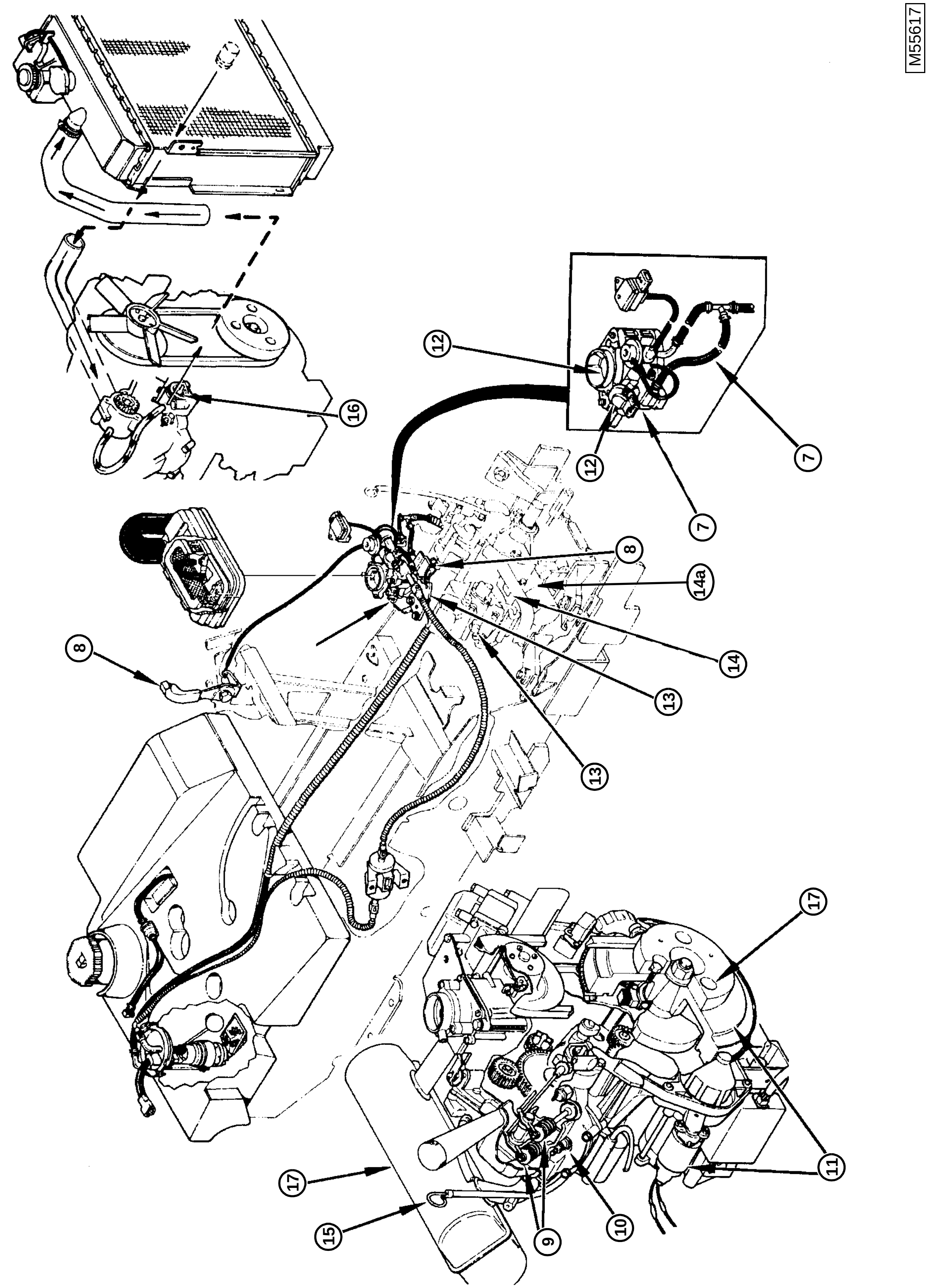
ENGINE SYSTEM TEST POINTS—445 FUEL INJECTED ENGINES (continued)



ENGINE SYSTEM DIAGNOSIS—445 FUEL INJECTED ENGINES (continued)

Test/Check Point	Normal	If Not Normal
14. Oil pressure switch port (on engines with test ports). 17a. Oil filter base (on machines without test ports).	Minimum oil pressure at 3600 rpm—276 kPa (40 psi). Oil pressure at slow and fast idle—138—272 kPa (20—40 psi).	See ENGINE OIL PRESSURE TEST. (Engines Without Oil Pressure Switch Ports) See ENGINE OIL PRESSURE TEST. (Engines Without Oil Pressure Switch Ports)
15. Dipstick tube.	Minimum crankcase vacuum—25 mm (1 in.) water at 3600 rpm.	See CRANKCASE VACUUM TEST.
16. Thermostat.	Clean from corrosion, rust, or debris. Opening temperature—66°C (150°F).	Replace thermostat.
17. Internal components, muffler, and driveshaft.	Wear within limits, all hardware tight, not bent or vibrating.	Repair or replace components.

ENGINE SYSTEM TEST POINTS—445 FUEL INJECTED ENGINES (continued)



TESTS AND ADJUSTMENTS

THROTTLE LEVER ADJUSTMENT

Reason:

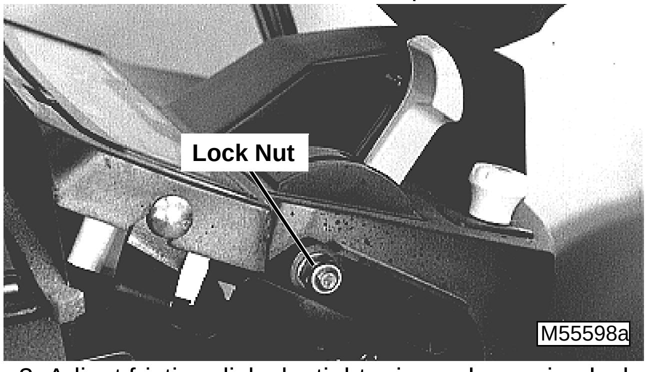
To achieve smooth throttle lever movement with enough tension to maintain throttle setting.

Test Equipment:

- Spring Scale

Procedure:

1. Connect a scale near the end of the throttle lever.
2. Move throttle lever to slow idle position.



3. Adjust friction disks by tightening or loosening lock nut until throttle lever movement in forward direction is **18—35 N (4—8 lb force)**.

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

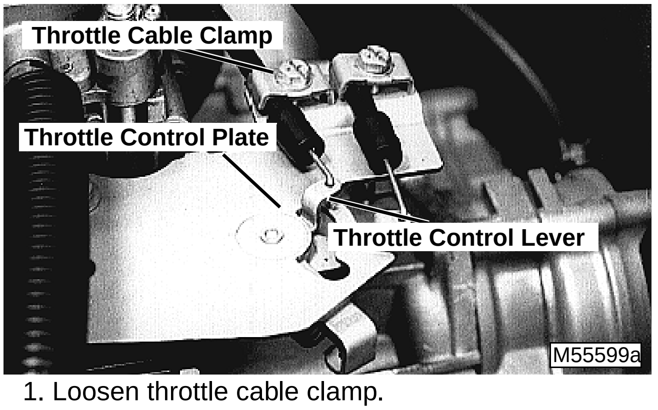
THROTTLE CABLE ADJUSTMENT

Reason:

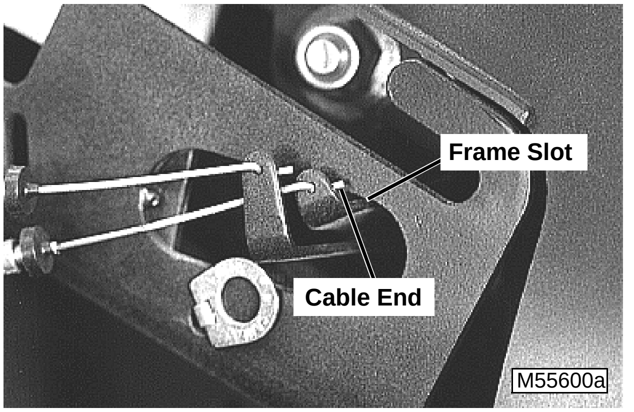
To insure that the throttle lever cable moves the governor linkage from slow to fast idle position.

Procedure:

NOTE: Air filter removed for clarity of photo. DO NOT remove air filter when making adjustment.



1. Loosen throttle cable clamp.



2. Move throttle lever on instrument panel towards fast idle position until the throttle lever cable end is 2—3 mm (0.080—0.120 in.) away from frame slot.
3. Pull throttle cable to hold throttle control lever tight against the throttle control plate. Tighten cable clamp.
4. Move throttle lever through full range to be sure linkage is not binding.

CHOKE ADJUSTMENT

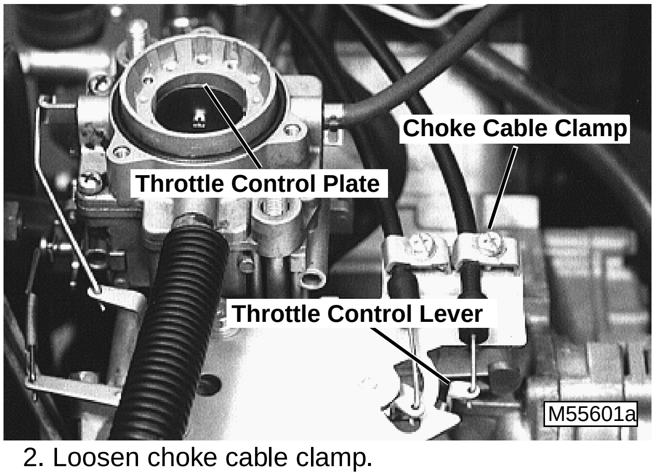
> **ATTENTION!**
>
> **Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board/Environmental Protection Agency (CARB/EPA) Certified engines.**

Reason:

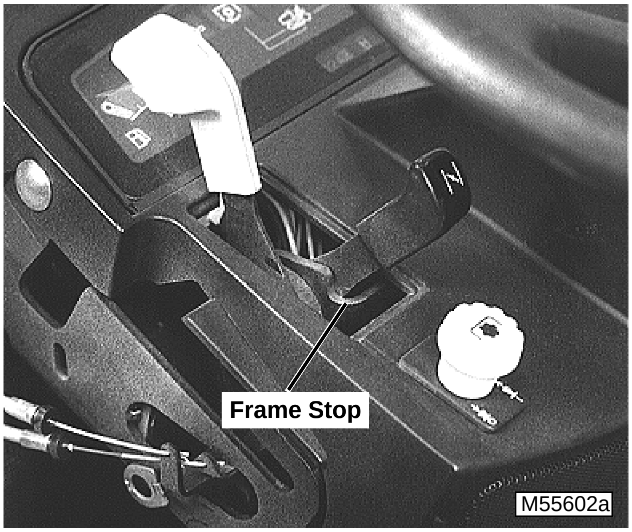
To obtain correct choke plate position.

Procedure:

1. Remove air filter cover.



2. Loosen choke cable clamp.



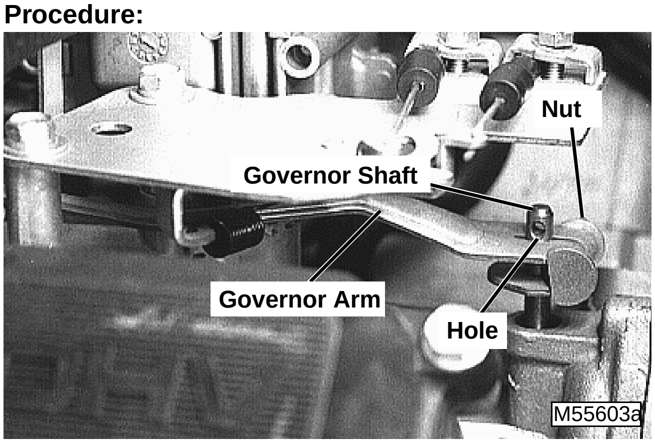
3. Move choke lever fully rearward. Be sure choke lever contacts the frame stop.
4. Push choke cable tight against the choke control lever. Be sure choke plate is fully open (straight up) in the carburetor. Tighten cable clamp.
5. Move choke lever fully forward. Be sure choke plate is fully closed.
6. Move choke lever through full range to be sure linkage is not binding.
7. Install air filter cover.

GOVERNOR ADJUSTMENT

Reason:

To correctly position governor arm against flyweight assembly for proper governor response.

Procedure:



1. Loosen nut.
2. Turn governor arm full counterclockwise and hold.
3. Turn governor shaft full counterclockwise using a small shaft through hole and hold.
4. Tighten nut.

SLOW IDLE ADJUSTMENT—425 NON-CARB/EPA ENGINES

*NOTE: For engines **WITHOUT** California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions/Carburetors.*

Reason:

To achieve a smooth running engine at slow idle.

Test Equipment:

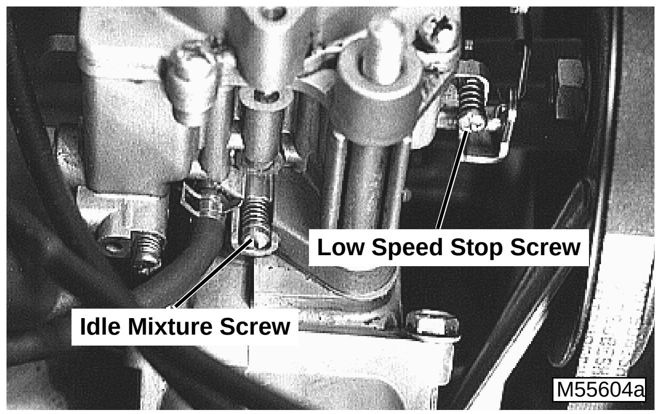
• JT05719 Digital Tachometer

Procedure:

NOTE: Air filter removed for clarity of photo. DO NOT remove air filter when making adjustment.

1. Put reflective tape on flywheel or front crankshaft to check engine rpm.

IMPORTANT: Do not turn idle mixture screw tight. Tightening screw will damage the needle and seat.

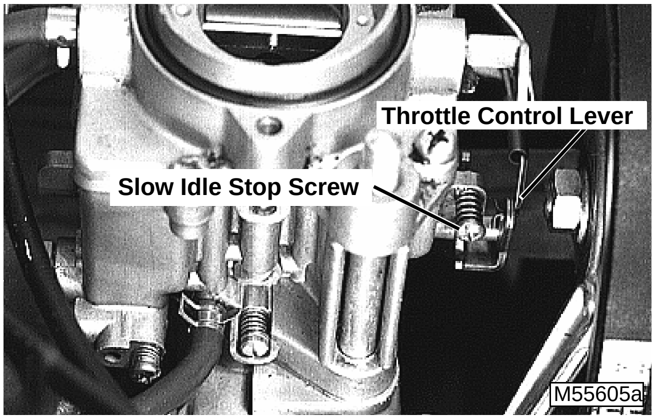


2. Turn idle mixture screw clockwise until lightly seated. Then turn counterclockwise 1-3/8 turns.
3. Lock park brake. Start engine and run for five minutes to operating temperature.
4. Move throttle lever to slow idle position.

c CAUTION

Engine will be HOT. Be careful not to burn hands. Keep hands away from fan belt and pulley.

5. Hold carburetor throttle lever against low speed stop screw.
6. Turn idle mixture screw clockwise until engine speed drops, then counterclockwise until engine speed increases and begins to drop again.
7. Adjust idle mixture screw for highest engine speed between drop points, then turn screw out an additional 1/4 turn.
8. Move throttle lever to slow idle position.



c CAUTION

Engine will be HOT. Be careful not to burn hands. Keep hands away from fan belt and pulley.

9. Hold carburetor throttle lever against slow idle stop screw. Check slow idle speed.

Results:

- If slow idle rpm is below 1500 ± 100 rpm, turn slow idle stop screw until idle speed is 1500 ± 100 rpm.

10. After idle speed adjustment, readjust throttle cable as necessary.

SLOW IDLE ADJUSTMENT—425 CARB/EPA ENGINES

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

BEGINNING ENGINE SERIAL NUMBER:

FD620D-CS02 . . . . (068728—)

ATTENTION!

Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board/Environmental Protection Agency (CARB/EPA) Certified engines.

Reason:

To achieve a smooth running engine at slow idle while maintaining emissions specifications.

Test Equipment:

- JT05719 Digital Tachometer

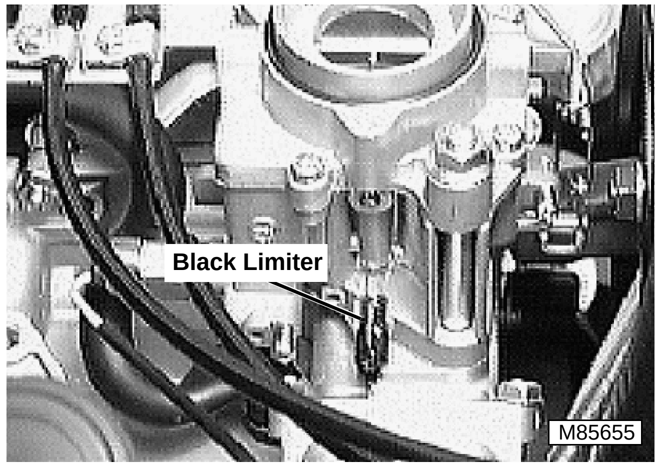
Procedure:

NOTE: Air filter removed for clarity of photo. DO NOT remove air filter when making adjustment.

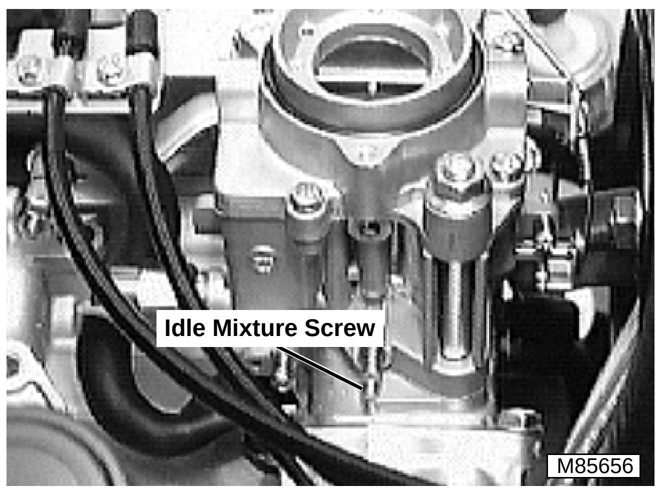
1. Put reflective tape on flywheel or front crankshaft to check engine rpm.

NOTE: Idle mixture screw on CARB/EPA engines can be adjusted 1/4 turn in either direction without removing black limiter.

IMPORTANT: Do not turn idle mixture screw tight. Tightening screw will damage the needle and seat.



2. Remove black limiter on idle mixture screw.



3. Turn idle mixture screw clockwise until lightly seated. Then turn counterclockwise 1-3/4 turns.
4. Lock park brake. Run engine for five minutes to operating temperature.

5. Move throttle lever to slow idle position.

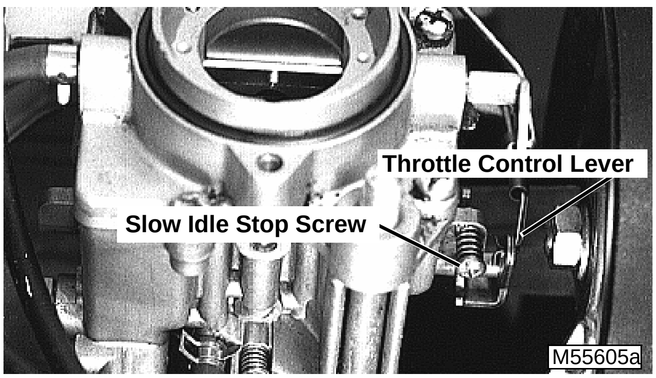
c CAUTION

Engine will be HOT. Be careful not to burn hands. Keep hands away from fan belt and pulley.

6. Hold carburetor throttle lever against slow speed stop screw—see photo below.
7. Turn idle mixture screw in until engine speed drops, then out until engine speed increases and begins to drop again.
8. Adjust idle mixture screw for highest engine speed between drop points.
9. Replace black limiter without turning idle mixture screw. Make sure limiter stop tab is centered between housing stops.

c CAUTION

Engine will be HOT. Be careful not to burn hands. Keep hands away from fan belt and pulley.



10. Hold carburetor throttle lever against slow idle stop screw. Check slow idle speed.

Results:

- If slow idle rpm is not 1500 ± 100 rpm, turn slow idle stop screw until idle speed is 1500 ± 100 rpm.

11. After slow idle speed adjustment, readjust throttle cable as necessary.

FAST IDLE ADJUSTMENT

ATTENTION!

Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board/Environmental Protection Agency (CARB/ EPA) Certified Engines.

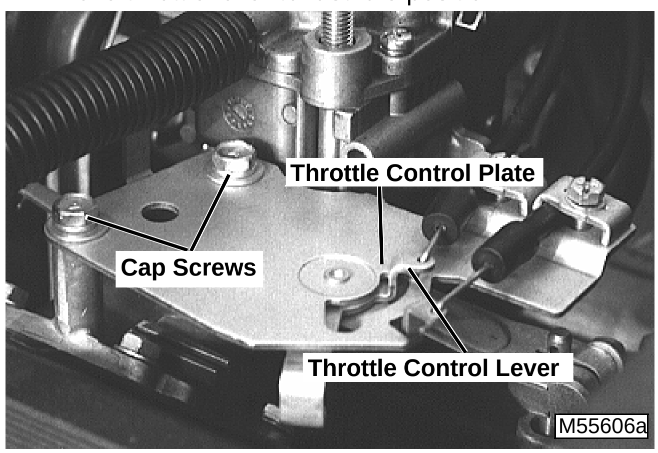
Reason:

To check and adjust the fast idle or operating range of the engine.

Procedure:

NOTE: Air filter removed for clarity of photo. DO NOT remove air filter when making adjustment.

1. Put reflective tape on flywheel or front crankshaft to check engine rpm.
2. Lock park brake. Start engine and run for five minutes (operating temperature).
3. Adjust carburetor idle mixture screw. (See SLOW IDLE ADJUSTMENT).
4. Move throttle lever to fast idle position.



c CAUTION

Engine will be HOT. Be careful not to burn hands. Keep hands away from fan belt and pulley.

5. Loosen cap screws.
6. Be sure the throttle control lever contacts the control plate.
7. Move control plate left or right until the tachometer reads 3600 ± 100 rpm.
8. Tighten cap screws.
9. Adjust choke. (See CHOKE ADJUSTMENT.)

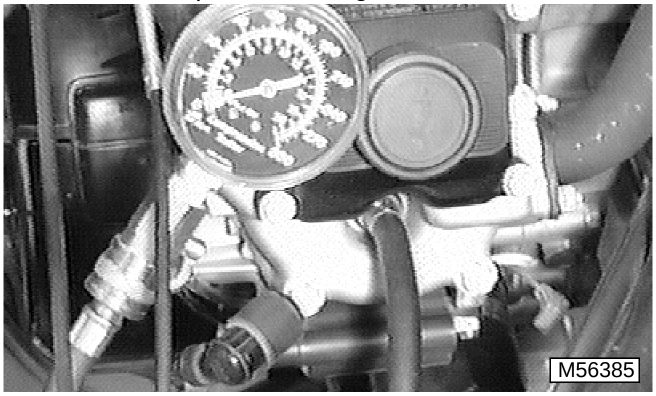
COMPRESSION TEST

Reason:

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

Test Equipment:

• JDM59 Compression Gauge



M56385

1. Adjust valve clearance to 0.25 mm (0.010 in.) with engine at top dead center (TDC) compression stroke. Engine must be “cold” (shop temperature, about 60—85°F (16—30°C).
2. Run engine until it reaches operating temperature (thermostat opens, both radiator hoses hot).
3. Remove both spark plugs and ground leads to block or use spark testers.
4. Put throttle lever in fast idle (wide open) position. Choke must be properly adjusted and fully open. Air filter must be clean.

IMPORTANT: DO NOT overheat starting motor during test. Starter duty is 5 seconds on, 10 seconds off. Additionally, if throttle lever is left in slow idle position (air flow into carburetor restricted), compression could read up to 483 kPa (70 psi) below specification.

5. Crank hot engine until highest compression reading is obtained.
6. Record pressure readings for each cylinder.

Specifications:

Minimum Compression . . . . 1171 kPa (170 psi)

Maximum Difference Between Cylinders . . . . 97 kPa (14 psi)

Results:

• If pressure readings are above specification, adjust valves and check fuel and intake air systems. Check exhaust for restriction.
• If pressure readings are below specification, squirt clean engine oil into cylinders and repeat test.
• If pressure increases significantly, check piston rings and cylinder walls for wear or damage,
• If pressure does NOT increase after retest, check for leaking valves, valve seats or cylinder head gaskets.

7. Reconnect ignition coils and install spark plugs.

VALVE CLEARANCE ADJUSTMENT

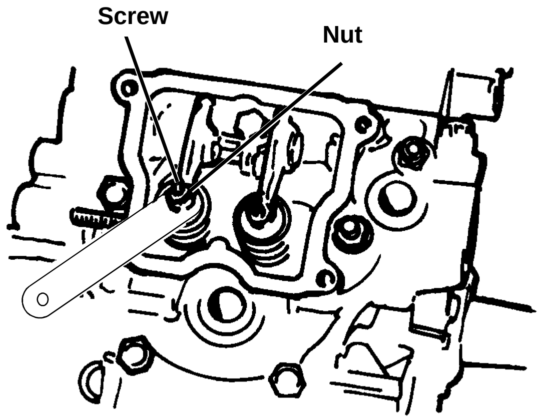
Reason:

Check and adjust valve clearance for proper engine operation.

IMPORTANT: Perform valve clearance measurement or adjustment when the engine is at 16—27°C (60—80°F). Proper valve clearance is essential for the engine to operate properly. Check valve clearance for each cylinder separately.

Procedure:

1. Remove spark plugs.
2. Remove valve covers.
3. Turn the crankshaft until piston, visible in the spark plug hole, is at TDC (top dead center) of the compression stroke. When the piston is at TDC, the "1" or "2" mark with a triangle embossed on the flywheel will align with the triangle on the engine crankcase directly above the flywheel at the 12 o'clock position. Both intake and exhaust valves will be closed and the rocker arms will be loose. If one rocker arm is tight, the piston is on the exhaust stroke and the crankshaft must be turned another revolution (360 degrees).



M46437

4. Use a feeler gauge to measure valve clearance. See specifications.
5. Repeat procedure for other cylinder.

Results:

• To adjust valve clearance, loosen nut and turn screw to correct clearance. Hold screw while tightening nut to specifications.

Specifications:

Valve Clearance
at 16—27°C (60—80°F). . . . . . 0.25 mm (0.010 in.)

Nut Torque . . . . 9 N•m (79 lb-in.)

Spark Plug Torque . . . . 25 N•m (221 lb-in.)

CRANKCASE VACUUM TEST

Reason:

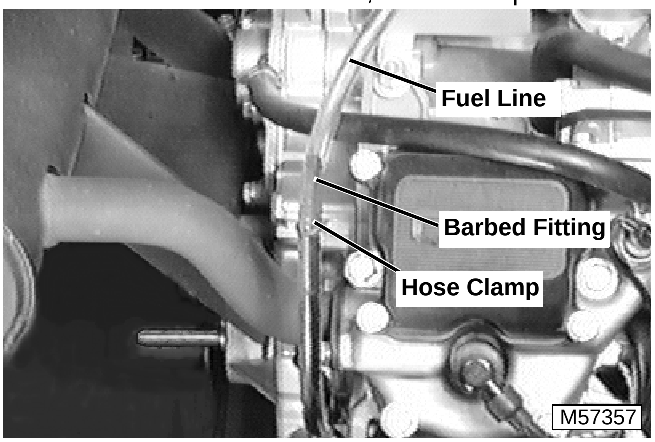
To check operation of breather and condition of seals, gaskets, rings, piston and cylinders walls.

Test Equipment:

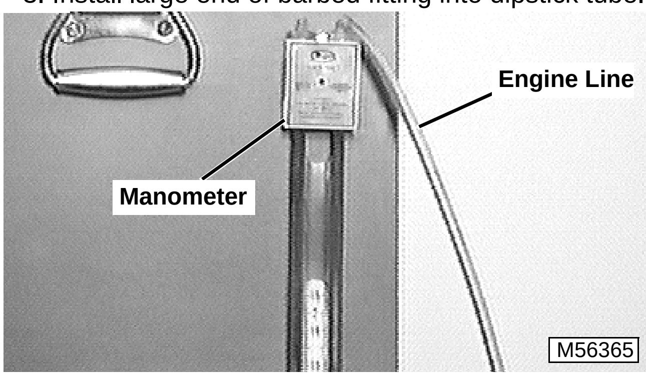
- JT05701 Hose Clamp
- JT05703 Barb Fitting
- JT05699 Line
- JT05698 U-Tube Manometer

Procedure:

1. Park machine on level surface, key switch OFF, transmission in NEUTRAL, and LOCK park brake.



2. Put small end of barbed fitting into line and fasten with hose clamp.
3. Install large end of barbed fitting into dipstick tube.



IMPORTANT: DO NOT make connection between manometer and engine line BEFORE engine is running or fluid in manometer could be drawn into crankcase. DO NOT turn engine OFF until line has been disconnected from manometer.

4. Start and run engine at SLOW idle.
5. Connect line to U-Tube Manometer Kit.
6. Run engine at fast idle.
7. Record crankcase vacuum reading. Manometer should show a **minimum vacuum of 25 mm (1.0 in.) of water**.
8. Run engine at SLOW idle. DO NOT TURN ENGINE OFF!
9. Disconnect clear tube from manometer.
10. Turn engine off.
11. Remove barbed fitting and install dipstick.

Results:

If crankcase vacuum is less than specification, check the following:

- Breather reed valve clearance is **0.2 mm (0.008 in.)** and is in good condition.
- Seals and gaskets for leakage.
- Valve cover gasket for leakage.
- Valve and valve seats for wear or damage.
- Head warpage.
- Rings, piston, and cylinder walls for wear or damage.

ENGINE OIL PRESSURE TEST (Engines With Oil Pressure Switch Ports)

Reason:

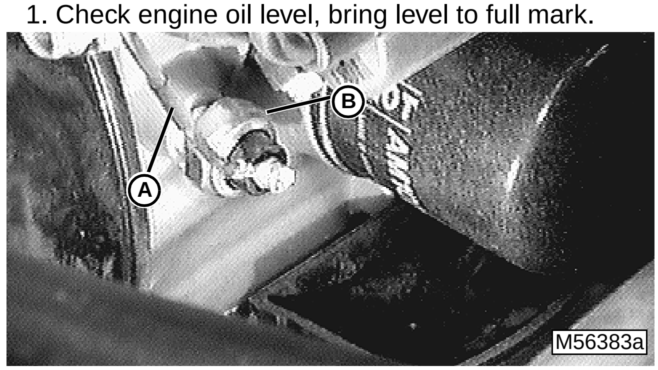
To determine condition of lubrication system.

Equipment:

- JT05577 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector

Procedure:

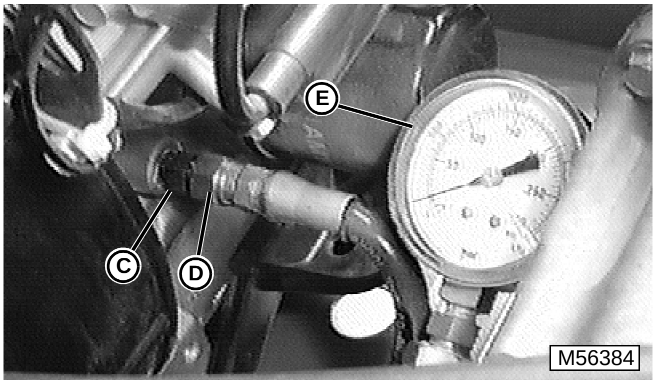
1. Check engine oil level, bring level to full mark.



c CAUTION

Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler, while making adjustments. Wear protective eye glasses and clothing.

2. Disconnect oil pressure switch wiring lead (A).
3. Remove oil pressure switch (B).



4. Install JT03349 Connector (C).
5. Connect JT03017 Hose Assembly (D) and JT05577 Pressure Gauge Assembly (E).
6. Crank engine and check oil pressure. If no oil pressure, determine cause before starting engine.

IMPORTANT: If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDATELY and determine cause.

7. Run engine at FAST idle and check. **Minimum oil pressure is 276 kPa (40 psi).**
8. Run engine at FAST idle until at operating temperature.
9. Install oil pressure switch and switch wiring lead. Use John Deere Pipe Sealant with TEFLON (medium strength), or equivalent, on switch threads.

Results:

If oil pressure is BELOW specifications, inspect or replace the following:

- Oil pressure relief valve for broken or worn spring.
- Oil pressure relief valve for stuck or damaged valve.
- Worn or damaged oil pump.
- Oil pump suction screen or oil passages plugged.
- Excessive wear of connecting rod and main bearing journals.

ENGINE OIL PRESSURE TEST (Engines Without Oil Pressure Switch Ports)

Reason:

To verify that the engine has enough oil pressure to lubricate the internal engine components.

Equipment:

JT07262 Oil Presure Test Adapter w/ o-ring (required ONLY on engines without pressure switch ports)

JT05847 Connector

JT03017 Hose Assembly

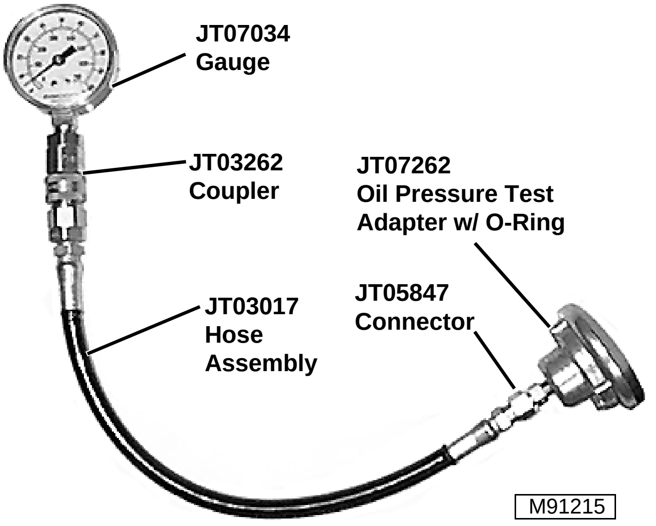
JT03262 Coupler

JT07034 Gauge, 0—700 kPa (0—100 psi)

NOTE: The connector, hose assembly, quick coupler, and gauge are found in other SERVICEGARD™ test kits. The connector pipe thread (NPT) also matches the oil pressure switch port on early Kohler engines.

Test Procedure at Oil Filter Base:

1. Perform test procedure with engine level.
2. Stop engine.
3. Disconnect spark plug wire and allow engine to cool.
4. Drain engine oil from oil filter.
5. Remove oil filter and wipe filter base clean.
6. Install preassembled adapter, connector, hose assembly, coupler, and gauge onto oil filter base. ONLY hand-tighten adapter to oil filter base.
7. Check crankcase oil level and adjust to full mark.



8. Monitor oil pressure during cranking, if oil pressure is **below 28 kPa (4 psi)—STOP engine immediately** and correct cause before continuing.
9. Connect spark plug wire.
10. Warm-up engine by running at MEDIUM idle for five minutes.

c CAUTION

Engine components are HOT. DO NOT touch with bare skin. Wear protective eye glasses and clothing.

11. Record oil pressure readings at SLOW and FAST idle.
12. Stop engine and allow to cool.
13. Remove adapter, connector, hose assembly, coupler, and gauge.
14. Install new oil filter.
15. Run engine for 30 seconds and stop engine.
16. Check crankcase oil level and adjust to full mark.

Results:

- If oil pressure readings are not within **138—272 kPa (20.0—40.0 psi)**, inspect or replace the following:
  –Oil pump assembly.
  –Oil suction screen.
  –Oil passages.

FUEL PUMP FLOW TEST FOR CARBURETOR—425

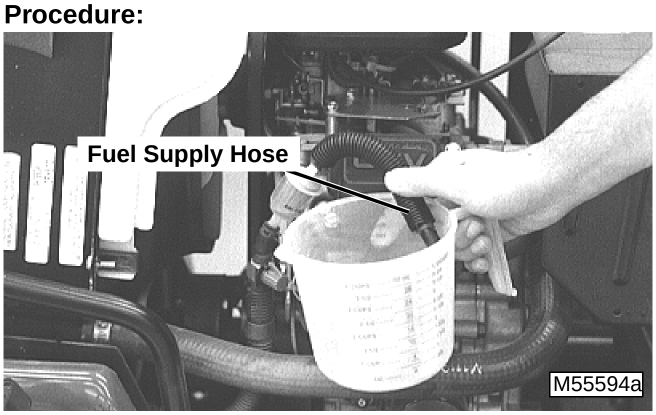
Reason:

To determine proper fuel flow from transfer pump.

Test Equipment:

- Graduated container

Procedure:



1. Disconnect fuel supply hose from carburetor and put end in a graduated container.
2. Turn key switch on for 10 seconds. DO NOT start engine.

Results:

- If fuel flow is **below 300 mL (10 oz)/10 seconds**, check fuel pump filter, in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Replace filters, then test again.
- If fuel flow is still **below 300 mL (10 oz)/10 seconds**, replace fuel pump.

FUEL PUMP PRESSURE TEST FOR CARBURETOR—425

Reason:

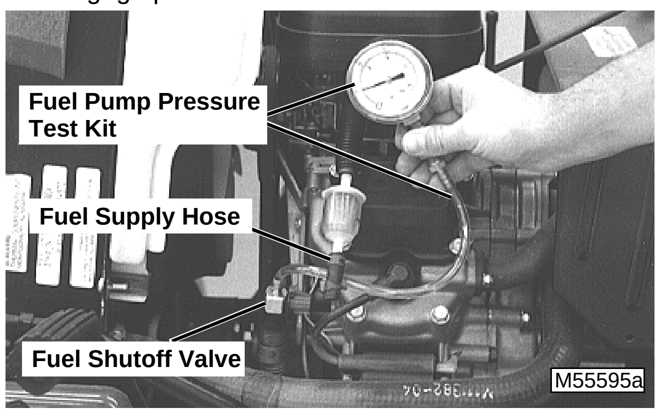
To check condition of fuel pump and determine fuel pressure.

Test Equipment:

- JDG356 Fuel Pump Pressure Test Kit

Procedure:

1. Engage park brake.



2. Disconnect fuel supply hose from fuel shutoff valve.
3. Connect Fuel Pump Pressure Test Kit to fuel shutoff valve outlet.
4. Turn key switch on. DO NOT start engine. Observe pressure reading.

Results:

- If fuel pressure is below **10 kPa (1.5 psi)**, check fuel pump filter, in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Replace filters, then test again.
- If pressure is still below **10 kPa (1.5 psi)**, replace fuel pump.

FUEL PUMP PRESSURE TEST FOR FUEL INJECTION—445

Reason:

To check condition of fuel pump and fuel pressure regulator which determines fuel pressure.

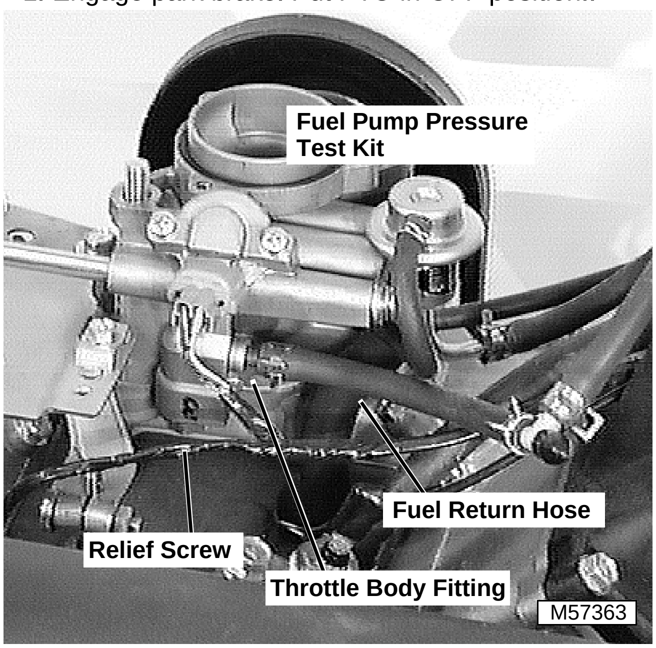
Test Equipment:

- JT07032 400 kPa (60 psi) Pressure Gauge
- JT03246 1/4 F NPT X 1/4 F NPT Coupler
- JDG41 1/4 M NPT X 1/8 ID Barbed Fitting
- Fuel Hose

Procedure:

> **c CAUTION**
>
> **Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before disconnecting fuel line.**

1. Engage park brake. Put PTO in OFF position..



2. Disconnect and plug fuel return hose from throttle body fitting.
3. Connect pressure gauge, coupler, barbed fitting, and hose to throttle body fitting. Fasten hose with hose clamp.
4. Turn fuel pressure relief screw open 1/2 turn.

NOTE: Check fuel pressure quickly as fuel pump will run for only two seconds.

5. Turn key switch on. DO NOT start engine. Observe pressure reading.
6. After test is completed, turn fuel pressure relief screw closed.
7. Put a shop towel over end of test fuel hose.
8. Remove hose slowly and carefully to allow pressure to escape.

Results:

- If fuel pressure is below **172—186 kPa (25—27 psi)**, check fuel pump screen, in-line filter, and hoses for debris or restrictions. Replace filters, then test again.
- If pressure is still below specification, replace pressure regulator or fuel pump.
- If pressure is above specification, check fuel tank return line for restrictions and check the pressure regulator vacuum line for air leaks. If OK, replace the pressure regulator.

FAN BELT TENSION ADJUSTMENT

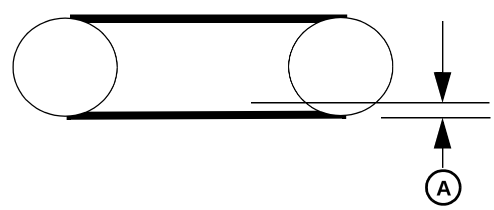
Reason:

To keep proper tension on belt to drive cooling fan.

Test Equipment:

- JDST28 Belt Tension Gauge

Procedure:



1. Use JDST28 Belt Tension Gauge to check belt deflection (A) midway between fan and drive sheaves. See specifications.

Specifications:

Applied Force . . . . . . 245—391 N (55—88 lb force)
Deflection (A) . . . . 12—19 mm (0.472—0.748 in.)

Results:

- If deflection is not within specifications, disconnect drive shaft and remove outer sheave half of fan drive pulley. Remove shim(s) to increase belt tension or add shim(s) to decrease tension.

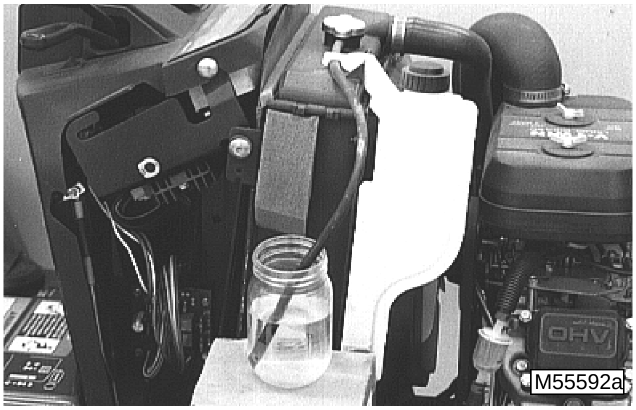
RADIATOR BUBBLE TEST

Reason:

To determine if compression pressure is leaking past head gaskets and into cooling system.

Procedure:

1. With coolant at proper level and radiator cap tight, start and run engine to bring it to operating temperature.
2. Disconnect overflow hose from coolant recovery tank.



3. Put end of hose in a container of water.
4. Check for bubbles coming from hose.

Results:

- If bubbles are present, replace head gaskets.

RADIATOR CAP PRESSURE TEST

Reason:

To test radiator cap for operating in correct pressure range.

Test Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Adapter

Procedure:

1. Install radiator cap on pressure pump.
2. Apply pressure and observe when cap relieves.

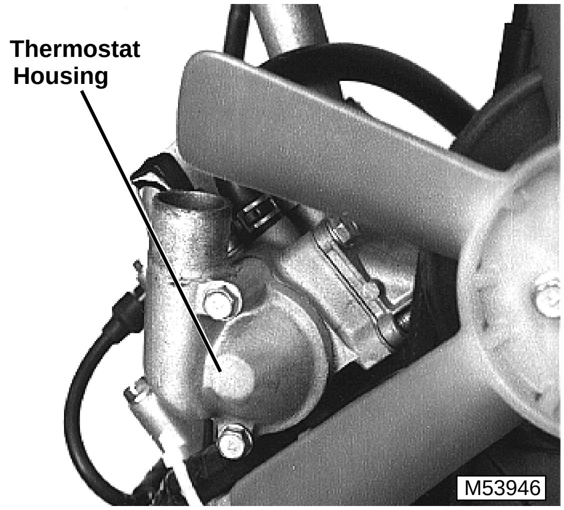
Specifications:

Opening Pressure . . . . 83—96 kPa (12—14 psi)
Minimum Pressure . . . . 76 kPa (11 psi)

Results:

- If cap leaks, retighten and test again. Replace cap if pressure is not according to specifications.

THERMOSTAT TEST



Temperature gauge (on tractor) will read slightly higher than normal until thermostat opens. Check thermostat using a thermostat tester. Heat thermostat in water to check opening temperature. Replace, if not according to specifications.

Thermostat Specifications

Begin Opening . . . . 66—66°C (145—150°F)
Fully Open. . . . . .80°C (176°F)

COOLING SYSTEM TEST

Reason:

Inspect cooling system for leaks.

Test Equipment:

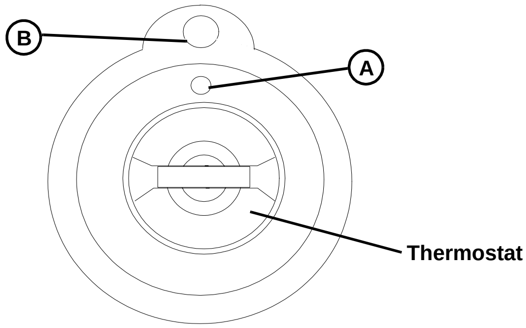
- D05104ST Cooling System Pressure Pump
- JDG692 Adapter

Procedure:

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

Results:

- Pressure should hold to **90 kPa (13 psi)**. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If pressure test still indicates leakage and all external leaks have been stopped, a defective head gasket or cracked block may be the cause.
- If antifreeze level drops after changing, or drops to “add” several days later, air may be escaping.



- Install thermostat so “jiggle” pin (A) is in line with upper bolt hole (B) which will be 12 o’clock position on engine. Pin in this location allows air to escape allowing for full fill level of antifreeze.

ENGINE OIL DIPSTICK

IMPORTANT: The John Deere “K” series engine is designed to accept, without any engine damage, a 10% increase in the crankcase level caused by fuel. This could result in as much as 12 mm (1/2 in.) above the “H “mark on the dipstick. Fuel entering the crankcase (in small amounts) is a normal condition on all gasoline engines. Fuel will dissipate to atmosphere during hot engine operation.

1. Check oil level with dipstick handle facing toward engine side panel. Oil level is difficult to read on dipstick. After wiping dipstick clean, be sure it is completely straight before inserting back into tube. Any “curl” of dipstick will give inaccurate level readings.

NOTE: Do not try to read oil level from back side of dipstick. Use a scale to actually measure level of oil above full mark.

If crankcase level increases after repeated checks, and engine does not run properly, there may be excessive fuel in the crankcase.

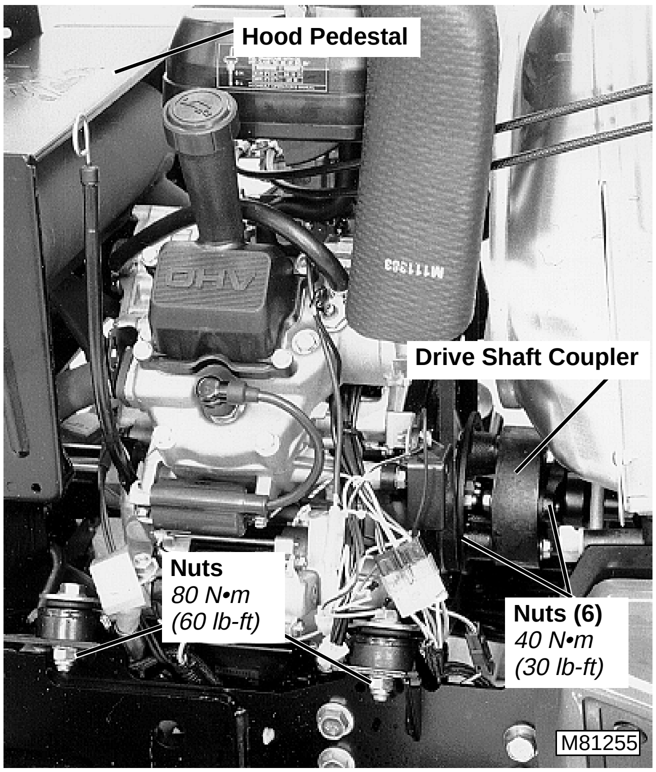
Excessive fuel in the crankcase can be caused by the following conditions:

- Fouled spark plugs.
- Choke not properly adjusted.
- Air filter restricted.

REPAIR

ENGINE—REMOVAL/ INSTALLATION—425

> **c CAUTION**
>
> **Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure and be sure engine is cool before servicing.**



Left Side View

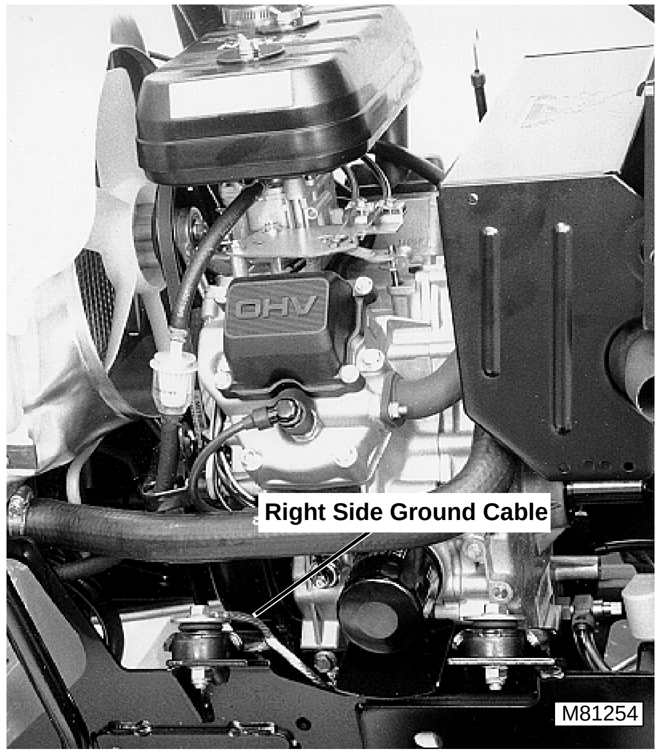
1. Remove side shields, grille, hood and hood pedestal.
2. Disconnect and remove battery.

NOTE: Cooling system capacity is approximately 2.8 L (3.0 qt).

3. Drain coolant and remove upper and lower radiator hoses.
4. Disconnect all hoses, wiring connectors and cables.
5. Remove muffler. (See MUFFLER REMOVAL/ INSTALLATION in the Miscellaneous Section.)
6. Disconnect throttle and choke cables.
7. Disconnect drive shaft coupler.
8. Install lift bracket to aid in engine removal/ installation.
9. Remove four mounting cap screws, washers and nuts, and right side ground cable.

IMPORTANT: When lifting engine, simultaneously move engine forward and away from radiator, so fan clears radiator shroud; otherwise, damage to radiator, cooling fan, or shroud may occur.

10. Safely attach overhead hoist and carefully remove engine making sure not to damage radiator, fan, or fan shroud.
11. Make repairs to engine as necessary.



Right Side View

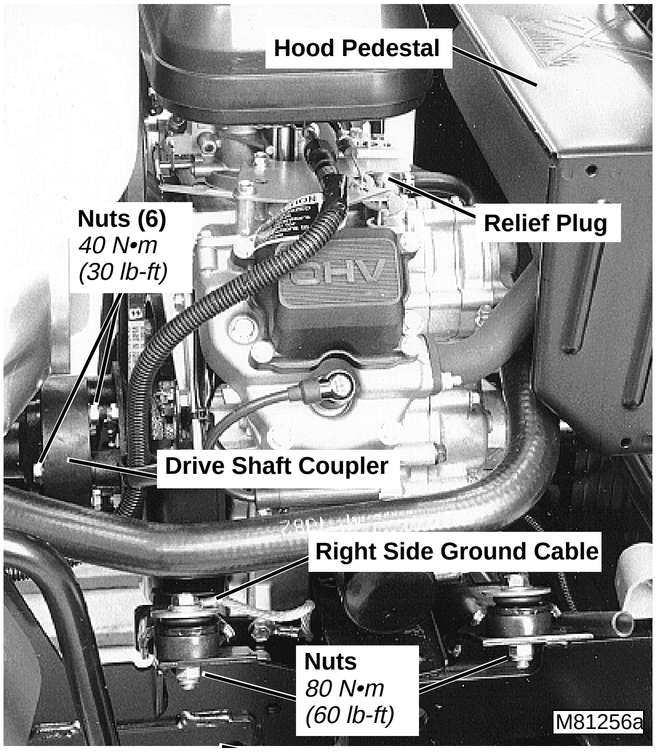
IMPORTANT: Ground cable must not be stretched tight after tightening engine mounting nut to prevent failure of cable from engine vibration.

Installation is done in the reverse order of removal.

- Carefully install engine so damage is not caused to radiator, fan, or fan shroud.
- Install right side ground cable between head of rear engine mounting bolt and washer.
- Tighten engine mounting hardware to **80 N•m (60 lb-ft)**, drive shaft coupler hardware to **40 N•m (30 lb-ft)**, and hood pedestal hardware to standard torque specifications.
- Close drain valve and fill radiator with proper mixture of coolant to top of filler neck.
- Start engine and allow it to reach proper operating temperature.
- Visually check radiator, hoses, and connections for leaks. Adjust coolant level in recovery tank only.

ENGINE—REMOVAL/INSTALLATION (445)

> **c CAUTION**
>
> **Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure and be sure engine is cool before servicing.**



Right Side View

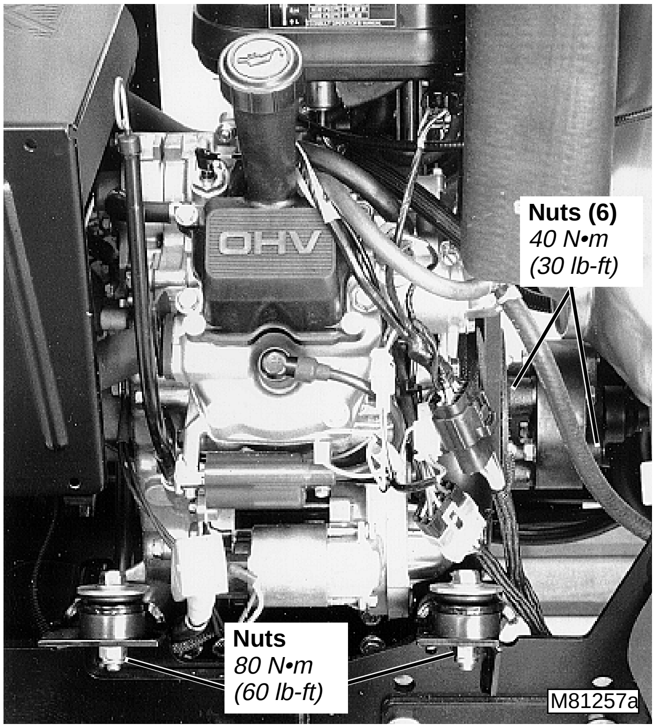
1. Remove side shields, grille, hood and hood pedestal.
2. Disconnect and remove battery.

NOTE: Cooling system capacity is approximately 2.8 L (3.0 qt).

3. Drain coolant and remove upper and lower radiator hoses.
4. Turn fuel pressure relief plug 1/2 turn to relieve pressure in fuel system.
5. Disconnect all hoses, wiring connectors and cables.
6. Remove muffler. (See MUFFLER REMOVAL/ INSTALLATION in the Miscellaneous Section.)
7. Disconnect throttle and choke cables.
8. Disconnect drive shaft coupler.
9. Install lift bracket to aid in engine removal/ installation.
10. Remove four mounting cap screws, washers and nuts, and right side ground cable.

IMPORTANT: When lifting engine, simultaneously move engine forward and away from radiator, so fan clears radiator shroud; otherwise, damage to radiator, cooling fan, or shroud may occur.

11. Safely attach overhead hoist and carefully remove engine making sure not to damage radiator, fan, or fan shroud.
12. Make repairs to engine as necessary.



Left Side View

IMPORTANT: Ground cable must not be stretched tight after tightening engine mounting nut to prevent failure of cable from engine vibration.

Installation is done in reverse order of removal.

- Carefully install engine so damage is not caused to radiator, fan, or fan shroud.
- Install right side ground cable between head of rear engine mounting bolt and washer.
- Tighten engine mounting hardware to **80 N•m (60 lb-ft)**, drive shaft coupler hardware to **40 N•m (30 lb-ft)**, and hood pedestal hardware to standard torque specifications and close fuel system relief plug to **15 N•m (133 lb-in.)**.
- Close drain valve and fill radiator with proper mixture of coolant to top of filler neck.
- Start engine and allow it to reach proper operating temperature.
- Visually check radiator, hoses, and connections for leaks.
- Adjust coolant level in recovery tank only.

CARBURETOR—EXPLODED VIEW

ATTENTION!

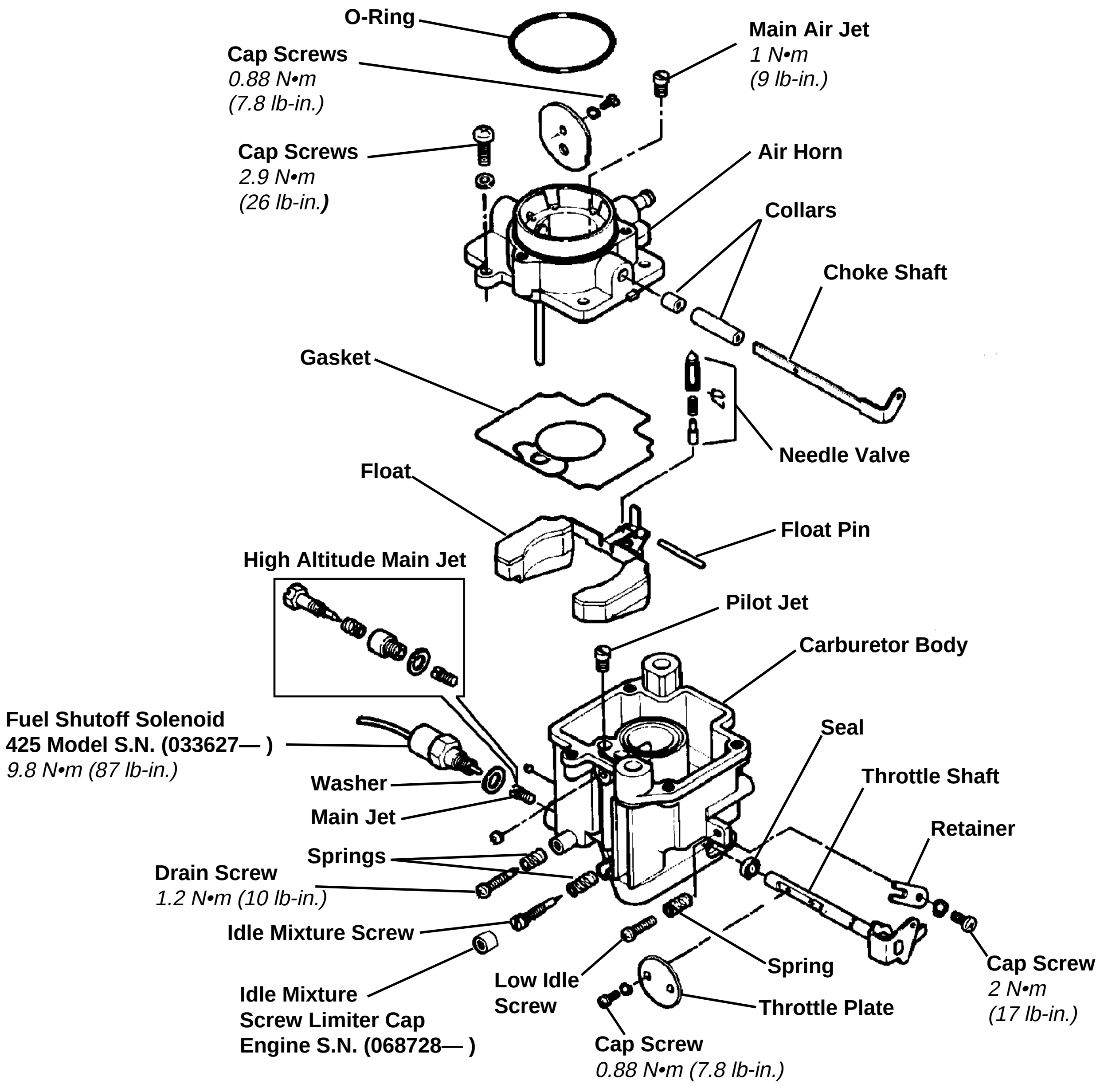
Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board/Environmental Protection Agency (CARB/EPA) Certified engines.

c CAUTION

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

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

NOTE: Late model 425 certified carburetors - Engine S.N: (068728—) have a limiter cap on the idle mixture screw . This capped idle mixture screw requires a special procedure for adjustment. 425 Model S.N. (033627—) use fuel shut-off solenoid. 425 Model S.N. (—033626) use carburetor vent tubes.



CARBURETOR—CLEAN AND REBUILD

There are a number of plates or boll plugs on/in the carburetor that should not be removed.

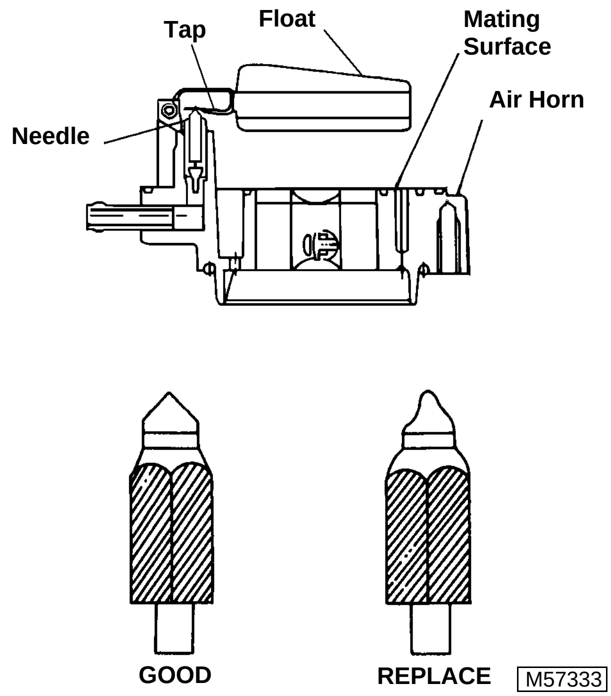
- Turn the idle mixture screw in and note the number of turns required to lightly seat it before removing it.

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

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

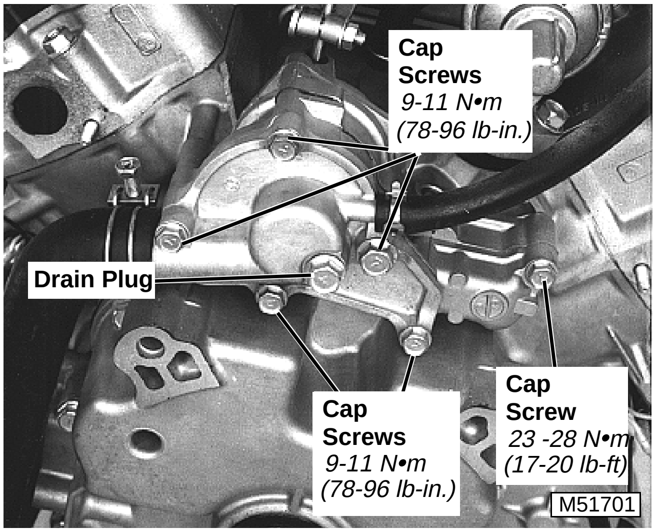
CARBURETOR—FLOAT LEVEL ADJUSTMENT

NOTE: Plastic floats are non-adjustable.



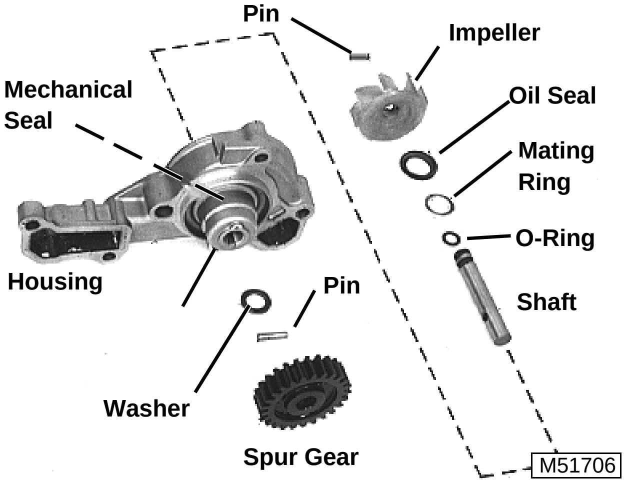
1. Hold air horn upside down at eye level with float assembly installed.
2. Gently support float with a finger and lower it slowly until the float arm tab just touches the float valve needle.
3. The float lower surface should be parallel with the body mating surface.
4. If necessary, bend float arm tab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

COOLANT PUMP—REMOVAL/ INSTALLATION



NOTE: *Cap screw attaches crankcase cover to crankcase.*

IMPORTANT: Leakage from water pump will drain into engine block and could cause engine damage. If there is any doubt of the condition of water pump, replace it as a complete assembly.



1. Remove gear with a puller.
2. Remove impeller assembly from shaft. Disassemble impeller assembly.

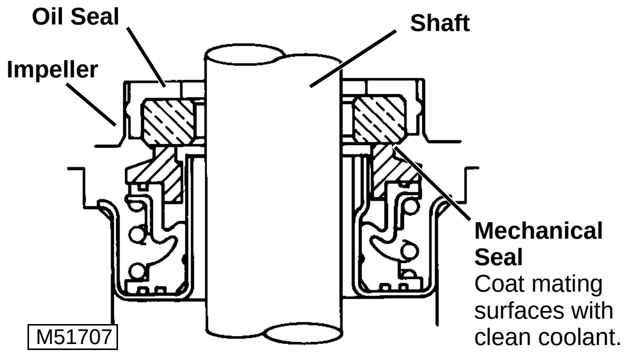
IMPORTANT: Check impeller for material breakdown or deterioration. Replace the complete coolant pump if impeller is damaged. Flush cooling system to remove debris and add new coolant.

3. Measure outside diameter of shaft. If less than specifications or if it shows any signs of corrosion, replace it.
4. Measure pump shaft bore in housing. Replace housing if greater than specifications.
5. Drive old mechanical seal from housing.

NOTE: *Mechanic seal is sealed into place and will be difficult to remove.*

When installing impeller assembly to housing, coat mating surfaces with clean water.

6. Install new mechanical seal.



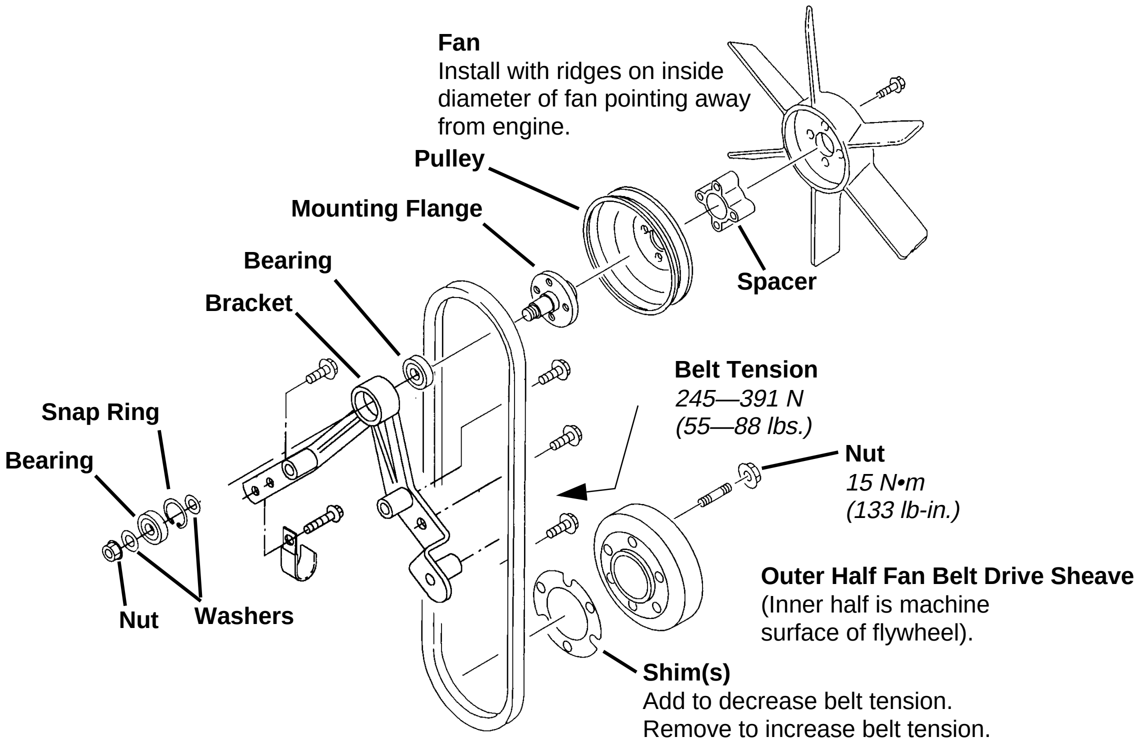
Pump Specifications

Shaft OD (Min) . . . . 9.94 mm (0.391 in.)

Housing Shaft Bore/ ID (Max)

. . . . . 10.09 mm (0.397 in.)

COOLING FAN AND BRACKET



IMPORTANT: Bearings are a press fit. Remove only if being replaced. To avoid pinching fan belt between flywheel and outer sheave half, rotate flywheel while tightening outer sheave half mounting cap screws.

c CAUTION

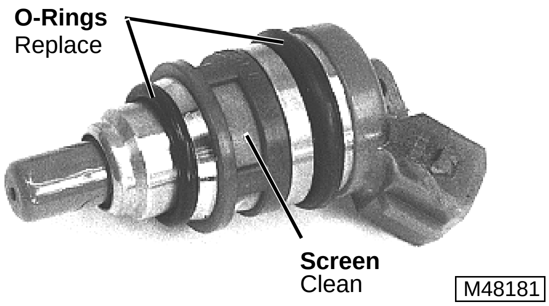
DO NOT heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. DO NOT allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area.

1. Heat mounting bracket with bearings in hot oil to remove bearings. Tap bearings from mounting bracket.
2. Install bearings using a bushing, bearing and seal driver set and press.
3. Assemble fan, spacer, and belt sheave to mounting flange and install fan assembly to engine. Tighten hardware to standard torque specifications.
4. Install fan belt, shim(s), and outer sheave half to flywheel. Tighten flange nuts to specification.
5. Adjust belt tension. (See FAN BELT TENSION ADJUSTMENT.

FUEL INJECTOR—445

NOTE: See electrical system for electrical tests.

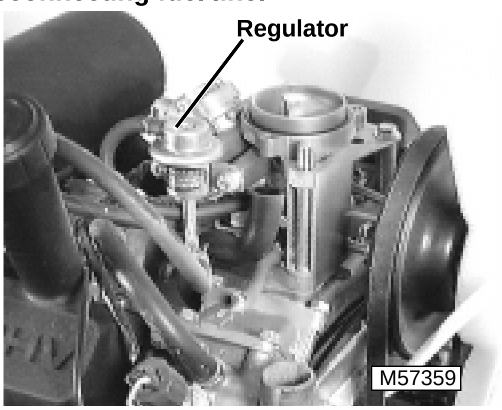
IMPORTANT: Do not drive against tip. Plastic cover can crack and nozzle will be damaged. Do not drop injector. Always install new O-rings.



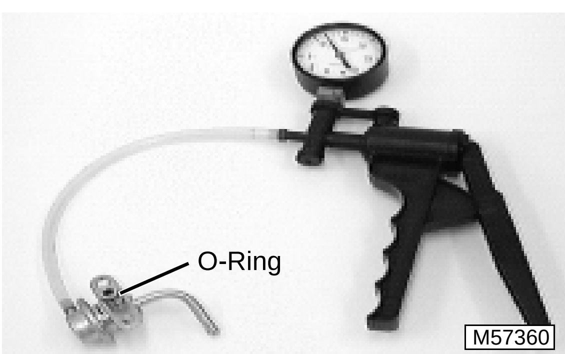
1. Remove injector retainer. Grip end of injector, twist and pull.
2. Replace injector O-rings and clean fuel screen.
3. Lubricate O-rings with clean engine oil.
4. Install injector in the same orientation as removed.

FUEL PRESSURE REGULATOR—445

IMPORTANT: Relieve fuel pressure before disconnecting fuel line.



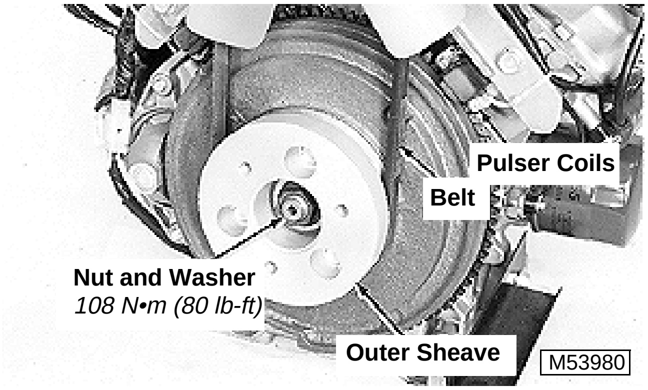
1. Remove fuel lines, vacuum line and regulator.



2. Apply vacuum to vacuum port of regulator. Regulator must hold vacuum.
3. Replace regulator if defective. Install new o-ring on regulator inlet and install regulator.

NOTE: Valve will not move without maximum fuel pressure on inlet.

FLYWHEEL—REMOVAL/ INSTALLATION



NOTE: Remove spark plugs to allow easy flywheel rotation during outer sheave half removal/ installtion.

1. Remove spark plugs.
2. Loosen and move pulser coils away from flywheel.
3. Remove outer sheave half with shim(s) and belt.
4. Hold flywheel with band wrench to remove flywheel nut and washer.
5. Use flywheel puller to remove flywheel.
6. Inspect stator (see Electrrical Section).
7. Inspect flywheel for cracks, chipped or broken teeth, and loose magnets.
8. Inspect flywheel magnets. Hold screwdriver blade close to magnet.

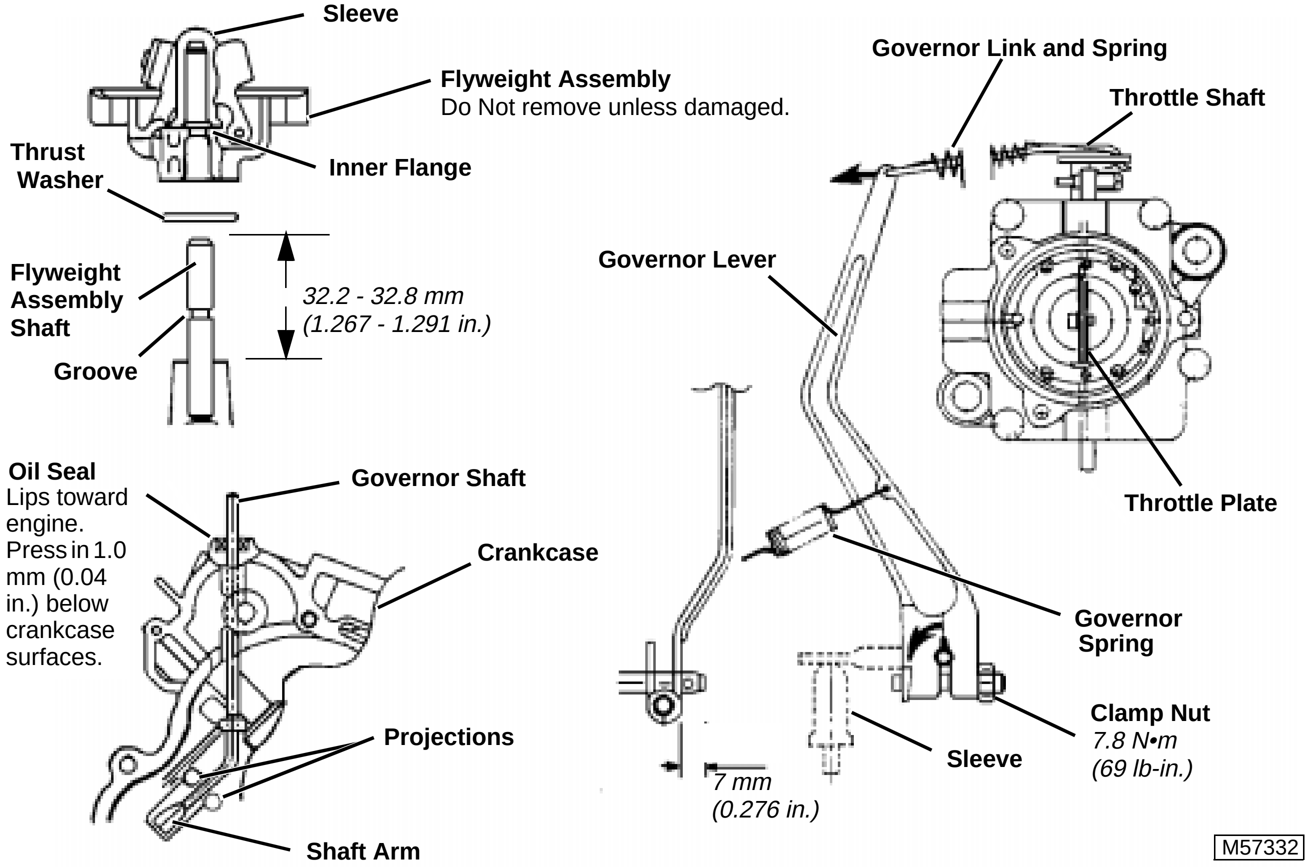
NOTE: Screwdriver blade should be drawn quickly and strongly to magnet.

9. Replace flywheel if necessary.

Installation is done in reverse order of removal.

- Install flywheel, washer, and nut and tighten nut to **108 N•m (80 lb-ft)**.
- Install belt, shim(s), outer sheave half and cap screws loosely then rotate flywheel while tightening cap screws to **15 N•m (130 lb-in.)**.
- Install spark plugs to **20 N•m (177 lb-in.)**.
- Install pulser coils.

GOVERNOR



1. Remove camshaft

IMPORTANT: DO NOT remove flyweight assembly or shaft unless damaged. Removal damages the assembly.

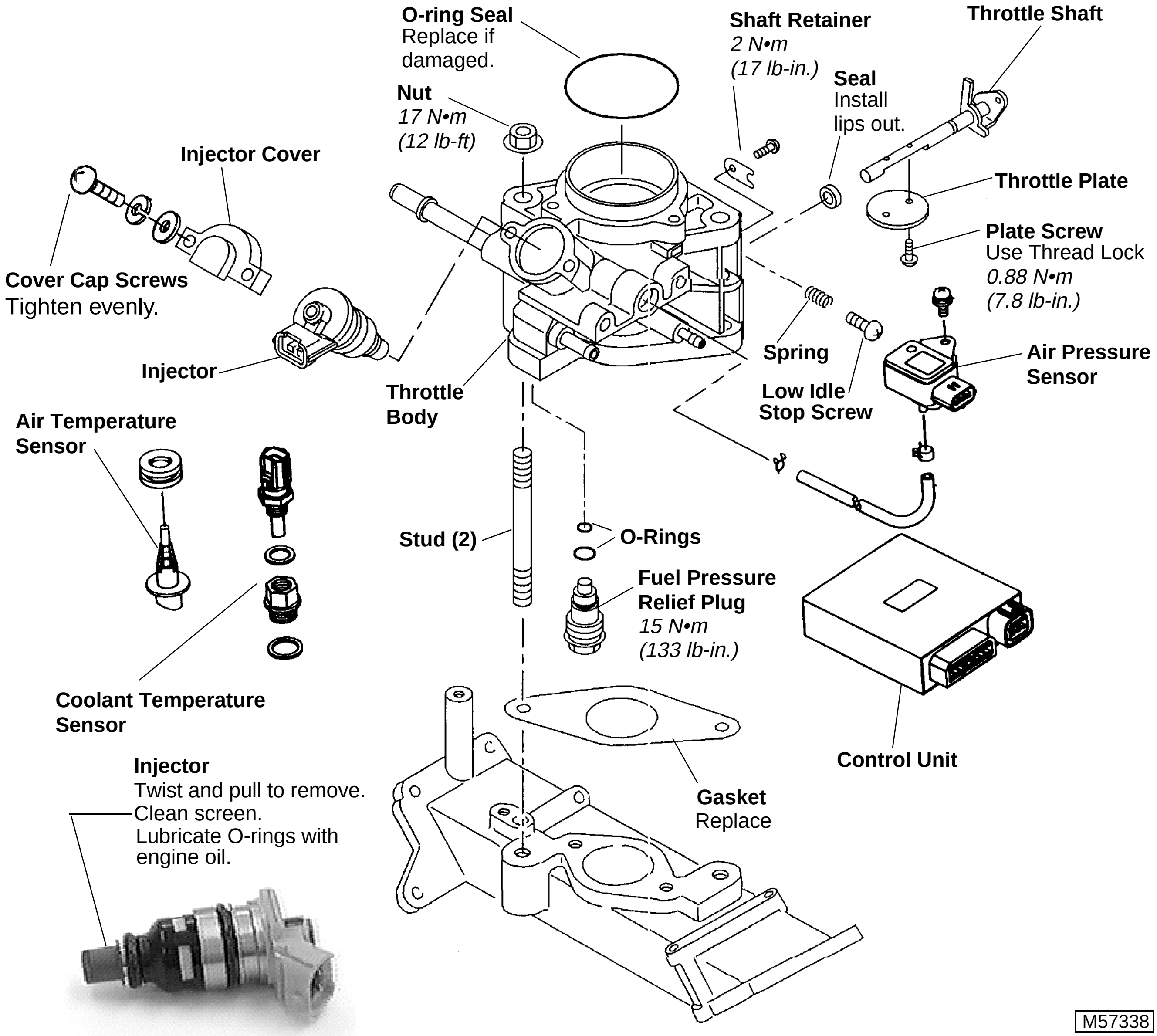
Flyweight assembly shaft is pressed into crankcase cover and is <u>not serviceable</u>. Therefore, if it is damaged or pulled loose, the crankcase cover MUST BE replaced.

2. Use two suitable pry bars to pry flyweight assembly from shaft. DO NOT damage crankcase cover sealing surfaces.
3. Unscrew governor lever clamp nut and remove governor lever.
4. Turn governor shaft **1/4 turn** clockwise to remove shaft.
5. Install new shaft oil seal. Press oil seal in to 1.0 mm (0.04 in) below crankcase surface.
6. Install governor shaft by properly positioning it between the two projections in crankcase.

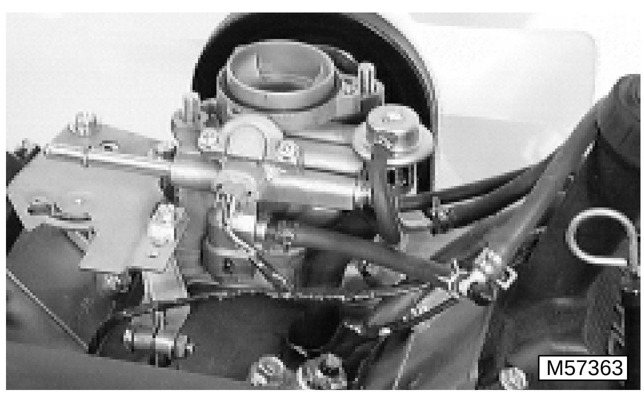
NOTE: Install sleeve into governor flyweights and install as an assembly.

7. Push flyweight assembly onto shaft until it snaps into place. Check assembly for freedom of movement.
8. Loosely install governor lever on governor shaft.
9. Hold top of governor lever fully counterclockwise to fully open throttle plate.
10. Turn governor shaft fully counterclockwise to end of its travel. Check dimension from outside edge of lever to end of shaft; it should be **7 mm (0.276 in.)**.
11. Hold governor lever and shaft stationary (fully counterclockwise) while you tighten lever clamp nut to **7.8 N•m (69 lb-in.)**.

THROTTLE BODY REPAIR—445



> **c CAUTION**
>
> **Relieve fuel pressure before removing any fuel line or components.**
> **Loosen fuel pressure relief valve plug.**



Do not remove throttle shaft unless it appears to be worn or damaged.

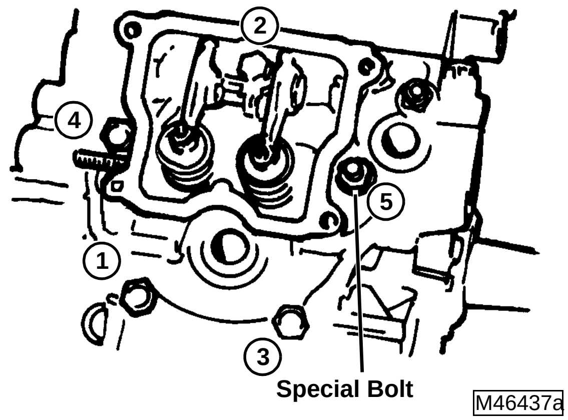
If throttle shaft is worn, check throttle body bushing. If worn, replace throttle body.

The throttle plate must be perfectly centered in bore when closed. It must also operate freely when plate screws are tightened.

CYLINDER HEAD—REMOVAL

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

Mark position of all valve train parts so they can be reinstalled in their original position.

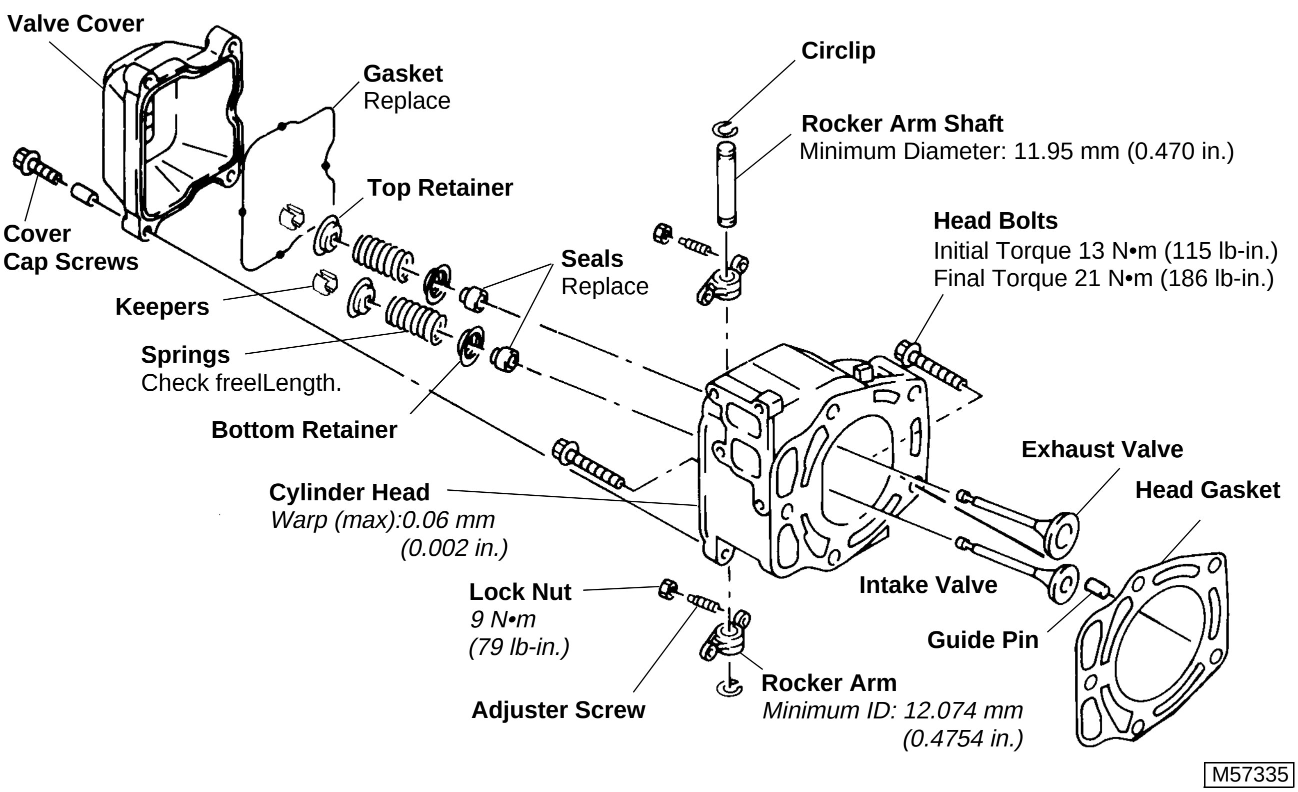


CYLINDER HEAD—CLEANING AND INSPECTION

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

1. Scrape heads to remove carbon deposits or use a de-carbonizing agent. Clean head with a suitable solvent and dry with compressed air.
2. Lay a straightedge along the sealing surface of head and measure warpage with a thickness gauge at several different points. If warpage exceeds service limit, repair or replace cylinder head.
3. Check cylinder head for cracks.
4. Apply clean engine oil to all contact surfaces and assemble cylinder head.

CYLINDER HEAD AND VALVE COMPONENTS

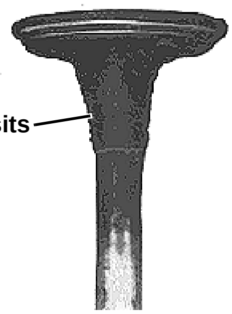


VALVE, VALVE SEAT, AND GUIDE—INSPECTION

Lead deposits on the intake valve are caused by exhaust gas leakage past the valve. This indicates that the valve is not seating properly.

Grind intake valve and reface the seat to correct this condition.

NOTE: Be sure to reset valve clearance after grinding valves.

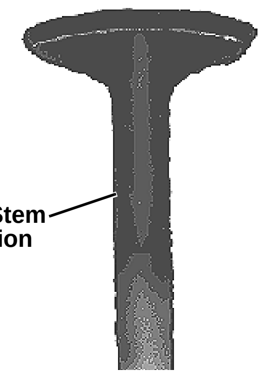


M29934

Valve stem corrosion is caused by moisture in the engine. Moisture in the fuel-air mixture can condense inside the engine when the engine is stopped and cools down.

Valve corrosion can also occur during storage. Fogging or pouring oil in the combustion chamber before storing helps prevent valve corrosion.

Corroded or pitted valves collect deposits and may cause sticking valves. Replace badly corroded or pitted valves.

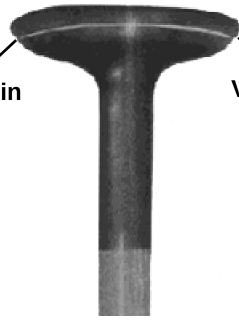


M5563

Exhaust valves are designed to function in temperatures exceeding 2760°C (5000°F). However, when operating at high temperatures for long periods of time, valve burning may occur.

Valves running too hot will show a dark discoloration of the valve stem into the area protected by the valve guide. Another indication is distortion of the valve margin and valve face. Valve inserts may also begin to burn away.

Other causes for valves running hot are worn valve guides or valve springs, incorrect valve clearance, lean fuel-air mixture and incorrect or overheated spark plug.



M30024

IMPORTANT: Do not run the engine with blower housing removed.

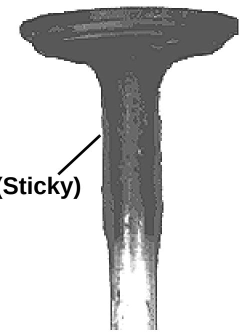
Poor engine cooling due to dirt or obstructions is a common cause for overheating an engine and the valves. Remove blower housing and clean the engine cooling fins.

Other causes for valves running hot are worn valve guides or valve springs, incorrect valve clearance, lean fuel-air mixture and incorrect or overheated spark plug.

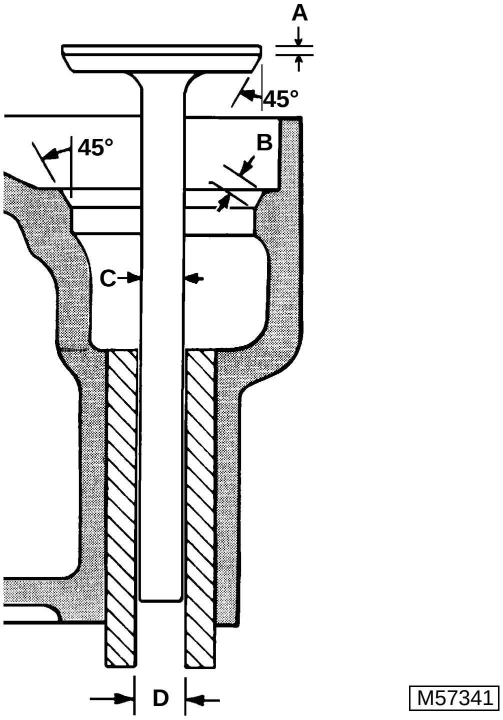
Using old or stale gasoline is a common cause for sticky valves.

This gummy deposit can be seen on the valve. When this condition exists, the carburetor may also contain gum deposits and will require a complete cleaning.

Always use fresh gasoline and drain fuel tank, lines, and carburetor before storing machine.



M29936



A - Valve Margin (Min) . . . . 0.6 mm (0.024 in.)
B - Valve Seating Width . . . . 0.5—1.1 mm (0.02—0.043 in.)
C - Valve Stem Diameter (Min)
Intake: . . . . 5.94 mm (0.234 in.)
Exhaust: . . . . 5.92 mm (0.233 in.)
D - Guide ID (Max)
. . . . . 6.05 mm (0.238 in.)
Valve Stem Run-Out (Max.) . . . . 0.05 mm (0.002 in.)

- Valve guides are not replaceable. If worn, replace head.
- If grinding the valve and valve seat is necessary, follow tool manufacturer's instructions carefully.
- Lap valves after grinding with lapping compound and recheck valve seating surface for correct width and evenness of seating pattern.

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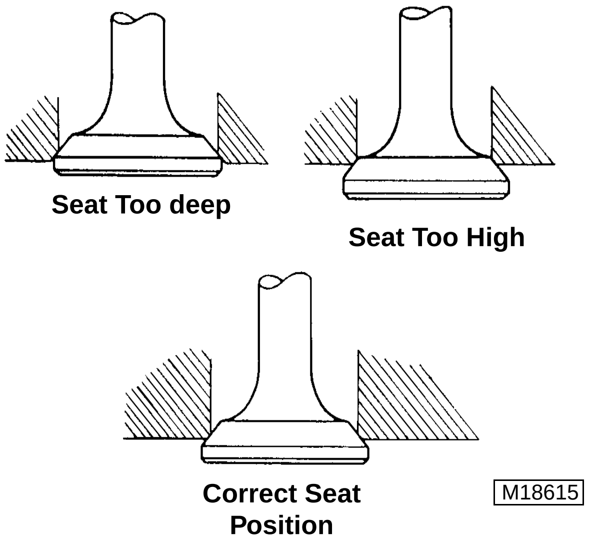


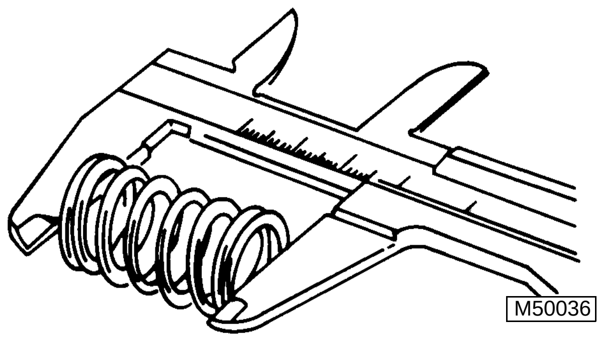
- If seats are warped or distorted beyond reconditioning, replace cylinder head.
- Check valve seating pattern for correct width and evenness all the way around.
- Clean and measure valve stem at three points along length of stem.

VALVE SPRING FREE LENGTH

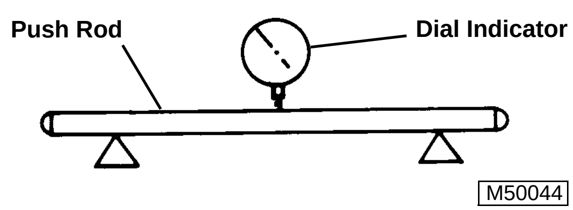
1. Inspect valve spring for pitting, rust and burrs.

Free Length Specifications (Min)

FD620D . . . . 29.70 mm (1.170 in.)



PUSH ROD—INSPECTION



1. Inspect push rods for straightness.

Specifications:

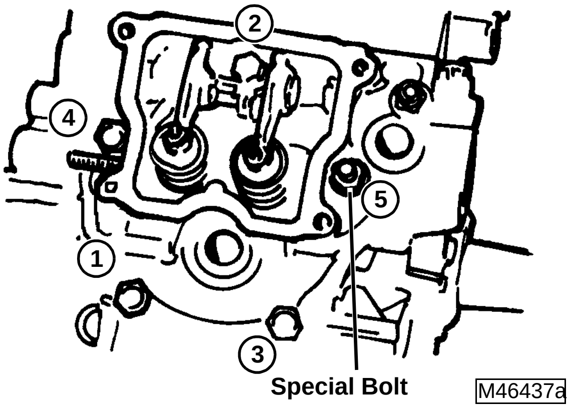
Maximum Run-Out . . . . 0.8 mm (0.03 in.)

CYLINDER HEAD—INSTALLATION

IMPORTANT: Handle head gaskets carefully to avoid removing the sealing agents from the surface.

NOTE: *For easier assembly turn flywheel until cam lobes are at their lowest position. Install the push-rods in their original positions. This will allow head to be installed without compressing valve springs.*

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



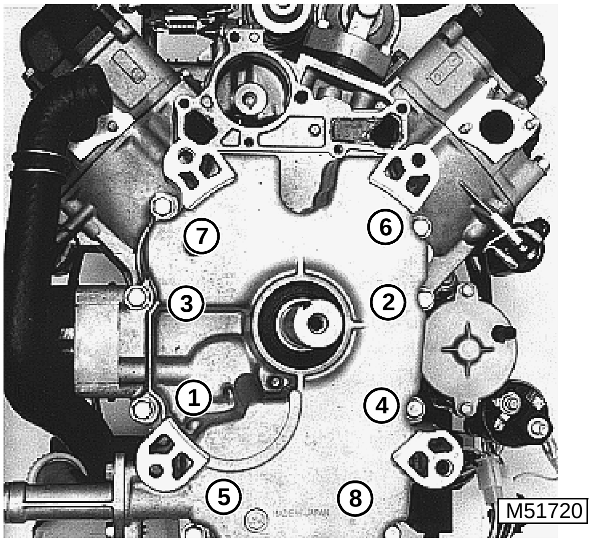
1. Tighten cylinder head bolts in sequence to initial torque of **13 N•m (115 lb-in.)**.
2. Install manifold before applying a final torque of **21 N•m (186 lb-in.)**.
3. Adjust valve clearance.

CRANKCASE COVER—DISASSEMBLY

1. Drain crankcase.
2. Remove coolant pump.

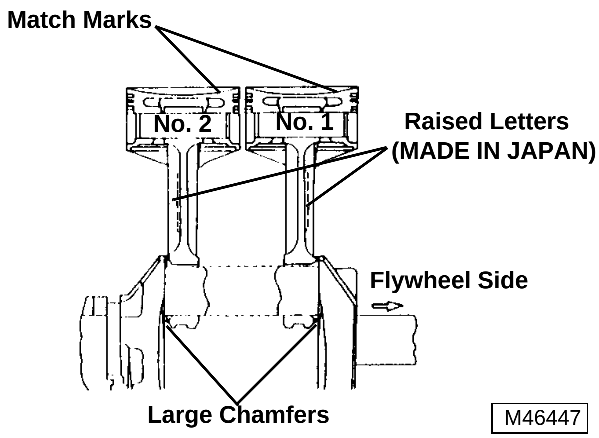
IMPORTANT: When installing crankcase cover, use bolt tightening sequence shown and tighten to 23—28 N•m (17—20 lb-ft).

NOTE: *Crankcase is pinned by oil filter and opposite side. Do not force cover.*



3. Remove crankcase cover and gasket.

PISTONS—REMOVAL



NOTE: *Note location of the arrow match mark on the piston head in relation to “Made in Japan” on the connecting rod. No. 1 piston is opposite No. 2. Keep parts together as a set.*

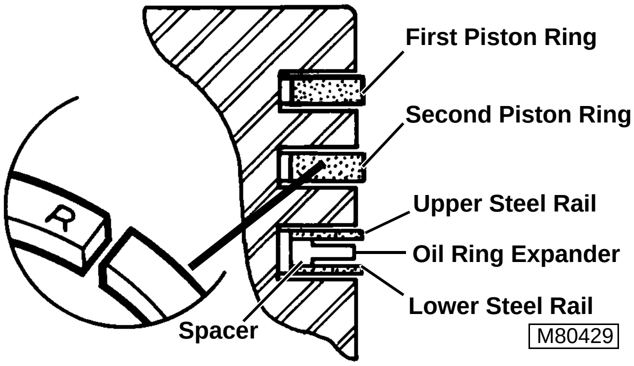
1. Turn the crankshaft to expose the connecting rod end caps. Mark the end caps for reassembly in the same position as removed.
2. Remove carbon and/or ridge from the top of the cylinder bore with a suitable ridge remover and remove the piston and connecting rod through the top of the cylinder bore.

PISTON RINGS—REMOVAL/ INSTALLATION

1. Remove piston rings with a piston ring expander.
2. Inspect piston for wear. Clean piston ring grooves. Check piston ring end gap.

IMPORTANT: Piston must be properly cleaned, inspected and the correct size rings and/or pistons obtained before proceeding with installation.

NOTE: FD620D engines are equipped with a second compression ring. Install ring with mark facing up.

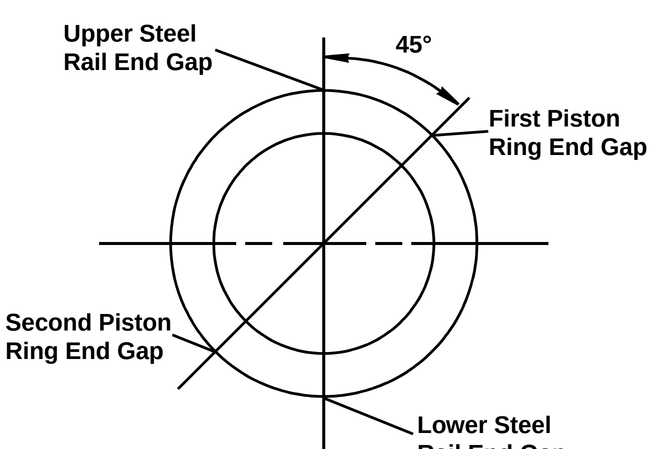


3. Install oil ring expander in the third piston oil ring groove.
4. Install upper and lower steel rails.

NOTE: There is no UP or DOWN position to the steel rails. They can be installed either way.

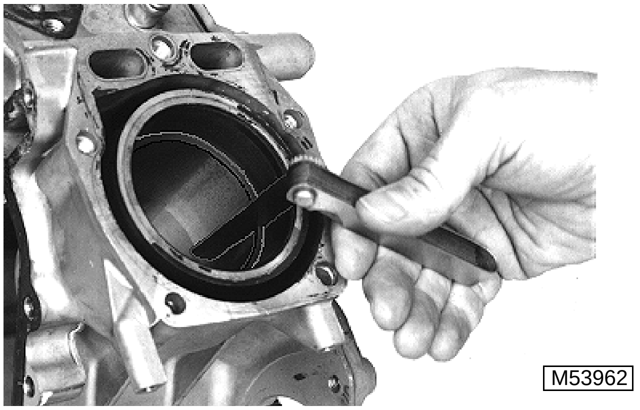
5. In second groove, install second piston ring (cast with no chrome edge) with the "Letter" mark, embossed dot, or any other mark facing up toward top of piston.

IMPORTANT: Align the piston ring and steel rail end gaps as shown.



PISTON RING END GAP

Before installing rings on piston, check end gap in cylinder bore.



Install each pistion ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder. Check end gap. Replace piston ring if end gap is more than **1.20 mm (0.050 in.) (Oil Rings—Not measured)**

PISTON RING WEAR

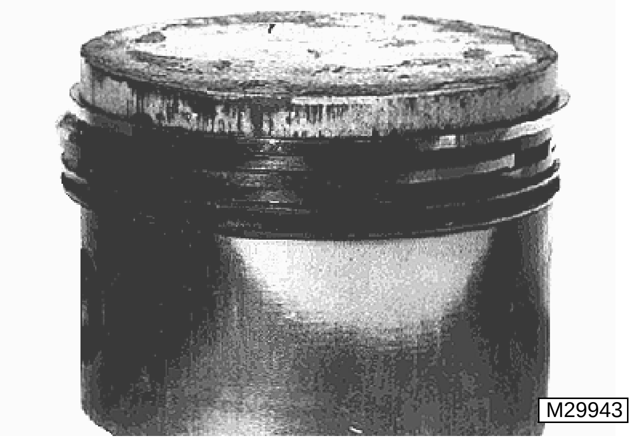
Rings of the wrong size or rings having improper end gap will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

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

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

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

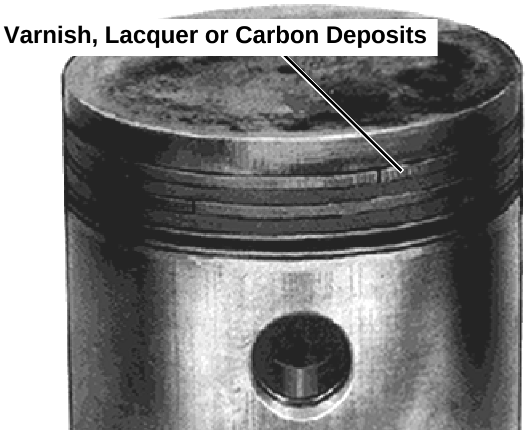
- Dirty cooling shroud and cylinder head.
- Lack of cylinder lubrication.
- Improper combustion.
- Wrong bearing or piston clearance.
- Too much oil in crankcase causing fluid friction.



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

Engine overheating and ring sticking is usually caused by one or more of the following:

- Overloading
- Incorrect ignition timing
- Lean fuel mixture
- Dirty cooling fins
- Incorrect oil
- Low oil supply
- Stale fuel

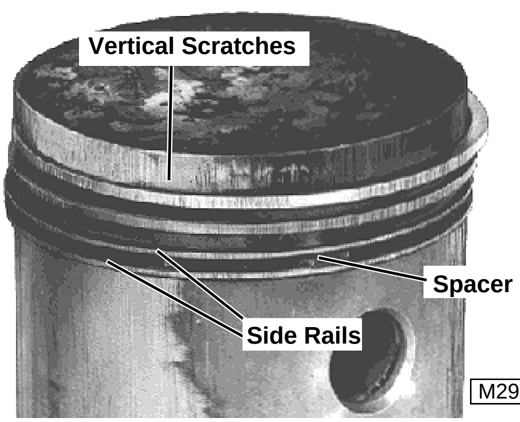


M29944

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

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

- Damaged, collapsed or improperly installed air filter.
- Loose connection or damaged gasket between air cleaner and carburetor.
- Air leak around carburetor-to-cylinder block gasket.
- Air leakage around throttle shaft.
- Failure to properly clean cylinder bore after reconditioning engine.



M29945

Abrasive particles in engine oil causes scratches on side rails of oil control ring. Inner spacer wear or distortion may cause:

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

Increased oil consumption may be caused by:

- Worn side rails with low tension.
- Worn or distorted inner spacer.

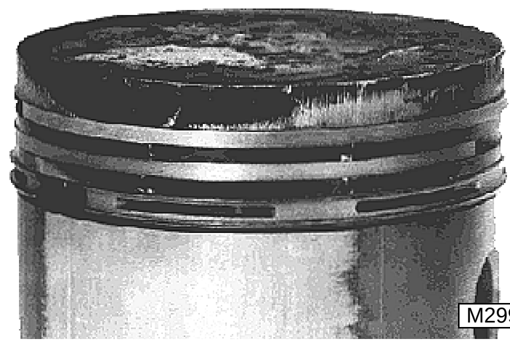
IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.

PISTON—INSPECTION

Detonation, is abnormal combustion causing excessive temperature and pressure in the combustion chamber. Commonly called carbon knock, spark knock or timing knock, detonation occurs as the compressed fuel-air mixture ignites spontaneously to interrupt the normal ignition.

The following is a list of possible causes for detonation:

- Lean fuel mixture.
- Low octane fuel.
- Advanced ignition timing.
- Engine lugging.
- Build-up of carbon deposits on piston or cylinder head, causing excessive compression.
- Wrong cylinder head or milling of head increasing compression ratio.

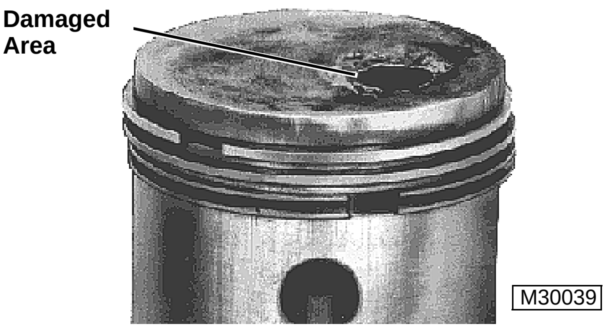


M29947

Pre-ignition is the igniting of the fuel-air mixture prior to regular ignition spark. Pre-ignition causes internal shock, resulting in pings, vibration, detonation and power loss. Severe damage to piston rings and valves results from pre-ignition.

Check the following for causes of pre-ignition:

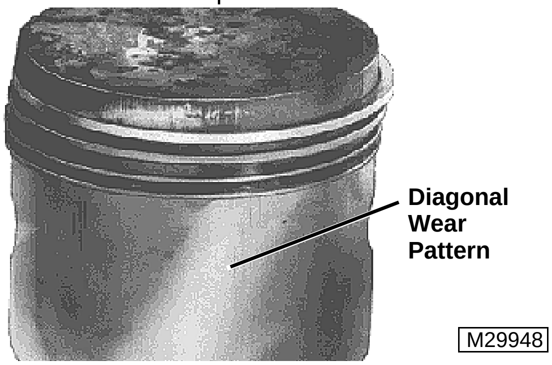
- Internal carbon deposits.
- Incorrect spark plug (high heat range).
- Broken ceramic in spark plug.
- Sharp edges on valves.



Check rod and piston alignment when piston shows a diagonal wear pattern extending across the skirt of the piston. Contact with the cylinder wall shows on bottom of skirt at left and ring lands on the right.

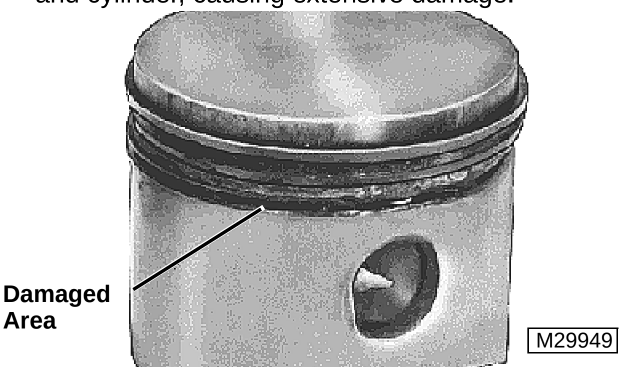
A cylinder bored at an angle to the crankshaft can also give improper ring contact with cylinder causing:

- Rapid piston wear.
- Uneven piston wear.
- Excessive oil consumption.

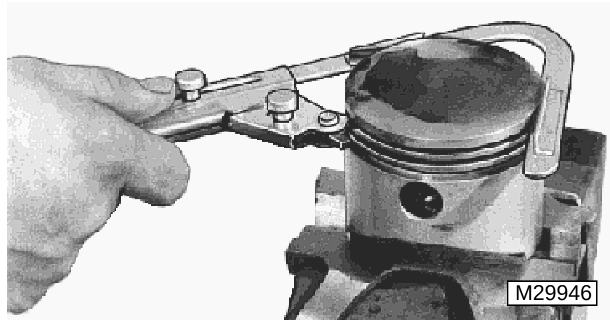


A broken retaining ring caused the damage shown. Retaining rings loosen or break due to:

- Rod misalignment.
- Excessive crankshaft end play.
- Crankshaft journal taper.
- Weak retaining rings.
- Incorrectly installed retaining rings. Inertia can cause a broken retaining ring to beat out the piston and cylinder, causing extensive damage.



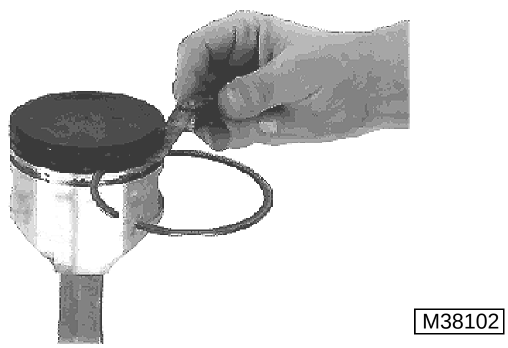
1. Remove all deposits from the piston.



2. Clean carbon from piston ring grooves with a ring groove cleaner. If cleaning tool is not available, break an old ring and use it carefully to clean groove.
3. Check that oil return passages in grooves are open.
4. Inspect piston for scoring or fractures. Replace piston if damaged.

NOTE: Inspect clearance visually. Replace piston if clearance appears excessive.

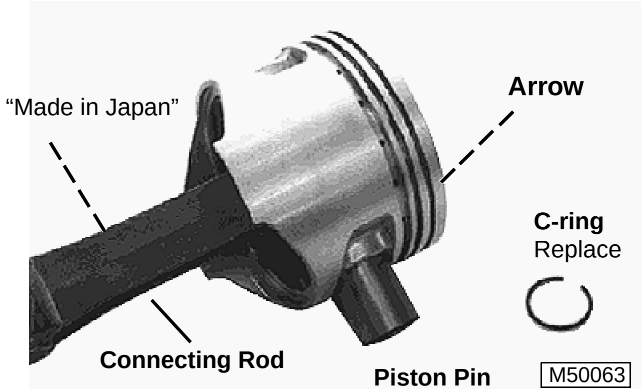
5. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.



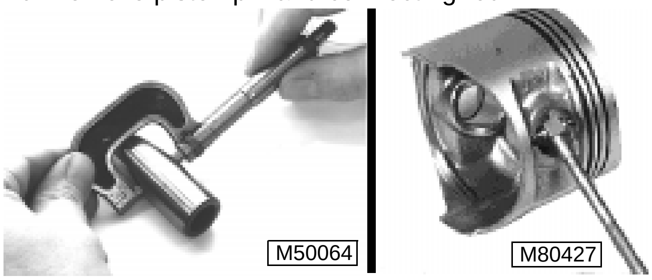
Ring Side Clearance Specification (Max):

Top Ring . . . . 0.15 mm (0.006 in.)
Second Ring . . . . 0.12 mm (0.005 in.)
Oil Rings . . . . Not Measured

IMPORTANT: Note location of arrow match mark on piston head in relation to MADE IN JAPAN on connecting rod. No. 1 piston is opposite of No. 2 piston. Keep parts together as a set.



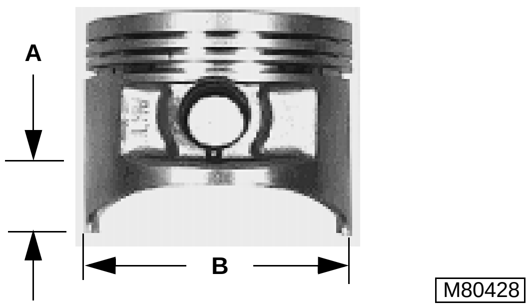
6. Remove piston pin and connecting rod.



7. Measure piston pin outer diameter and piston pin bore.

Piston And Piston Pin Specifications:

Piston Pin OD (Min) . . . . 16.98 mm (0.668 in.)
Piston Pin Bore ID (Max) . . . . . 17.04 mm (0.671 in.)



8. Measure piston OD (B) perpendicular to piston pin bore at approximate specified distance (A) from bottom of piston skirt.
9. Subtract piston OD measurement (B) from cylinder bore measurement to determine piston-to-cylinder bore clearance.
10. Replace piston and/or rebore cylinder block if not within specifications.

Distance (A) . . . . 11 mm (0.433 in.)
Piston OD (B) . . . . 75.935—75.950 mm (2.989—2.990 in.)
Piston-to-Cylinder Bore Clearance. . . . . 0.030—0.170 mm (0.00118—0.0067 in.)

CONNECTING ROD—INSPECTION

CRANKSHAFT AND CONNECTING ROD WEAR

Check connecting rod and cap for damage or unusual wear patterns.

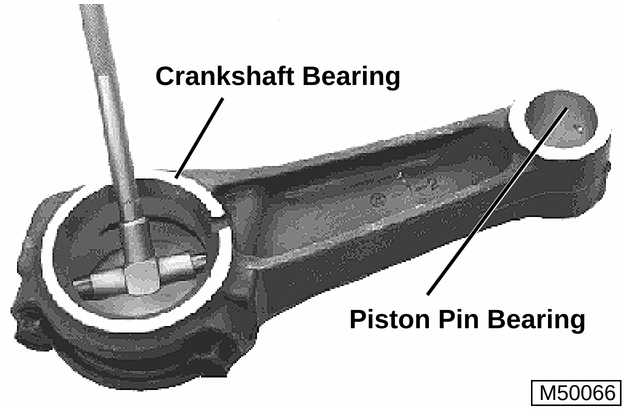
Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

1. Install connecting rod cap. Tighten to: **21 N•m (186 lb-in.)**
2. Clean and inspect rod. Replace if scored.



3. Measure connecting rod crankshaft bearing and piston pin bearing. Replace connecting rod if either measurement is greater than specifications.

Connecting Rod Bearing ID Specifications (Max)

Crankshaft Piston Bearing . . . 34.06 mm (1.341 IN.)
Piston Pin Bearing . . . . 17.05 mm (0.671 in.)

CONNECTING ROD AND PISTON—ASSEMBLY

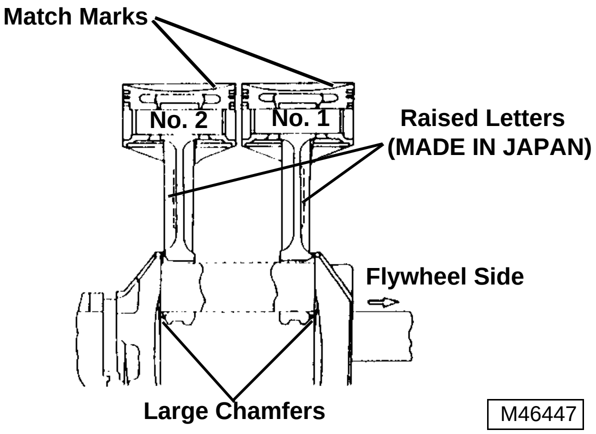
IMPORTANT: No. 1 piston is piston nearest flywheel. Install No. 1 piston with the large chamfer on connecting rod facing TOWARD the flywheel. The arrow match mark on piston head will be on the SAME side (toward flywheel) as the "Made in Japan" mark on the connecting rod.

No. 2 piston is piston farthest from flywheel. Install No. 2 piston with large chamfer on connecting rod facing AWAY from the flywheel.

The arrow match mark on piston head will be OPPOSITE the “Made in Japan” on connecting rod.

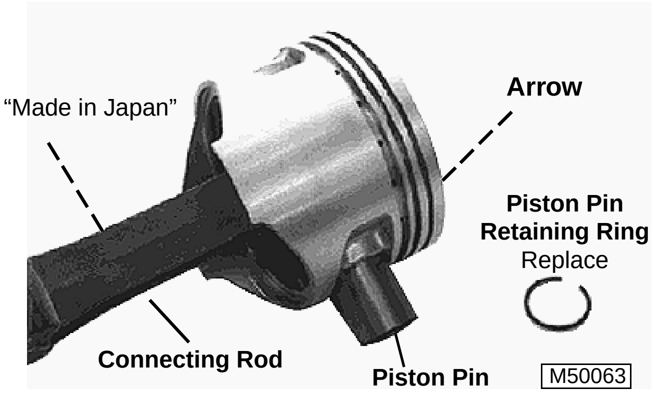
Use clean engine oil and apply on piston skirt, cylinder bore, and connecting rod bearing surface.

Use piston ring compressor to install piston in the cylinder bore.



1. Insert piston and connecting rod so arrow match mark on the top of the piston is facing the proper direction.

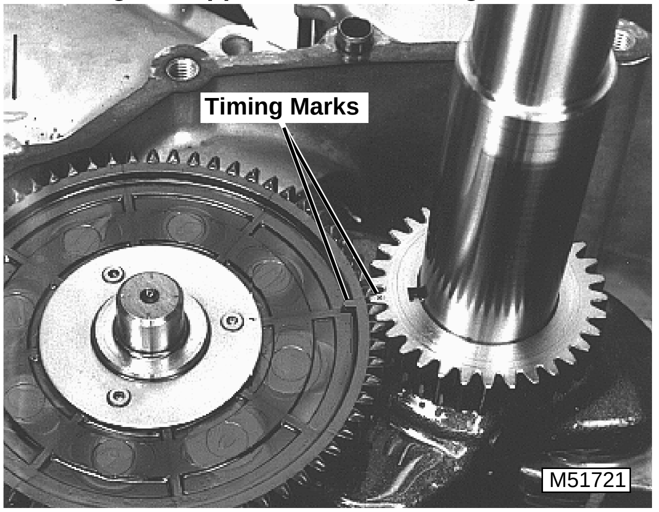
IMPORTANT: Do not reuse piston pin retaining rings.



2. Tighten connecting rod end caps to **21 N•m (186 lb-in.)**.

CAMSHAFT—REMOVAL/ INSTALLATION

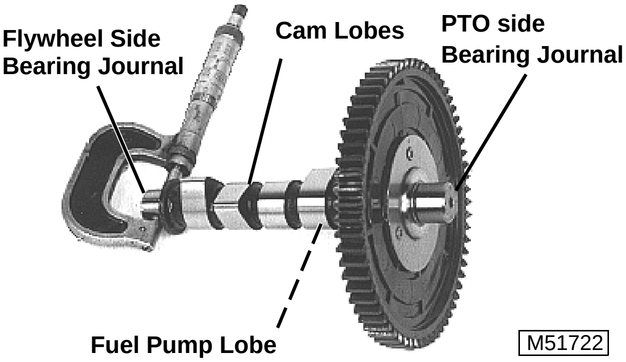
IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.



1. Rotate crankshaft until timing marks align.
2. Remove and inspect camshaft.
3. Lubricate journals.
4. Align timing marks and install camshaft.

CAMSHAFT—INSPECTION

1. Inspect camshaft for worn or broken teeth and loose rivets holding gear to camshaft. Replace camshaft if loose.



2. Measure cam lobes. Replace camshaft if less than specifications.

Camshaft Specifications (Min)

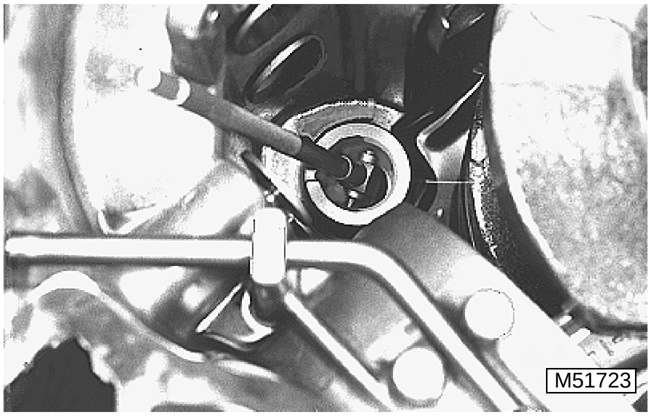
Bearing Journals OD . . . . 15.91 mm (0.626 in.)

Cam Lobes

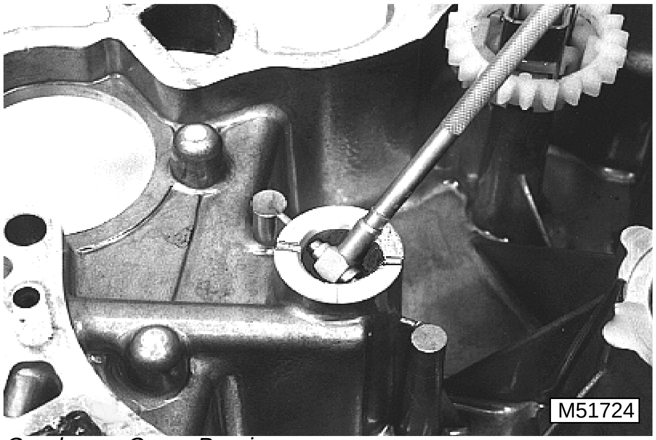
Intake. . . . . 25.21 (0.993 in.)
Exhaust . . . . 25.46 mm (1.002 in.)
Fuel Pump Lobe . . . . 19.50 mm (0.760 in.)

CAMSHAFT BEARINGS

1. Measure camshaft bearings in cylinder block and crankcase cover. Replace block or cover if diameter is greater than specification.



Cylinder Block Bearing



Crankcase Cover Bearing

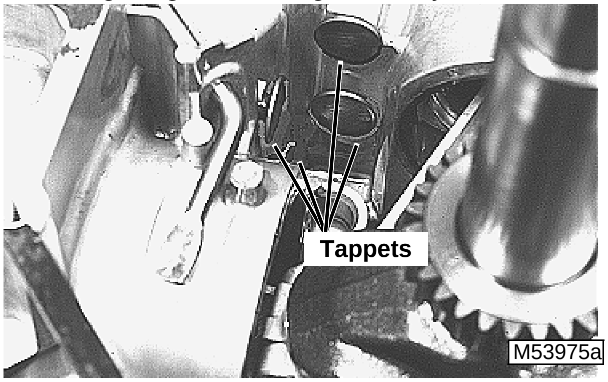
Camshaft Bearing ID Specifications (Max)

Cylinder Block Bearing . . . . . . 16.07 mm (0.633 in.)
Crankcase Cover Bearing . . . . 16.07 mm (0.633 in.)

TAPPETS—REMOVAL/ INSTALLATION

1. Remove camshaft.

NOTE: Mark tappets so they can be installed in their original guides during assembly.

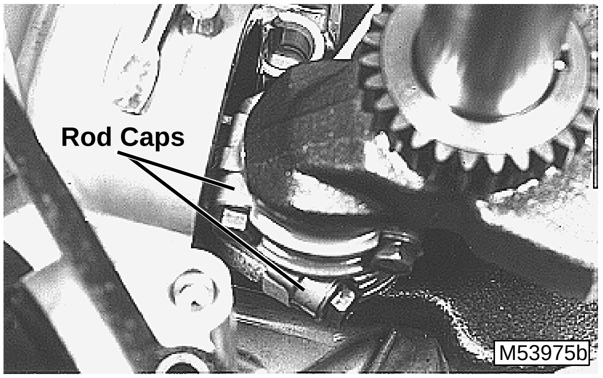


2. Remove tappets. Replace if scored.
3. Install tappets in original positions.

CRANKSHAFT—REMOVAL

1. Remove camshaft.

IMPORTANT: Mark connecting rod caps so they can be reinstalled in the same location.



2. Remove connecting rod caps and push pistons to top of cylinder. Remove crankshaft.

IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.

CRANKSHAFT—INSPECTION

CRANKSHAFT AND CONNECTING ROD WEAR

Check connecting rod and cap for damage or unusual wear patterns.

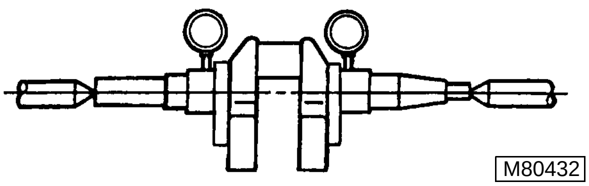
Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

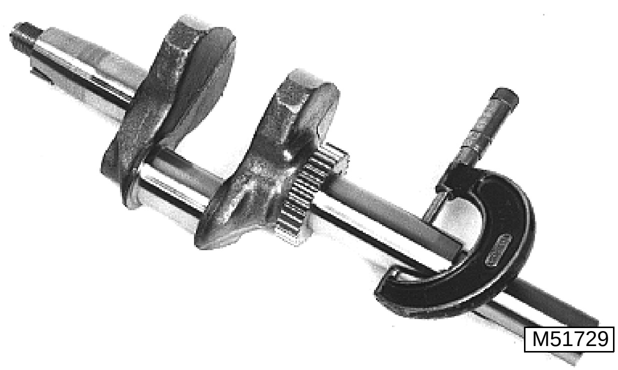
1. Check crankshaft alignment (T.I.R).
2. Place crankshaft into an alignment jig. Using dial indicators, rotate crankshaft slowly.



Maximum Crankshaft Bend

All . . . . 0.05 mm (0.002 in.)

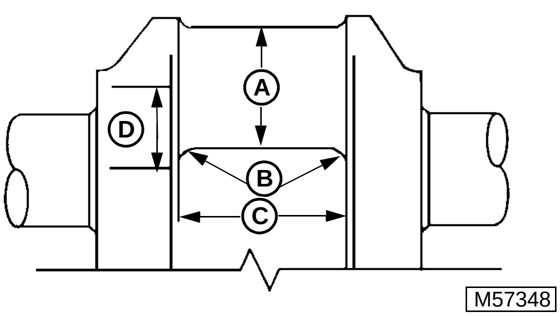
3. Clean and inspect crankshaft. Measure crankshaft main bearing journals and connecting rod journal.



NOTE: Connecting rod journal can be resized to accept under-sized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii for cracks.

Crankshaft Specifications (Min):

Main Bearing Journal . . . . 33.91 mm (1.335 in.)
Connecting Rod Journal . . . . 33.91 mm (1.336 in.))



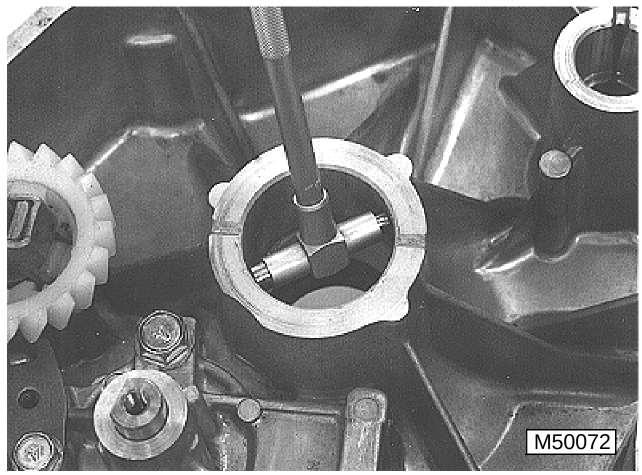
Resizing Specifications:

A . . . . 33.48—33.47 mm (1.3181—1.3176 in.)
B . . . . 2.30—2.70 mm (0.090—0.110 in.)
C . . . . 44.50 mm Max 1.752 in.)
D . . . . 34.00—33.95 mm (1.3386—1.3366 in.)

CRANKSHAFT—INSTALLATION

1. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
2. Put a light film of oil on crankshaft bearing surfaces.
3. Pack grease in oil seals and install crankshaft.
4. Install connecting rod caps and torque to **21 N•m (186 lb-in.)**.

CRANKSHAFT PLAIN BEARINGS



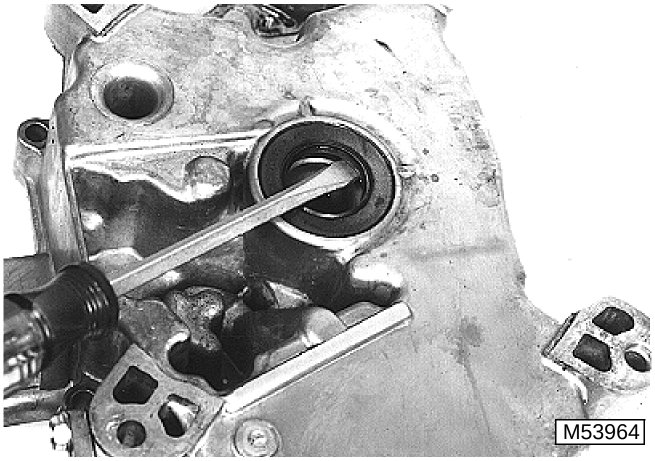
1. Measure crankshaft bearings in crankcase and crankcase cover. Replace block, cover or shells, if equipped, if diameter is greater than specifications.

Bearing ID Specifications (Max):

Crankcase and Cover
Crankcase Cover. . . . . 34.07 mm (1.341 in.)
Crankcase . . . . 34.11 mm (1.343 in.)

CRANKSHAFT JOURNAL BUSHING AND SEALS—REPLACEMENT

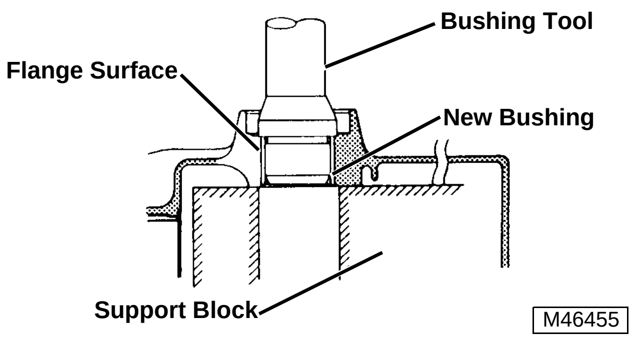
1. Place crankcase on bench with oil seal side up.



Crankcase Seal

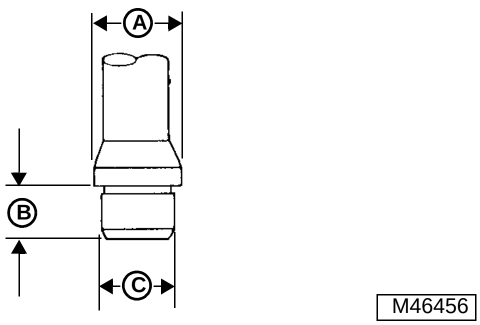
2. Remove oil seal.

NOTE: Do not re-use oil seal. Replace with new.



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

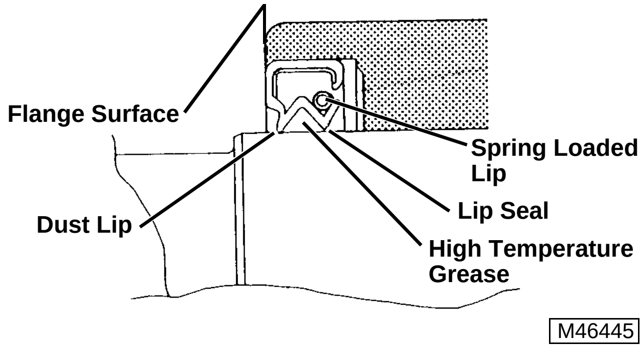
To Design a Bushing Tool



Bushing Tool Dimensions

(A) . . . . 40 mm (1.575 in.)
(B) . . . . 26 mm (1.024 in.)
(C) . . . . 33.8 mm (1.331 in.)

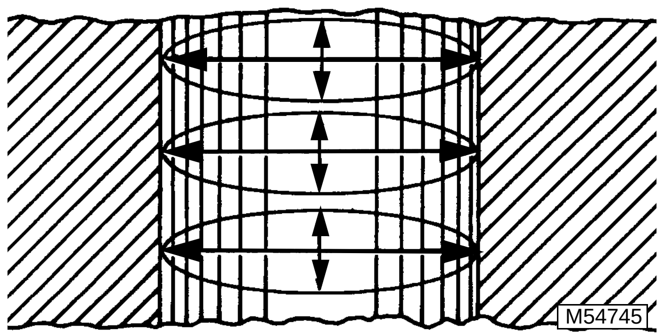
3. Remove bearing shell using a bushing, bearing and seal driver set and press.
4. Apply a light coat of oil on outside diameter of new bearing shell.
5. Install new bearing shell flush with crankcase flange surface.



6. Remove crankshaft oil seal and press in a new seal with spring loaded lip towards inside of the engine and outside edge of seal flush with flange surface.
7. Pack space between seal lip and dust lip with high temperature grease.
8. Install new seal with flange flush with case.

CYLINDERS—BLOCK INSPECTION

1. Clean and check block for cracks.
2. Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25 percent kerosene and 75 percent light engine oil.
3. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.



4. Measure cylinder bore parallel with crankshaft and right angles to crankshaft at top and bottom of ring travel.
5. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder.

NOTE: Before reboring, check availability of oversize piston and rings. They must be installed.

Cylinder Bore Specifications:

Standard ID . . . . 75.98 - 76.00 mm (2.9913 - 2.9921 in.)
Maximum ID . . . . 76.07 mm (2.997 in.)

CYLINDER BORE—DEGLAZING

1. Deglaze cylinder bore using a rigid hone with a 220 to 300 grit stone.
2. Use hone as instructed by manufacturer to obtain 45° crosshatch pattern as shown.

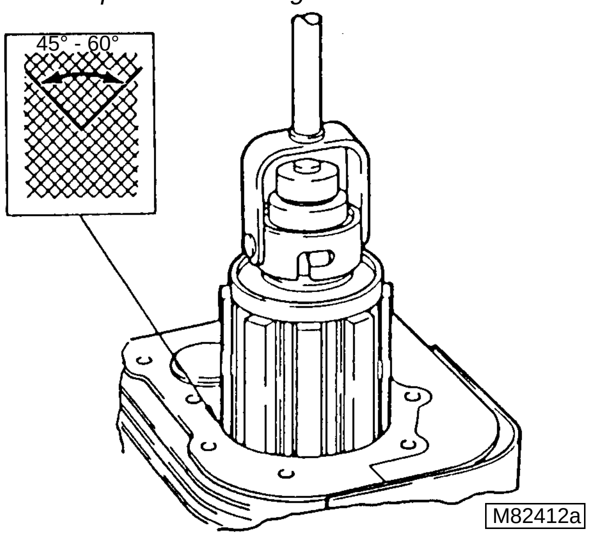
IMPORTANT: Do not use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Clean cylinder walls using clean white rags and water. Continue to clean cylinder until white rags show no discoloration.

CYLINDER BLOCK—REBORING

IMPORTANT: Check stone for wear or damage. Use correct stone for the job.

NOTE: The cylinder block can be rebored to use 0.50 (0.020) oversize pistons and rings. Have a reliable repair shop rebore the block, or use a drill press and honing tool.



1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from 200±250 rpm.
3. Lower and raise hone until ends extend 20—25 mm (0.75—1.0 in.) past ends of cylinder.
4. Turn adjusting nut on hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately 20 times per minute to get 40—60° cross-hatch pattern.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

Cylinder Initial Bore Specifications:

Piston Oversize—
0.50 mm (0.020 in.) . . . . **76.46—76.48 mm (3.012—3.013 in.)**

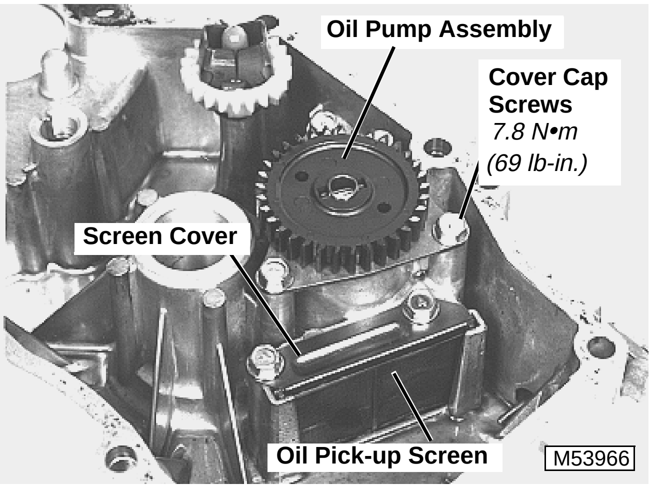
8. Hone the cylinder an additional 0.028—0.030 mm (0.0011—0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.
10. Apply oil to cylinder walls.

OIL PUMP—REMOVAL/ INSTALLATION

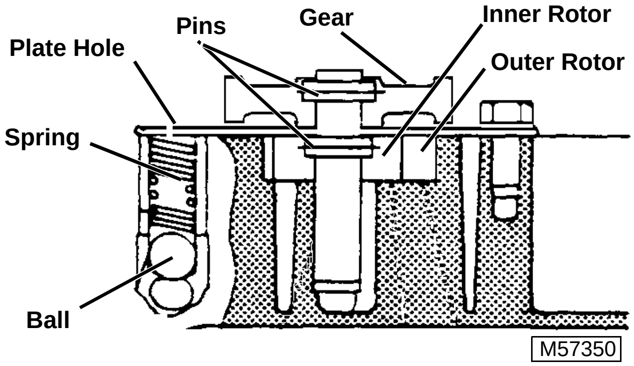
FD440V Shown



IMPORTANT: Oil pressure relief valve spring and ball will be loose when pump cover is removed.

1. Remove oil pump assembly, relief valve spring and ball.

2. Remove, clean or install a new oil pick-up screen.

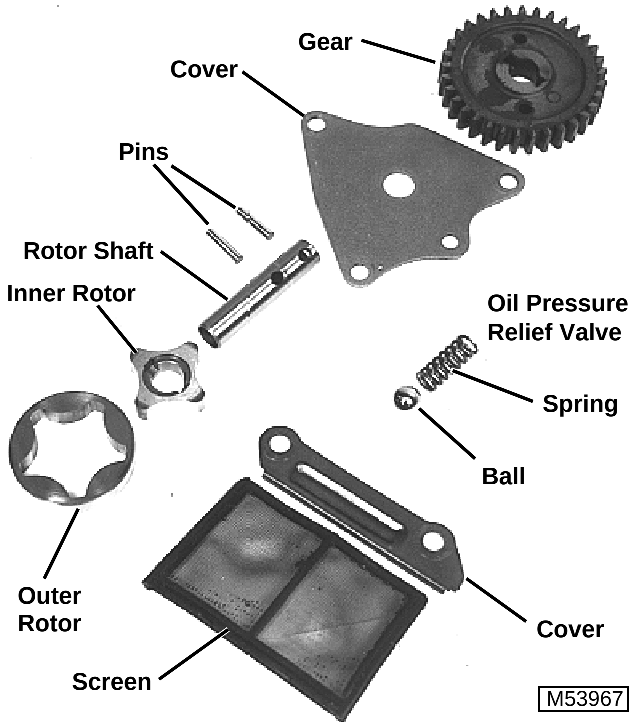


3. Install oil pressure relief valve ball, spring and oil pump assembly.

IMPORTANT: Fill rotor housing with engine oil for initial lubrication.

4. Install cover so that hole in cove plate is centered over relief valve. Tighten cover screws evenly.

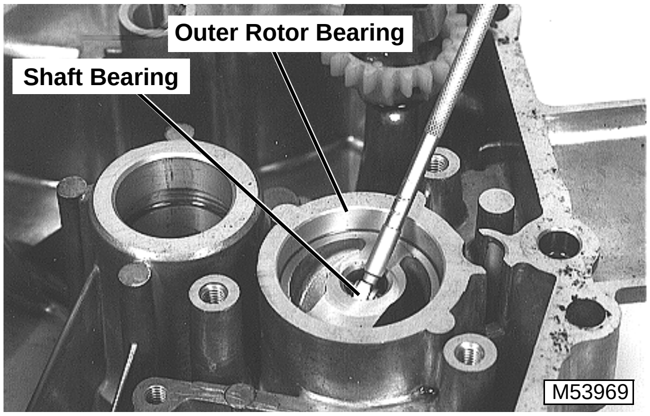
OIL PUMP—DISASSEMBLY, INSPECTION AND ASSEMBLY



1. Disassemble oil pump.

NOTE: Rotors and rotor shaft are replaced as a kit. If any of the parts show signs of wear or are scored—replace.

2. Measure parts per the oil pump specifications. If parts show signs of premature wear, check condition of pick-up screen and sealing area around screen.



3. Measure bearing surfaces.
4. Replace crankcase if bearing surfaces are worn or scored greater than specifications.

Oil Pump Specifications:

Rotor Shaft
Minimum Shaft OD . . . . 10.92 mm (0.430 in.)
Maximum Bearing ID . . . . . . 11.07 mm (0.436 in.)

Outer Rotor
Minimum Rotor OD . . . . 40.43 mm (1.592 in.)
Maximum Bearing ID . . . . . . 40.80 mm (1.606 in.)
Thickness (Max.) . . . . 9.830 mm (0.3870)

Inner and Outer Rotor Clearance
Maximum. . . . . 0.3 mm (0.012 in.)

Pump Housing Depth
Maximum . . . . 10.230 mm (1.6063 in.)

Spring Free Length
Specifications (Min) . . . . 19.50 mm (0.770 in.)

5. Assemble oil pump.

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CONTENTS

DIESEL ENGINE

Page

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SPECIFICATIONS—3TNA72

GENERAL SPECIFICATIONS

Slow Idle	1650 ± 150 rpm
Fast Idle	3350 ± 100 rpm
Compression	
Minimum Pressure (Min)	2448 kPa (355 psi)
Maximum Variation between Cylinders	490 kPa (71 psi)
Minimum Cranking Speed	250 rpm
Valve Clearance (Cold)	0.20 mm (0.008 in.)
Oil Pressure	
Pressure Sensor Activates	Below 69 kPa (10 psi)
Pressure (Fast Idle Min)	294 kPa (43 psi)
Radiator Cap	
Opening Pressure	83—97 kPa (12—14 psi)
Minimum Pressure	76 kPa (11 psi)
Thermostat	
Begin Opening	71°C (160°F)
Full Open	82°C (180°F)
Fan Drive Belt Deflection with 98 N (22 lb-force)	
Applied between Fan and Crank Drive Sheave	10—15mm (0.4—0.6 in.)
Fuel Pump	
Flow (Min)	450 mL (15 oz)/15 seconds
Pressure (Min)	172 kPa (25 psi)
Throttle Lever Friction Movement	18—35 N (4—8 lb-force)

TEST AND ADJUSTMENT SPECIFICATIONS

Air Intake System Leakage

Test Pressure	34—69 kPa (5—10 psi)

Throttle Lever Friction

Force Required for Movement	18—35 N (4—8 lb force)

Idle

Slow idle	1650 ± 150 rpm
Fast idle	3350 ± 100 rpm
Fast Idle Adjustment Screw Lock Nut (CARB/EPA Engines) Torque	4 N•m (35 lb-in.)

Fuel Transfer Pump

Test Temperature	15—25°C (59—77°F)
Minimum Flow before Filter	450 mL (15 oz)/15 seconds
Minimum Flow at Return Hose	200 mL (7 oz)/15 seconds
Minimum Pressure	172 kPa (25 psi)
Drain-Back Test Pressure (Maximum)	103 kPa (15 psi)

TEST AND ADJUSTMENT SPECIFICATIONS (continued)

Fuel Injection Nozzle

Opening Pressure ... 11722 ± 480 kPa (1700 ± 70 psi)
Leakage at 11032 kPa (1600 psi) ... Minimum of 10 Seconds with No Leakage
Chatter and Spray Pattern at 11722 ± 480 kPa (1700 ± 70 psi)
Slow Hand Lever Movement ... Chatter Sound
Slow Hand Lever Movement ... Fine Stream Spray Pattern
Fast Hand Lever Movement ... Fine Atomized Spray Pattern

Fuel Injection Pump Timing

Injection Pump Timing ... 13° BTDC (Before Top Dead Center)
Distance on Outer Surface of Crankshaft Pulley for
Every 0.1 mm (0.004 in.) of Shim Thickness ... 1° or 1 mm (3/64 in.)
Engine Crankshaft Position ... No. 1 Cylinder on TDC Compression Stroke
Total Shim Pack Thickness (New Shims) ... 0.5 mm (0.020 in.)
Mounting Nut Torque ... 20 N•m (180 lb-in.)
Delivery Valve Fitting Torque ... 42 N•m (31 lb-ft)

Radiator, Bubble Test

Maximum Air Pressure into Cylinder ... 2448 kPa (355 psi)

Radiator Cap Pressure

Opening Pressure ... 83—96 kPa (12—14 psi)
Minimum Pressure ... 76 kPa (11 psi)

Thermostat Opening

Begin Opening ... 71°C (160°F)
Full Open ... 82°C (180°F)
Minimum Lift Height ... 8 mm (0.310 in.)

Cooling System Pressure

Maximum Test Pressure ... 117 kPa (17 psi)
Minimum Pressure after 15 Seconds ... 90 kPa (14 psi)

Coolant Temperature Sensor

Continuity ... 107—113°C (225—235°F)

Compression

Pressure (Min) ... 2448 kPa (355 psi)
Maximum Difference between Cylinders ... 490 kPa (71 psi)
Minimum Cranking Speed ... 250 rpm

Valve Clearance and Lift

Valve Clearance (Cold) ... 0.20 mm (0.008 in.)
Valve Lift (Intake and Exhaust) ... 7.5 mm (0.300 in.)

TEST AND ADJUSTMENT SPECIFICATIONS (continued)

Fan/Alternator Drive Belt Tension

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

Engine Oil pressure

Pressure Sensor Activates . . . . . Below 69 kPa (10 psi)
Pressure (Fast Idle Min) . . . . . 294 kPa (43 psi)

Camshaft End Play

Standard Clearance . . . . . 0.05—0.20 mm (0.0020—0.0079 in.)
Wear Limit . . . . . 0.40 mm (0.016 in.)

Timing Gear Backlash

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

Connecting Rod Side Play

Standard Clearance . . . . . 0.20—0.40 mm (0.0079—0.0157 in.)
Wear Limit . . . . . 0.55 mm (0.0217 in.)

Connecting Rod Bearing Clearance

Connecting Rod End Cap Screws Torque . . . . . 23 N•m (203 lb-in.)
Standard Clearance . . . . . 0.020—0.072 mm (0.0008—0.0028 in.)
Wear Limit . . . . . 0.15 mm (0.0059 in.)

Crankshaft End Play

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

Crankshaft Main Bearing Clearance

Main Bearing Cap Cap Screw Torque . . . . . 79 N•m (58 lb-ft)
Standard Clearance . . . . . 0.020—0.072 mm (0.0008—0.0028 in.)
Wear Limit . . . . . 0.15 mm (0.0059 in.)

REPAIR SPECIFICATIONS

Engine

Drive Shaft Coupler Screws Torque . . . . . 40 N•m (30 lb-ft)
Mounting Bolts Torque . . . . . 80 N•m (60 lb-ft)

Thermostat

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

REPAIR SPECIFICATIONS (continued)

Fuel Injection Pump

Mounting Nut Torque	20 N•m (180 lb-in.)

Fuel Control and Governor Linkage

Governor Shaft	
OD (Minimum)	7.90 mm (0.311 in.)
Governor Shaft Bore ID	
Wear Limit	8.15 mm (0.321 in.)
Clearance	0.18 mm (0.007 in.)
Sleeve	
ID (Maximum)	8.20 mm (0.323 in.)
Injection Pump Camshaft OD	
Wear Limit	7.90 mm (0.311 in.)
Clearance	0.15 mm (0.006 in.)

Fuel Injection Nozzles

Leak-Off Hose Nut Torque	40 N•m (30 lb-ft)
Nozzle Fitting Torque	40 N•m (30 lb-ft)
Nozzle Torque	50 N•m (37 lb-ft)
Separator Plate Nozzle Contact Surface Maximum Wear	0.10 mm (0.0039 in.)

Exhaust Manifold

Mounting Cap Screw and Nut Torque	26 N•m (19 lb-ft)

Intake Manifold

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

Water Pump

Mounting Cap Screw Torque	26 N•m (19 lb-ft)
Fan Mounting Cap Screw Torque	11 N•m (96 lb-in.)
Plate-to-Housing Screw Torque	9 N•m (78 lb-in.)

Flywheel

Maximum Distortion (Flatness)	0.02 mm (0.0008 in.)
Mounting Cap Screw Torque	83 N•m (61 lb-ft)

Flywheel Housing

Housing to Extension Cap Screw Torque	49 N•m (36 lb-ft)
Housing to Block Cap Screw Torque	49 N•m (36 lb-ft)

Flywheel Plate

Mounting Cap Screw Torque	49 N•m (36 lb-ft)

REPAIR SPECIFICATIONS (continued)

Rocker Arm Cover

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

Rocker Arm Assembly

Mounting Cap Screw and Nut Torque . . . . 26 N•m (19 lb-ft)
Rocker Arm Shaft OD
Standard. . . . . 11.96—11.98 mm (0.4711—0.4718 in.)
Wear Limit . . . . 11.95 mm (0.4706 in.)
Rocker Arm and Shaft Support IDs
Standard. . . . . 12.00—12.02 mm (0.4724—0.4732 in.)
Wear Limit . . . . 12.09 mm (0.4759 in.)
Clearance. . . . . 0.14 mm (0.005 in.)
Push Rod Length
Standard. . . . . 141—142 mm (5.550—5.590 in.)
Push Rod Bend
Wear Limit . . . . 0.08 mm (0.003 in.)

Timing Gear Cover

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

Timing Gear Housing

Cap Screw Torque
Aluminum Housing-to-Block. . . . . 9 N•m (78 lb-in.)
Cast Iron Housing-to-Block . . . . 11 N•m (96 lb-in.)
Crankcase Extension-to-Housing Cap Screw Torque . . . . 22 N•m (16 lb-ft)

Idler Gear

Shaft OD
Standard. . . . . 19.959—19.980 mm (0.786—0.787 in.)
Wear Limit . . . . 19.93 mm (0.785 in.)
Bushing ID
Standard. . . . . 20.000—20.021 mm (0.787—0.788 in.)
Wear Limit . . . . 20.08 mm (0.791 in.)
Clearance. . . . . 0.15 mm (0.0059 in.)

REPAIR SPECIFICATIONS (continued)

Cylinder Head and Valves

- Mounting Cap Screw Torque
  - First . . . . . 19 N•m (14 lb-ft)
  - Second . . . . . 38 N•m (28 lb-ft)
  - Final . . . . . 61 N•m (45 lb-ft)
- Cylinder Head Distortion
  - Standard . . . . . 0.05 mm (0.002 in.) or less
  - Wear Limit . . . . . 0.15 mm (0.006 in.)
  - Maximum Amount of Metal to Be Removed . . . . . 0.20 mm (0.008 in.)
- Valve Seat Width
  - Intake Valve
    - Standard . . . . . 1.44 mm (0.057 in.)
    - Wear Limit . . . . . 1.98 mm (0.078 in.)
  - Exhaust Valve
    - Standard . . . . . 1.77 mm (0.070 in.)
    - Wear Limit . . . . . 2.27 mm (0.089 in.)
- Intake and Exhaust Valves
  - Valve Faces
    - Minimum Margin . . . . . 0.51 mm (0.020 in.)
    - Exhaust Angle . . . . . 45°
    - Intake Angle . . . . . 30°
  - Valve Stem OD
    - Distance A . . . . . 25 mm (0.984 in.)
    - Distance B . . . . . 45 mm (1.772 in.)
  - Intake Valve Stem OD
    - Standard . . . . . 6.94—6.96 mm (0.2732—0.2740 in.)
    - Wear Limit . . . . . 6.90 mm (0.2717 in.)
  - Exhaust Valve Stem OD
    - Standard . . . . . 6.94—6.96 mm (0.2732—0.2740 in.)
    - Wear Limit . . . . . 6.90 mm (0.2717 in.)
  - Valve Recession
    - Intake Valve . . . . . 0.50 mm (0.020 in.)
    - Exhaust Valve . . . . . 0.85 mm (0.033 in.)
- Valve Guides
  - Valve Guide ID
    - Maximum Clearance . . . . . 0.20 mm (0.008 in.)
    - Standard . . . . . 7.00—7.02 mm (0.275—0.276 in.)
    - Wear Limit . . . . . 5.58 mm (0.220 in.)
    - Valve Guide Height . . . . . 9 mm (0.354 in.)
- Valve Springs
  - Maximum Free Length . . . . . 28 mm (1.102 in.)
  - Maximum Spring Inclination . . . . . 0.80 mm (0.032 in.)

REPAIR SPECIFICATIONS (continued)

Valve Seats Angles

- Intake Valve Seat . . . . 30°
- Exhaust Valve Seat . . . . 45°
- Lower Seat Surface (Intake and Exhaust) . . . . 70°
- Upper Seat Surface (Intake and Exhaust) . . . . 15°

Camshaft

- Mounting Cap Screw Torque . . . . 11 N•m (96 lb-in.)

Camshaft Side Gap
- Standard. . . . 0.05—0.15 mm (0.0020—0.0060 in.)
- Wear Limit . . . . 0.40 mm (0.016 in.)

Camshaft Bend
- Maximum Bend . . . . 0.02 mm (0.001 in.)

Lobe Height
- Standard. . . . 33.95—34.05 mm (1.337—1.341 in.)
- Wear Limit . . . . 33.75 mm (1.329 in.)

Journal OD
- Gear Housing and Flywheel Ends
  - Standard. . . . 39.94—39.96 mm (1.5724—1.5732 in.)
  - Wear Limit . . . . 39.85 mm (1.5689 in.)
- Intermediate
  - Standard. . . . 39.91—39.94 mm (1.5713—1.5724 in.)
  - Wear Limit . . . . 39.85 mm (1.5689 in.)

Bushing ID
- Standard. . . . 40.000—40.065 mm (1.575—1.577 in.)
- Wear Limit . . . . 40.10 mm (1.579 in.)
- Clearance. . . . 0.18 mm (0.007 in.)

Bore ID
- Standard. . . . 40.000—40.025 mm (1.575—1.576 in.)
- Wear Limit . . . . 40.10 mm (1.579 in.)
- Clearance. . . . 0.18 mm (0.007 in.)

Cam Followers

OD
- Standard. . . . 20.927—20.960 mm (0.8239—0.8276 in.)
- Wear Limit . . . . 17.93 mm (0.706 in.)

Bore ID
- Standard. . . . 21.00—21.021 mm (0.8268—0.8276 in.)
- Wear Limit . . . . 21.05 mm (0.829 in.)
- Clearance. . . . 0.040—0.094 mm (0.0016—0.0037 in.)

Pistons and Cylinder Head

- Piston-to-Cylinder Head Clearance . . . . 0.61—0.9 mm (0.023—0.029 in.)

REPAIR SPECIFICATIONS (continued)

Piston and Connecting Rod

Connecting Rod Cap Screw Torque . . . . 23 N•m (17 lb-ft)

Connecting Rod Bearing ID

Standard. . . . . 40.000—40.042 mm (1.575—1.577 in.)
Wear Limit . . . . 40.07 mm (1.578 in.)
Clearance. . . . . 0.16 mm (0.006 in.)

Piston Ring Groove Clearance

First Compression Ring
Standard. . . . . 0.075—0.110 mm (0.0030—0.0043 in.)
Wear Limit . . . . 0.20 mm (0.0079 in.)
Second Compression Ring
Standard. . . . . 0.030—0.065 mm (0.0012—0.0026 in.)
Wear Limit . . . . 0.20 mm (0.0079 in.)
Oil Ring
Standard. . . . . 0.020—0.055 mm (0.0008—0.0022 in.)
Wear Limit . . . . 0.20 mm (0.0079 in.)

Piston Ring End Gap

First Compression Ring . . . . 0.10—0.25 mm (0.004—0.010 in.)
Second Compression Ring . . . . 0.25—0.40 mm (0.010—0.016 in.)
Oil Ring . . . . 0.15—0.35 mm (0.006—0.014 in.)
Wear Limit . . . . 1.50 mm (0.0591 in.)

Piston Pin

Pin OD
Standard. . . . . 20.991—21.00 mm (0.826—0.827 in.)
Wear Limit . . . . 20.975 mm (0.825 in.)
Bore ID
Standard. . . . . 21.00—21.009 mm (0.8268—0.8271 in.)
Wear Limit . . . . 21.02 mm (0.828 in.)
Clearance. . . . . 0.045 mm (0.0018 in.)
Bushing ID
Standard. . . . . 21.025—21.038 mm (0.8278—0.8282 in.)
Wear Limit . . . . 21.10 mm (0.831 in.)
Clearance. . . . . 0.11 mm (0.0043 in.)

REPAIR SPECIFICATIONS (continued)

Piston OD

Distance A . . . . . 8 mm (0.315 in.)

Standard Size Piston

Standard . . . . . 71.922—71.952 mm (2.832—2.833 in.)

Wear Limit . . . . . 71.81 mm (2.827 in.)

0.25 mm (0.010 in.) Oversize Piston

Standard . . . . . 72.17—72.20 mm (2.841—2.842 in.)

Wear Limit . . . . . 72.06 mm (2.837 in.)

0.50 mm (0.020 in.) Oversize Piston

Standard . . . . . 72.42—72.45 mm (2.851—2.852 in.)

Wear Limit . . . . . 72.31 mm (2.847 in.)

Crankcase Extension Housing

Flywheel Housing/Plate-to-Extension Cap Screw Torque . . . . . 49 N•m (36 lb-ft)

Seal Case-to-Extension Cap Screw Torque . . . . . 26 N•m (19 lb-ft)

Crankshaft, Main Bearings and Flywheel

Crankshaft Rear Oil Seal

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

Seal Case-to-Extension Cap Screw Torque . . . . . 9 N•m (78 lb-in.)

Crankshaft and Main Bearings

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

Crankshaft Maximum Bend . . . . . 0.02 mm (0.0007 in.)

Connecting Rod Journal OD

Standard . . . . . 39.97—39.98 mm (1.5736—1.5740 in.)

Wear Limit . . . . . 39.92 mm (1.572 in.)

Main Bearing Journal OD

Standard . . . . . 43.97—43.98 mm (1.7311—1.7315 in.)

Wear Limit . . . . . 39.92 mm (1.572 in.)

Main Bearing ID

Standard . . . . . 44.00—44.042 mm (1.732—1.734 in.)

Wear Limit . . . . . 44.07 mm (1.735 in.)

Clearance . . . . . 0.15 mm (0.0059 in.)

REPAIR SPECIFICATIONS (continued)

Cylinder Bore

Standard Size Bore ID	
Standard	72.00—72.03 mm (2.835—2.836 in.)
Wear Limit	72.20 mm (2.843 in.)
Clearance	0.28 mm (0.011 in.)
0.25 mm (0.010 in.) Oversize Bore ID	
Standard	72.25—72.28 mm (2.845—2.846 in.)
Wear Limit	72.45 mm (2.852 in.)
0.50 mm (0.020 in.) Oversize Bore ID	
Standard	72.50—72.53 mm (2.855—2.856 in.)
Wear Limit	72.70 mm (2.862 in.)
Cross-Hatch Pattern	
Deglazing	30—40°
Reboring	30—40°

Oil Pan and Strainer

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

Oil Pump

Mounting Cap Screw Torque	25 N•m (18 lb-ft)
Rotor Shaft OD-to-Backing Plate ID Clearance	
Standard	0.015—0.048 mm (0.0006—0.0035 in.)
Wear Limit	0.20 mm (0.0078 in.)
Rotor Recess	
Wear Limit	0.25 mm (0.010 in.)
Outer Rotor-to-Pump Body Clearance	
Standard	0.03—0.09 mm (0.0011—0.0035 in.)
Wear Limit	0.13 mm (0.0057 in.)
Inner-to-Outer Rotor Clearance	
Wear Limit	0.15 mm (0.0059 in.)

Oil Pressure Regulating Valve

Spring	
Free Length	43.50—48.50 mm (1.710—1.910 in.)
Compressed Length	27.50 mm (1.080 in.) with 20.5 N (4.6 lb-force)
Housing-to-Valve Body Retaining Nut Torque	30 N•m (22 lb-ft)
Housing-to-Engine Block Cap Screw Torque	27 N•m (20 lb-ft)

Fuel Injection Pump Camshaft

Bearing Retaining Screw Torque	20 N•m (180 lb-in.)
Minimum Lobe Height	30.90 mm (1.217 in.)

REPAIR SPECIFICATIONS—(continued)

Freeze Plugs

Plug OD . . . . .30.218—30.30 mm (1.190—1.193 in.)
Hole ID . . . . .30.00—30.030 mm (1.181—1.182 in.)

OTHER MATERIALS

LOCTITE® PRODUCTS U.S./Canadian/
LOCTITE No.

TY15130/ . . . . .John Deere Form-In-Place
. . . . .Seals, rear oil seal case, crankcase gasket.
TY9370/Thread Lock and Sealer . . . . Apply to threads of crankshaft pulley
TY9477/(Medium Strength #242). . . . . .Cap screws
TY9369/Thread Lock and Sealer . . . . Apply to threads of studs in timing
(Low Strength #222). . . . . Gear housing

SERVICE PARTS KITS

The following kits are available through your parts catalog:

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

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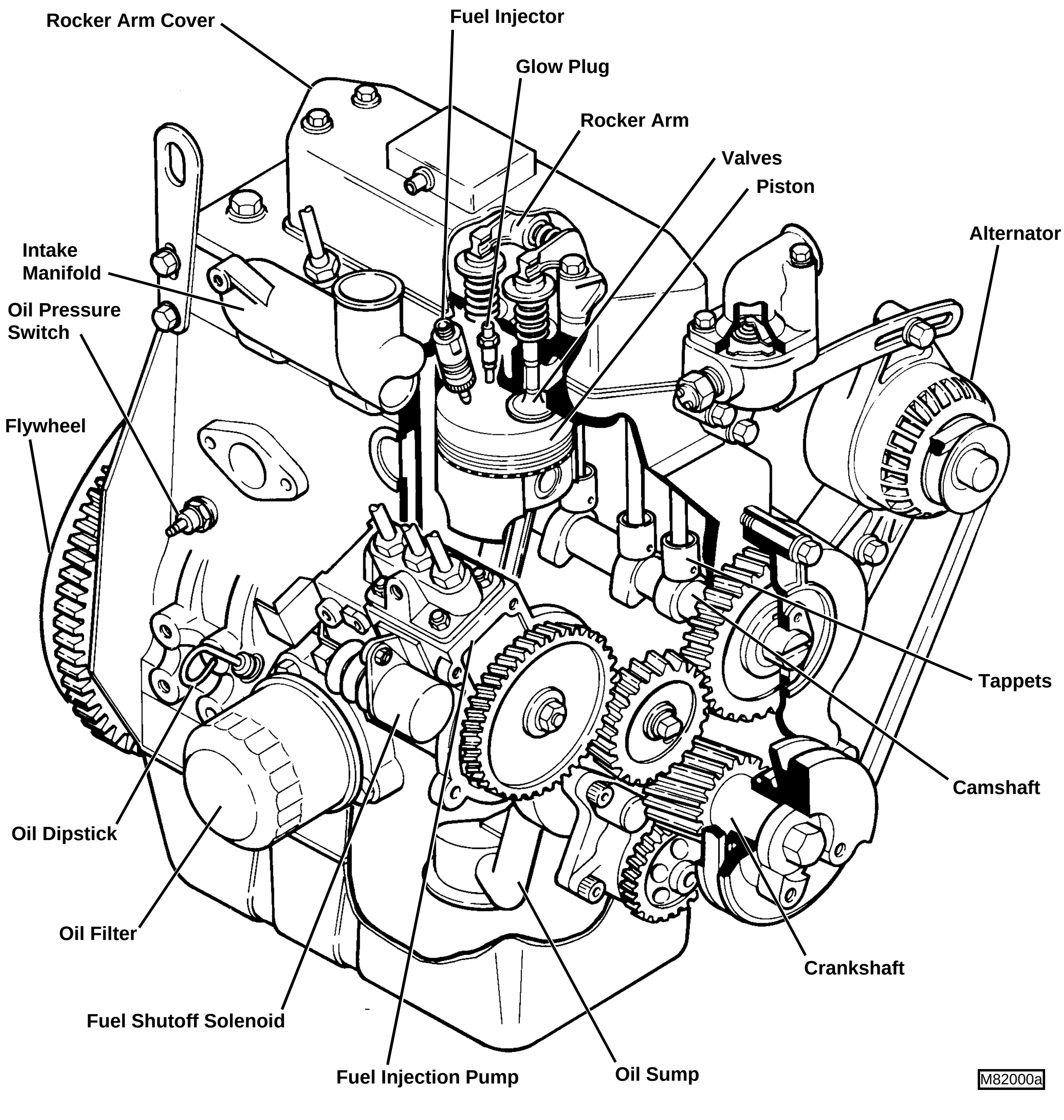
COMPONENT LOCATION

DIESEL ENGINE



THEORY OF OPERATION

DIESEL ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION

Function:

The fuel system supplies pressurized fuel to the injection pump. The air intake system filters air needed for combustion.

System Operation:

An electric fuel transfer pump mounted inside the fuel tank provides pressurized fuel to the injection pump. The fuel pump uses the fuel for lubrication and cooling. The fuel pump draws fuel through the fuel pump screen. Low pressure fuel from the fuel pump flows through the supply hose through the in-line fuel filter to the injection pump. After the injection pump galley is full, excess fuel is returned, along with the return fuel from the injectors, through the return line, back to the fuel tank.

If the unit should ever run 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 make this a self-bleeding system.

The fuel tank relief/check valve prevents fumes from escaping into the air for emission control. When the fuel tank starts to create a vacuum, the check valve opens and allows air into the tank, but closes for air trying to escape from the tank. The tank will pressurize up to **3 kPa (0.4 psi)** before the relief valve opens and allows the air pressure out. The fuel tank cap is not vented.

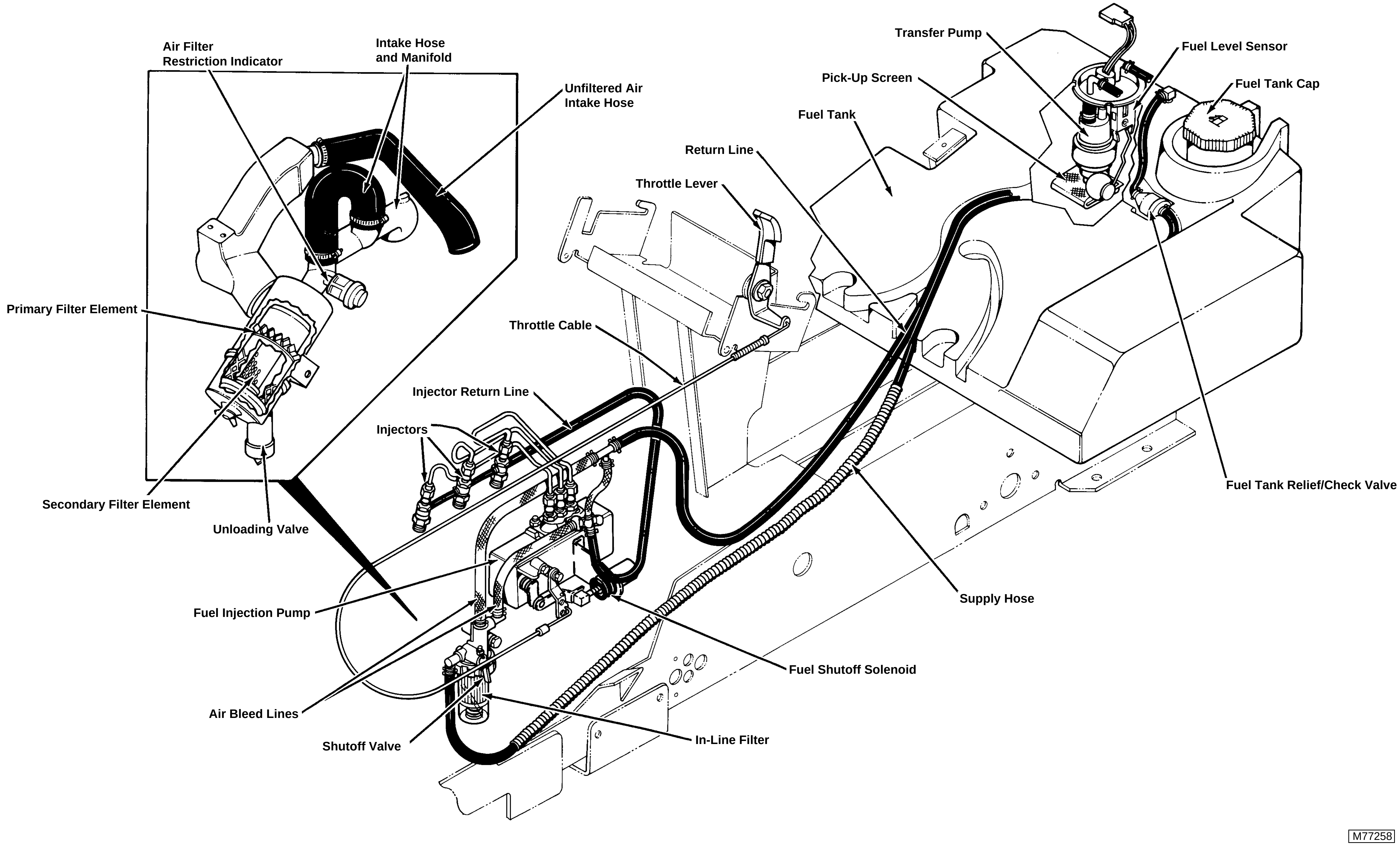
The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key on), the engine can be started. When the key is turned off, return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

Air enters the air filter through the side panel screen and air filter intake hose. The primary and secondary elements filter the air before entering the intake manifold.

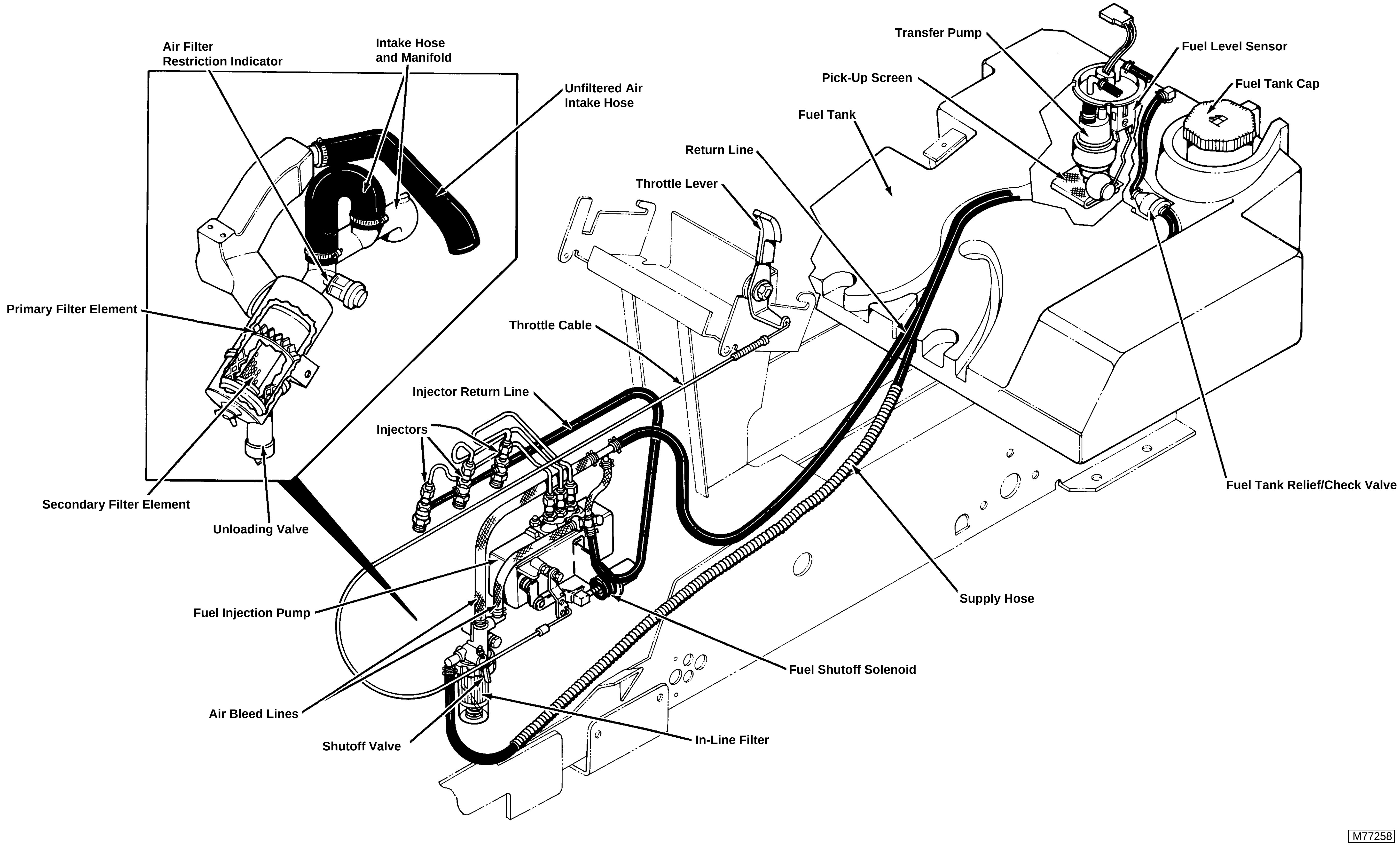
An air restriction indicator alerts the operator when the filters need servicing. The air restriction indicator senses the amount of vacuum in the intake system. A small amount is always present due to some restriction of air movement through the filter elements. The vacuum increases as the filter elements become plugged. The indicator moves to the highest vacuum rating and holds that position until the operator resets it. An air intake leak will prevent the air restriction from operating properly.

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 cleaner housing. The operator can squeeze the valve to let the large filtered particles out.

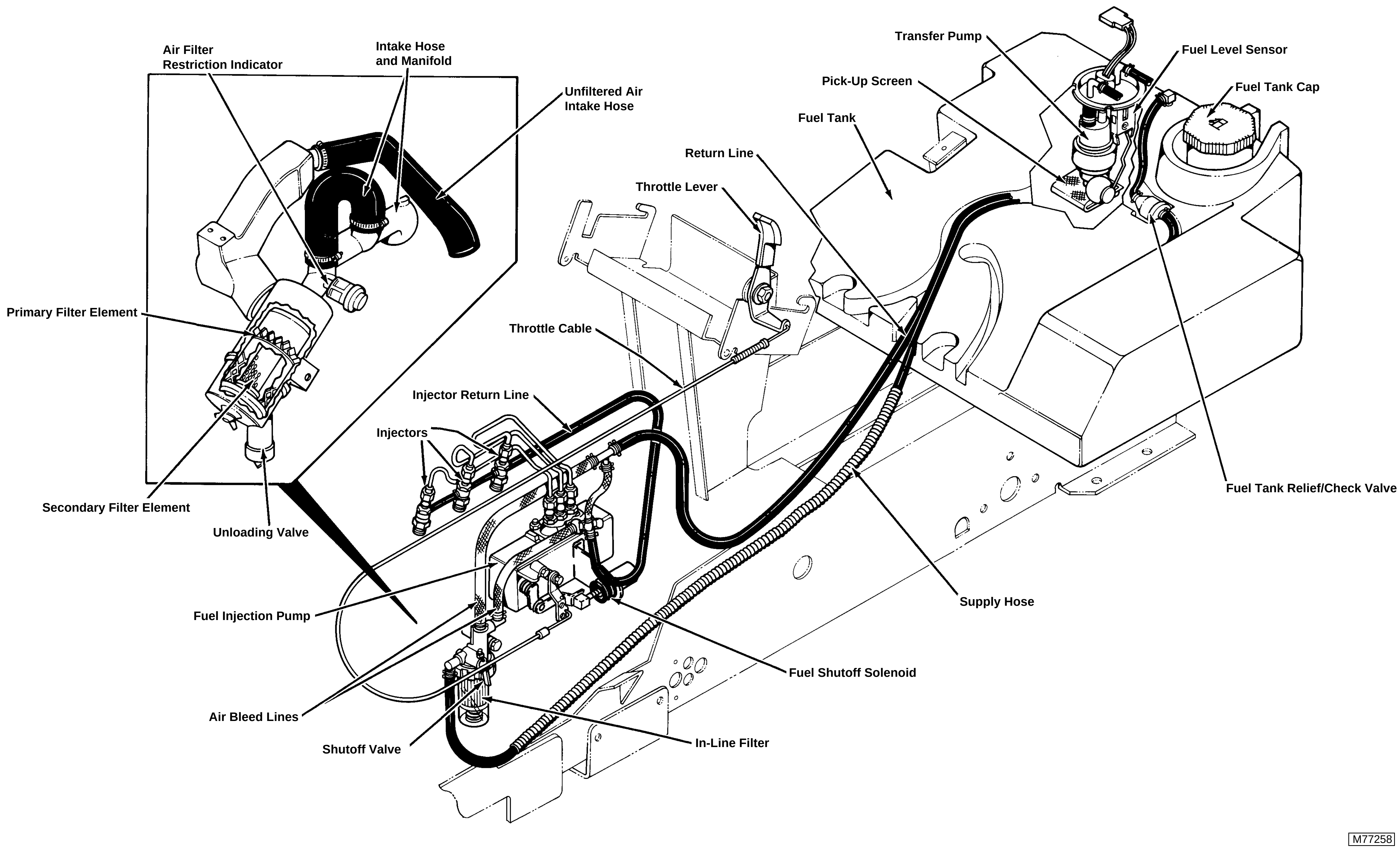
DIESEL ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION



DIESEL ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION



DIESEL ENGINE FUEL AND AIR SYSTEM COMPONENTS AND OPERATION



COOLING SYSTEM OPERATION

Function:

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

System Operation:

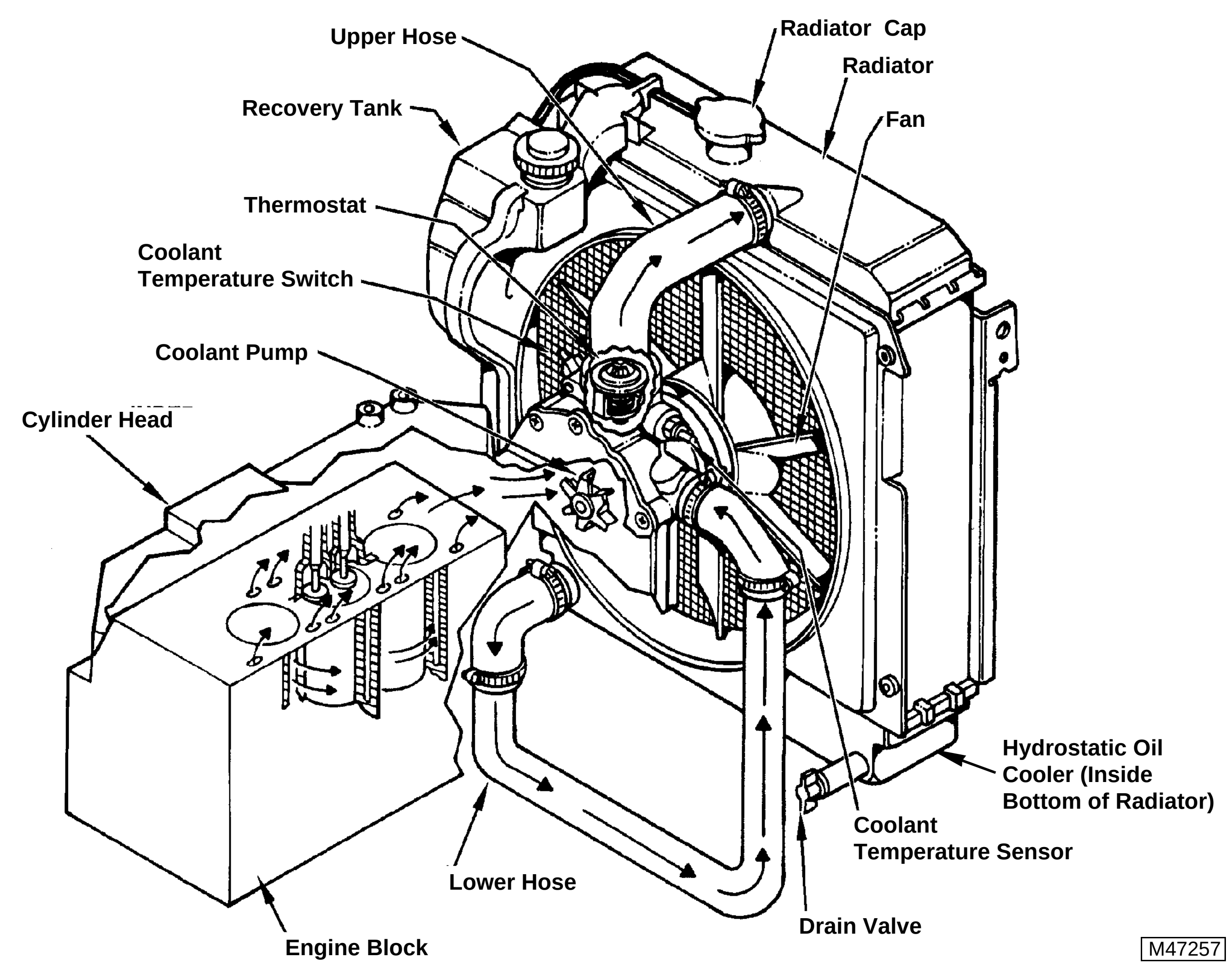
The impeller type coolant pump draws coolant from the bottom of the radiator when the thermostat is open or from the bypass when the thermostat is closed. Coolant from the water pump flows to the water jackets in the block, up through the cylinder heads, past the coolant temperature sensor switch and thermostat. The water temperature sensor operates the temperature gauge, alerting the operator of the engine operating temperature. The water temperature switch, monitors high engine temperature, shutting off the PTO if the engine should overheat.

(See the electrical section for information on temperature sensor and switch).

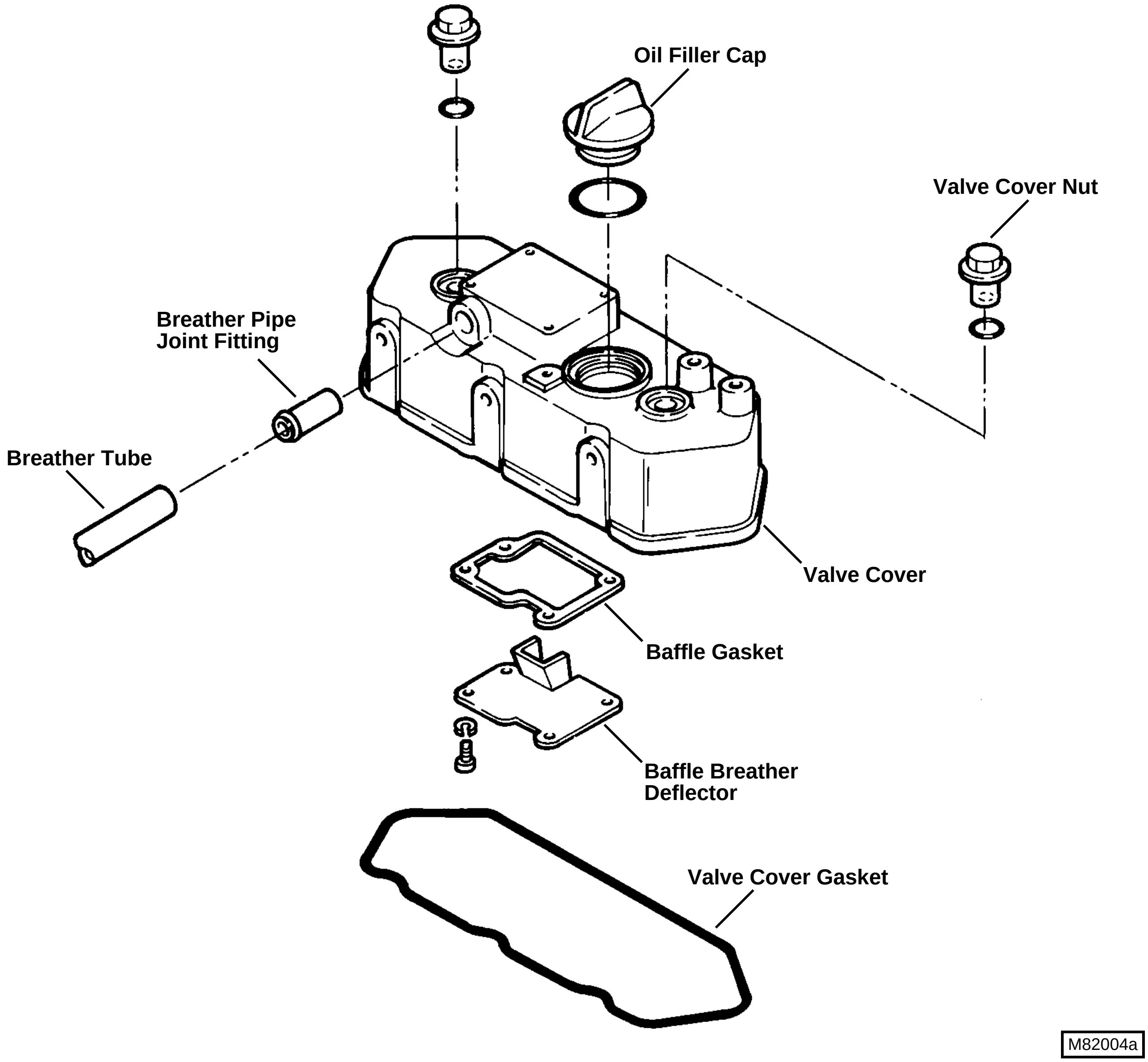
When the engine temperature is below 71 or 82°C (160 or 180°F), the thermostat is closed and coolant is directed back to the water pump through the bypass valve in the thermostat to be recirculated. This allows the engine to warm up to operating temperature quickly.

When the engine temperature is 71 or 82°C (160 or 180°F), the thermostat begins to open and is fully open at 77 or 86°C (165 or 185°F). Coolant from the water jackets and cylinder heads now flow through the thermostat to the radiator which is cooled by the radiator fan. The fan is driven by a belt off the crankshaft pulley.

The radiator cap maintains a constant pressure of 90 kPa (13 psi) inside the radiator which actually raises the boiling point of the coolant. The radiator cap contains a pressure valve and a vacuum valve. When the coolant is hot and pressure is above 90 kPa (13 psi), the pressure valve opens, allowing some coolant to flow to the recovery tank. After the engine is stopped, the coolant cools and the pressure inside the radiator decreases. The pressure difference between the radiator and recovery tank forces the vacuum valve open and some coolant from the recovery tank flows back to the radiator.



CRANKCASE BREATHER OPERATION



Function:

Vents crankcase fuel and water vapor out of engine without losing engine oil. Controls the pressurization of the crankcase.

System Operation:

During normal engine operation, unburned fuel vapors and water vapors, tend to contaminate the crankcase. Most of these vapors are expelled by the exchange of air which is controlled by the breather. The crankcase is slightly pressurized by the leakage of compression around the pistons. The air is circulated by the movement of the pistons.

LUBRICATION SYSTEM OPERATION

Function:

A full pressure system lubricates engine parts with clean oil.

System 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. Some models are also equipped with an oil cooler, safety valve and piston cooling nozzles.

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, oil cooler, if equipped, and through the engine block main oil galley.

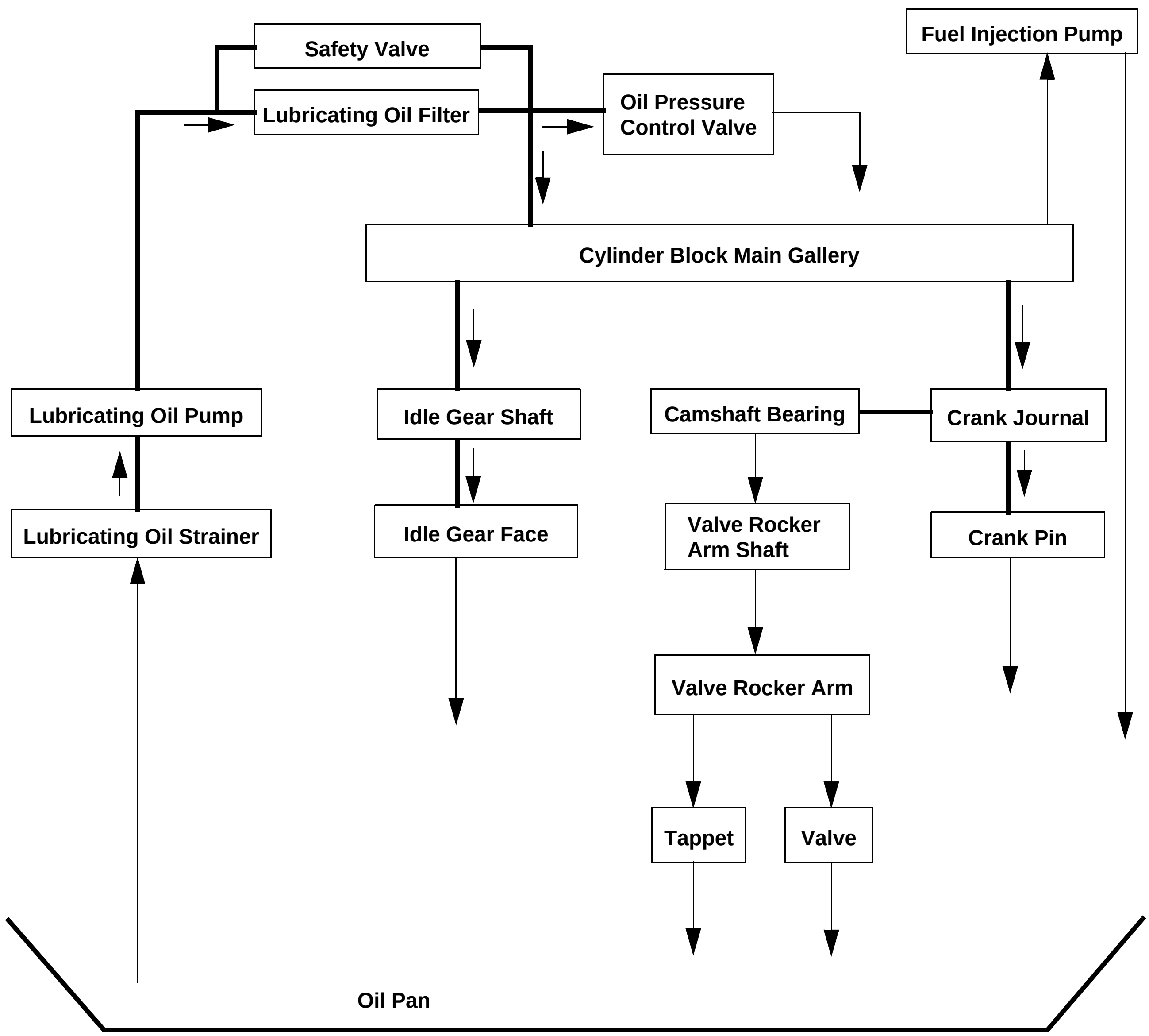
From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals, idler gear shaft and piston cooling nozzles, if equipped. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to connecting rod bearings.

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

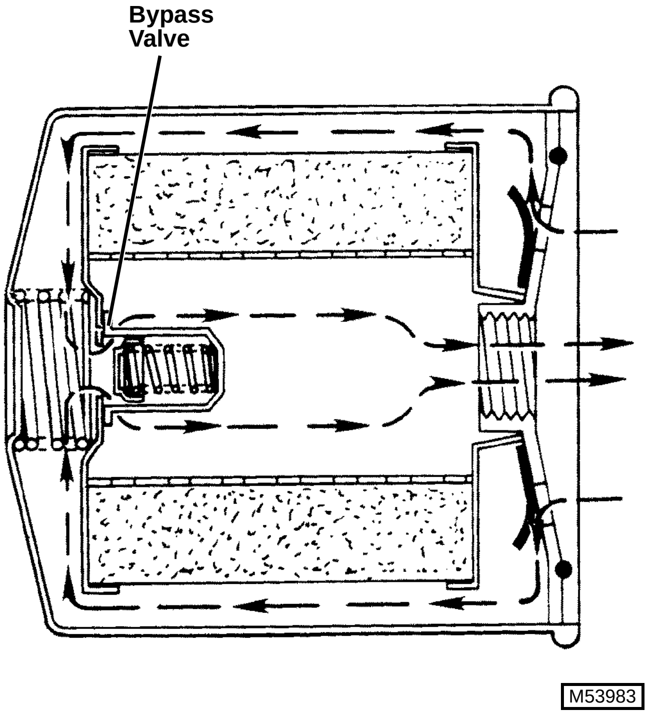
A drilled passage from the rear camshaft bearing, through the cylinder block and cylinder head, supplies lubricating oil to the rocker arm shaft. The hollow shaft distributes oil to the rocker arms, tappets and valves.

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

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



OIL FILTER OPERATION



Function:

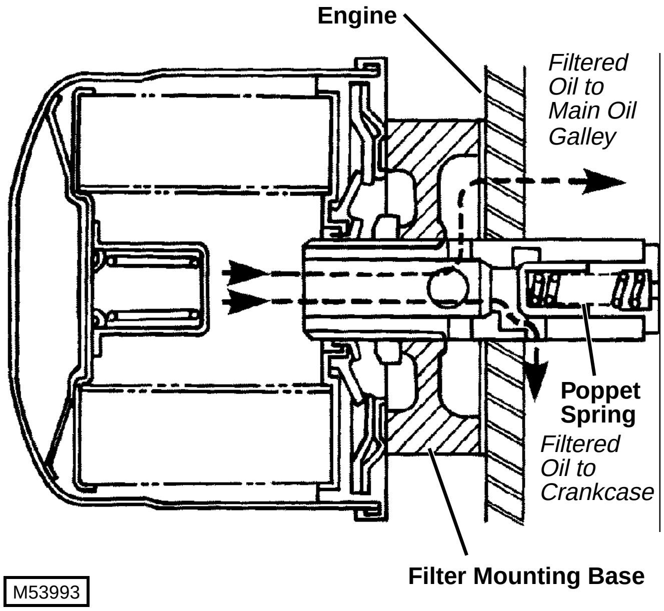
Filters contaminants from the oil between oil/filter changes.

System Operation:

Pressurized oil is directed from the oil pump to the oil filter. Oil flows through the filter element to the main oil galley and to the engine components.

The oil filter is equipped with a bypass valve to ensure adequate engine lubrication if the filter is clogged or oil viscosity is too heavy to properly flow through the filter. The bypass valve opens at **96 kPa (14 psi)** pressure differential.

OIL PRESSURE REGULATING VALVE OPERATION



Function:

Regulates engine oil pressure.

System Operation:

The oil pressure regulating valve is located in the oil filter mounting base stud. Filtered oil passes through the pressure regulating valve to the main oil galley.

If oil pressure is higher than the valve is set for, a poppet spring is overcome, opening the relief valve. When opened, a passage is opened to route oil back to the crankcase.

The oil pressure regulating valve is set to maintain a pressure of **294—440 kPa (43—64 psi)**.

NOTE: All pressure regulating valves operate the same. The most common mounting location is shown.

NOTES

TROUBLESHOOTING CHART

System	Cause \ Problem or Symptom	Engine will not start: Engine will not start	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: No smoke	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: Excess smoke	Low engine output: Exhaust color: Normal	Low engine output: Exhaust color: White	Low engine output: Exhaust color: Black	Poor exhaust color: Under load: White	Poor exhaust color: Under load: Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	Engine surges: During Idling	Engine surges: Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel comsumption	Lubricating oil: Excessive oil consumption	Lubricating oil: Fuel oil in crankcase	Lubricating oil: Water in crankcase	Lubricating oil: Low oil pressure	Low compression	Coolant: Overheating	Coolant: Low water temperature	Intake manifold pressure: Low pressure	Intake manifold pressure: High pressure	Exhaust temperature too high	Solution \ Problem or Symptom
Engine System	Improper intake or exhaust valve clearance	●	●		●						●														●		●	Adjust valve clearance
Engine System	Compression leakage from valve seat				●		●		●		●						●					●			●		●	Grind valve seat; regrind valves
Engine System	Seized intake/exhaust valve	●		●	●		●		●		●			●	●				●			●			●			Replace valve and check valve guide
Engine System	Leaking cylinder head gasket				●															●			●					Replace head gasket
Engine System	Broken or seized piston ring	●		●		●		●			●		●		●			●	●			●	●				●	Replace rings and check cylinder
Engine System	Piston ring, piston or cylinder worn	●		●		●		●										●	●			●						Bore or hone cylinder & replace piston
Engine System	Crankshaft pin or bearing seized	●	●								●		●	●	●							●						Regrind crank and replace bearings
Engine System	Piston ring gaps not positioned properly		●			●												●				●						Stagger piston ring gaps
Engine System	Piston rings installed incorrectly					●		●										●				●						Install piston rings correctly
Engine System	Crankshaft pin or bearing worn				●						●		●	●	●						●							Regrind crank and replace bearings
Engine System	Connecting rod bolt loose										●				●						●							Check for damage and re-torque bolts
Engine System	Foreign matter trapped in combustion chamber	●									●							●				●						Remove head and inspect for damage
Engine System	Excessive timing gear backlash										●																	Measure timing gear backlash
Engine System	Intake/exhaust valve guides worn					●												●				●						Check valve guides and stems
Engine System	Governor not functioning properly		●										●	●	●	●												Repair or replace governor
Engine System	Improper timing between injection pump, intake and exhaust valves	●				●	●	●	●		●																	Adjust valve clearance; check vlave timimg
Cooling System	Engine running too cool							●									●							●				Check thermostat
Cooling System	Engine running too hot						●																●				●	Check thermostat, fan belt tension
Cooling System	Coolant level low						●																●				●	Check cooling system for level/leaks
Cooling System	Cracked water jacket																			●	●		●					Repair or replace water jacket
Cooling System	Malfunctioning thermostat						●																●	●				Check or replace thermostat
Cooling System	Water pump/alternator belt loose						●																●				●	Adjust fan belt tension

TROUBLESHOOTING CHART

Cause	Problem or Symptom	Engine will not start			Low engine output			Poor exhaust color											Lubricating oil					Coolant		Intake manifold pressure			Problem or Symptom
			Engine starts but does not continue to run		Exhaust color			Under load					Engine surges																Solution
			Exhaust smoke																										
		Engine will not start	No smoke	Excess smoke	Normal	White	Black	White	Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	During Idling	Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel comsumption	Excessive oil consumption	Fuel oil in crankcase	Water in crankcase	Low oil pressure	Low compression	Overheating	Low water temperature	Low pressure	High pressure	Exhaust temperature too high	
Engine System	Improper intake or exhaust valve clearance	●	●		●						●														●		●	Adjust valve clearance
Engine System	Compression leakage from valve seat				●		●		●		●						●					●			●		●	Grind valve seat; regrind valves
Engine System	Seized intake/exhaust valve	●		●	●		●		●		●			●	●				●			●			●			Replace valve and check valve guide
Engine System	Leaking cylinder head gasket				●															●			●					Replace head gasket
Engine System	Broken or seized piston ring	●		●		●		●			●		●		●			●	●			●	●				●	Replace rings and check cylinder
Engine System	Piston ring, piston or cylinder worn	●		●		●		●										●	●			●						Bore or hone cylinder & replace piston
Engine System	Crankshaft pin or bearing seized	●	●								●		●	●	●							●						Regrind crank and replace bearings
Engine System	Piston ring gaps not positioned properly		●			●												●				●						Stagger piston ring gaps
Engine System	Piston rings installed incorrectly					●		●										●				●						Install piston rings correctly
Engine System	Crankshaft pin or bearing worn				●						●		●	●	●						●							Regrind crank and replace bearings
Engine System	Connecting rod bolt loose										●				●						●							Check for damage and re-torque bolts
Engine System	Foreign matter trapped in combustion chamber	●									●							●				●						Remove head and inspect for damage
Engine System	Excessive timing gear backlash										●																	Measure timing gear backlash
Engine System	Intake/exhaust valve guides worn					●												●				●						Check valve guides and stems
Engine System	Governor not functioning properly		●										●	●	●	●												Repair or replace governor
Engine System	Improper timing between injection pump, intake and exhaust valves	●				●	●	●	●		●																	Adjust valve clearance; check vlave timimg
Cooling System	Engine running too cool							●									●							●				Check thermostat
Cooling System	Engine running too hot						●																●				●	Check thermostat, fan belt tension
Cooling System	Coolant level low						●																●				●	Check cooling system for level/leaks
Cooling System	Cracked water jacket																			●	●		●					Repair or replace water jacket
Cooling System	Malfunctioning thermostat						●																●	●				Check or replace thermostat
Cooling System	Water pump/alternator belt loose						●																●				●	Adjust fan belt tension

TROUBLESHOOTING CHART

System	Cause / Problem or Symptom	Engine will not start: Engine will not start	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: No smoke	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: Excess smoke	Low engine output: Exhaust color: Normal	Low engine output: Exhaust color: White	Low engine output: Exhaust color: Black	Poor exhaust color: Under load: White	Poor exhaust color: Under load: Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	Engine surges: During Idling	Engine surges: Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel cumsumption	Lubricating oil: Excessive oil consumption	Lubricating oil: Fuel oil in crankcase	Lubricating oil: Water in crankcase	Lubricating oil: Low oil pressure	Low compression	Coolant: Overheating	Coolant: Low water temperature	Intake manifold pressure: Low pressure	Intake manifold pressure: High pressure	Exhaust temperature too high	Solution / Problem or Symptom
Engine System	Improper intake or exhaust valve clearance	●	●		●						●														●		●	Adjust valve clearance
Engine System	Compression leakage from valve seat				●		●		●		●						●					●			●		●	Grind valve seat; regrind valves
Engine System	Seized intake/exhaust valve	●		●	●		●		●		●			●	●				●			●			●			Replace valve and check valve guide
Engine System	Leaking cylinder head gasket				●															●			●					Replace head gasket
Engine System	Broken or seized piston ring	●		●		●		●			●		●		●			●	●			●	●				●	Replace rings and check cylinder
Engine System	Piston ring, piston or cylinder worn	●		●		●		●										●	●			●						Bore or hone cylinder & replace piston
Engine System	Crankshaft pin or bearing seized	●	●								●		●	●	●							●						Regrind crank and replace bearings
Engine System	Piston ring gaps not positioned properly		●			●												●				●						Stagger piston ring gaps
Engine System	Piston rings installed incorrectly					●		●										●				●						Install piston rings correctly
Engine System	Crankshaft pin or bearing worn				●						●		●	●	●						●							Regrind crank and replace bearings
Engine System	Connecting rod bolt loose										●				●						●							Check for damage and re-torque bolts
Engine System	Foreign matter trapped in combustion chamber	●									●							●				●						Remove head and inspect for damage
Engine System	Excessive timing gear backlash										●																	Measure timing gear backlash
Engine System	Intake/exhaust valve guides worn					●												●				●						Check valve guides and stems
Engine System	Governor not functioning properly		●										●	●	●	●												Repair or replace governor
Engine System	Improper timing between injection pump, intake and exhaust valves	●				●	●	●	●		●																	Adjust valve clearance; check vlave timimg
Cooling System	Engine running too cool							●									●							●				Check thermostat
Cooling System	Engine running too hot						●																●				●	Check thermostat, fan belt tension
Cooling System	Coolant level low						●																●				●	Check cooling system for level/leaks
Cooling System	Cracked water jacket																			●	●		●					Repair or replace water jacket
Cooling System	Malfunctioning thermostat						●																●	●				Check or replace thermostat
Cooling System	Water pump/alternator belt loose						●																●				●	Adjust fan belt tension

System	Cause (Problem or Symptom →)	Engine will not start: Engine will not start	Engine will not start: Engine starts but does not continue to run – Exhaust smoke: No smoke	Engine will not start: Engine starts but does not continue to run – Exhaust smoke: Excess smoke	Low engine output – Exhaust color: Normal	Low engine output – Exhaust color: White	Low engine output – Exhaust color: Black	Poor exhaust color – Under load: White	Poor exhaust color – Under load: Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	Engine surges: During Idling	Engine surges: Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel comsumption	Lubricating oil: Excessive oil consumption	Lubricating oil: Fuel oil in crankcase	Lubricating oil: Water in crankcase	Lubricating oil: Low oil pressure	Low compression	Coolant: Overheating	Coolant: Low water temperature	Intake manifold pressure: Low pressure	Intake manifold pressure: High pressure	Exhaust temperature too high	Solution
Lubricating Oil System	Improper engine oil viscosity/type	●	●		●													●			●	●						Replace engine oil and filter
	External/internal oil leak																	●			●							Repair
	Oil pump worn																											Check and repair oil pump
	Oil filter clogged																				●	●						Replace oil filter
	Oil pressure relief valve worn																				●							Clean, adjust or replace relief valve
	Oil level low																				●							Add oil
Fuel System	Advanced fuel injection pump timing							●	●	●					●													Check and adjust injection pump timing
	Retarded fuel injection pump timing					●	●	●	●								●										●	Check and adjust injection pump timing
	Wrong type of fuel				●	●	●	●	●			●																Drain and replace fuel
	Water in fuel	●		●		●		●				●	●	●														Check and repair
	Fuel filter clogged	●	●		●																							Replace fuel filter
	Air entering fuel system	●	●		●																							Cheack and repair fuel supply system
	Clogged or cracked fuel lines	●	●		●																							Clean or replace fuel lines
	Fuel volume to injection pump low	●	●		●																							Check or replace fuel transfer pump
	Uneven volume of fuel injected					●	●	●	●			●	●	●	●												●	Check fuel injector pump and injectors
	Excessive volume of fuel injected								●								●	●				●	●			●	●	Check fuel injector pump and injectors
	Poor fuel injection pattern					●	●	●	●			●	●	●	●		●											Clean or replace fuel injector nozzles
Air/Exhaust	Clogged air filter			●			●		●			●													●			Clean or replace air filter
	Engine at high altitude/temperature						●		●														●		●			Use higher output engine
	Clogged exhaust pipe						●		●			●															●	Clean exhaust pipe
Electrical	Starting motor defective	●																										Repair or replace starting motor
	Alternator defective	●																										Repair or replace alternator
	Open circuit in wiring	●																										Repair wiring
	Battery voltage low	●																										Recharge battery

Problem or Symptom / Cause		Engine will not start			Low engine output			Poor exhaust color										Lubricating oil					Coolant		Intake manifold pressure			Problem or Symptom / Solution
			Engine starts but does not continue to run: Exhaust smoke		Exhaust color			Under load					Engine surges															
		Engine will not start	No smoke	Excess smoke	Normal	White	Black	White	Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	During Idling	Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel comsumption	Excessive oil consumption	Fuel oil in crankcase	Water in crankcase	Low oil pressure	Low compression	Overheating	Low water temperature	Low pressure	High pressure	Exhaust temperature too high	
Lubricating Oil System	Improper engine oil viscosity/type	●	●		●													●			●	●						Replace engine oil and filter
	External/internal oil leak																	●			●							Repair
	Oil pump worn																											Check and repair oil pump
	Oil filter clogged																				●	●						Replace oil filter
	Oil pressure relief valve worn																				●							Clean, adjust or replace relief valve
	Oil level low																				●							Add oil
Fuel System	Advanced fuel injection pump timing							●	●	●					●													Check and adjust injection pump timing
	Retarded fuel injection pump timing					●	●	●	●								●										●	Check and adjust injection pump timing
	Wrong type of fuel				●	●	●	●	●			●																Drain and replace fuel
	Water in fuel	●		●		●		●				●	●	●														Check and repair
	Fuel filter clogged	●	●		●																							Replace fuel filter
	Air entering fuel system	●	●		●																							Cheack and repair fuel supply system
	Clogged or cracked fuel lines	●	●		●																							Clean or replace fuel lines
	Fuel volume to injection pump low	●	●		●																							Check or replace fuel transfer pump
	Uneven volume of fuel injected					●	●	●	●			●	●	●	●												●	Check fuel injector pump and injectors
	Excessive volume of fuel injected								●								●	●				●	●			●	●	Check fuel injector pump and injectors
	Poor fuel injection pattern					●	●	●	●			●	●	●	●		●											Clean or replace fuel injector nozzles
Air/Exhaust	Clogged air filter			●			●		●			●													●			Clean or replace air filter
	Engine at high altitude/temperature						●		●														●		●			Use higher output engine
	Clogged exhaust pipe						●		●			●															●	Clean exhaust pipe
Electrical	Starting motor defective	●																										Repair or replace starting motor
	Alternator defective	●																										Repair or replace alternator
	Open circuit in wiring	●																										Repair wiring
	Battery voltage low	●																										Recharge battery

	Problem or Symptom / Cause	Engine will not start: Engine will not start	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: No smoke	Engine will not start: Engine starts but does not continue to run: Exhaust smoke: Excess smoke	Low engine output: Exhaust color: Normal	Low engine output: Exhaust color: White	Low engine output: Exhaust color: Black	Poor exhaust color: Under load: White	Poor exhaust color: Under load: Black	Loud knocking noise during combustion	Misfiring	Uneven combustion sound	Engine surges: During Idling	Engine surges: Under Load	Excessive engine vribration	Poor return to low speed	Excessive fuel comsumption	Lubricating oil: Excessive oil consumption	Lubricating oil: Fuel oil in crankcase	Lubricating oil: Water in crankcase	Lubricating oil: Low oil pressure	Low compression	Coolant: Overheating	Coolant: Low water temperature	Intake manifold pressure: Low pressure	Intake manifold pressure: High pressure	Exhaust temperature too high	Problem or Symptom / Solution
Lubricating Oil System	Improper engine oil viscosity/type	●	●		●													●			●	●						Replace engine oil and filter
	External/internal oil leak																	●			●							Repair
	Oil pump worn																											Check and repair oil pump
	Oil filter clogged																				●	●						Replace oil filter
	Oil pressure relief valve worn																				●							Clean, adjust or replace relief valve
	Oil level low																				●							Add oil
Fuel System	Advanced fuel injection pump timing							●	●	●					●													Check and adjust injection pump timing
	Retarded fuel injection pump timing					●	●	●	●								●										●	Check and adjust injection pump timing
	Wrong type of fuel				●	●	●	●	●			●																Drain and replace fuel
	Water in fuel	●		●		●		●				●	●	●														Check and repair
	Fuel filter clogged	●	●		●																							Replace fuel filter
	Air entering fuel system	●	●		●																							Cheack and repair fuel supply system
	Clogged or cracked fuel lines	●	●		●																							Clean or replace fuel lines
	Fuel volume to injection pump low	●	●		●																							Check or replace fuel transfer pump
	Uneven volume of fuel injected					●	●	●	●			●	●	●	●												●	Check fuel injector pump and injectors
	Excessive volume of fuel injected								●								●	●				●	●			●	●	Check fuel injector pump and injectors
	Poor fuel injection pattern					●	●	●	●			●	●	●	●		●											Clean or replace fuel injector nozzles
Air/Exhaust	Clogged air filter			●			●		●			●													●			Clean or replace air filter
	Engine at high altitude/temperature						●		●														●		●			Use higher output engine
	Clogged exhaust pipe						●		●			●															●	Clean exhaust pipe
Electrical	Starting motor defective	●																										Repair or replace starting motor
	Alternator defective	●																										Repair or replace alternator
	Open circuit in wiring	●																										Repair wiring
	Battery voltage low	●																										Recharge battery

NOTES

DIAGNOSIS

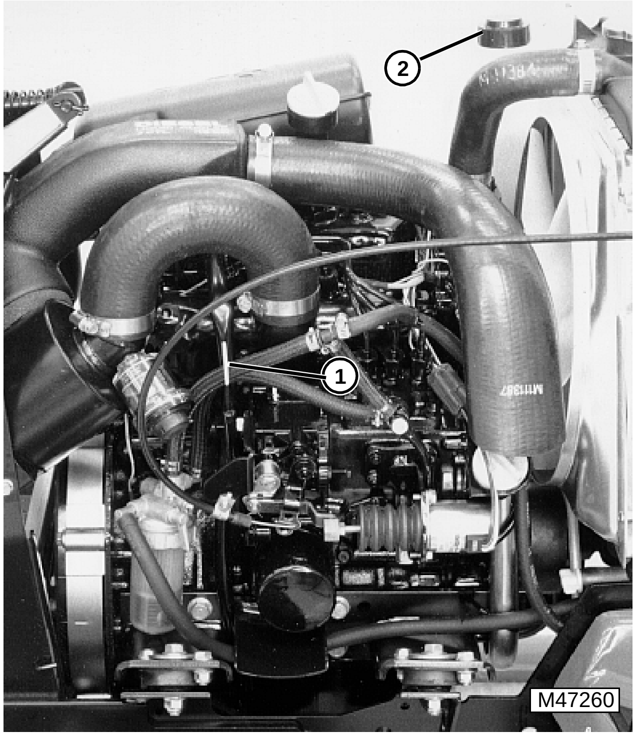
ENGINE SYSTEM DIAGNOSIS

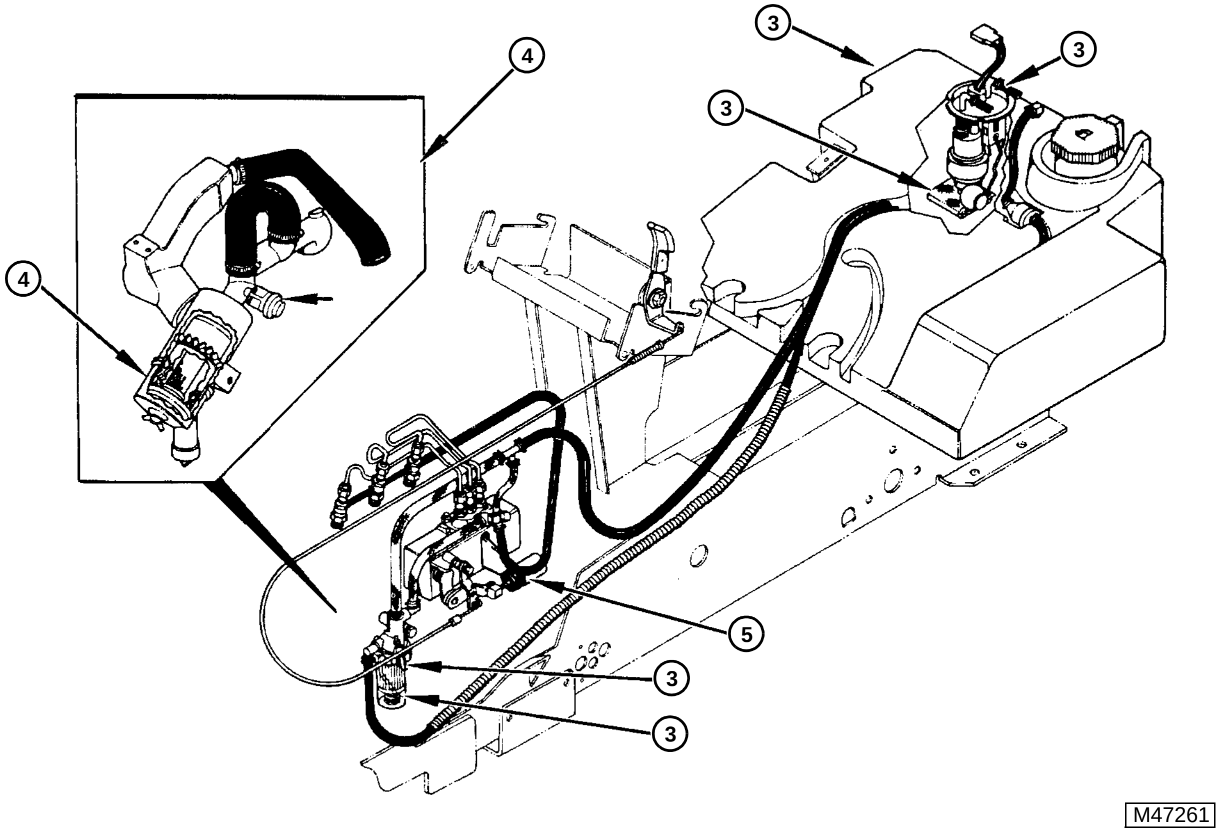
Test Conditions:

- Machine parked on level surface.
- Park brake engaged.
- Key switch off unless indicated otherwise.

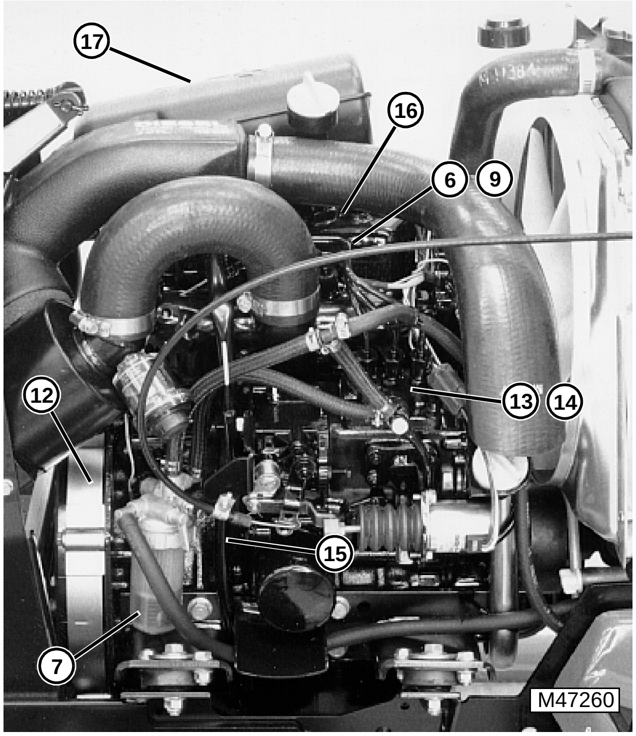
Test/Check Point	Normal	If Not Normal
1. Engine dipstick and exterior engine surface. Engine Oil Check.	Oil level between “L” and “H” marks. Oil not burnt, or contaminated with metal particles, fuel, or coolant. No external leakage. Filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather. Change oil filter.
2. Coolant tank and radiator. Cooling System Check.	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top. Coolant not contaminated with oil or fuel or discolored brown. Radiator screen free of debris. Hoses not cracked or leaking; clamps and radiator cap tight. Fan belt tight, not glazed or cracked. Fan blades not damaged or warped.	Add proper coolant mix. Drain and flush system. Check for source of contamination. Clean or replace. Pressure test radiator and cap. Replace and adjust belt tension. Replace fan.
3. Fuel tank, pump, pump screen, lines, filter and filter shutoff valve. Fuel System Check.	Fuel level correct; not contaminated. Correct grade of fuel; no water. Fuel pump screen and in-line filter free of debris. Fuel shutoff valve in “ON” position. Fuel hoses not cracked or leaking. Fuel hose clamps tight. Fuel tank does not have vacuum.	Drain and clean fuel tank. Add fresh fuel. Replace filters. Move to “ON” position. Replace. Replace or tighten. Replace fuel tank check valve.
4. Air filter and air intake. Air Intake System Check.	Air filter hose not cracked; clamps tight. Element not plugged. Air filter housing sealed. No dirt tracking inside filter element.	Replace and tighten clamps. Replace element or housing.
5. Fuel shut-off solenoid. (Key switch in run position.)	Fuel shutoff solenoid must pull in and stay in. Solenoid must bottom out. Shut-off solenoid shaft must still move slightly.	Check fuel shutoff solenoid adjustment. Clean any dirt from under solenoid boot. If solenoid will not pull in and hold in, see FUEL PUMP AND FUEL SHUT-OFF SOLENOID CIRCUIT DIAGNOSIS in the Electrical section.

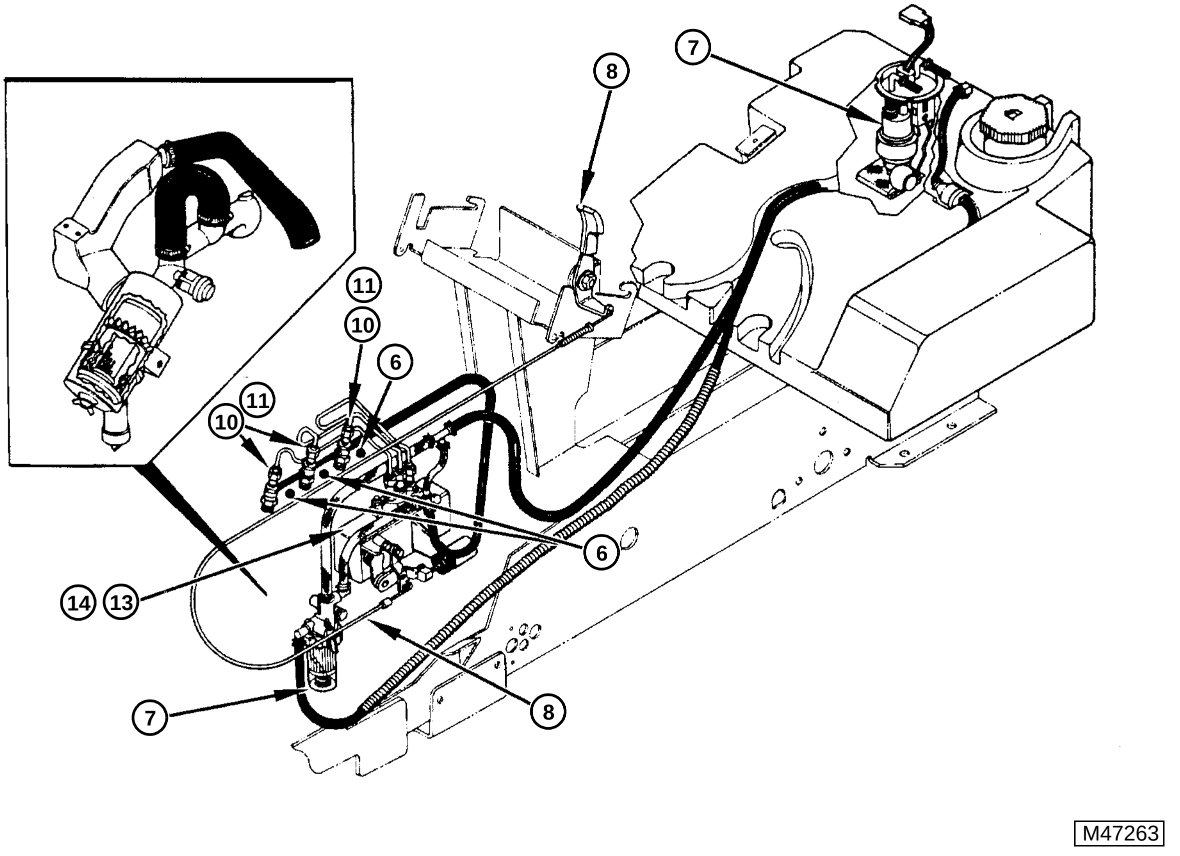
ENGINE SYSTEM TEST POINTS





ENGINE SYSTEM TEST POINTS (continued)





TESTS AND ADJUSTMENTS

AIR INTAKE SYSTEM LEAKAGE TEST

Reason:

Check for leaks in air intake system.

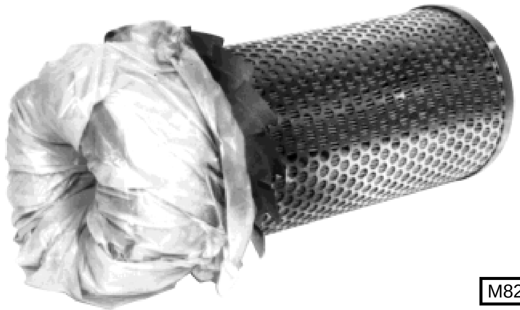
Equipment:

- Air Pressure Regulator

Procedure:

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

IMPORTANT: When reinstalling starting aid nozzle, position arrow on nozzle pointing against intake air flow.



M82124

Results:

- Find leaks and repair or replace parts as necessary.

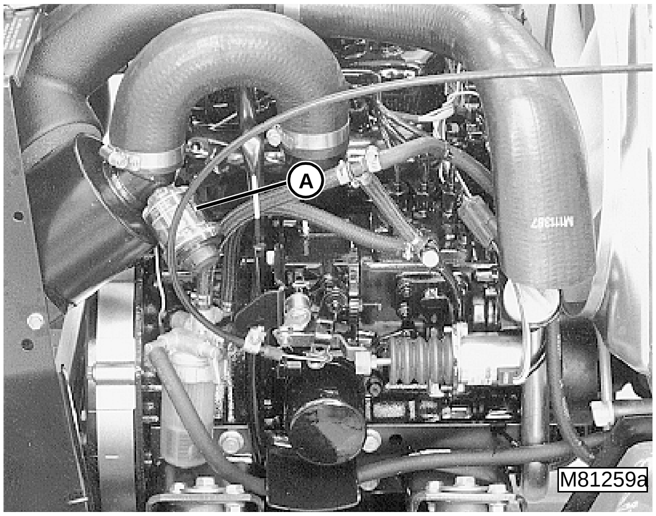
AIR FILTER RESTRICTION INDICATOR TEST

Reason:

Check operation of indicator and check intake system for leaks.

NOTE: If encountering performance problems (black smoke, etc.), check for plugged radiator cooling fins. Also check connecting hose is not damaged.

Procedure:



M81259a

1. Release restriction indicator (A).
2. Start engine and run at wide-open throttle.

Results:

- If restriction indicator is at or above 635 mm (25 in.) vacuum, replace primary element.
- With new primary element installed, indicator at or above 500mm (20 in.) vacuum, replace secondary element.

NOTE: Normal restriction is approximately 380 mm (15 in.) vacuum.

Procedure:

1. Squeeze air supply hose to create a restriction.

Results:

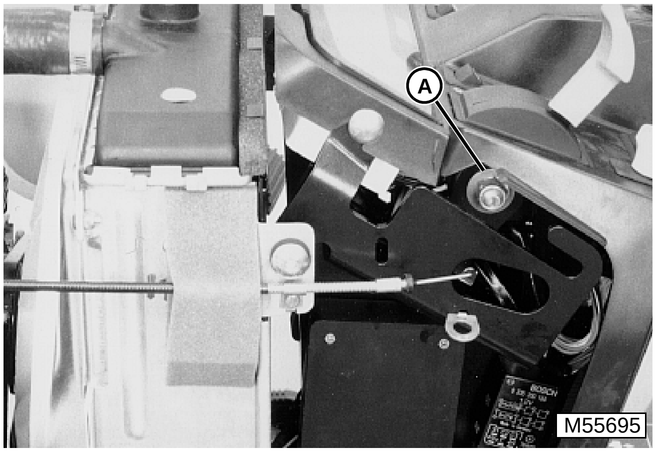
- With engine at wide-open throttle and restriction applied, vacuum should increase and hold reading on indicator. If not, check for air leak in air intake hoses, or replace indicator.

THROTTLE LEVER FRICTION ADJUSTMENT

Reason:

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

Procedure:



1. Adjust friction disks by tightening or loosening lock nut (A) until there is adequate friction to hold throttle in a set position.

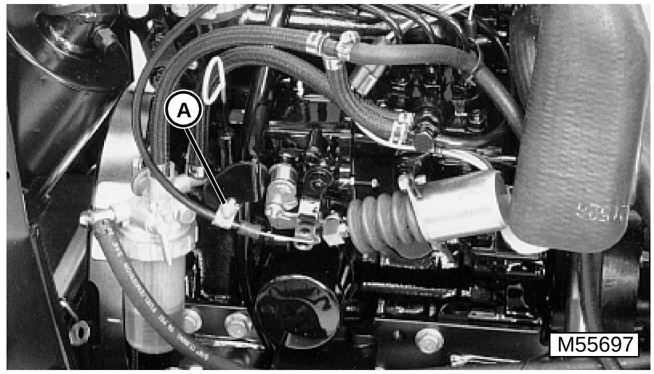
NOTE: Make sure throttle cable is not binding or stuck.

THROTTLE CABLE ADJUSTMENT

Reason:

To insure that the throttle lever cable moves the governor lever completely to slow and to fast idle positions.

Procedure:



1. Loosen throttle cable clamp (A).
2. Move throttle lever on instrument panel towards fast idle position until the throttle lever cable end is 2—3 mm (0.080—0.120 in.) away from frame slot.
3. Hold throttle control lever against fast idle stop. Pull throttle cable tight. Tighten cable clamp.
4. Move throttle lever through full range. Check to be sure governor control lever moves through complete range and linkage is not binding.

BLEED FUEL SYSTEM

NOTE: These diesel engines are equipped with self-bleeding fuel injection systems. No bleed procedure is required.

SLOW IDLE ADJUSTMENT

Reason:

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

Equipment:

• Digital Tachometer

Procedure:

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

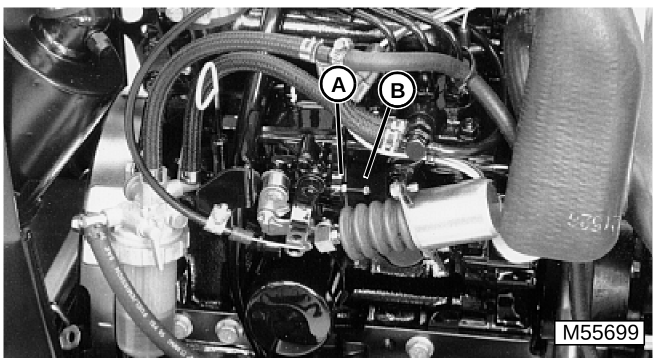
NOTE: *Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.*

2. Start engine and run for 5 minutes.
3. Use a digital tachometer to check engine speed at flywheel.
4. Visually check that injection pump throttle lever is against slow idle stop screw. Check slow idle speed.
5. After slow idle speed adjustment, adjust throttle cable. (See THROTTLE CABLE ADJUSTMENT in this section.)

Specifications:

Slow Idle Speed . . . . 1650 ±150 rpm

Results:



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

FAST IDLE ADJUSTMENT—NON-CARB/EPA ENGINES

EARLY 455 TRACTORS ONLY

NOTE: *For engines **WITHOUT** California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.*

Reason:

To achieve proper fast idle speed setting. This provides proper speed for PTO operation and insures that engine is running at proper rpm's for peak performance.

Equipment:

• Digital Tachometer

Procedure:

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

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

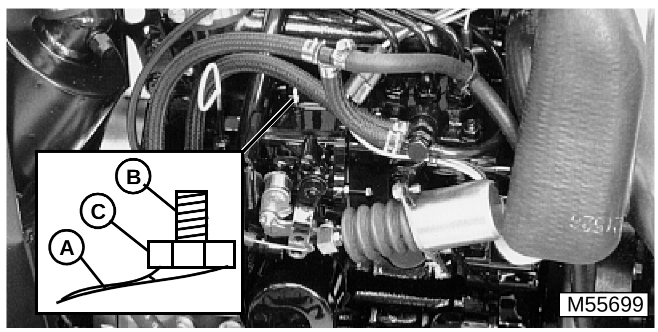
2. Start engine and run for 5 minutes.
3. Use a digital tachometer to check engine speed at flywheel.
4. Push against injection pump throttle lever to insure it is up against fast idle stop screw. Check fast idle speed.
5. After fast idle speed adjustment, adjust throttle cable. (See THROTTLE CABLE ADJUSTMENT in this section.)

Specifications:

Fast Idle Speed. . . . . 3350 ±100 rpm

Results:

NOTE: *Some adjustment can be made without removing sealed wire (A). Attempt to make the adjustment before removing wire.*



• If fast idle rpm is not according to specifications, remove fast idle acorn nut and loosen nut (C). Turn screw (B) until fast idle speed is correct. After adjustment, tighten nut (C) WITHOUT moving screw (B).
• Install acorn nut and new wire seal (A) and mark with a new paint stripe.
• If engine still does not meet fast idle specifications, have pump inspected by an Authorized Diesel Service (ADS) center.

FAST IDLE ADJUSTMENT—CARB/ EPA ENGINES

LATE MODEL 455 DOMESTIC TRACTORS ONLY

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

ENGINE MODEL NUMBER3TNA72C-UJ3

ATTENTION!

Do not attempt to adjust fast idle stop screw unless you are a factory trained technician with authorization to service CARB/EPA Certified Engines.

Reason:

To achieve proper fast idle speed setting. This insures that the engine is running at proper speed for peak performance and also meets the CARB/EPA emissions requirements.

Equipment:

- Digital Tachometer
- JDG991 Fast Idle Adjustment Tool

Procedure:

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

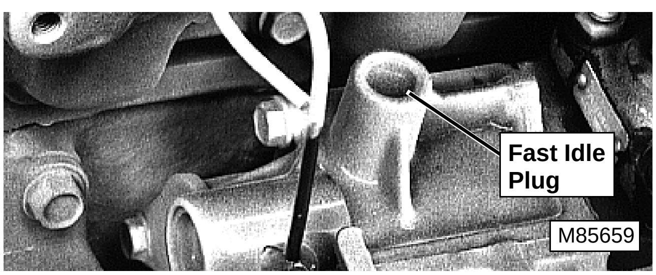
NOTE: *Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.*

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

Specification:

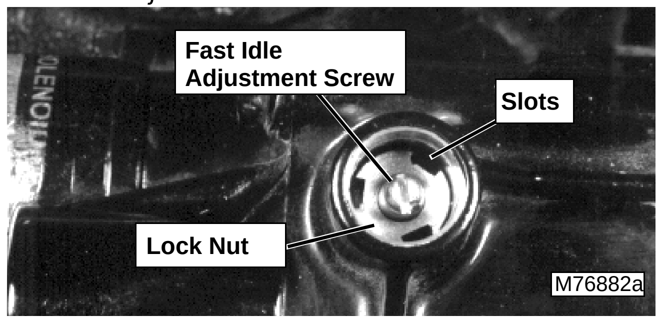
Fast Idle Speed3350 ± 100 rpm

5. Turn engine OFF.

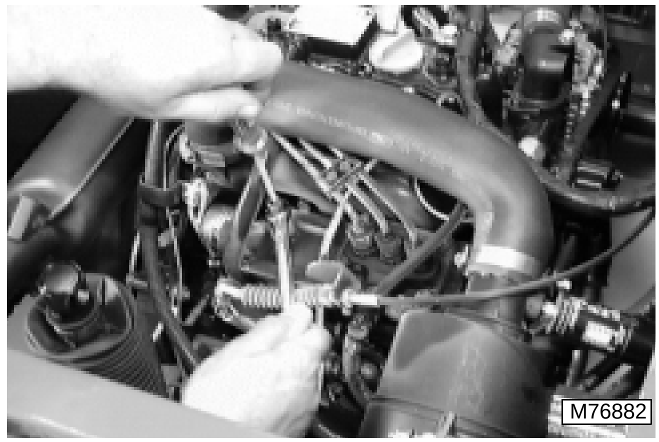


6. If fast idle speed DOES NOT meet specification, remove plug from fast idle adjustment screw hole.

Fast Idle Adjustment Tool—JDG991.



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



8. Start engine and move throttle lever to fast idle position.
9. Use a flat blade screwdriver to turn fast idle adjustment screw until fast idle speed is set at **3350 ± 100 rpm**. Adjust throttle cable, if necessary.
10. While holding fast idle adjustment screw stationary, tighten lock nut with essential adjustment tool to **4 N•m (35 lb-in.)**.
11. Check fast idle speed again (steps 2—5).
12. Install a new plug into the fast idle adjustment screw hole.

Results:

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

FUEL CONTROL SCREW ADJUSTMENT—CARB/EPA ENGINES

LATE MODEL 455 DOMESTIC TRACTORS ONLY

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

ENGINE MODEL NUMBER. 3TNA72C-UJ3

ATTENTION!

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

IMPORTANT: Adjust fuel control screw ONLY when governor assembly or any of it's individual components are replaced and/or fuel injection pump is serviced by an Authorized Diesel Service (ADS) center or it's control rack alignment mark has been recalibrated.

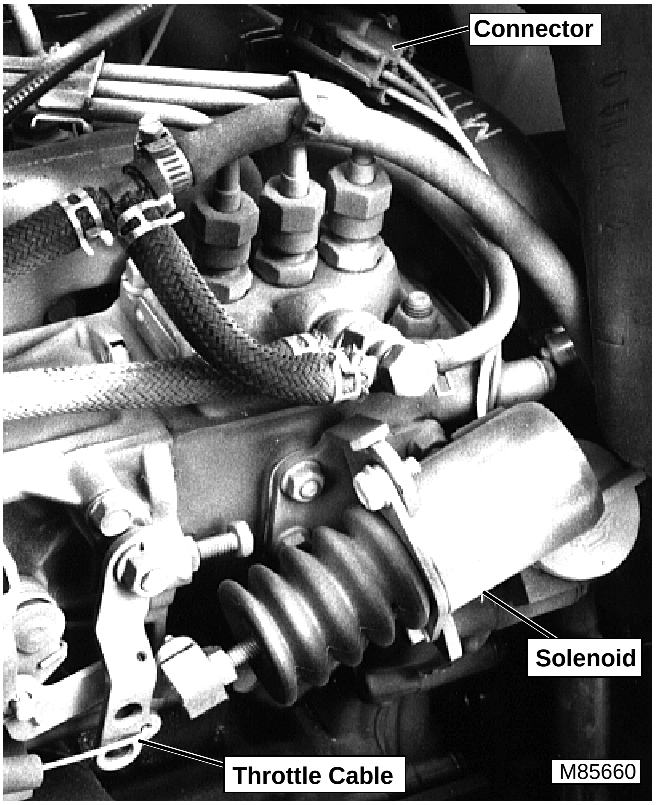
Reason:

To ensure engine performs at peak power with optimum torque rise recovery under load.

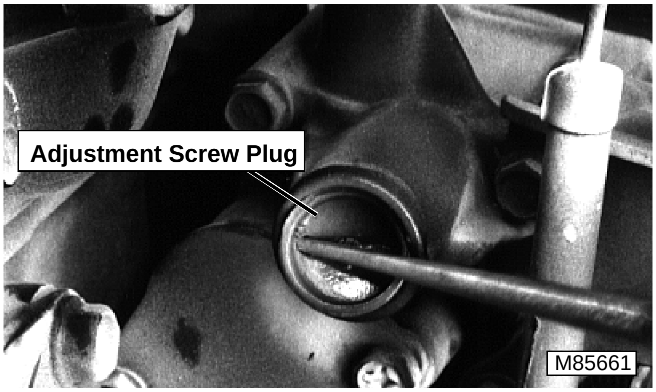
Equipment:

- Fuel Control Screw Adjustment Tool #DG1060
- Spring #M72632

Procedure:



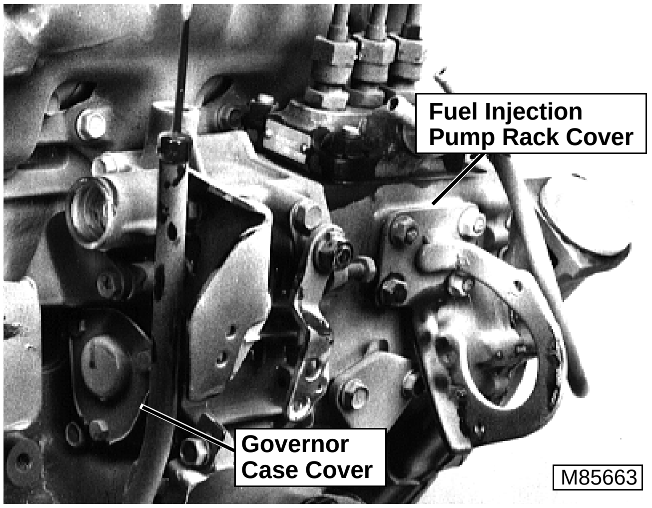
1. Unplug fuel shutoff solenoid connector from wiring harness.
2. Disconnect and remove solenoid from bracket.
3. Disconnect throttle cable from throttle lever.
4. Remove fuel filter from bracket WITHOUT disconnecting fuel lines.
5. Remove air cleaner assembly and intake hose.
6. Remove any additional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



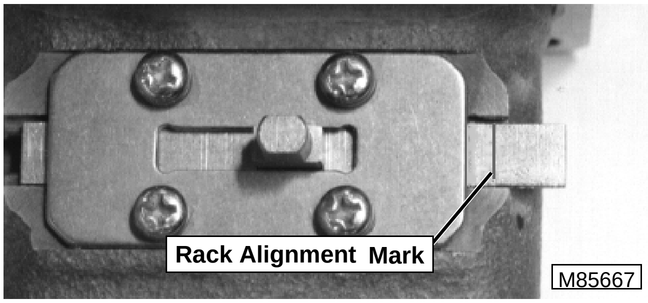
7. CARB/EPA engines use a plug to cover the fuel control screw instead of an acorn nut.

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

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



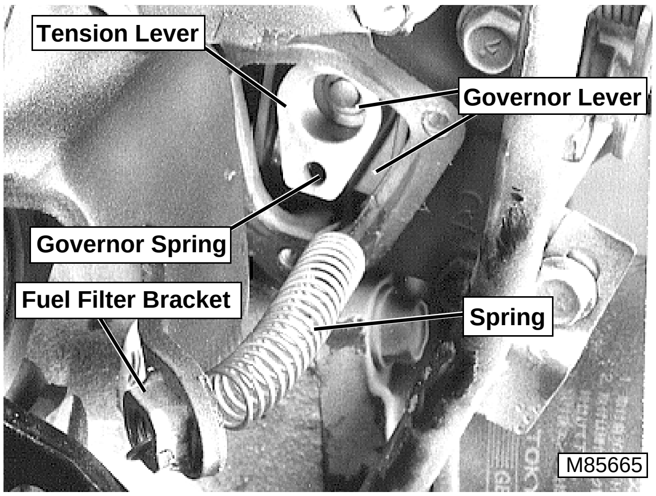
9. Remove governor case cover and fuel injection pump rack cover.

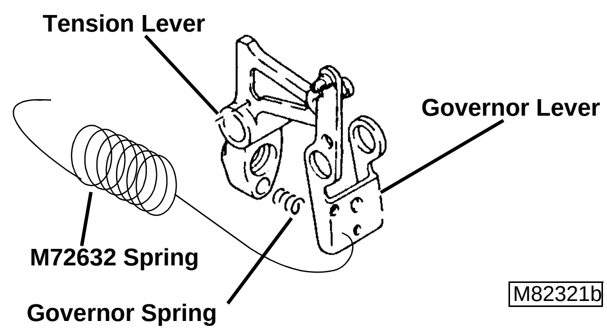


IMPORTANT: Fuel injection rack should have an alignment mark on it. If rack is NOT MARKED, fuel injection pump MUST BE sent to an Authorized Diesel Service (ADS) center to be calibrated and re-marked. Instruct ADS technician that there must be only one distinguishable alignment mark on rack.

Always replace shims between fuel injection pump and injection pump housing whenever pump has been removed. (See INJECTION PUMP TIMING ADJUSTMENT.

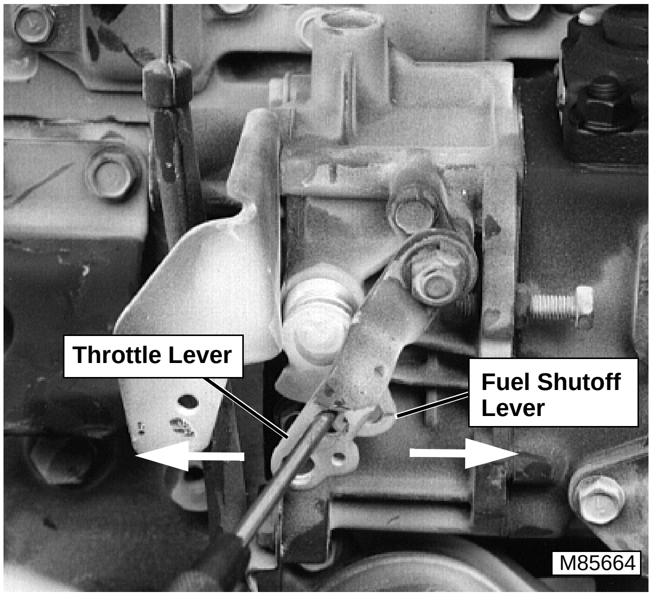
10. Find rack alignment mark before adjusting fuel control screw. Correct mark is approximately 9 mm (11/32-in.) from right edge of rack.



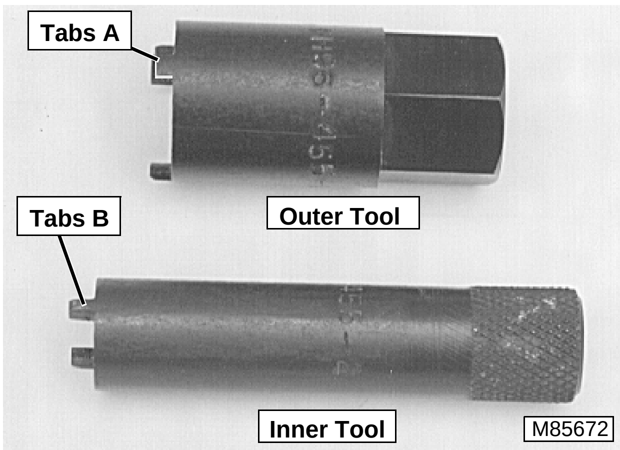


NOTE: Ends of spring may have to be bent to fit behind governor lever and to attach to fuel filter bracket.

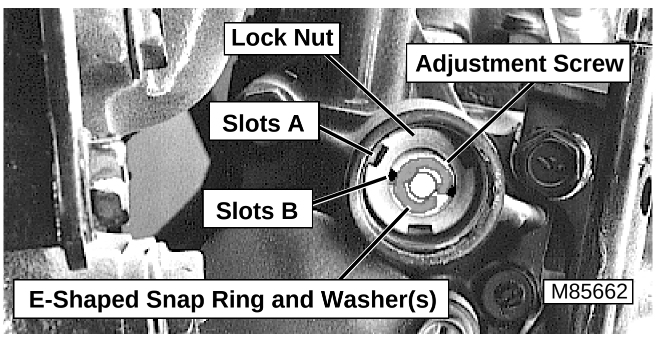
11. Install M72632 spring to compress governor spring between tension lever and governor lever.



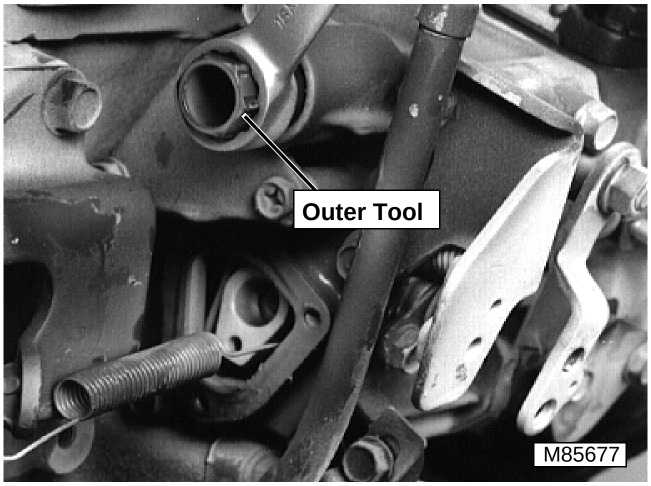
12. Use a helper at this point to make adjustment.
13. Use a punch or strong wire to hold fuel shutoff lever fully counterclockwise and throttle lever fully clockwise .



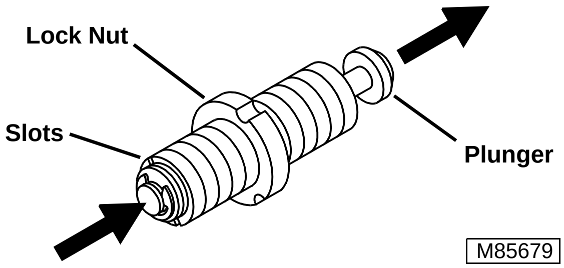
Screw Adjustment Tool—JDG1060



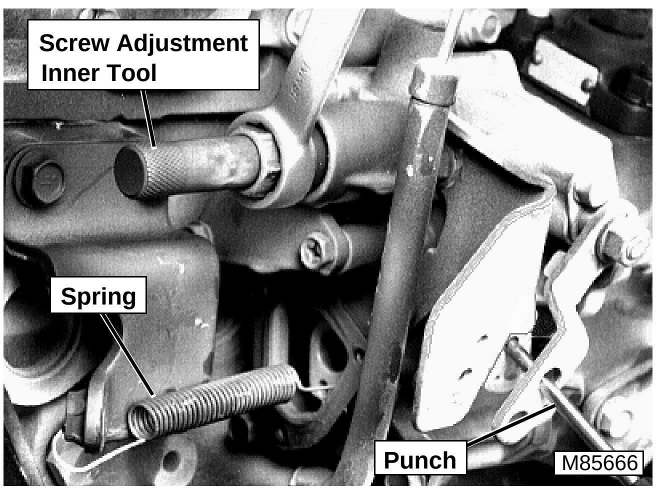
14. Use tabs (A) on outer tool in slots (A) of lock nut and tabs (B) on inner tool in slots (B) of adjustment screw. Check that E-shaped snap ring and washer(s) are not damaged and installed properly.



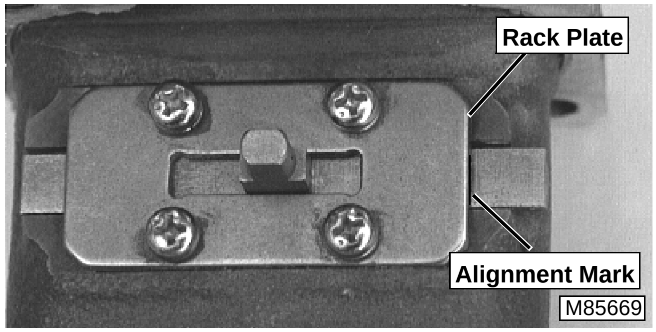
15. Insert outer tool in lock nut chamber and rotate slowly until tabs seat into slots on lock nut. Loosen lock nut which then allows adjustment of fuel control screw.



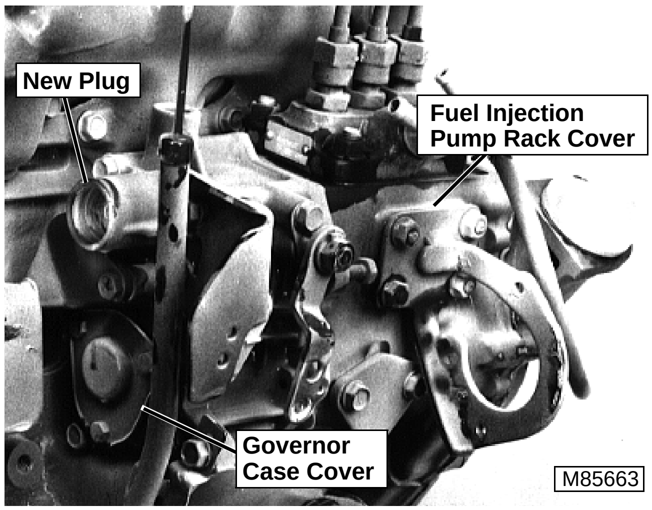
IMPORTANT: Fuel control screw plunger MUST BE fully forward any time adjustment is made. Inner tool has been designed to accomplish this when properly installed in slots of adjustment screw.



16. Properly install screw adjustment inner tool and rotate slowly until tabs seat into slots of adjustment screw.
17. Have helper hold outer tool and lock nut stationary and maintain tension on fuel shutoff lever and throttle lever with punch.



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



22. Install new fuel control screw plug.
23. Assemble parts in reverse order of removal.

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

FUEL CONTROL SCREW ADJUSTMENT—NON-CARB/EPA ENGINES

EARLY MODEL 455 TRACTORS ONLY—

*NOTE: For engines **WITHOUT** California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.*

IMPORTANT: Always replace shims between fuel injection pump and injection pump housing whenever pump has been removed. (See INJECTION PUMP TIMING ADJUSTMENT.

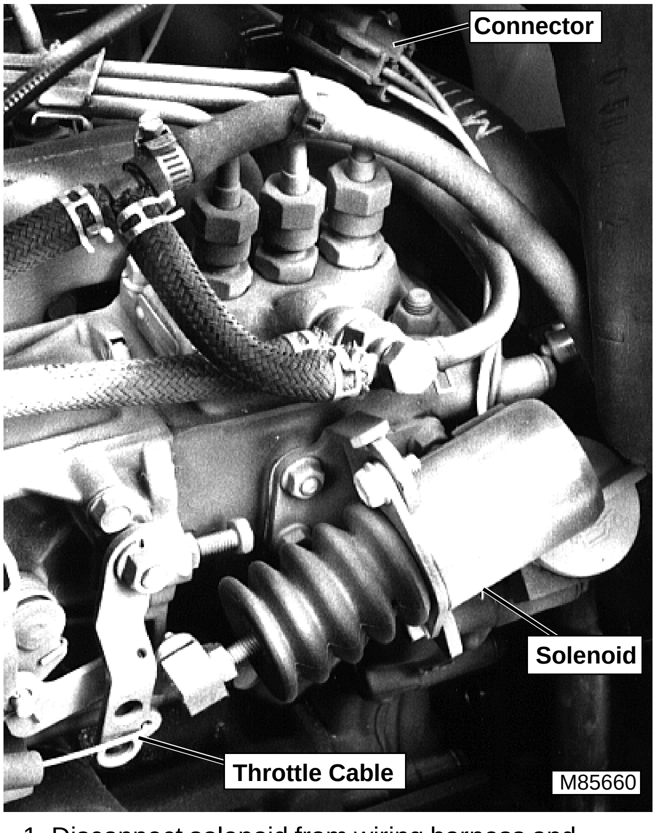
Reason:

To ensure engine performs at peak power with optimum torque rise recovery under load.

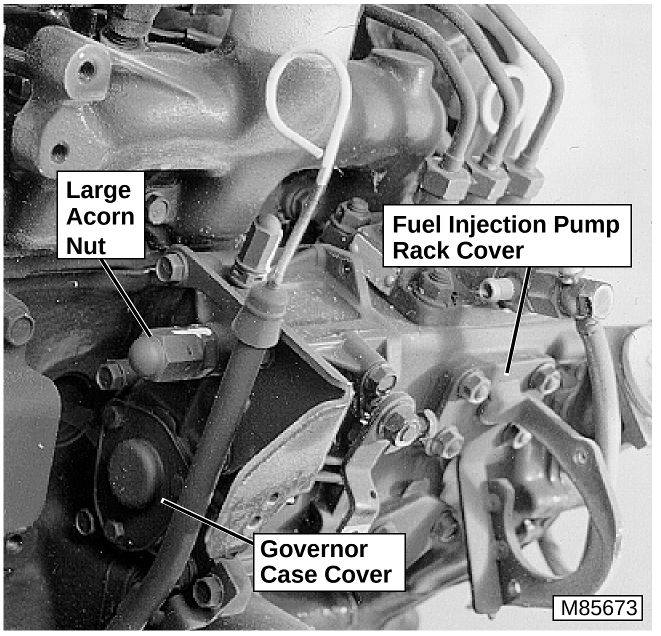
Equipment:

- Spring M72632

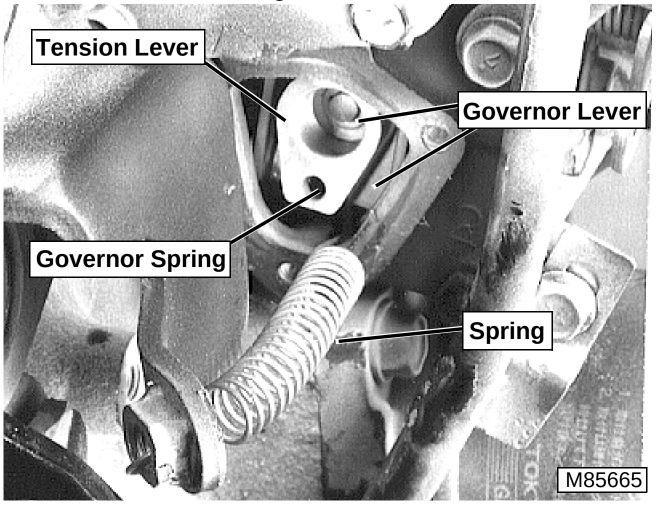
Procedure:

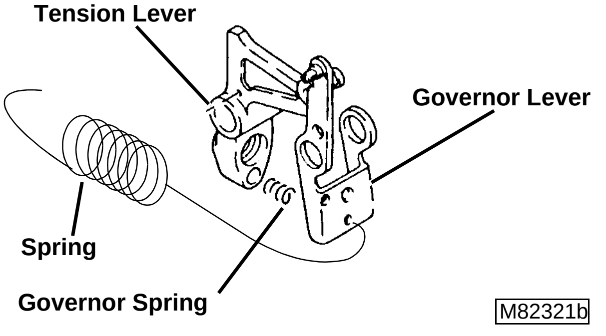


1. Disconnect solenoid from wiring harness and shutoff lever. Remove solenoid from bracket.
2. Disconnect throttle cable from throttle lever.
3. Remove fuel filter from bracket WITHOUT disconnecting fuel lines.
4. Remove air cleaner assembly and intake hose.



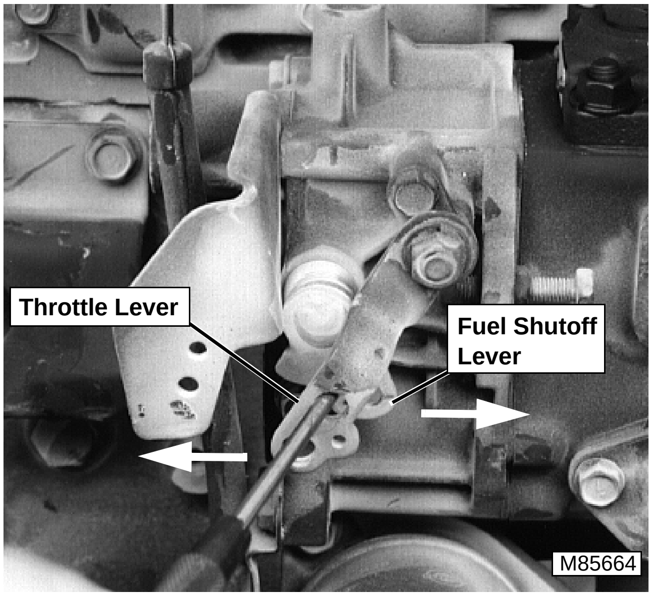
5. Remove governor case cover, fuel injection pump rack cover, and large acorn nut.



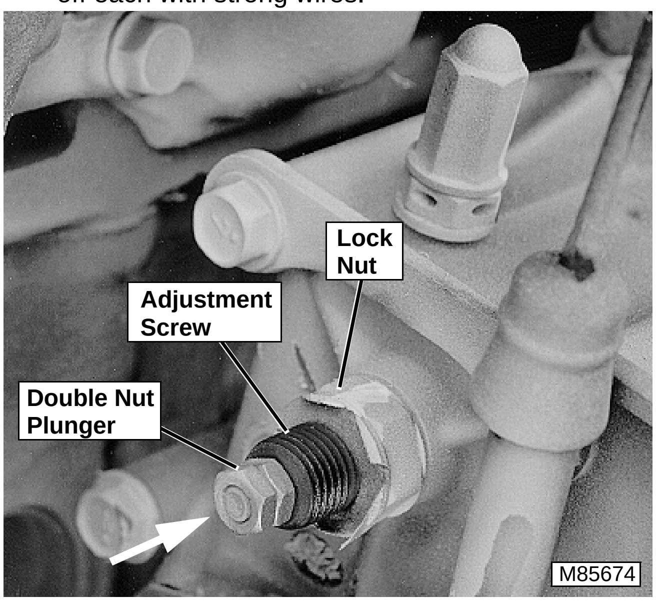


NOTE: Ends of spring may have to be bent to hold governor lever and to attach to fuel filter bracket.

6. Install M72632 spring to compress the governor spring between the tension lever and the governor lever.



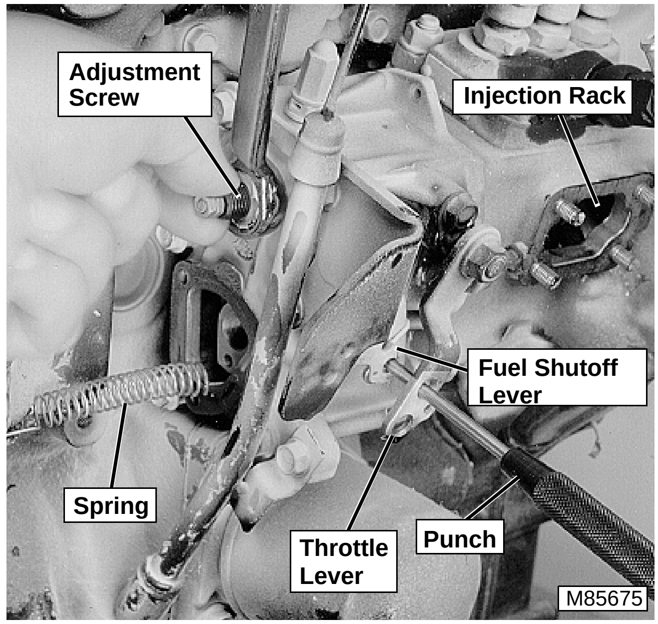
7. Hold fuel shutoff lever fully counterclockwise and at the same time hold throttle lever fully clockwise. Insert a punch to hold both levers in position or tie off each with strong wires.



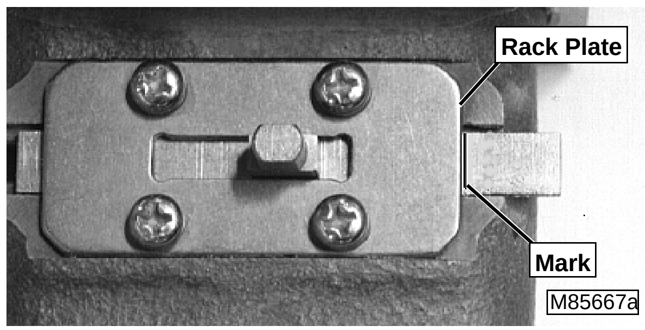
IMPORTANT: DO NOT tamper with double nuts or engine warranty will be voided. These are pre-set by engine manufacturer and must not be altered.

Press in fully on double nut plunger assembly any time adjustment is being made.

8. Loosen lock nut to allow movement of adjustment screw.



9. Use a helper at this point to perform adjustment.
10. Use a punch or strong wires to hold fuel shutoff lever fully counterclockwise and throttle lever fully clockwise.



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

11. Push in on double nut plunger assembly and at the same time turn adjustment screw to align mark. When mark is aligned with right edge of rack plate, tighten lock nut while keeping adjustment screw stationary.
12. Check that alignment mark has not moved. Re-adjust if necessary.
13. Remove spring and punch or wires.

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

14. Assemble parts in reverse order of removal.
15. Install new wire seal to acorn nuts and mark them with a new paint stripe.

FUEL TRANSFER PUMP FLOW TEST

Reason:

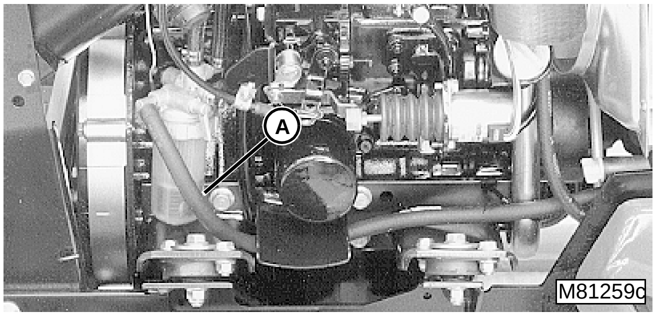
To determine proper fuel flow from transfer pump.

Equipment:

- Graduated Container

Connections:

1. Engage park brake. PTO switch off.

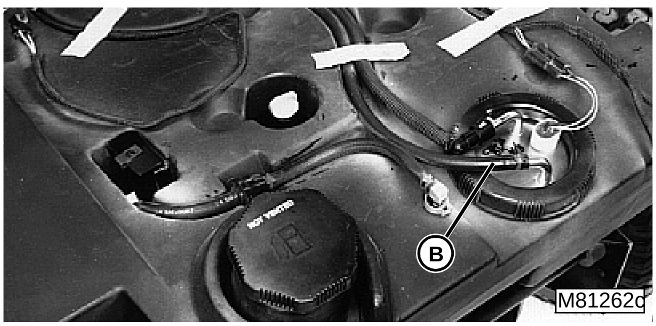


2. Disconnect fuel supply hose (A) from filter inlet and put end in a graduated container.

Procedure:

1. Turn key on for 15 seconds.
2. Compare collected fuel amount to specification.

Connections:



1. Reconnect supply hose to filter. Disconnect fuel return hose (B) from filter to injection pump and put end in a graduated container.

Procedure:

1. Turn key on for 15 seconds.
2. Compare collected fuel amount to specification.
3. Reconnect fuel shutoff solenoid connector.
4. Reconnect fuel lines.

Specifications (Factory Observed Flow):

Fuel Temperature for Test . . . 15—25°C (59—77°F)
Minimum Fuel Flow before Filter . . . 450 mL (15 oz)
Flow at Return Hose . . . . 200 mL (7 oz)

Results:

- If fuel flow at transfer pump is below minimum, check for pinched or deteriorated fuel lines between fuel tank and pump. Also check fuel tank vent for plugging or tank pickup screens for possible restriction. Replace lines and screen as necessary.
- If fuel flow is still below minimum, replace transfer pump.
- If output at return hose is low, replace filter element and repeat test. Check for pinched or restricted return hoses.

FUEL TRANSFER PUMP PRESSURE TEST

Reason:

To determine condition of transfer pump.

Equipment:

- JTO3115 Pressure Gauge (100 psi).
- Small piece of fuel line

Connections:

1. Engage park brake. PTO switch off.

2. Disconnect hose from transfer pump outlet (A). Connect pressure gauge to transfer pump outlet.

Procedure:

1. Turn key on. Observe pressure reading.
2. Reconnect fuel lines.

Specifications:

Fuel Temperature for Test . . . . 15—25°C (59—77°F)
Minimum Fuel Pressure. . . . . 172 kPa (25 psi)
Factory Observed Pressure . . . . . . 248kPa (36 psi)

Results:

- If pressure is below minimum, replace transfer pump.

FUEL DRAIN-BACK TEST

Reason:

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

Procedure:

1. Disconnect fuel supply line and return line at fuel tank.

IMPORTANT: Fuel return line MUST extend below fuel level in fuel tank before performing this test. Fill fuel tank if necessary.

2. Drain all fuel from the system, including fuel supply pump, injection pump, filter(s) and water separator, if equipped.
3. Plug end of fuel return hose.
4. Pressurize fuel system at fuel supply line to a maximum pressure of **103 kPa (15 psi)**.
5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results:

- Find leaks and repair or replace parts as necessary.

FUEL INJECTION NOZZLE TEST (PINTLE-TYPE)

CAUTION

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

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

Reason:

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

Equipment:

- D01109AA Diesel Fuel Injection Nozzle Tester
- D01110AA Adapter Set
- 36352 Fuel Line Assembly
- 23621 Straight Adapter
- 23622 Straight Adapter
- 23617 90° Adapter
- Container

Connections:

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

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

Procedure 1:

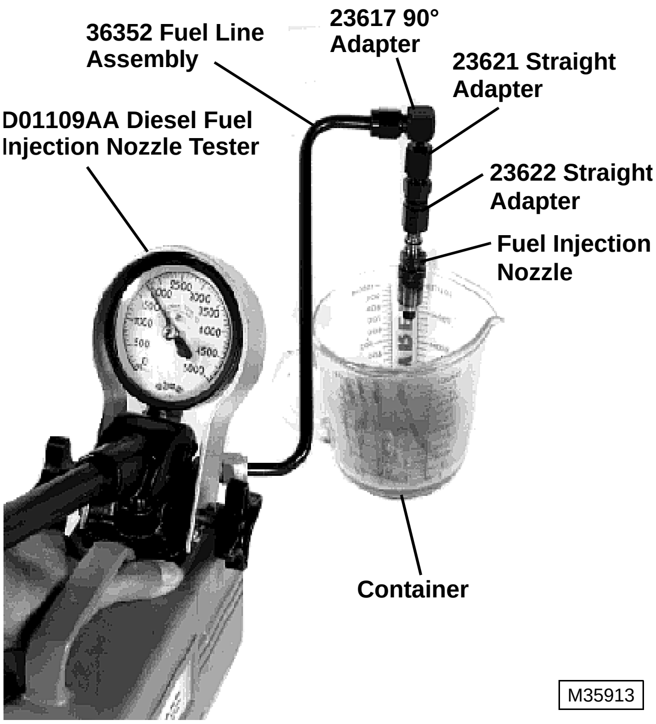
Test fuel injection nozzle **opening pressure** following the nozzle tester manufacturer's instructions.

Specifications:

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

Results:

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



Procedure 2:

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

1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to **11032 kPa (1600 psi)**.
3. Watch for leakage from nozzle spray orifice. Leakage time should be a minimum of **10 seconds**.

Results:

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

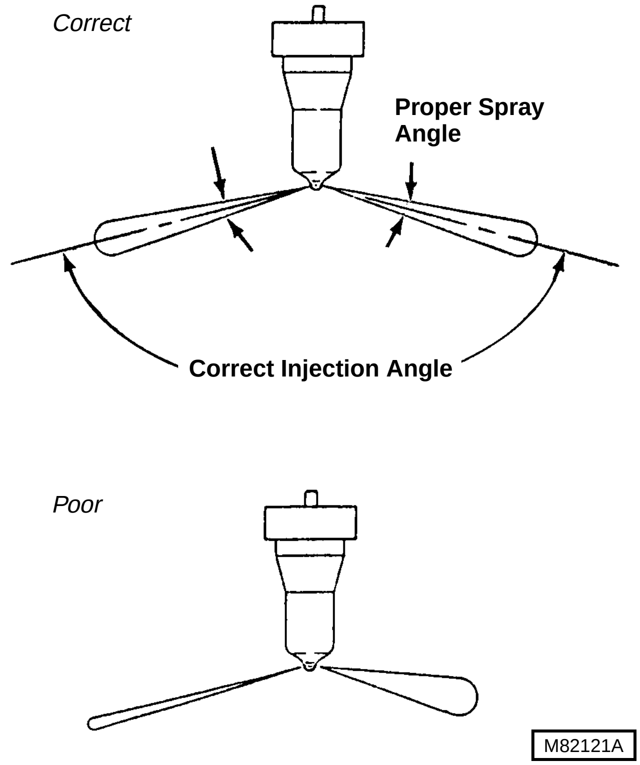
Procedure 3:

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

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

Specifications:

Slow Hand Lever Movement . . . . Chatter Sound
Slow Hand Lever Movement . . . . Fine Stream Spray Pattern
Fast Hand Lever Movement. . . . . Fine Atomized Spray Pattern



Results:

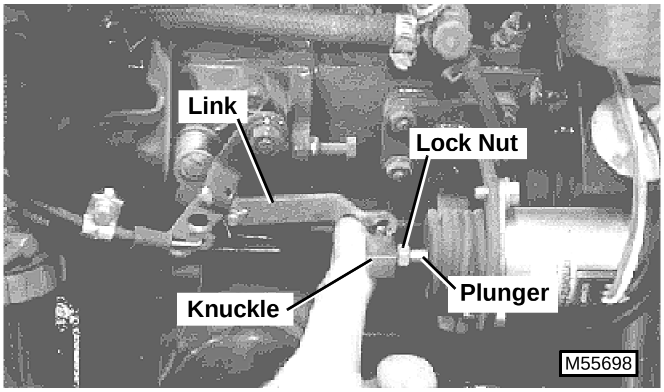
- If nozzle chatter or spray pattern do not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary.
- If there is excessive difference in spray angle or injection angle, incomplete atomization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

FUEL SHUTOFF SOLENOID ADJUSTMENT

Reason:

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

Procedure:



1. Loosen lock nut.
2. Disconnect link from solenoid.
3. Hold solenoid plunger bottomed in solenoid body.
4. Move link toward solenoid until it stops.
5. Turn plunger rod in or out of knuckle until knuckle and link holes line up. Turn out two additional turns. The additional turns insure that the solenoid bottoms out before the linkage.
6. Reassemble the knuckle to the shutoff linkage.

NOTE: Total turns of knuckle shuld NOT EXCEED 5 FULL turns from where hole and knuckle stud line up. Additional turns may limit FULL delivery.

7. If sloenoid still does not pull in, loosen lock nut and turn knuckle out one FULL turn at a time. After each full turn, check for solenoid to pull in when key is turned on.
8. Assemble and check for free movement when key switch is turned on. Also check that linkage returns completely to the stop position when key switch is turned off.

INJECTION PUMP TIMING ADJUSTMENT

ATTENTION!

Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board/Environmental Protection Agency (CARB/EPA) Certified engines.

IMPORTANT: On CARB/EPA certified engines, adjust fuel controller ONLY when governor assembly or individual components are replaced, and/or fuel injection pump is serviced by Authorized Diesel Service (ADS) center or control rack alignment mark has been recalibrated.

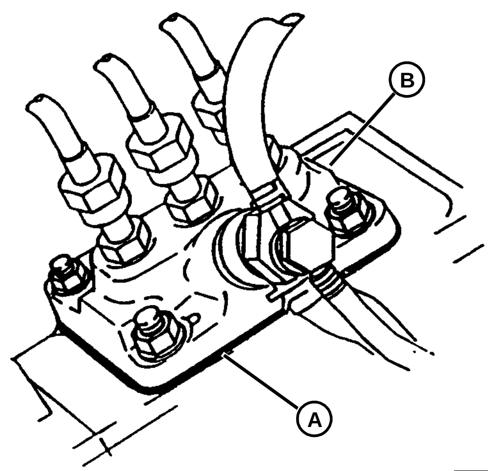
Reason:

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

Procedure:

IMPORTANT: In most instances the timing should not have to be checked. A general rule of thumb is that if the engine performed well at one time, and then performance changed, timing is not the problem. Timing once set by shims, will not change during the life of the engine.

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



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1. Remove fuel injection pump cover (B).
2. Install shim (A).
3. Install fuel injection pump cover (B).

Specifications:

Shim . . . . 0.5 mm (0.02 in.)
Mounting Nut Torque . . . . .20 N•m (180 lb-in.)

Shim Thickness	**Injection Timing**
1.1 mm	**11° & 12° BTDC**
0.9 mm	**13° BTDC**
0.8 mm	**14° & 15° BTDC**
0.7 mm	**16° BTDC**
0.6 mm	**18° BTDC**
0.5 mm	**20° BTDC**

RADIATOR BUBBLE TEST

Reason:

To determine if compression pressure is leaking from cylinder.

Equipment:

- JDG472 Adapter

Procedure:

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

   If bubbles are present, isolate source of compression leak:

- Remove injection nozzles.
- Install JDG472 Adapter in injection port of cylinder to be tested.
- Move piston to bottom of stroke with intake and exhaust valves closed.
- Connect hose from compressed air source to adapter.
- Apply air pressure of **2448 kPa (355 psi) maximum** into cylinder:
- Check for bubbles in recovery tank or air escaping from muffler, air cleaner or oil fill opening.
- Repeat for each cylinder.

Results:

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

RADIATOR CAP PRESSURE TEST

Reason:

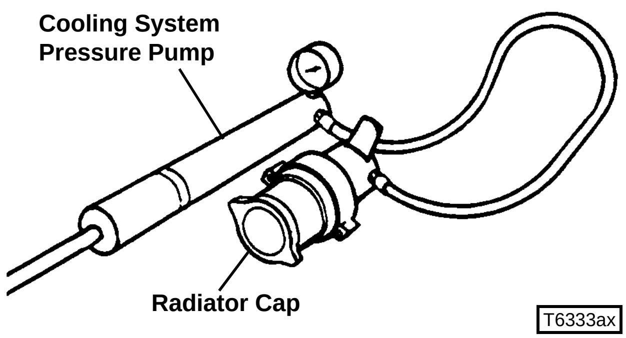
Test radiator cap for operating in correct pressure range.

Equipment:

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

Procedure:

1. Install radiator cap on pressure pump.
2. Apply pressure. Pressure valve in cap should open according to specifications.



Specifications:

Radiator Cap Pressure
Valve Opening Pressure . . 83—97 kPa (12—14 psi)
Minimum pressure . . . . 76 kPa (11 psi)

Results:

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

THERMOSTAT OPENING TEST

Reason:

To determine opening temperature of thermostat.

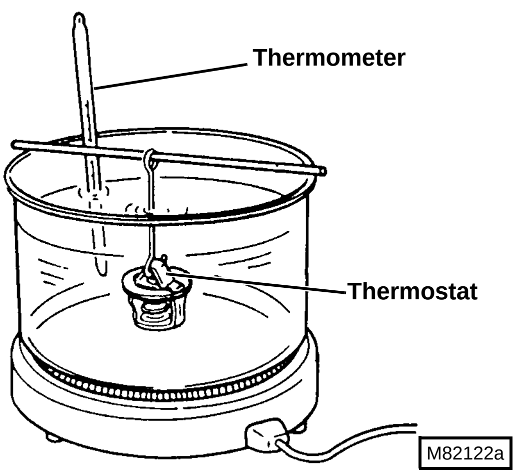
Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

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

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



Specifications:

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

Results:

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

COMPRESSION TEST

Reason:

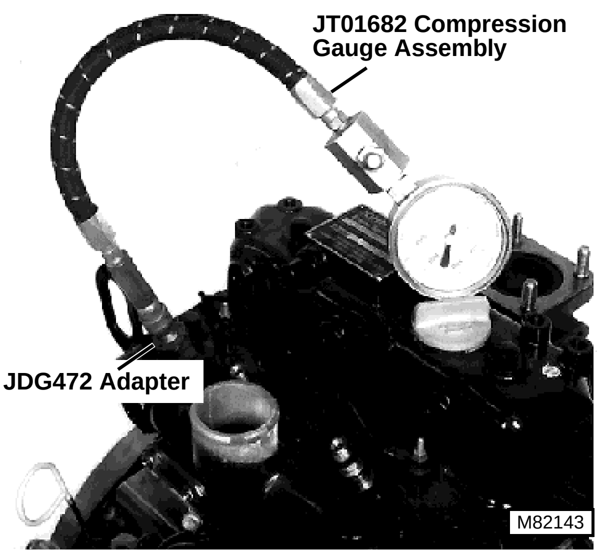
To determine the condition of the pistons, rings, cylinder walls and valves.

Equipment:

- JT01682 Compression Gauge Assembly
- JDG472 Adapter

Procedure:

1. Run engine for 5 minutes to bring to operating temperature. Shut off engine.
2. Remove injection nozzles. (See FUEL INJECTION NOZZLES.
3. Install JDG472 Adapter and JT01682 Compression Gauge Assembly in injector port.
4. Disconnect fuel shutoff solenoid connector.
5. Crank engine for 3 seconds with starter.
6. Record pressure reading for each cylinder.



Specifications:

Compression Pressure . . . . 2448 kPa (355 psi)
Maximum Difference Between Cylinders. . . . . 490 kPa (71 psi)
Minimum Cranking Speed . . . . 250 rpm

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

Results:

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

VALVE CLEARANCE CHECK AND ADJUSTMENT

Reason:

To achieve correct engine operation.

Equipment:

- Feeler Gauge

Procedure:

NOTE: *Location of the index mark will be different as a result of the various engine applications.*

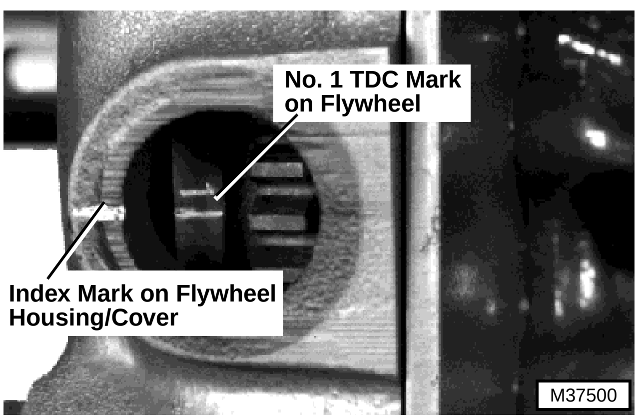
The index mark appears on the following:

- *415: Flywheel cover.*
- *455: Flywheel guard and plate.*

1. Remove rocker arm cover.
2. Remove plug from timing hole in flywheel housing/ cover, if equipped.

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

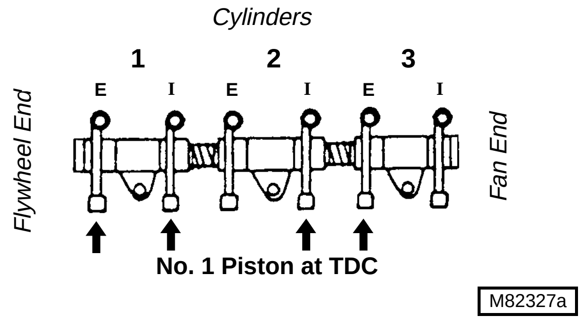
3. Turn crankshaft pulley clockwise until No.1 cylinder TDC mark on flywheel aligns with index mark on flywheel housing/cover or plate.



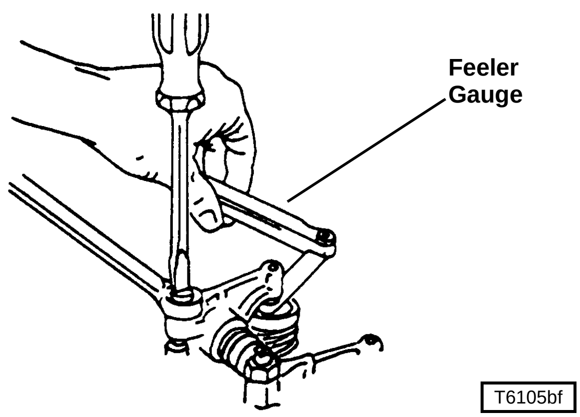
NOTE: *No. 1 cylinder is the closest to the flywheel.*

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

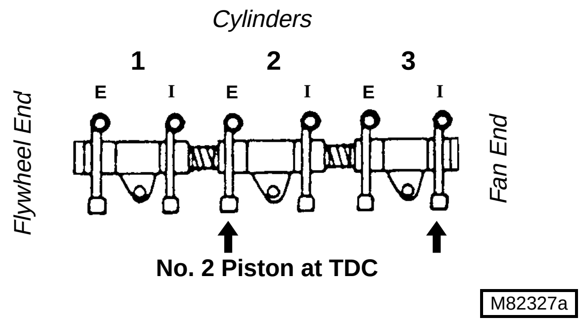
   If rocker arm push rods are not loose, rotate flywheel one revolution (360°). If both rocker arm push rods are loose, the piston is at TDC on compression stroke.
5. Measure and adjust valve clearance on the valves (arrows) with No. 1 piston at TDC.



To adjust valves, loosen nut and turn adjusting screw until clearance is **0.20 mm (0.008 in.)**. Hold screw while tightening nut.



6. Turn crankshaft pulley one revolution (360°). This puts the piston in No. 2 cylinder at TDC compression stroke.
7. Measure and adjust valve clearance on the valves (arrows) with No. 2 piston at TDC.



VALVE LIFT CHECK

Reason:

Can indicate excessive wear on cam lobes, followers, and/or push rods.

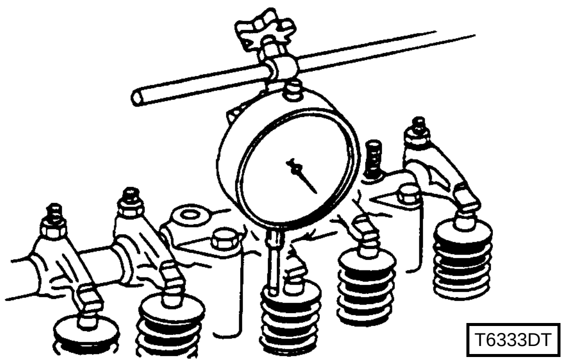
Equipment:

- Dial Indicator

Procedure:

1. Adjust valve clearance. (See VALVE CLEARANCE CHECK AND ADJUSTMENT.
2. Remove rocker arm cover. (See CYLINDER HEAD AND VALVES.
3. Fasten dial indicator to engine and position indicator tip on valve retainer. Valve must be fully closed and rocker arm must move freely.
4. Zero the dial indicator.
5. Manually turn crankshaft pulley clockwise (from fan end).
6. Observe dial indicator as valve is moved to the full open position. Valve lift (intake and exhaust) should be **7.5 mm (0.300 in.)**.

Repeat for each valve.



Results:

- If valve lift is less than specification, remove and inspect camshaft, cam followers and push rods. (See procedures in this section.)

COOLANT TEMPERATURE SENSOR TEST

Reason:

To determine operating temperature of sensor.

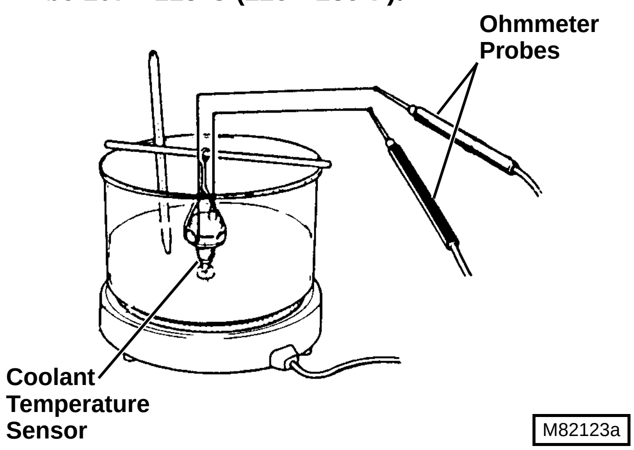
Equipment:

- Thermometer
- Glass Container
- Heating Unit
- Ohmmeter

Procedure:

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

1. Connect lead wires from ohmmeter probes to sensor terminal and body.
2. Suspend sensor and a thermometer in a container of water.
3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be **107—113°C (225—235°F)**.



Results:

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

COOLING SYSTEM PRESSURE TEST

Reason:

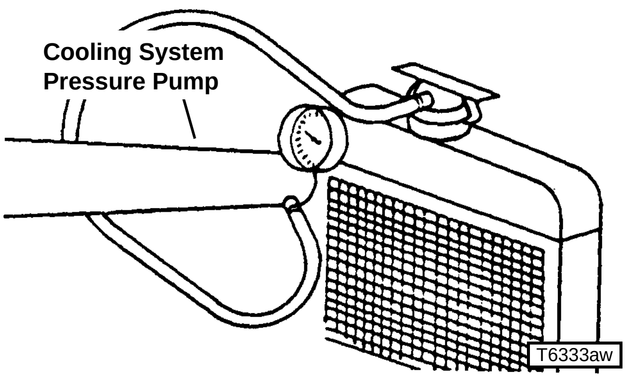
Inspect cooling system for leaks.

Equipment:

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

Procedure:

1. Remove cap and attach pressure pump to radiator.
2. Apply pressure according to specifications.
3. Check for leaks throughout cooling system.



Specifications:

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

Results:

- Pressure should hold to specifications. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If 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 RADIATOR BUBBLE TEST.)

FAN/ALTERNATOR DRIVE BELT ADJUSTMENT

Reason:

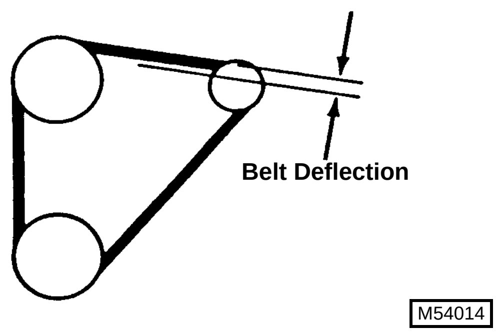
To keep proper tension on belt to drive water pump and alternator. To prevent shortened belt and bearing life.

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straightedge

Procedure:

1. Check belt tension between fan and alternator using JDG529 or JDST28 Belt Tension Gauge and a straightedge.



Specifications:

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

Results:

If deflection is not within specifications:

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

ENGINE OIL PRESSURE TEST

Reason:

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

Equipment:

- JT03017 Hose Assembly
- JT05577 Pressure Gauge 690 kPa (100 psi)
- JT03349 Connector
- JT03338 90° Elbow Connector
- JT05487 Connector

Procedure:

1. Remove oil pressure sender.
2. Install connector.
3. Connect hose assembly and pressure gauge.

IMPORTANT: Do not run engine if no pressure is present.

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

Specifications:

Engine Oil Pressure . . . . 294—440 kPa (43—64 psi)

Results:

- If oil pressure is not within specifications, inspect oil pressure regulating valve parts for wear or damage.
- If oil pressure does not increase, check for a worn or damaged oil pump. Also check for excessive wear of connecting rod and main bearing journals.

CAMSHAFT END PLAY CHECK

Reason:

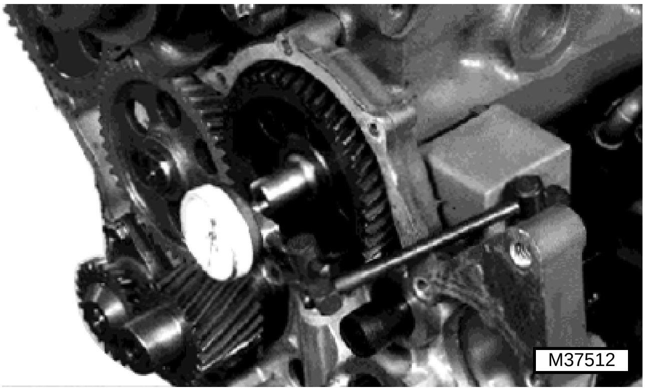
To determine proper side clearance between camshaft gear end journal and thrust plate.

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover. (See TIMING GEAR COVER.)



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

Specifications:

Standard Clearance . . . . 0.05—0.20 mm (0.0020—0.0079 in.)
Wear Limit . . . . 0.40 mm (0.016 in.)

Results:

- If end play exceeds wear limit, remove camshaft and replace thrust plate. (See TIMING GEAR COVER.)

TIMING GEAR BACKLASH CHECK—LATE MODELS

Reason:

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

Equipment:

- Dial Indicator

Procedure:

1. Measure backlash between meshing gears.

Specifications:

Standard Backlash

Crankshaft Gear-to-Oil Pump Gear . . . . 0.11—0.19 mm (0.0043—0.0075 in.)

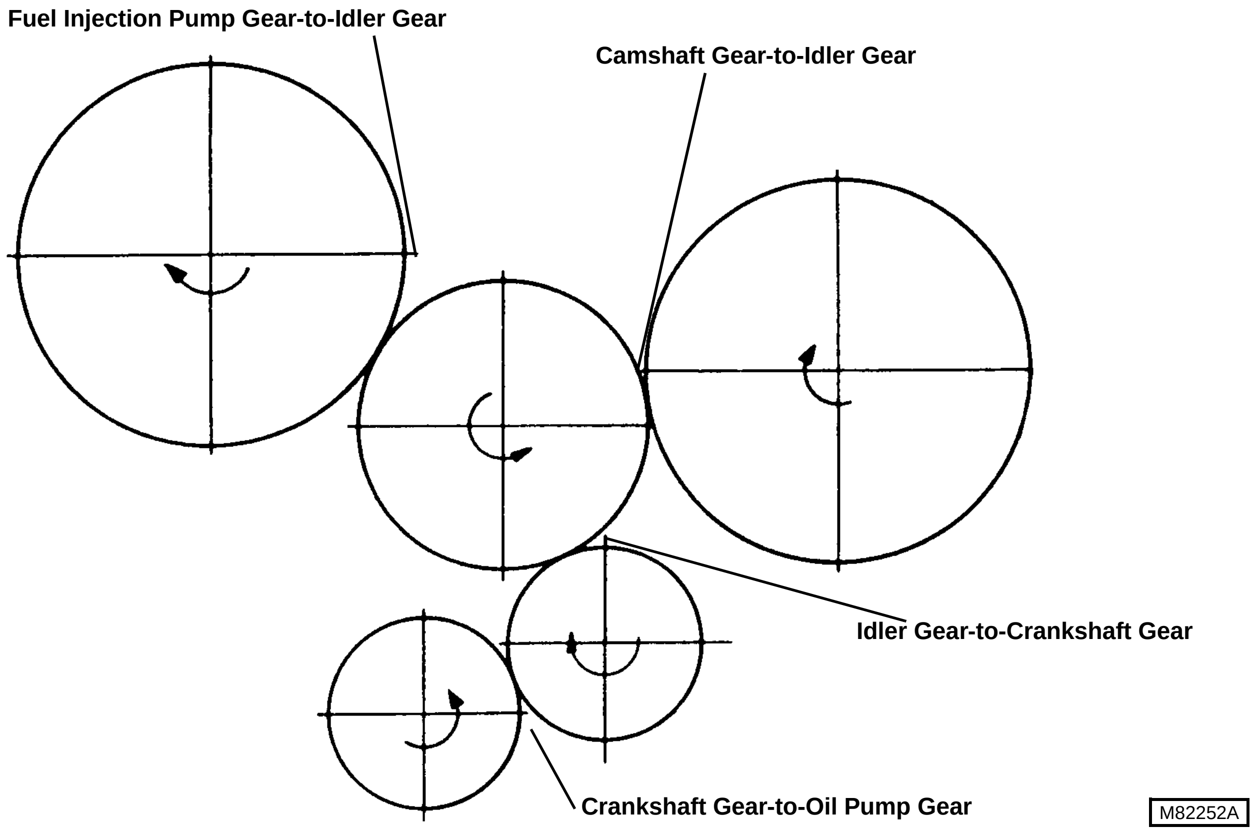
All Except Crankshaft Gear-to-Oil Pump Gear . . . . 0.04—0.12 mm (0.0016—0.0047 in.)

Wear Limit . . . . 0.20 mm (0.0079 in.)

Results:

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

  Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear AND/OR Idler Gear, Fuel Injection Pump Gear.



CONNECTING ROD SIDE PLAY CHECK

Reason:

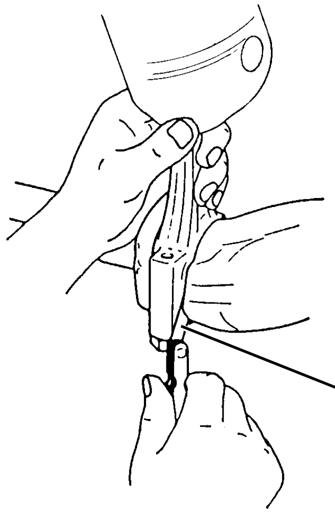
To determine proper side clearance between crankshaft and connecting rod.

Equipment:

- Feeler Gauge

Procedure:

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



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Specifications:

Standard Clearance . . . . 0.20—0.40 mm (0.0079—0.0157 in.)
Wear Limit. . . . . 0.55 mm (0.0217 in.)

Results:

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

CONNECTING ROD BEARING CLEARANCE CHECK

Reason:

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

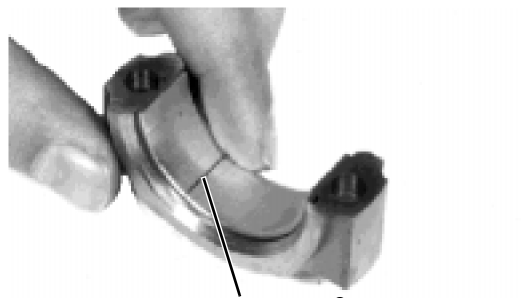
Equipment:

- PLASTIGAGE®

Procedure:

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

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.
3. Put a piece of PLASTIGAGE®, or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.



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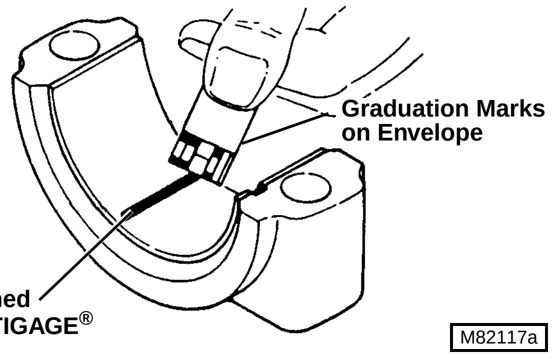
4. Turn crankshaft approximately 30° from bottom dead center.
5. Install connecting rod end cap and original cap screws. Tighten cap screws to **23 N•m (203 lb-in.)**.
6. Remove cap screws and connecting rod cap.

PLASTIGAGE is registered trademark of DANA Corporation

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



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

Specifications:

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

Results:

- If clearance exceeds wear limit, replace bearing inserts.

CRANKSHAFT END PLAY CHECK

Reason:

To determine proper side clearance between crankshaft and engine block.

Equipment:

- Dial Indicator

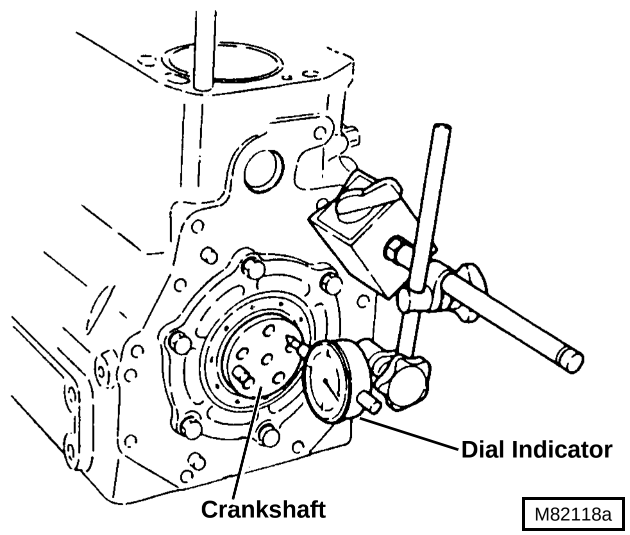
Procedure:

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

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

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

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



Specifications:

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

Results:

- If end play exceeds wear limit, replace thrust bearings.

CRANKSHAFT MAIN BEARING CLEARANCE CHECK

Reason:

To measure oil clearance between main bearing and crankshaft journal.

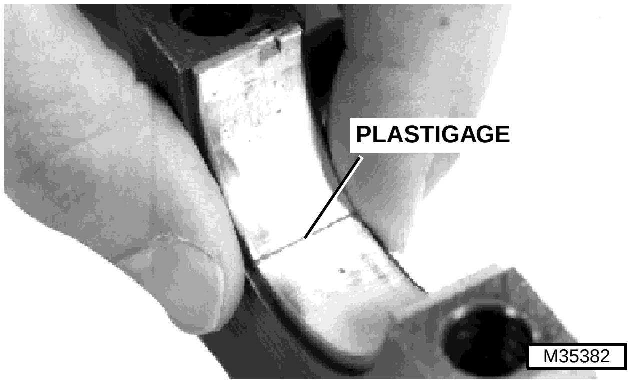
Equipment:

- PLASTIGAGE

Procedure:

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

1. Remove main bearing cap.
2. Wipe oil from bearing insert and crankshaft journal.
3. Put a piece of PLASTIGAGE, or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.



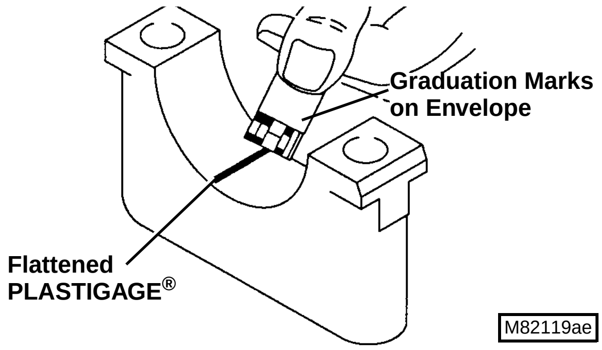
4. Install main bearing cap and cap screws. Tighten cap screws to:

3TN66 . . . . 54 N•m (40 lb-ft)
3TNA72 (3009) . . . . 79 N•m (58 lb-ft)

5. Remove cap screws and main bearing cap.

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

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



Specifications:

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

Results:

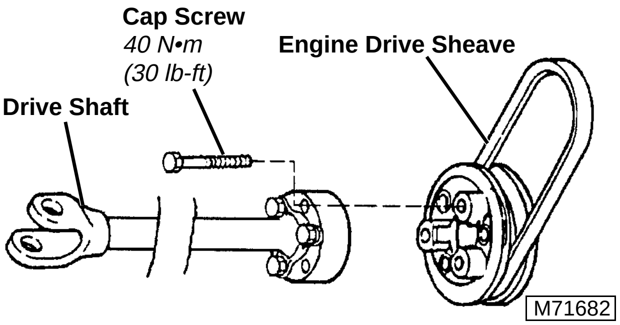
- If clearance exceeds wear limit, replace bearing inserts.

REPAIR

DIESEL ENGINE—REMOVAL/ INSTALLATION

NOTE: See Miscellaneous section for removal of common components.

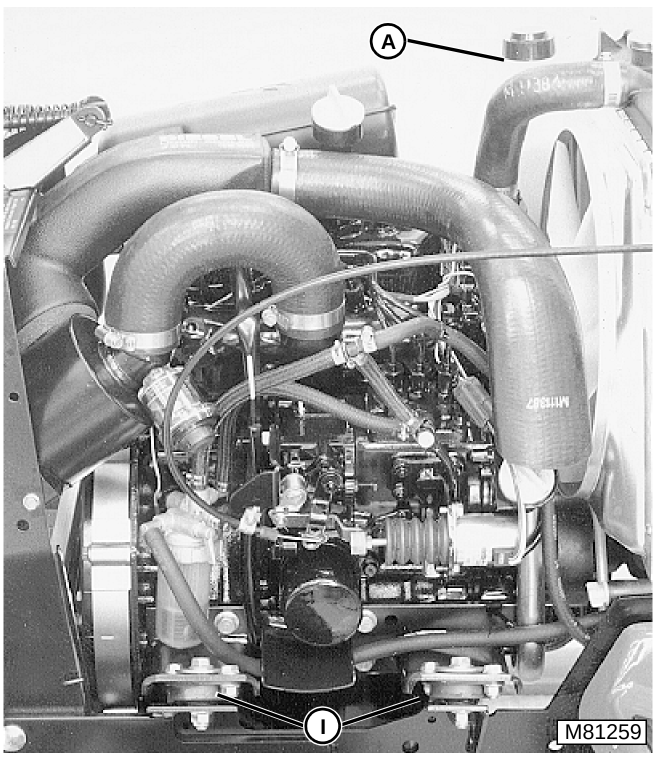
1. Disconnect battery negative (–) cable.



2. Disconnect drive shaft.
3. Remove air cleaner assembly.
4. Remove front grille panel.
5. Remove upper carriage bolt and nut.
6. Loosen lower nut and tilt front support away from engine.
7. Remove muffler. (See procedure in Miscellaneous section.)

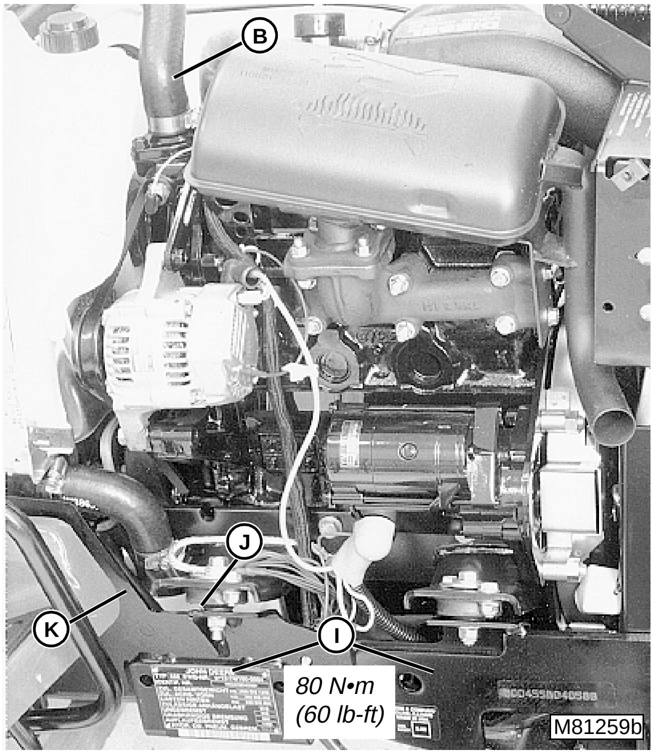
NOTE: Cooling system capacity is approximately 2.8 L (3.0 qt).

8. Drain coolant.



Left Side View

9. Remove upper and lower radiator hoses (B and K).
10. Remove overflow tank (A). Remove fan shroud and lay over engine.
11. Disconnect all hoses, wiring connectors and cables.



Right Side View

NOTE: To aid in engine removal, turn engine lift bracket around so loop points up. After engine has been installed, reinstall lift bracket in original position.

12. Remove four mounting cap screws, washers and nuts (I). Remove engine.
13. Make repairs to engine as necessary.
14. Install ground cable and wiring leads (J) between head of rear engine mounting bolt and washer (preferred) or under nut.

IMPORTANT: Ground cable and wiring leads MUST NOT be stretched tight after tightening engine mounting nut to prevent failure from engine vibration. BE SURE cable and wires are loose.

15. Install ground cable and leads (J) under rear engine mounting nut. Tighten engine mounting hardware to **80 N•m (60 lb-ft)** and drive shaft coupler hardware to **40 N•m (30 lb-ft)**.
16. Close drain valve and fill radiator with proper coolant to top of filler neck.
17. Start engine and allow it to reach proper operating temperature. Check radiator, hoses and connections for leaks. Adjust coolant level in recovery tank.

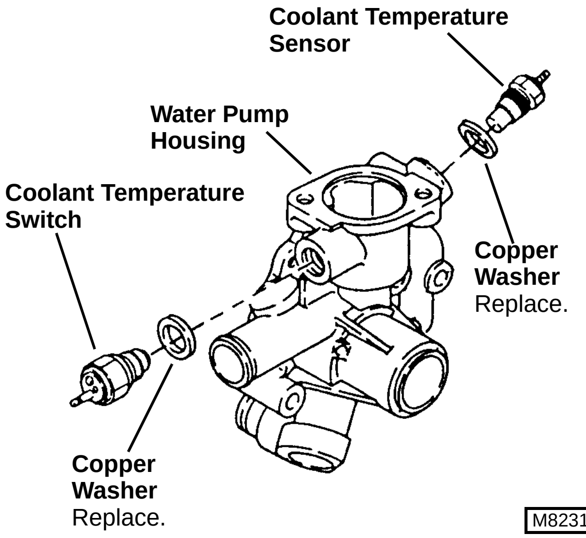
COOLANT TEMPERATURE SENSOR

Replacement

NOTE: Some engines may also be equipped with a coolant temperature switch. Switch is located opposite of sensor in water pump housing. Replacement procedures are the same.

1. Disconnect wiring lead, if equipped.
2. Open engine drain valve to drain coolant.
3. Remove sensor and washer.
4. Test sensor. (See COOLANT TEMPERATURE SENSOR TEST.)

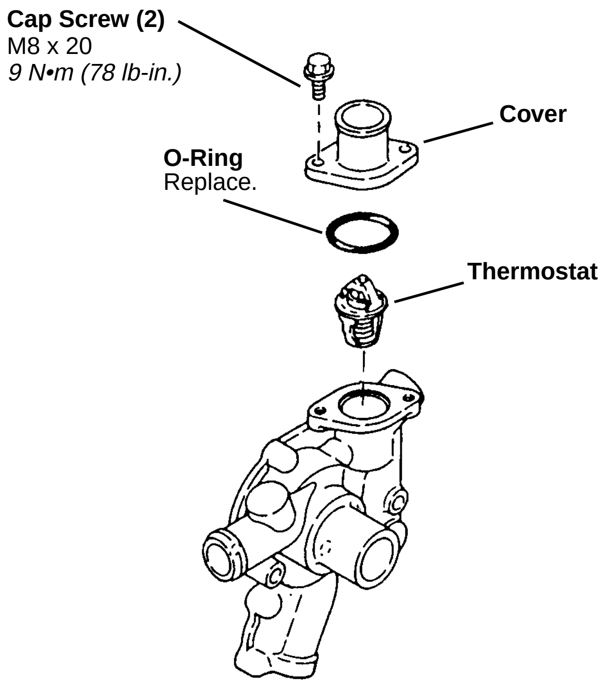
Installation is done in reverse order of removal.



M82313A

THERMOSTAT

1. Replace gaskets.
2. Test thermostat. (See THERMOSTAT OPENING TEST.)



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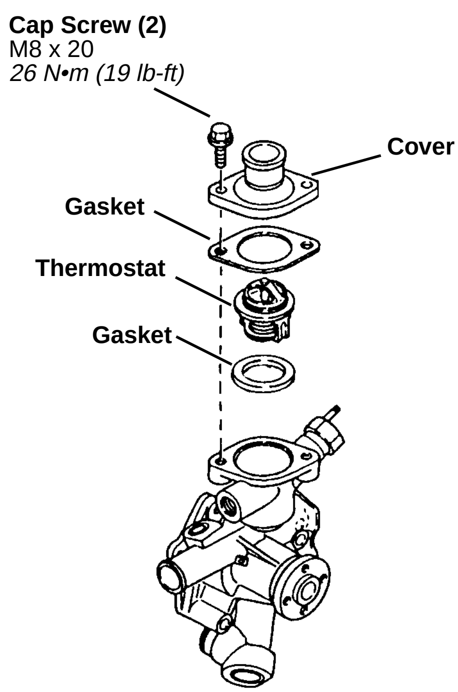

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FUEL INJECTION PUMP

Removal

CAUTION

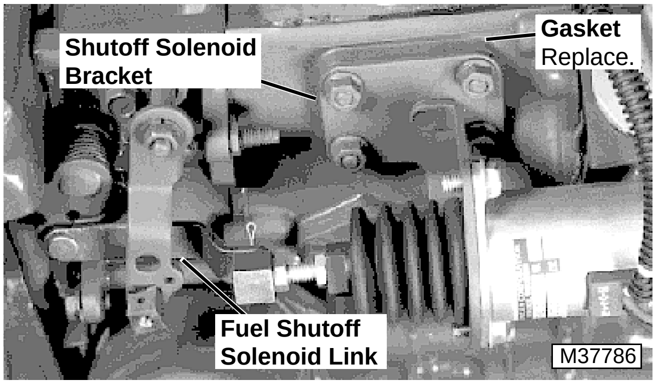
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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

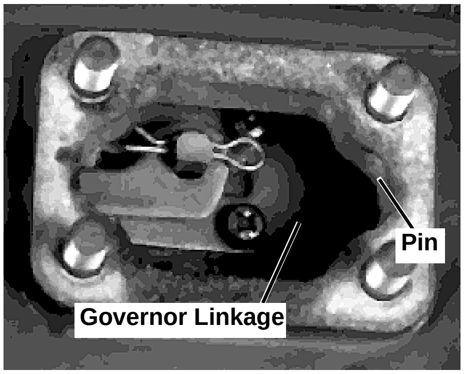
IMPORTANT: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

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

2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.
3. Loosen line clamp and remove fuel injection lines.

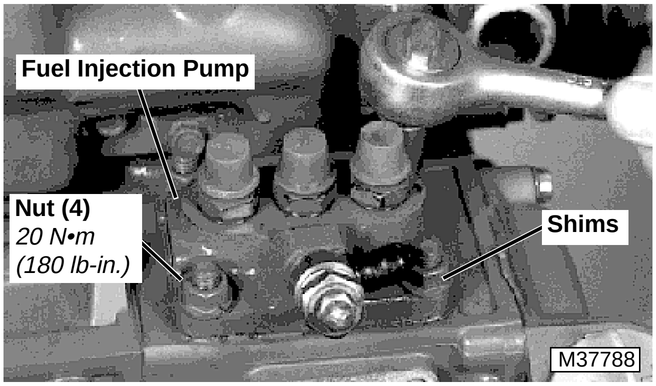


4. Disconnect hose from fuel filter or supply pump if equipped.
5. Disconnect leak-off hoses to/from injection pump.
6. Disconnect fuel shutoff solenoid link.
7. Remove four nuts, shutoff solenoid bracket and gasket.



M37787

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



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

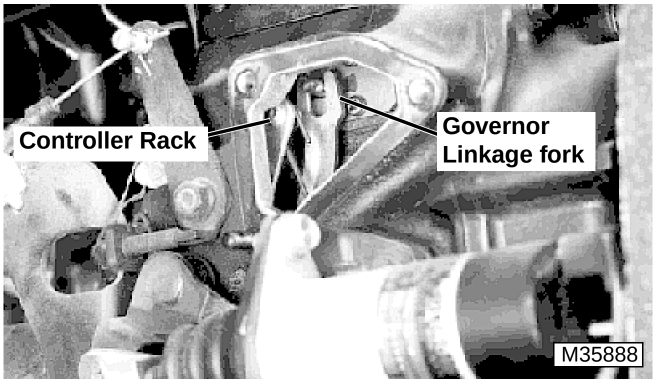
9. Remove four nuts to remove fuel injection pump and shims.

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

Installation

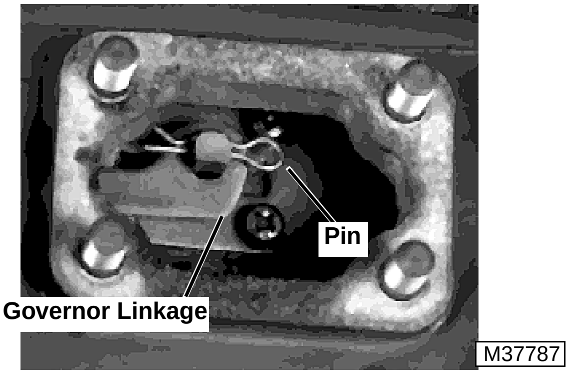
Installation is done in the reverse order of removal.

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



Early

1. Early: When installing fuel injection pump into housing, align controller rack with governor linkage fork.

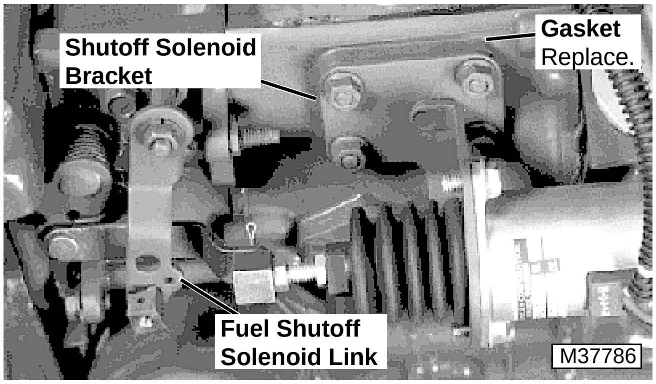


Late

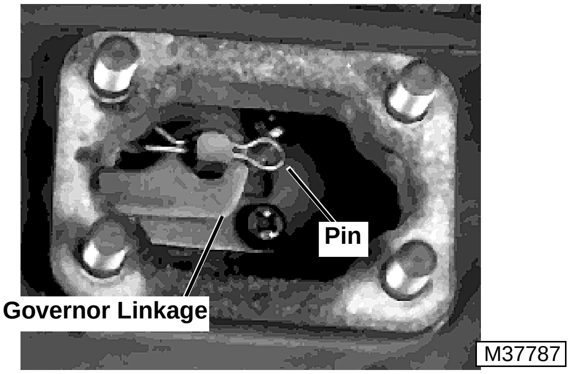
2. Late: When installing fuel injection pump into housing, align controller rack with governor linkage and insert pin.
3. Late: When connecting governor linkage to injection pump rack, attach link to rack at hole closest to injection pump gear.
4. Bleed the fuel system.
5. If new injection pump is being installed, check and adjust injection pump timing.

FUEL CONTROL AND GOVERNOR LINKAGE

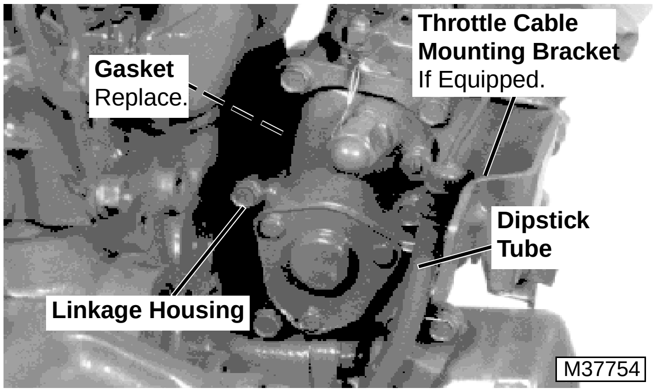
Removal



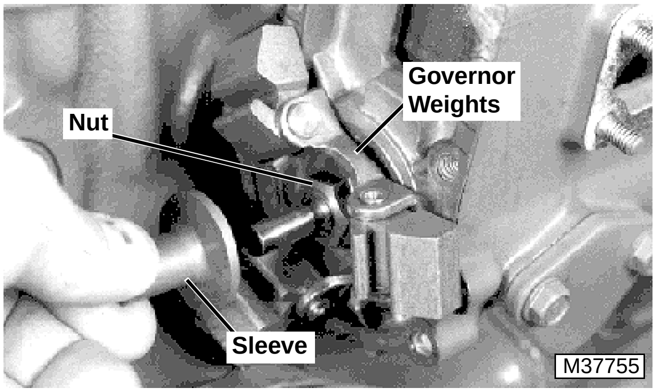
1. Disconnect fuel shutoff solenoid link.
2. Remove four nuts, shutoff solenoid bracket and gasket.



3. Remove pin and washer, if equipped, to disconnect governor linkage.



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



M37755

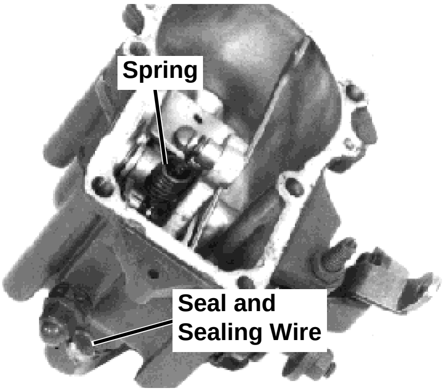
7. Remove sleeve.
8. Remove nut and governor weights.
9. Disassemble and inspect all parts for wear or damage. (See disassembly and inspection procedures.)

Installation

Installation is done in the reverse order of removal.

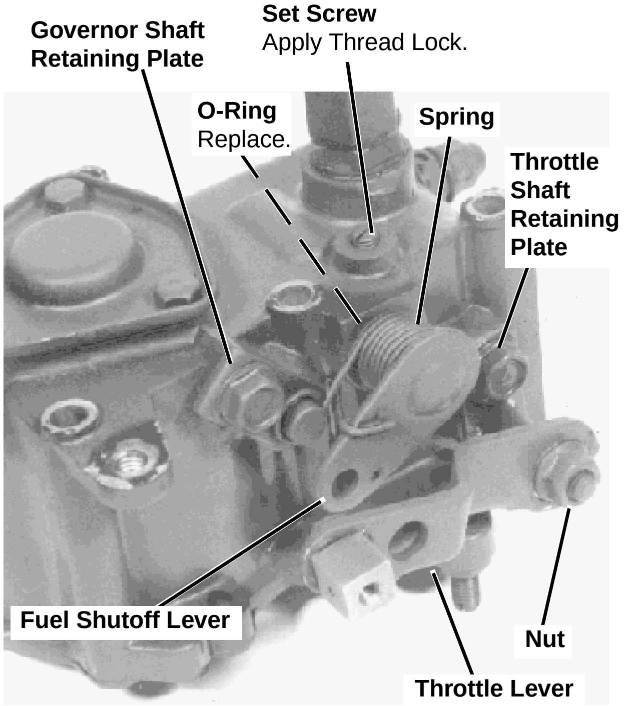
- Governor linkage may have two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.
- Adjust fuel shutoff solenoid. (See TESTS AND ADJUSTMENTS.
- Check and adjust slow and fast idle settings.

Disassembly



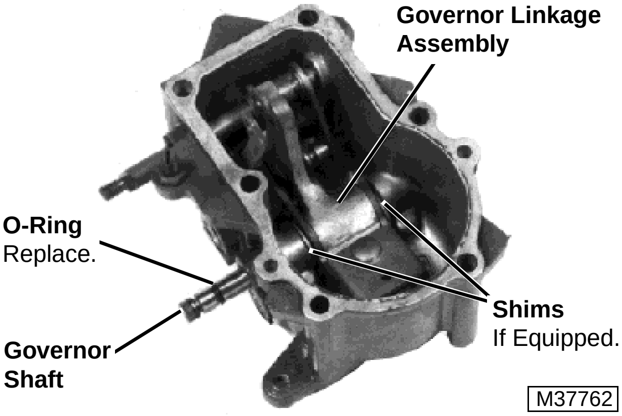
M37759

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



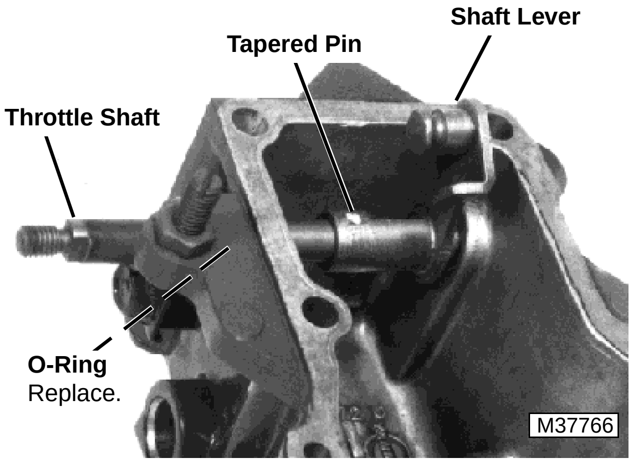
M37760

3. Remove nut, washer, if equipped, and thottle lever.
4. Remove cap screw and throttle shaft retaining plate.
5. Remove cap screw and governor shaft retaining plate.
6. Remove set screw, fuel shutoff lever, spring and O-ring.

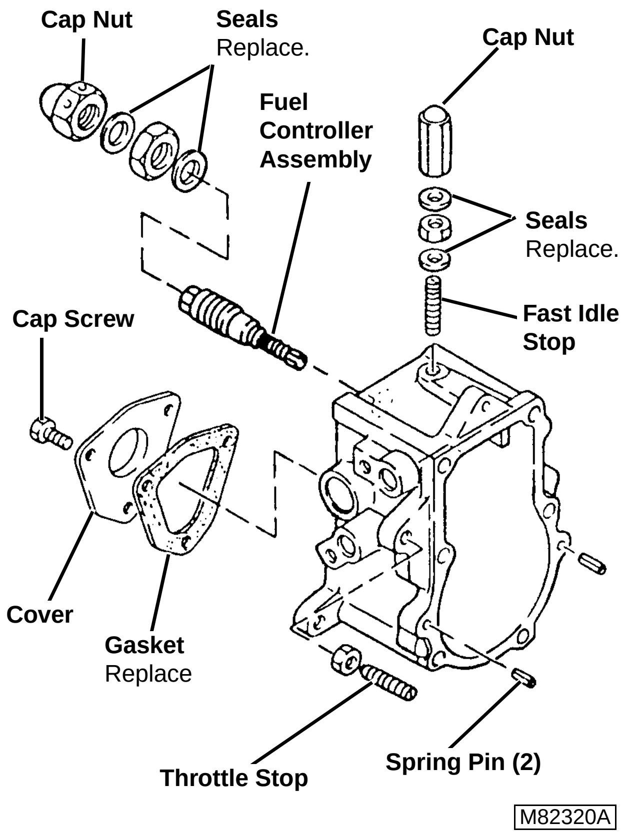


M37762

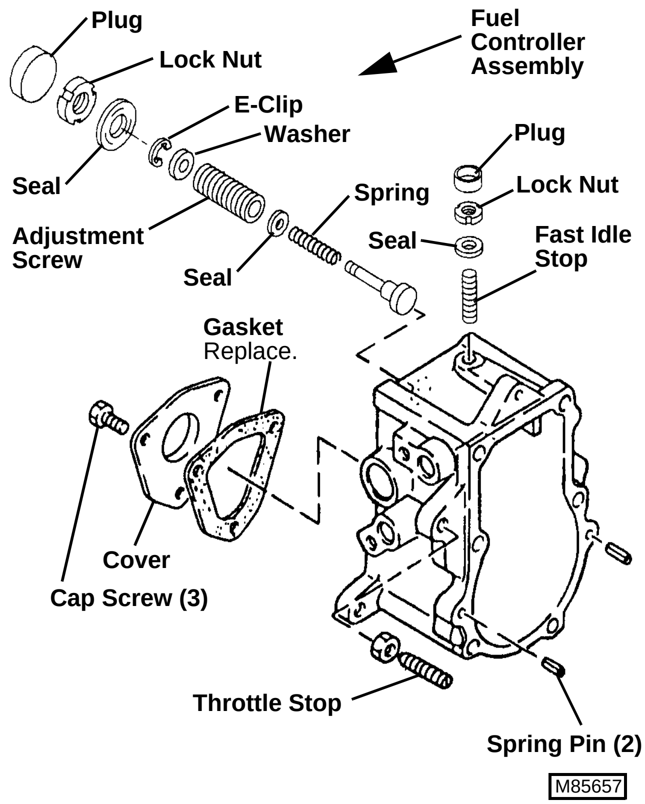
7. Remove governor shaft, governor linkage assembly, shims and O-ring.



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

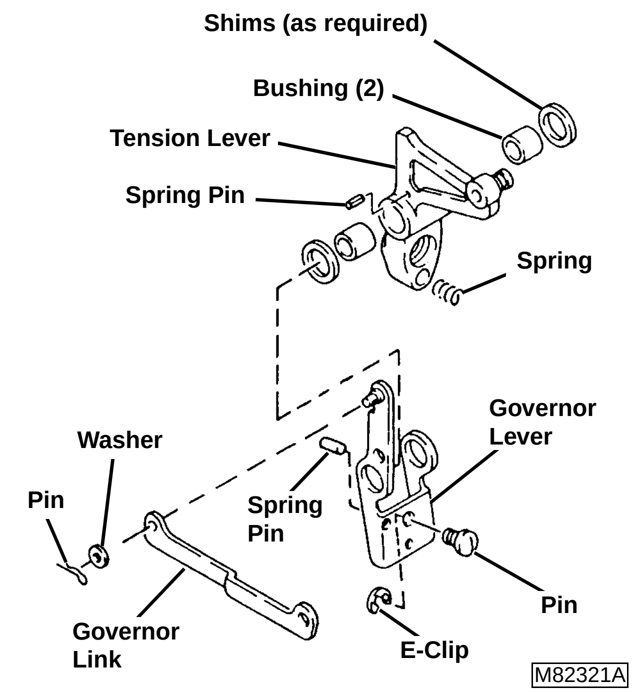


Early only



CARB/EPA—Only

11. Remove cover, gasket, fuel controller assembly, fast idle stop and throttle stop.



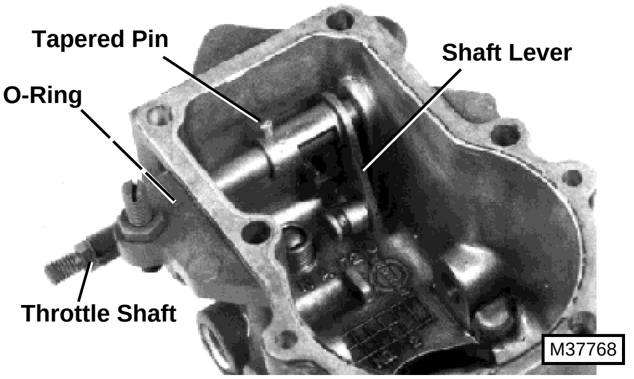
12. Disassemble governor linkage assembly.
13. Inspect all parts for wear or damage. Replace as necessary.

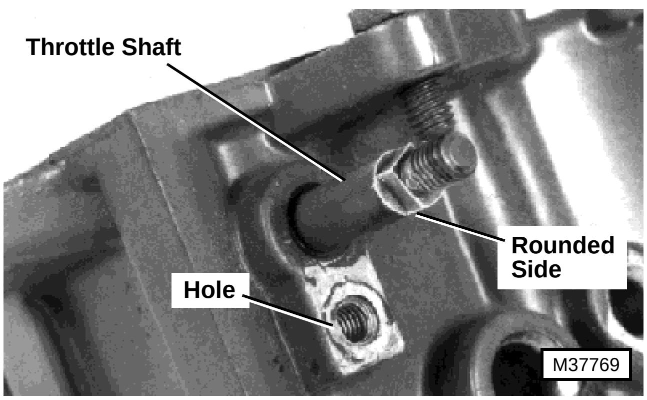
Assembly

Assembly is done in the reverse order of disassembly.

IMPORTANT: Apply clean engine oil on all internal parts.

- When installing throttle shaft:
- Install new O-ring, throttle shaft and shaft lever. Rotate shaft until rounded side of shaft is facing toward hole.
- Position shaft lever as shown and install tapered pin in tapered hole.





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

Inspection

1. Measure governor shaft diameter. If OD is less than **7.90 mm (0.311 in.)**, replace governor shaft.

2. Measure governor shaft bore diameter in governor linkage.

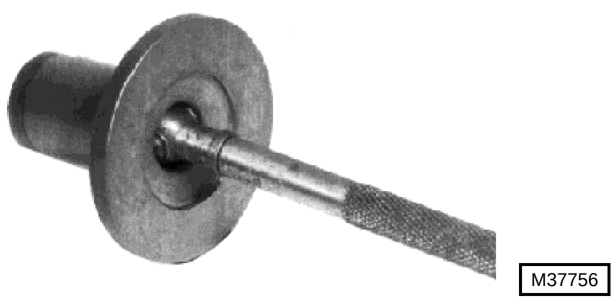
Governor Shaft Bore ID:

Wear Limit . . . . 8.15 mm (0.321 in.)
Clearance . . . . 0.18 mm (0.007 in.)

If shaft bore exceeds wear limit, replace governor linkage.

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

3. Measure inside diameter of sleeve. If ID is more than **8.20 mm (0.323 in.)**, replace sleeve.



4. Measure injection pump camshaft diameter

Injection Pump Camshaft OD:

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

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

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

If clearance (sleeve ID minus camshaft OD) exceeds specification, replace sleeve, injection pump camshaft or both.

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

FUEL INJECTION NOZZLES

Removal/Installation

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

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

CAUTION

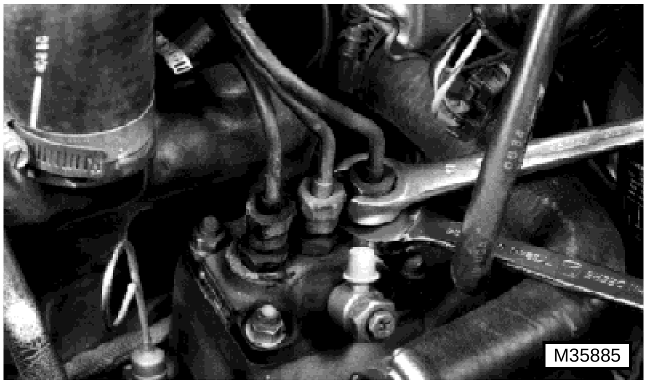
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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

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

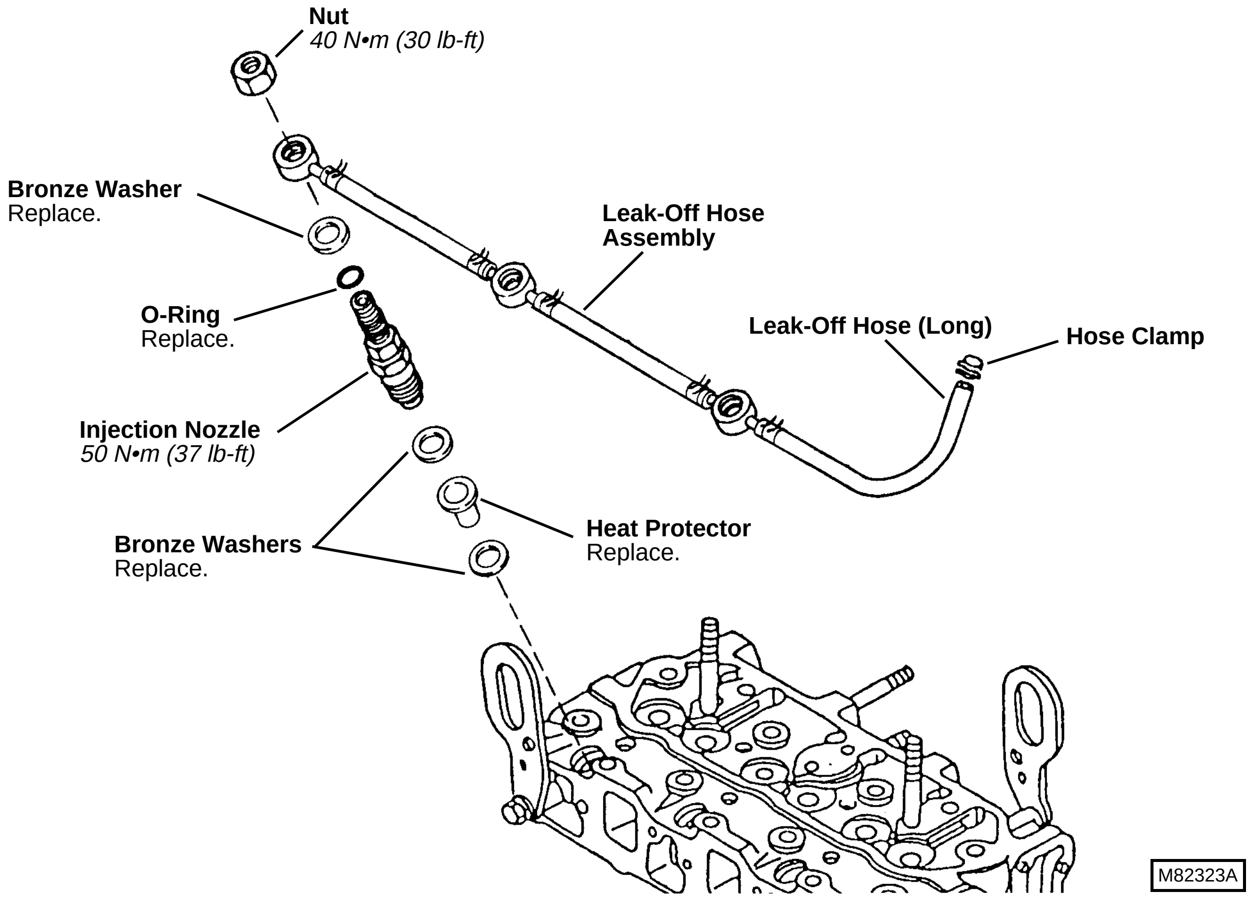
IMPORTANT: When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

2. Loosen fuel injection line connectors slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.



3. Loosen line clamp and remove fuel injection lines.
4. Disconnect long leak-off hose.
5. Remove nuts and leak-off hose assembly.
6. Remove bronze washers and O-rings.
7. Remove injection nozzle, washers and heat protector.
8. Test injection nozzles. (See TESTS AND ADJUSTMENTS.

Installation is done in reverse order of removal.

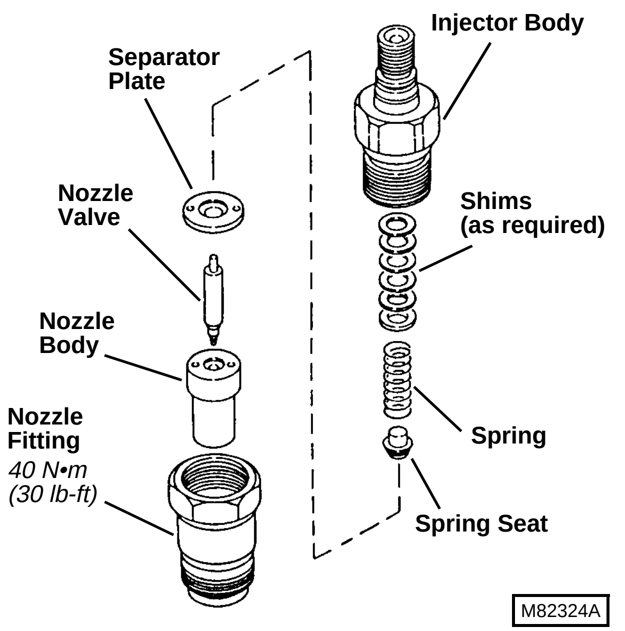


Disassembly/Assembly

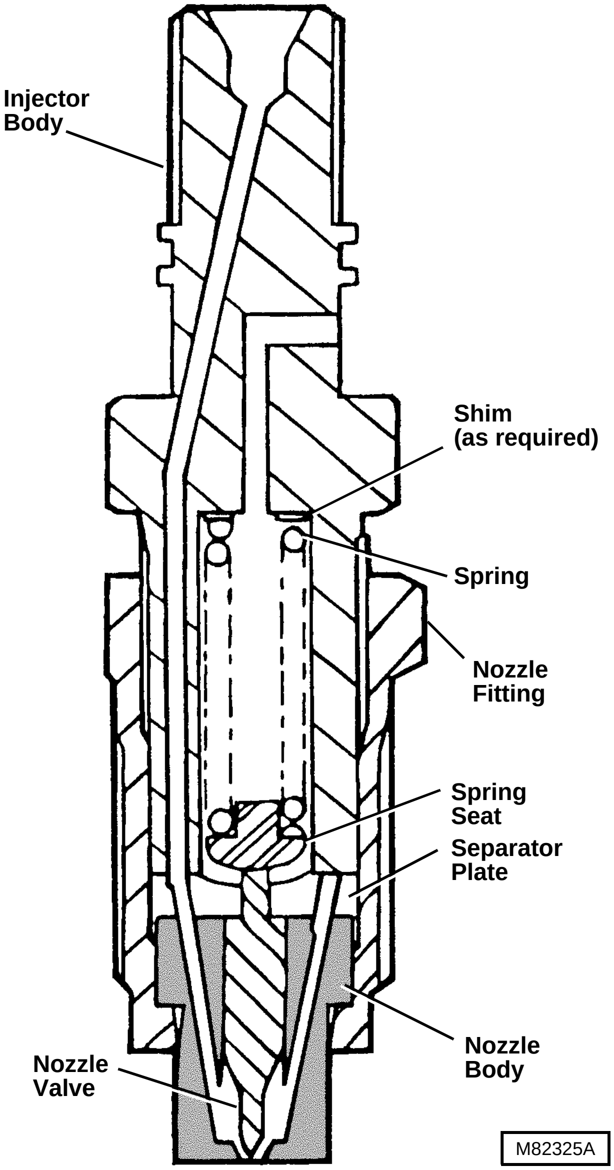
NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

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

- Clean and inspect nozzle assembly.
- After assembly is complete, test injection nozzle. (See TESTS AND ADJUSTMENTS.)



FUEL INJECTOR CROSS SECTION



M82325A

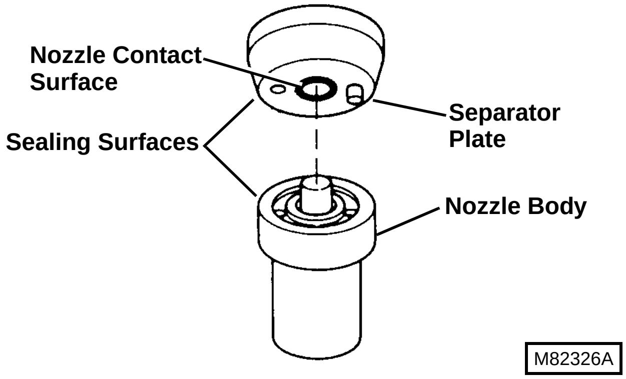
Cleaning/Inspection

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

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

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

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in Nozzle Cleaning Kit).
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.
4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.
5. Check nozzle contact surface on separator plate for wear. If contact surface is more than **0.10 mm (0.0039 in.)**, replace nozzle assembly.

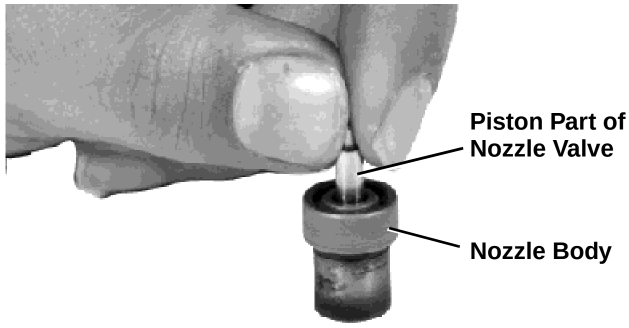


M82326A

6. Inspect the piston (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.
7. Further inspect the nozzle assembly by performing a slide test. Use the following procedure:

- Dip the nozzle valve in clean diesel fuel. Insert valve in nozzle body.
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

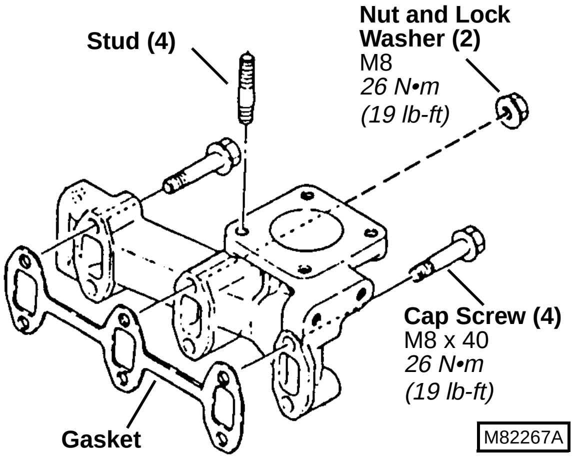
Replace nozzle assembly if the valve does not slide freely to its seat.



M35919

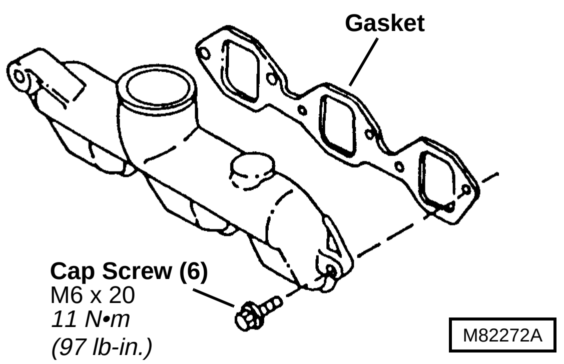
EXHAUST MANIFOLD

1. Remove muffler and gasket, if equipped.
2. Remove extension/elbow and gasket, if equipped.
3. Tighten all mounting hardware to **26 N•m (19 lb-ft)**.



INTAKE MANIFOLD

1. Remove fuel filter assembly mounting cap screw(s), if equipped.
2. Remove fuel injection lines. (See INJECTION PUMP.)
3. Tighten all mounting cap screws to **11 N•m (97 lb-in.)**.



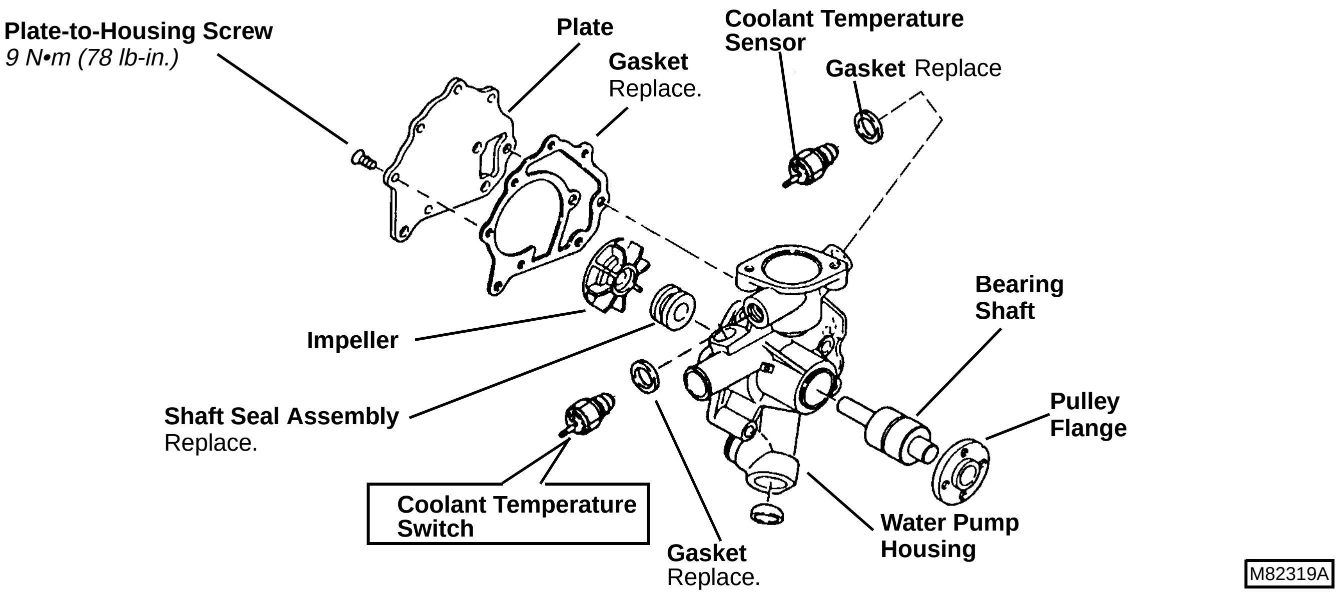
WATER PUMP

Removal/Installation

1. Open engine drain valve to drain coolant.
2. Remove fan/alternator drive belt.
3. Remove fan and spacer/plate, if equipped, and pulley.
4. Remove three mounting cap screws, pump and gasket.
5. Inspect all parts for wear or damage. (See disassembly/assembly procedures.)

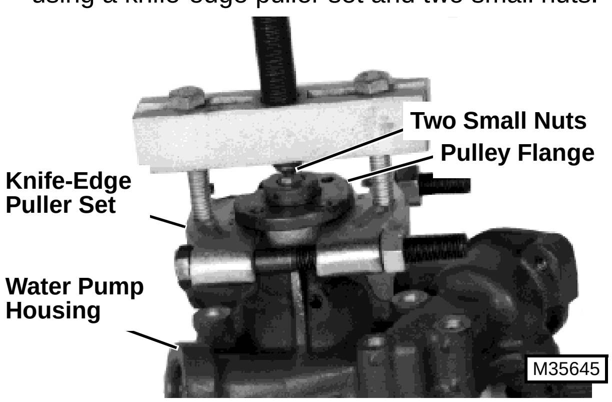
Installation is done in the reverse order of removal.

- Adjust fan/alternator drive belt tension. (See TESTS AND ADJUSTMENTS.)
- Tighten mounting cap screws to **26 N•m (19 lb-ft)**.



Disassembly

1. Remove thermostat. (See THERMOSTAT.)
2. Remove coolant temperature sensor. (See COOLANT TEMPERATURE SENSOR.)
3. Apply heat to plate-to-housing screws. Remove screws, plate and gasket.
4. Apply extreme heat to pulley flange. Remove flange using a knife-edge puller set and two small nuts.



5. Place water pump assembly on a press table. Install supports under water pump housing, staying clear of impeller. Press bearing shaft assembly through water pump housing using a piece of pipe or a deep socket.

IMPORTANT: Impeller bore is tapered. When pressing bearing shaft from impeller, allow enough clearance between cap screw and impeller bore to prevent cap screw from binding.

6. Remove impeller from bearing shaft using a knife-edge puller, a 3/8 - in. cap screw and a press.
7. Remove shaft seal assembly (seal, ceramic seal and seal cup).
8. Inspect all parts for wear or damage. Replace as necessary.

Assembly

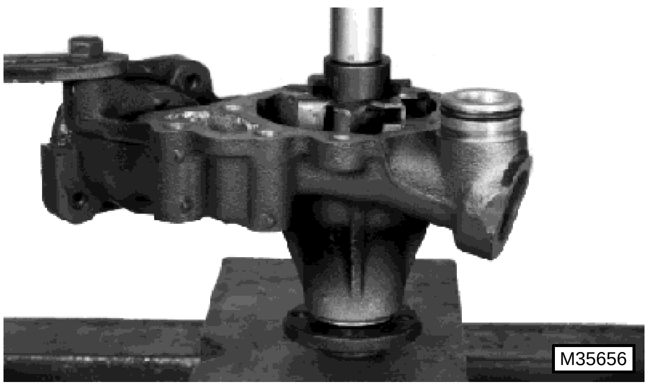
IMPORTANT: Support pump housing on bearing shaft only. DO NOT support on housing or damage to housing will occur.

1. Install bearing shaft into pump housing, long end down, using a piece of pipe or deep socket and a press. Press shaft into pump housing until bearing surface is flush with pump housing surface.
2. Install new shaft seal over impeller side of bearing shaft, rubber seal side away from pump housing. Push shaft seal into pump housing, until it stops, using a 25 - mm or 1 - in. socket and a press.

3. Place water pump housing on a press table. Support housing on bearing shaft using a driver disk.
4. Install pulley flange onto shaft with straight hub facing away from housing.
5. Press pulley flange onto bearing shaft until flange is flush with end of shaft.

IMPORTANT: DO NOT touch lapped sealing surface of ceramic seal with bare hands. It must be clean and dry.

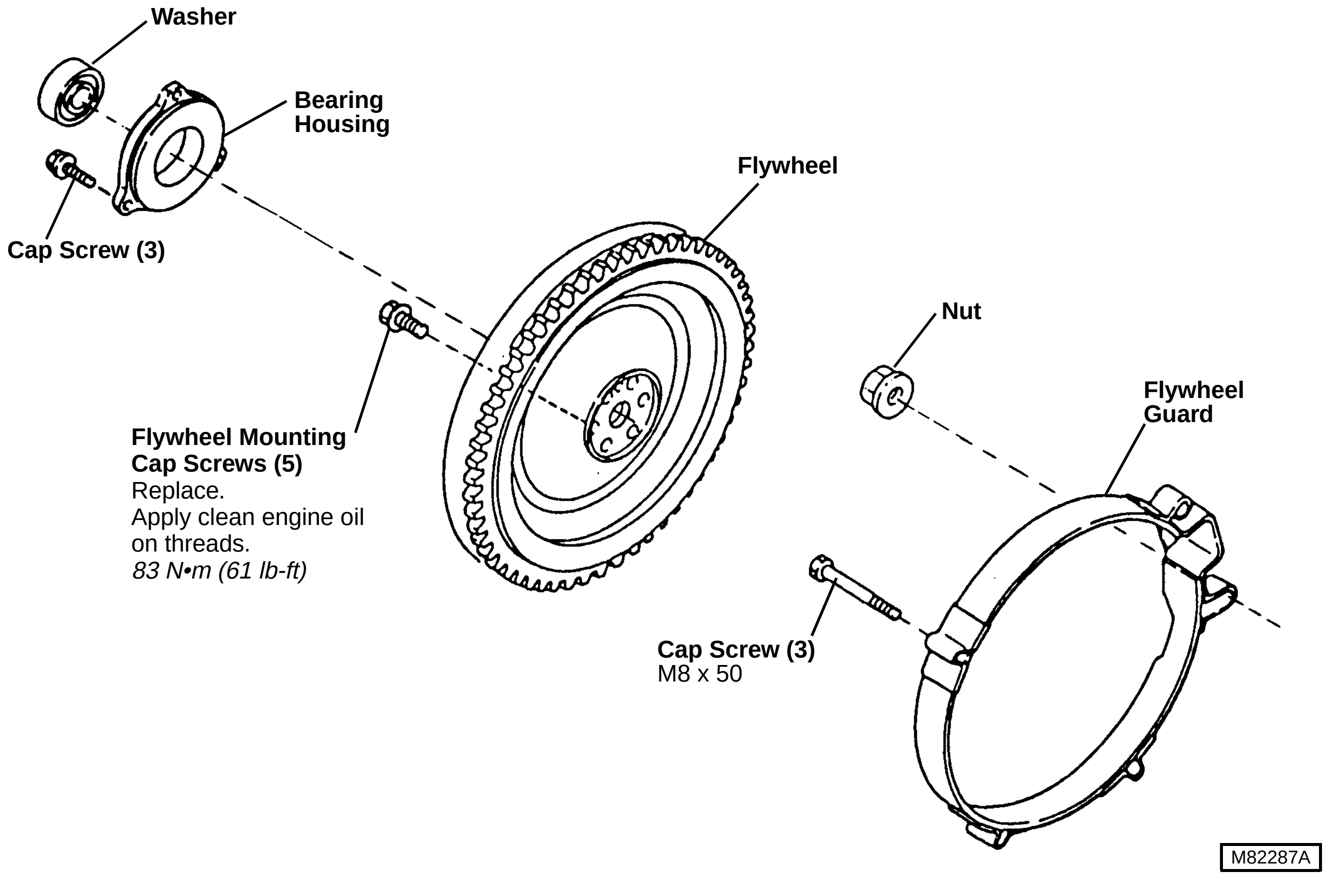
6. Install seal cup and ceramic seal in impeller.
7. Install a knife-edge puller around bearing shaft, between pulley flange and pump housing. Place pump housing, with knife-edge puller down, on a press table.
8. Install impeller with ceramic seal toward shaft seal.
9. Press impeller on bearing shaft until top of impeller is even with end of shaft.



10. Install new gasket, plate and screws. Tighten to **9 N•m (78 lb-in.)**.
11. Install coolant temperature sensor. (See COOLANT TEMPERATURE SENSOR.)
12. Install thermostat. (See THERMOSTAT.)

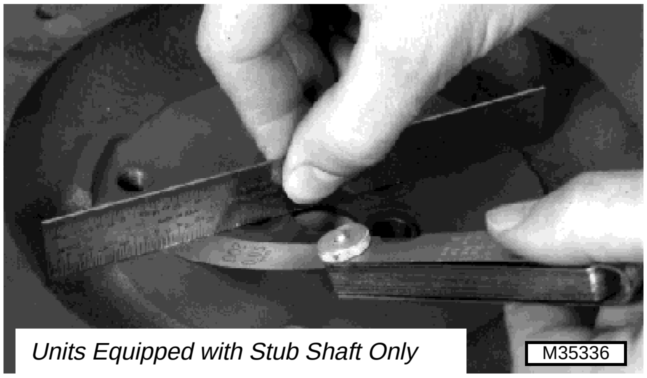
FLYWHEEL

1. Remove starter and flywheel guard.



2. Remove mounting cap screws and flywheel.

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

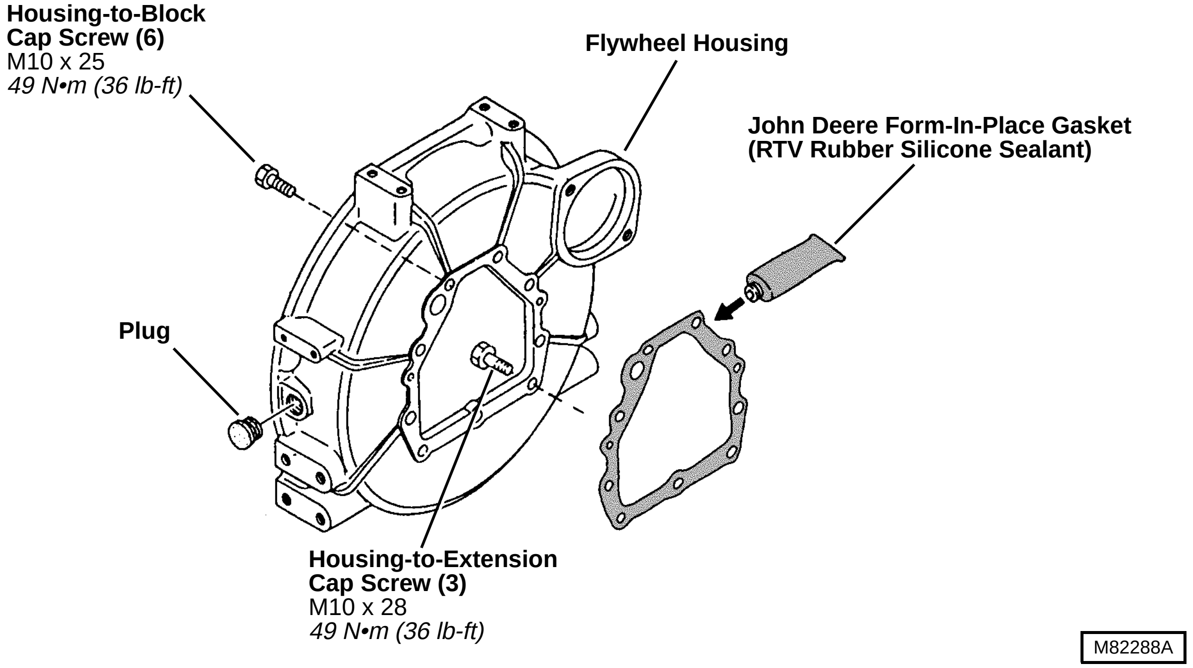


Units Equipped with Stub Shaft Only

3. Measure flywheel flatness. Place a straightedge across flywheel surface opposite of ring gear. Measure clearance between straightedge and flywheel surface with a feeler gauge. If clearance exceeds **0.02 mm (0.0008 in.)**, replace flywheel.

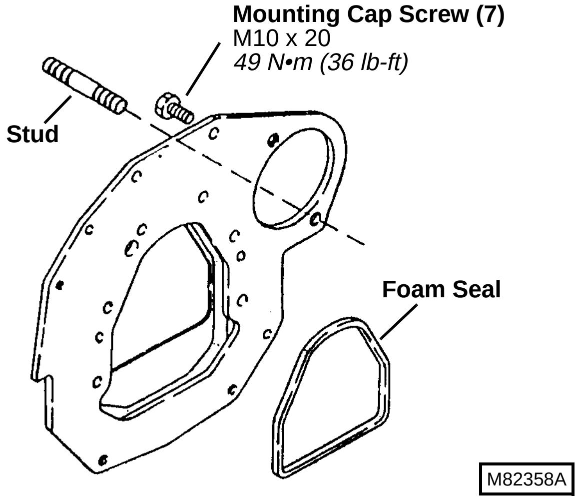
FLYWHEEL HOUSING

1. Remove flywheel. (See FLYWHEEL.)
2. Remove starter.



FLYWHEEL PLATE

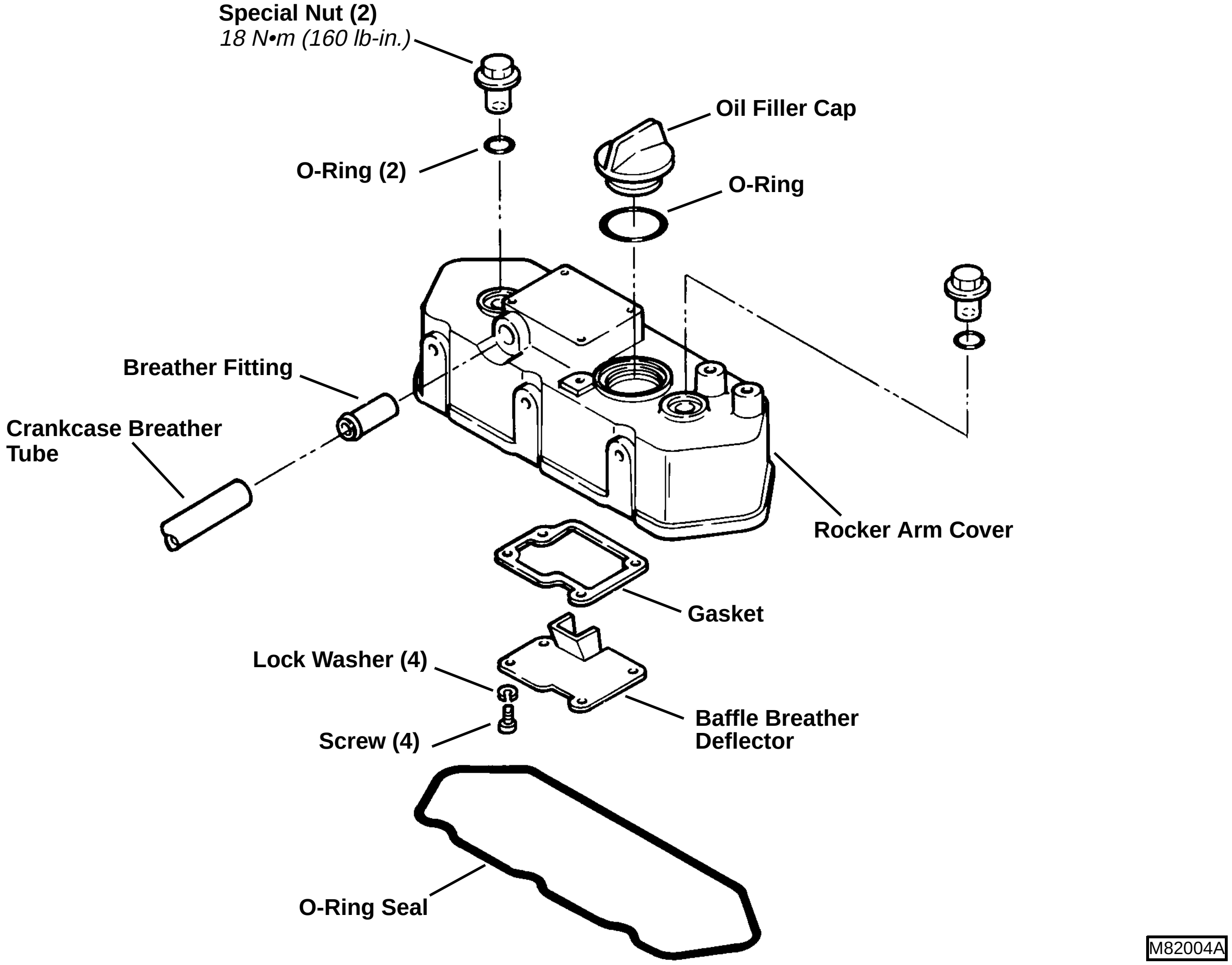
1. Remove flywheel. (See FLYWHEEL.)
2. Remove starter.



3. Install in reverse order of removal.

ROCKER ARM COVER

NOTE: Some models may be equipped with an oil fill extension and/or adaptor with an O-ring.



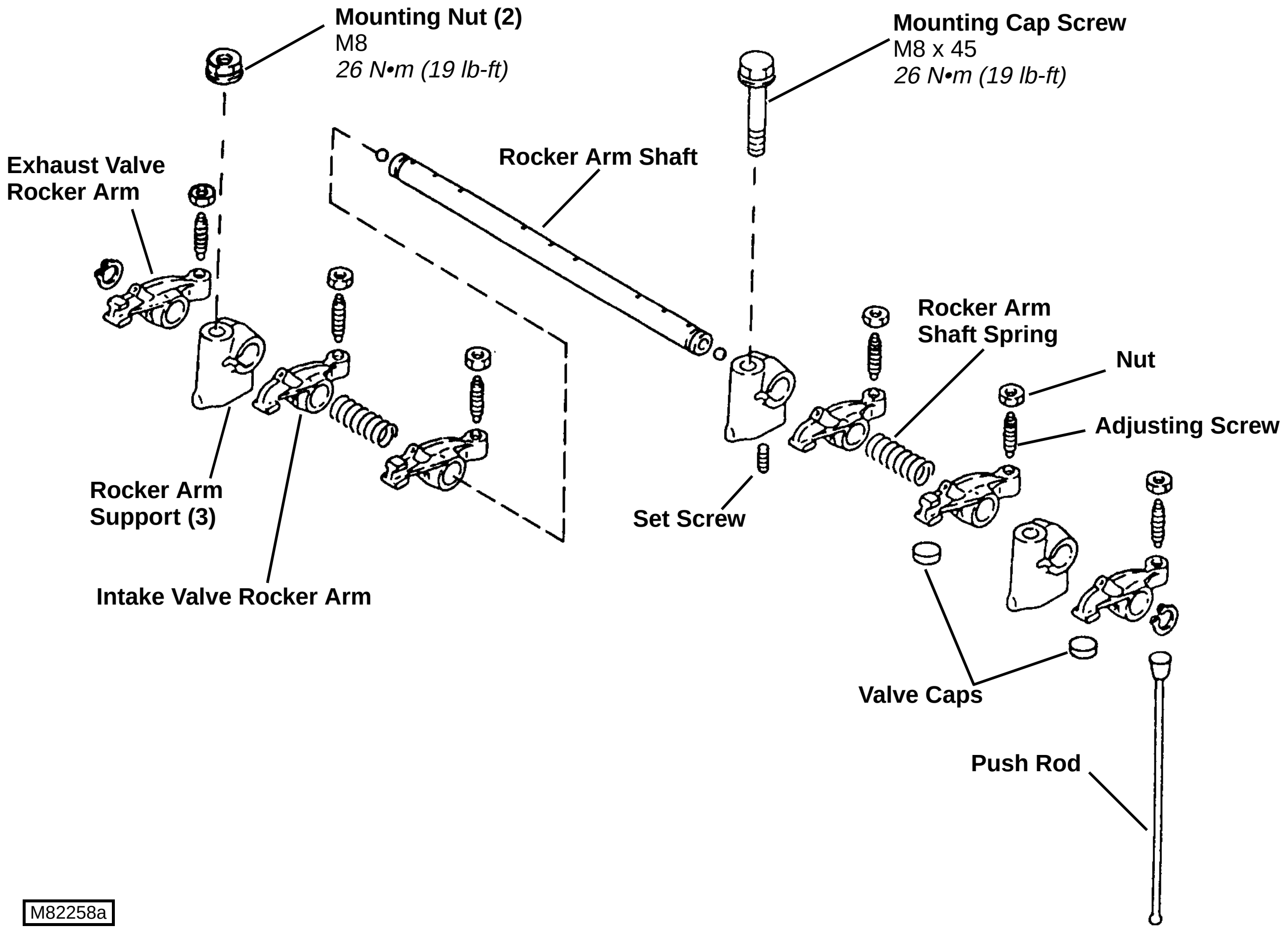
Removal/Installation and Disassembly/Assembly

1. Remove rocker arm cover.
2. Inspect all parts for wear or damage.

IMPORTANT: Install center rocker arm support on shaft, aligning set screw hole in support with center hole in shaft.

3. Lubricate all parts with clean oil during assembly.
4. Adjust valve clearance.

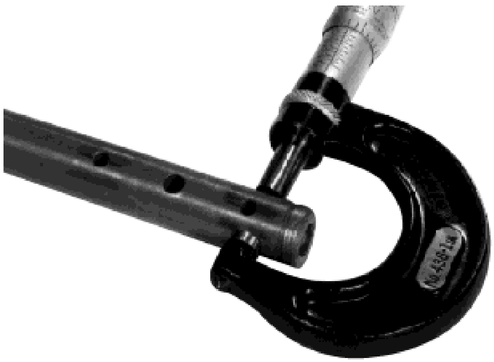
ROCKER ARM ASSEMBLY



M82258a

Inspection

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



M35262

Rocker Arm Shaft OD:

Standard . . . . 11.96—11.98 mm (0.4711—0.4718 in.)

Wear Limit . . . . 11.95 mm (0.4706 in.)

2. Replace rocker arm shaft if less than wear limit.
3. Measure inner diameters of rocker arms and supports.

Rocker Arm and Shaft Support IDs:

Standard . . . . 12.00—12.02 mm (0.4724—0.4732 in.)

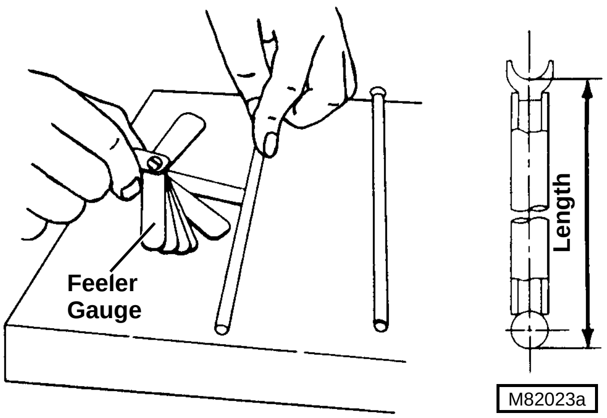
Wear Limit . . . . 12.09 mm (0.4759 in.)

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

- Replace rocker arms or supports if ID is more than wear limit.

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

4. Measure length and bending of push rod.



Push Rod Length: . . . . 141—142 mm (5.550—5.590 in.)

Push Rod Bend:

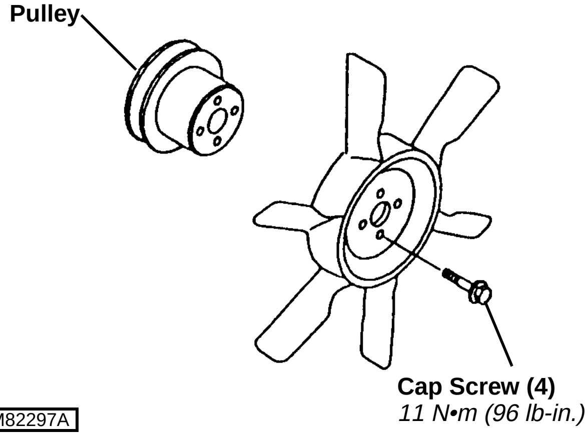
Wear Limit . . . . 0.08 mm (0.003 in.)

Replace push rod if not within specifications.

TIMING GEAR COVER

Removal/Installation

1. Remove alternator and belt.
2. Remove fan, spacer/plate, if equipped, and pulley
3. Remove crankshaft pulley cap screw and washer.



M82297A

4. Remove crankshaft pulley using a two-jaw puller kit.
5. Remove tachometer, if equipped.

NOTE: It is not necessary to remove auxiliary drive cover and gasket, if equipped, or end cover and O-ring to remove timing gear cover.

6. Remove mounting cap screws and timing gear cover.

Installation is done in the reverse order of removal.

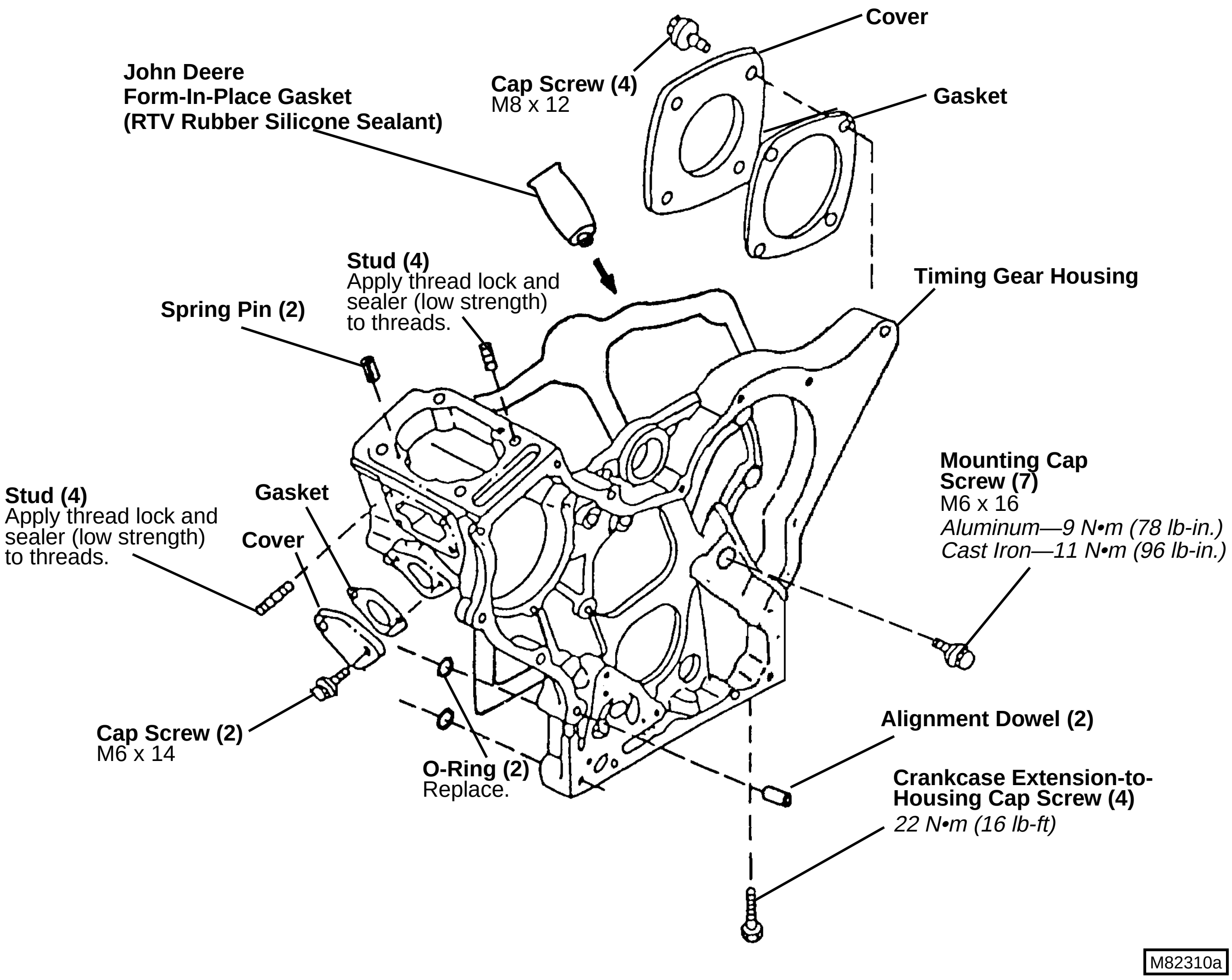
- Tighten all mounting cap screws to **9 N•m (78 lb - in.)**
- Adjust fan/alternator drive belt tension.

TIMING GEAR HOUSING

Removal/Installation

1. Remove idler gear. (See IDLER GEAR.)
2. Remove engine camshaft. (See CAMSHAFT REMOVAL.)
3. Remove oil pump. (See OIL PUMP.)
4. Remove water pump. (See WATER PUMP.)
5. Remove mounting cap screws and housing.
6. Replace O-rings.

Installation is done in reverse order of removal.



IDLER GEAR

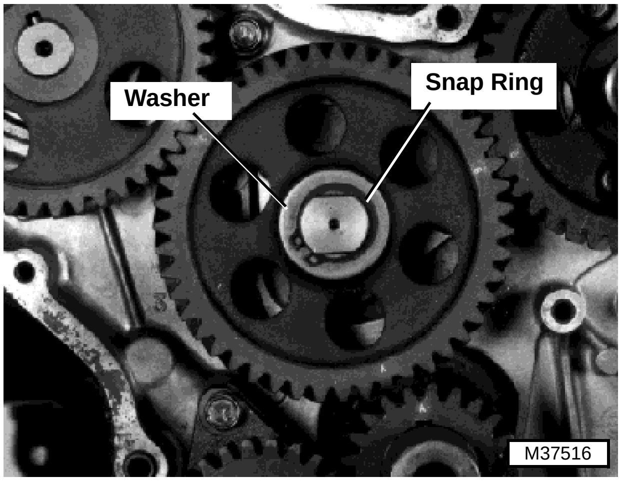
Removal/Installation

1. Remove timing gear cover. (See TIMING GEAR COVER.)
2. Check backlash of timing gears.

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

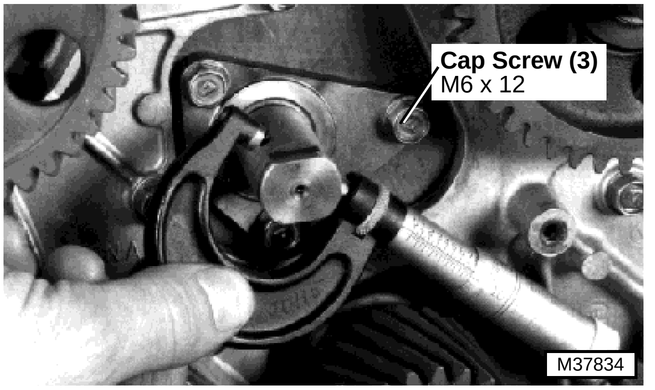
3. Rotate crankshaft and align timing marks.
4. Remove snap ring, washer and gear.
5. Inspect all parts for wear or damage. (See inspection/replacement procedures.)

Installation is done in the reverse order of removal.



Inspection/Replacement

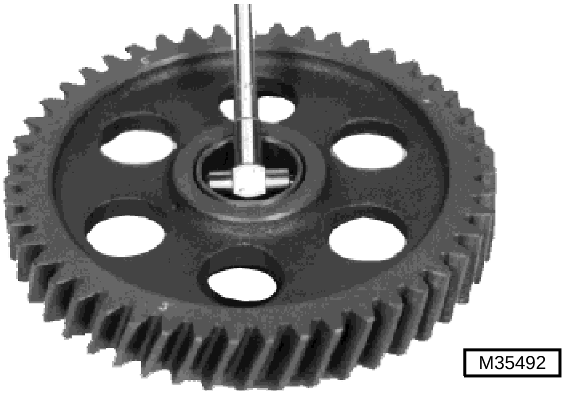
1. Inspect gear for chipped or broken teeth. Replace if necessary.
2. Measure idler gear shaft diameter.



Idler Gear Shaft OD:

Standard . . . . 19.959—19.980 mm (0.786—0.787 in.)
Wear Limit. . . . . 19.93 mm (0.785 in.)

3. If shaft diameter is less than wear limit, remove three cap screws and replace idler gear shaft.
   - Measure idler gear bushing and diameter.



Idler Gear Bushing ID:

Standard . . . . 20.000—20.021 mm (0.787—0.788 in.)
Wear Limit. . . . . 20.08 mm (0.791 in.)
Clearance . . . . 0.15 mm (0.0059 in.)

- If bushing diameter exceeds wear limit, replace bushing.

  To replace bushing:

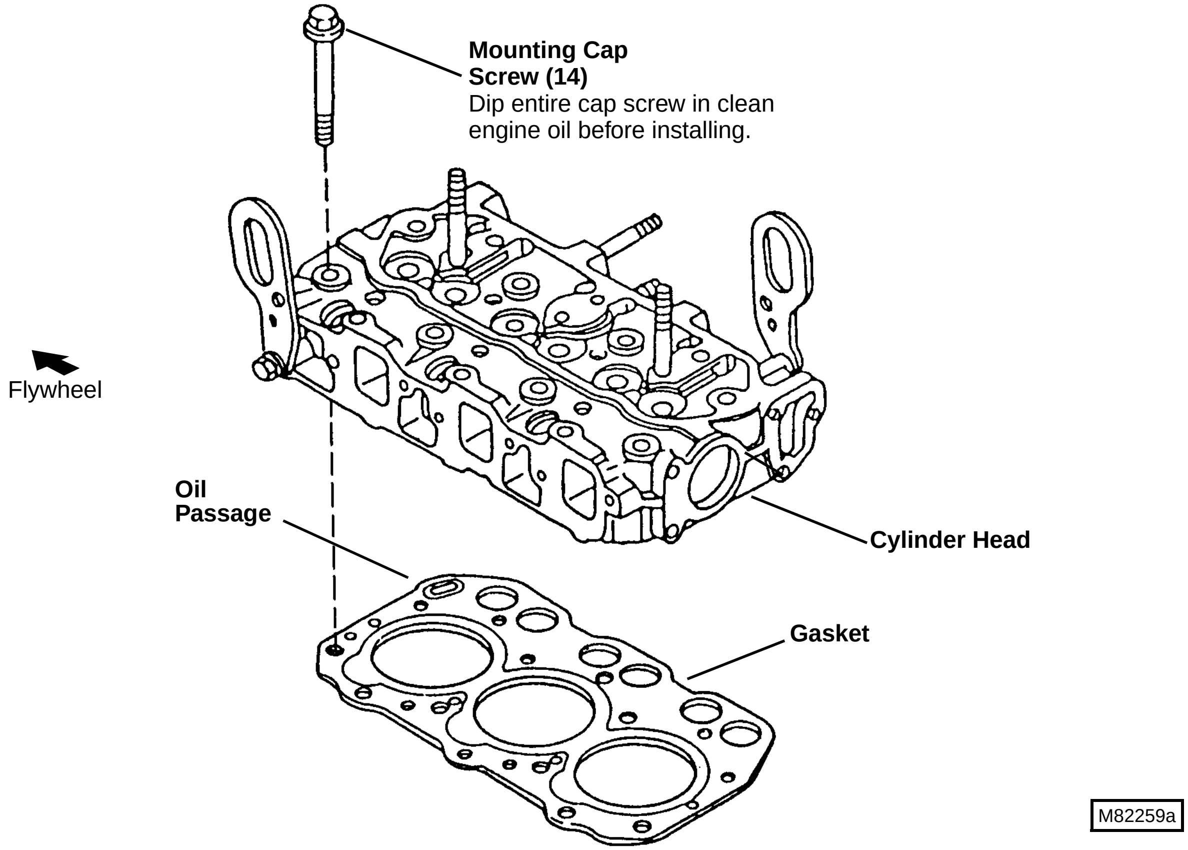
  Use a driver set. Align oil holes in bushing and idler gear. Install bushing flush with surface of idler gear.

  If bushing clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft or both.

CYLINDER HEAD AND VALVES

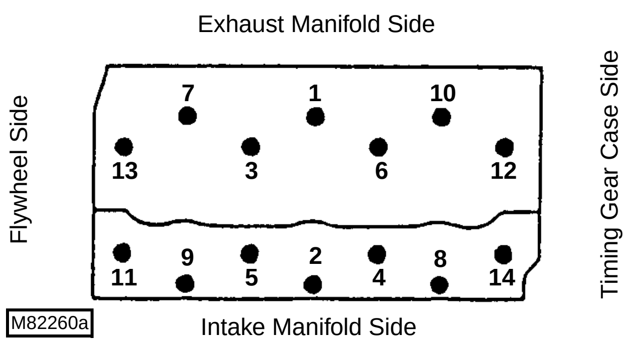
Removal/Installation

1. Remove rocker arm assembly, push rods and valve caps. (See ROCKER ARM ASSEMBLY.)
2. Remove exhaust and intake manifolds. (See



4. Remove fuel injection nozzles. (See FUEL INJECTION NOZZLES.)
5. Remove glow plugs.
6. Disassemble and inspect cylinder head and valves. (See disassembly/assembly and inspection/replacement procedures.)

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



7. Tighten mounting cap screws, in the sequence shown, in three stages of gradually-increasing torque.

Torque Specifications:

First . . . . .19 N•m (14 lb-ft)
Second . . . . .38 N•m (28 lb-ft)
Final. . . . . .61 N•m (45 lb-ft)

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

Disassembly/Assembly

NOTE: Size and shape of lifting brackets will vary due to numerous engine applications.

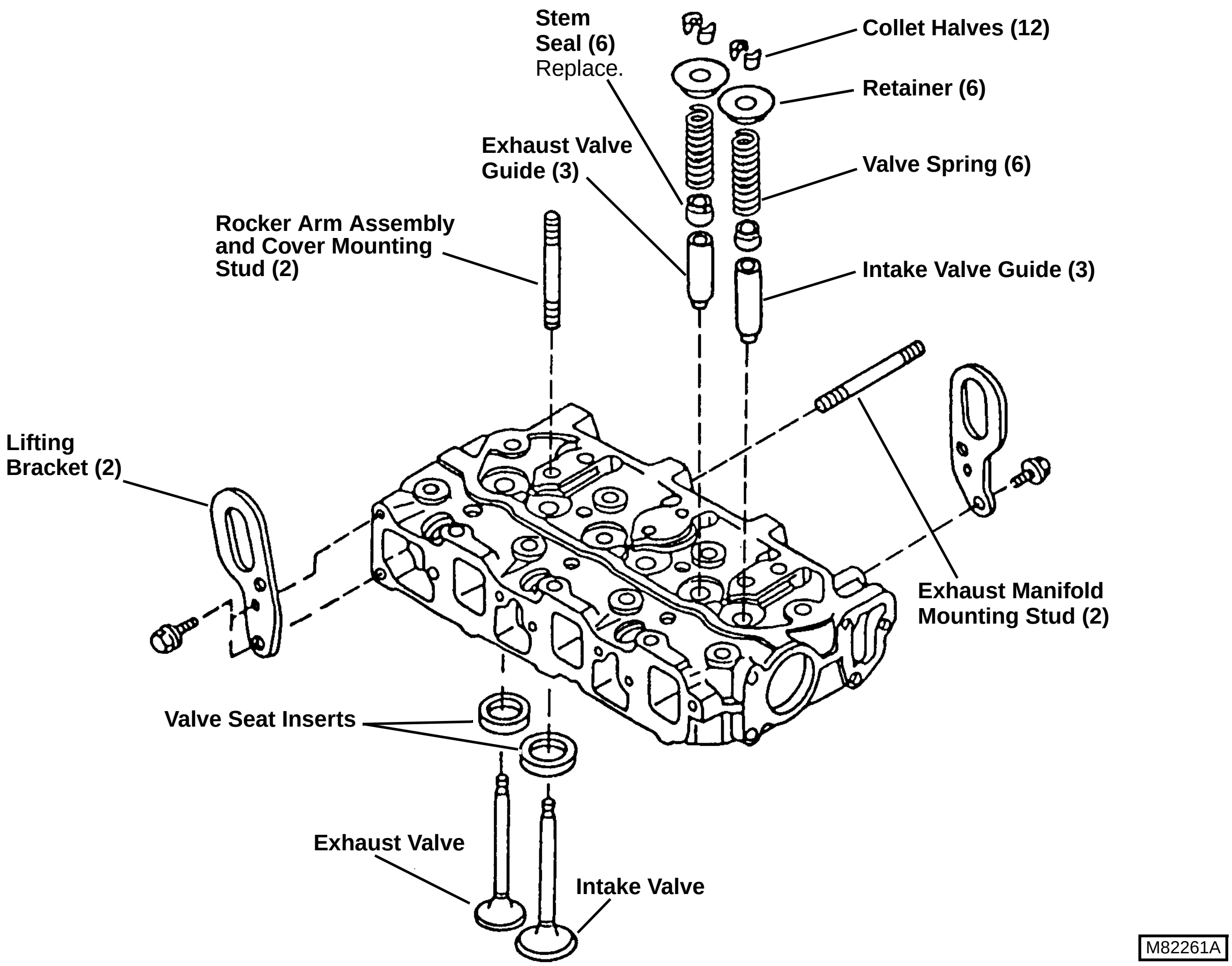
1. Compress valve springs using a valve spring compressor.
2. Intake and exhaust valve guides are press fit. Remove guides only if replacement is necessary.
3. Inspect all parts for wear or damage.

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

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

NOTE: If new valves are installed, measure valve recession. (See inspection/replacement *procedures.)*

6. After each valve has been assembled, tap on top of valve stem with a plastic hammer to seat retainer.

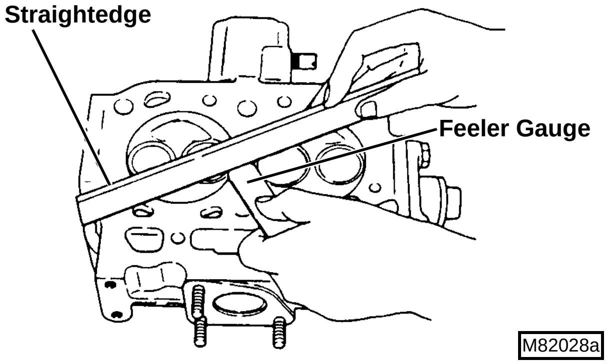


Inspection/Replacement

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

Cylinder Head:

1. Measure cylinder head distortion (flatness). Place a straightedge along each of the four sides and each diagonal. Measure the clearance between straightedge and combustion surface with a feeler gauge.



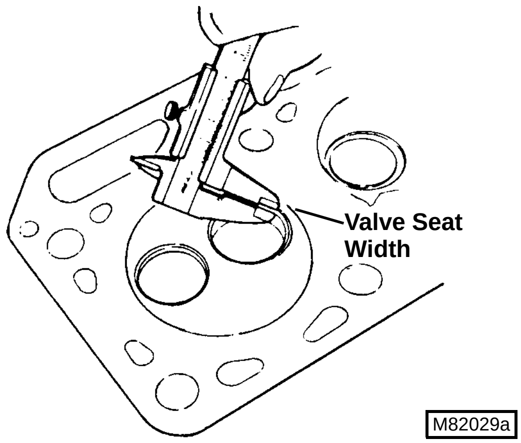
Cylinder Head Distortion:

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

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

If cylinder head was resurfaced:

- Measure piston-to-cylinder head clearance.
- Measure valve recession.
- Measure valve seat width



Valve Seat Width:

Intake Valve

Standard . . . . 1.44 mm (0.057 in.)
Wear Limit. . . . . 1.98 mm (0.078 in.)

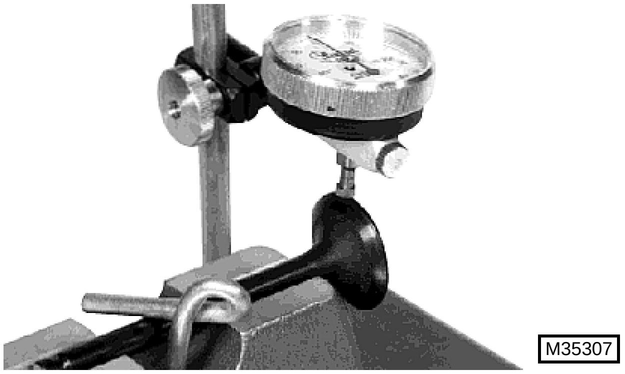
Exhaust Valve

Standard . . . . 1.77 mm (0.070 in.)
Wear Limit. . . . . 2.27 mm (0.089 in.)

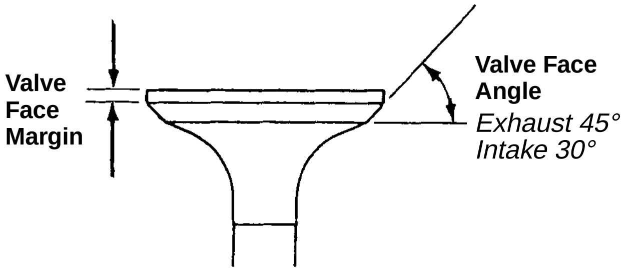
If necessary, grind valve seats to meet specifications. (See VALVE SEATS—GRINDING.)

Intake and Exhaust Valves:

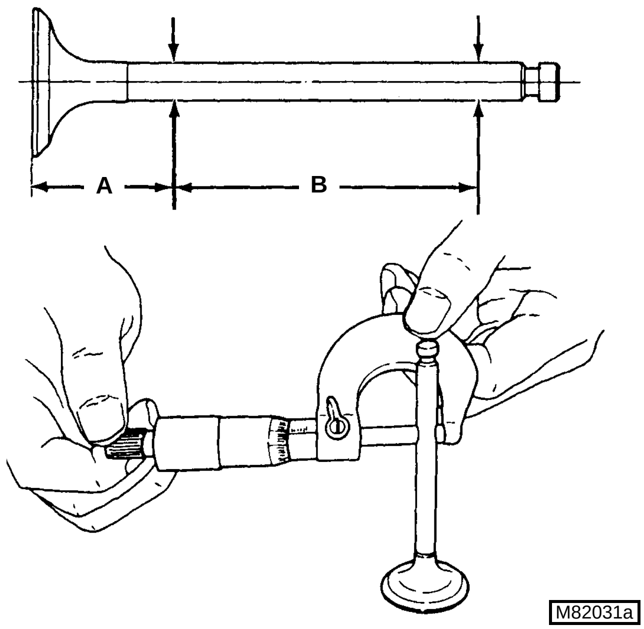
1. Check valve for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



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



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



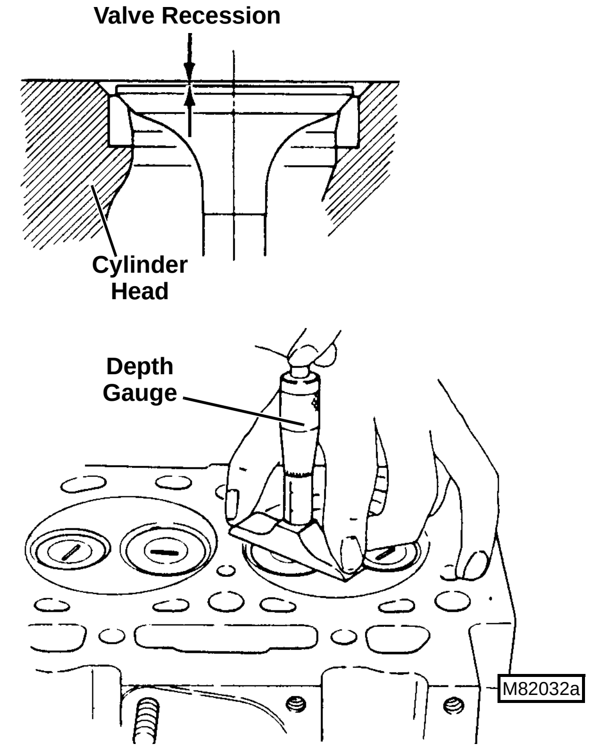
Valve Stem OD:

Distance A . . . . 25 mm (0.984 in.)
Distance B . . . . 45 mm (1.772 in.)

Intake and Exhaust Valves

Standard . . . . 6.94—6.96 mm (0.2732—0.2740 in.)
Wear Limit. . . . . 6.90 mm (0.2717 in.)

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



Valve Recession:

Intake Valve. . . . . 0.50 mm (0.020 in.)
Exhaust Valve. . . . . 0.85 mm (0.033 in.)

Valve Guides:

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

Valve Guide ID:

Standard . . . . 7.00—7.02 mm (0.275—0.276 in.)
Wear Limit. . . . . 7.08 mm (0.279 in.)

If diameter exceeds wear limit, knurl or replace guide.

If diameter is less than wear limit, determine guide-to-stem clearance (guide diameter minus stem diameter).

If clearance exceeds **0.15 mm (0.006 in.)** but is less than **0.20 mm (0.008 in.)**, knurl valve guides.

Knurl valve guides using:

- If the clearance exceeds **0.20 mm (0.008 in.)**, replace valve guides.

Replace valve guides using:

- JDE118 Valve Guide Driver

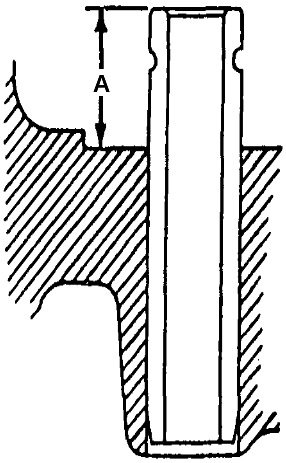
IMPORTANT: Intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none. Install valve guides with tapered ends down.

- Push valve guides down until top of valve guides are a specified distance (A) from top of cylinder head.

Valve Guide Height "A": . . . . 9 mm (0.354 in.)

Ream inside diameter of valve guides using:

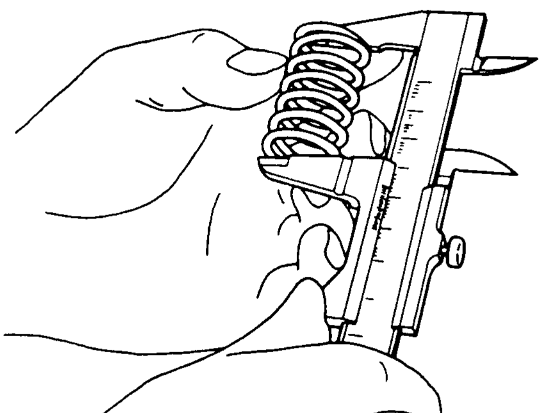
- D-20020WI Valve Guide Reamer



M82193A

Valve Springs:

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

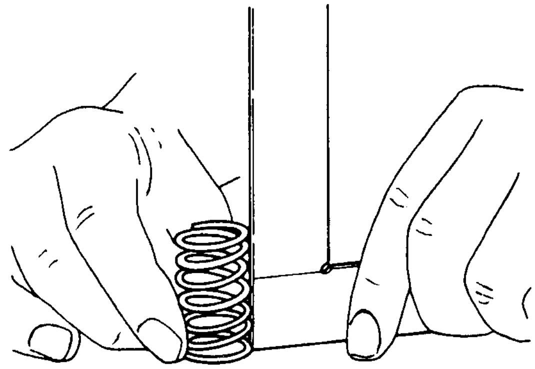


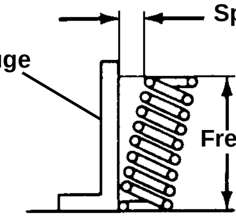
M82034A

Spring Free Length:

(Maximum) . . . . 37.40 mm (1.472 in.)

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





M82035A

Spring Inclination:

(Maximum) . . . . 1.00 mm (0.040 in.)

VALVE SEATS—GRINDING

SPECIAL OR ESSENTIAL TOOLS

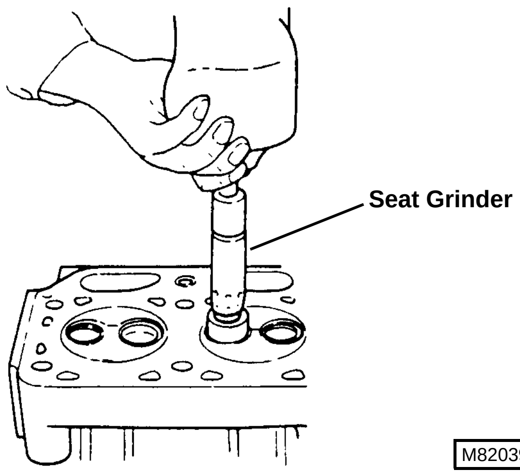
NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

- JDE118 Valve Guide Driver
  Use to remove and install valve guides in cylinder head.
- D-20018WI Valve Guide Knurler
  Use to knurl inside diameter of valve guides.
- D-20020WI Valve Guide Reamer
  Use to ream out new valve guides.

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

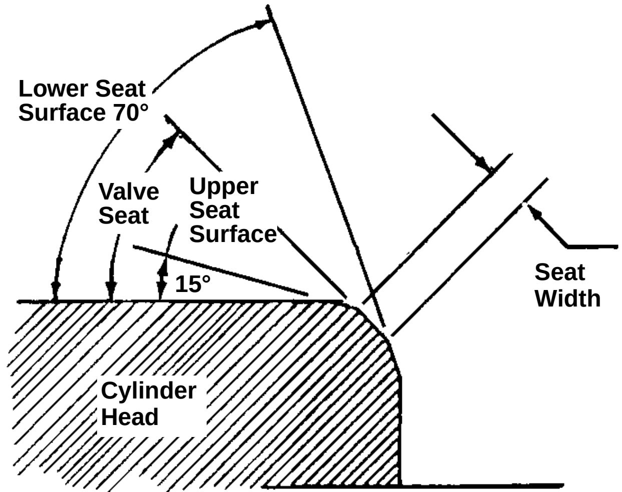
NOTE: LIGHTLY grind valve seats for a few seconds only to avoid excessive valve seat width.

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



M82039A

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



Intake Valve Seat Angle—30°
Exhaust Valve Seat Angle—45°
M82040A

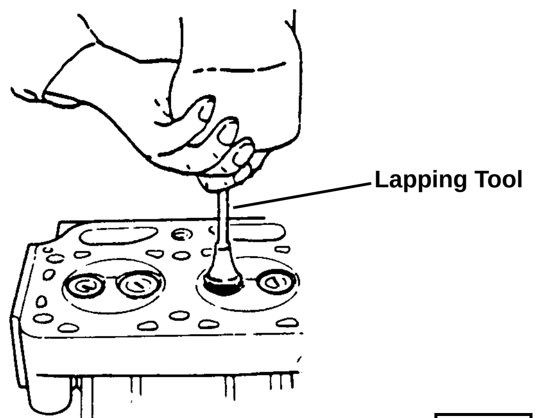
If valve recession exceeds maximum specifications or seats cannot be reconditioned, replace valves, valve seats, if equipped, and/or cylinder head.

VALVES—LAPPING

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

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

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



M82041A

CAMSHAFT REMOVAL

SPECIAL OR ESSENTIAL TOOLS

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

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

1. Remove rocker arm assembly and push rods. (See CYLINDER HEAD AND VALVES.)
2. Remove timing gear cover. (See TIMING GEAR COVER.)
3. Check camshaft end play. (See TESTS AND ADJUSTMENTS.)
4. Check backlash of timing gears. (See TESTS AND ADJUSTMENTS.)

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

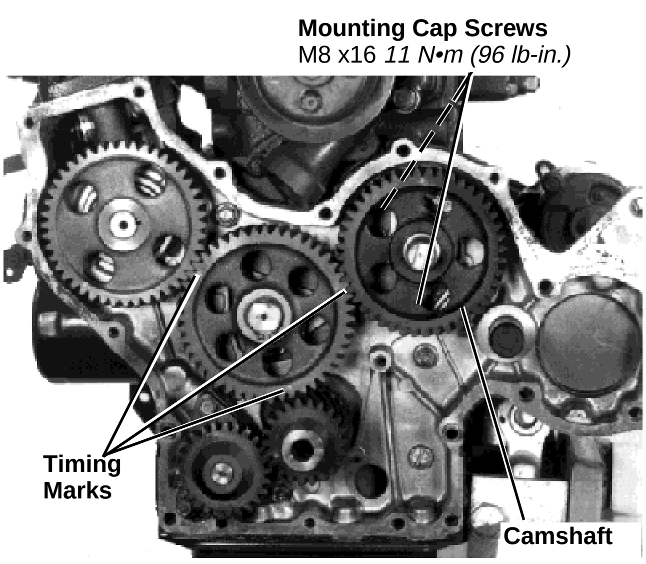
5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

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

6. Rotate crankshaft and align timing marks.

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

7. Remove two cap screws and camshaft.
8. Inspect all parts for wear or damage. (See inspection/replacement procedures.)



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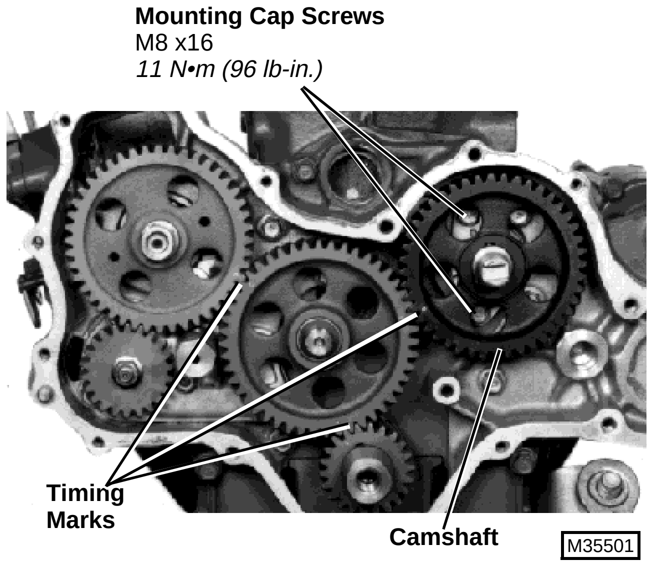


Early

CAMSHAFT INSTALLATION

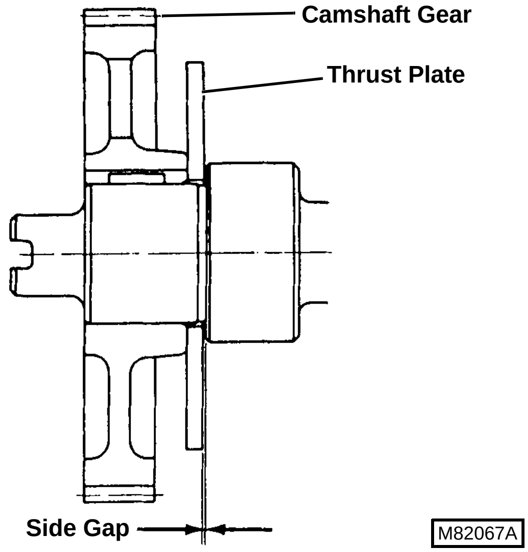
- Apply clean engine oil on all parts during installation.

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

1. Rotate crankshaft to align timing marks.
2. Install camshaft.
3. Install and tighten mounting cap screws to **11 N•m (96 lb-in.)**.
4. Install timing gear cover. (See TIMING GEAR COVER.)
5. Install push rods and rocker arm assembly. (See CYLINDER HEAD AND VALVES.)

CAMSHAFT INSPECTION/ REPLACEMENT

1. Check camshaft side gap using a feeler gauge.



Camshaft Side Gap:

Standard . . . . 0.05—0.15 mm (0.0020—0.0060 in.)

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

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

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

To remove/replace gear:

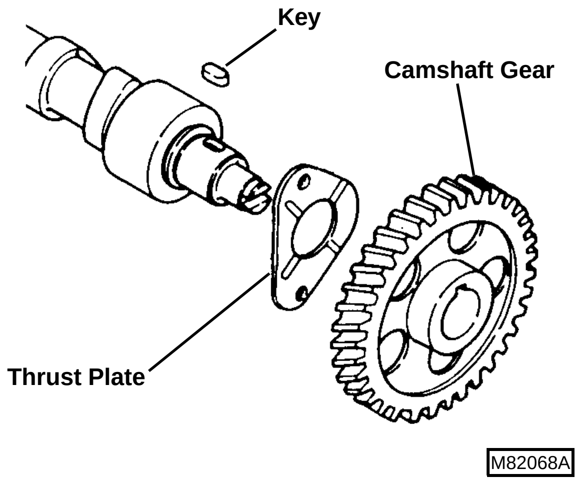
- Remove gear from camshaft using a knife-edge puller and a press.

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

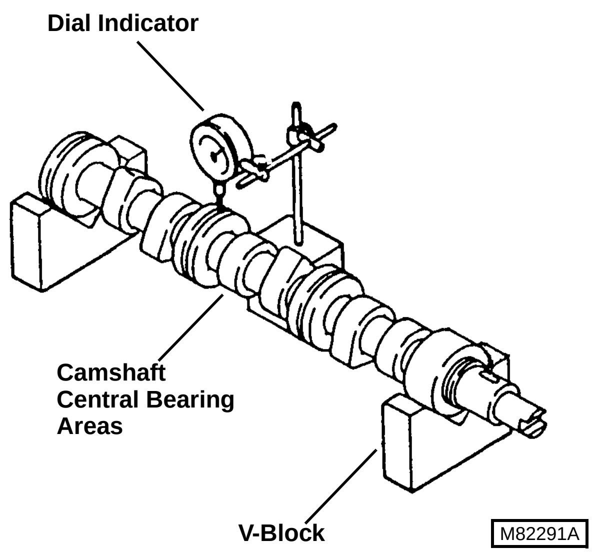
- Heat gear to approximately 150°C (300°F).

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

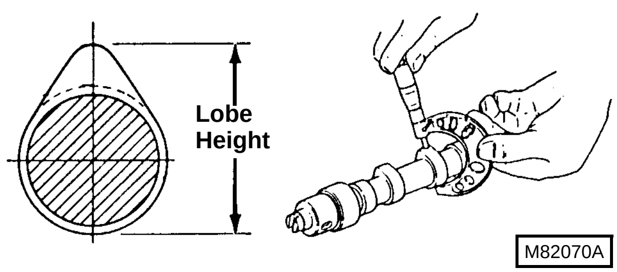
- Install thrust plate, if removed. Install gear with timing mark “C” side toward press table. Align slot in gear with key in shaft. Press camshaft into gear until gear is tight against camshaft shoulder.
- Thrust plate must spin freely on camshaft.



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



4. Measure camshaft lobe height.



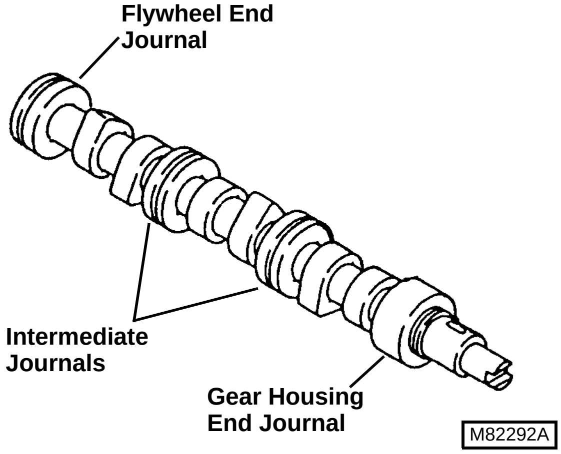
Lobe Height:

Standard . . . . 33.95—34.05 mm (1.337—1.341 in.)

Wear Limit. . . . . 33.75 mm (1.329 in.)

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

5. Measure camshaft end and intermediate journal diameters.



Camshaft Journal OD:

Gear Housing and Flywheel Ends

Standard . . . . 39.94—39.96 mm (1.5724—1.5732 in.)

Wear Limit. . . . . 39.85 mm (1.5689 in.)

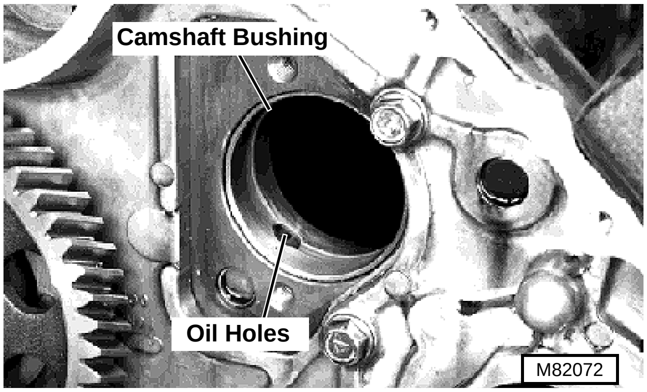
Intermediate

Standard . . . . 39.91—39.94 mm (1.5713—1.5724 in.)

Wear Limit. . . . . 39.85 mm (1.5689 in.)

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

6. Measure camshaft bushing diameter at gear housing end



Camshaft Bushing ID:

Standard . . . . 40.000—40.065 mm . . . .(1.575—1.577 in.)

Wear Limit. . . . . 40.10 mm (1.579 in.)

Clearance . . . . 0.18 mm (0.007 in.)

If bushing diameter exceeds wear limit, replace bushing.

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

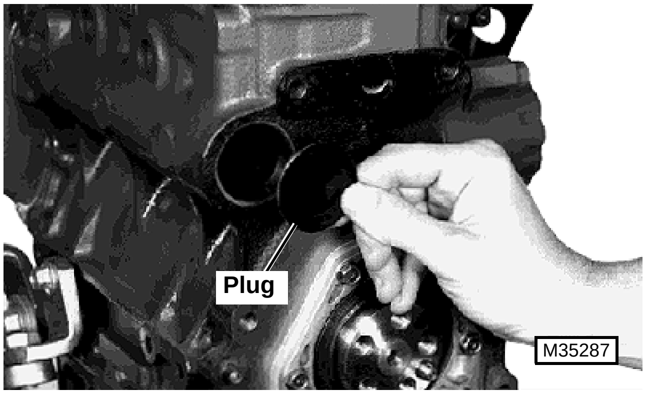
To replace bushing:

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

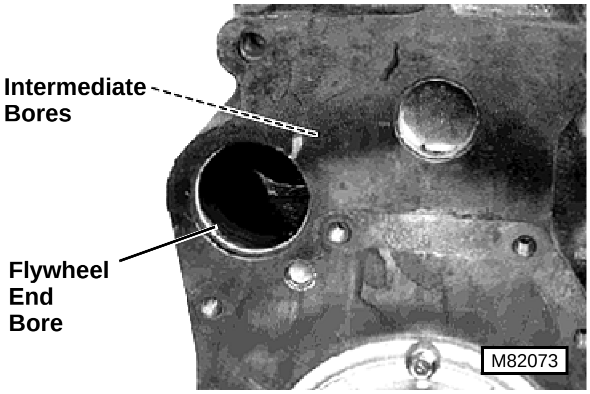
NOTE: Flywheel housing/plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

7. Measure intermediate and flywheel end camshaft bore diameters using the following procedures:

- Remove flywheel housing/plate. (See FLYWHEEL HOUSING, FLYWHEEL PLATE, and CRANKSHAFT and MAIN BEARINGS.)
- Remove plug using a long wooden dowel. Insert wooden dowel through gear housing side.



- Measure intermediate and flywheel end camshaft bore diameters.



Camshaft Bore ID:

Standard . . . . 40.00—40.025 mm (1.575—1.576 in.)
Wear Limit. . . . . 40.10 mm (1.579 in.)
Clearance . . . . 0.18 mm (0.007 in.)

If bore diameter exceeds wear limit, replace cylinder block.

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

- Apply John Deere Form-In Place Gasket, or an equivalent, on outer edge of plug. Install plug until it bottoms in bore.
- Install flywheel housing/plate.

CAM FOLLOWERS

Removal/Installation

1. Remove cylinder head. (See CYLINDER HEAD AND VALVES.)

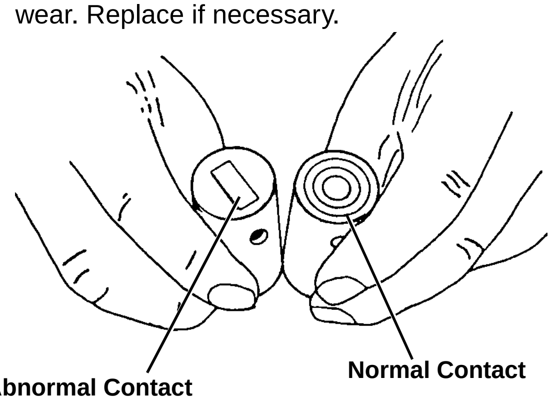
IMPORTANT: Cam followers must be installed in the same bores from which they were removed.

2. Put a mark on each cam follower and cylinder block bore to aid in installation.
3. Remove cam followers.
4. Inspect all parts for wear or damage. (See Inspection procedures.)
5. Apply clean engine oil on all parts during installation.

Installation is done in the reverse order of removal.

Inspection

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



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2. Measure cam follower diameter.

M35268

Cam Follower OD—3TN66:

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

Cam Follower OD:

Standard . . . . 20.927—20.960 mm (0.8239—0.8252 in.)
Wear Limit. . . . . 20.93 mm (0.824 in.)

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

3. Measure cam follower bore diameter in cylinder block.

Cam Follower Bore ID:

Standard . . . . 21.00—21.021 mm (0.8268—0.8276 in.)
Wear Limit. . . . . 21.05 mm (0.829 in.)
Clearance . . . . 0.040—0.094 mm (0.0016—0.0037 in.)

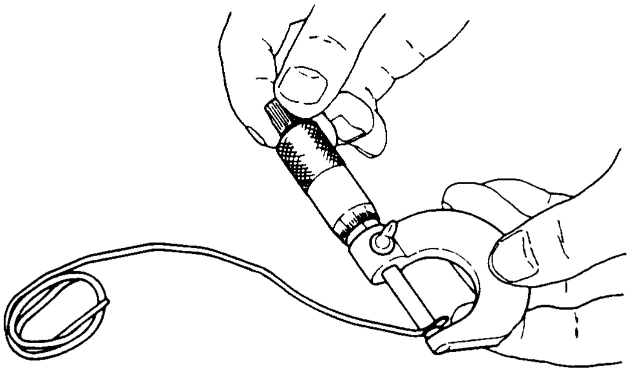
If cam follower bore diameter exceeds wear limit, replace cylinder block.

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

PISTON-TO-CYLINDER HEAD CLEARANCE—MEASURE

1. Place three 10 mm (0.400 in.) long pieces of 1.50 mm (0.060 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence to specified torque. (See CYLINDER HEAD AND VALVES.)
3. Slowly turn crankshaft one complete revolution.
4. Remove cylinder head and gasket.

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



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Piston-to-Cylinder Head Clearance . 0.61—0.79 mm (0.024—0.031 in.)

If clearance is less than specifications, replace cylinder head.

PISTON AND CONNECTING ROD

Removal

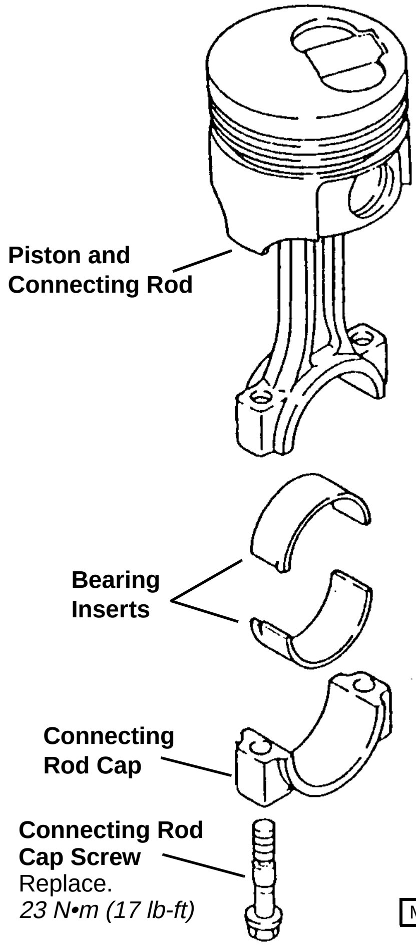
1. Remove oil pan and strainer tube. (See OIL PAN AND STRAINER.)
2. Remove cylinder head. (See CYLINDER HEAD AND VALVES.)
3. Check cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.
4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.
5.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

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

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

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

8. Note connecting rod alignment mark in relation to the cylinders, starting at flywheel end with cylinder number one, then two, etc.
9. Push piston and connecting rod out of cylinder bore using a wooden dowl.
10. Disassemble and inspect all parts for wear or damage. (See disassembly and inspection/ replacement procedures.)



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Installation

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

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

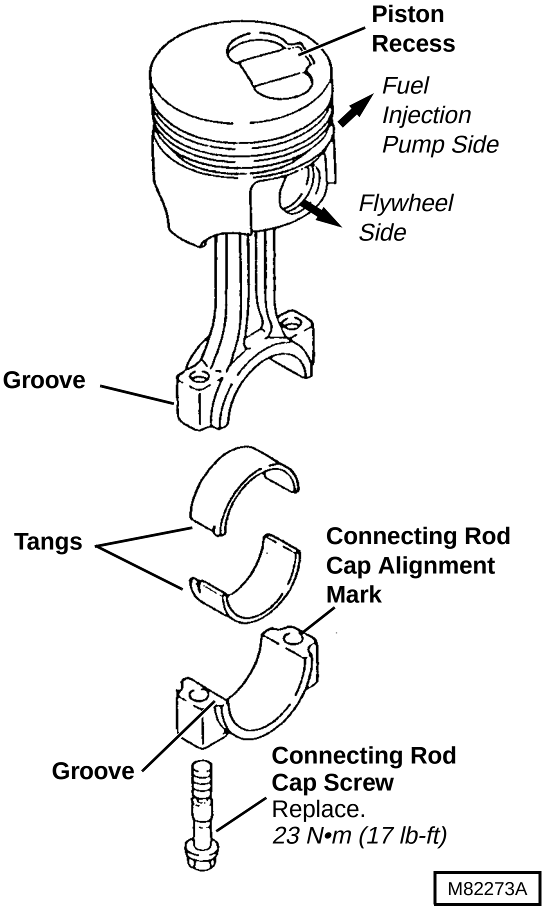
1. If new piston rings were installed, deglaze cylinder bore. (See CYLINDER BORE.)
2. Install piston and connecting rod into the cylinder from which it was removed, with piston recess on top of piston toward fuel injection pump.

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

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

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

4. Match the connecting rods to caps using alignment marks. Install caps.
5. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws and tighten to **23 N•m (17 lb-ft)**.
6. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod cap and connecting rod.

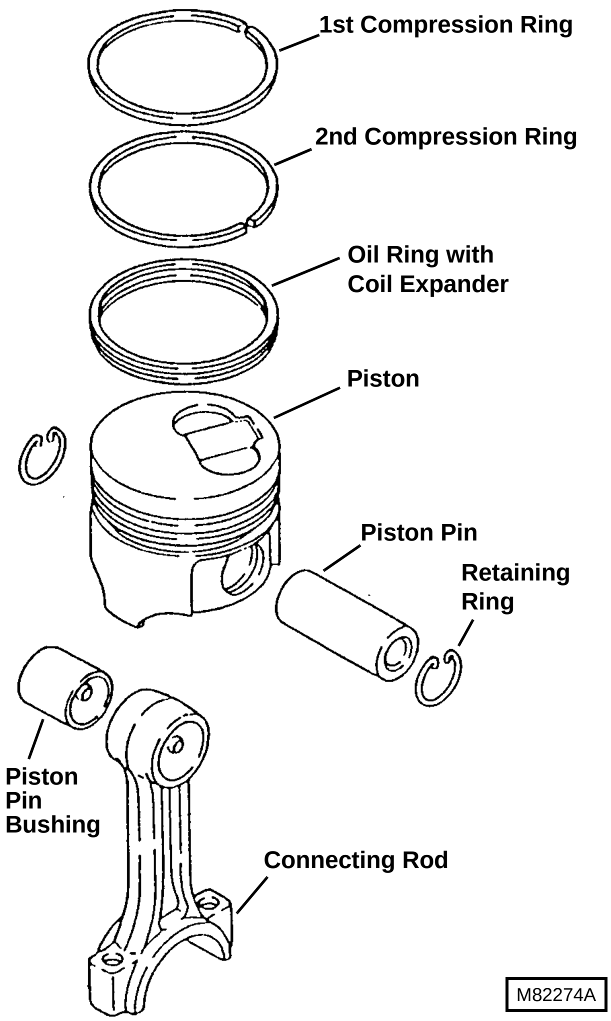


7. Install cylinder head. (See CYLINDER HEAD AND VALVES.)
8. Install oil pan and strainer tube. (See OIL PAN AND STRAINER.)

Disassembly

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

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

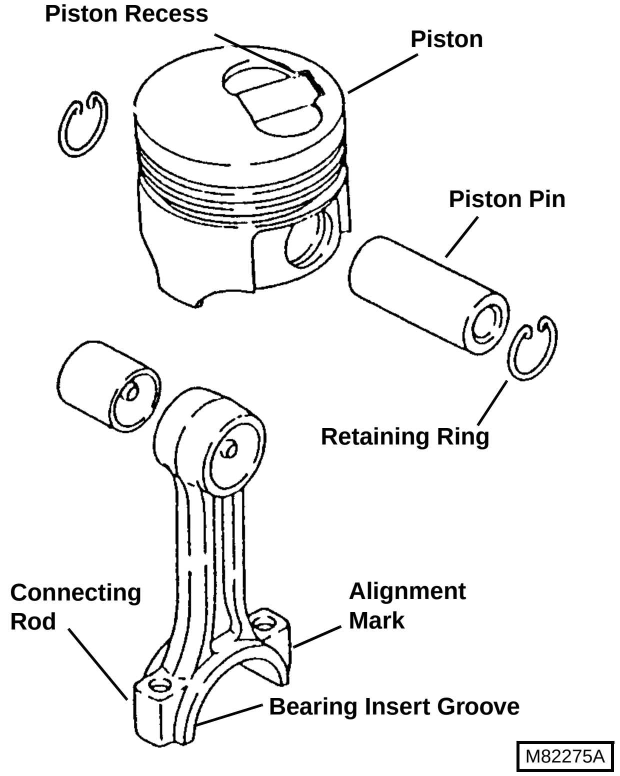


Assembly

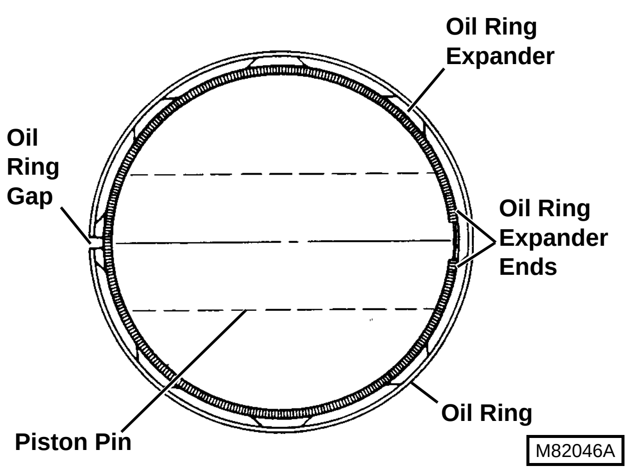
- Apply clean engine oil to all parts during assembly.

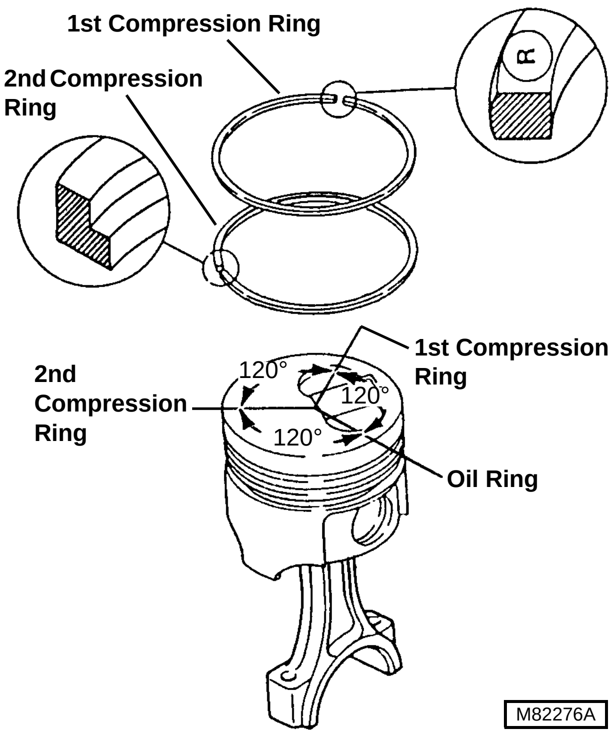
IMPORTANT: Pistons must be installed on the same connecting rod they were removed from.

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



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

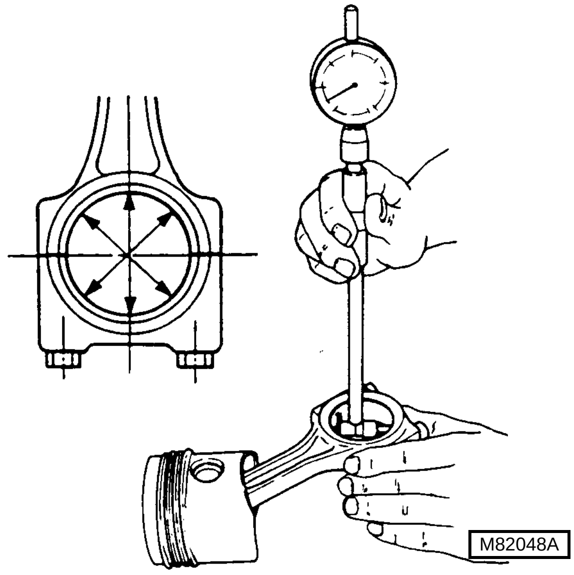




5. Install second compression ring, with chamfer toward top of piston, in middle groove. Turn ring until gap is 120^{o} away from oil ring gap.
6. Install first compression ring (chrome plated), with manufacturer's mark “T”, “R” or “RN” (near ring gap) toward top of piston, in top groove. Turn ring until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

Inspection/Replacement

1. Inspect all parts for wear or damage. Replace as necessary.
2. Measure crankshaft connecting rod journal diameter. (See CRANKSHAFT AND MAIN BEARINGS.)
3. Install connecting rod cap and bearing inserts on connecting rod. Install old connecting rod cap screws and tighten to **23 N•m (17 lb-ft)**.
4. Measure connecting rod bearing diameter.

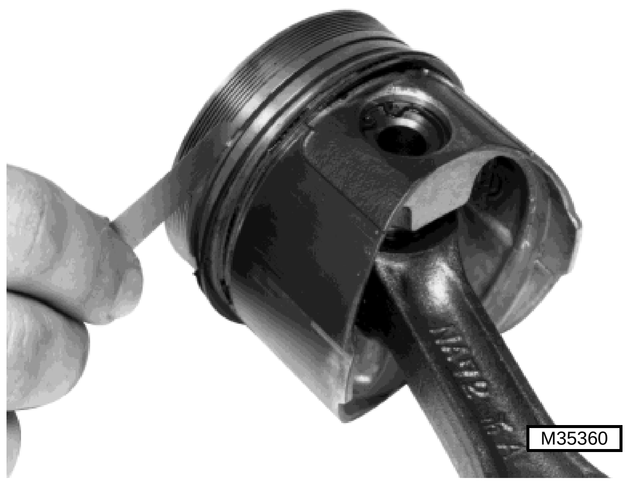


Connecting Rod Bearing ID:

Standard .40.00—40.042 mm (1.575—1.577 in.)
Wear Limit. . . . . 40.07 mm (1.578 in.)
Clearance . . . . 0.16 mm (0.006 in.)

If bearing diameter exceeds wear limit, replace bearing inserts.

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



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

Piston Ring Groove Clearance:

First Compression Ring

Standard . . . . 0.075—0.110 mm (0.0030—0.0043 in.)

Wear Limit. . . . . 0.20 mm (0.0079 in.)

Second Compression Ring

Standard . . . . 0.030—0.065 mm (0.0012—0.0026 in.)

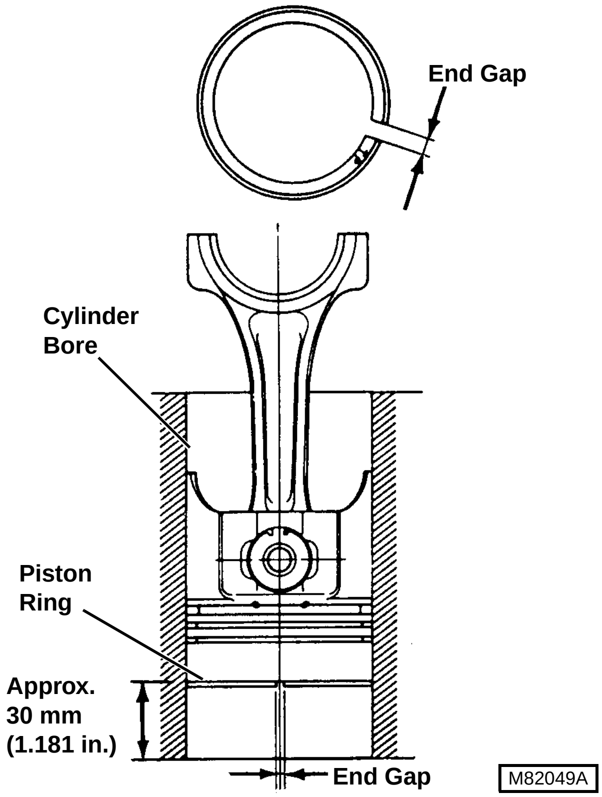
Wear Limit. . . . . 0.20 mm (0.0079 in.)

Oil Ring

Standard . . . . 0.020—0.055 mm (0.0008—0.0022 in.)

Wear Limit. . . . . 0.20 mm (0.0079 in.)

If clearance exceeds wear limit, replace rings or piston.



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

Piston Ring End Gap:

Standard

First Compression Ring . . . . 0.10—0.25 mm (0.004—0.010 in.)

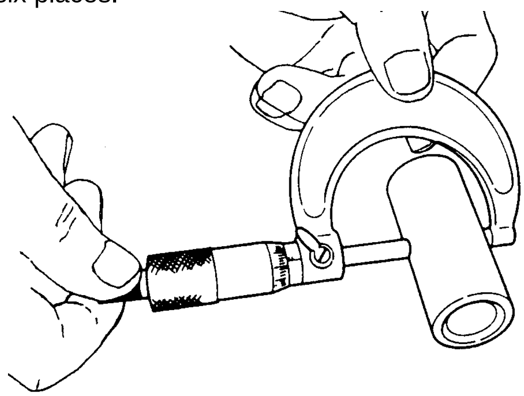
Second Compression Ring . . . . 0.25—0.40 mm (0.010—0.016 in.)

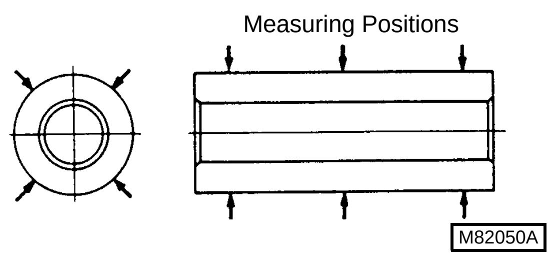
Oil Ring . . . . 0.15—0.35 mm (0.006—0.014 in.)

Wear Limit: . . . . 1.50 mm (0.0591 in.)

If end gap exceeds wear limit, replace rings.

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





Piston Pin OD:

Standard .20.991—21.00 mm (0.826—0.827 in.)

Wear Limit. . . . . 20.975 mm (0.825 in.)

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

M37683

8. Measure piston pin bore diameter in piston.

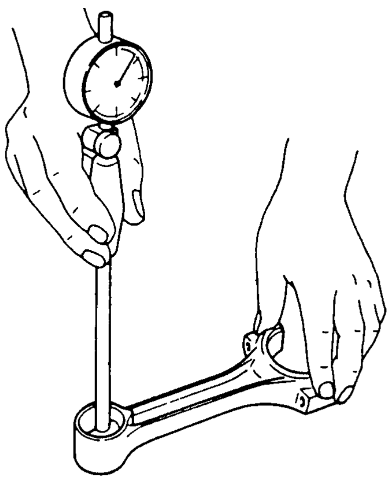
Piston Pin Bore ID:

Standard .21.00—21.009 mm (0.8268—0.8271 in.)
Wear Limit. . . . . 21.02 mm (0.828 in.)
Clearance . . . . 0.045 mm (0.0018 in.)

If piston pin bore exceeds wear limit, replace piston.

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

9. Measure piston pin bushing diameter in connecting rod.



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Piston Pin Bushing ID:

Standard . . . . .21.025—21.038 mm (0.8278—0.8282 in.)
Wear Limit. . . . . 21.10 mm (0.831 in.)
Clearance . . . . 0.11 mm (0.0043 in.)

If bushing diameter exceeds wear limit, replace bushing.

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

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

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

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) oversize

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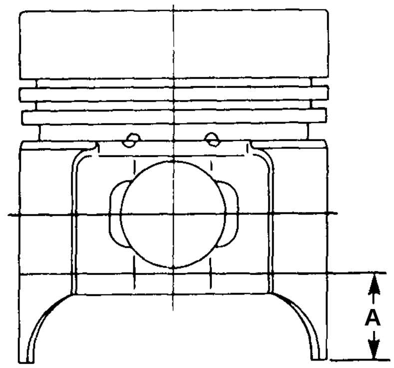

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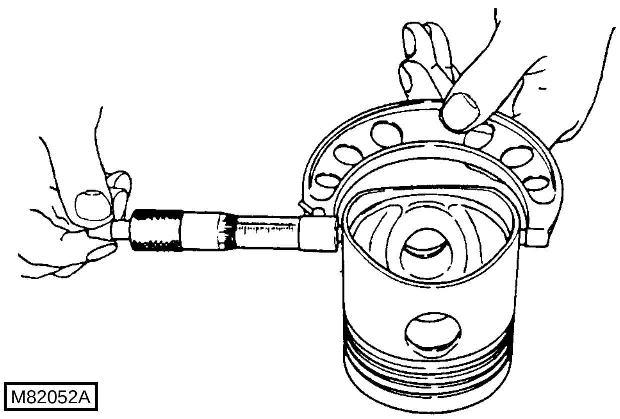

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Piston OD:

Distance A. .8 mm (0.315 in.)

Standard Size Piston

Standard . . . . .71.922—71.952 mm (2.832—2.833 in.)
Wear Limit. . . . . 71.81 mm (2.827 in.)

0.25 mm (0.010 in.) Oversize Piston

Standard . . . . .72.17—72.20 mm (2.841—2.842 in.)
Wear Limit. . . . . 72.06 mm (2.837 in.)

0.50 mm (0.020 in.) Oversize Piston

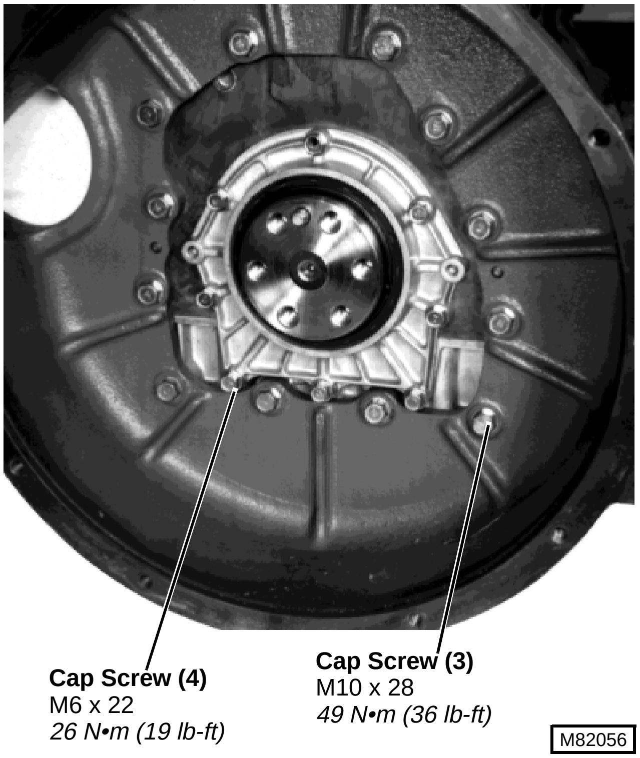
Standard . . . . .72.42—72.45 mm (2.851—2.852 in.)
Wear Limit. . . . . 72.31 mm (2.847 in.)

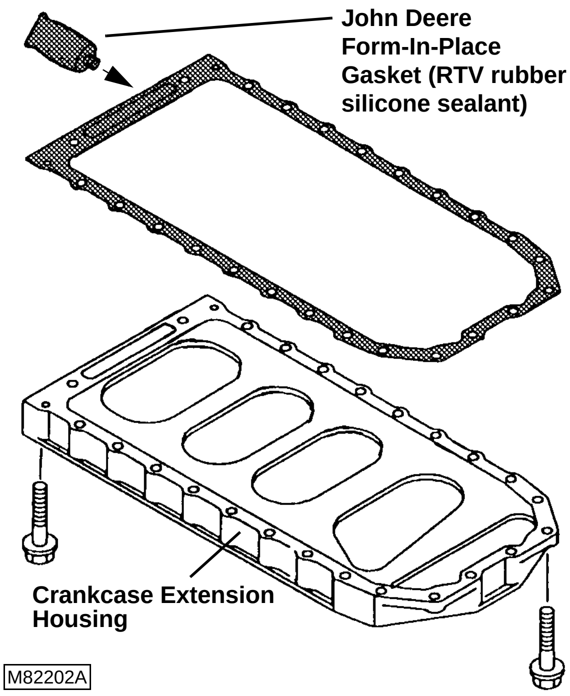
If piston diameter is less than wear limit, install a new piston.

11. Measure cylinder bore diameter. (See CYLINDER BORE.)

CRANKCASE EXTENSION HOUSING

1. Remove flywheel. (See FLYWHEEL.)
2. Remove oil pan and oil strainer. (See OIL PAN AND STRAINER.)



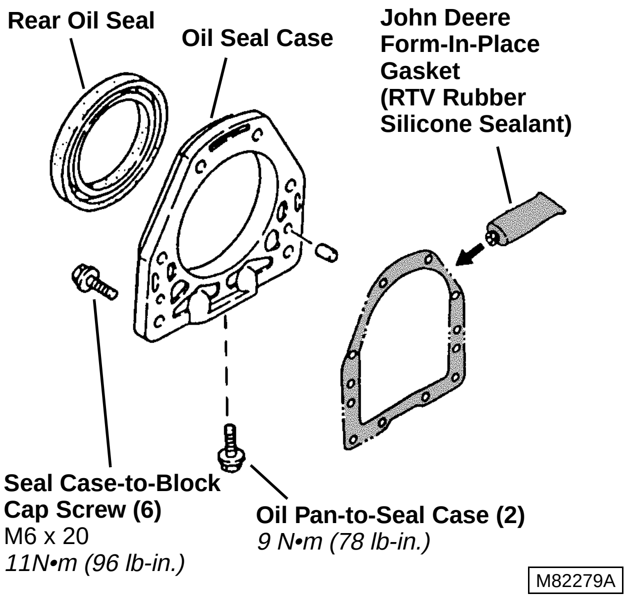


CRANKSHAFT REAR OIL SEAL

Replacement

1. Remove flywheel plate. (See FLYWHEEL PLATE.)
   - Replace oil seal using a driver set. Install seal, with lip toward cylinder block. Install seal flush with surface of oil seal case.

NOTE: If crankshaft is grooved at oil seal contact point, seal can be installed 3 mm (0.120 in.) farther into oil seal case.

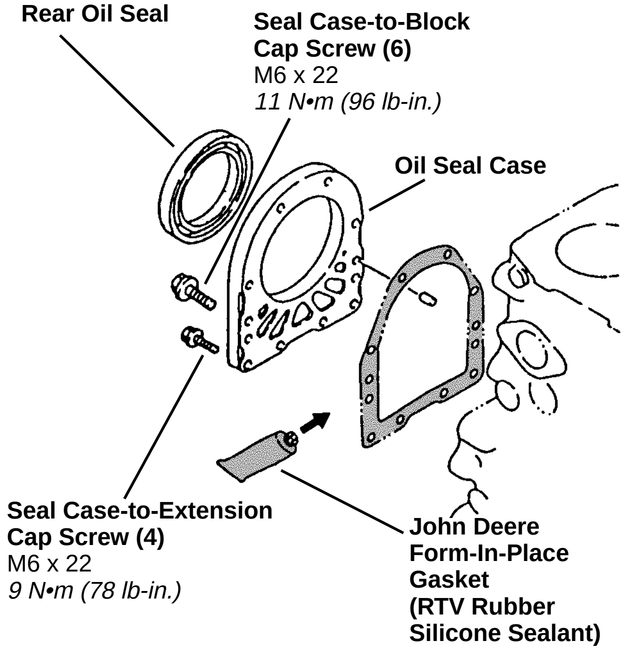


CRANKSHAFT EXTENSION REAR OIL SEAL

Replacement

1. Remove flywheel plate. (See FLYWHEEL PLATE.)
- Replace oil seal using a driver set. Install seal, with lip toward cylinder block. Install seal flush with surface of oil seal case.

If crankshaft is grooved at oil seal contact point, seal can be installed 3 mm (0.120 in.) farther into oil seal case.



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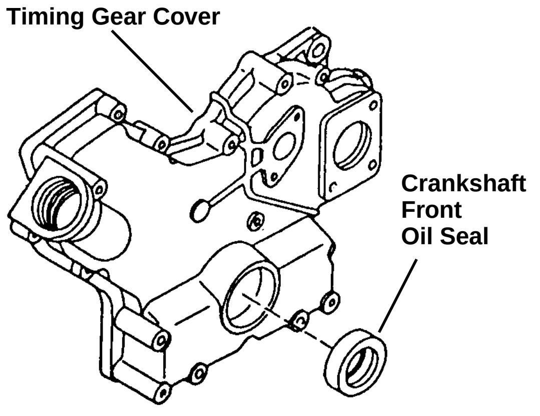
CRANKSHAFT FRONT OIL SEAL

Replacement

NOTE: Timing gear covers are similar. The most common applications are shown.

1. Remove timing gear cover. (See TIMING GEAR COVER.)
2. Replace oil seal using a driver set. Install seal with lip toward inside of gear housing cover. Install seal flush with surface of cover.



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CRANKSHAFT AND MAIN BEARINGS

Removal

1. Check crankshaft end play. (See TESTS AND ADJUSTMENTS.)
2. Remove rear oil seal. (See CRANKSHAFT REAR OIL SEAL.)
3. Remove flywheel housing, if equipped. (See FLYWHEEL HOUSING.)
4. Remove crankcase extension housing, if equipped. (See CRANKCASE EXTENSION HOUSING.)
5. Remove timing gear housing. (See TIMING GEAR HOUSING.)
6. Check crankshaft bearing clearance. (See TESTS AND ADJUSTMENTS.)

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

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

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

9. Remove main bearing cap screws, caps and cap thrust bearings.
10. Remove crankshaft.
11. Remove block thrust bearings and main bearing inserts.
12. Inspect all parts for wear or damage. (See inspection/replacement procedures.)

Installation

- Apply clean engine oil on all parts during installation.

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

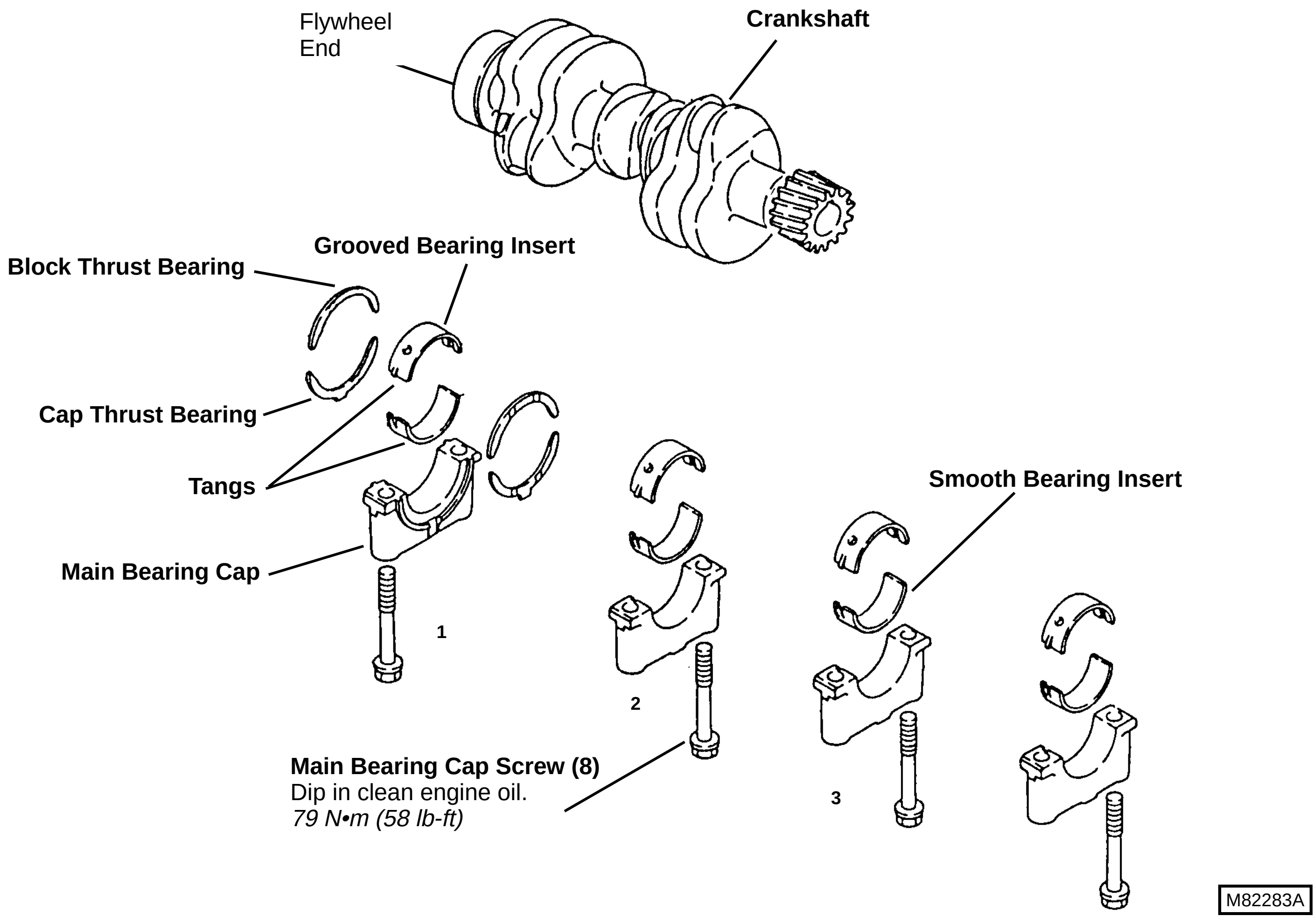
1. Install grooved bearing inserts in crankshaft bearing bores, aligning tangs with slots in bores.
2. Install block thrust bearings with oil grooves facing away from engine block.

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

3. Install crankshaft.
4. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
5. Install cap thrust bearings, with oil grooves facing away from cap, in the number "1" main bearing cap.
6. Install main bearing caps in their original locations with arrows pointing toward flywheel side of engine.

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

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



9. Tighten main bearing cap screws to specifications. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

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

Never reuse connecting rod cap screws. Replace with new.

10. Match the connecting rod caps to the rods using alignment marks. Install caps.
11. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws and tighten to **23 N•m (17 lb-ft)**.
12. Install timing gear housing. (See TIMING GEAR HOUSING.)
13. Install crankcase extension housing, if equipped. (See CRANKCASE EXTENSION HOUSING.)
14. Install flywheel housing, if equipped. (See FLYWHEEL HOUSING.)
15. Install rear oil seal. (See CRANKCASE REAR OIL SEAL.)

Inspection/Replacement

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

To replace gear:

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

c CAUTION

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

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

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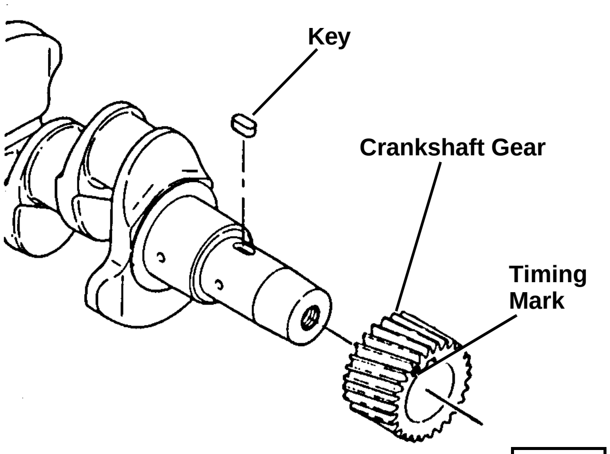

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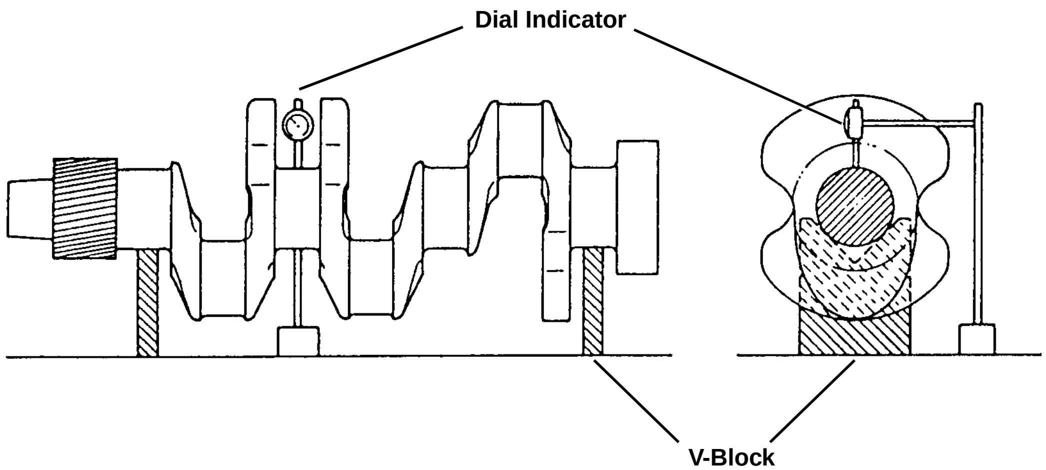
2. Inspect crankshaft for bend using V-blocks and a dial indicator. Turn crankshaft slowly and read variation on indicator. If variation is greater than **0.02 mm (0.0007 in.)**, replace crankshaft.



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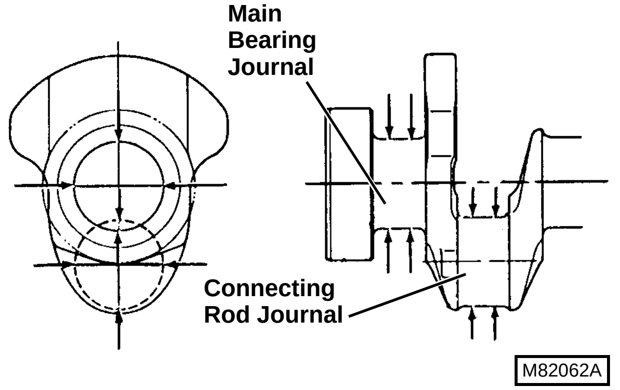
3. Measure crankshaft connecting rod journal and main bearing journal diameters. Measure several places around each journal.

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



Connecting Rod Journal OD:

Standard . . . . .39.97—39.98 mm (1.5736—1.5740 in.)

Wear Limit. . . . . 39.92 mm (1.572 in.)

Main Bearing Journal OD:

Standard . . . . .43.97—43.98 mm (1.7311—1.7315 in.)

Wear Limit. . . . . 43.92 mm (1.729 in.)

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

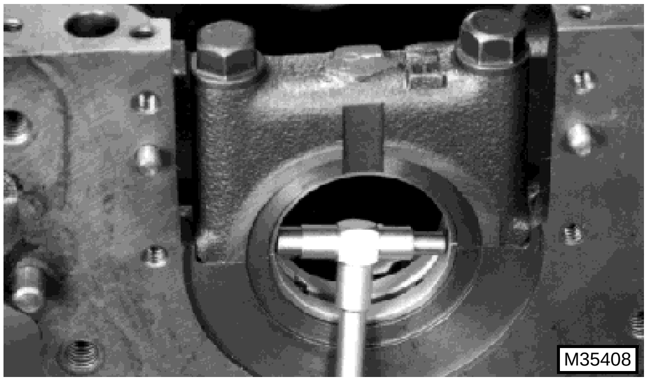
If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

4. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specifications.

Main Bearing Cap Screw Torque Specifications:

Torque . . . . .79 N•m (58 lb-ft)

5. Measure main bearing diameter.



Main Bearing ID:

Standard . . . . 44.00—44.042 mm (1.732—1.734 in.)

Wear Limit. . . . . 44.07 mm (1.735 in.)

Clearance . . . . 0.15 mm (0.0059 in.)

If bearing diameter exceeds wear limit, replace bearing inserts.

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

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

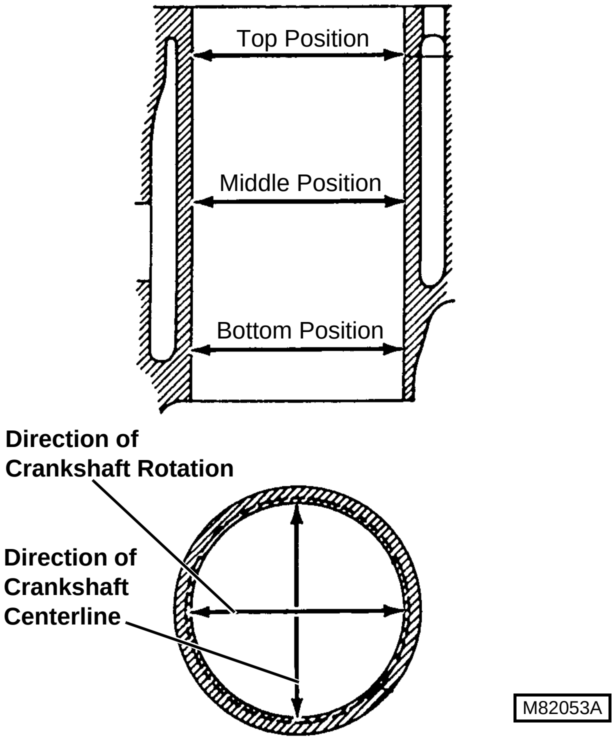
6. Clean and inspect oil passages in main bearing journals, connecting rod journals and main bearing bores in cylinder block.
7. Inspect crankshaft for cracks or damage. Replace if necessary.

CYLINDER BORE

Inspection

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

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.



Cylinder Bore ID:

Standard Size Bore

Standard . . . . 72.00—72.03 mm (2.835—2.836 in.)
Wear Limit . . . . 72.20 mm (2.843 in.)
Clearance . . . . 0.28 mm (0.011 in.)

0.25 mm (0.010 in.) Oversize Bore

Standard . . . . 72.25—72.28 mm (2.845—2.846 in.)
Wear Limit. . . . . 72.45 mm (2.852 in.)

0.50 mm (0.020 in.) Oversize Bore

Standard . . . . 72.50—72.53 mm (2.855—2.856 in.)
Wear Limit. . . . . 72.70 mm (2.862 in.)

If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. (See Reboring procedure.)

If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) oversize.

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

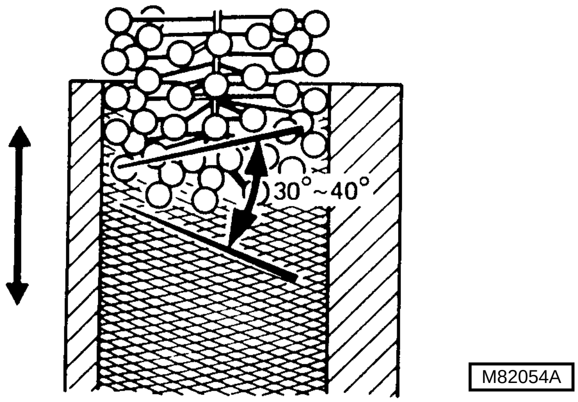
Deglazing

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

1. Deglaze cylinder bores using a flex-hone with 180 grit stones.
2. Use flex-hone as instructed by manufacturer to obtain a **30—40° crosshatch pattern** as shown.

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

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



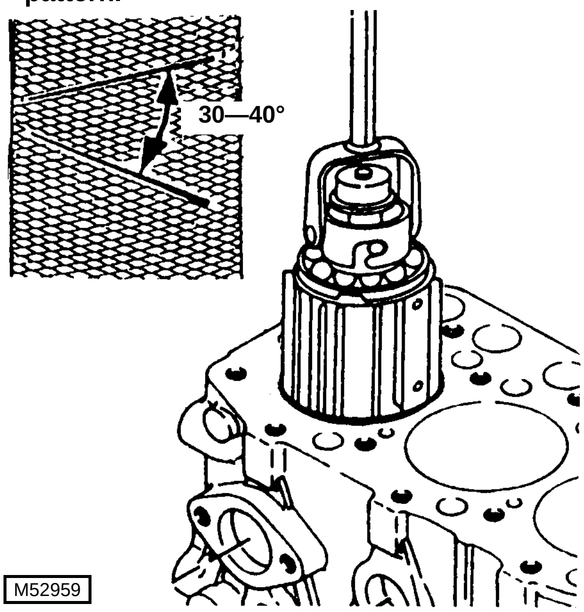
Reboring

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) oversize. (See this group for cylinder bore ID specifications.)

1. Align center of bore to drill press center.

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

2. Adjust hone so lower end is even with lower end of cylinder bore.
3. Adjust rigid hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.
5. Run drill press at about 250 rpm. Move hone up and down in order to obtain a **30—40° crosshatch pattern.**



NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 30—40^0 crosshatch pattern.

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

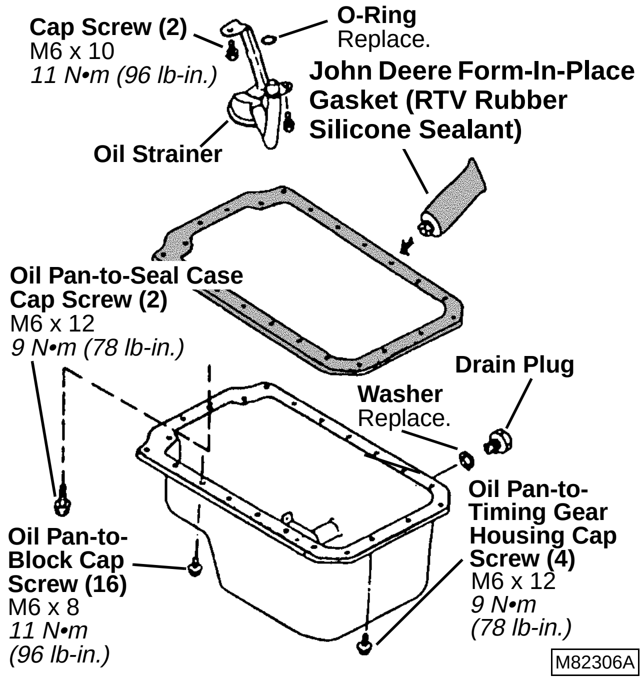
IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

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

OIL PAN AND STRAINER

Removal/Installation

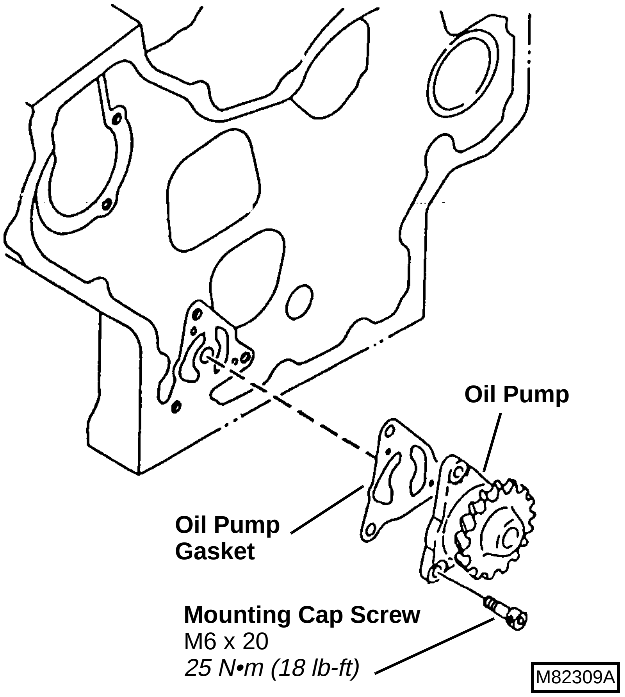
- Approximate crankcase oil capacity is **2.8L (3 qt)**
- Fill engine with proper engine oil.



OIL PUMP

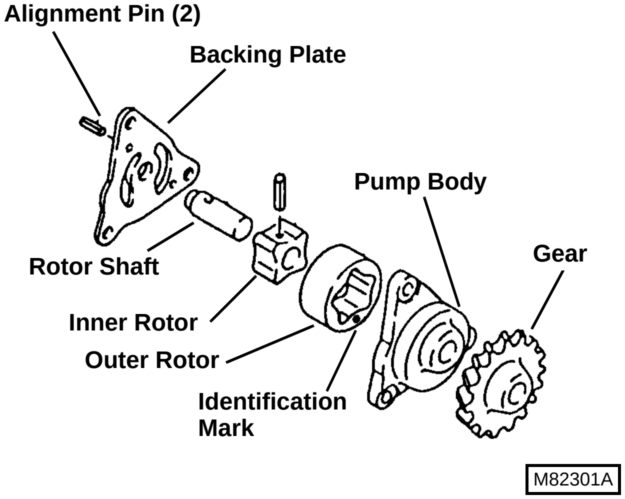
Removal/Installation

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



Disassembly/Assembly

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



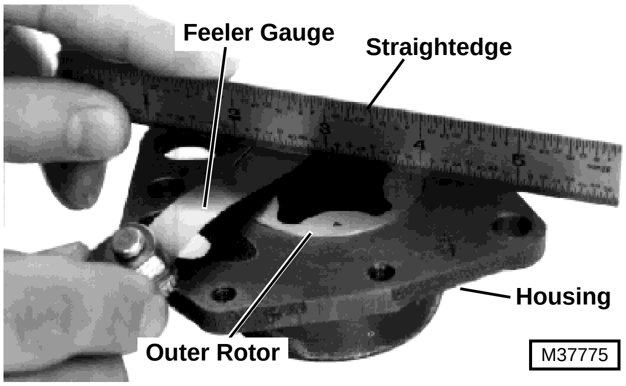
Inspection

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

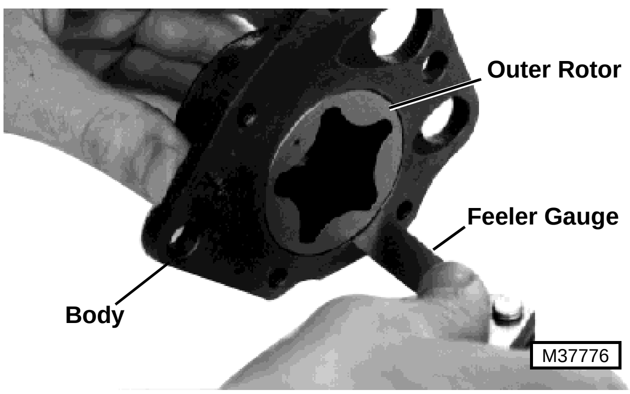
Rotor Shaft and Plate Clearance:

Standard . . . . 0.015—0.048 mm (0.0006—0.0035 in.)
Wear Limit. . . . . 0.20 mm (0.0078 in.)

2. Check rotor recess. If rotors are below face of pump housing more than **0.25 mm (0.010 in.)**, replace rotor assembly.



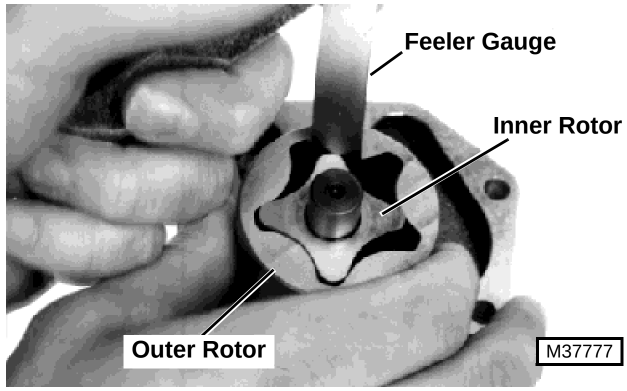
3. Check outer rotor-to-pump body clearance. If clearance is more than wear limit, replace entire assembly.



Outer Rotor-to-Pump Body Clearance:

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

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



OIL PRESSURE REGULATING VALVE

Removal/Installation

1. Remove oil filter.
2. Remove three cap screws, valve assembly and gasket.

NOTE: If adjusting engine oil pressure, retaining nut need not be removed.

3. If adjusting pressure only, remove cap and add shims. Each 1 mm (0.039 in.) of shim thickness increases oil pressure 10.9 kPa (1.6 psi).

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

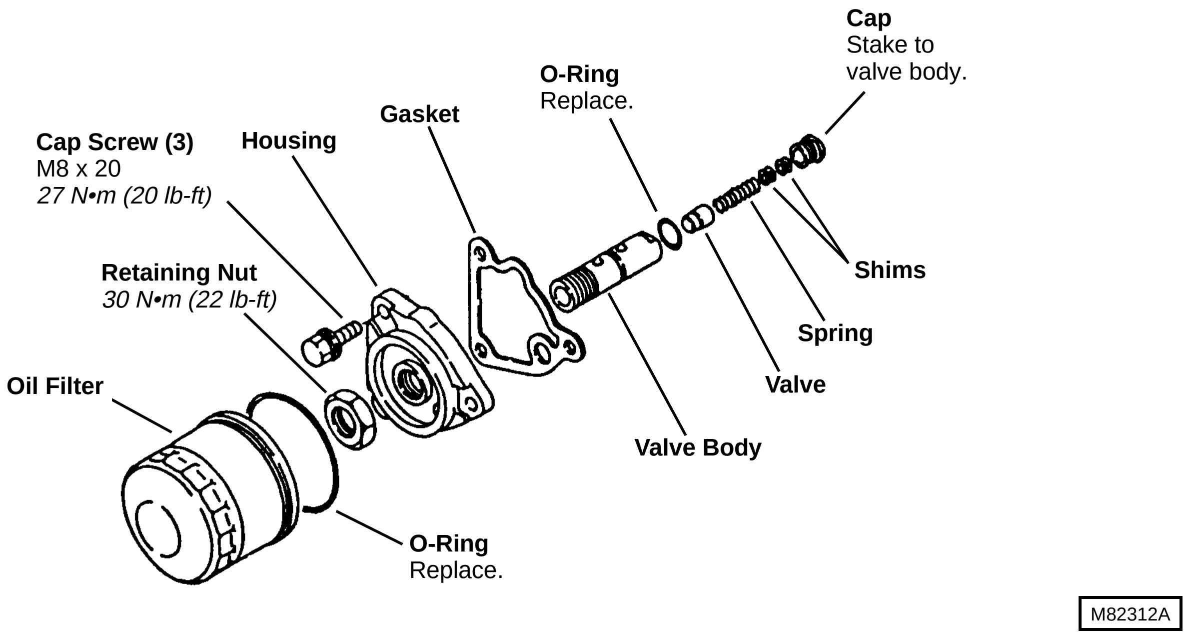
4. Inspect all parts for wear or damage. Replace complete valve if necessary.
5. Check spring free and compressed lengths.

Spring Specifications:

Free Length. . . . . 43.50—48.50 mm (1.710—1.910 in.)

Compressed Length . . . . 27.50 mm (1.080 in.) with 20.5 N (4.6 lb-force)

Installation is done in the reverse order of removal.



FREEZE PLUGS

IMPORTANT: If freeze plug is removed or is leaking, replace freeze plug.

NOTE: If one plug is leaking check all freeze plugs.

1. Check plug OD It should be **30.218 mm—30.30 mm (1.190—1.193 in.)**.
2. Check hole size in engine, it should be **30.00 mm—30.030 mm (1.181—1.182 in.)**.
3. Coat OD of plug with a high temperature gasket maker like TY15130 or TY15941 before installing.
4. Insert plug into block 1mm (0.039 in.) below outer surface of block, then seat plug.
5. Let sealant set up a couple of hours before filling with coolant.
6. If freeze plug failure is due to over-heating, keep radiator fins clean—especially behind the fan. Install anti-blowout kit on 48/54 mower decks. This will help prevent radiator fins from plugging.

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ELECTRICAL

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SPECIFICATIONS

GENERAL SPECIFICATIONS

Ignition	Electronic
Starter Type	Solenoid Shift
Charging System	415—20-amp Alternator
	425 and 445—15-amp Stator
	455—40-amp Alternator
	455—20-amp Alternator
Battery	
Type	BCI Group U1
Voltage	12V
Reserve Capacity @25A	44 Minutes
	455 (40-amp alternator)—76 Minutes
Cold Cranking Amps @0°	342
	455 (40-amp alternator)—470
Headlights	
Incandescent	Standard
Halogen Bulbs	Optional
Tail Lights	Standard

TEST AND ADJUSTMENT SPECIFICATIONS

425 and 445

Stator	15 amps
Regulated Amperage/Voltage	15 amps (min.) at 12.2—13.8 volts
Unregulated Voltage	26 VAC (min.)
Starter	
Amp Draw/RPM	72 amps (max.) at 500 RPM
No-Load Amps/RPM	50 amps (max.) at 6000 RPM
Pulser Coil Resistance—425	85—270 ohms
Pulser Coil Resistance—445	190—290 ohms
Ignition Coil	
Primary Winding Resistance	3.4—4.5 ohms
Secondary Winding Resistance	18.0 k-ohms
Spark Plug Gap	0.64 mm (0.025 in.)
Fuel Gauge Sensor Float Resistance	Smooth Increase/Decrease 6—200 ohms

445

Air Pressure Sensor Terminal Resistance (Approximation):	
Left and Center	2986—3034 ohms
Left and Right	773—787 ohms
Center and Right	3774—3798 ohms
Input Voltage	about 5 volts
Output Voltage	0.5—4.9 volts Depending on Air Pressure
Air and Coolant Temperature Sensor Resistance (Approximation):	
At 20°C (68°F)	2.21—2.69 k-ohms
At 0—30°C (32—86°F)	5.88—1.65 k-ohms
Fuel Injector Resistance (Approximation) at 20°C (68°F)	13.8 ohms

455

Alternator . . . . .20 amps
Regulated Amperage/Voltage . . . . 35 amps (min.) at 12.2—13.8 volts
Regulated Voltage . . . . .12.2—14.7
Starter Amp Draw/RPM . . . . 230 amps (max.) at 300 RPM
No-Load Amps/RPM . . . . 90 amps (max.) at 3000 RPM
Fuel Shut-Off Solenoid Pull-In Amperage . . . . 60 amps (max.) for 1/2 second
Hold-In Amperage . . . . .1 amp (max.) continuous
Fuel Gauge Sensor Float Resistance . . . . . Smooth Increase/Decrease 6—200 ohms

455

Alternator . . . . .40 amps
Regulated Amperage/Voltage . . . . 35 amps (min.) at 12.2—13.8 volts
Regulated Voltage. . . . . .12.2—14.7
Starter Amp Draw/RPM . . . . 230 amps (max.) at 300 RPM
No-Load Amps/RPM . . . . 90 amps (max.) at 3000 RPM
Fuel Shut-Off Solenoid Pull-In Amperage . . . . 60 amps (max.) for 1/2 second
Hold-In Amperage . . . . .1 amp (max.) continuous
Fuel Gauge Sensor Float Resistance . . . . . Smooth Increase/Decrease 6—200 ohms

REPAIR SPECIFICATIONS

Alternator—455 (20 amp)

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

Alternator—455 (40 amp)

Minimum Rotor Slip Ring O.D. . . . . 14 mm (0.550 in.)
Retainer-to-Front Frame Screw Torque. . . . . 2 N•m (16 lb-in.)
Sheave Nut Torque . . . . 69 N•m (51 lb-ft)
Brush Length
New . . . . .10.50 mm (0.410 in.)
Wear Limit . . . . .4.50 mm (0.170 in.)

Starter—425 and 445

Minimum Brush Length . . . . 6 mm (0.240 in.)

Starter—455

Minimum Brush Length . . . . 8.5 mm (0.300 in.)

OTHER MATERIALS

John Deere pipe sealant with Teflon® . . . . To seal threads on coolant temperature sensor and oil pressure switches

Teflon is a registered trademark of the Du Pont Company.

READING ELECTRICAL SCHEMATICS

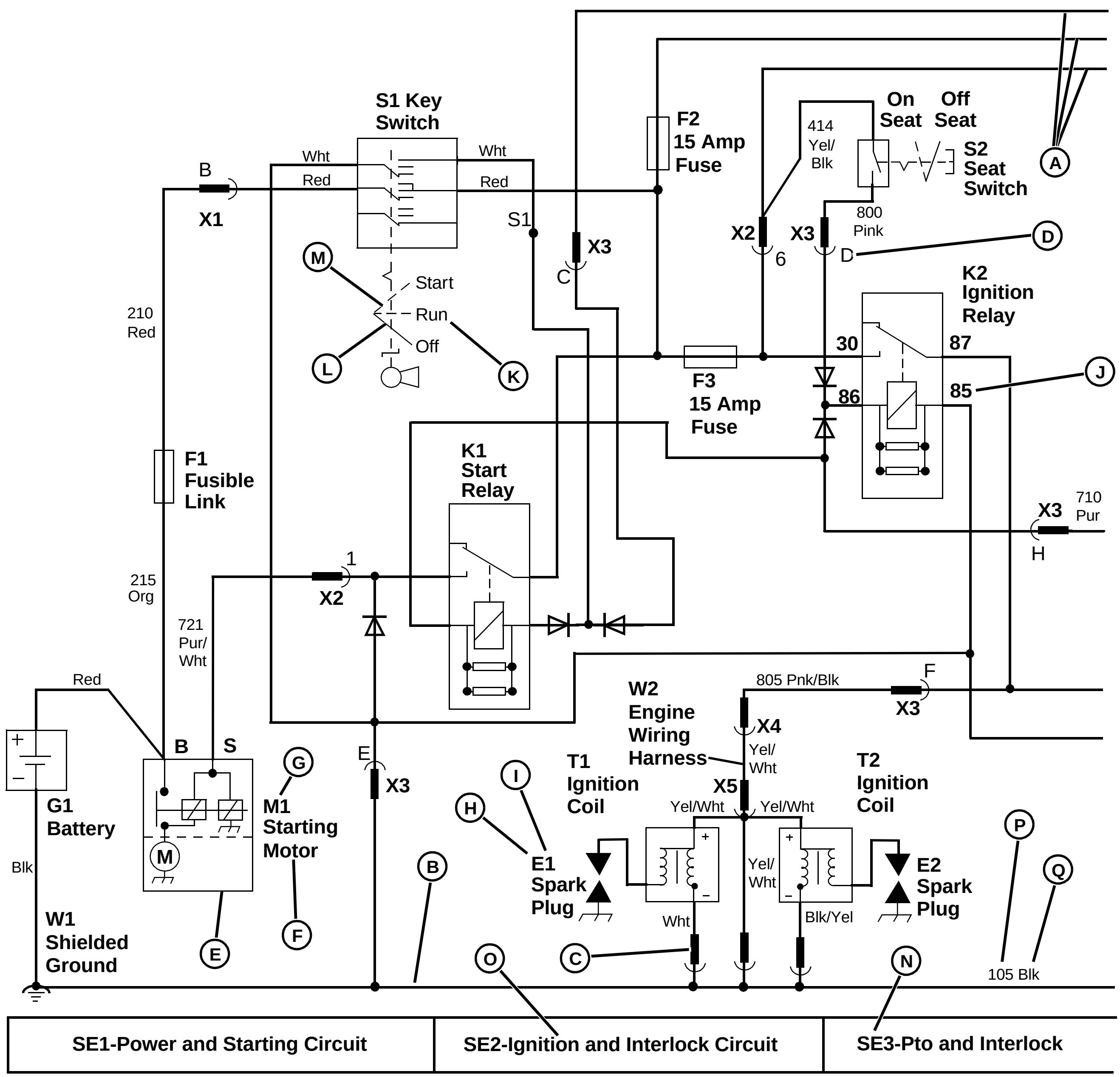
The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in 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.



THEORY AND DIAGNOSTIC INFORMATION

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

DIAGNOSTIC INFORMATION

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

The diagnostic procedure lists:

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

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

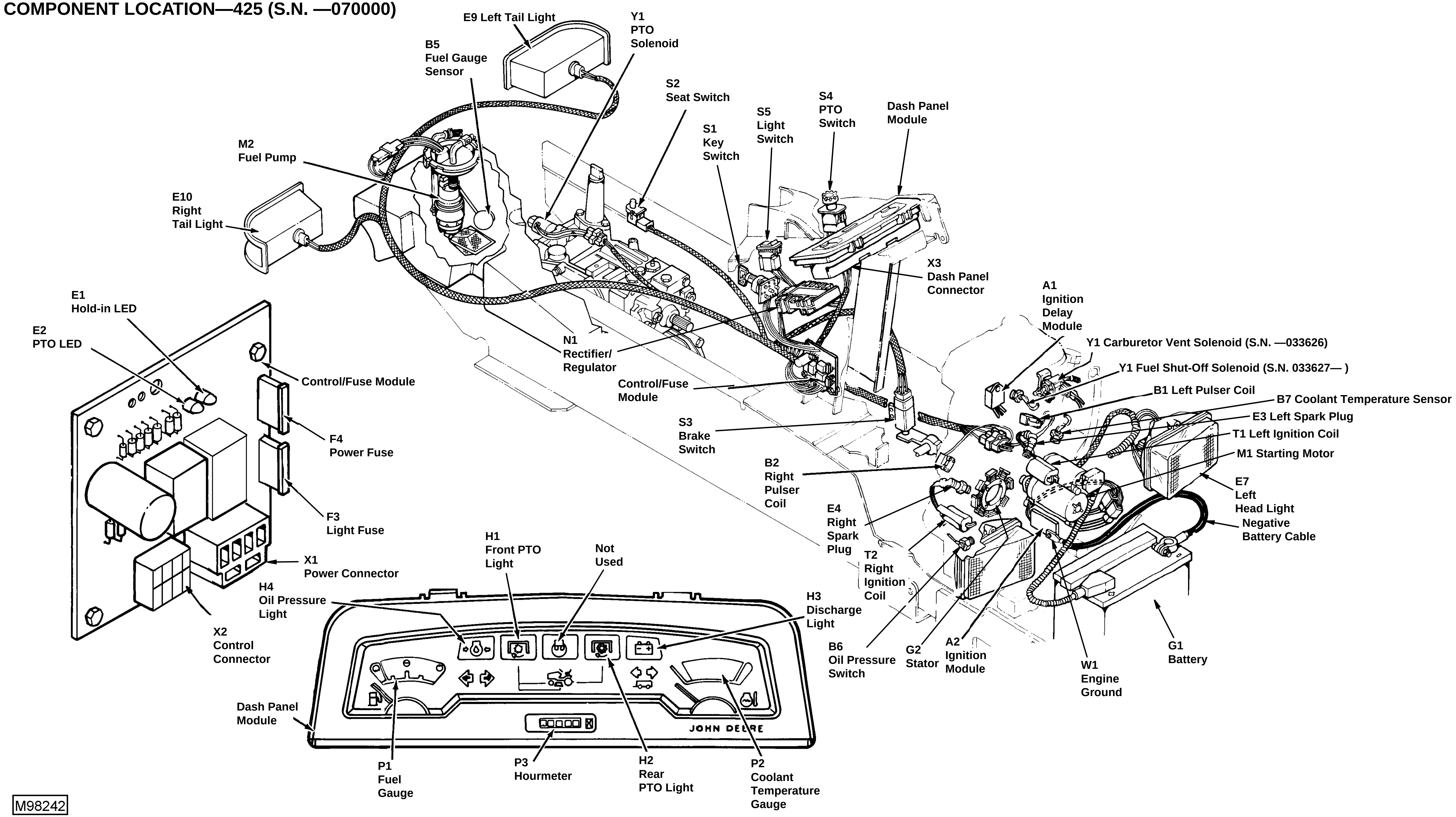
IMPORTANT: The fusible links are designed into the wiring harness to sacrifice themselves should there be a short or other problem in a portion of the wiring harness. If the fusible link fails and the wiring problem is not corrected, the link will fail again.

WIRE COLOR ABBREVIATION CHART

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

COMPONENT LOCATION—425

COMPONENT LOCATION—425 (S.N. —070000)



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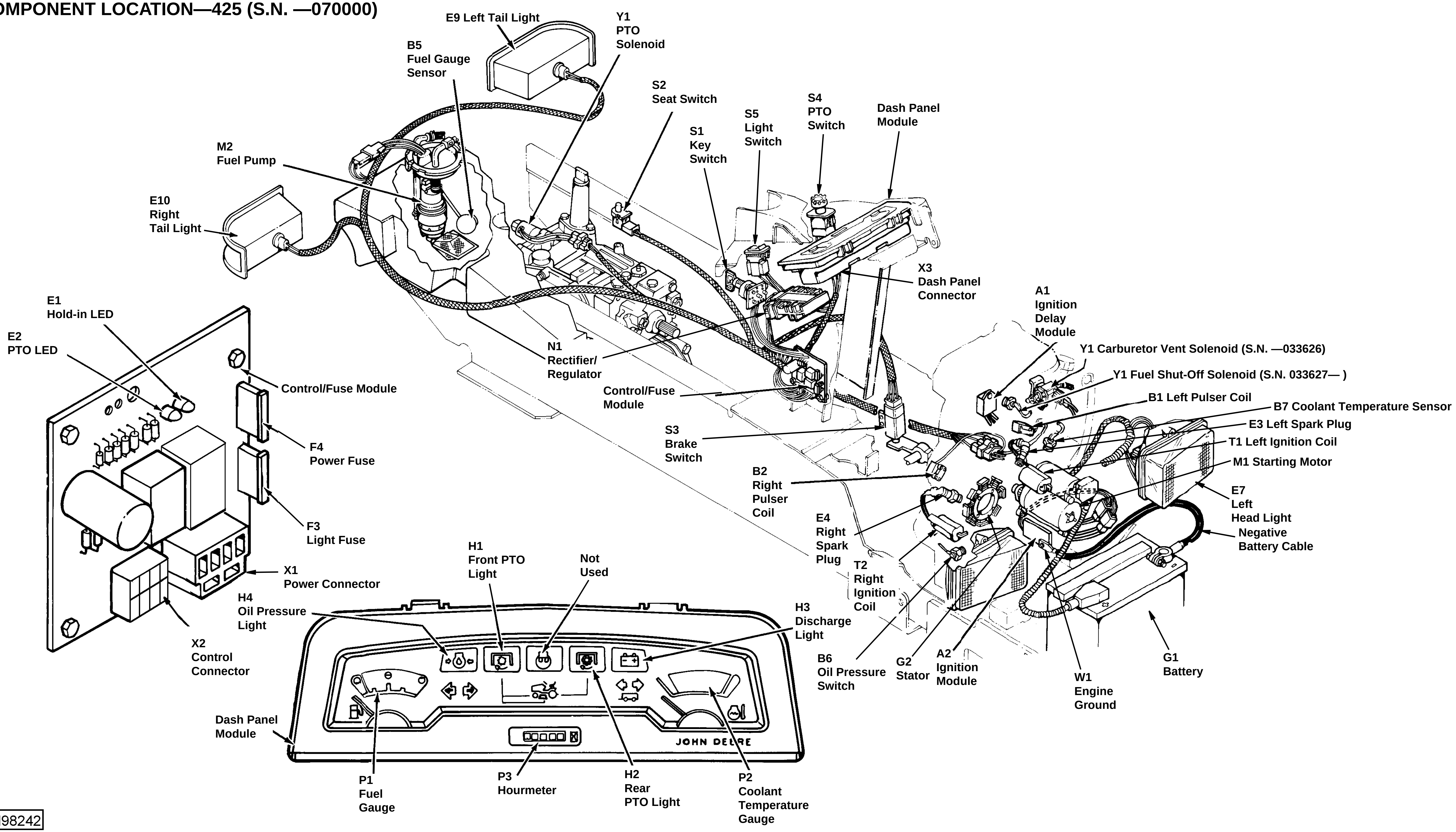
COMPONENT LOCATION—425

COMPONENT LOCATION—425 (S.N. —070000)



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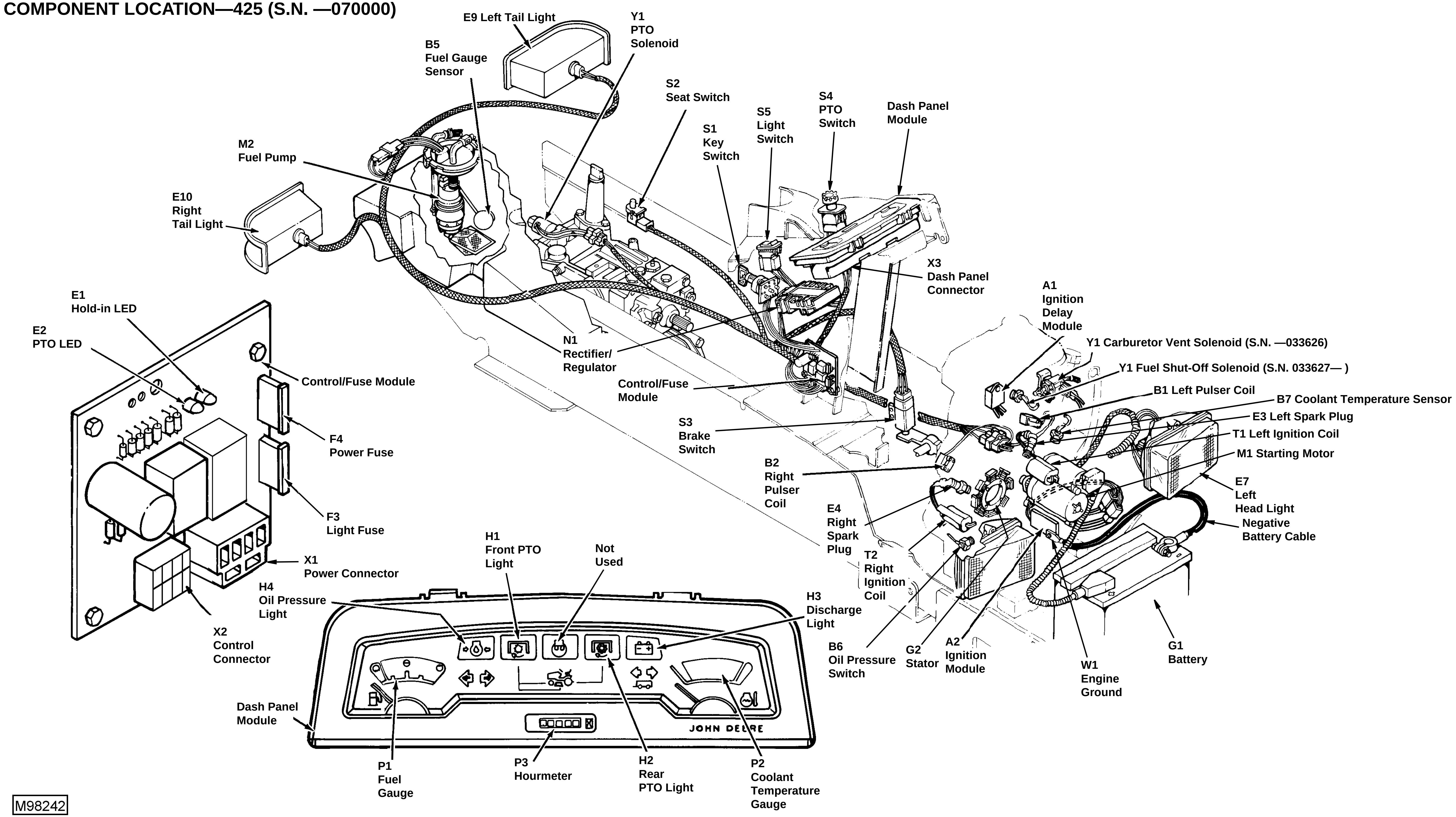

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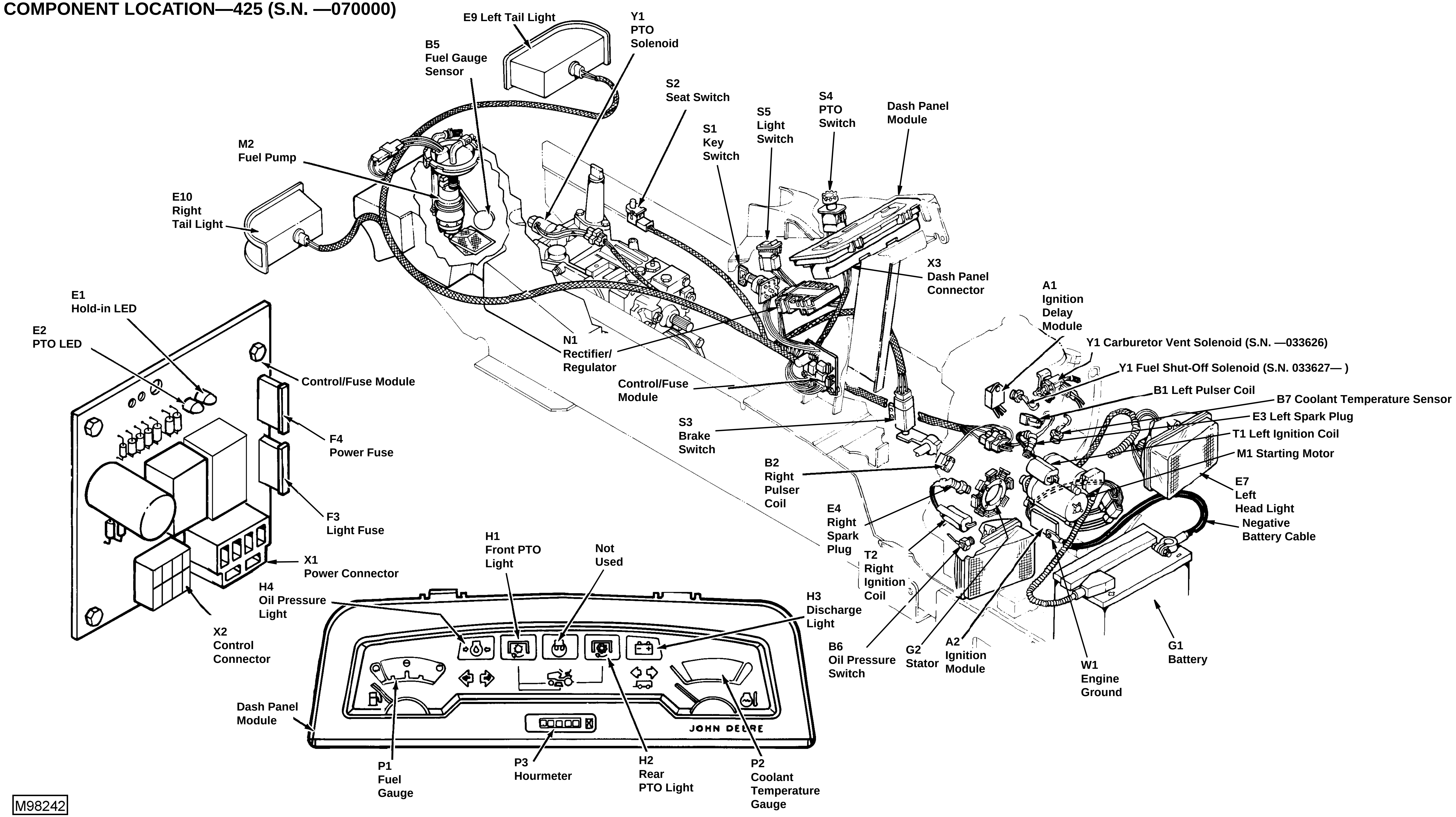

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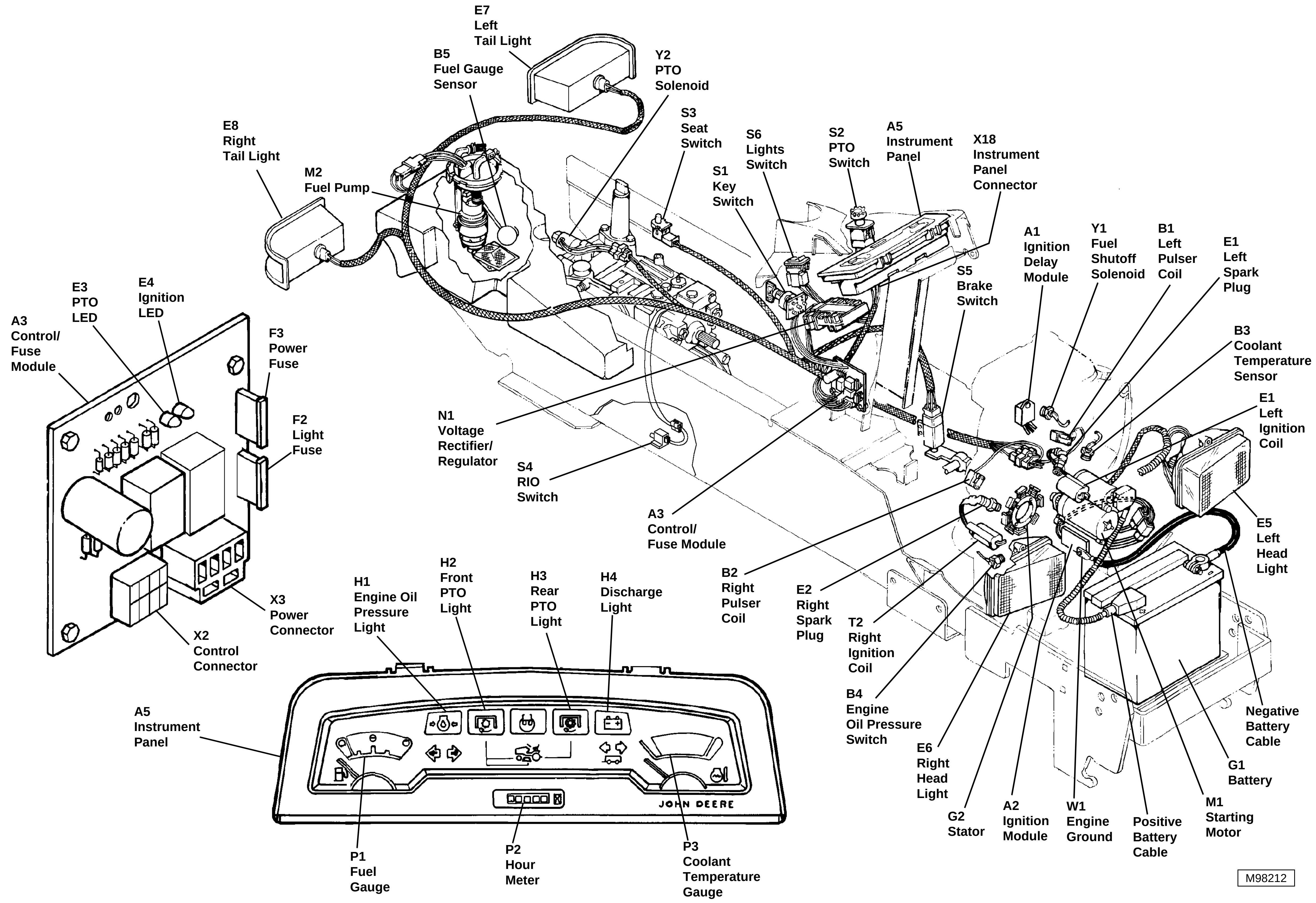

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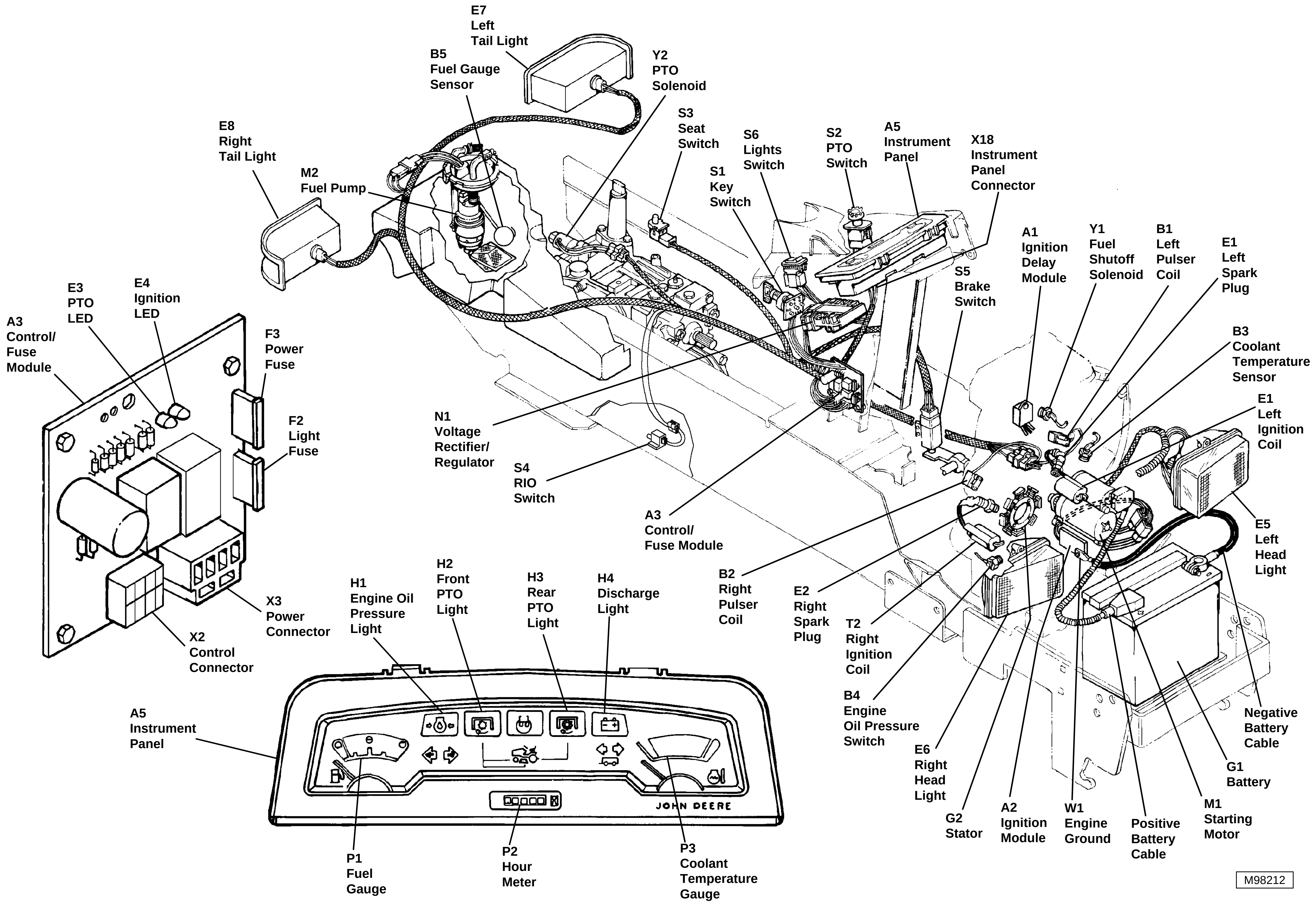

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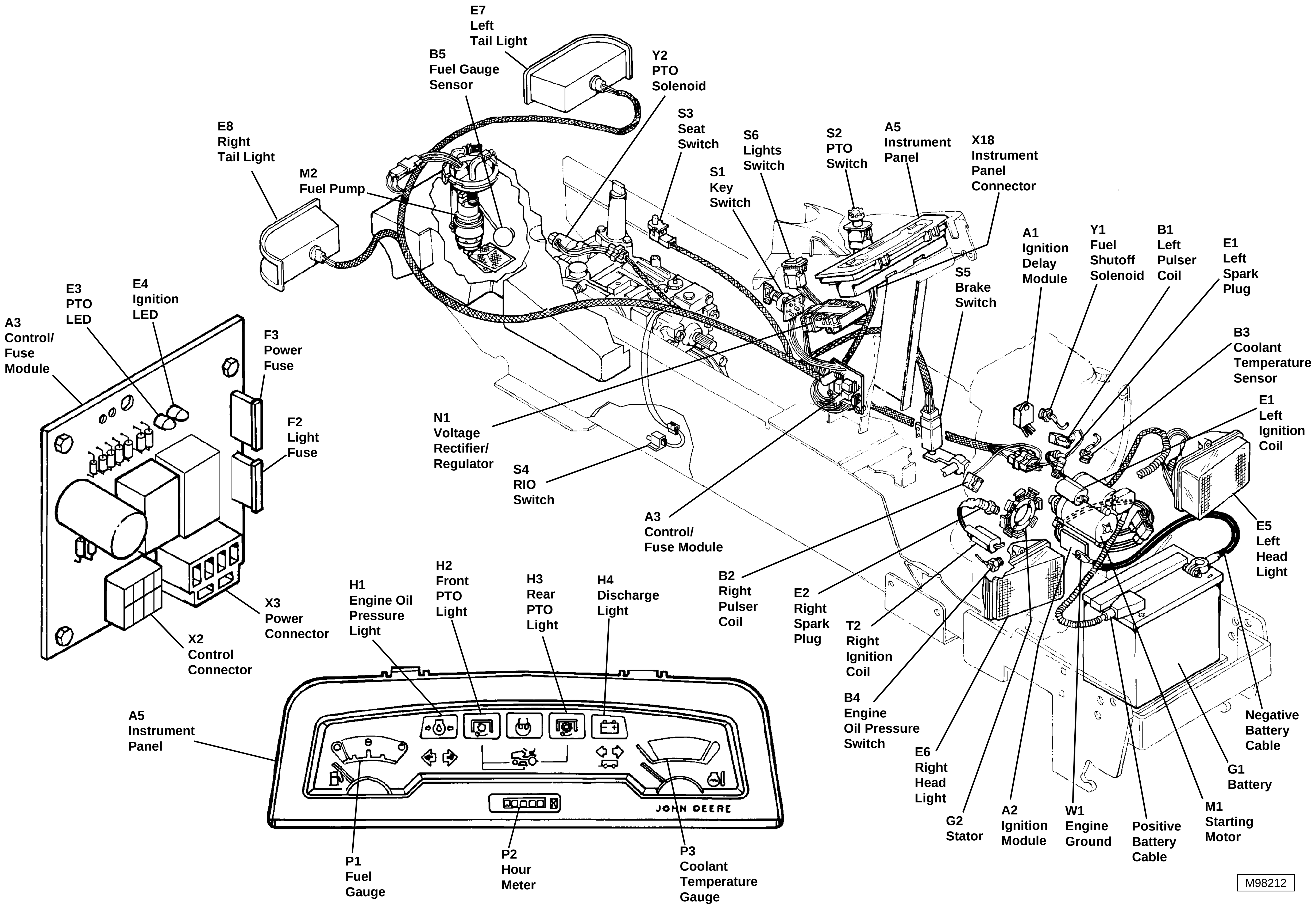

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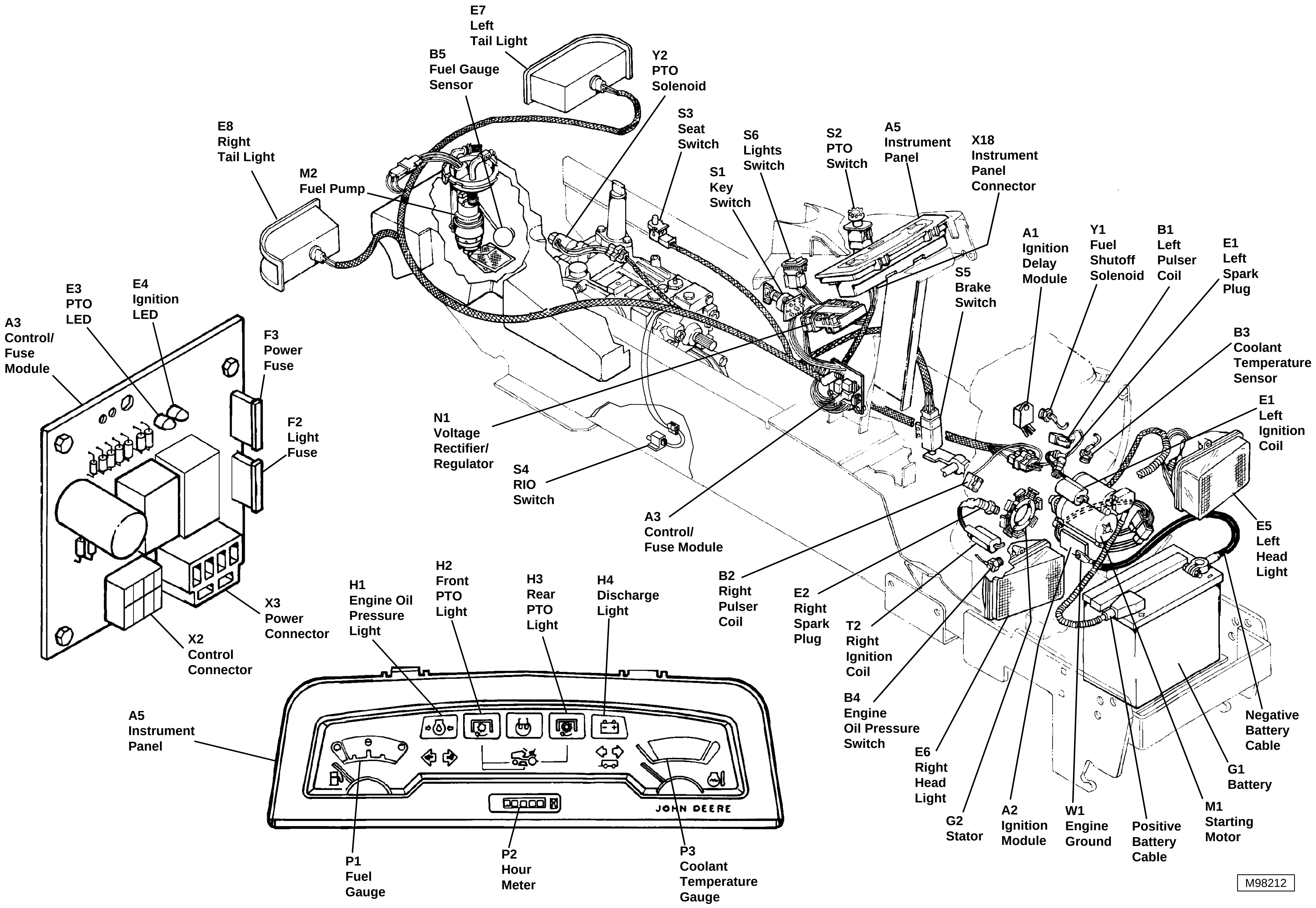


LEGENDS FOR ELECTRICAL COMPONENTS—425

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. —070000)

A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Not Used
B4—Not Used
B5—Fuel Gauge Sensor (SE4, W1)
B6—Oil Pressure Switch (SE5)
B7—Coolant Temperature Sensor (SE5)
E1—Ignition LED (SE1)
E2—PTO LED (SE2)
E3—Left Spark Plug (SE1)
E4—Right Spark Plug (SE1)
E5—Left Dash Light (SE6)
E6—Right Dash Light (SE6)
E7—Left Head Light (SE6)
E8—Right Head Light (SE6)
E9—Left Tail Light (SE6)
E10—Right Tail Light (SE6)
F1—Fusible Link
F2—Not Used
F3—Light Fuse (SE1)
F4—Power Fuse (SE1)
G1—Battery (SE1)
G2—Stator (SE3)
H1—Front PTO Light (SE2)
H2—Rear PTO Light (SE2)
H3—Charge Light (SE3)
H4—Oil Pressure Light (SE5)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE5)
N1—Rectifier/Regulator (SE3, W1)
P1—Fuel Gauge (SE4)
P2—Coolant Temperature Gauge (SE5)
P3—Hour Meter (SE5)
S1—Key Switch (SE1)
S2—Seat Switch (SE1, W1)
S3—Brake Switch (SE1, W1)
S4—PTO Switch (SE1, W1)
S5—Light Switch (SE6, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Power Connector (SE1, SE2, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Dash Panel Connector (SE3, SE4, SE5, SE6, W1)
X4—Rear PTO Connector (SE1, W1)
X5—Front PTO light Connector (SE2, W1)
X6—Rear PTO Connector (SE1, W1)
X7—Rear PTO Connector (SE1, W1)
X8—Fuel Pump Shut-Off Connector (SE5, W1)
X9—Engine Connector (W1)
Y1—Fuel Shut-Off/Carburetor Vent Solenoid (SE1)
Y2—PTO Solenoid (SE2, W1)

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. 070001—)

A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
A3—Control/Fuse Module (SE1)
A4—Seat Switch Delay Module (SE2)
A5—Instrument Panel (SE3, W1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Coolant Temperature Sensor (SE1)
B4—Engine Oil Pressure Switch (SE1)
B5—Fuel Gauge Sensor (SE3)
E1—Left Spark Plug (SE1)
E2—Right Spark Plug (SE1)
E3—PTO LED (SE1)
E4—Ignition LED (SE1)
E5—Left Head Light (SE3, W1)
E6—Right Head Light (SE3, W1)
E7—Left Tail Light (SE3, W1)
E8—Right Tail Light (SE3, W1)
G1—Battery (SE1)
G2—Stator (SE1)
H1—Engine Oil Pressure Light (SE3)
H2—Front PTO Light (SE3)
H3—Rear PTO Light (Option) (SE3)
H4—Discharge Light (SE3)
H5—Dash Light (SE3)
H6—Dash Light (SE3)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
K4—RIO Latch Relay (SE1)
K5—RIO Unlatch Relay (SE1)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE3)
N1—Rectifier/Regulator (SE1, W1)
P1—Fuel Gauge (SE3)
P2—Hour Meter (SE3)
P3—Coolant Temperature Gauge (SE3)
S1—Key Switch (SE1)
S2—PTO Switch (SE2, W1)
S3—Seat Switch (SE2, W1)
S4—RIO Switch (SE2, W1)
S5—Brake Switch (SE2, W1)
S6—Light Switch (SE3, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Key Switch Power connector (SE1, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Power Connector (SE1, SE2, W1)
X4—Ignition Delay Module/Starting Motor Connector (SE1)
X5—Ignition Delay Module Connector (SE1)
X6—Ignition Delay Module/Ignition Module Connector (SE1)
X7—Ignition Delay Module/Ignition Coils Connector (SE1)
X8—Ignition Module/Ignition coils Connector (SE1)
X9—Ignition Module/Pulser Coils Connector (SE1)
X10—Engine Connector (SE1, W1)
X11—Rear PTO Module (Option) Connector (SE2, W1)
X12—Rear PTO Module (Option) Connector (SE2, W1)
X13—Rear PTO Harness (Option) Connector (SE2, W1)
X14—Front PTO Light Connector (SE2, W1)
X15—PTO Solenoid Connector (SE2, W1)
X16—Fuel Pump Shut-Off Connector (SE3, W1)
X17—Fuel Pump and Fuel Gauge Sensor Connector (SE3, W1)
X18—Instrument Panel Connector (SE3, W1)
X19—Left Head Light Ground Connector (SE3, W1)
X20—Left Head Light Power Connector (SE3, W1)
X21—Right Head Light Ground Connector (SE3, W1)
X22—Right Head Light Power Connector (SE3, W1)
X23—Left Tail Light Connector (SE3, W1)
X24—Right Tail Light Connector (SE3, W1)

LEGENDS FOR ELECTRICAL COMPONENTS—425

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. —070000)

A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Not Used
B4—Not Used
B5—Fuel Gauge Sensor (SE4, W1)
B6—Oil Pressure Switch (SE5)
B7—Coolant Temperature Sensor (SE5)
E1—Ignition LED (SE1)
E2—PTO LED (SE2)
E3—Left Spark Plug (SE1)
E4—Right Spark Plug (SE1)
E5—Left Dash Light (SE6)
E6—Right Dash Light (SE6)
E7—Left Head Light (SE6)
E8—Right Head Light (SE6)
E9—Left Tail Light (SE6)
E10—Right Tail Light (SE6)
F1—Fusible Link
F2—Not Used
F3—Light Fuse (SE1)
F4—Power Fuse (SE1)
G1—Battery (SE1)
G2—Stator (SE3)
H1—Front PTO Light (SE2)
H2—Rear PTO Light (SE2)
H3—Charge Light (SE3)
H4—Oil Pressure Light (SE5)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE5)
N1—Rectifier/Regulator (SE3, W1)
P1—Fuel Gauge (SE4)
P2—Coolant Temperature Gauge (SE5)
P3—Hour Meter (SE5)
S1—Key Switch (SE1)
S2—Seat Switch (SE1, W1)
S3—Brake Switch (SE1, W1)
S4—PTO Switch (SE1, W1)
S5—Light Switch (SE6, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Power Connector (SE1, SE2, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Dash Panel Connector (SE3, SE4, SE5, SE6, W1)
X4—Rear PTO Connector (SE1, W1)
X5—Front PTO light Connector (SE2, W1)
X6—Rear PTO Connector (SE1, W1)
X7—Rear PTO Connector (SE1, W1)
X8—Fuel Pump Shut-Off Connector (SE5, W1)
X9—Engine Connector (W1)
Y1—Fuel Shut-Off/Carburetor Vent Solenoid (SE1)
Y2—PTO Solenoid (SE2, W1)

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. 070001—)

A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
A3—Control/Fuse Module (SE1)
A4—Seat Switch Delay Module (SE2)
A5—Instrument Panel (SE3, W1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Coolant Temperature Sensor (SE1)
B4—Engine Oil Pressure Switch (SE1)
B5—Fuel Gauge Sensor (SE3)
E1—Left Spark Plug (SE1)
E2—Right Spark Plug (SE1)
E3—PTO LED (SE1)
E4—Ignition LED (SE1)
E5—Left Head Light (SE3, W1)
E6—Right Head Light (SE3, W1)
E7—Left Tail Light (SE3, W1)
E8—Right Tail Light (SE3, W1)
G1—Battery (SE1)
G2—Stator (SE1)
H1—Engine Oil Pressure Light (SE3)
H2—Front PTO Light (SE3)
H3—Rear PTO Light (Option) (SE3)
H4—Discharge Light (SE3)
H5—Dash Light (SE3)
H6—Dash Light (SE3)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
K4—RIO Latch Relay (SE1)
K5—RIO Unlatch Relay (SE1)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE3)
N1—Rectifier/Regulator (SE1, W1)
P1—Fuel Gauge (SE3)
P2—Hour Meter (SE3)
P3—Coolant Temperature Gauge (SE3)
S1—Key Switch (SE1)
S2—PTO Switch (SE2, W1)
S3—Seat Switch (SE2, W1)
S4—RIO Switch (SE2, W1)
S5—Brake Switch (SE2, W1)
S6—Light Switch (SE3, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Key Switch Power connector (SE1, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Power Connector (SE1, SE2, W1)
X4—Ignition Delay Module/Starting Motor Connector (SE1)
X5—Ignition Delay Module Connector (SE1)
X6—Ignition Delay Module/Ignition Module Connector (SE1)
X7—Ignition Delay Module/Ignition Coils Connector (SE1)
X8—Ignition Module/Ignition coils Connector (SE1)
X9—Ignition Module/Pulser Coils Connector (SE1)
X10—Engine Connector (SE1, W1)
X11—Rear PTO Module (Option) Connector (SE2, W1)
X12—Rear PTO Module (Option) Connector (SE2, W1)
X13—Rear PTO Harness (Option) Connector (SE2, W1)
X14—Front PTO Light Connector (SE2, W1)
X15—PTO Solenoid Connector (SE2, W1)
X16—Fuel Pump Shut-Off Connector (SE3, W1)
X17—Fuel Pump and Fuel Gauge Sensor Connector (SE3, W1)
X18—Instrument Panel Connector (SE3, W1)
X19—Left Head Light Ground Connector (SE3, W1)
X20—Left Head Light Power Connector (SE3, W1)
X21—Right Head Light Ground Connector (SE3, W1)
X22—Right Head Light Power Connector (SE3, W1)
X23—Left Tail Light Connector (SE3, W1)
X24—Right Tail Light Connector (SE3, W1)

LEGENDS FOR ELECTRICAL COMPONENTS—425

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. —070000)

A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Not Used
B4—Not Used
B5—Fuel Gauge Sensor (SE4, W1)
B6—Oil Pressure Switch (SE5)
B7—Coolant Temperature Sensor (SE5)
E1—Ignition LED (SE1)
E2—PTO LED (SE2)
E3—Left Spark Plug (SE1)
E4—Right Spark Plug (SE1)
E5—Left Dash Light (SE6)
E6—Right Dash Light (SE6)
E7—Left Head Light (SE6)
E8—Right Head Light (SE6)
E9—Left Tail Light (SE6)
E10—Right Tail Light (SE6)
F1—Fusible Link
F2—Not Used
F3—Light Fuse (SE1)
F4—Power Fuse (SE1)
G1—Battery (SE1)
G2—Stator (SE3)
H1—Front PTO Light (SE2)
H2—Rear PTO Light (SE2)
H3—Charge Light (SE3)
H4—Oil Pressure Light (SE5)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE5)
N1—Rectifier/Regulator (SE3, W1)
P1—Fuel Gauge (SE4)
P2—Coolant Temperature Gauge (SE5)
P3—Hour Meter (SE5)
S1—Key Switch (SE1)
S2—Seat Switch (SE1, W1)
S3—Brake Switch (SE1, W1)
S4—PTO Switch (SE1, W1)
S5—Light Switch (SE6, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Power Connector (SE1, SE2, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Dash Panel Connector (SE3, SE4, SE5, SE6, W1)
X4—Rear PTO Connector (SE1, W1)
X5—Front PTO light Connector (SE2, W1)
X6—Rear PTO Connector (SE1, W1)
X7—Rear PTO Connector (SE1, W1)
X8—Fuel Pump Shut-Off Connector (SE5, W1)
X9—Engine Connector (W1)
Y1—Fuel Shut-Off/Carburetor Vent Solenoid (SE1)
Y2—PTO Solenoid (SE2, W1)

LEGEND FOR ELECTRICAL COMPONENTS—425 (S.N. 070001—)

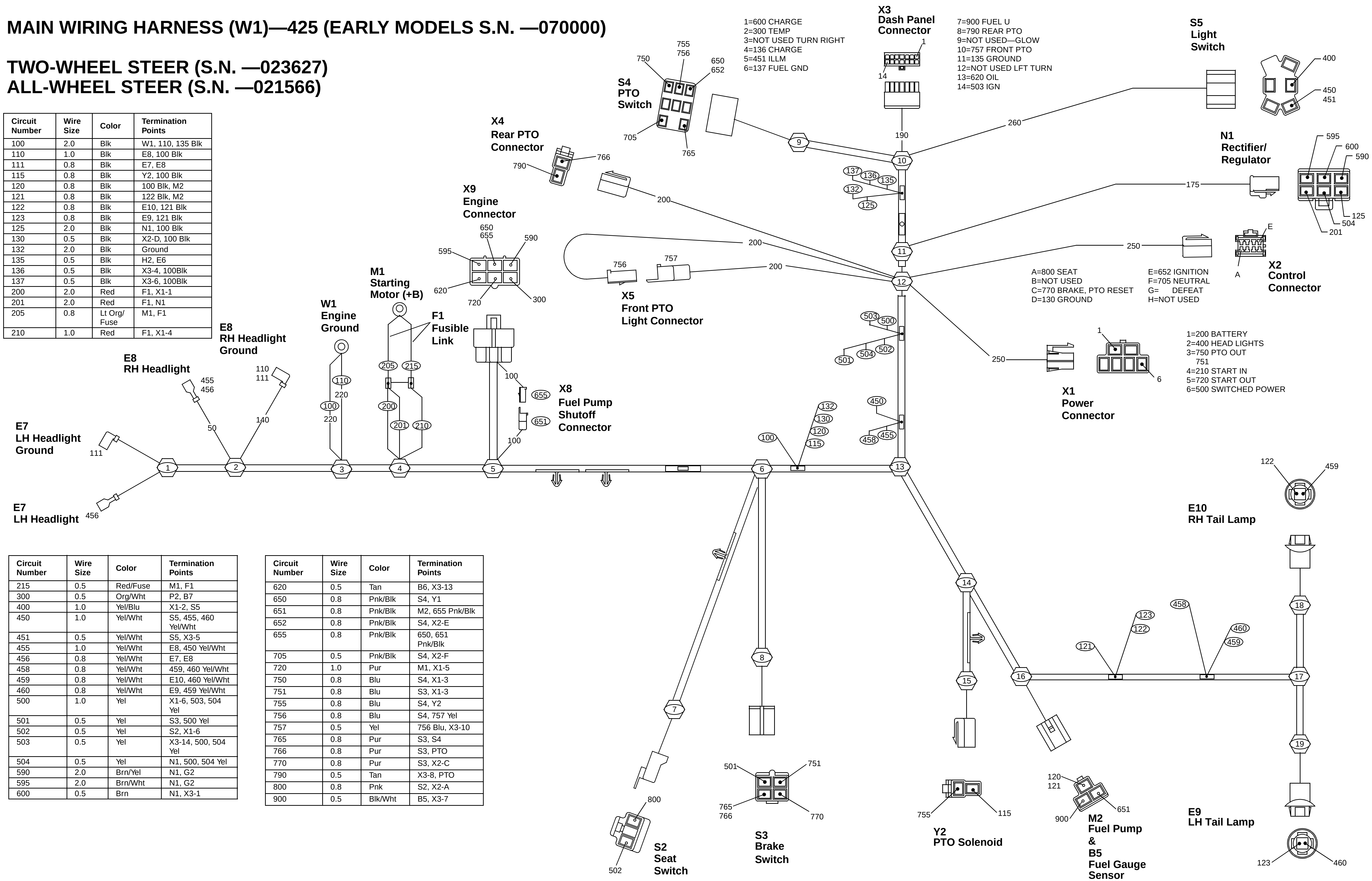
A1—Ignition Delay Module (SE1)
A2—Ignition Module (SE1)
A3—Control/Fuse Module (SE1)
A4—Seat Switch Delay Module (SE2)
A5—Instrument Panel (SE3, W1)
B1—Left Pulser Coil (SE1)
B2—Right Pulser Coil (SE1)
B3—Coolant Temperature Sensor (SE1)
B4—Engine Oil Pressure Switch (SE1)
B5—Fuel Gauge Sensor (SE3)
E1—Left Spark Plug (SE1)
E2—Right Spark Plug (SE1)
E3—PTO LED (SE1)
E4—Ignition LED (SE1)
E5—Left Head Light (SE3, W1)
E6—Right Head Light (SE3, W1)
E7—Left Tail Light (SE3, W1)
E8—Right Tail Light (SE3, W1)
G1—Battery (SE1)
G2—Stator (SE1)
H1—Engine Oil Pressure Light (SE3)
H2—Front PTO Light (SE3)
H3—Rear PTO Light (Option) (SE3)
H4—Discharge Light (SE3)
H5—Dash Light (SE3)
H6—Dash Light (SE3)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
K4—RIO Latch Relay (SE1)
K5—RIO Unlatch Relay (SE1)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE3)
N1—Rectifier/Regulator (SE1, W1)
P1—Fuel Gauge (SE3)
P2—Hour Meter (SE3)
P3—Coolant Temperature Gauge (SE3)
S1—Key Switch (SE1)
S2—PTO Switch (SE2, W1)
S3—Seat Switch (SE2, W1)
S4—RIO Switch (SE2, W1)
S5—Brake Switch (SE2, W1)
S6—Light Switch (SE3, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Key Switch Power connector (SE1, W1)
X2—Control Connector (SE1, SE2, W1)
X3—Power Connector (SE1, SE2, W1)
X4—Ignition Delay Module/Starting Motor Connector (SE1)
X5—Ignition Delay Module Connector (SE1)
X6—Ignition Delay Module/Ignition Module Connector (SE1)
X7—Ignition Delay Module/Ignition Coils Connector (SE1)
X8—Ignition Module/Ignition coils Connector (SE1)
X9—Ignition Module/Pulser Coils Connector (SE1)
X10—Engine Connector (SE1, W1)
X11—Rear PTO Module (Option) Connector (SE2, W1)
X12—Rear PTO Module (Option) Connector (SE2, W1)
X13—Rear PTO Harness (Option) Connector (SE2, W1)
X14—Front PTO Light Connector (SE2, W1)
X15—PTO Solenoid Connector (SE2, W1)
X16—Fuel Pump Shut-Off Connector (SE3, W1)
X17—Fuel Pump and Fuel Gauge Sensor Connector (SE3, W1)
X18—Instrument Panel Connector (SE3, W1)
X19—Left Head Light Ground Connector (SE3, W1)
X20—Left Head Light Power Connector (SE3, W1)
X21—Right Head Light Ground Connector (SE3, W1)
X22—Right Head Light Power Connector (SE3, W1)
X23—Left Tail Light Connector (SE3, W1)
X24—Right Tail Light Connector (SE3, W1)

ELECTRICAL WIRING HARNESSES—425

MAIN WIRING HARNESS (W1)—425 (EARLY MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. —023627)
ALL-WHEEL STEER (S.N. —021566)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
121	0.8	Blk	122 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	H2, E6
136	0.5	Blk	X3-4, 100Blk
137	0.5	Blk	X3-6, 100Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1
210	1.0	Red	F1, X1-4



Circuit Number	Wire Size	Color	Termination Points
215	0.5	Red/Fuse	M1, F1
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
458	0.8	Yel/Wht	459, 460 Yel/Wht
459	0.8	Yel/Wht	E10, 460 Yel/Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1

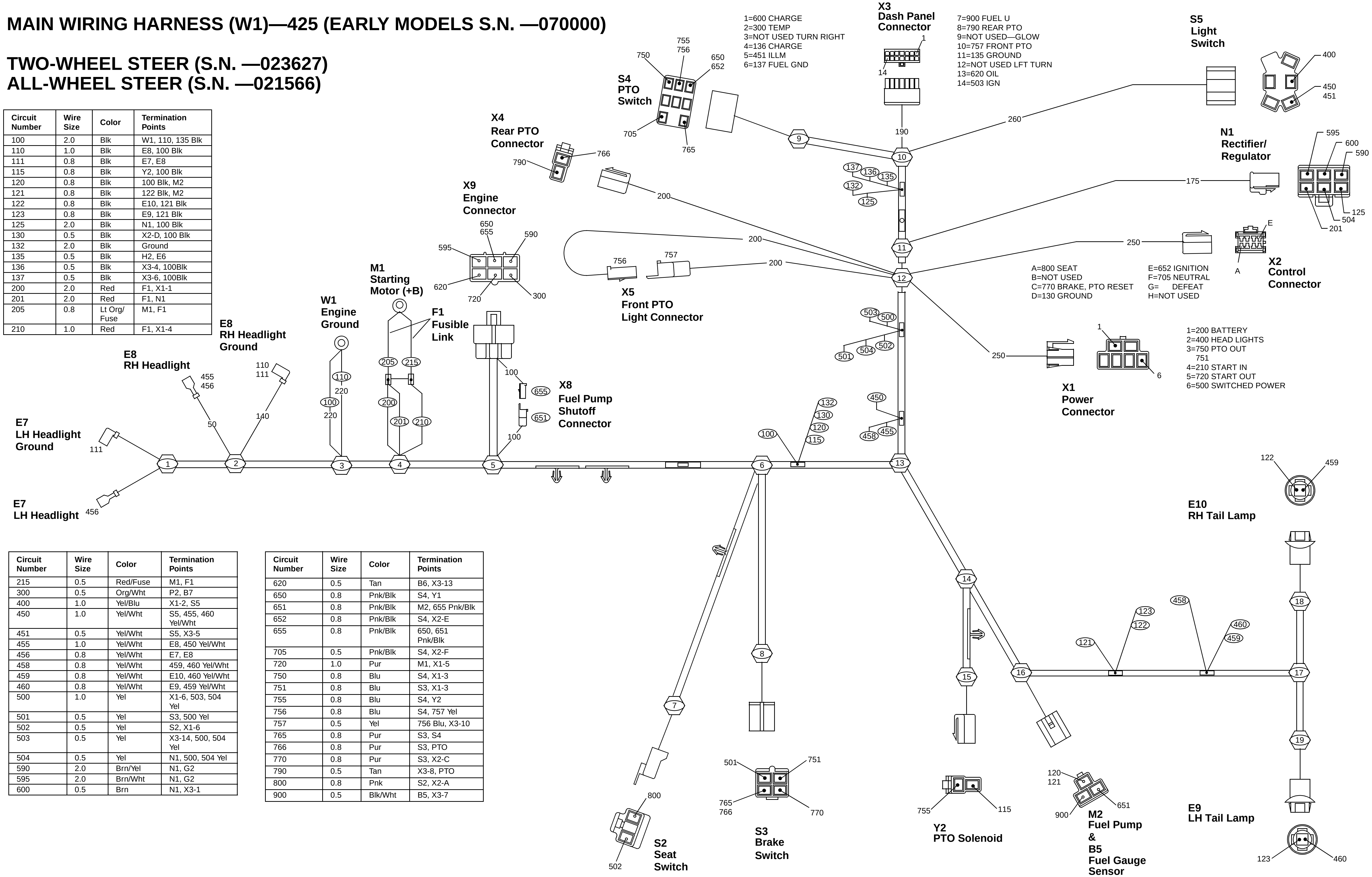
Circuit Number	Wire Size	Color	Termination Points
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	M2, 655 Pnk/Blk
652	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S3, X2-C
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7

ELECTRICAL WIRING HARNESSES—425

MAIN WIRING HARNESS (W1)—425 (EARLY MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. —023627)
ALL-WHEEL STEER (S.N. —021566)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
121	0.8	Blk	122 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	H2, E6
136	0.5	Blk	X3-4, 100Blk
137	0.5	Blk	X3-6, 100Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1
210	1.0	Red	F1, X1-4



Circuit Number	Wire Size	Color	Termination Points
215	0.5	Red/Fuse	M1, F1
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
458	0.8	Yel/Wht	459, 460 Yel/Wht
459	0.8	Yel/Wht	E10, 460 Yel/Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1

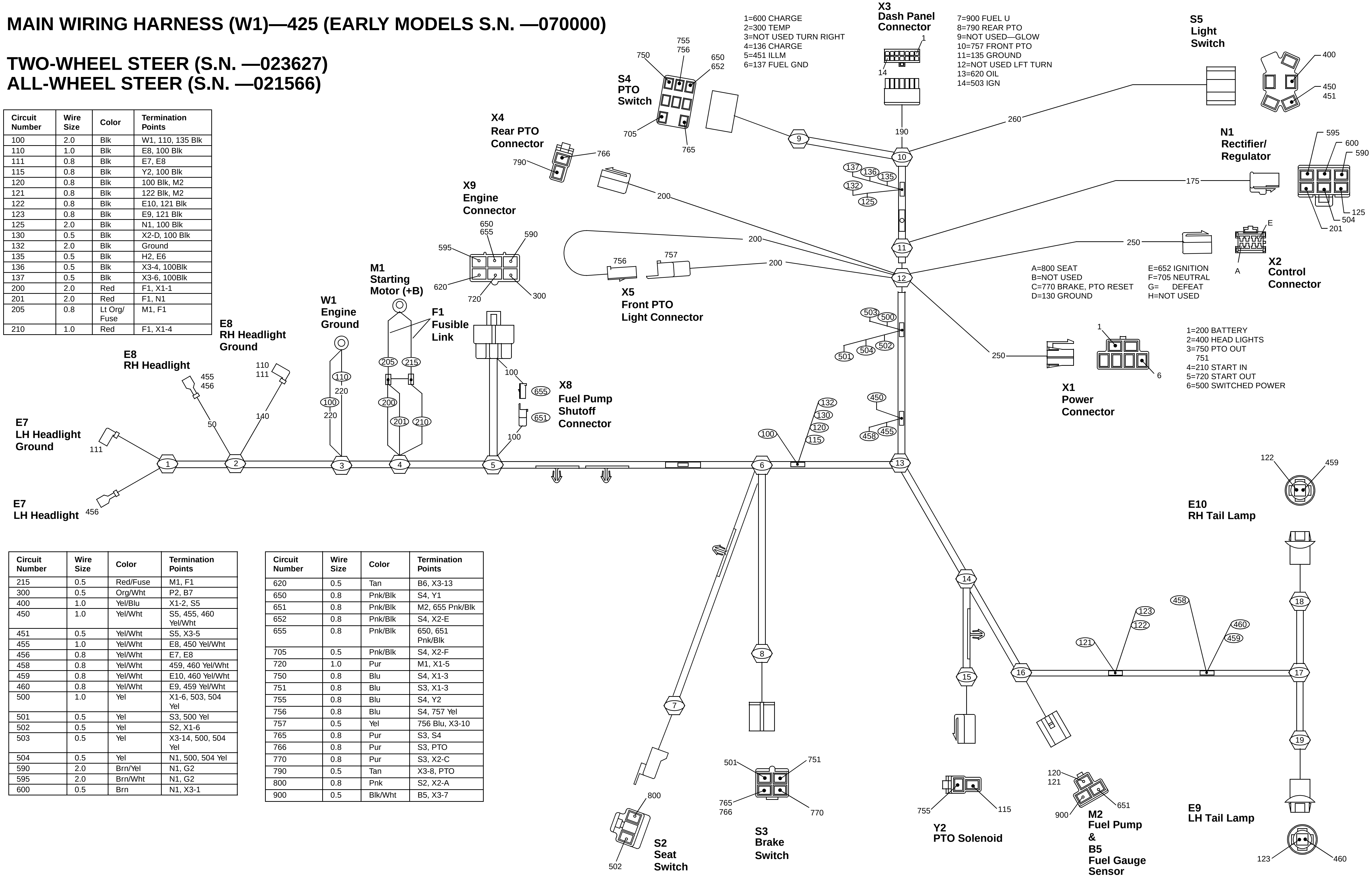
Circuit Number	Wire Size	Color	Termination Points
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	M2, 655 Pnk/Blk
652	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S3, X2-C
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7

ELECTRICAL WIRING HARNESSES—425

MAIN WIRING HARNESS (W1)—425 (EARLY MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. —023627)
ALL-WHEEL STEER (S.N. —021566)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
121	0.8	Blk	122 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	H2, E6
136	0.5	Blk	X3-4, 100Blk
137	0.5	Blk	X3-6, 100Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1
210	1.0	Red	F1, X1-4



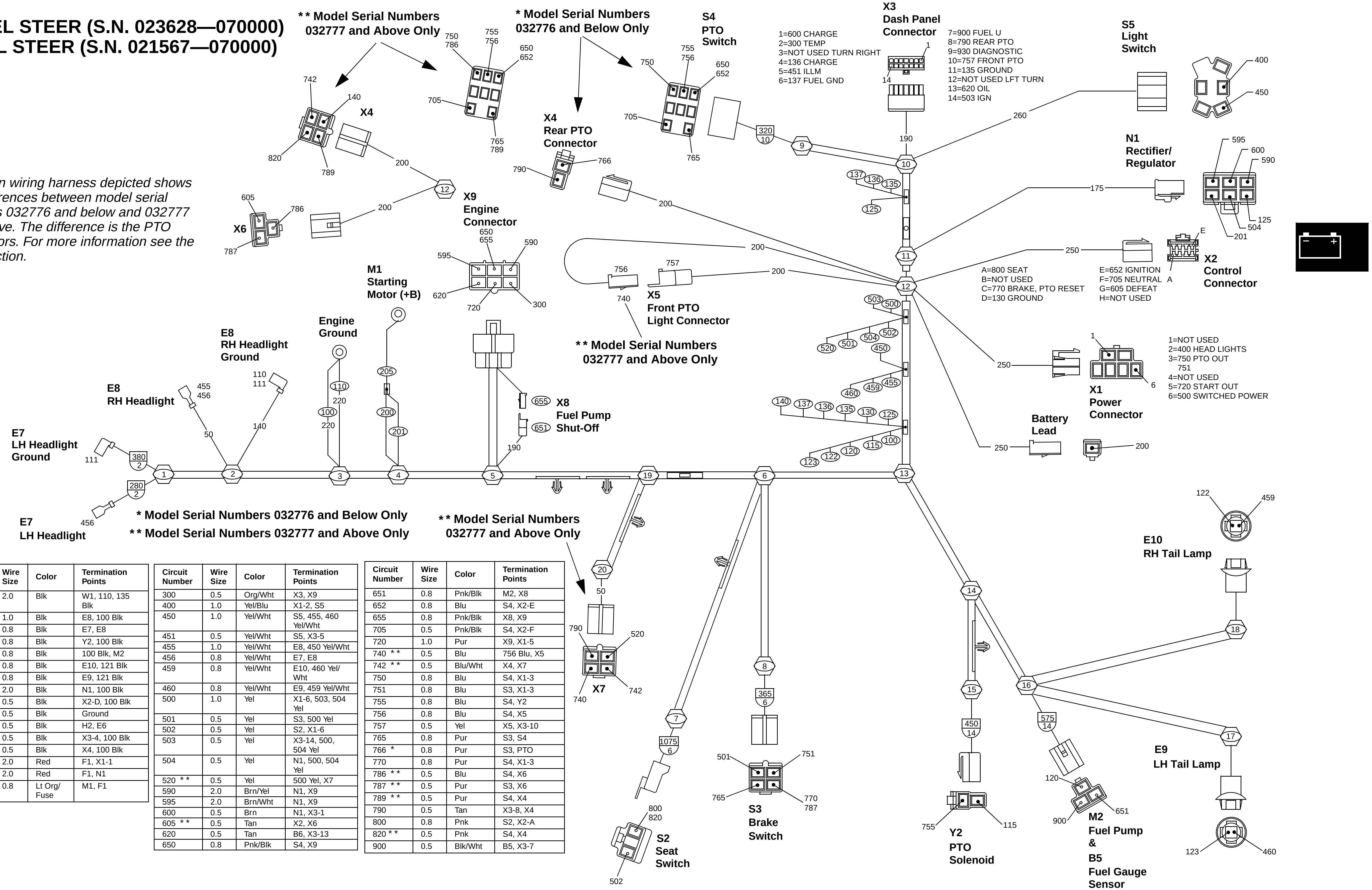
Circuit Number	Wire Size	Color	Termination Points
215	0.5	Red/Fuse	M1, F1
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
458	0.8	Yel/Wht	459, 460 Yel/Wht
459	0.8	Yel/Wht	E10, 460 Yel/Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1

Circuit Number	Wire Size	Color	Termination Points
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	M2, 655 Pnk/Blk
652	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S3, X2-C
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7

MAIN WIRING HARNESS (W1)—425 (LATE MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. 023628—070000)
ALL-WHEEL STEER (S.N. 021567—070000)

NOTE: *The main wiring harness depicted shows the differences between model serial numbers 032776 and below and 032777 and above. The difference is the PTO connectors. For more information see the PTO section.*



Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
135	0.5	Blk	Ground
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-4, 100 Blk
140	0.5	Blk	X4, 100 Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1

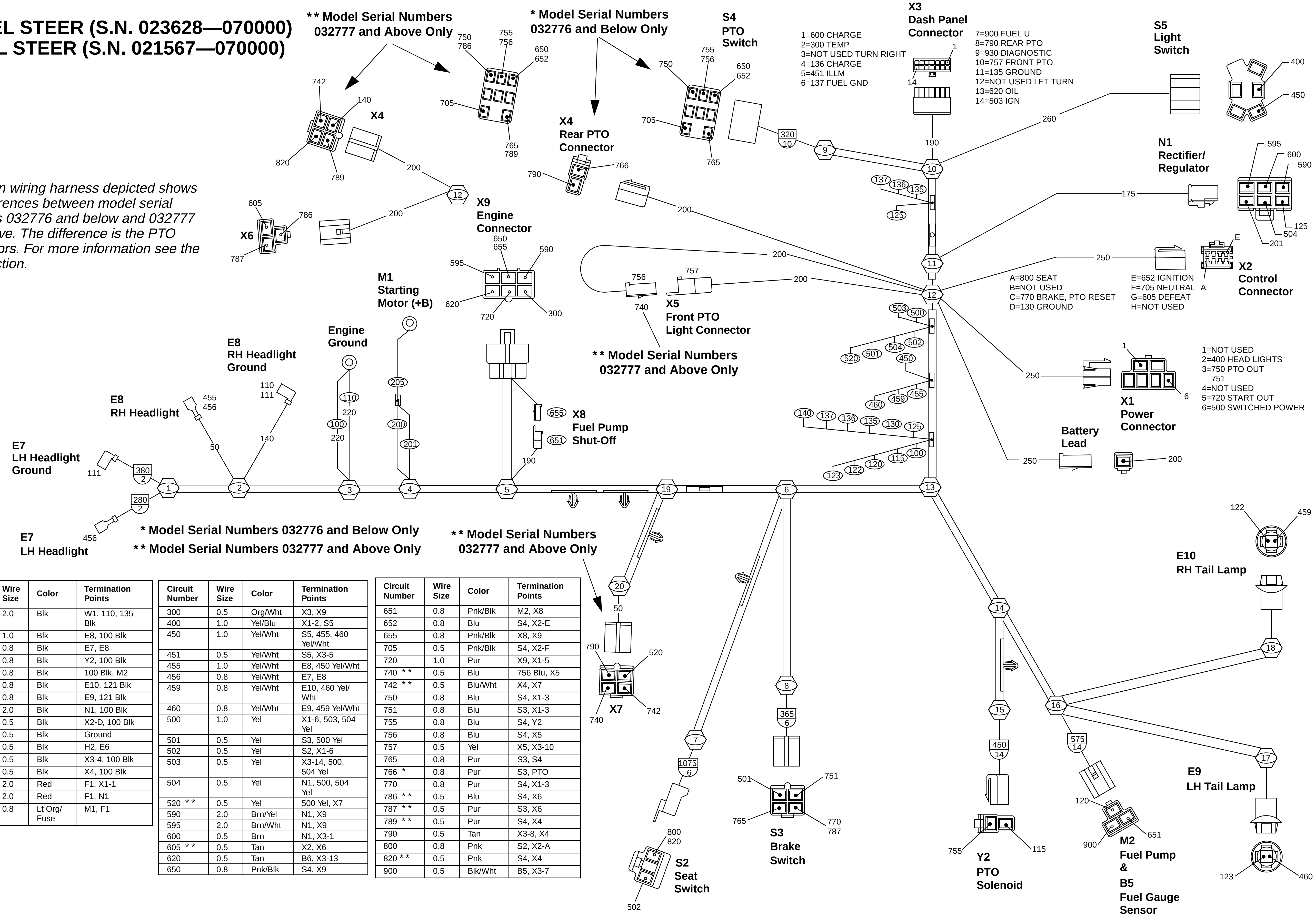
Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X3, X9
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
520 * *	0.5	Yel	500 Yel, X7
590	2.0	Brn/Yel	N1, X9
595	2.0	Brn/Wht	N1, X9
600	0.5	Brn	N1, X3-1
605 * *	0.5	Tan	X2, X6
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, X9

Circuit Number	Wire Size	Color	Termination Points
651	0.8	Pnk/Blk	M2, X8
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	X8, X9
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	X9, X1-5
740 * *	0.5	Blu	756 Blu, X5
742 * *	0.5	Blu/Wht	X4, X7
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, X5
757	0.5	Yel	X5, X3-10
765	0.8	Pur	S3, S4
766 *	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
786 * *	0.5	Blu	S4, X6
787 * *	0.5	Pur	S3, X6
789 * *	0.5	Pur	S4, X4
790	0.5	Tan	X3-8, X4
800	0.8	Pnk	S2, X2-A
820 * *	0.5	Pnk	S4, X4
900	0.5	Blk/Wht	B5, X3-7

MAIN WIRING HARNESS (W1)—425 (LATE MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. 023628—070000)
ALL-WHEEL STEER (S.N. 021567—070000)

NOTE: *The main wiring harness depicted shows the differences between model serial numbers 032776 and below and 032777 and above. The difference is the PTO connectors. For more information see the PTO section.*



Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
135	0.5	Blk	Ground
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-4, 100 Blk
140	0.5	Blk	X4, 100 Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1

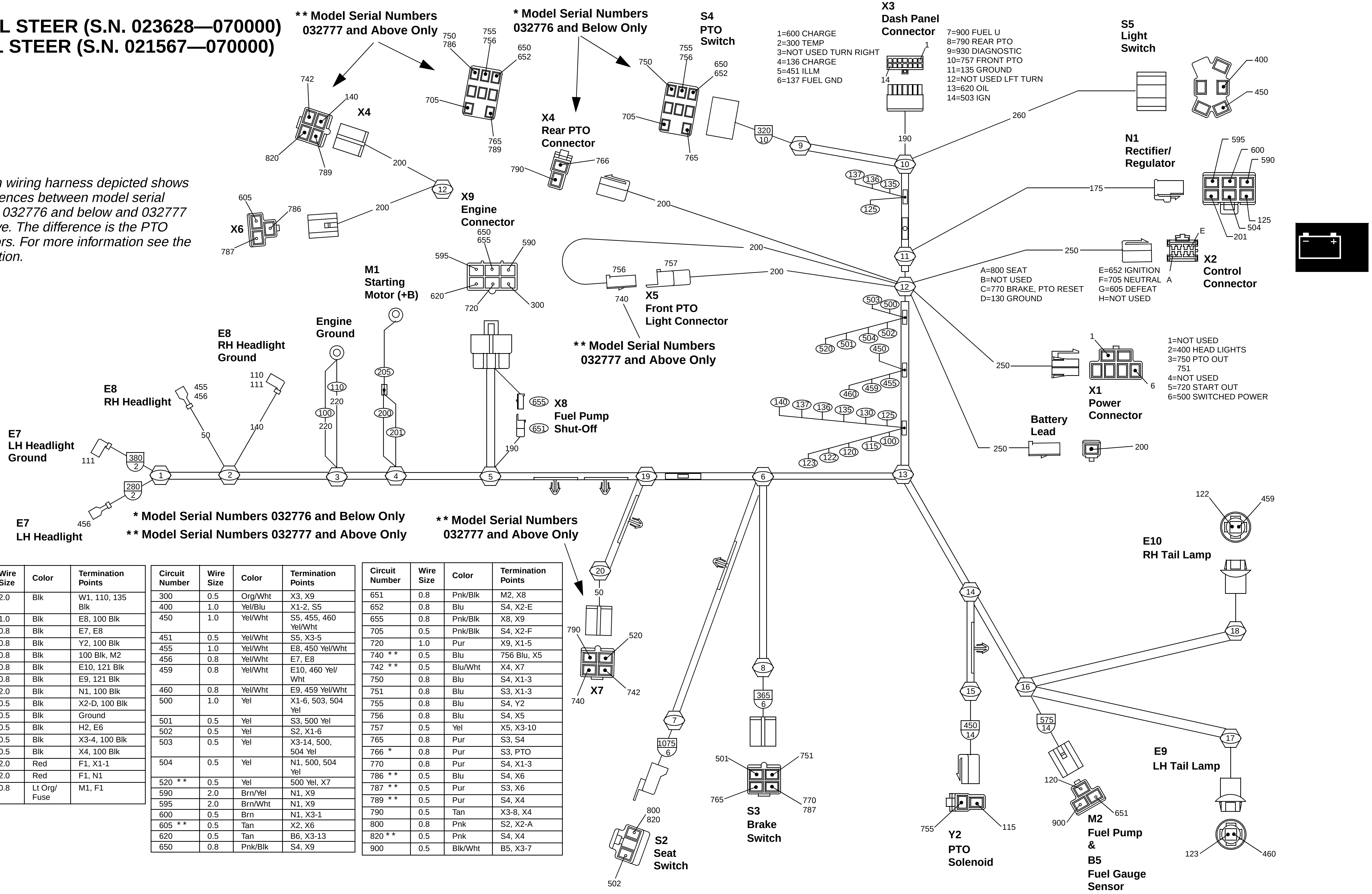
Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X3, X9
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
520 * *	0.5	Yel	500 Yel, X7
590	2.0	Brn/Yel	N1, X9
595	2.0	Brn/Wht	N1, X9
600	0.5	Brn	N1, X3-1
605 * *	0.5	Tan	X2, X6
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, X9

Circuit Number	Wire Size	Color	Termination Points
651	0.8	Pnk/Blk	M2, X8
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	X8, X9
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	X9, X1-5
740 * *	0.5	Blu	756 Blu, X5
742 * *	0.5	Blu/Wht	X4, X7
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, X5
757	0.5	Yel	X5, X3-10
765	0.8	Pur	S3, S4
766 *	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
786 * *	0.5	Blu	S4, X6
787 * *	0.5	Pur	S3, X6
789 * *	0.5	Pur	S4, X4
790	0.5	Tan	X3-8, X4
800	0.8	Pnk	S2, X2-A
820 * *	0.5	Pnk	S4, X4
900	0.5	Blk/Wht	B5, X3-7

MAIN WIRING HARNESS (W1)—425 (LATE MODELS S.N. —070000)

TWO-WHEEL STEER (S.N. 023628—070000)
ALL-WHEEL STEER (S.N. 021567—070000)

NOTE: *The main wiring harness depicted shows the differences between model serial numbers 032776 and below and 032777 and above. The difference is the PTO connectors. For more information see the PTO section.*



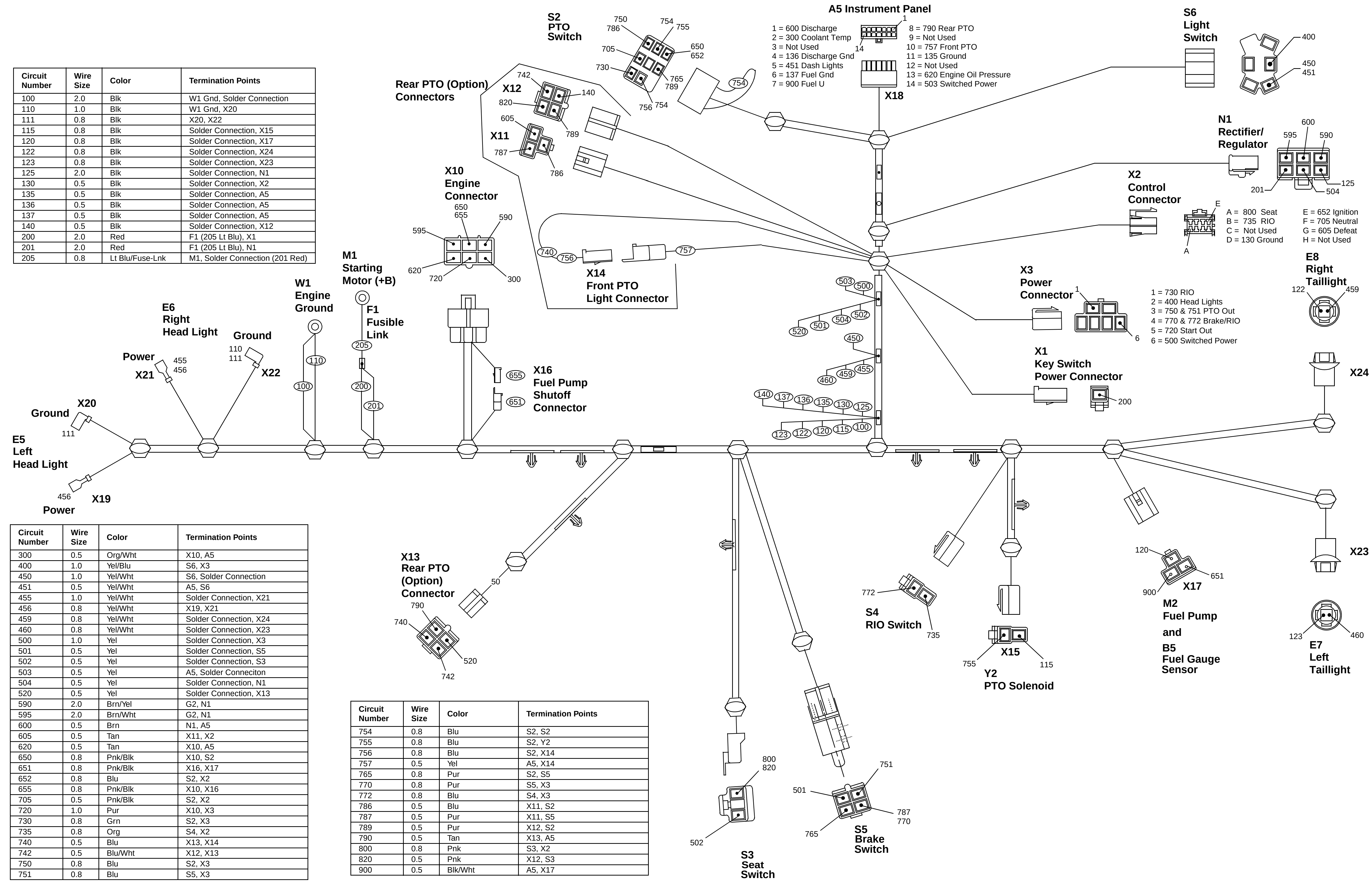
Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100 Blk, M2
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
135	0.5	Blk	Ground
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-4, 100 Blk
140	0.5	Blk	X4, 100 Blk
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	M1, F1

Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X3, X9
400	1.0	Yel/Blu	X1-2, S5
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 504 Yel
520 * *	0.5	Yel	500 Yel, X7
590	2.0	Brn/Yel	N1, X9
595	2.0	Brn/Wht	N1, X9
600	0.5	Brn	N1, X3-1
605 * *	0.5	Tan	X2, X6
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, X9

Circuit Number	Wire Size	Color	Termination Points
651	0.8	Pnk/Blk	M2, X8
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	X8, X9
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	X9, X1-5
740 * *	0.5	Blu	756 Blu, X5
742 * *	0.5	Blu/Wht	X4, X7
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, X5
757	0.5	Yel	X5, X3-10
765	0.8	Pur	S3, S4
766 *	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
786 * *	0.5	Blu	S4, X6
787 * *	0.5	Pur	S3, X6
789 * *	0.5	Pur	S4, X4
790	0.5	Tan	X3-8, X4
800	0.8	Pnk	S2, X2-A
820 * *	0.5	Pnk	S4, X4
900	0.5	Blk/Wht	B5, X3-7

MAIN WIRING HARNESS (W1)—425 (S.N. 070001—)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, X15
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
135	0.5	Blk	Solder Connection, A5
136	0.5	Blk	Solder Connection, A5
137	0.5	Blk	Solder Connection, A5
140	0.5	Blk	Solder Connection, X12
200	2.0	Red	F1 (205 Lt Blu), X1
201	2.0	Red	F1 (205 Lt Blu), N1
205	0.8	Lt Blu/Fuse-Lnk	M1, Solder Connection (201 Red)

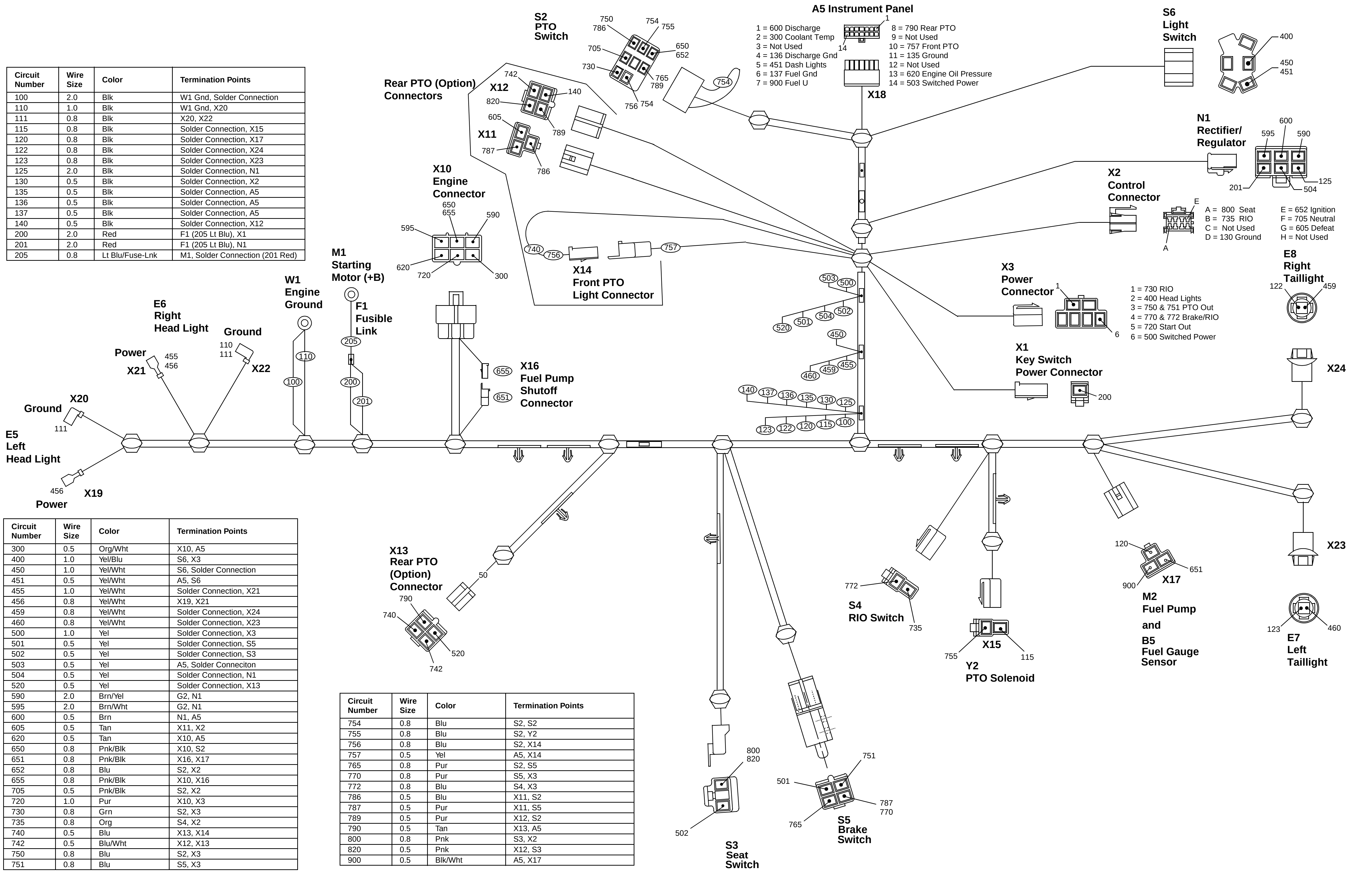


Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X10, A5
400	1.0	Yel/Blu	S6, X3
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A5, S6
455	1.0	Yel/Wht	Solder Connection, X21
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	Solder Connection, X3
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A5, Solder Conneciton
504	0.5	Yel	Solder Connection, N1
520	0.5	Yel	Solder Connection, X13
590	2.0	Brn/Yel	G2, N1
595	2.0	Brn/Wht	G2, N1
600	0.5	Brn	N1, A5
605	0.5	Tan	X11, X2
620	0.5	Tan	X10, A5
650	0.8	Pnk/Blk	X10, S2
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X10, X16
705	0.5	Pnk/Blk	S2, X2
720	1.0	Pur	X10, X3
730	0.8	Grn	S2, X3
735	0.8	Org	S4, X2
740	0.5	Blu	X13, X14
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	S5, X3

Circuit Number	Wire Size	Color	Termination Points
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A5, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	X11, S2
787	0.5	Pur	X11, S5
789	0.5	Pur	X12, S2
790	0.5	Tan	X13, A5
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A5, X17

MAIN WIRING HARNESS (W1)—425 (S.N. 070001—)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, X15
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
135	0.5	Blk	Solder Connection, A5
136	0.5	Blk	Solder Connection, A5
137	0.5	Blk	Solder Connection, A5
140	0.5	Blk	Solder Connection, X12
200	2.0	Red	F1 (205 Lt Blu), X1
201	2.0	Red	F1 (205 Lt Blu), N1
205	0.8	Lt Blu/Fuse-Lnk	M1, Solder Connection (201 Red)

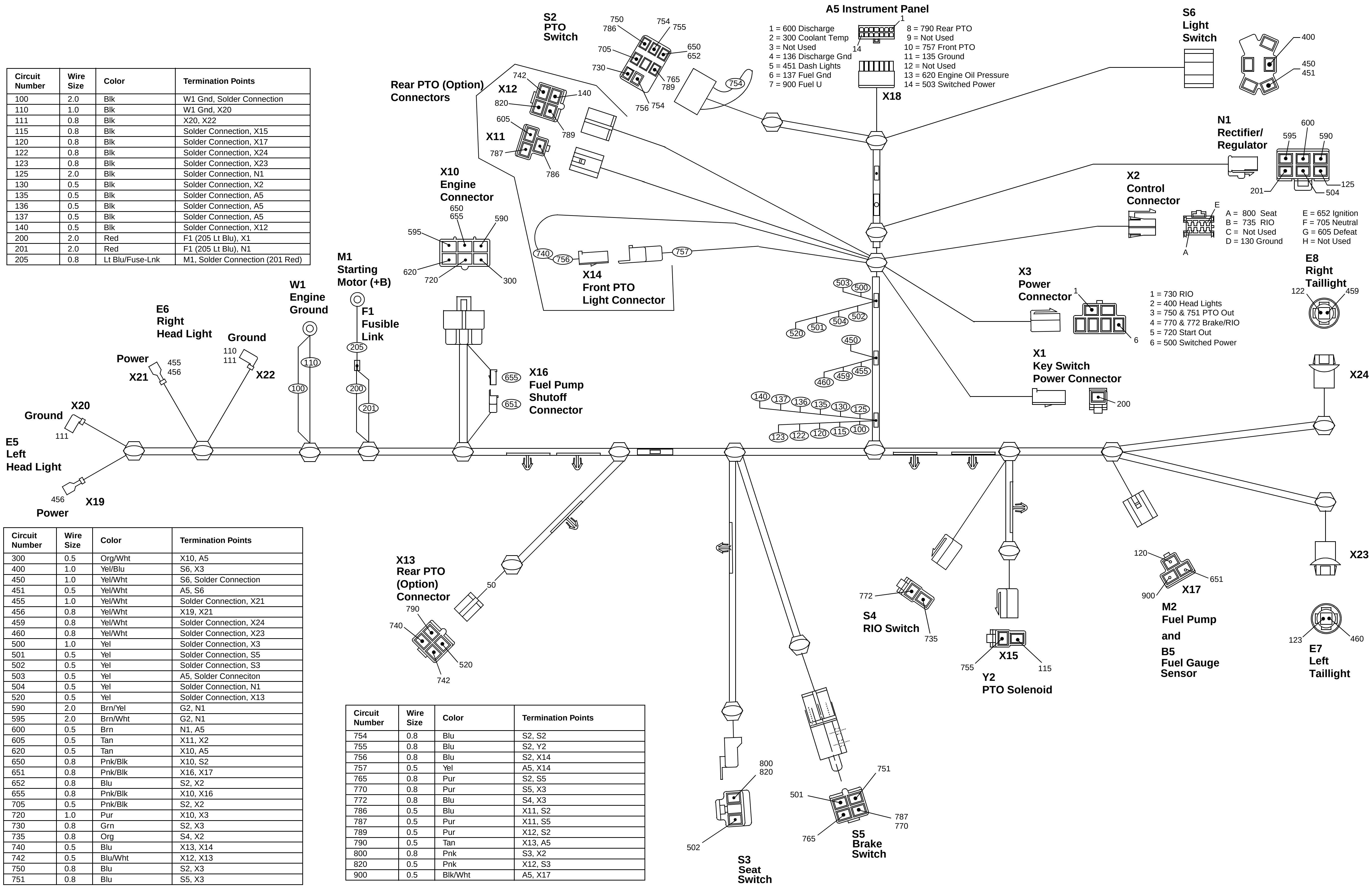


Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X10, A5
400	1.0	Yel/Blu	S6, X3
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A5, S6
455	1.0	Yel/Wht	Solder Connection, X21
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	Solder Connection, X3
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A5, Solder Conneciton
504	0.5	Yel	Solder Connection, N1
520	0.5	Yel	Solder Connection, X13
590	2.0	Brn/Yel	G2, N1
595	2.0	Brn/Wht	G2, N1
600	0.5	Brn	N1, A5
605	0.5	Tan	X11, X2
620	0.5	Tan	X10, A5
650	0.8	Pnk/Blk	X10, S2
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X10, X16
705	0.5	Pnk/Blk	S2, X2
720	1.0	Pur	X10, X3
730	0.8	Grn	S2, X3
735	0.8	Org	S4, X2
740	0.5	Blu	X13, X14
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	S5, X3

Circuit Number	Wire Size	Color	Termination Points
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A5, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	X11, S2
787	0.5	Pur	X11, S5
789	0.5	Pur	X12, S2
790	0.5	Tan	X13, A5
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A5, X17

MAIN WIRING HARNESS (W1)—425 (S.N. 070001—)

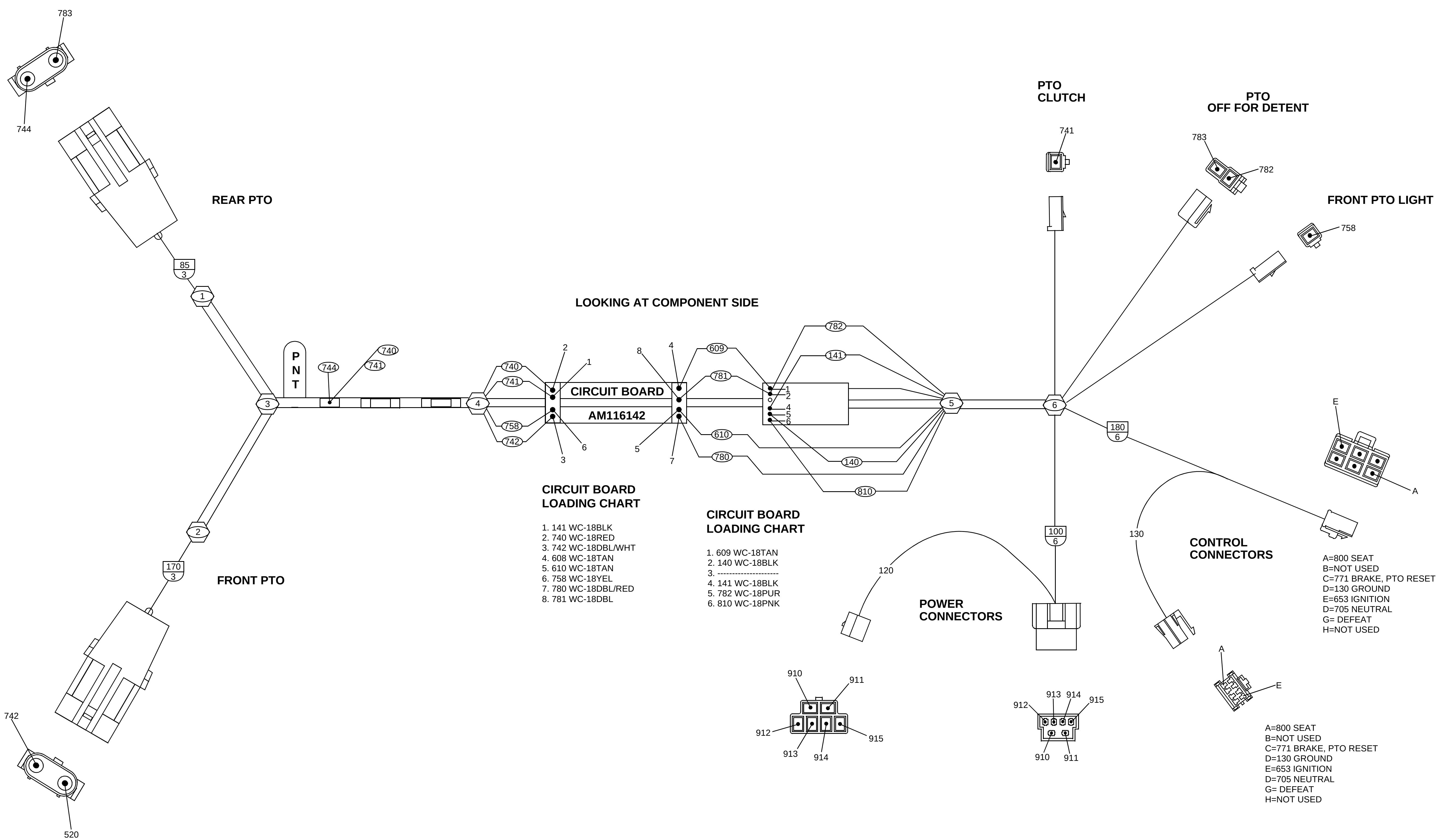
Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, X15
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
135	0.5	Blk	Solder Connection, A5
136	0.5	Blk	Solder Connection, A5
137	0.5	Blk	Solder Connection, A5
140	0.5	Blk	Solder Connection, X12
200	2.0	Red	F1 (205 Lt Blu), X1
201	2.0	Red	F1 (205 Lt Blu), N1
205	0.8	Lt Blu/Fuse-Lnk	M1, Solder Connection (201 Red)



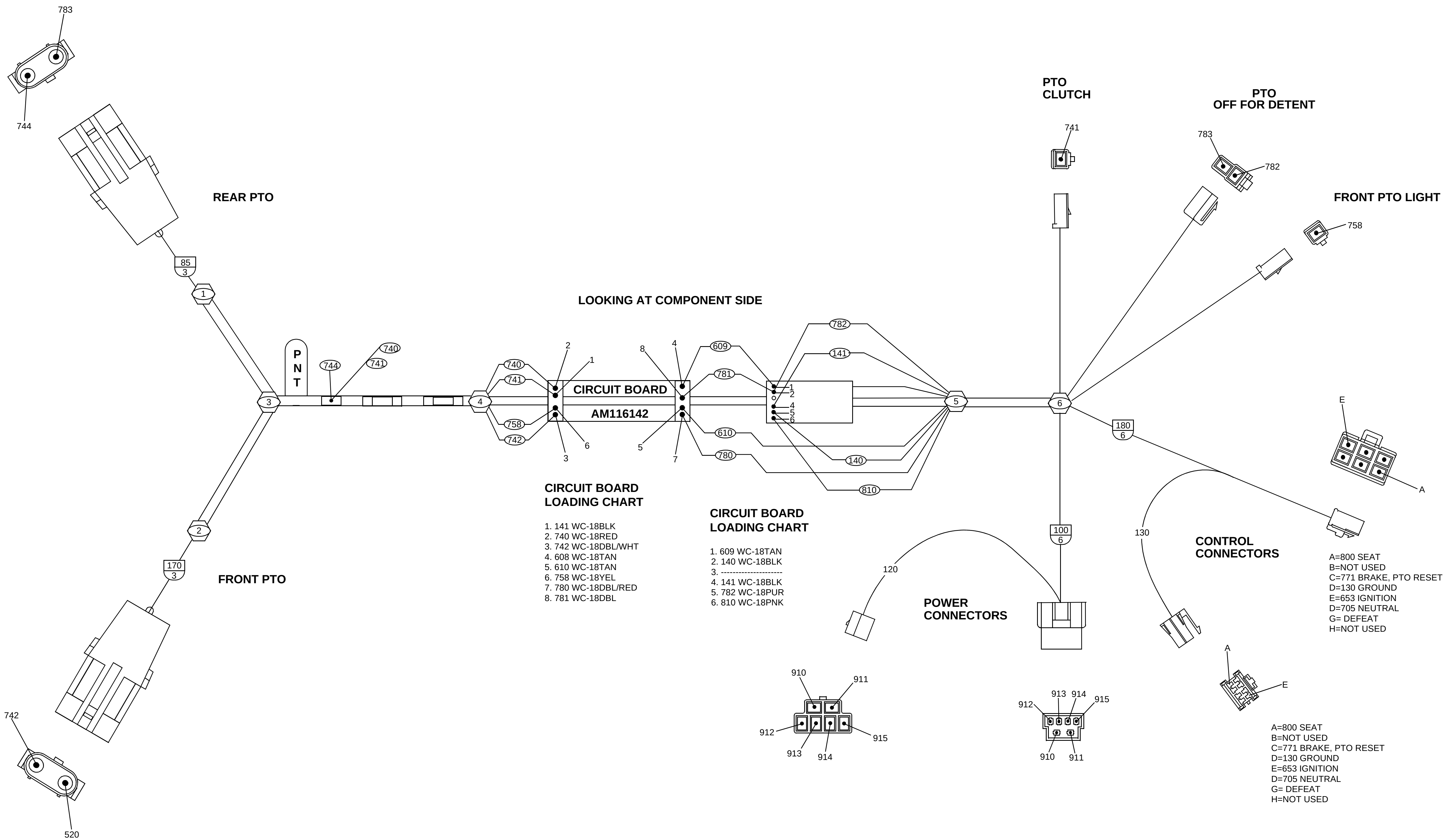
Circuit Number	Wire Size	Color	Termination Points
300	0.5	Org/Wht	X10, A5
400	1.0	Yel/Blu	S6, X3
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A5, S6
455	1.0	Yel/Wht	Solder Connection, X21
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	Solder Connection, X3
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A5, Solder Conneciton
504	0.5	Yel	Solder Connection, N1
520	0.5	Yel	Solder Connection, X13
590	2.0	Brn/Yel	G2, N1
595	2.0	Brn/Wht	G2, N1
600	0.5	Brn	N1, A5
605	0.5	Tan	X11, X2
620	0.5	Tan	X10, A5
650	0.8	Pnk/Blk	X10, S2
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X10, X16
705	0.5	Pnk/Blk	S2, X2
720	1.0	Pur	X10, X3
730	0.8	Grn	S2, X3
735	0.8	Org	S4, X2
740	0.5	Blu	X13, X14
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	S5, X3

Circuit Number	Wire Size	Color	Termination Points
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A5, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	X11, S2
787	0.5	Pur	X11, S5
789	0.5	Pur	X12, S2
790	0.5	Tan	X13, A5
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A5, X17

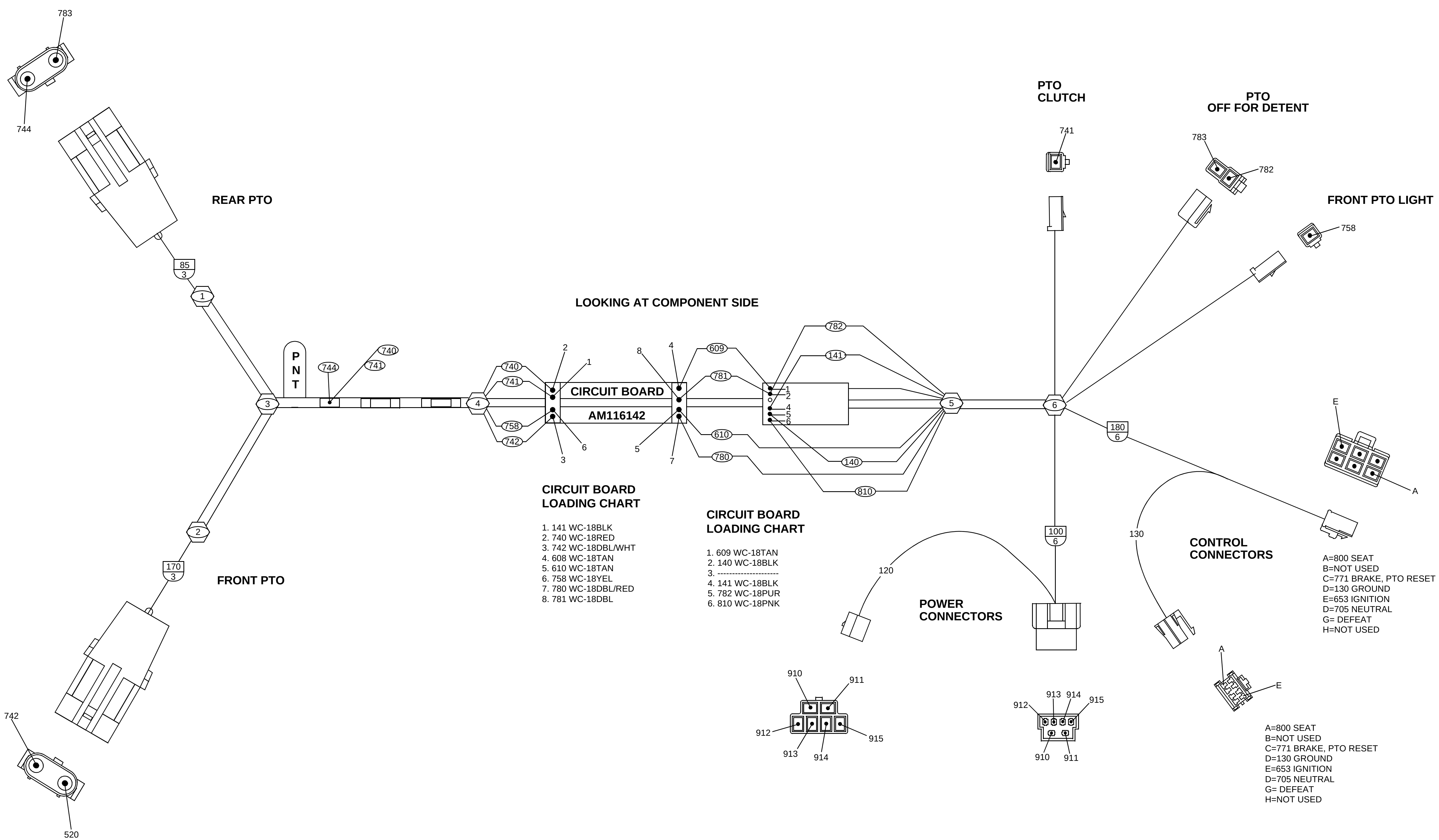
REAR PTO WIRING HARNESS (W2)—425 EARLY MODELS



REAR PTO WIRING HARNESS (W2)—425 EARLY MODELS

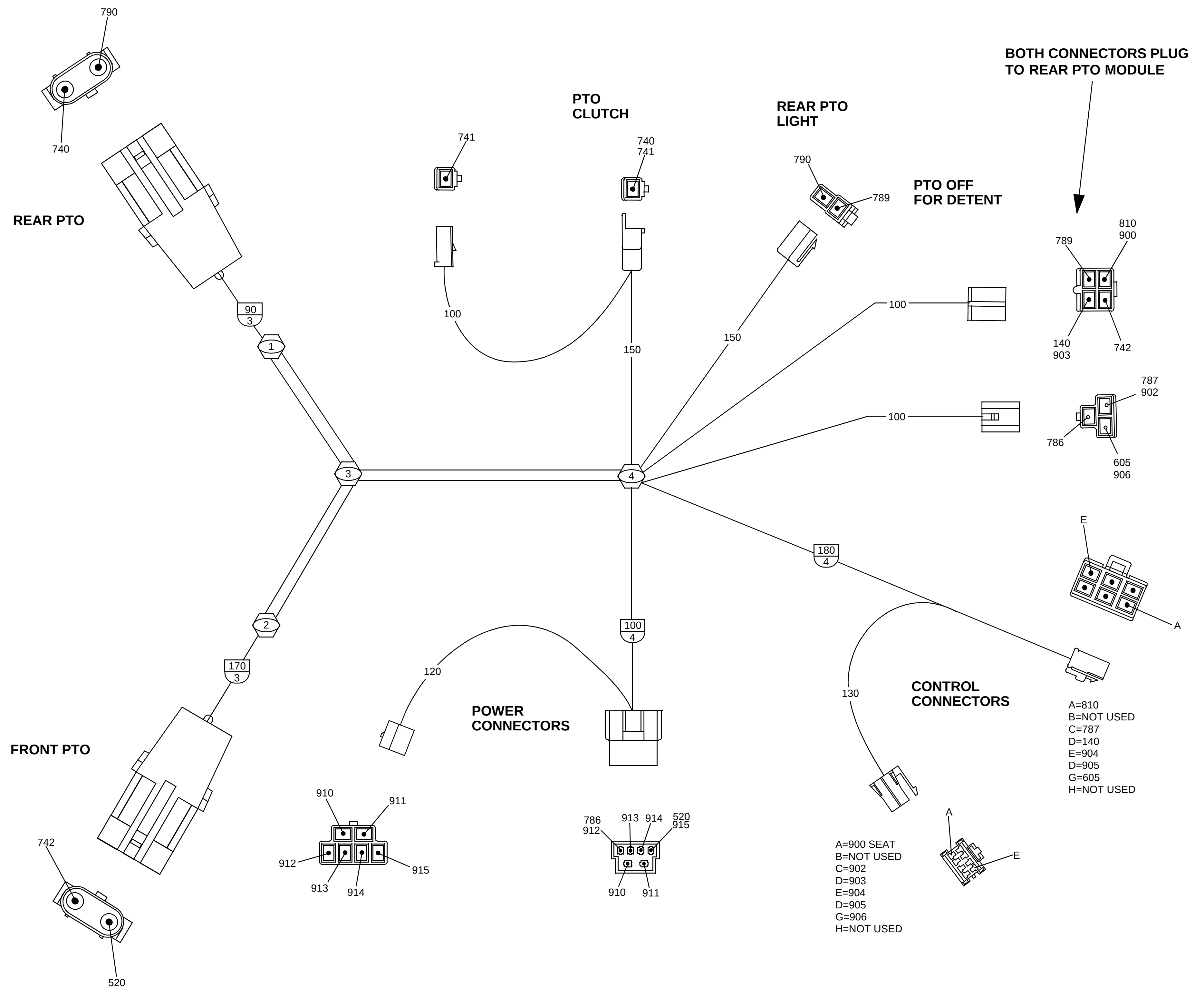


REAR PTO WIRING HARNESS (W2)—425 EARLY MODELS



REAR PTO WIRING HARNESS (W2)—425 LATER MODELS

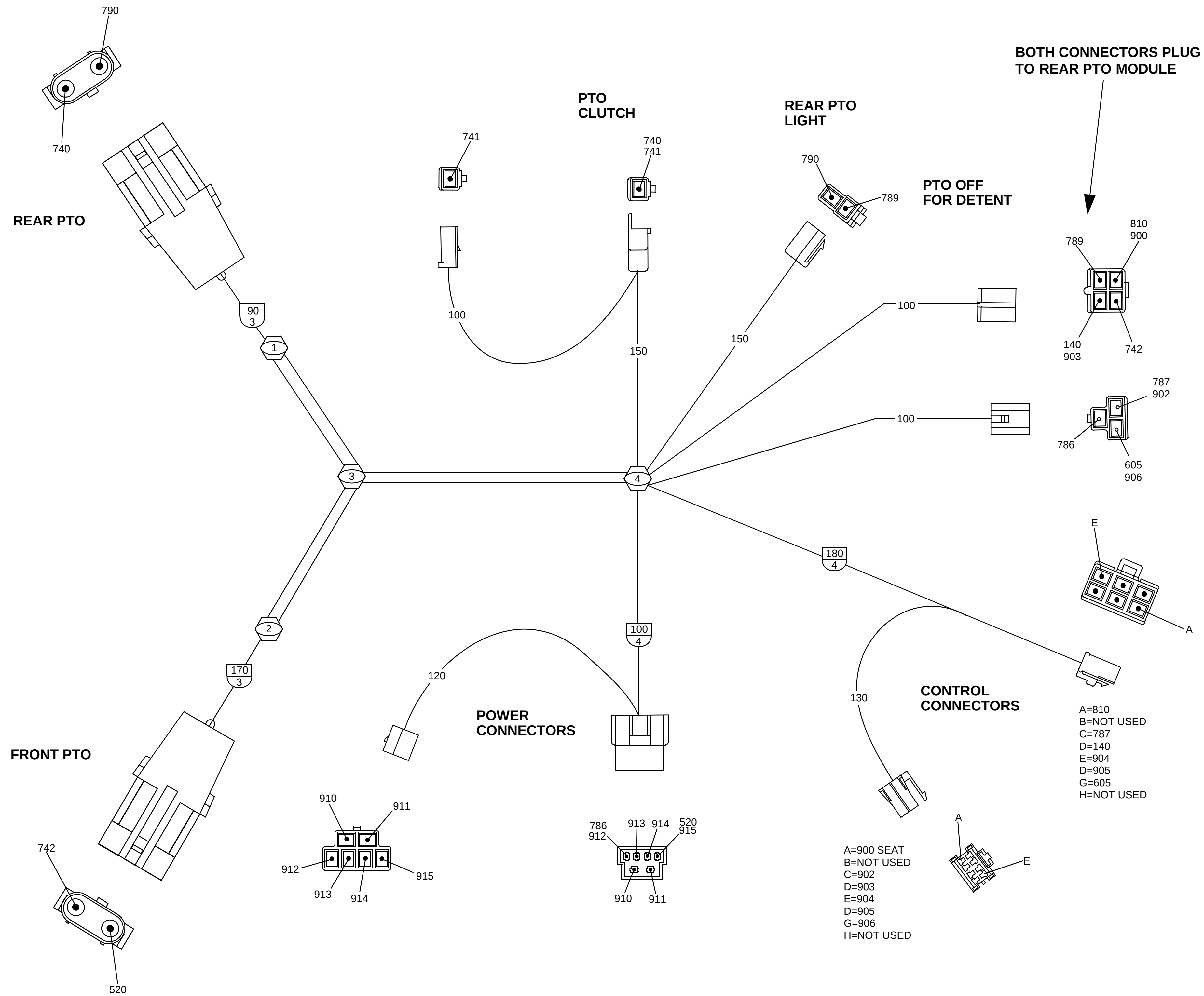
TWO-WHEEL STEER (S.N. —032776)
ALL-WHEEL STEER (S.N. —031422)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
140	0.8	BLK	902	0.8	PUR
520	0.8	YEL	903	0.8	BLK
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—425 LATER MODELS

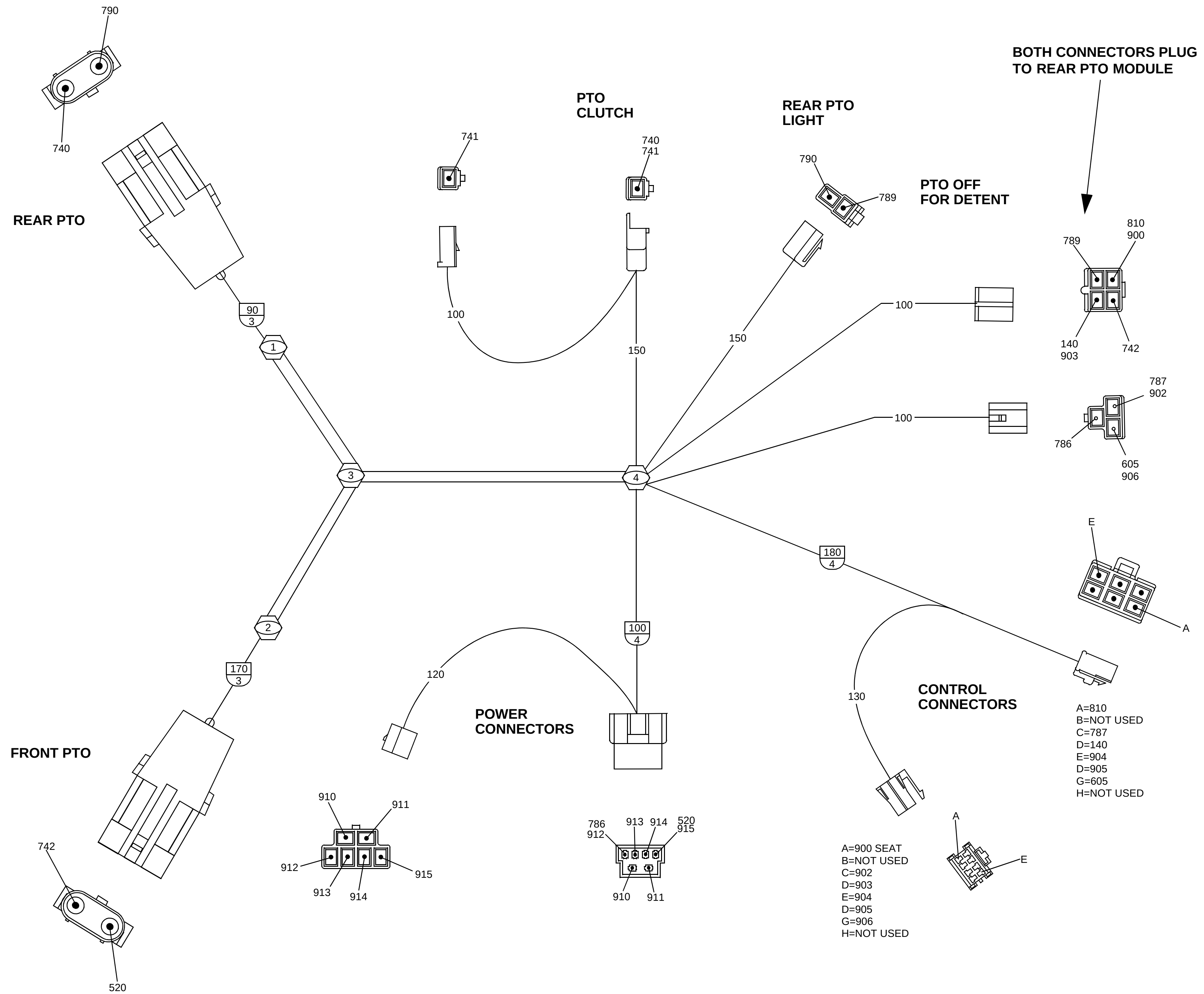
TWO-WHEEL STEER (S.N. —032776)
ALL-WHEEL STEER (S.N. —031422)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
140	0.8	BLK	902	0.8	PUR
520	0.8	YEL	903	0.8	BLK
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—425 LATER MODELS

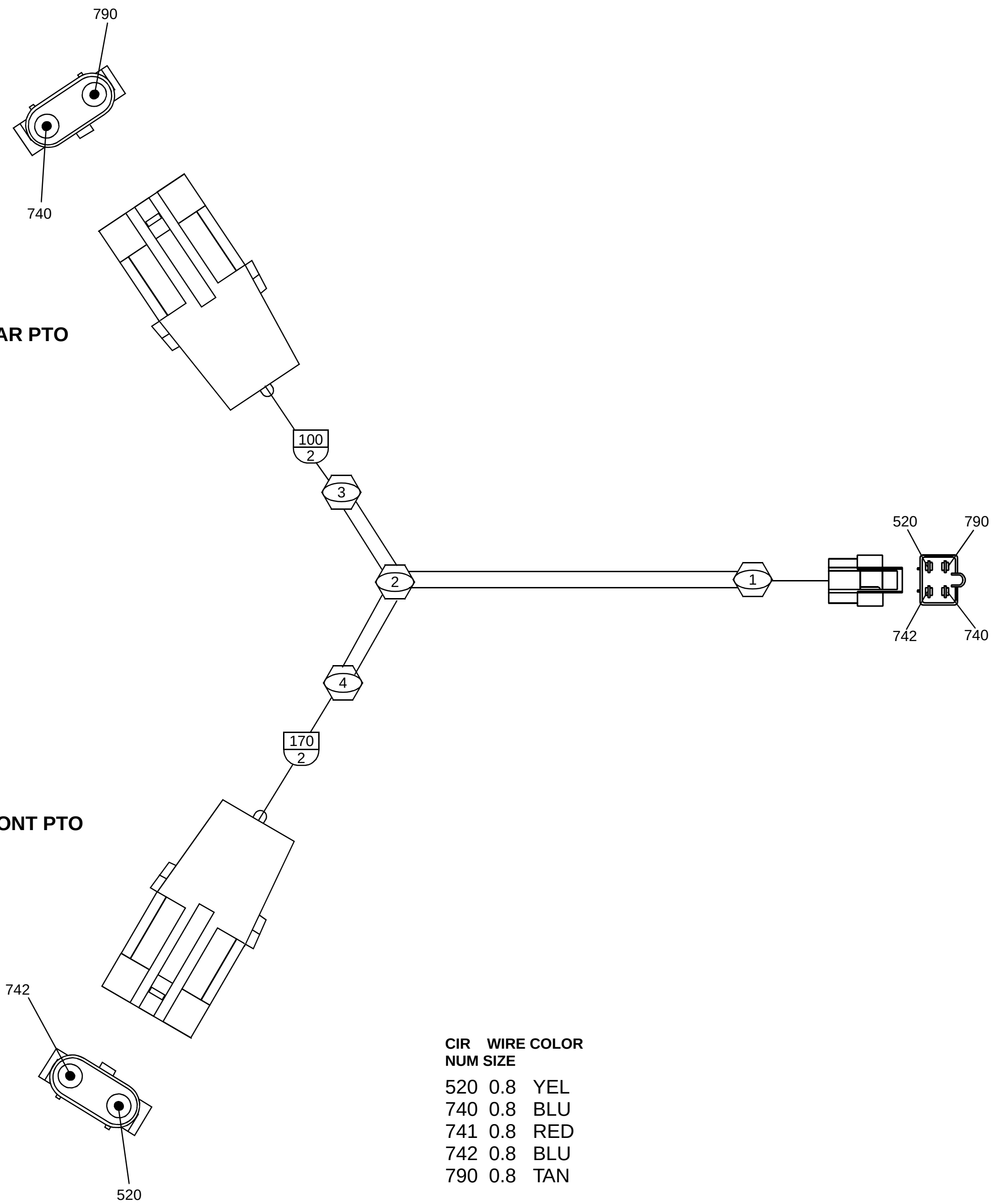
TWO-WHEEL STEER (S.N. —032776)
ALL-WHEEL STEER (S.N. —031422)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
140	0.8	BLK	902	0.8	PUR
520	0.8	YEL	903	0.8	BLK
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—425 LATER MODELS (continued)

TWO-WHEEL STEER (S.N. 032777—)
ALL-WHEEL STEER (S.N. 031423—)



CIR NUM	WIRE SIZE	COLOR
520	0.8	YEL
740	0.8	BLU
741	0.8	RED
742	0.8	BLU
790	0.8	TAN

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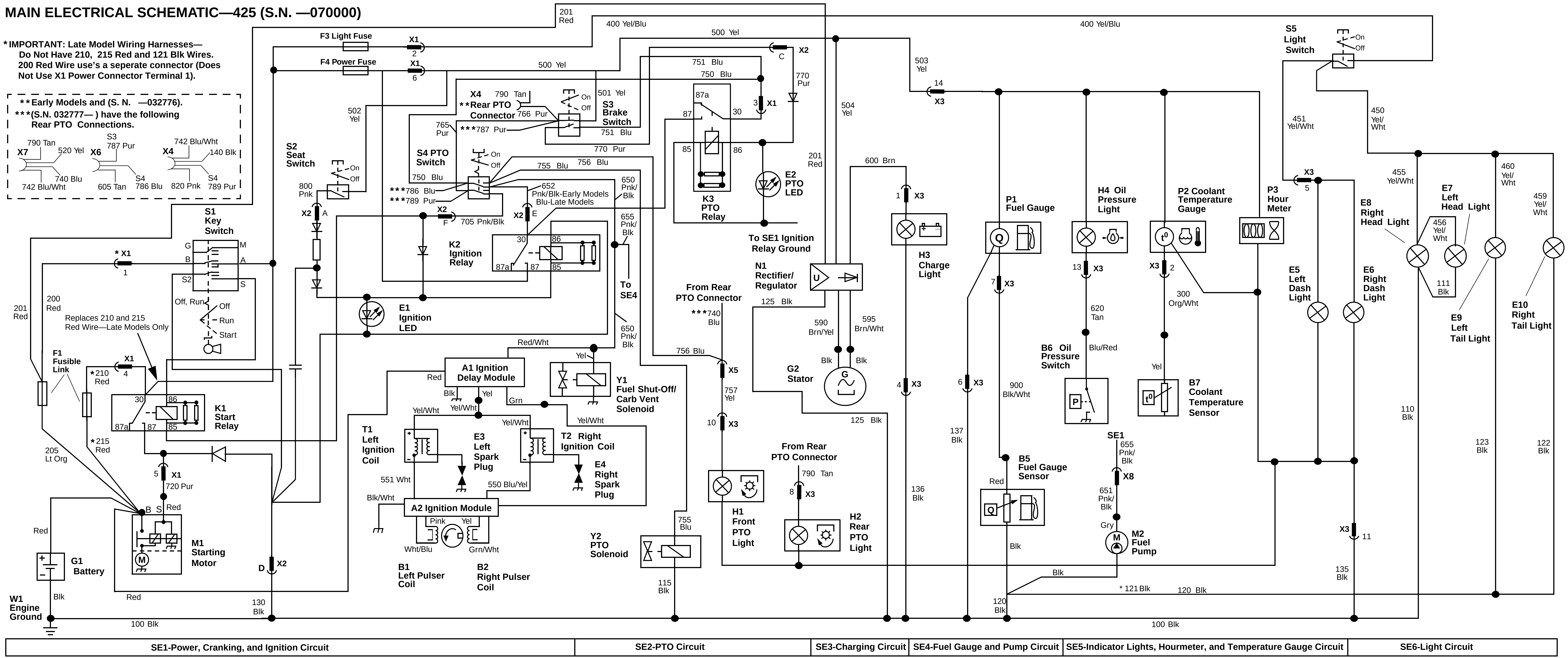
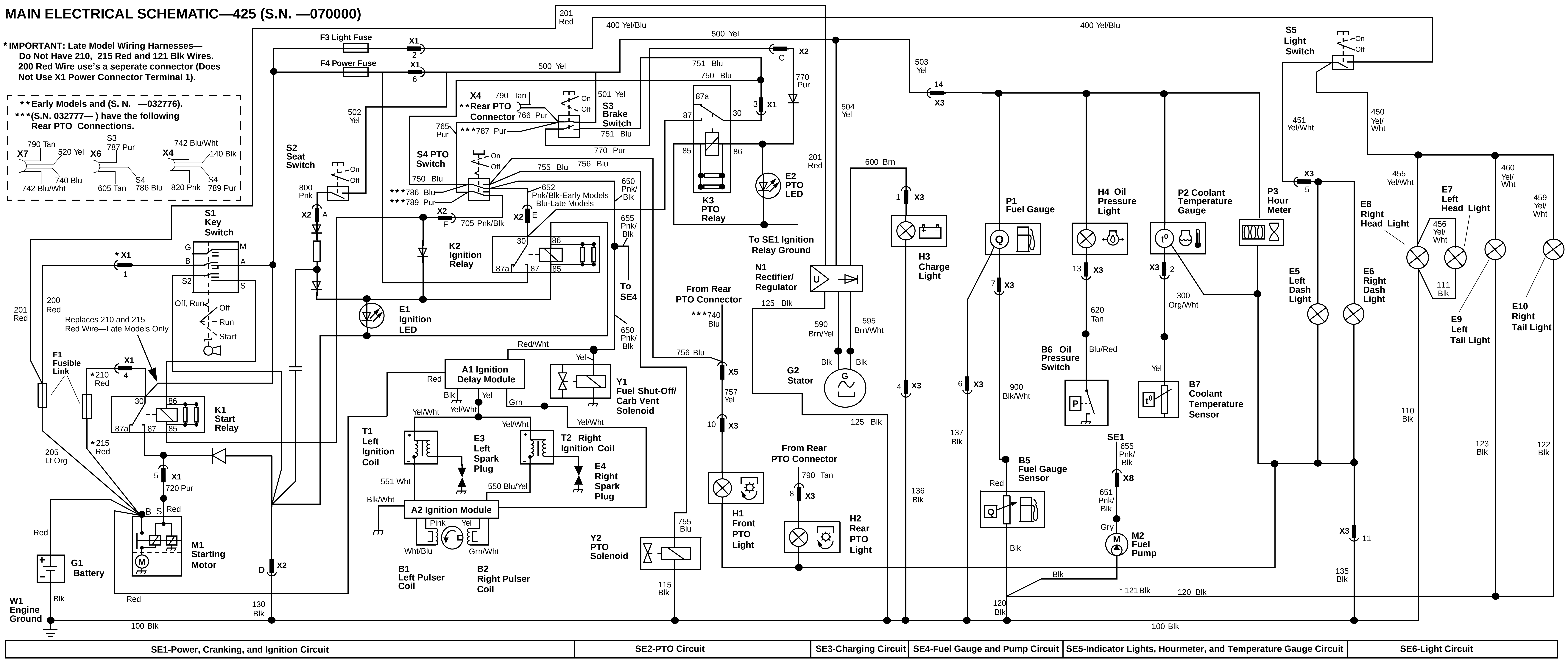
ELECTRICAL SCHEMATICS—425

MAIN ELECTRICAL SCHEMATIC—425 (S.N. —070000)



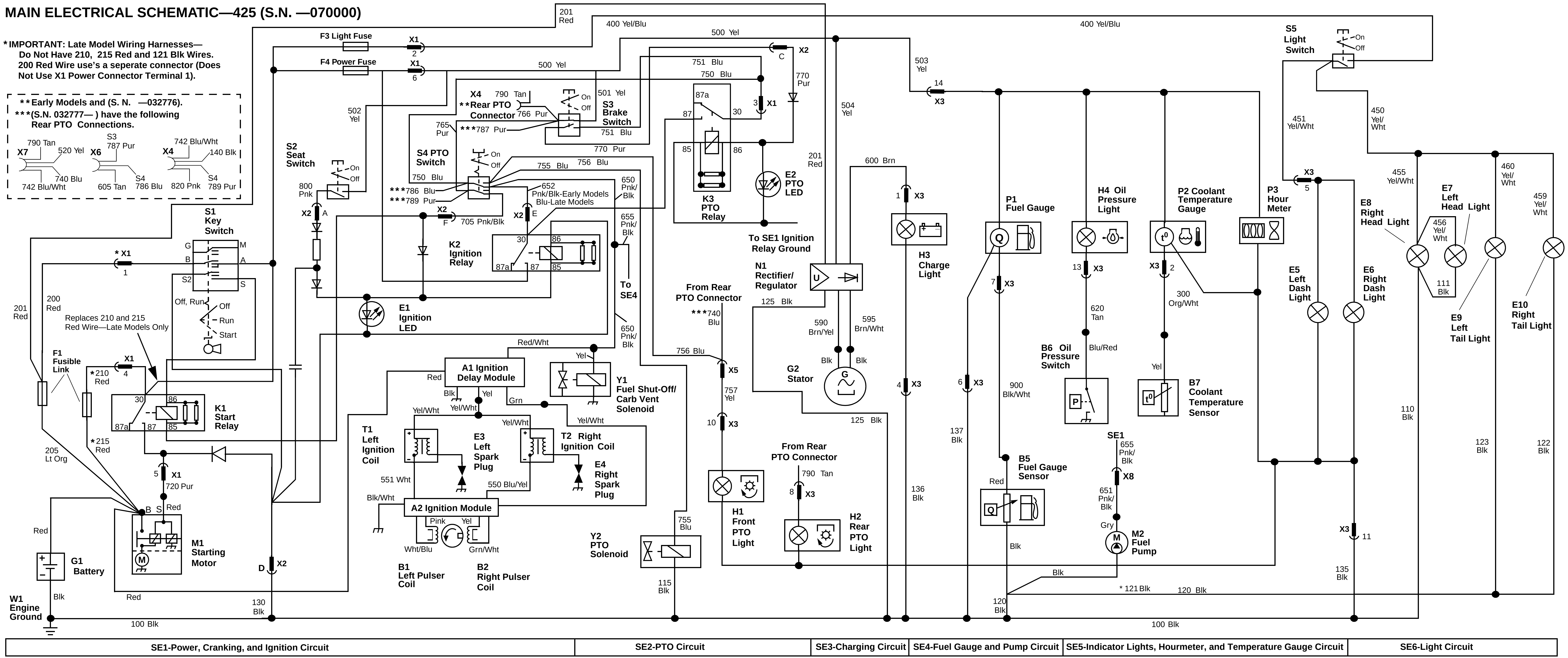
ELECTRICAL SCHEMATICS—425

MAIN ELECTRICAL SCHEMATIC—425 (S.N. —070000)



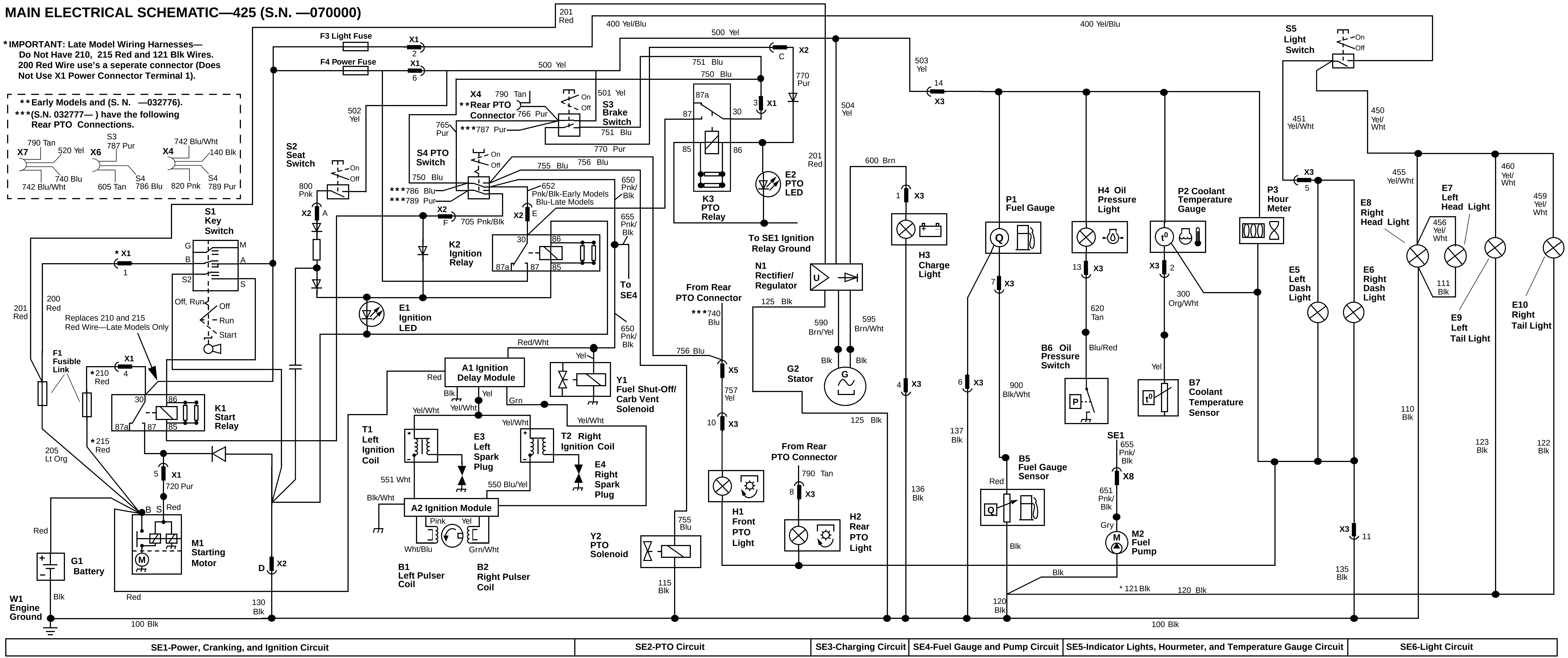
ELECTRICAL SCHEMATICS—425

MAIN ELECTRICAL SCHEMATIC—425 (S.N. —070000)

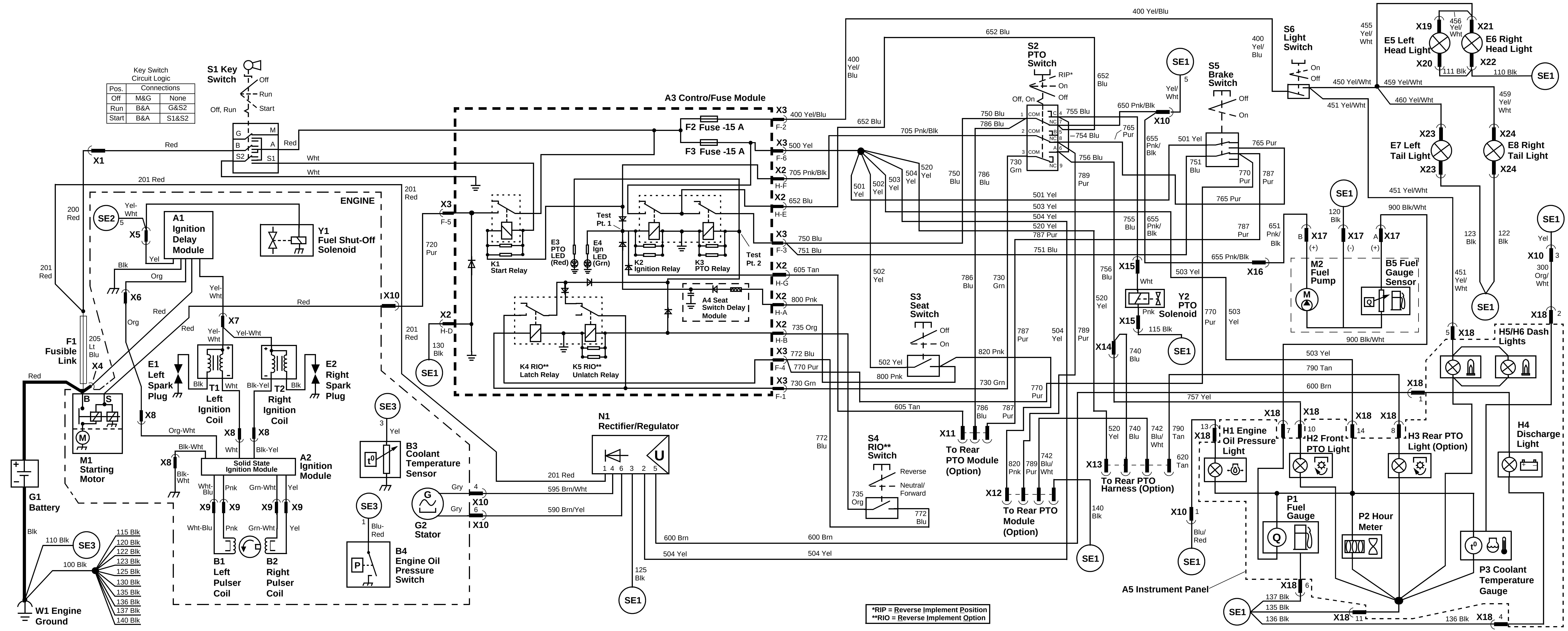


ELECTRICAL SCHEMATICS—425

MAIN ELECTRICAL SCHEMATIC—425 (S.N. —070000)

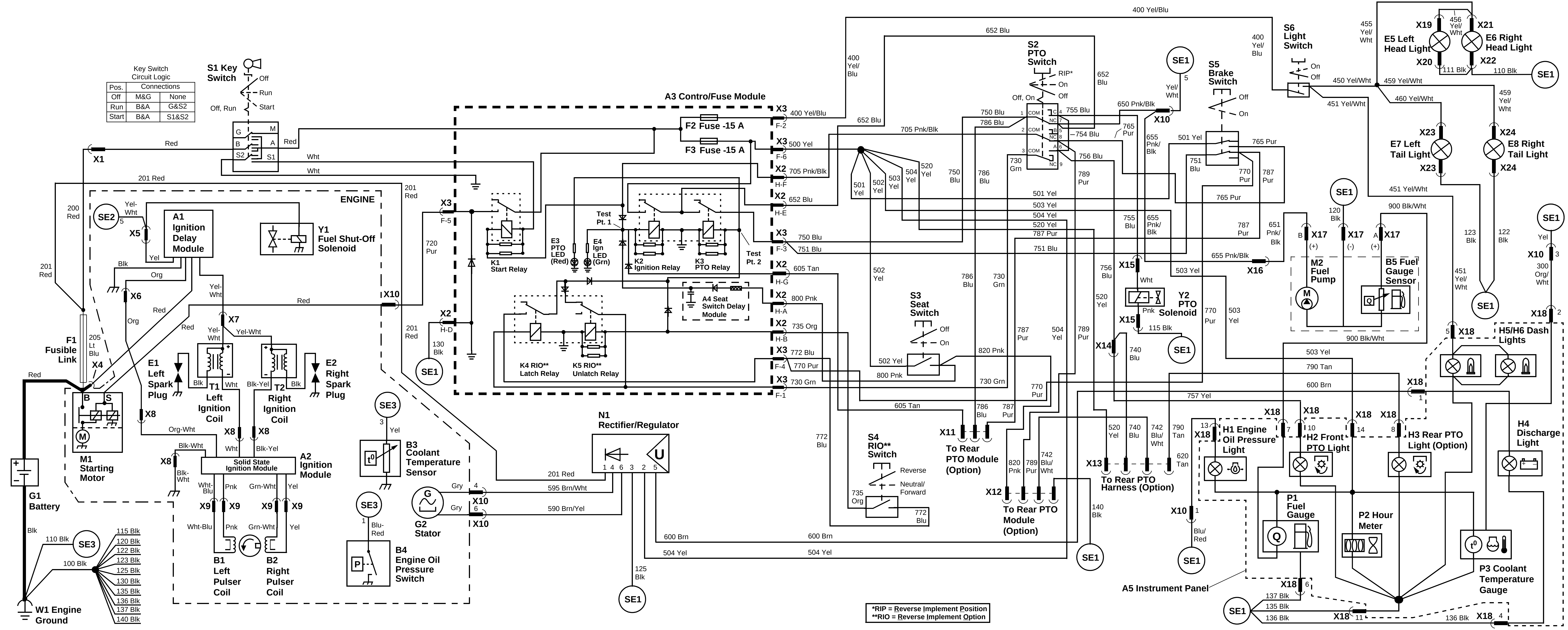


MAIN ELECTRICAL SCHEMATIC—425 (S.N. 070001—)



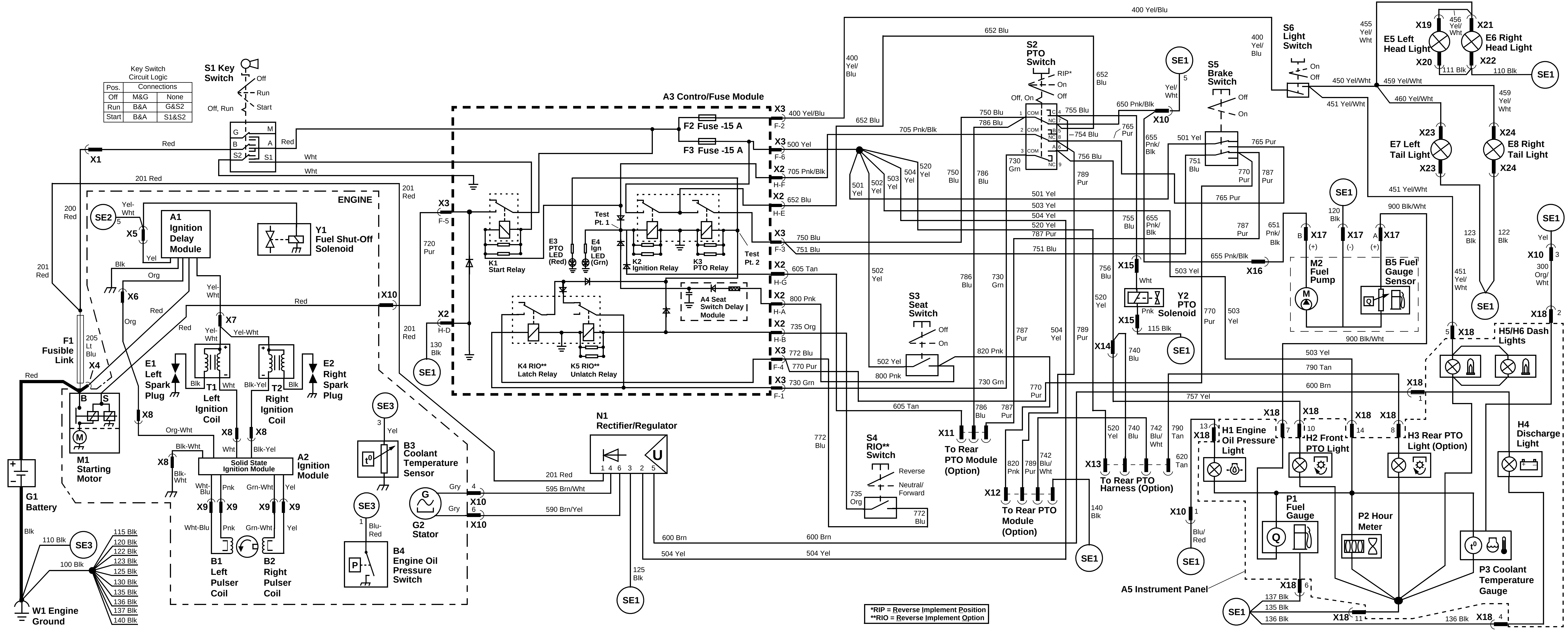
SE1 – Power & Start Circuits and Ignition & Charging Circuits	SE2 – Safety Start & PTO & RIO** Interlock Circuits	SE3–Fuel Pump & Level Circuits and Instrumentation & Headlights Circuits

MAIN ELECTRICAL SCHEMATIC—425 (S.N. 070001—)



SE1 – Power & Start Circuits and Ignition & Charging Circuits | SE2 – Safety Start & PTO & RIO** Interlock Circuits | SE3–Fuel Pump & Level Circuits and Instrumentation & Headlights Circuits

MAIN ELECTRICAL SCHEMATIC—425 (S.N. 070001—)

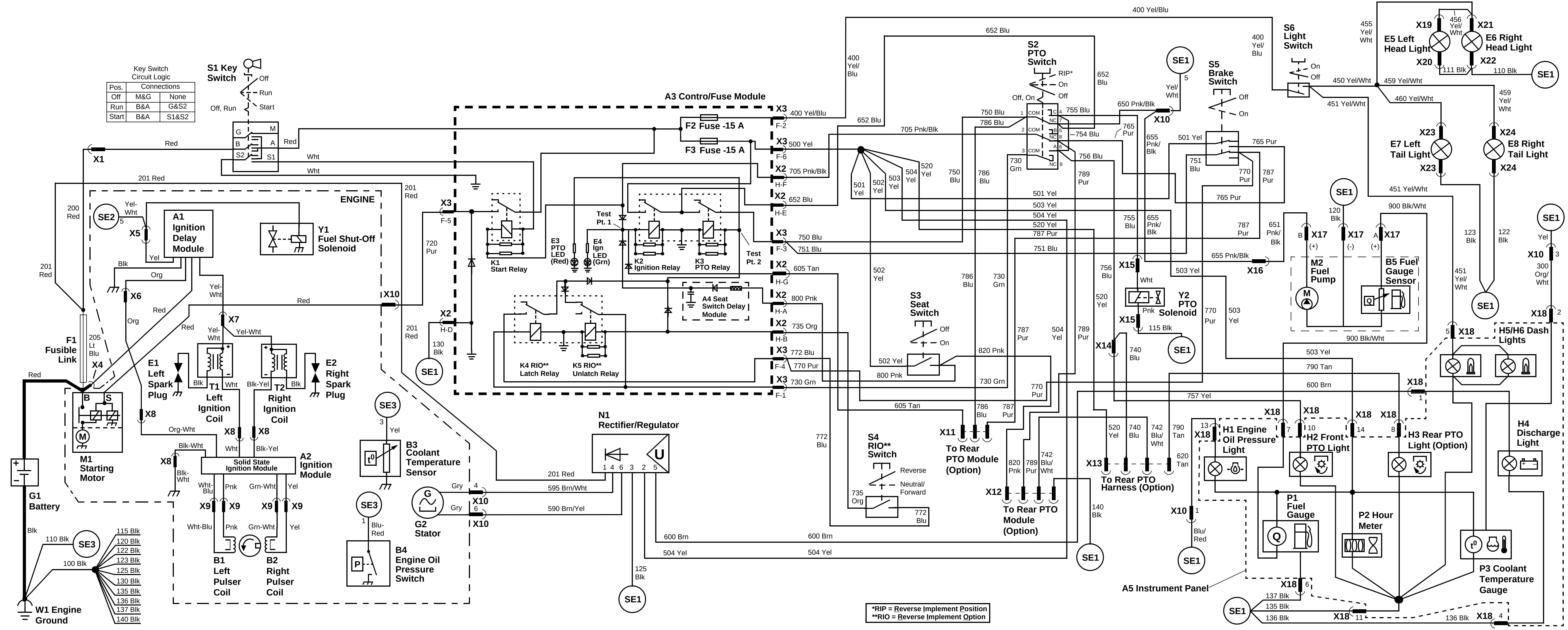


SE1 – Power & Start Circuits and Ignition & Charging Circuits	SE2 – Safety Start & PTO & RIO** Interlock Circuits	SE3–Fuel Pump & Level Circuits and Instrumentation & Headlights Circuits

MAIN ELECTRICAL SCHEMATIC—425 (S.N. 070001—)

Key Switch Circuit Logic

Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2



SE1 – Power & Start Circuits and Ignition & Charging Circuits | SE2 – Safety Start & PTO & RIO** Interlock Circuits | SE3–Fuel Pump & Level Circuits and Instrumentation & Headlights Circuits

TROUBLESHOOTING—425

ELECTRICAL SYSTEM QUICK TEST—425 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Check connections for corrosion and loose terminals.
- Battery fully charged and in good condition.
- Fuel tank full of fresh clean fuel.

Test/Check Point	Normal	If Not Normal
1. Only if no spark one or both cylinders. Battery—measure DC voltage across battery terminals. Measure DC voltage between engine block and positive (+) terminal of each coil (left and right).	Voltage is 0.7 or less lower at the coils than battery. Voltage readings are the same—go to step 2	Voltage is more than 0.7 volts lower at the coils than battery—check battery terminal connections, battery-to-engine ground connection, positive side circuit from coil to battery to verify circuit is good.
2. Only if no spark one or both cylinders. Remove both spark plug wires and use jumper wires to ground plugs to engine. With engine cranking, measure AC voltage across pulsar leads (pulsar side of connector.)	Pulsars should produce low levels of AC voltage (as low as 0.05 VAC). Output ok—with engine cranking, use a test light to test between negative post of battery and negative terminal of each coil. If battery voltage is measured at coils, pulsars are ok, connections at both (4) terminal connectors test good, and proper ground is verified, and still no light pulsations at negative terminal of both coils, replace ignition module.	No output either pulsar—replace. Test light results: Light pulsation (flickering) indicates ignition module, pulsars, and electrical connections are ok. Lack of spark is caused by coil failure, defective spark plug, or spark plug cap. Replace defective parts. If no light pulsations (steady glow)—check resistance at 4 terminal connectors for coil negative lead, ground lead, and pulsar leads. If resistance not the same clean and tighten—retest. Test Ignition module ground (blk/wht) wire to engine.
3. Dash panel.	Oil pressure and charge light on, fuel and temperature gauge needle movement indicates fuel level and engine temperature.	See troubleshooting chart and check problem circuit.
4. Ignition LED.	Light on.	Check ignition circuit test points.
5. Fuel pump—turn key switch to off and then to on position, listen for fuel pump operation.	Fuel pump must run, listen for humming or ticking noise near carburetor.	Check fuel pump circuit test points.
6. Engine starting—turn key switch to start position.	Engine must start.	Engine will not crank—check cranking circuit test points. Engine cranks but will not start—check wiring harness is grounded to engine block, spark and compression.
7. Engine operation.	Engine must run smoothly. Oil pressure and charge light goes off.	Check ignition, charge, and indicator lights circuit test points.
8. PTO LED and light—release brake pedal and pull PTO switch upward.	PTO LED and indicator light on. PTO must engage.	Check PTO circuit test points. PTO must engage.

ELECTRICAL SYSTEM QUICK TEST—425 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch in off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Check connections for corrosion and loose terminals.
- Battery fully charged and in good condition.
- Fuel tank full of fresh clean fuel.

Test/Check Point	Normal	If Not Normal
1. Only if no spark one or both cylinders. Battery—measure DC voltage across battery terminals. Measure DC voltage between engine block and positive (+) terminal of each coil (left and right).	Voltage is 0.7 or less lower at the coils than battery. Voltage readings are the same—go to step 2	Voltage is more than 0.7 volts lower at the coils than battery—check battery terminal connections, battery-to-engine ground connection, positive side circuit from coil to battery to verify circuit is good.
2. Only if no spark one or both cylinders. Remove both spark plug wires and use jumper wires to ground plugs to engine. With engine cranking, measure AC voltage across pulsar leads (pulsar side of connector.)	Pulsars should produce low levels of AC voltage (as low as 0.05 VAC). Output ok—with engine cranking, use a test light to test between negative post of battery and negative terminal of each coil. If battery voltage is measured at coils, pulsars are ok, connections at both (4) terminal connectors test good, and proper ground is verified, and still no light pulsations at negative terminal of both coils, replace ignition module.	No output either pulsar—replace. Test light results: Light pulsation (flickering) indicates ignition module, pulsars, and electrical connections are ok. Lack of spark is caused by coil failure, defective spark plug, or spark plug cap. Replace defective parts. If no light pulsations (steady glow)—check resistance at 4 terminal connectors for coil negative lead, ground lead, and pulsar leads. If resistance not the same clean and tighten—retest. Test Ignition module ground (blk/wht) wire to engine.
3. Instrument panel.	Oil pressure and charge light on, fuel and temperature gauge needle movement indicates fuel level and engine temperature.	See troubleshooting chart and check problem circuit.
4. Ignition LED.	Light on.	Check ignition circuit test points.
5. Fuel pump—turn key switch to off and then to on position, listen for fuel pump operation.	Fuel pump must run, listen for humming or ticking noise near carburetor.	Check fuel pump circuit test points.
6. Engine starting—turn key switch to start position.	Engine must start.	Engine will not crank—check cranking circuit test points. Engine cranks but will not start—check wiring harness is grounded to engine block, spark and compression.
7. Engine operation.	Engine must run smoothly. Oil pressure and charge light goes off.	Check ignition, charge, and indicator lights circuit test points.
8. PTO LED and light—release brake pedal and pull PTO switch upward.	PTO LED and indicator light on. PTO must engage.	Check PTO circuit test points. PTO must engage.

ELECTRICAL SYSTEM TROUBLESHOOTING CHART—425

Problem or Symptom / Check or Solution	Engine will not crank	Engine cranks but will not start	Charge light stays on, will not come on, battery over-charges or discharges	PTO clutch will not engage PTO light not on	PTO clutch will not disengage	Fuel gauge does not show correct level	No spark
See power circuit diagnosis	●	●	●	●		●	●
See charging circuit diagnosis	●		●				●
See PTO circuit diagnosis				●	●		
See cranking circuit diagnosis	●						
See fuel gauge circuit diagnosis						●	
See glow plug circuit diagnosis		●					
See fuel pump circuit diagnosis		●					
See ignition circuit diagnosis		●					●
Check ground circuit	●	●	●	●		●	●
Check for shorted circuit	●	●	●	●		●	●
See power circuit diagnosis	●		●	●	●	●	●
See charging circuit diagnosis				●		●	
See PTO circuit diagnosis				●	●		

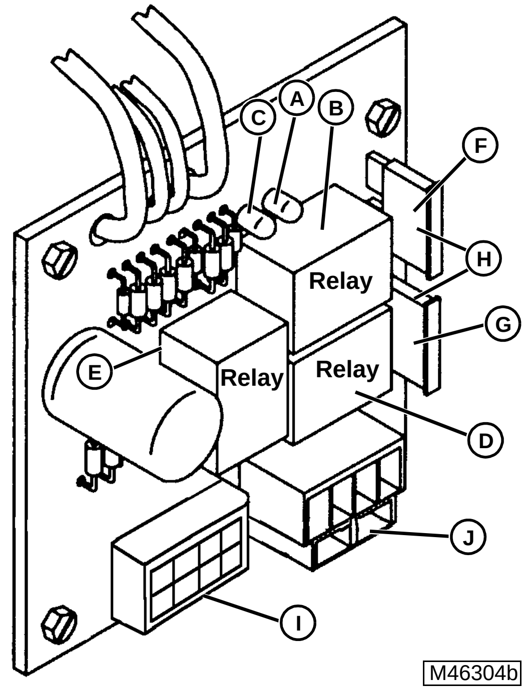
ELECTRICAL SYSTEM TROUBLESHOOTING CHART—425 (continued)

Problem or Symptom / Check or Solution	Coolant temperature gauge problem.	Oil pressure light stays on, or will not come on.	Hourmeter does not run.	Head lights, tail lights, or dash lights do not come on.	Engine stops when PTO is engaged or when brake pedal is released.	No indicator lights come on.	Ignition LED or PTO LED lights not on.	No components operate.	Ignition or PTO continues to run with operator off seat.
See charging circuit diagnosis.						●		●	
See PTO circuit diagnosis.					●	●	●		
See coolant temperature gauge circuit diagnosis.	●								
See oil pressure light circuit diagnosis.		●				●			
See hourmeter circuit diagnosis.			●						
See lights circuit diagnosis.				●					
See ignition circuit diagnosis.					●				●
Check ground circuit.					●				
Check for shorted circuit.					●				

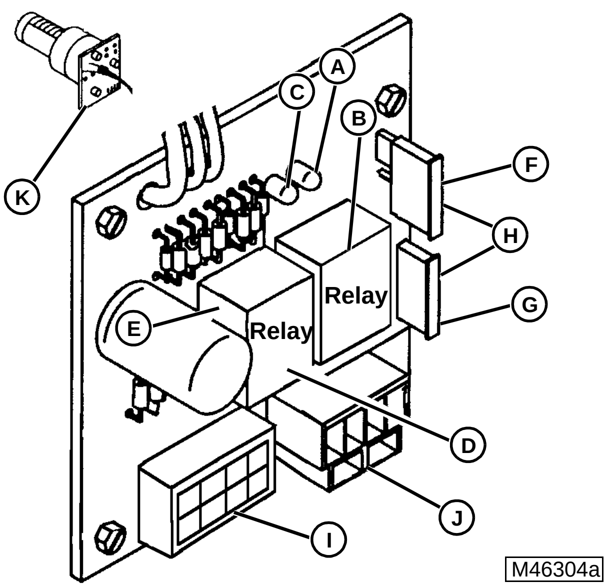
CONTROL/FUSE MODULE—425

IMPORTANT: The only way to determine the actual cause of a problem is to conduct the system and component tests.

Early modules have three visible relays and four main wires instead of three. Late modules have two visible relays (PTO relay and start relay is combined). All test procedures remain the same.



Early Module



Late Module

The two small LEDs (light emitting diodes) that are a part of the control/fuse module can be used to make a quick check of some of the circuits of the machine. The LEDs will not determine the exact location of the problem. When the LEDs are on, this indicates power is available to the ignition and PTO relays. When the LEDs are off, no power is present at the ignition and PTO relays. If the LEDs are off, they are not an indicator of the failure of the printed circuit board.

The ignition green LED (A) indicates that there is power to the ignition relay (B) coil through either of the following circuits:

- Key switch on and operator on seat (run circuit).
- Key switch on, PTO turned off, and park brake engaged (neutral start circuit).

The PTO red LED (C) indicates that there is power to the PTO relay (D) coil through either of the following circuits:

- Key switch on, operator on seat, park brake disengaged, and PTO turned off (PTO pre-operation circuit).
- Key switch on, operator on seat, PTO turned on, park brake disengaged, and ignition relay engaged (PTO operation circuit).

When diagnosing a problem using the LEDs, and the LEDs are off, check that part of the circuit before the control/fuse module LEDs (neutral start or PTO pre-operation circuit). When the LEDs are on, check that part of the circuit after the control/fuse module LEDs. Tests for voltage or ground will be at the control connector (I) or the power connector (J) of the control/ fuse module and not on the printed circuit board paths.

The ignition relay (B), PTO relay (D), start relay (E), fuse terminals (H), key switch (K), ignition LED (A), and PTO LED (C) are mounted on a printed circuit board. The components are solid state and are not serviced separately except for the 15 amp fuses.

A—Ignition or Hold-In LED

B—Ignition Relay (K2)

C—PTO Red LED

D—PTO Relay (K3)

E—Start Relay (K1)

F—Ignition Hold-In Fuse

G—Head Light Fuse

H—Fuse Terminals

I—Control Connector (X1)

J—Power Connector (X2)

K—Key Switch (S1)

CIRCUIT OPERATION AND DIAGNOSIS—425

POWER CIRCUIT OPERATION—425 (S.N. —070000)

Function:

To provide battery power to the primary machine components through main current paths.

Operating Conditions:

Voltage must be present at the following components for the other circuits to operate:

- B Terminal of Starting Motor
- Fusible Links
- B Terminal of Key Switch
- Control/fuse Module
- Control/fuse Module Fuses
- Ignition Delay Module

System Operation:

With the key switch (S1) in the off position, unswitched current from the battery positive terminal flows to the starter solenoid battery terminal (M1), fusible links (F1), key switch battery terminal, start relay (K1), ignition delay module (A1), left ignition coil (T1), right ignition coil (T2), and the regulator/rectifier (N1). With the key switch in the run position, current flows from key switch B to A terminal, fuses (F3, F4), seat switch (S2), ignition relay (K2), brake switch (S3), regulator/ rectifier (N1), oil pressure light (H4), coolant temperature gauge (P2), fuel gauge (P1), hourmeter (P3), and light switch (S5). With the key switch in the start position, terminals S1 and S2 provide a path to ground for the start relay.

POWER CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

To provide battery power to the primary machine components through main current paths.

Operating Conditions:

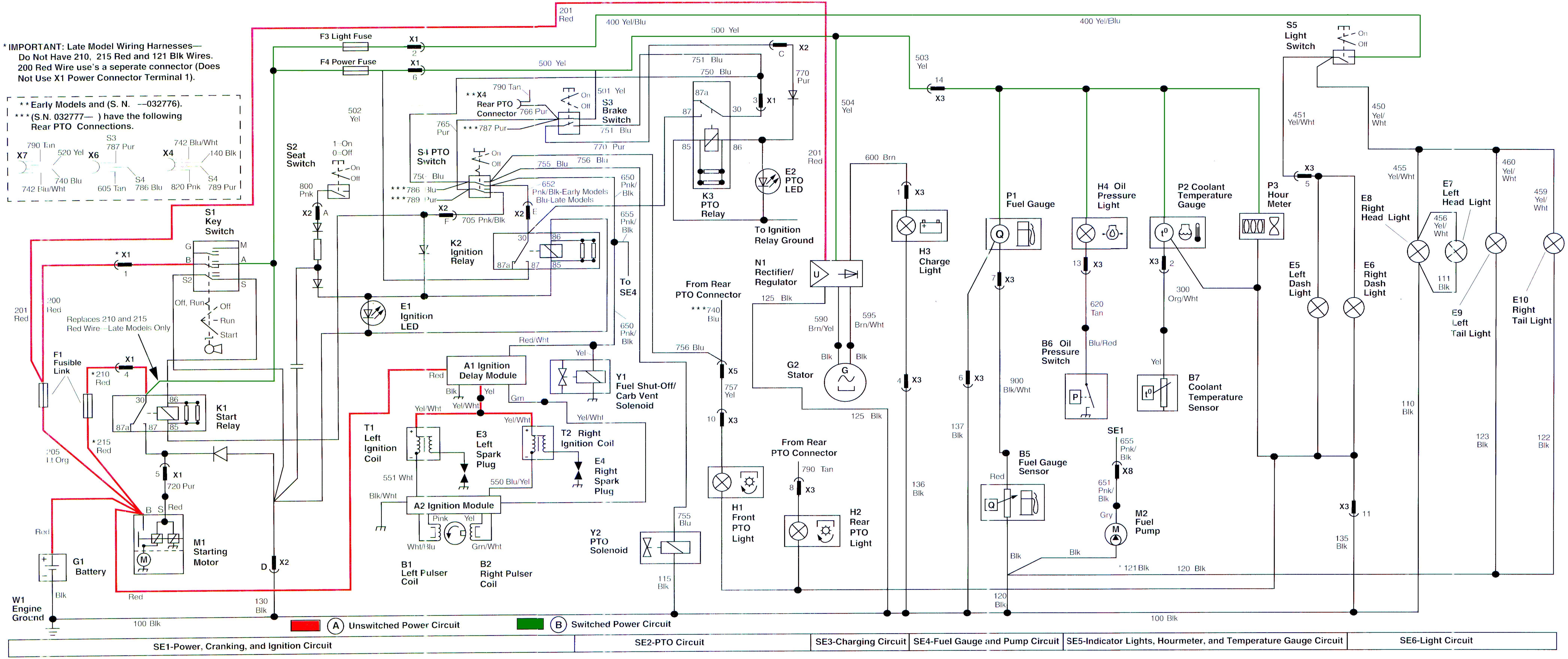
Voltage must be present at the following components for the other circuits to operate:

- B Terminal of Starting Motor
- Fusible Links
- B Terminal of Key Switch
- Control/fuse Module
- Control/fuse Module Fuses
- Ignition Delay Module

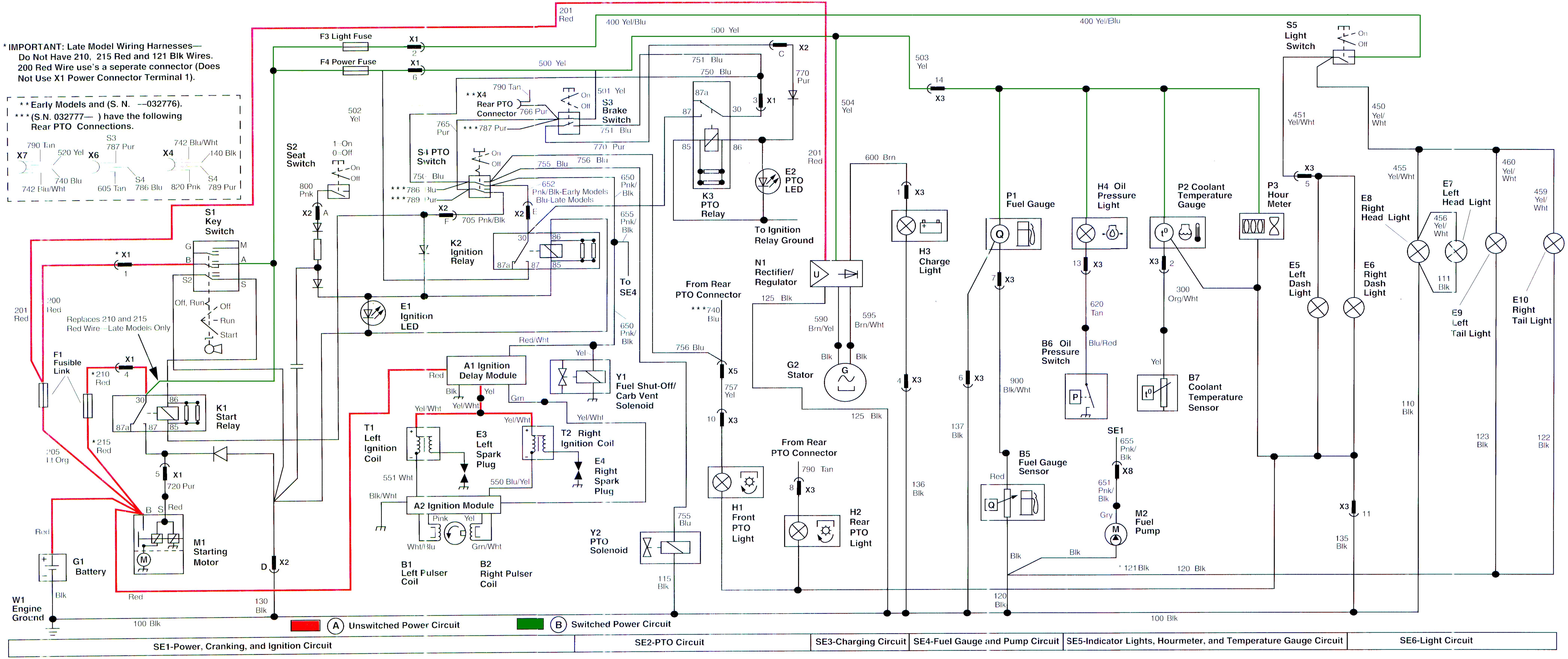
System Operation:

Unswitched current from the battery positive terminal flows to the battery terminal of starting motor (M1), fusible link (F1), battery terminal on key switch (S1), start relay (K1), ignition delay module (A1), and the rectifier/regulator (N1). With the key switch in the run position, current flows from terminal B to terminal A of the key switch and to fuses (F3, F4), seat switch (S3), ignition relay (K2), brake switch (S5), rectifier/regulator (N1), instrument panel (A5) and lights switch (S6).

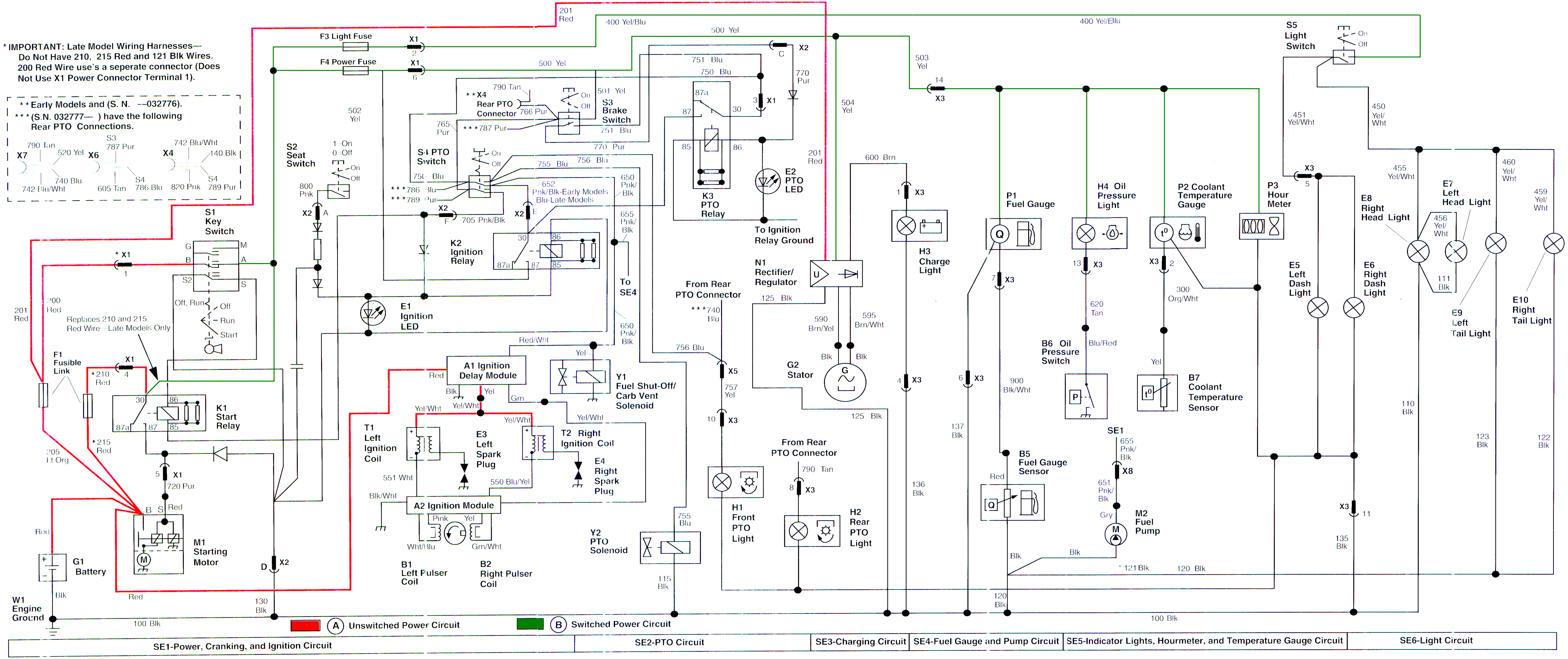
POWER CIRCUIT SCHEMATIC—425 (S.N. —070000)



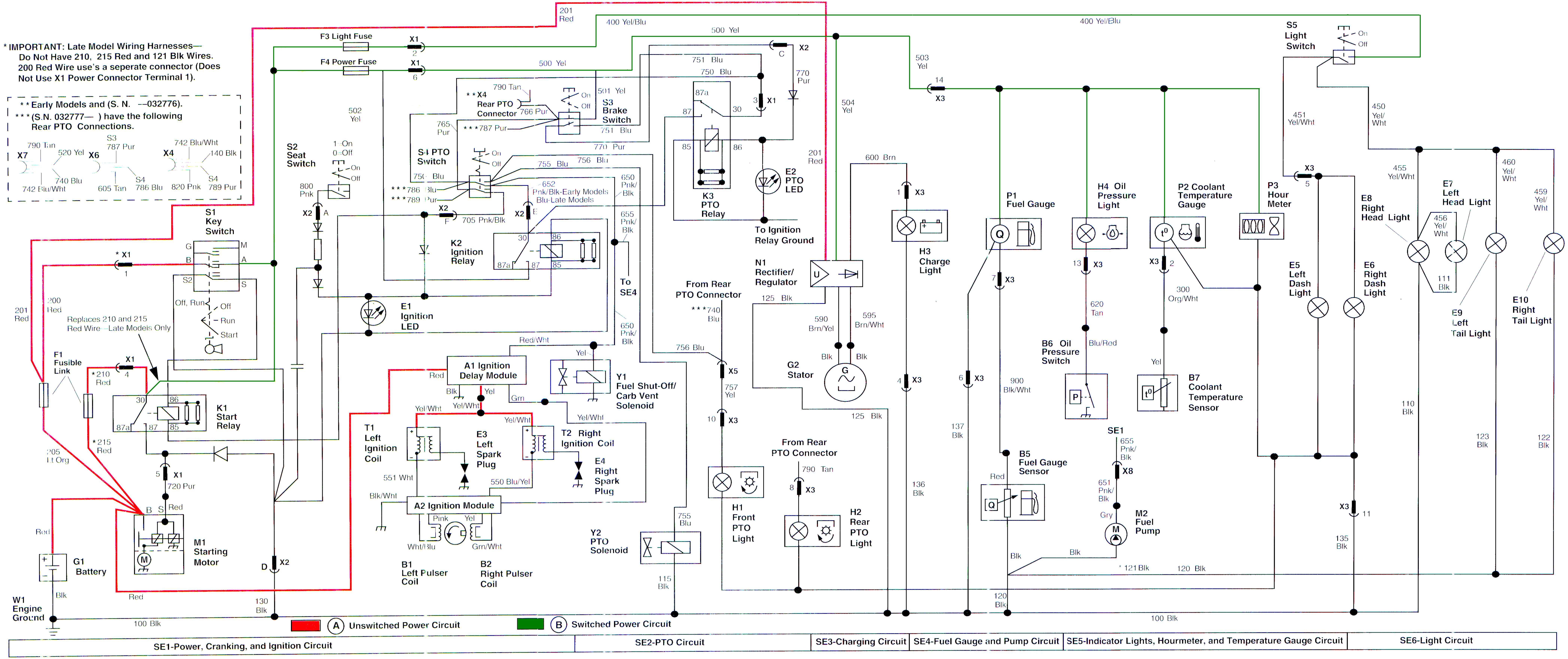
POWER CIRCUIT SCHEMATIC—425 (S.N. —070000)



POWER CIRCUIT SCHEMATIC—425 (S.N. —070000)



POWER CIRCUIT SCHEMATIC—425 (S.N. —070000)



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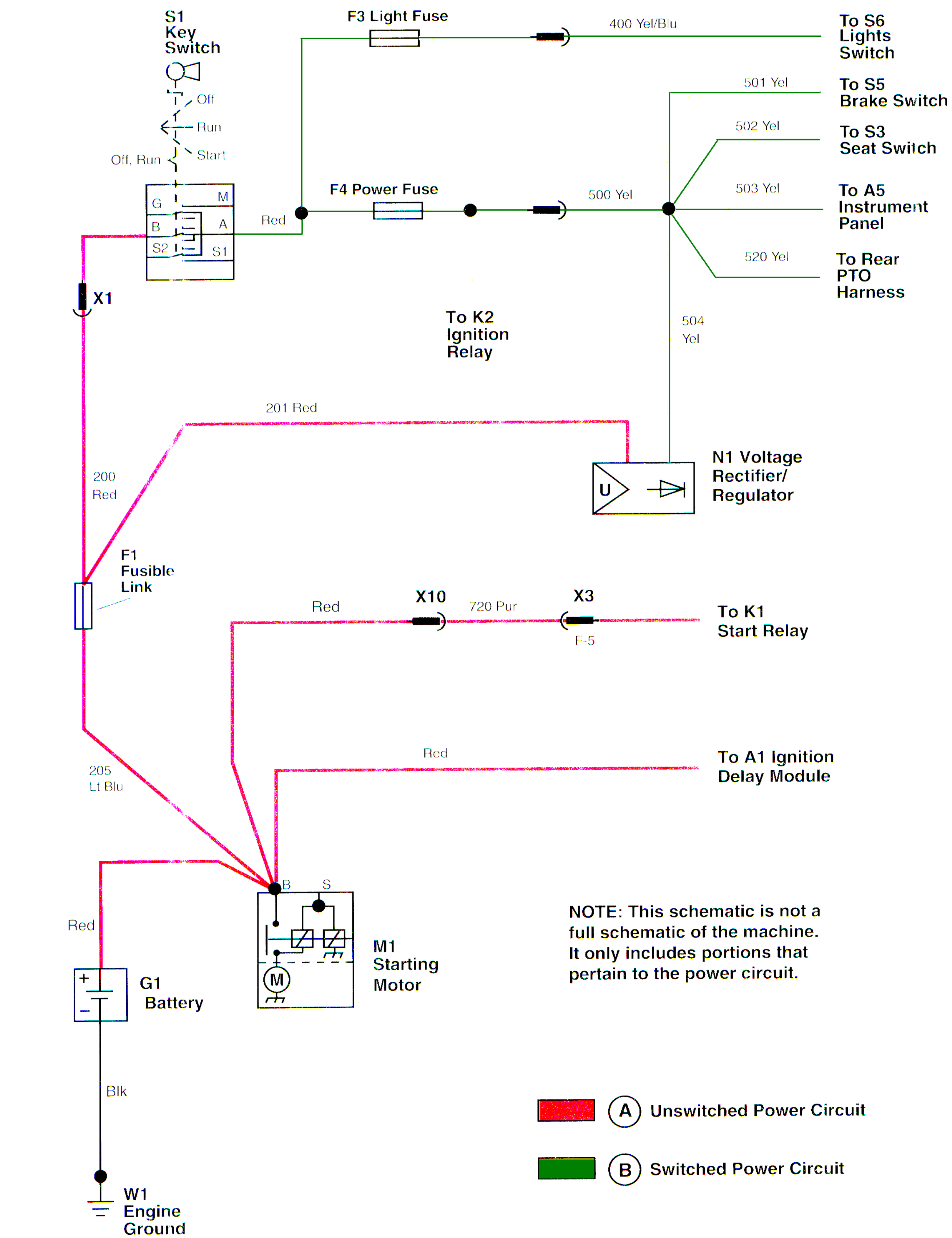


NOTE: This schematic is not a full schematic of the machine. It only includes portions that pertain to the power circuit.

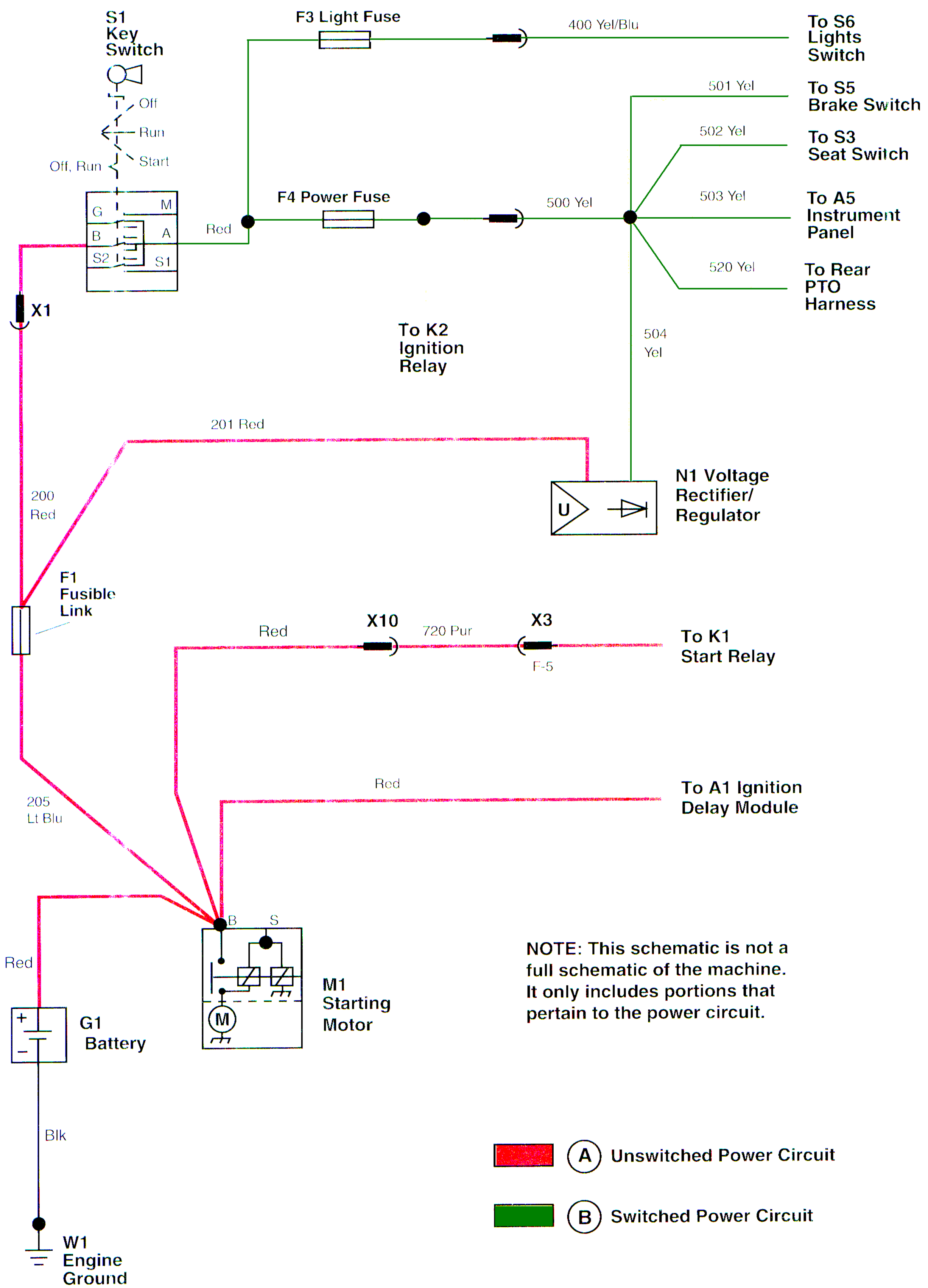
POWER CIRCUIT DIAGNOSIS —425 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Regulator/rectifier.	Battery voltage.	Check 201 red wire, and 205 fusible link (light orange).
4. Control/fuse module terminal 1.	Battery voltage.	Check 205 (light orange) fusible link, 200 red wire.
5. Early models —Control/fuse module terminal 4. Late models have red 210 and light orange 215 wires removed.	Battery voltage.	Check 215 (grey) fusible link, 210 red wire.
6. Control/fuse module terminal 2.	Battery voltage.	Check light fuse, if ok replace control/fuse module.
7. Control/fuse module terminal 6.	Battery voltage.	Check power fuse, if ok replace control/fuse module.
8. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
9. Seat switch.	Battery voltage.	Check 502 yel wire.
10. Regulator/rectifier.	Battery voltage.	Check 504 yel wire.
11. Dash panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
12. Light switch.	Battery voltage.	Check 400 yel/blu wire.
13. Ignition coils.	Battery voltage.	Check ignition delay module red, yel, and yel/wht wire connections, if ok, replace ignition delay module.

POWER CIRCUIT SCHEMATIC—425 (S.N. —070001)



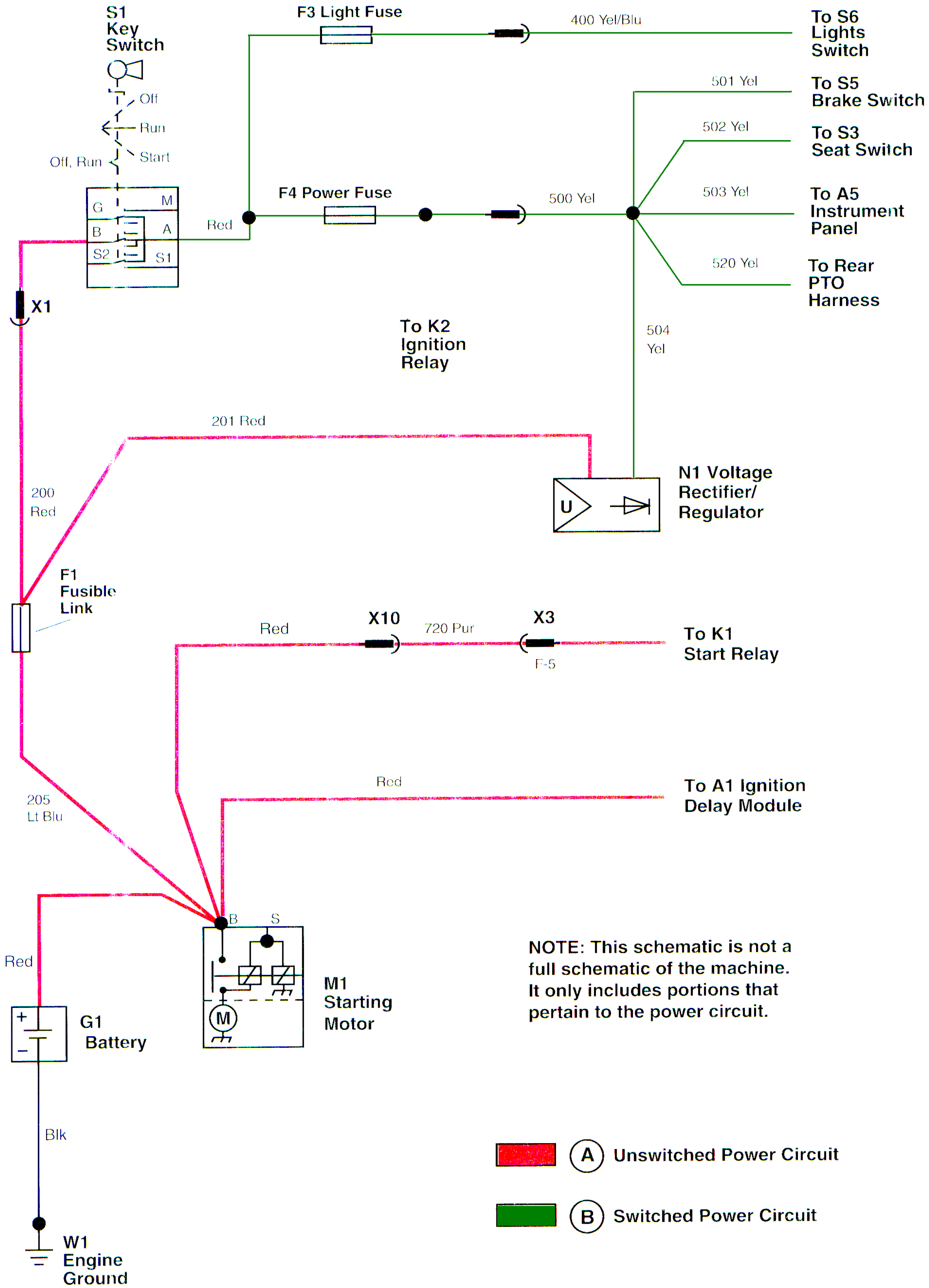
POWER CIRCUIT DIAGNOSIS —425 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Regulator/rectifier.	Battery voltage.	Check 201 red wire, and 205 fusible link (light orange).
4. Control/fuse module terminal 1.	Battery voltage.	Check 205 (light orange) fusible link, 200 red wire.
5. Early models —Control/fuse module terminal 4. Late models have red 210 and light orange 215 wires removed.	Battery voltage.	Check 215 (grey) fusible link, 210 red wire.
6. Control/fuse module terminal 2.	Battery voltage.	Check light fuse, if ok replace control/fuse module.
7. Control/fuse module terminal 6.	Battery voltage.	Check power fuse, if ok replace control/fuse module.
8. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
9. Seat switch.	Battery voltage.	Check 502 yel wire.
10. Regulator/rectifier.	Battery voltage.	Check 504 yel wire.
11. Dash panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
12. Light switch.	Battery voltage.	Check 400 yel/blu wire.
13. Ignition coils.	Battery voltage.	Check ignition delay module red, yel, and yel/wht wire connections, if ok, replace ignition delay module.

POWER CIRCUIT SCHEMATIC—425 (S.N. —070001)



NOTE: This schematic is not a full schematic of the machine. It only includes portions that pertain to the power circuit.

Ⓐ Unswitched Power Circuit

Ⓑ Switched Power Circuit

POWER CIRCUIT DIAGNOSIS —425 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Regulator/rectifier.	Battery voltage.	Check 201 red wire, and 205 fusible link (light orange).
4. Control/fuse module terminal 1.	Battery voltage.	Check 205 (light orange) fusible link, 200 red wire.
5. Early models —Control/fuse module terminal 4. Late models have red 210 and light orange 215 wires removed.	Battery voltage.	Check 215 (grey) fusible link, 210 red wire.
6. Control/fuse module terminal 2.	Battery voltage.	Check light fuse, if ok replace control/fuse module.
7. Control/fuse module terminal 6.	Battery voltage.	Check power fuse, if ok replace control/fuse module.
8. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
9. Seat switch.	Battery voltage.	Check 502 yel wire.
10. Regulator/rectifier.	Battery voltage.	Check 504 yel wire.
11. Dash panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
12. Light switch.	Battery voltage.	Check 400 yel/blu wire.
13. Ignition coils.	Battery voltage.	Check ignition delay module red, yel, and yel/wht wire connections, if ok, replace ignition delay module.

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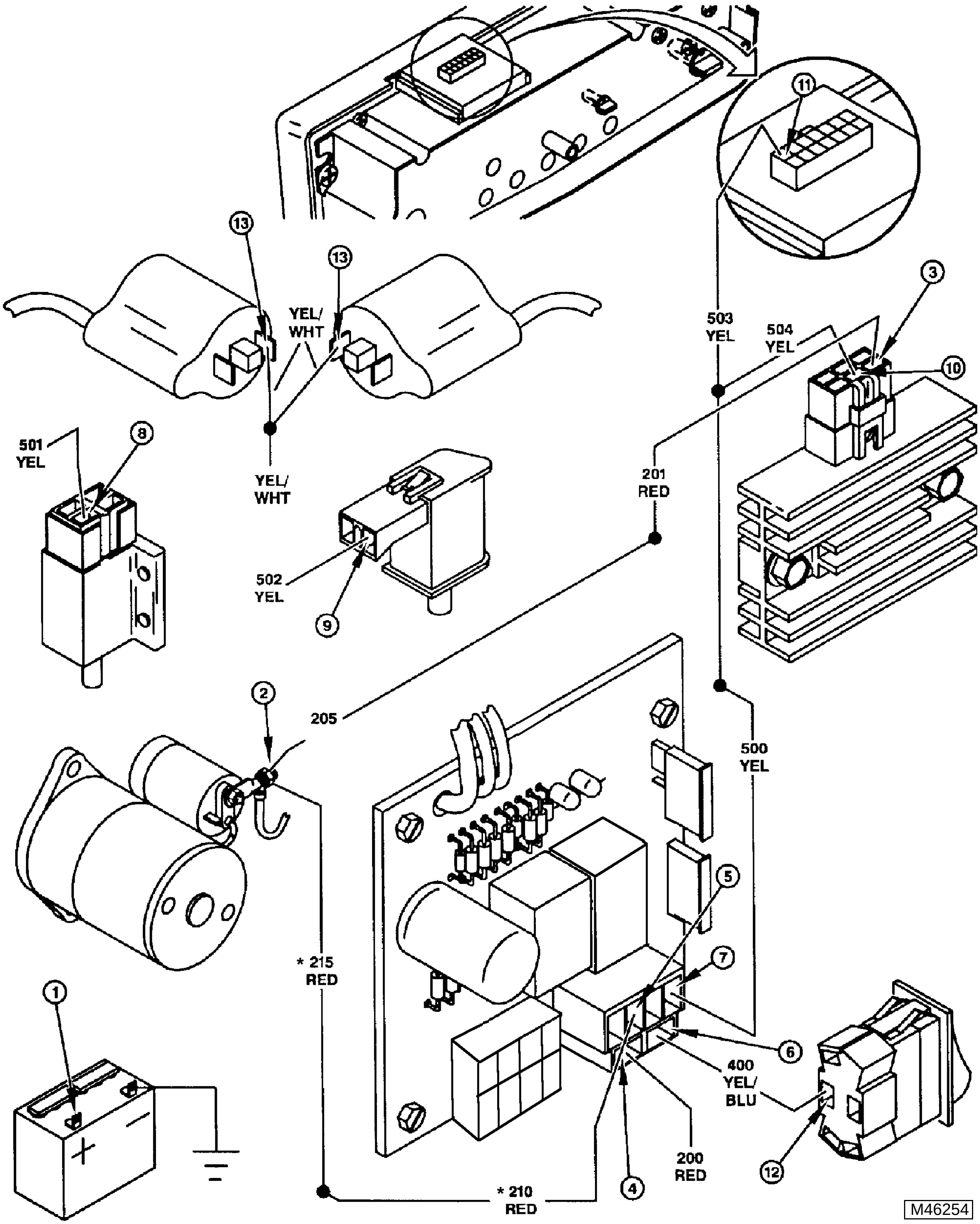
POWER CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Rectifier/regulator.	Battery voltage.	Check 201 red wire, and 205 lt org (fusible link).
4. Control/fuse module terminal 1.	Battery voltage.	Check 205 lt org (fusible link), 200 red wire.
5. Control/fuse module terminal 4. (Late models have red 210 and lt org 215 wires removed.)	Battery voltage.	Early models—Check 215 grey (fusible link), 210 red wire. Late models—Replace control/fuse module.
6. Control/fuse module terminal 2.	Battery voltage.	Check light fuse, if ok replace control/fuse module.
7. Control/fuse module terminal 6.	Battery voltage.	Check power fuse, if ok replace control/fuse module.
8. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
9. Seat switch.	Battery voltage.	Check 502 yel wire.
10. Rectifier/regulator.	Battery voltage.	Check 504 yel wire.
11. Dash panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
12. Light switch.	Battery voltage.	Check 400 yel/blu wire.
13. Ignition coils.	Battery voltage.	Check ignition delay module red, yel, and yel/wht wire connections, if ok, replace ignition delay module.

POWER CIRCUITS TEST POINTS—425 (S.N. —070000)



*** Early models have 210 and 215 red wires.**

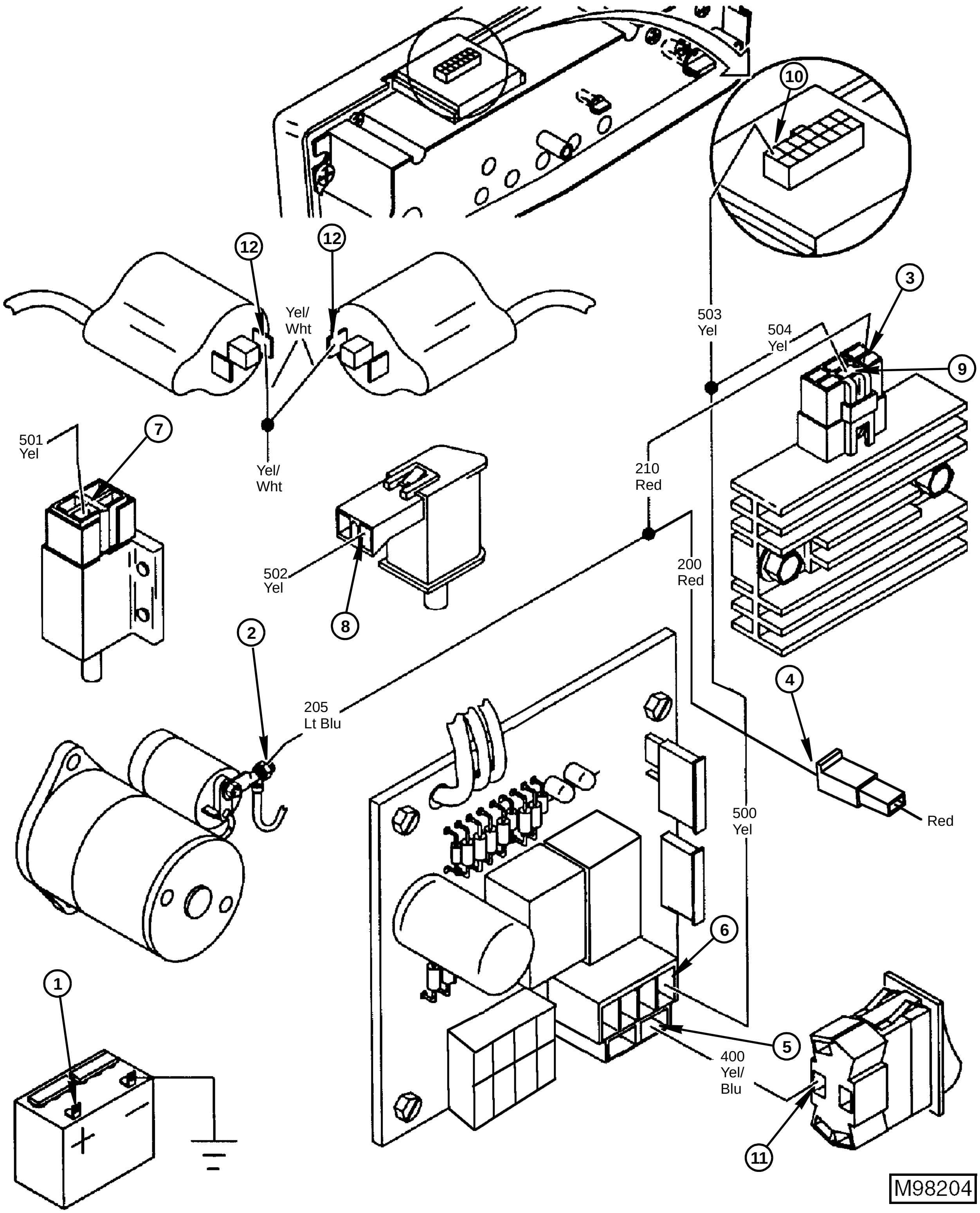
POWER CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Rectifier/regulator.	Battery voltage.	Check 201 red wire, and 205 lt blu wire (fusible link).
4. Key switch power connector.	Battery voltage.	Check 200 red wire.
5. Control/fuse module terminal 2.	Battery voltage.	Check light fuse (F2), if ok replace control/fuse module.
6. Control/fuse module terminal 6.	Battery voltage.	Check power fuse (F3), if ok replace control/fuse module.
7. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
8. Seat switch.	Battery voltage.	Check 502 yel wire.
9. Rectifier/regulator.	Battery voltage.	Check 504 yel wire.
10. Instrument panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
11. Lights switch.	Battery voltage.	Check 400 yel/blu wire.
12. Ignition coils.	Battery voltage.	Check ignition delay module red, yel, and yel/wht wire connections, if ok, replace ignition delay module.

POWER CIRCUIT TEST POINTS—425 (S.N. 070001—)



CRANKING CIRCUIT OPERATION—425 (S.N. —070000)

Function:

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

Operation Conditions:

To crank the engine, the key switch must be in the start position, with the PTO switch off (PTO switch closed), and the park brake engaged (brake switch closed).

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1), key switch terminal B (S1), and start relay (K1). Current from the start relay cannot flow to the starter solenoid until the relay is energized. The start relay receives the energizing current from the neutral start circuit.The neutral start circuit prevents the engine from cranking if the PTO is engaged, or the park brake is not engaged.

With the key switch in the start position, current flows from terminal B to terminal A, 15 amp fuse (F4), park brake switch (S3) (park brake pedal engaged), PTO switch (S4) (PTO disengaged), and start relay coil terminal (K1).

A ground circuit for the start relay coil must be provided for the relay to energize. With the key switch in the start position, current flows to ground through the key switch terminals S1 and S2, energizing the start relay coil which closes the relay.

With the relay closed, current flows to the starter solenoid, engaging the solenoid. The solenoid is engaged by current flowing through both the pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in winding stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

CRANKING CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

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

Operation Conditions:

To crank the engine, the key switch must be in the start position, with the PTO switch off (PTO switch closed), and the park brake engaged (brake switch closed).

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1), key switch terminal B (S1), and start relay (K1). Current from the start relay cannot flow to the starter solenoid until the relay is energized. The start relay receives the energizing current from the neutral start circuit.The neutral start circuit prevents the engine from cranking if the PTO is engaged, or the park brake is not engaged.

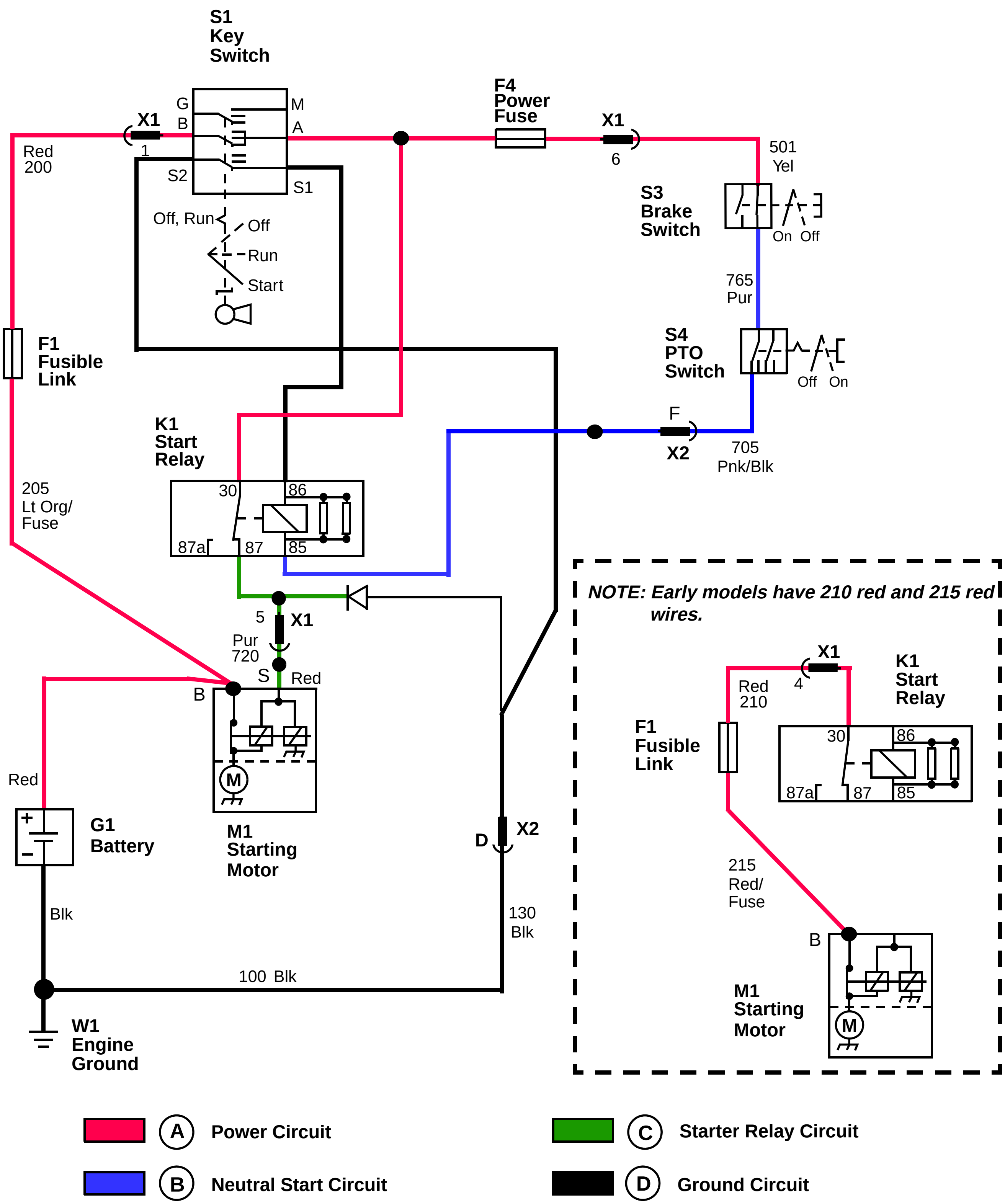
With the key switch in the start position, current flows from terminal B to terminal A, 15 amp fuse (F3), brake switch (S5) (brake pedal engaged), PTO switch (S2) (PTO disengaged), and start relay coil terminal (K1).

A ground circuit for the start relay coil must be provided for the relay to energize. With the key switch in the start position, current flows to ground through the key switch terminals S1 and S2, energizing the start relay coil which closes the relay.

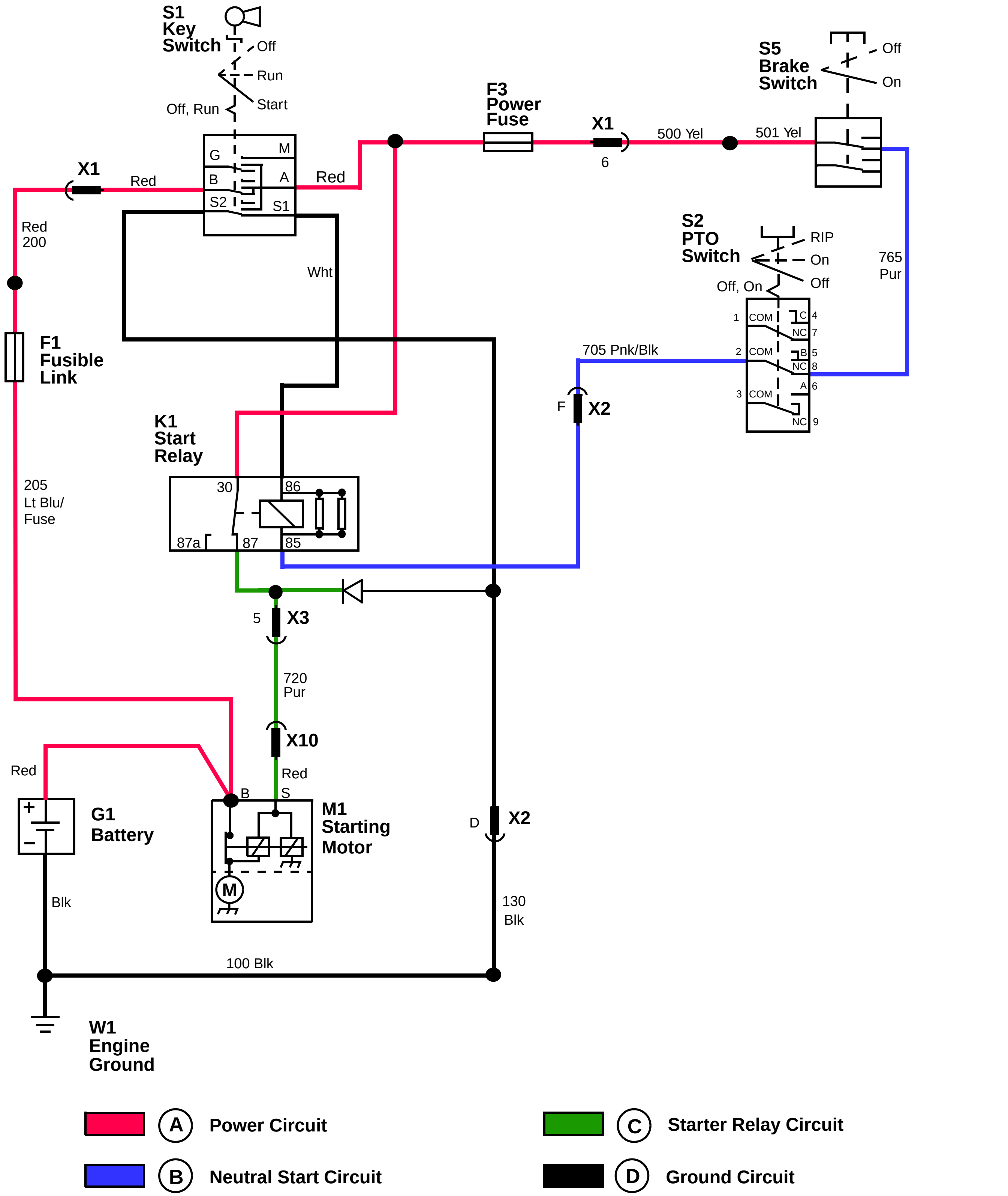
With the relay closed, current flows to the starter solenoid, engaging the solenoid. The solenoid is engaged by current flowing through both the pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in winding stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starting motor (M1) causing it to turn.

CRANKING CIRCUIT SCHEMATIC—425 (S.N. —070000)



CRANKING CIRCUIT SCHEMATIC—425 (S.N. 070001—)



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CRANKING CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Check neutral start circuit—go to step 5.

Test Conditions:

- Key switch in start position.

Test/Check Point	Normal	If Not Normal
3. Starter solenoid terminal S.	Minimum 10 volts.	No voltage—go to step 4. Low voltage—check neutral start circuit for voltage drop—go to step 5. Voltage ok—test starter solenoid and motor.

Test Conditions:

- Disconnect starter solenoid connector (A).
- Turn key switch from on to start repeatedly while holding relay.

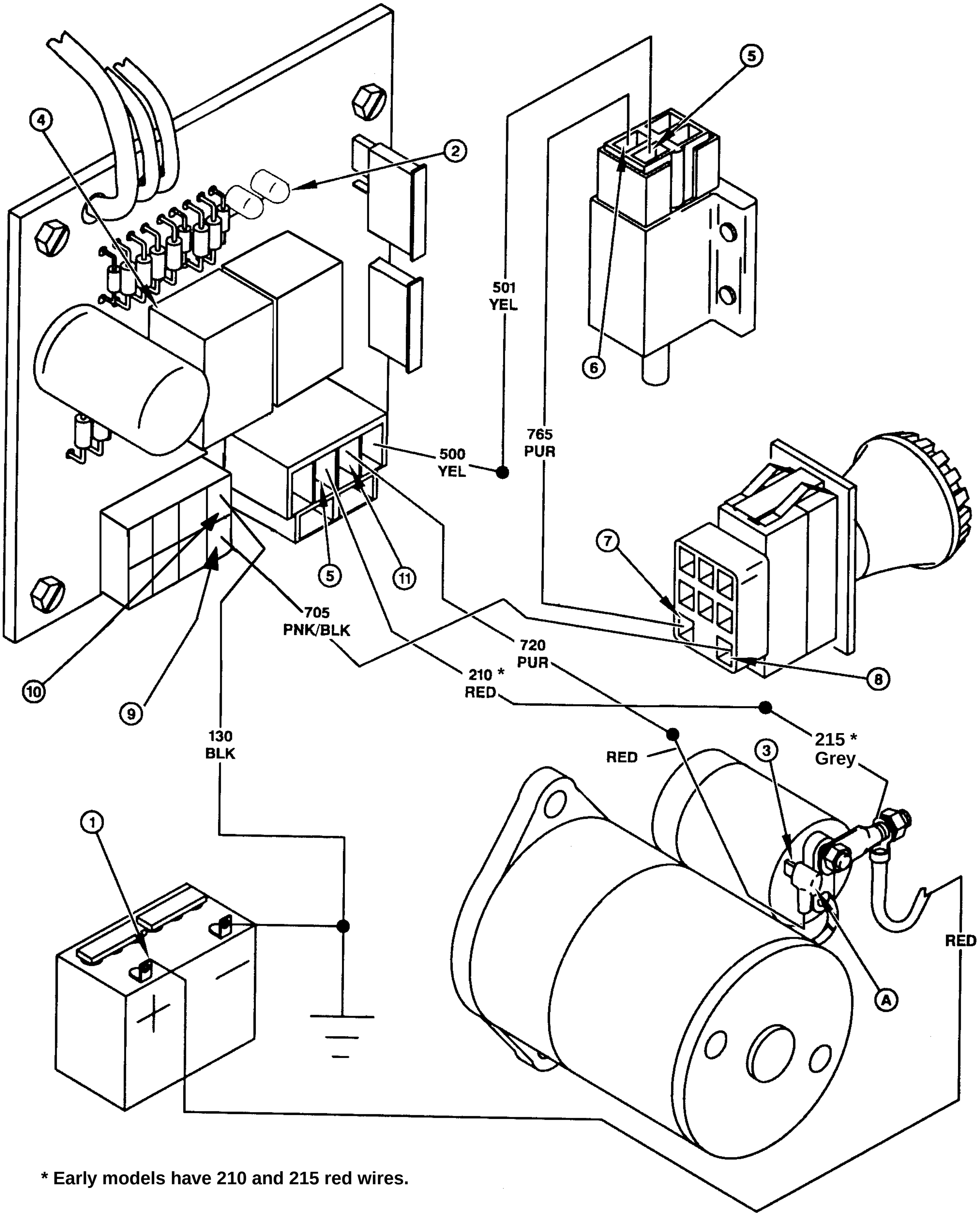
Test/Check Point	Normal	If Not Normal
4. Start relay.	Relay clicks.	Relay does not click or cannot feel, go step 5. Relay clicks, go to step 11.

Test Conditions:

- Connect starter solenoid connector (A).
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
5. Brake switch and control/fuse switch module terminal 4.	Battery voltage.	Check power circuit test points from battery to brake and control/fuse module terminal 4.
6. Brake switch.	Battery voltage.	Test brake switch.
7. PTO switch.	Battery voltage.	Test 765 pur wire.
8. PTO switch.	Battery voltage.	Test PTO switch.
9. Control/fuse module terminal F.	Battery voltage.	Test 705 pnk/red wire.

CRANKING CIRCUIT TEST POINTS—425 (S.N. —070000)



* Early models have 210 and 215 red wires.

CRANKING CIRCUIT DIAGNOSIS—425 (S.N. —070000) (continued)

Test Conditions:

- Control/fuse module fuses removed.
- Key switch start position.

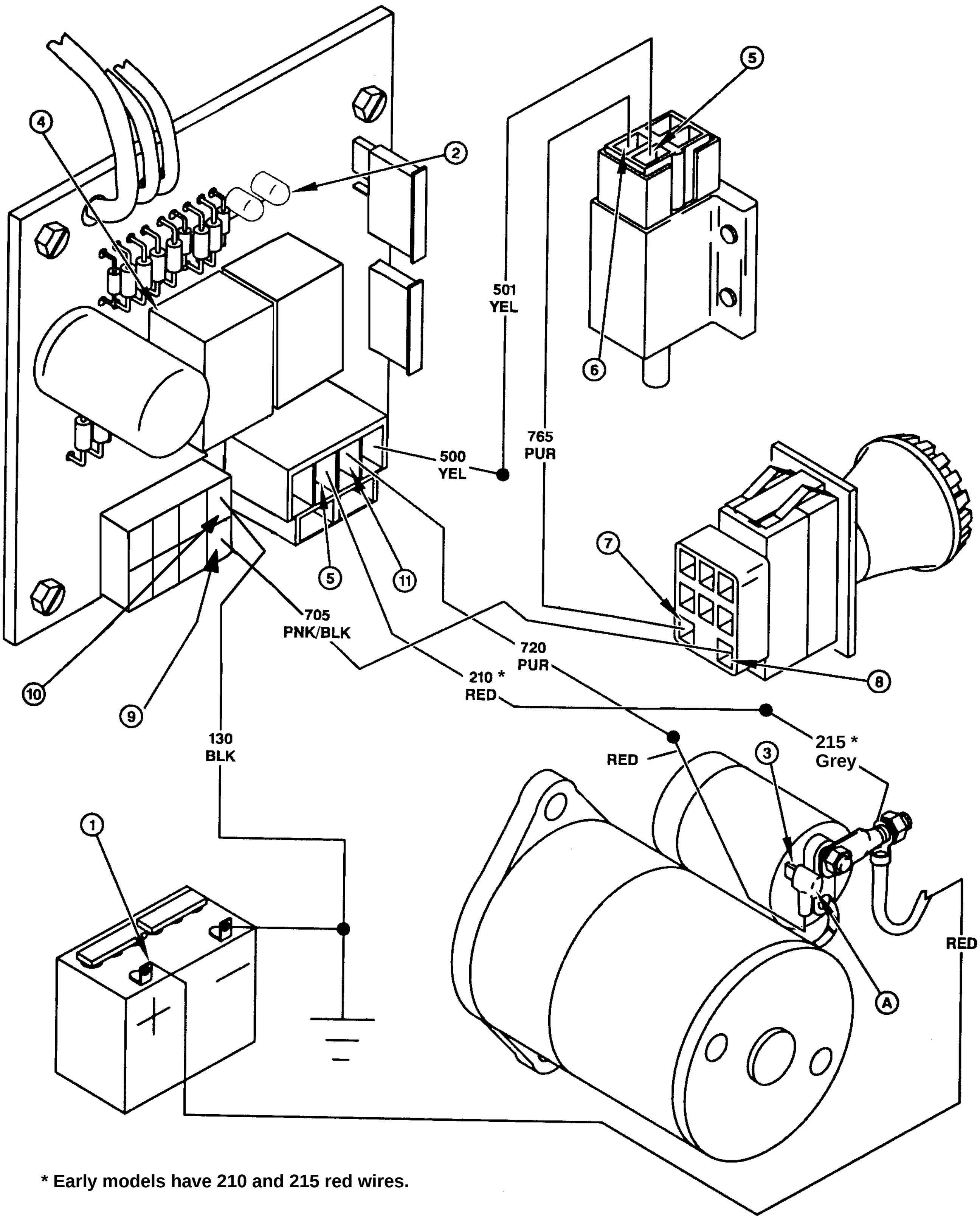
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check control/fuse module ground circuit-130 and 100 blk wires.

Test Conditions:

- Control/fuse module fuses installed.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
11. Control/fuse module terminal 5.	Battery voltage.	No voltage-replace control/fuse module. Voltage-check 720 pur and red wires.

CRANKING CIRCUIT TEST POINTS—425 (S.N. —070000) (continued)



* Early models have 210 and 215 red wires.

CRANKING CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch in off position.
- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Check neutral start circuit, go to step 5.

Test Conditions:

- Key switch in start position.

Test/Check Point	Normal	If Not Normal
3. Starter solenoid terminal S.	Minimum 10 volts.	No voltage—go to step 4. Low voltage—check neutral start circuit for voltage drop, go to step 5. Voltage ok—test starter solenoid and motor.

Test Conditions:

- Disconnect starter solenoid connector (A).
- Turn key switch from on to start repeatedly while holding relay.

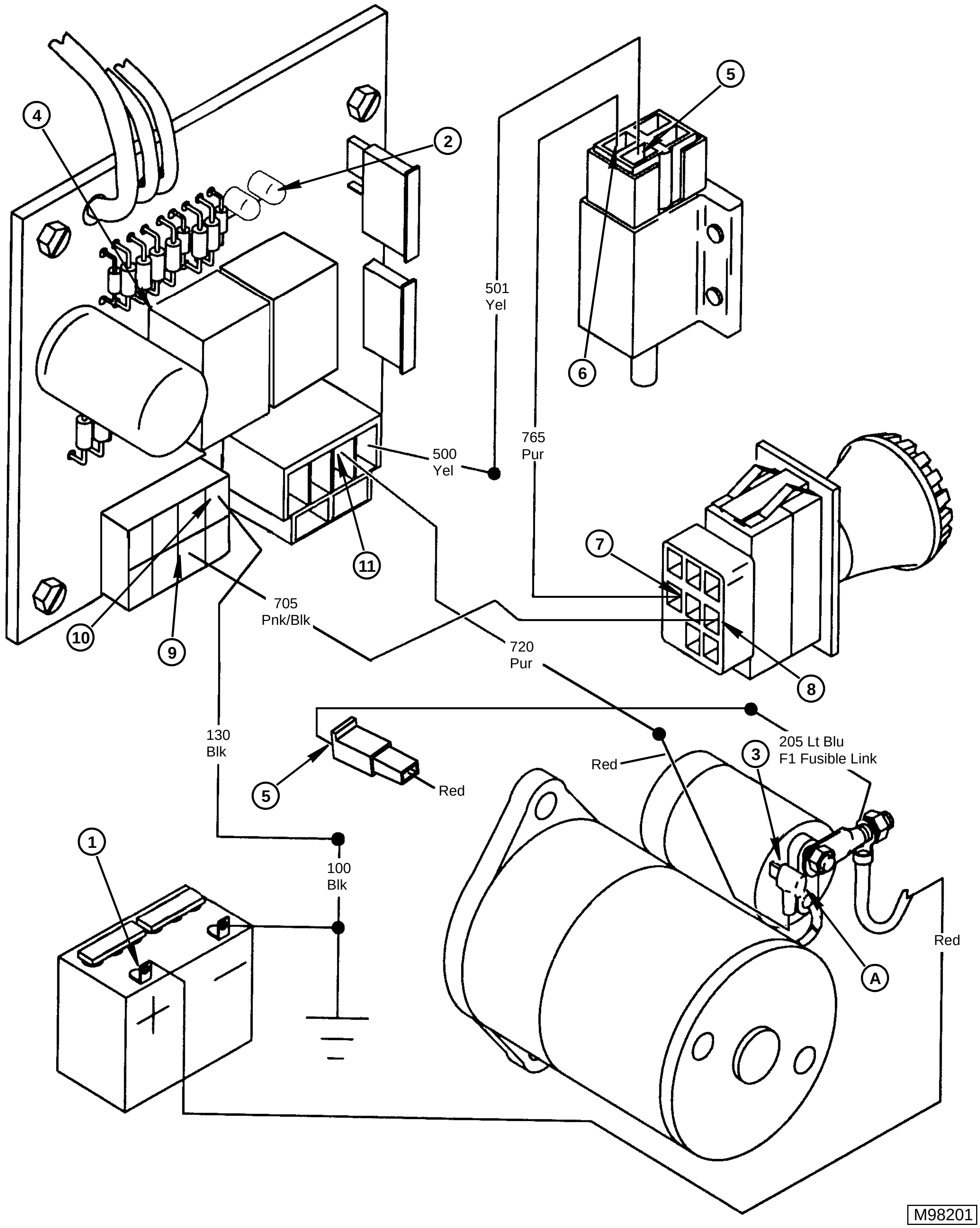
Test/Check Point	Normal	If Not Normal
4. Start relay.	Relay clicks.	Relay does not click or cannot feel, go to step 5. Relay clicks, go to step 11.

Test Conditions:

- Connect starter solenoid connector (A).
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
5. Key switch power connector and control/fuse switch module terminal 4.	Battery voltage.	Check power circuit test points from battery to key switch power connector and control/fuse module terminal 4.
6. Brake switch.	Battery voltage.	Test brake switch.
7. PTO switch.	Battery voltage.	Test 765 pur wire.

CRANKING CIRCUIT TEST POINTS—425 (S.N. 070001—)



CRANKING CIRCUIT DIAGNOSIS—425 (S.N. 070001—) (continued)

Test/Check Point	Normal	If Not Normal
8. PTO switch.	Battery voltage.	Test PTO switch.
9. Control/fuse module terminal F.	Battery voltage.	Test 705 pnk/red wire.

Test Conditions:

- Control/fuse module fuses removed.
- Key switch in start position.

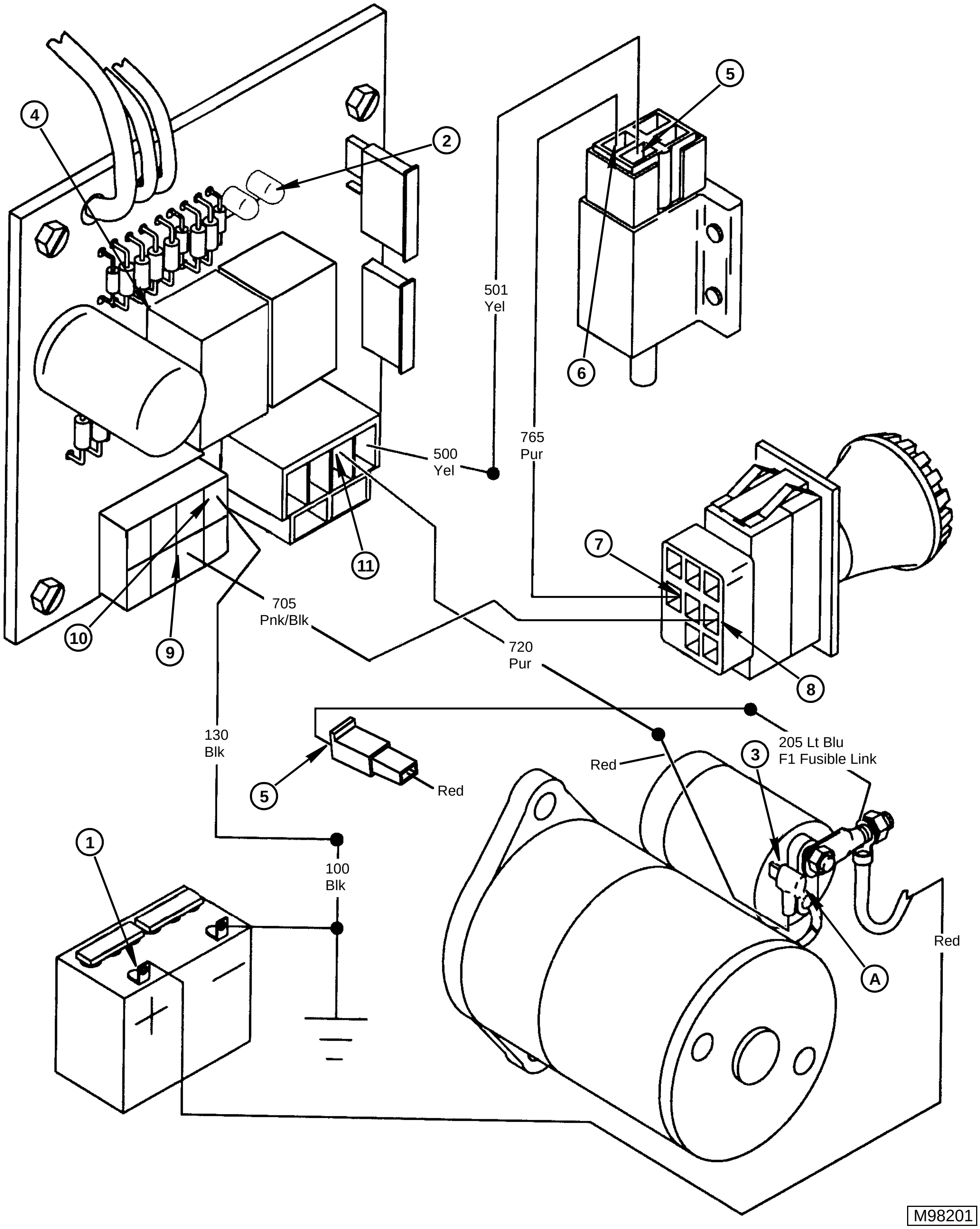
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check control/fuse module ground circuit, 130 and 100 blk wires.

Test Conditions:

- Control/fuse module fuses installed.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
11. Control/fuse module terminal 5.	Battery voltage.	No voltage—replace control/fuse module. Voltage—check 720 pur and red wires.

CRANKING CIRCUIT TEST POINTS—425 (S.N. 070001—) (continued)



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IGNITION CIRCUIT OPERATION—425 (S.N. —070000)

Function:

To create a spark at the correct time, that ignites the fuel/air mixture in the cylinders.

Operating Conditions:

To produce a spark, the key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) or with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off (PTO switch closed).

System Operation:

The ignition system is a transistor controlled battery ignition design. The battery (G1) supplies current to the ignition coils (T1 and T2). Ignition timing is controlled by the ignition module and is not adjustable. The engine is shut off by de-energizing the ignition relay and ignition delay module which stops current flow to the ignition module. The ignition delay module allows the sparks plugs to fire for 1 additional second after the key switch is turned off to burn any remaining fuel in the cylinder. The ignition delay module is used with the carburetor vent solenoid (serial numbers 033626 and below) fuel shut-off solenoid (serial numbers 033627 and above) to prevent backfire. When the key switch is turned off, current flow from the ignition relay stops. A timer in the ignition delay module allows current from the starting motor B terminal to flow to the ignition module and both ignition coils for the extra 1 second spark.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1), key switch terminal B (S1), ignition delay module (A1), left ignition coil (T1), and right ignition coil (T2). Current cannot flow to the ignition delay module (A1) or the ignition module (A2) until the ignition relay (K2) is energized.

With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, brake switch (S3) (brake pedal depressed), PTO switch (S4) (PTO disengaged), ignition relay coil terminal 85, and ignition LED(E1). The ignition LED indicates that power is available to the ignition relay coil. With the ignition relay energized, current (C) flows to the PTO switch, and ignition delay module. The ignition delay module allows current (D) to flow to the ignition module.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S2) closed), current (E) flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition relay opens, which stops current flow to the ignition delay module and the ignition module, stopping the engine. A delay capacitor in the ignition module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

As the flywheel turns, a tab on the flywheel travels past the pulser coils and produces current in the pulser coils by electromagnetic induction. Two pulser coils, one for each cylinder, are mounted in a fixed position next to the flywheel. Pulser coil current flows to a transistor inside the ignition module and energizes the transistor. With the transistor energized, a path to ground is provided for the ignition coil primary winding circuit. The ignition coils (T1 and T2) consist of iron cores with two sets of wires wound around them. The primary windings are connected to the ignition module. The secondary windings connect to the spark plugs (E3 and E4) through the high tension leads. There are more windings in the secondary coil than in the primary coil.

As the flywheel rotates prior to spark plug firing, the ignition module allows battery current flow through the primary windings (F) of the coil. At the correct time, pulser current flow to the ignition module transistor stops and the transistor is de-energized. The transistor opens and breaks the path to ground for ignition coil primary current. When the current flow stops, the primary coil electromagnetic field collapses and induces high voltage current in the secondary coil (G). The high voltage current flows through the ignition coil wire to the spark plug. The voltage is now high enough to jump the spark plug gap and a spark is produced. Each spark plug fires on both the compression and exhaust strokes. The spark produced during the exhaust stroke does not affect engine operation because there is no compression or combustible mixture in the cylinder.

IGNITION CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

To create a spark at the correct time, that ignites the fuel/air mixture in the cylinders.

Operating Conditions:

To produce a spark, the key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) or with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off (PTO switch closed).

System Operation:

The ignition system is a transistor controlled battery ignition design. The battery (G1) supplies current to the ignition coils (T1 and T2). Ignition timing is controlled by the ignition module and is not adjustable. The engine is shut off by de-energizing the ignition relay and ignition delay module which stops current flow to the ignition module. The ignition delay module allows the spark plugs to fire for 1 additional second after the key switch is turned off to burn any remaining fuel in the cylinder. The ignition delay module is used with the fuel shut-off solenoid to prevent backfire. When the key switch is turned off, current flow from the ignition relay stops. A timer in the ignition delay module allows current from the starting motor B terminal to flow to the ignition module and both ignition coils for the extra 1 second spark.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), terminal B of key switch (S1), ignition delay module (A1), left ignition coil (T1), and right ignition coil (T2). Current cannot flow to the ignition delay module (A1) or the ignition module (A2) until the ignition relay (K2) is energized.

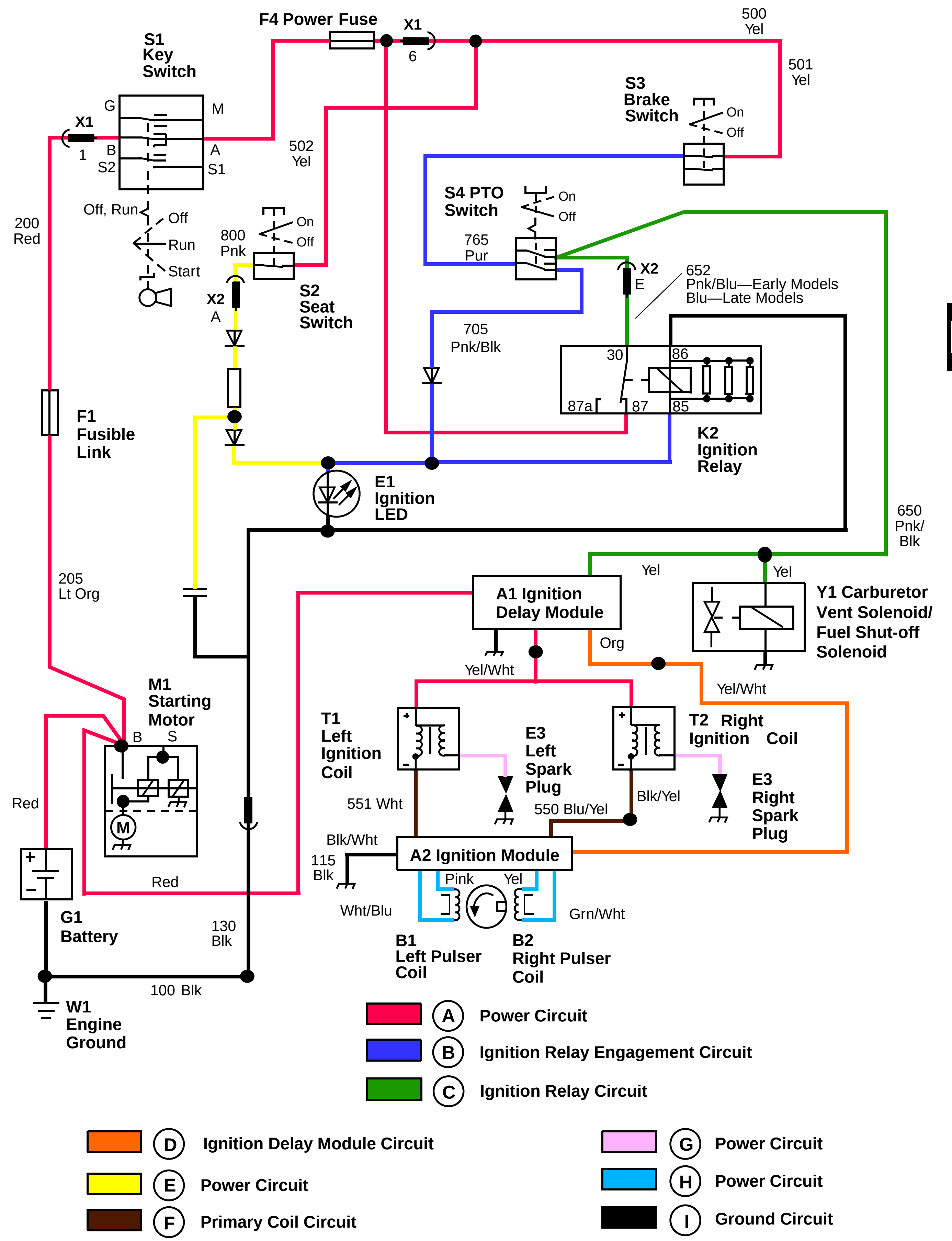
With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, brake switch (S5) (brake pedal depressed), PTO switch (S2) (PTO disengaged), ignition relay coil terminal 85, and ignition LED (E4). The ignition LED indicates that power is available to the ignition relay coil. With the ignition relay energized, current (C) flows to the PTO switch, and ignition delay module. The ignition delay module allows current (D) to flow to the ignition module.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S3) closed), current flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition relay opens, which stops current flow to the ignition delay module and the ignition module, stopping the engine. A delay capacitor in the ignition module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

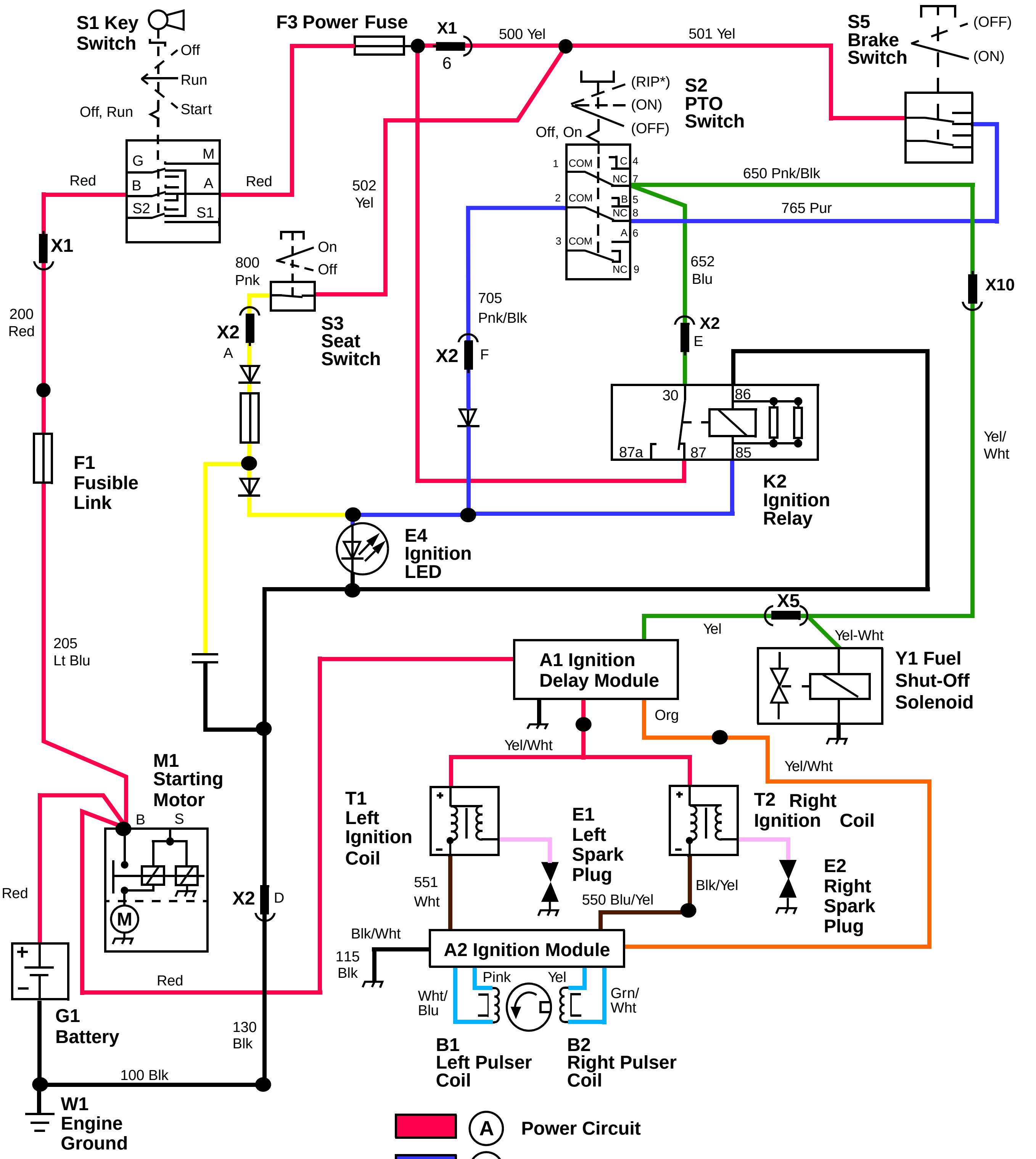
As the flywheel turns, a tab on the flywheel travels past the pulser coils and produces current in the pulser coils by electromagnetic induction. Two pulser coils, one for each cylinder, are mounted in a fixed position next to the flywheel. Pulser coil current flows to a transistor inside the ignition module and energizes the transistor. With the transistor energized, a path to ground is provided for the ignition coil primary winding circuit. The ignition coils (T1 and T2) consist of iron cores with two sets of wires wound around them. The primary windings are connected to the ignition module. The secondary windings connect to the spark plugs (E1 and E2) through the high tension leads. There are more windings in the secondary coil than in the primary coil.

As the flywheel rotates prior to spark plug firing, the ignition module allows battery current flow through the primary windings of the coil. At the correct time, pulser current flow to the ignition module transistor stops and the transistor is de-energized. The transistor opens and breaks the path to ground for ignition coil primary current. When the current flow stops, the primary coil electromagnetic field collapses and induces high voltage current in the secondary coil. The high voltage current flows through the ignition coil wire to the spark plug. The voltage is now high enough to jump the spark plug gap and a spark is produced. Each spark plug fires on both the compression and exhaust strokes. The spark produced during the exhaust stroke does not affect engine operation because there is no compression or combustible mixture in the cylinder.

IGNITION CIRCUIT SCHEMATIC—425 (S.N. —070000)



IGNITION CIRCUIT SCHEMATIC—425 (S.N. 070001—)



A Power Circuit

B Ignition Relay Engagement Circuit

C Ignition Relay Circuit

D Ignition Delay Module Circuit

E Power Circuit

F Primary Coil Circuit

G Power Circuit

H Power Circuit

I Ground Circuit

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IGNITION CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

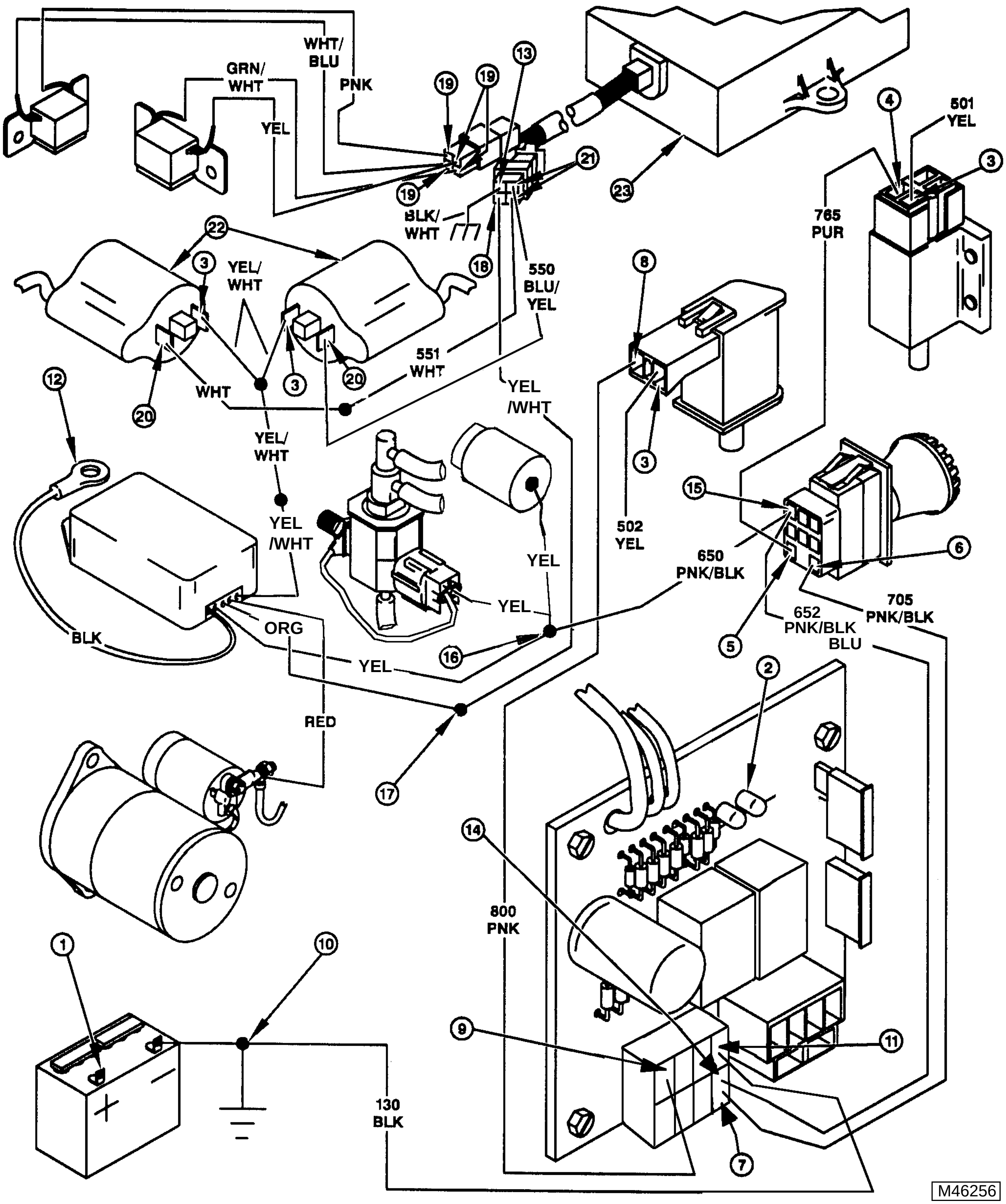
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3. Light on—go to step 12.
3. Brake switch, seat switch, and ignition coil positive terminals.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
10. Engine ground.	Maximum 0.1—0.5 ohms resistance.	Check battery negative cable and engine ground connection.
11. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. Ignition delay module.	Maximum 0.1 ohms resistance.	Clean terminal ground connection.
13. Ignition module.	Maximum 0.1 ohms resistance.	Check blk/wht wire and ground connection.

IGNITION CIRCUIT TEST POINTS—425 (S.N. —070000)



IGNITION CIRCUIT DIAGNOSIS—425 (S.N. —070000) (continued)

Test Conditions:

- Key switch in run position.

Test/Check Point	Normal	If Not Normal
14. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
15. PTO switch. Early model check 652 pnk/blk wire. Late model check 652 blu wire.	Battery voltage.	Check 652 pnk/blk wire. Check 652 blu wire.
16. Ignition delay module.	Battery voltage at: Org wire which goes into yel/wht wire to ignition module. Yel/wht wire which goes to coils. Yel wire going to carburetor vent solenoid or fuel shut-off solenoid. Red wire from starter will always have battery voltage.	If any of these wires do not have battery voltage—Replace ignition delay module.
17. Ignition module.	Battery voltage.	Check yel/wht wire.

Test Conditions:

- Meter set for AC voltage for step 19.
- Key switch in start position.
- Voltage test light connected to battery negative terminal (checking for current pulses) for step 20.

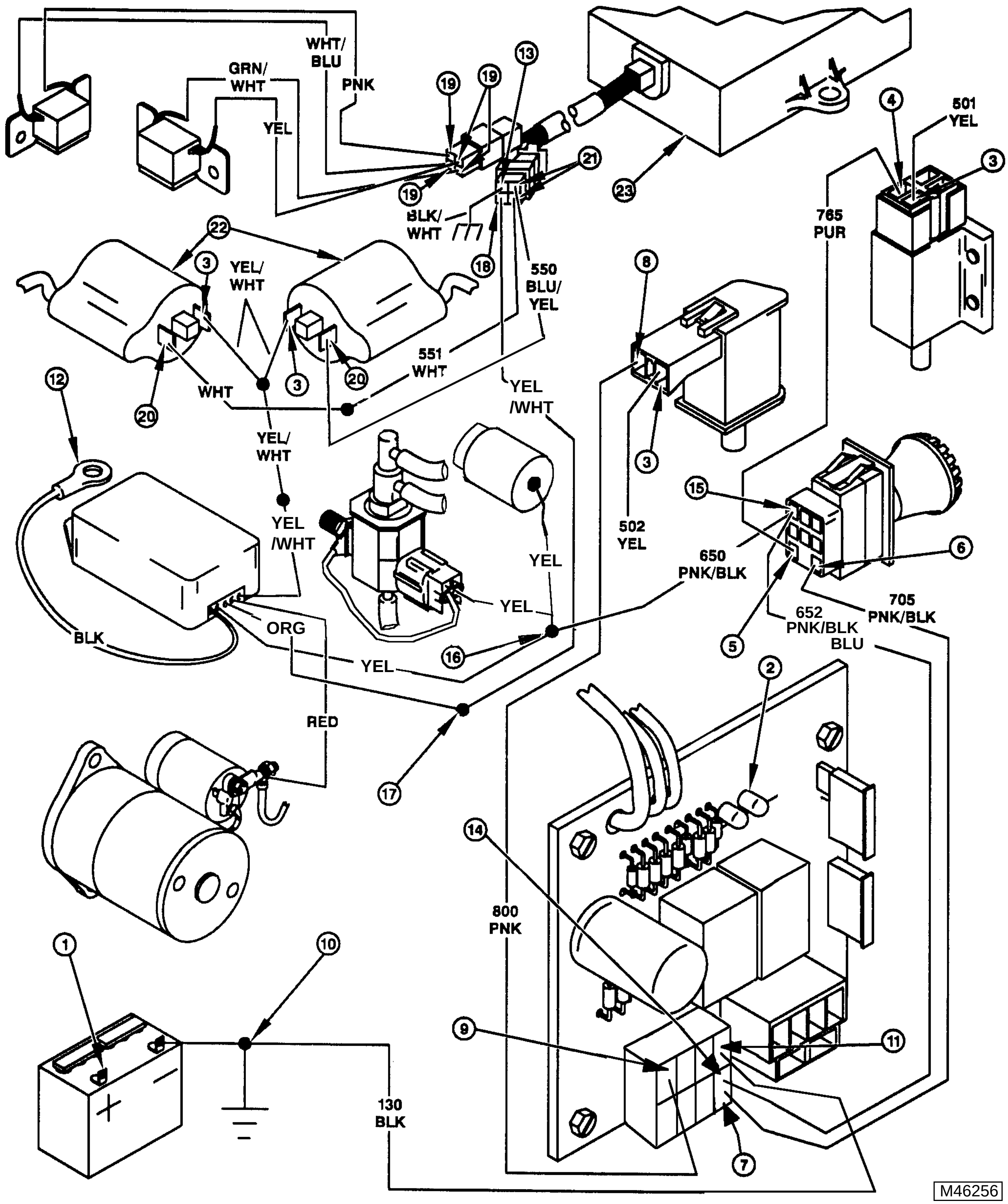
Test/Check Point	Normal	If Not Normal
18. Left and right pulser coils blu/wht and pnk, then grn/wht and yel.	0.1—1.0 VAC	Check pulser coil connections, and test pulser coil resistance.
19. Ignition coil negative terminal.	Rapidly flashing light, not steady glow	Slowly flashing light—check ignition coil, go to step 22. Light steady glow—check ignition coil ground circuit—step 21.

Test Conditions:

- Key switch in run position.

Test/Check Point	Normal	If Not Normal
20. Ignition module.	Battery voltage.	Check 551 wht and 550 blu/yel wires, if ok, replace ignition module.
21. Ignition coil-resistance.	Primary—3.4—4.6 ohms. Secondary—10.4—15.5 k-ohms. Core—infinite.	Replace ignition coil.
22. Ignition module-replace with known good module.	Spark produced.	Replace ignition module.

IGNITION CIRCUIT TEST POINTS—425 (S.N. —070000) (continued)



IMPORTANT: Serial Numbers 033626 and below use carburetor vent solenoid. Serial Numbers 033627 and above use fuel shut-off solenoid. Both are depicted, circuit test points remain the same.

IGNITION CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch in off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

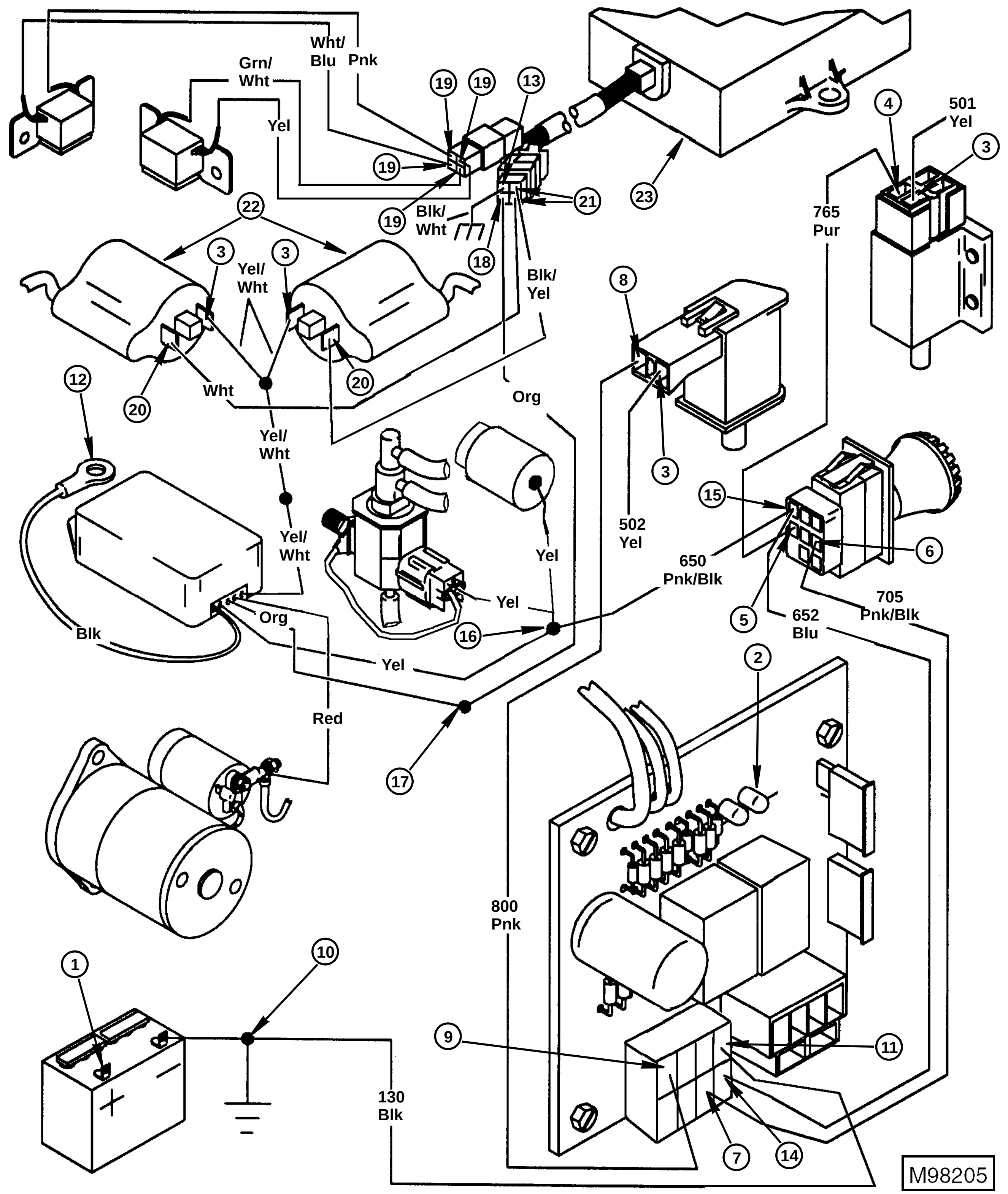
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3. Light on—go to step 12.
3. Brake switch, seat switch, and ignition coil positive terminals.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
10. Engine ground.	Maximum 0.1—0.5 ohms resistance.	Check battery negative cable and engine ground connection.
11. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. Ignition delay module.	Maximum 0.1 ohms resistance.	Clean terminal ground connection.
13. Ignition module.	Maximum 0.1 ohms resistance.	Check blk/wht wire and ground connection.

IGNITION CIRCUIT TEST POINTS—425 (S.N. 070001—)



IGNITION CIRCUIT DIAGNOSIS—425 (S.N. 070001—) (continued)

Test Conditions:

- Key switch in run position.

Test/Check Point	Normal	If Not Normal
14. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
15. PTO switch—check 652 blu wire.	Battery voltage.	Check 652 blu wire.
16. Ignition delay module.	Battery voltage at: Org wire which goes into yel/wht wire to ignition module. Yel/wht wire which goes to coils. Yel wire going to fuel shut-off solenoid. Red wire from starter will always have battery voltage.	If any of these wires do not have battery voltage—Replace ignition delay module.
17. Ignition delay module.	Battery voltage.	Replace ignition delay module.
18. Ignition module.	Battery voltage.	Check org wire between ignition module and ignition delay module.

Test Conditions:

- Meter set for AC voltage for step 19.
- Key switch in start position.
- Voltage test light connected to battery negative terminal (checking for current pulses) for step 20.

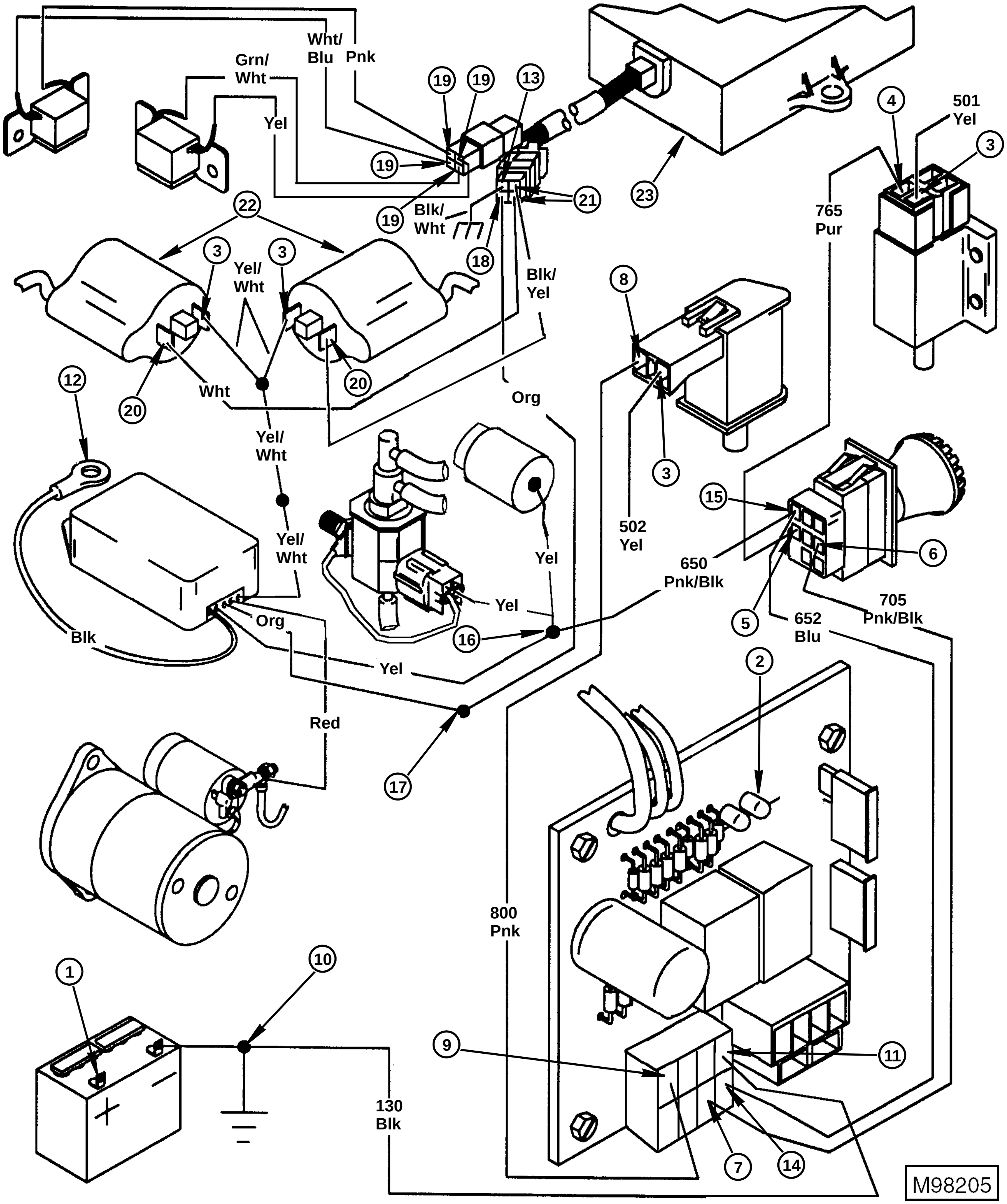
Test/Check Point	Normal	If Not Normal
19. Left and right pulser coils blu/wht and pnk, then grn/wht and yel.	0.1—1.0 VAC.	Check pulser coil connections, and test pulser coil resistance.
20. Ignition coil negative terminal.	Rapidly flashing light, not steady glow.	Slowly flashing light—check ignition coil, go to step 22. Light steady glow—check ignition coil ground circuit—step 21.

Test Conditions:

- Key switch in run position, engine off.

Test/Check Point	Normal	If Not Normal
21. Ignition module.	Battery voltage.	Check wht and blu/yel wires, if ok, replace ignition module.
22. Ignition coil-resistance.	Primary—3.4—4.6 ohms. Secondary—10.4—15.5 K ohms. Core-infinite.	Replace ignition coil.
23. Ignition module-replace with known good module.	Spark produced.	Replace ignition module.

IGNITION CIRCUIT TEST POINTS—425 (S.N. 070001—) (continued)



CHARGING CIRCUIT OPERATION—425—(S.N. —070000)

Function:

To maintain battery voltage between 11.8 and 13.2.

Operating Conditions:

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

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a rectifier/regulator. A charge light warns the operator if the stator stops charging. The charge light circuit monitors stator output, not battery voltage.

The power circuit (A) provides current to the key switch (S1) battery terminal and protects the charging circuit with a fusible link (F1). With the key switch in the run position, current flows from battery (G1) positive terminal to fusible link, key switch, power fuse (F4), and rectifier/regulator (N1). The voltage sensing circuit allows the rectifier/regulator to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the rectifier/regulator. The rectifier/regulator converts AC current to DC current needed to charge the battery. If battery voltage is low, the rectifier/regulator allows DC current to flow to the battery to charge it through the battery charging circuit (B). When the battery is fully charged, the regulator stops current flow to the battery.

If stator output current to the rectifier/regulator stops, the rectifier/regulator provides current to the charge light (H3) to light the lamp.

The ground circuit (E) provides a path to ground for the rectifier/regulator.

CHARGING CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

To maintain battery voltage between 11.8 and 13.2 volts.

Operating Conditions:

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

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a rectifier/regulator. The discharge light (H4) warns the operator if the stator stops charging. The discharge light circuit monitors stator output, not battery voltage.

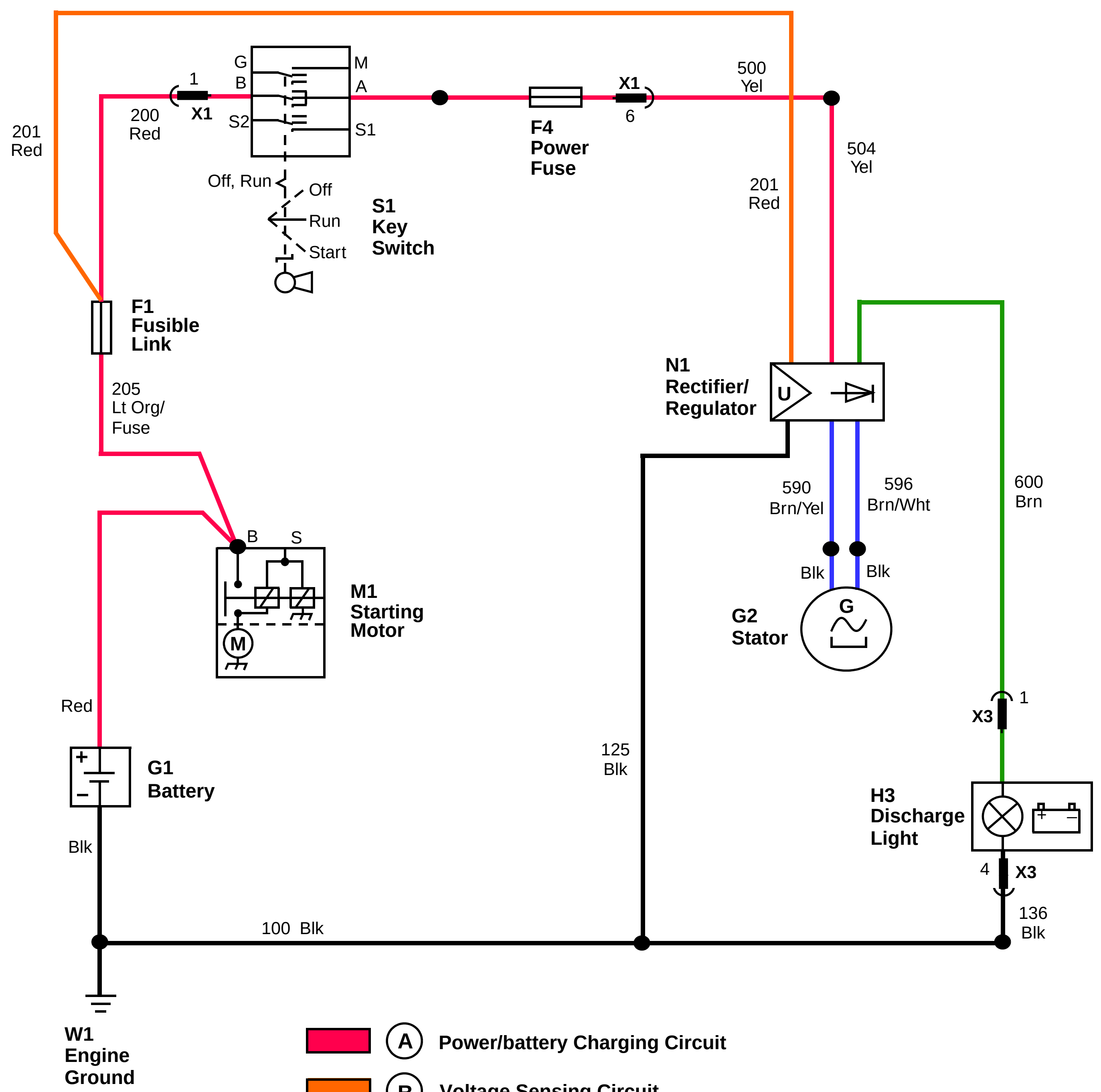
The power circuit (A) provides current to the key switch (S1) battery terminal and protects the charging circuit with a fusible link (F1). With the key switch in the run position, current flows from battery (G1) positive terminal to fusible link, key switch, power fuse (F3), and rectifier/regulator (N1). The voltage sensing circuit allows the rectifier/regulator to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the rectifier/regulator. The rectifier/regulator converts AC current to DC current needed to charge the battery. If battery voltage is low, the rectifier/regulator allows DC current to flow to the battery to charge it through the battery charging circuit (B). When the battery is fully charged, the regulator stops current flow to the battery.

If stator output current to the rectifier/regulator stops, the rectifier/regulator provides current to the discharge light (H4) to light the lamp.

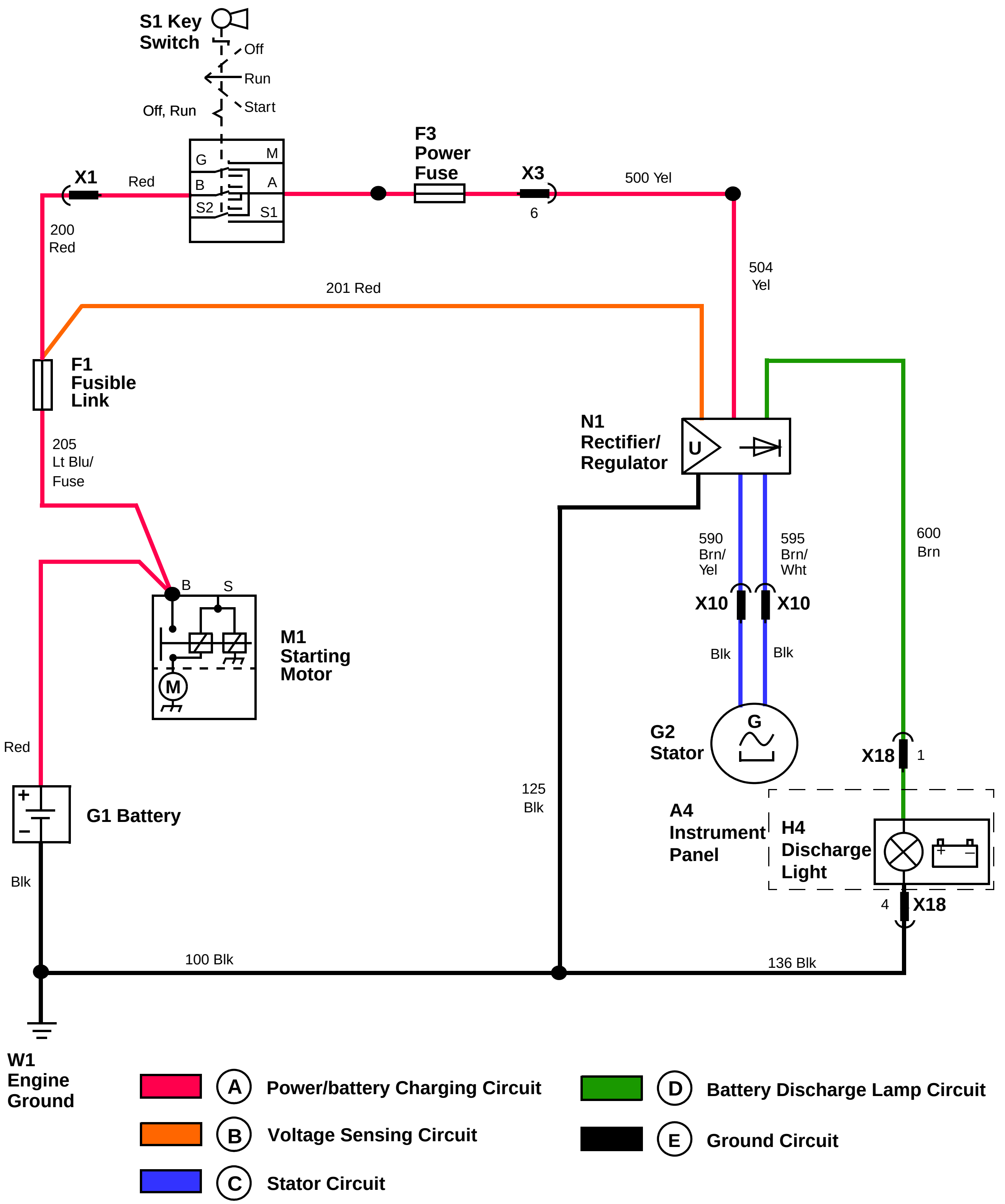
The ground circuit (E) provides a path to ground for the rectifier/regulator.

CHARGING CIRCUIT SCHEMATIC—425 (S.N. —070000)



- A — Power/battery Charging Circuit
- B — Voltage Sensing Circuit
- C — Stator Circuit
- D — Battery Discharge Lamp Circuit
- E — Ground Circuit

CHARGING CIRCUIT SCHEMATIC—425 (S.N. 070001—)



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CHARGING CIRCUIT DIAGNOSIS— 425 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Transaxle/Transmission in neutral.
- Regulator/Rectifier connector disconnected.
- Key switch in run position.
- Engine running at fast idle.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Regulator/rectifier connector.	Minimum unregulated voltage output— 26 VAC.	Test stator, check flywheel magnets, 595 brn/wht and 590 brn/yel wires.

Test Conditions:

- Regulator/rectifier connector connected.

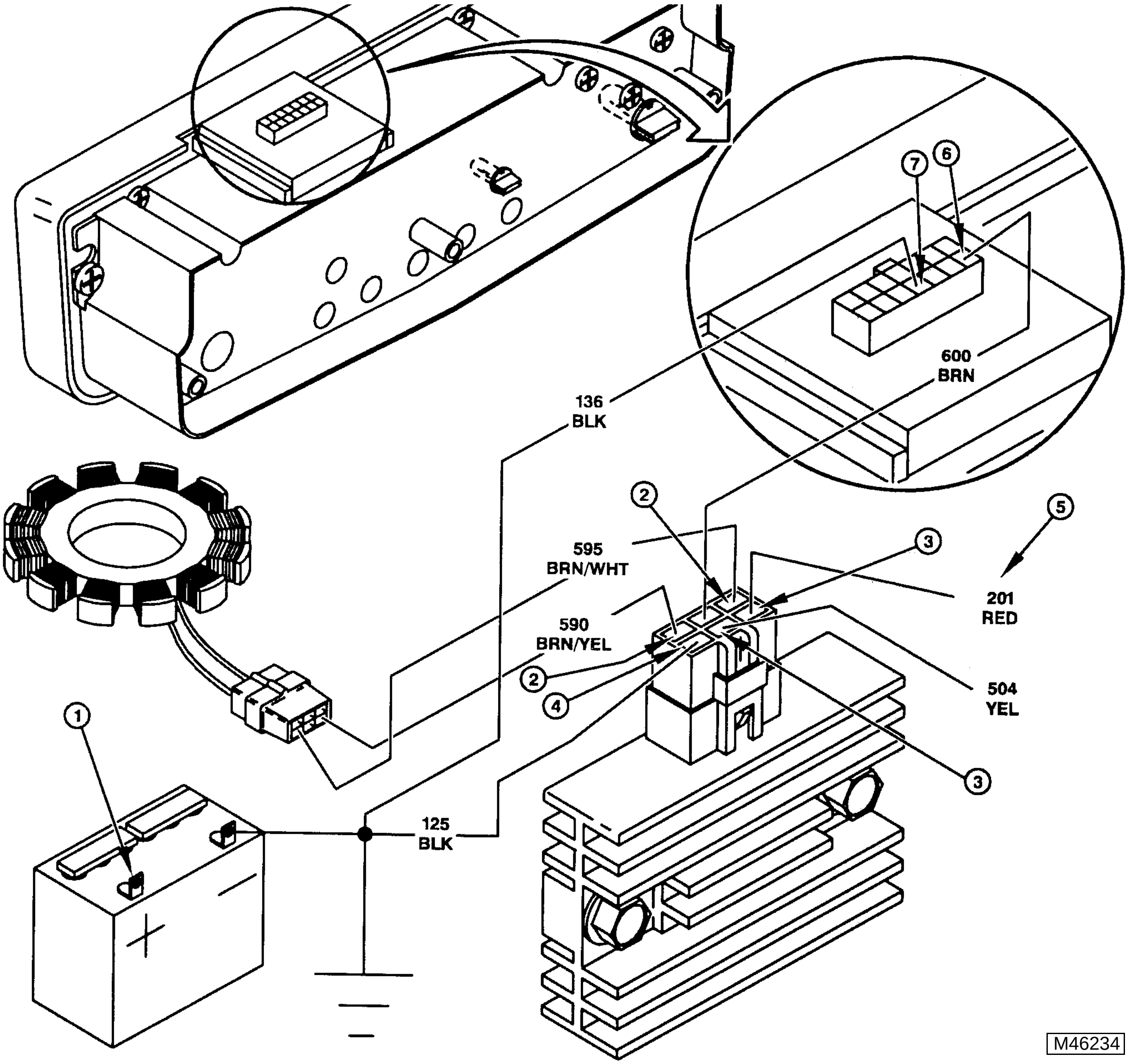
Test/Check Point	Normal	If Not Normal
3. Regulator/rectifier.	Battery voltage.	Check power circuit.
4. Regulator/rectifier.	0.0—0.2 volts.	Greater than 0.2 volts—test regulator/rectifier ground circuit (125 and 100 blk wires). 0.0 volts—Replace regulator/ rectifier.
5. Regulator/rectifier wire.	Minimum regulated output— 13 amps.	Replace regulator/rectifier.

Test Conditions:

- Engine off.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
6. Discharge light.	Battery voltage.	Check 600 brn wire then replace regulator/rectifier.
7. Discharge light.	0.0—0.2 volts.	Greater than 0.2 volts—test charge light ground circuit—136 blk wire. 0.0 volts—replace bulb.

CHARGING CIRCUIT TEST POINTS—(S.N. —070000)



CHARGING CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Park brake engaged.
- Transaxle/Transmission in neutral.
- Rectifier/regulator connector disconnected.
- Key switch in run position.
- Engine running at fast idle.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Rectifier/regulator connector.	Minimum unregulated voltage output— 26 VAC.	Test stator, check flywheel magnets, 595 brn/wht and 590 brn/yel wires.

Test Conditions:

- Regulator/rectifier connector connected.

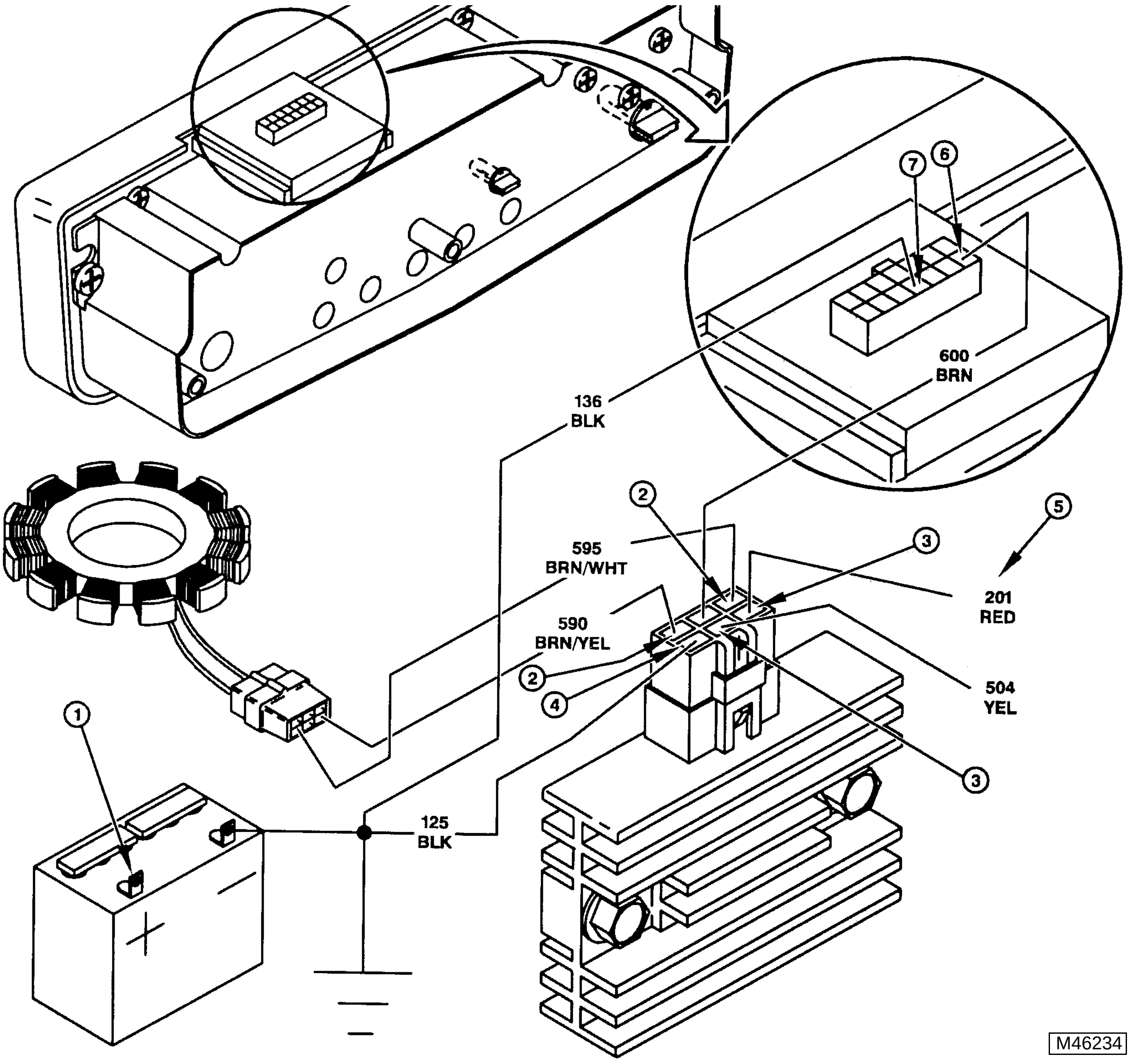
Test/Check Point	Normal	If Not Normal
3. Rectifier/regulator.	Battery voltage.	Check power circuit.
4. Rectifier/regulator.	0.0—0.2 volts.	Greater than 0.2 volts—test rectifier/regulator ground circuit (125 and 100 blk wires). 0.0 volts—Replace regulator/ rectifier.
5. Rectifier/regulator wire.	Minimum regulated output—13 amps.	Replace rectifier/regulator.

Test Conditions:

- Engine off.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
6. Discharge light.	Battery voltage.	Check 600 brn wire then replace rectifier/regulator.
7. Discharge light.	0.0—0.2 volts.	Greater than 0.2 volts—test charge light ground circuit—136 blk wire. 0.0 volts—replace bulb.

CHARGING CIRCUIT TEST POINTS—425 (S.N. 070001—)



PTO CIRCUIT OPERATION—425 (S.N. —070000)

Function:

To provide power to energize or de-energize the PTO solenoid when desired by the operator.

Operating Conditions:

The key switch must be in the run position, with the brake pedal released (brake switch closed), the PTO switch off, and the operator on the seat to initially provide power to the PTO switch for PTO solenoid operation.

System Operation:

The PTO circuit uses the seat switch (S2), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO solenoid (Y1) if the operator gets off the seat with the PTO engaged. Also, the PTO will be disengaged if the brake pedal is depressed with the PTO switch on.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and key switch terminal B (S1). With the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, and the seat switch. Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay must come from the seat switch circuit (B). With the seat switch closed, current flows to the ignition relay coil terminal, and the ignition relay LED (E1). The ignition relay LED indicates that power is available to the ignition relay coil.

With the ignition relay energized, current (C) flows to the PTO relay terminal 87. Current cannot flow to the PTO switch (S4) until the PTO relay is energized. Energizing current for the PTO relay must come from the PTO switch and the brake switch (S3). The PTO switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO switch is in the ON position. The brake switch prevents the PTO relay from energizing if the brake pedal is depressed. With the PTO switch off, current flows to the PTO relay terminal 30, brake switch (brake pedal released), PTO LED (E2), PTO relay coil and energizes the coil, closing the relay. PTO relay circuit current (D) is available to operate the PTO solenoid (Y1) and lamp (H1) when the PTO switch is turned on. The PTO relay LED indicates that power is available to the PTO relay coil.

If the operator leaves the seat or depresses the brake pedal with the PTO engaged, current to the ignition and PTO relay coil is stopped. The relays open and current flow to the PTO solenoid stops, disengaging the PTO clutch. The operator must return to the seat, release the brake pedal, and turn the PTO switch OFF before the PTO relay will energize again. A delay capacitor in the control/fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

When the PTO switch is moved to the ON position, current flows to the PTO solenoid and energizes the solenoid to engage the clutch. At the same time, current also flows to the PTO light. An alternate path for PTO relay coil energizing current must be provided when the PTO switch is on. With the brake pedal released, PTO relay circuit current (D) from terminal 30 flows to the brake switch, and PTO relay coil, keeping the relay energized.

PTO CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

To provide power to energize or de-energize the PTO solenoid when desired by the operator.

Operating Conditions:

The key switch must be in the run position, with the brake pedal released (brake switch closed), the PTO switch off, and the operator on the seat to initially provide power to the PTO switch for PTO solenoid operation.

System Operation:

The PTO circuit uses the seat switch (S3), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO solenoid (Y2) if the operator gets off the seat with the PTO engaged. Also, the PTO will be disengaged if the brake pedal is depressed with the PTO switch on.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and terminal B of key switch (S1). With the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F3), ignition relay terminal 87, and the seat switch. Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay comes from the seat switch circuit (B). With the seat switch closed, current flows to the ignition relay coil terminal, and the ignition LED (E4). The ignition LED indicates that power is available to the ignition relay coil.

With the ignition relay energized, current (C) flows to the PTO relay terminal 87. Current cannot flow to the PTO switch (S2) until the PTO relay is energized. Energizing current for the PTO relay must come from the PTO switch, the brake switch (S5), and RIO switch (S4). The PTO safety circuit is used to prevent the PTO relay from energizing, if the PTO switch is in the ON position. The brake switch prevents the PTO relay from energizing if the brake pedal is depressed. With the PTO switch off, current flows to the PTO relay terminal 30, brake switch (brake pedal released), RIO switch, PTO LED (E3), PTO relay coil and energizes the coil, closing the relay. PTO relay circuit current (D) is available to operate the PTO solenoid (Y1) and front PTO light (H2) when the PTO switch is turned on. The PTO LED indicates that power is available to the PTO relay coil.

When the PTO switch is moved to the ON position, current flows to the PTO solenoid and energizes the solenoid to engage the clutch. At the same time, current also flows to the front PTO light.

If the operator leaves the seat or depresses the brake pedal with the PTO engaged, current to the ignition and PTO relay coil is stopped. The relays open and current flow to the PTO solenoid stops, disengaging the PTO clutch. The operator must return to the seat, release the brake pedal, and turn the PTO switch to OFF before the PTO relay will energize again. A delay capacitor in the control/fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

When the PTO is engaged and the operator changes to reverse, current flow to the PTO relay coil is stopped, de-energizing the relay. With the PTO relay de-energized, current flow to the PTO switch and PTO solenoid is also stopped, preventing the PTO solenoid from energizing and the PTO is disengaged.

If the PTO switch is placed in the RIP position before changing to reverse, current will flow to the RIO latch relay coil. The RIO latch relay allows current to flow to the PTO relay. Once reverse motion has begun the RIO switch is open, current to the RIO latch relay must come from the brake switch and is routed through the RIO latch relay contacts and RIO unlatch relay contacts back to the RIO latch relay coil to keep it latched.

When forward or neutral is resumed, the RIO switch closes and current flows to the RIO unlatch relay coil and energizes the relay, stopping current flow to the RIO latch coil and de-energizes it and stops current flow to the PTO relay, PTO switch, and PTO solenoid. After the PTO relay is de-energized by changing to reverse, it cannot be energized again until the PTO switch is returned to the OFF position.

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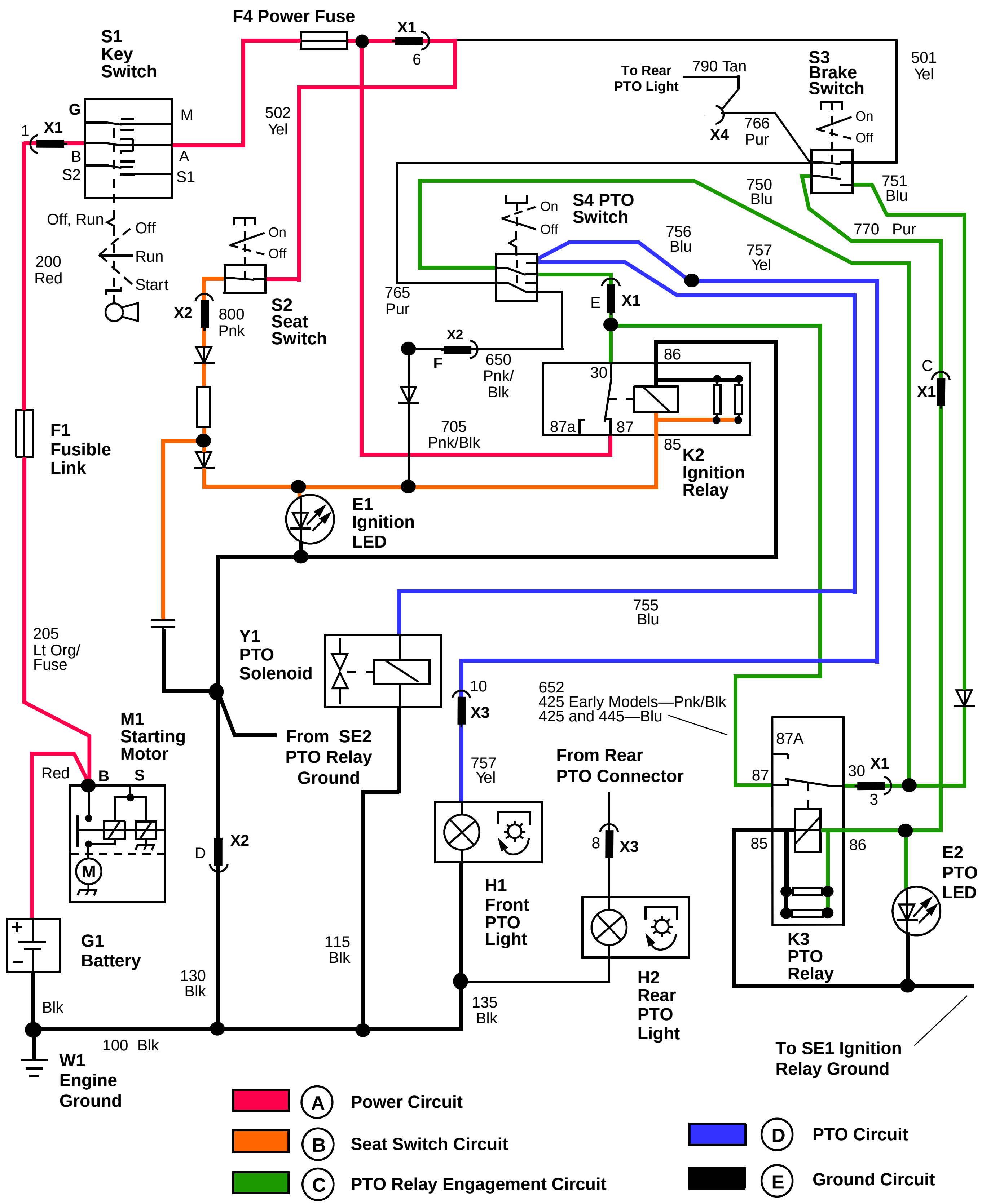
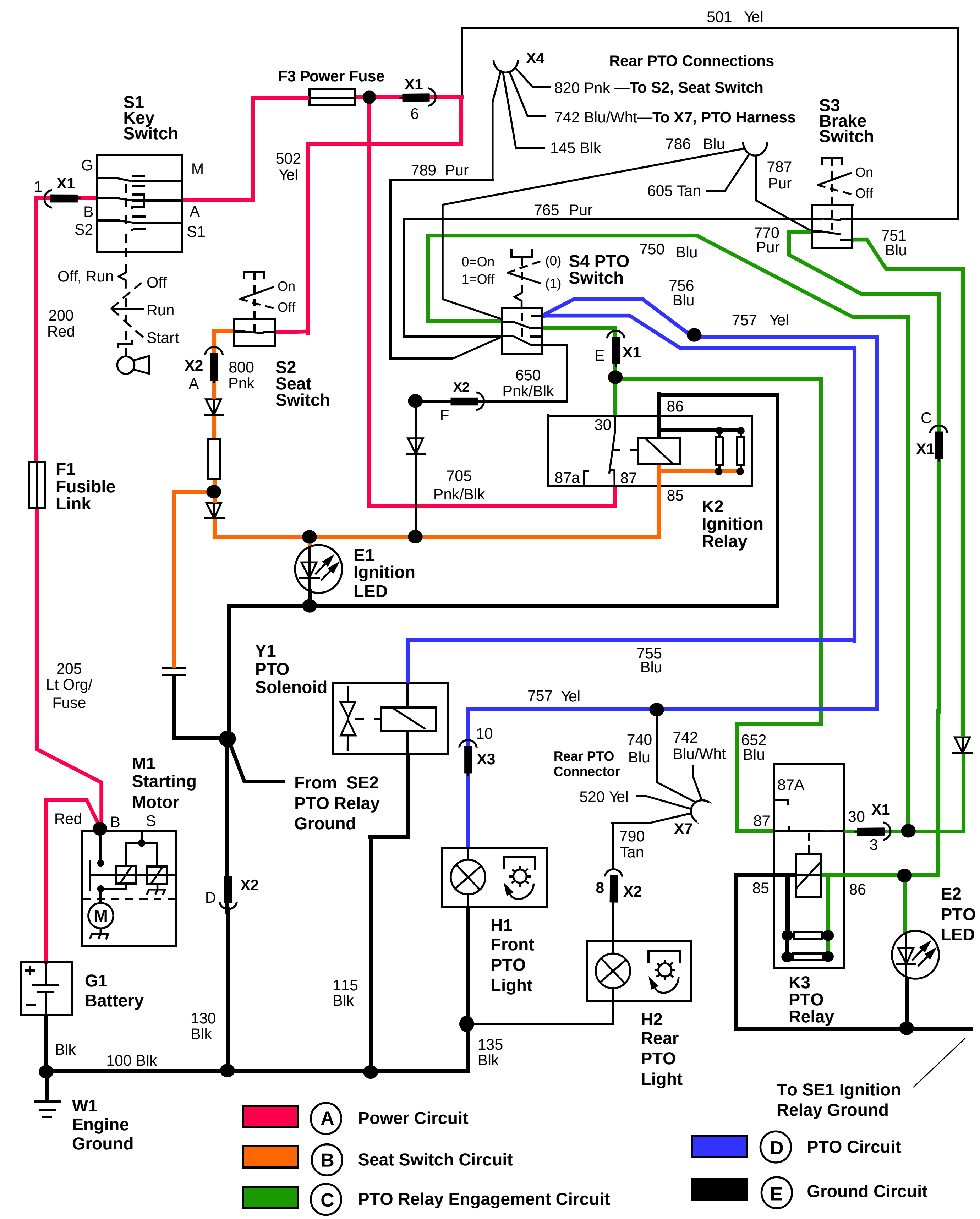
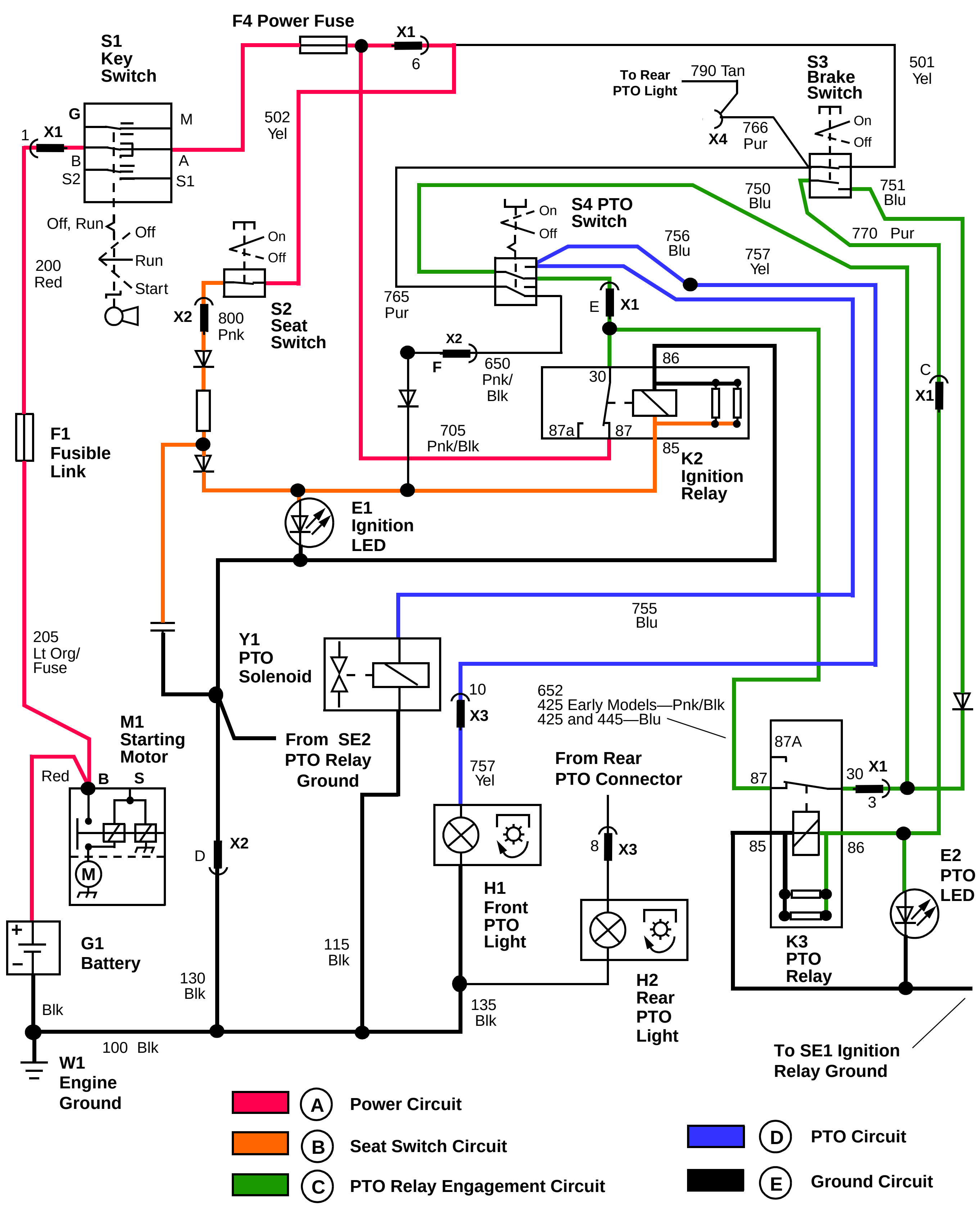
PTO CIRCUIT SCHEMATIC—425 (S.N. —032776)



PTO CIRCUIT SCHEMATIC—425 (S.N. 032777—070000)



PTO CIRCUIT SCHEMATIC—425 (S.N. —032776)



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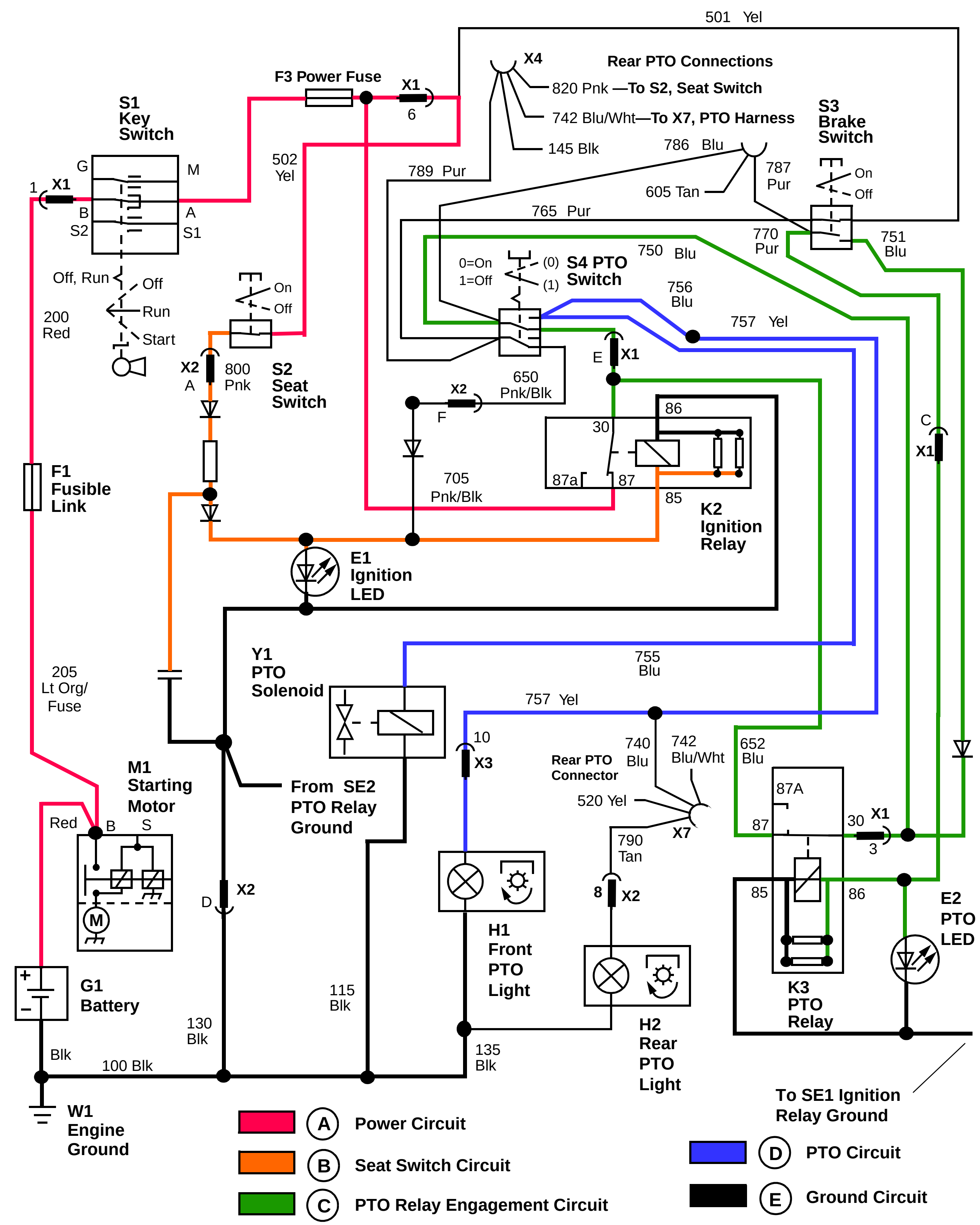

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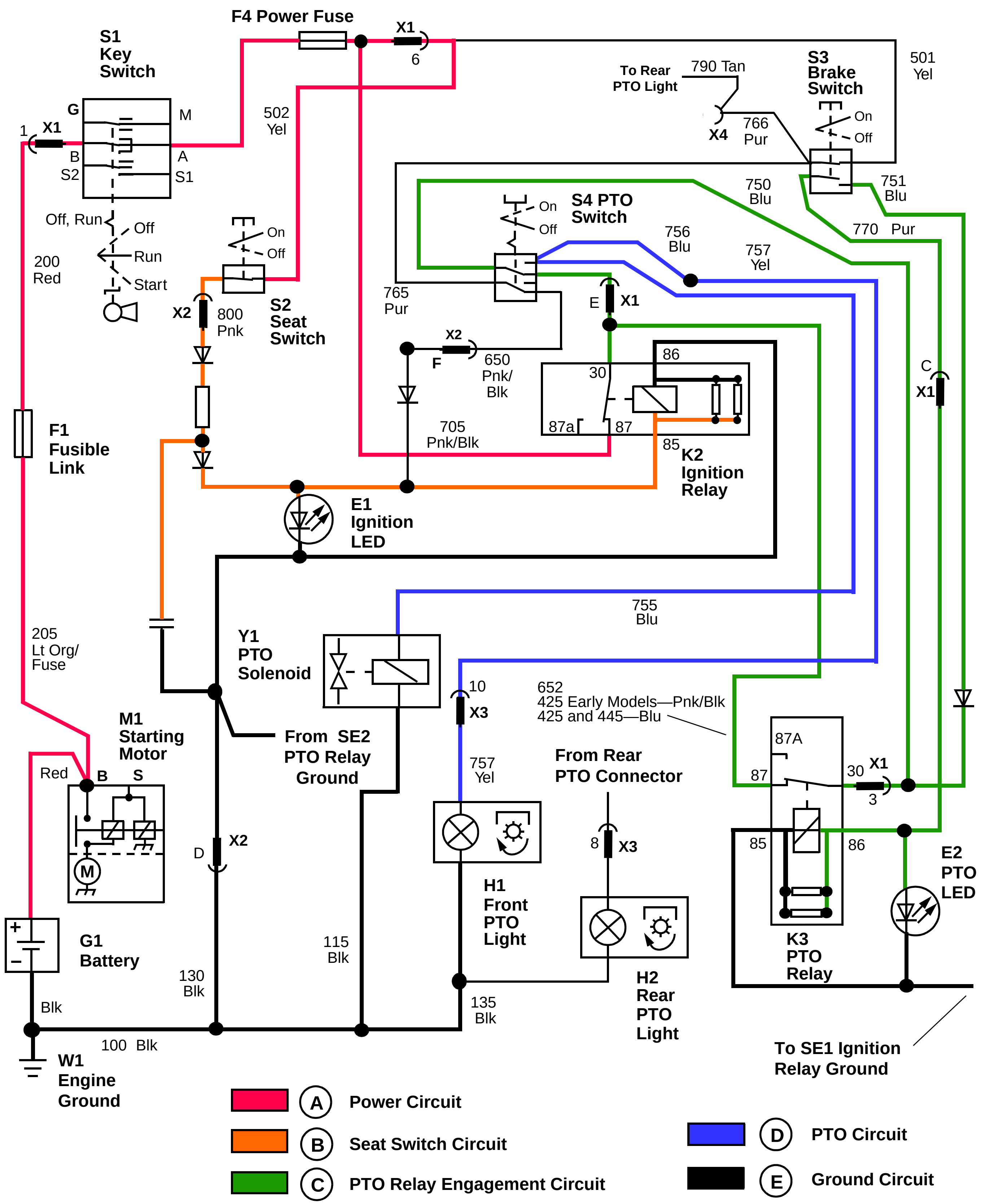

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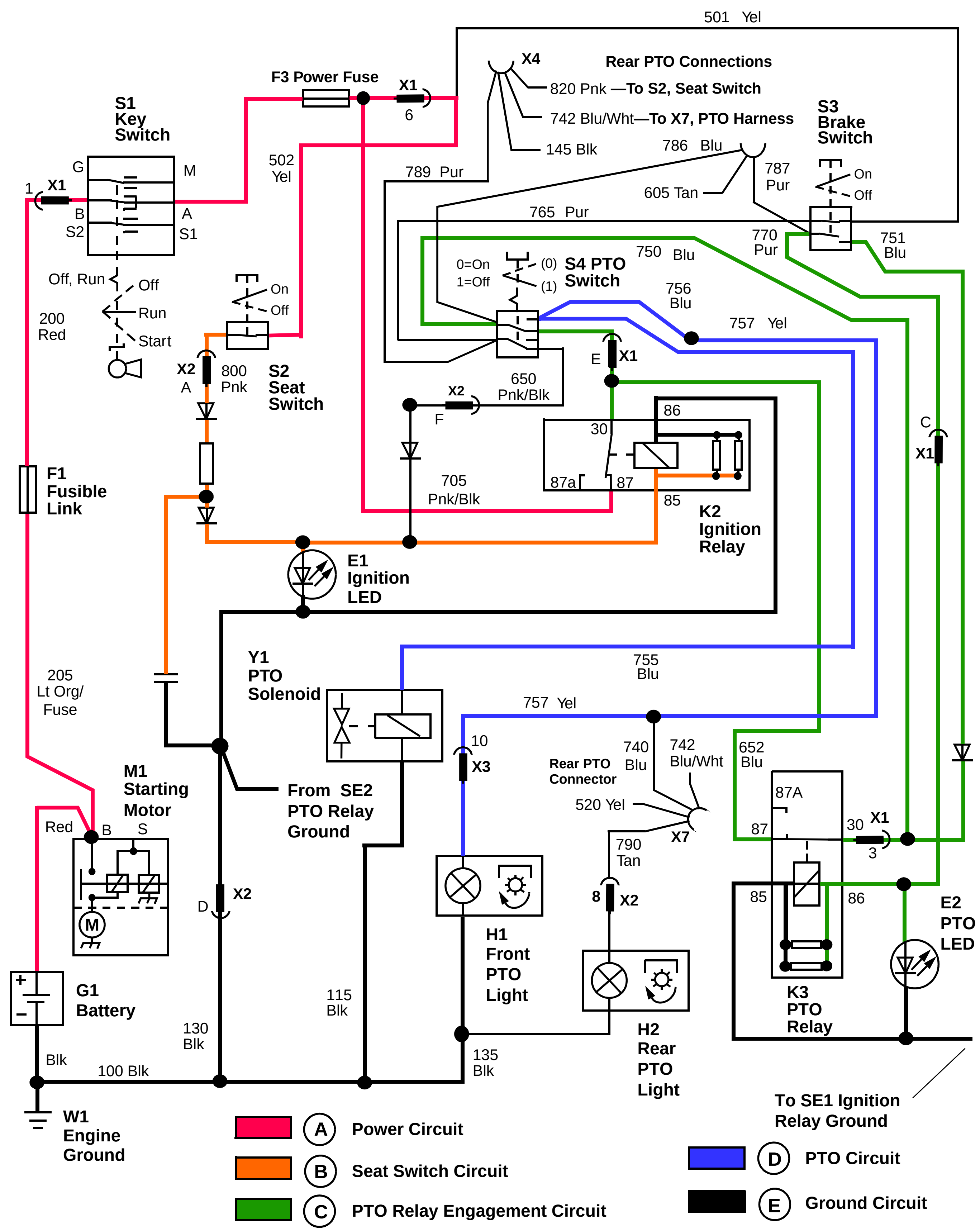

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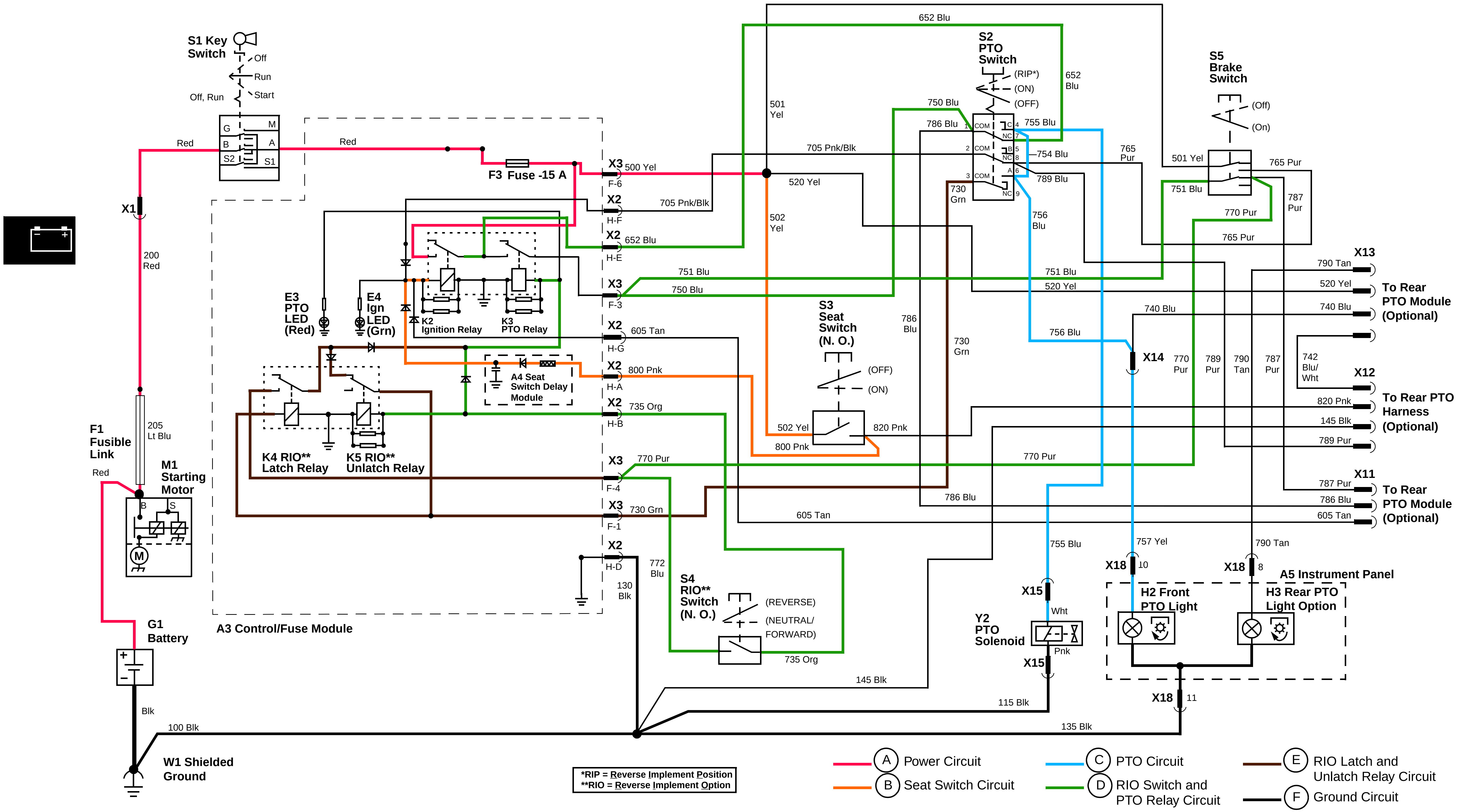

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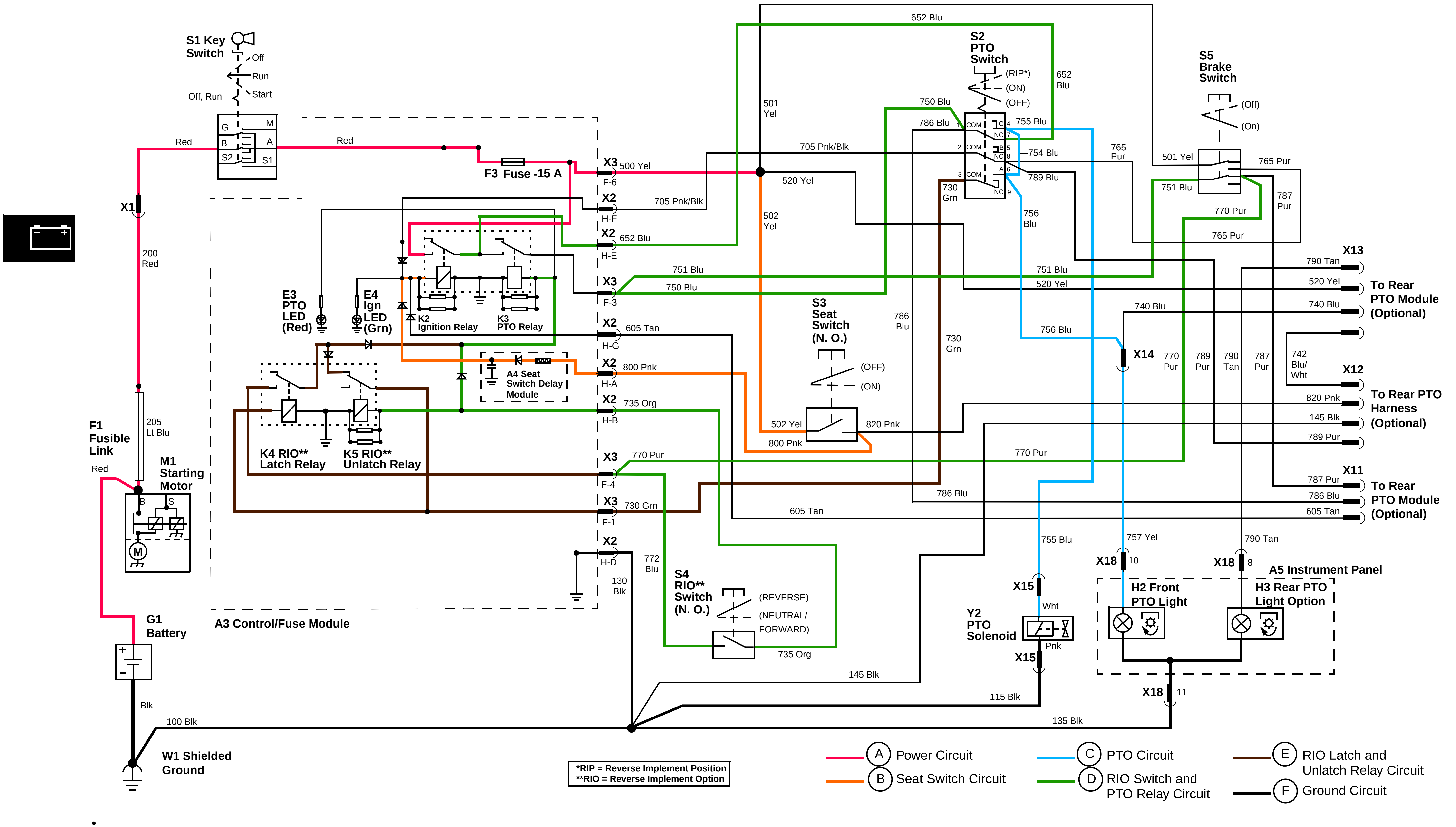
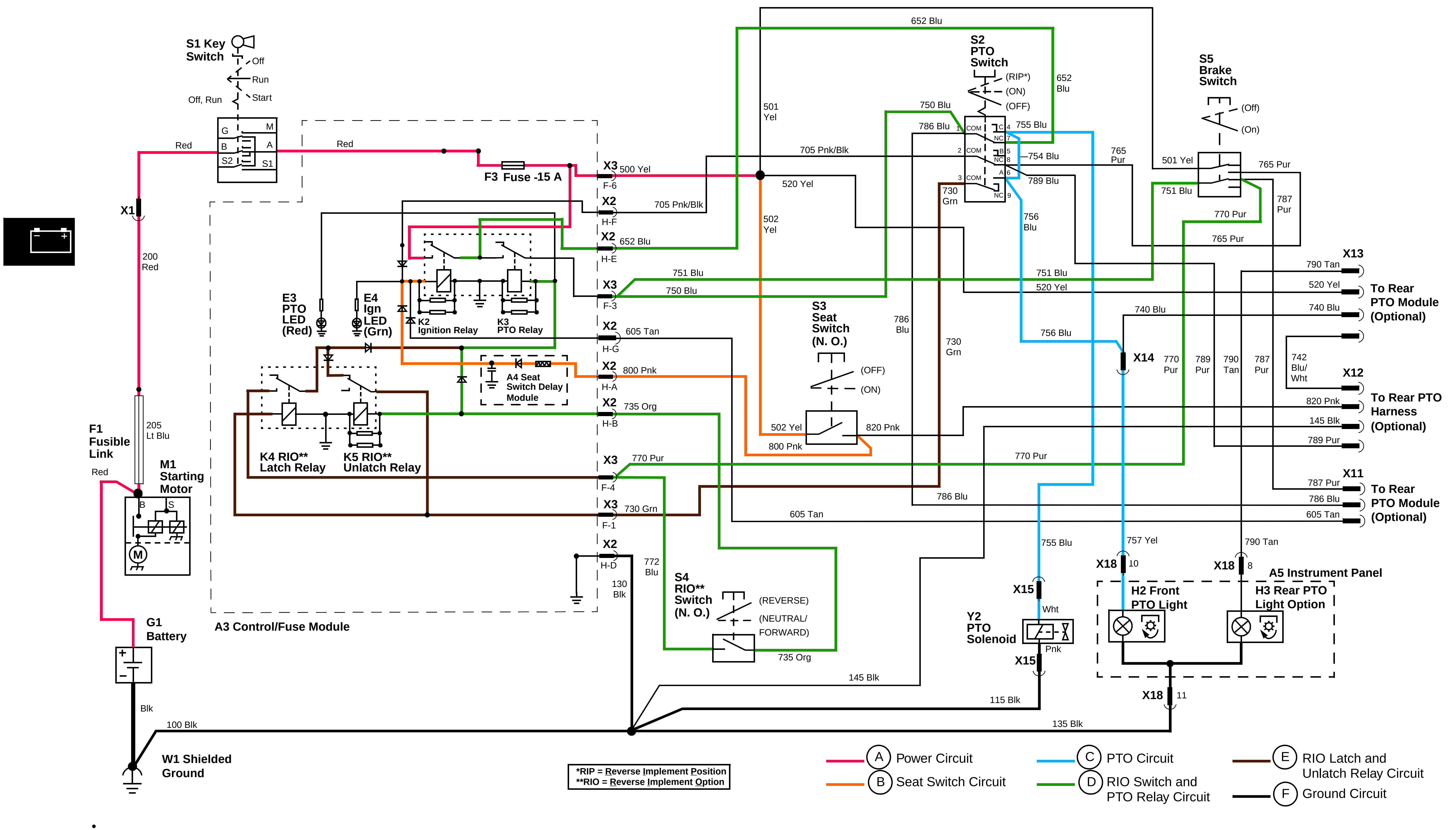


PTO CIRCUIT SCHEMATIC—425 (S.N. 070001—)



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PTO CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- PTO switch off position.
- Brake pedal released.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

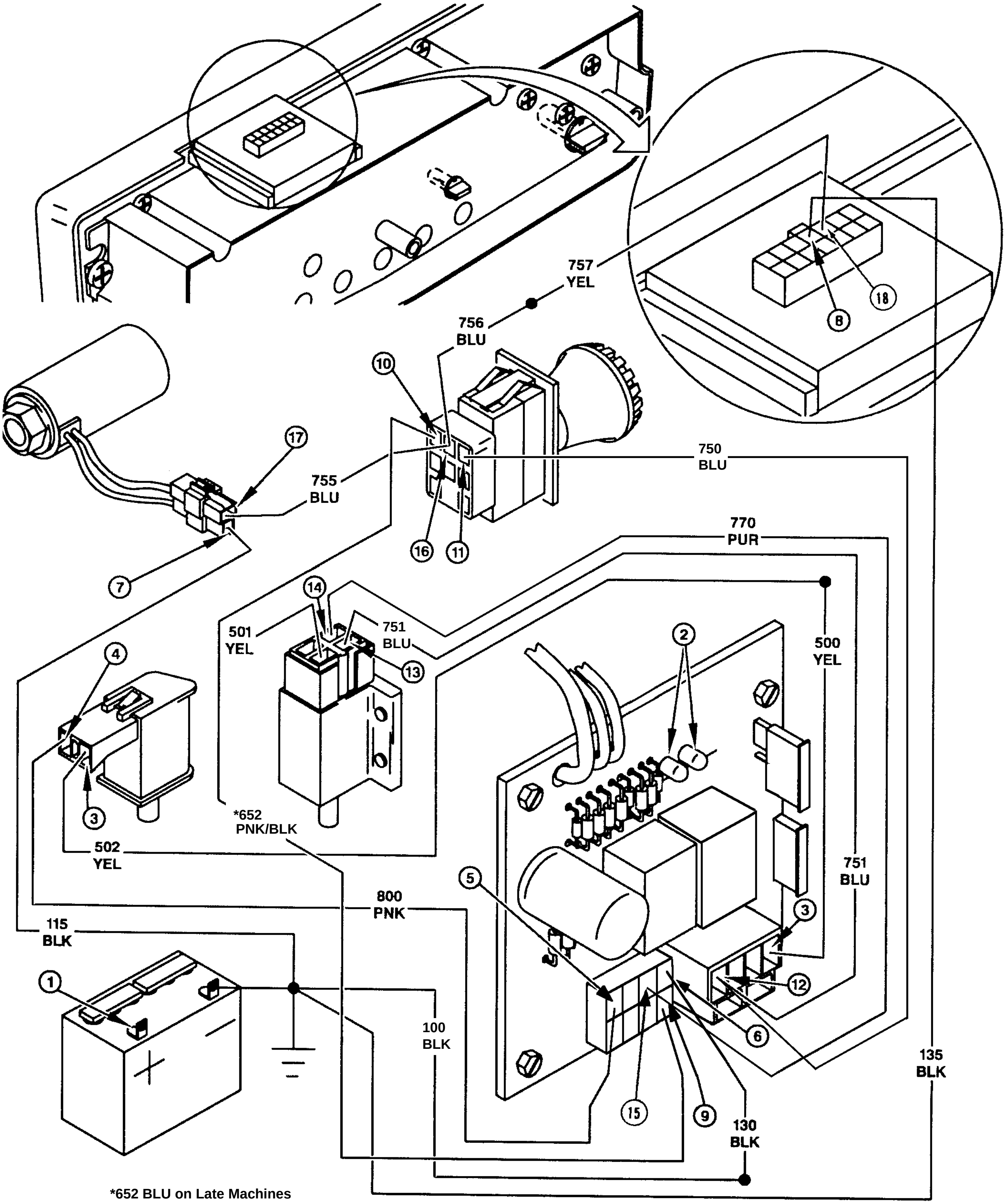
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition and PTO LED.	Lights on.	Lights off—check relay engagement circuit—go to step 3. Lights on—go to step 7.
3. Seat switch and control/fuse module terminal 6.	Battery voltage.	Check power circuit test points from battery to control fuse module.
4. Seat switch.	Battery voltage.	Test seat switch.
5. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
6. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check battery negative cable and harness ground connection, 100 and 130 blk wires.
7. PTO solenoid.	Maximum 0.1 ohms resistance.	Check 115 blk wire.
8. Dash panel.	Maximum 0.1 ohms resistance.	Check 135 blk wire.

PTO CIRCUIT TEST POINTS—425 (S.N. —070000)



PTO CIRCUIT DIAGNOSIS—425 (S.N. —070000) (continued)

Test Conditions:

- Key switch in run position.

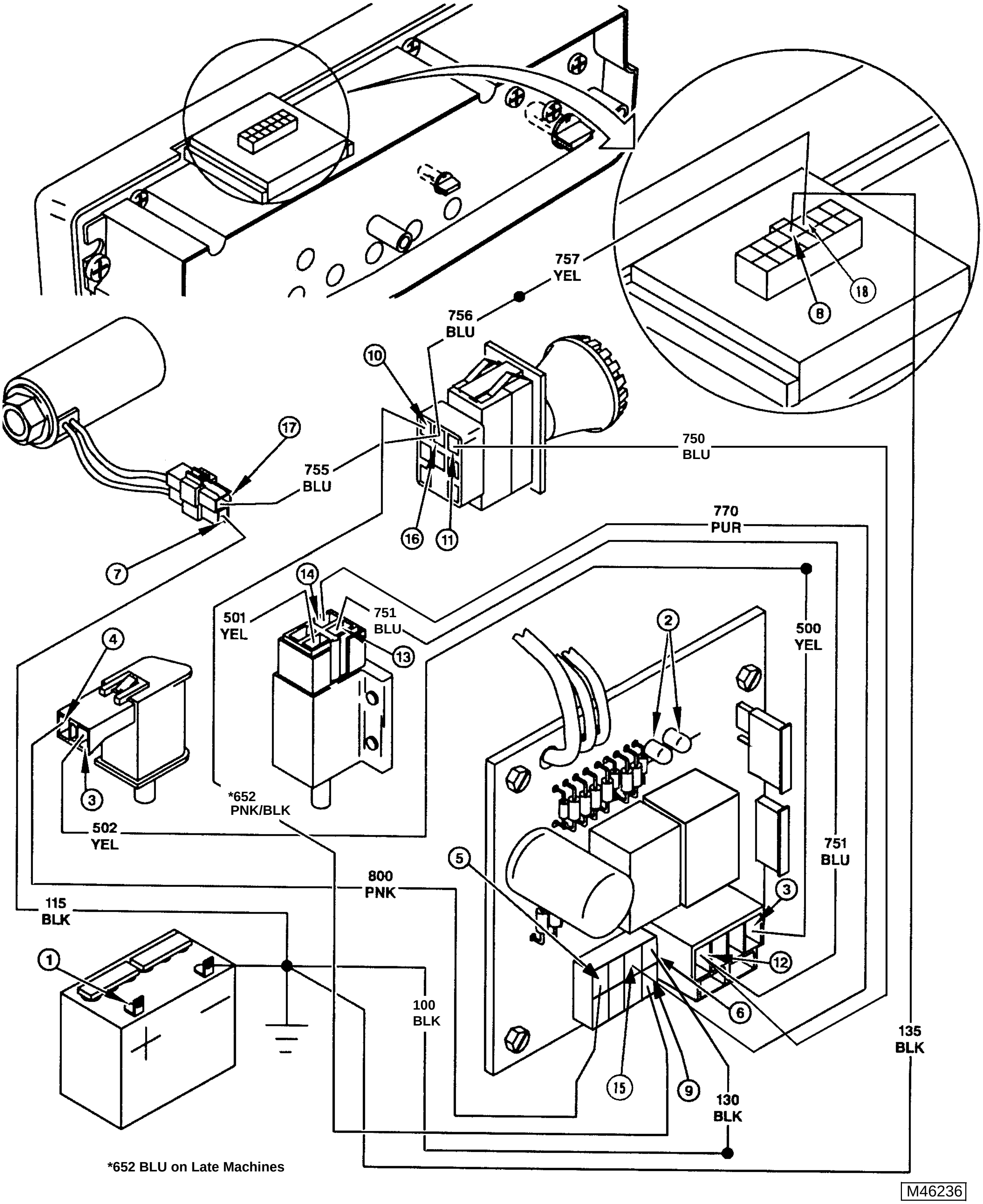
Test/Check Point	Normal	If Not Normal
9. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
10. PTO switch.	Battery voltage.	Early machines—Check 652 pnk/blk wire. Late machines—Check 652 blu wire.
11. PTO switch.	Battery voltage.	Test PTO switch.
12. Control/fuse module terminal 3.	Battery voltage.	Check 750 blu wire.
13. Brake switch.	Battery voltage.	Check 751 blu wire.
14. Brake switch.	Battery voltage.	Test brake switch.
15. Control/fuse module terminal C.	Battery voltage.	Check 770 pur wire.

Test Conditions:

- PTO switch on.

Test/Check Point	Normal	If Not Normal
16. PTO switch.	Battery voltage.	Test PTO switch.
17. PTO solenoid.	Battery voltage.	Check 755 blu wire, if ok replace PTO solenoid.
18. Dash panel.	Battery voltage.	Check 756 blu, 757 yel wire, and PTO light, if ok replace dash panel module.

PTO CIRCUIT TEST POINTS—425 (S.N. —070000) (continued)



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PTO CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- PTO switch in off position.
- Brake pedal released.
- Seat switch depressed or jumper wire installed in connector.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

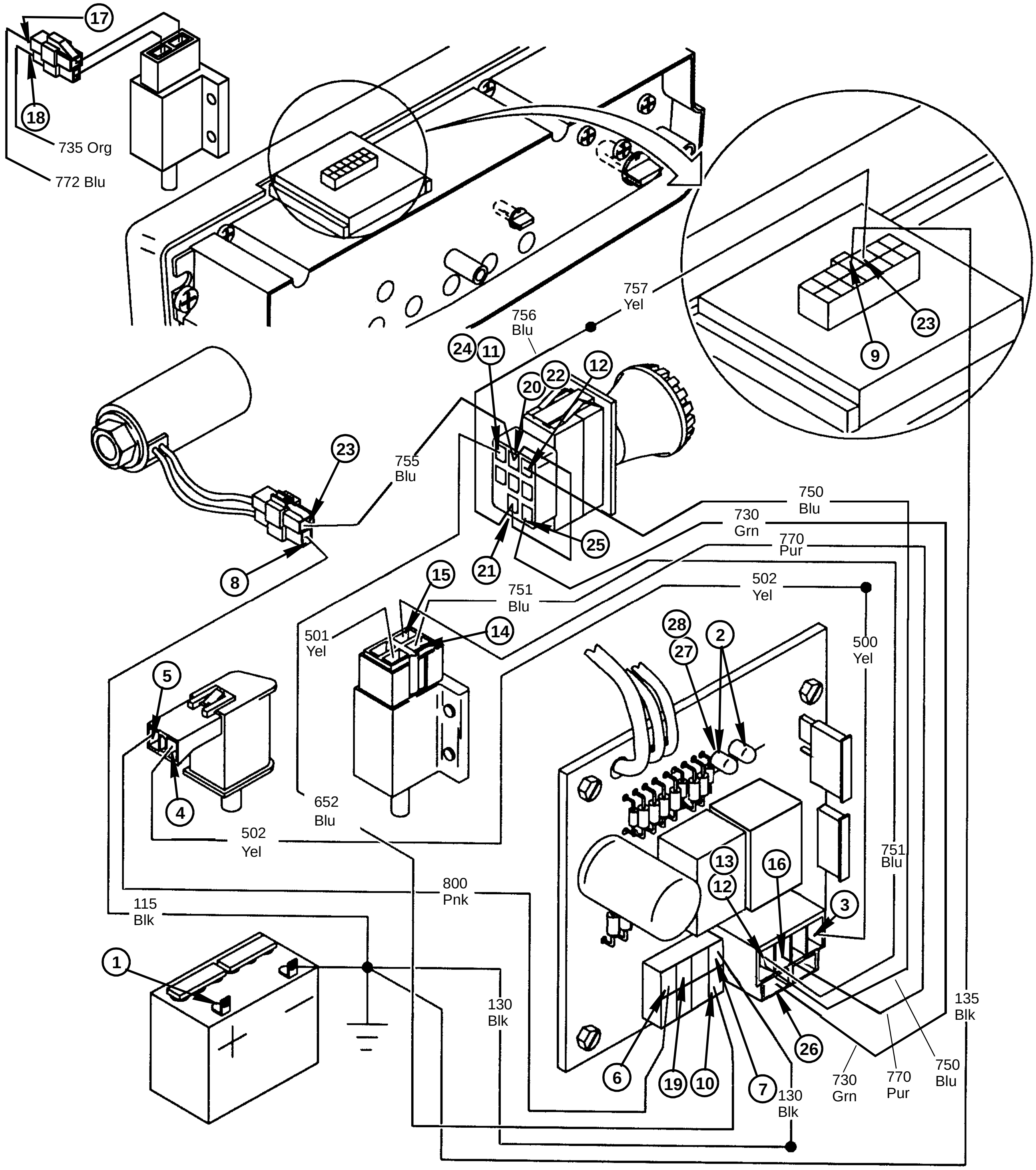
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition and PTO LED.	Lights on.	Lights off—check relay engagement circuit—go to step 3. Lights on—go to step 7.
3. Control/fuse module terminal 6.	Battery voltage.	Check power circuit test points from battery to control fuse module. If ok, replace control/fuse module.
4. Seat switch.	Battery voltage.	Check 502 yel wire.
5. Seat switch.	Battery voltage.	Test seat switch.
6. Control/fuse module terminal D.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
7. Control/fuse module terminal 4.	Maximum 0.1 ohms resistance.	Check battery negative cable and harness ground connection, 100 and 130 blk wires.
8. PTO solenoid.	Maximum 0.1 ohms resistance.	Check 115 blk wire.
9. Instrument panel.	Maximum 0.1 ohms resistance.	Check 135 blk wire.

PTO CIRCUIT TEST POINTS—425 (S.N. 070001—)



PTO CIRCUIT DIAGNOSIS—425 (S.N. 070001—) (continued)

Test Conditions:

• Key switch in run position.

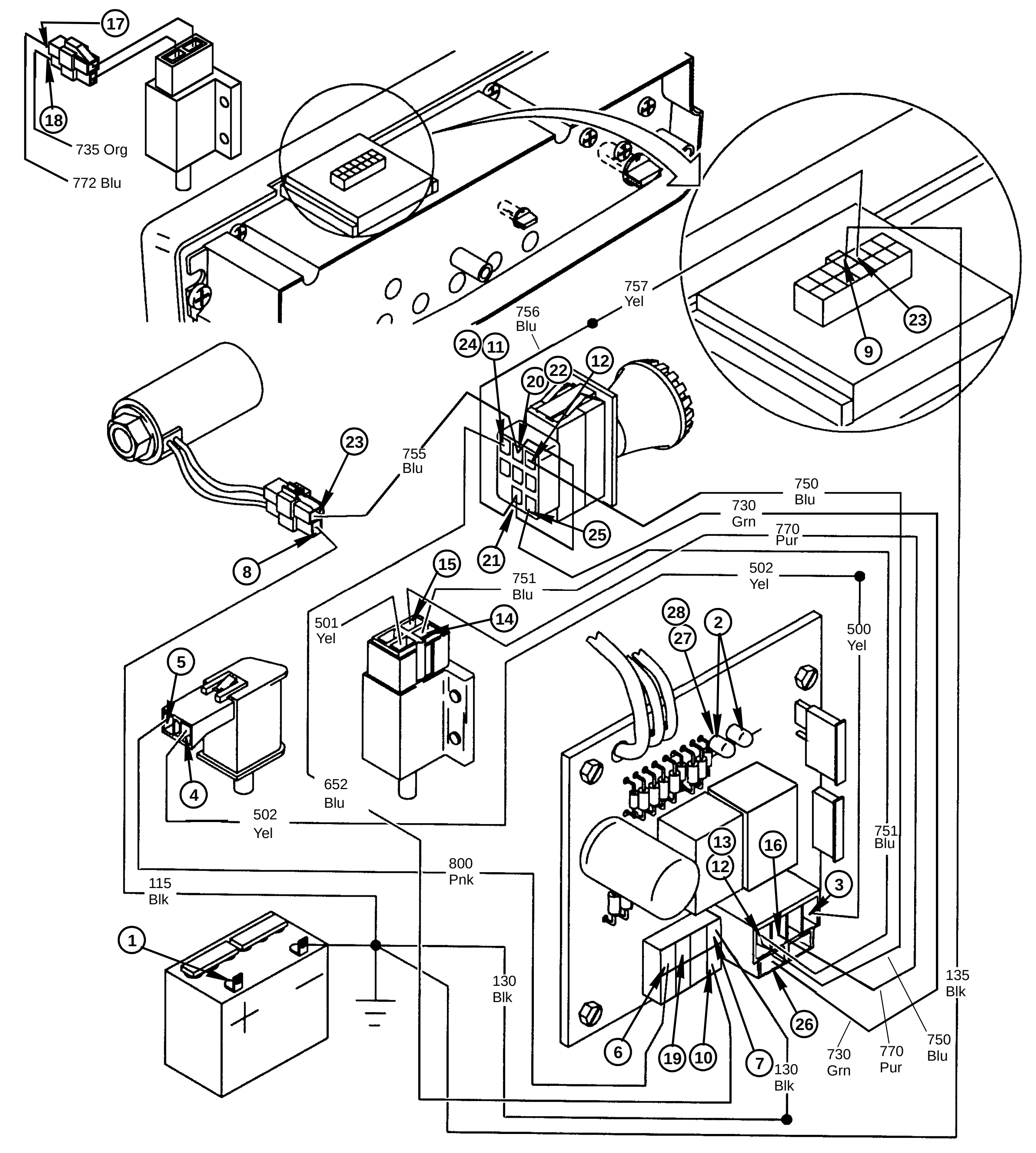
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
11. PTO switch.	Battery voltage.	Check 652 blu wire.
12. PTO switch.	Battery voltage.	Test PTO switch.
13. Control/fuse module terminal 3.	Battery voltage.	Check 750 blu wire.
14. Brake switch.	Battery voltage.	Check 751 blu wire.
15. Brake switch.	Battery voltage.	Test brake switch.
16. Control/fuse module terminal 4.	Battery voltage.	Check 770 pur wire.

Test Conditions:

• PTO switch in on position.

Test/Check Point	Normal	If Not Normal
17. RIO switch.	Battery voltage.	Check 772 blu wire.
18. RIO switch.	Battery voltage.	Test RIO switch.
19. Control/fuse module terminal B.	Battery voltage.	Check 735 org wire.
20. PTO switch.	Battery voltage.	Replace control/fuse module.
21. PTO switch.	Battery voltage.	Check 754 blu wire.
22. PTO solenoid.	Battery voltage.	Check 755 blu wire, if ok replace PTO solenoid.
23. Instrument panel connector terminal 10.	Battery voltage.	Check 756 blu, 757 yel wire, and PTO light, if ok replace instrument panel.

PTO CIRCUIT TEST POINTS—(S.N. 070001—) (continued)



PTO CIRCUIT DIAGNOSIS—425 (S.N. 070001—) (continued)

Test Conditions:

- PTO switch in RIP position.
- Forward/reverse pedal in reverse.

Test/Check Point	Normal	If Not Normal
24. PTO switch.	Battery voltage.	Test PTO switch.
25. PTO switch.	Battery voltage.	Test PTO switch.
26. Control/fuse module terminal 1.	Battery voltage.	Check 730 grn wire.

Test Conditions:

- Release the PTO switch to on.

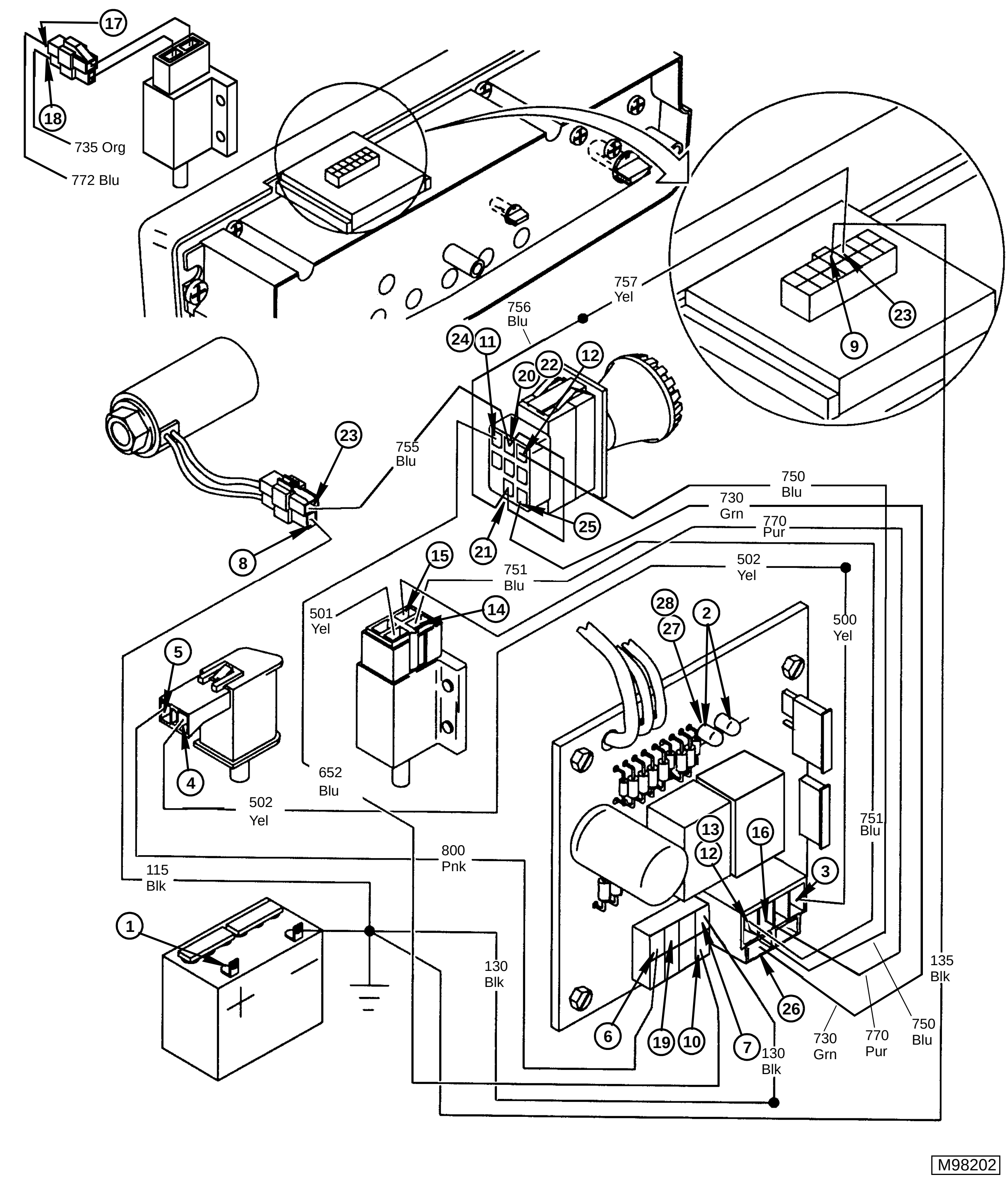
Test/Check Point	Normal	If Not Normal
27. PTO LED.	Light on.	Test RIO latch relay.

Test Conditions:

- Forward/reverse pedal in forward.

Test/Check Point	Normal	If Not Normal
28. PTO LED.	Light off.	Test RIO unlatch relay.

PTO CIRCUIT TEST POINTS—425 (S.N. 070001—) (continued)



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INDICATOR LIGHTS, GAUGES, HOURMETER, AND LIGHTS CIRCUIT OPERATION—425 (S.N. —070000)

Function:

OIL PRESSURE LIGHT:

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

FUEL GAUGE:

To inform the operator of the fuel level in the tank.

COOLANT TEMPERATURE GAUGE:

To inform the operator of the engine coolant temperature.

HOURMETER:

To record the number of hours the engine is running.

HEADLIGHTS:

To provide power to the headlights, taillights, and dash panel lights for illumination if desired by the operator.

Operating Conditions:

The key switch must be in the run position; and the oil pressure switch, or light switch closed.

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and key switch B terminal (S2). With the key switch in the run position, current flows through the switch to the light and power fuses (F3 and F4—425 and 445, F2 and F3—415 and 455), fuel gauge (P1), oil pressure light (H4), coolant temperature gauge (P2), hourmeter (P3), and light switch (S5).

OIL PRESSURE LIGHT:

When the oil pressure switch (B6) is closed a path to ground (D) is made which illuminates the indicator light. The oil pressure switch will be closed if the engine is not running or the oil pressure is below 28 kPa (4 psi). With the key switch in the run position, the oil pressure light will be on. This is to inform the operator that the light is functioning. The warning light will go out after a normal engine start-up.

FUEL GAUGE:

Current (C) flows from the gauge (P1) to the fuel gauge sensor (B5). Current flow through the sensor is controlled by a variable resistor. As the sensor float moves to agree with the fuel level, the amount of resistance increases/decreases accordingly. This change in resistance is sensed back at the gauge needle which moves to indicate fuel level.

COOLANT TEMPERATURE GAUGE:

Current (E) flows from the gauge (P2) to the coolant temperature sensor (B7). Current flow through the sensor is controlled by a temperature sensitive variable resistor. As the coolant temperature increases or decreases, the amount of resistance in the sensor increases/decreases accordingly. This change in resistance is sensed back at the gauge needle which moves to indicate coolant temperature.

HOURMETER:

Power for the hourmeter (P3) comes from the key switch (S3). When the key switch is in the run position, the hourmeter will be operating.

HEADLIGHTS:

With the light switch (S5) on (switch closed), current flows to the headlights (E7 and E8), taillights (E9 and 10), and dash lights (E5 and E6) and illuminates the lamps. The circuit is protected by a 15 amp fuse in the control/fuse module.

INDICATOR LIGHTS, GAUGES, HOURMETER, AND LIGHTS CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

ENGINE OIL PRESSURE LIGHT:
To alert operator of low engine oil pressure by illuminating a lamp.

FUEL GAUGE:
To inform the operator of the fuel level in the tank.

COOLANT TEMPERATURE GAUGE:
To inform the operator of the engine coolant temperature.

HOURMETER:
To record the number of hours the engine is running.

HEADLIGHTS AND TAIL LIGHTS:
To provide power to the head lights, tail lights, and instrument panel lights for illumination if desired by the operator.

Operating Conditions:

The key switch must be in the run position and the lights switch must be in the on position.

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and B terminal of the key switch (S1). With the key switch in the run position, current flows through the switch to the light and power fuses (F3 and F4), fuel gauge, engine oil pressure light (H1), coolant temperature gauge (P3), hourmeter (P2) dash lights (H5), and light switch (S6).

ENGINE OIL PRESSURE LIGHT:

When the oil pressure switch (B4) is closed, a path to ground (D) is made which turns on the engine oil pressure light (H1). The oil pressure switch will be closed if the engine is not running or the oil pressure is below 28 kPa (4 psi). With the key switch in the run position, the engine oil pressure light (H1) will be on. This is to inform the operator that the light is functioning. The engine oil pressure light will go out after normal engine start-up.

FUEL GAUGE:

Current (C) flows from the fuel gauge (P1) to the fuel gauge sensor (B5). Current flow through the sensor is controlled by a variable resistor. As the sensor float moves to agree with the fuel level, the amount of resistance increases or decreases accordingly. The gauge senses the change in resistance and moves the gauge needle to indicate the fuel level.

COOLANT TEMPERATURE GAUGE:

Current (E) flows from the coolant temperature gauge (P3) to the coolant temperature sensor (B7). Current flow through the sensor is controlled by a temperature sensitive variable resistor. As the coolant temperature increases or decreases, the amount of resistance in the sensor increases or decreases accordingly. The gauge senses the change in resistance and moves the gauge needle to indicate the coolant temperature.

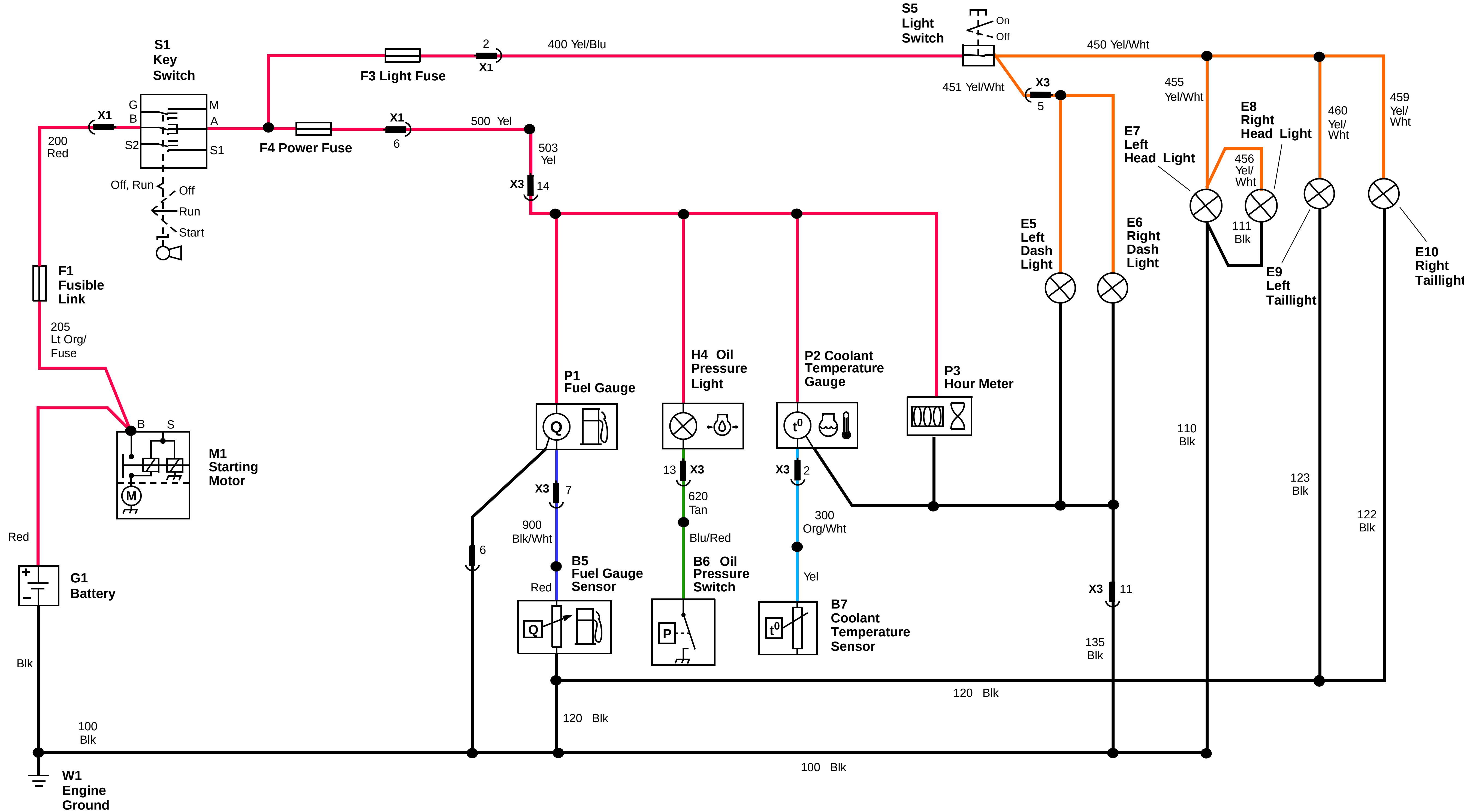
HOURMETER:

Power for the hourmeter (P2) comes from the key switch (S3). When the key switch is in the run position, the hourmeter will be operating.

HEADLIGHTS AND TAIL LIGHTS:

With the light switch (S6) in the on position (switch closed), current flows to the head lights (E5 and E6), tail lights (E7 and E8), and dash lights (H5 and H6) in the instrument panel (A5) to turn on each light. The circuit is protected by a F2 fuse - 15A in the control/ fuse module (A3).

INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. —070000)



A Power Circuit

B Light Circuit

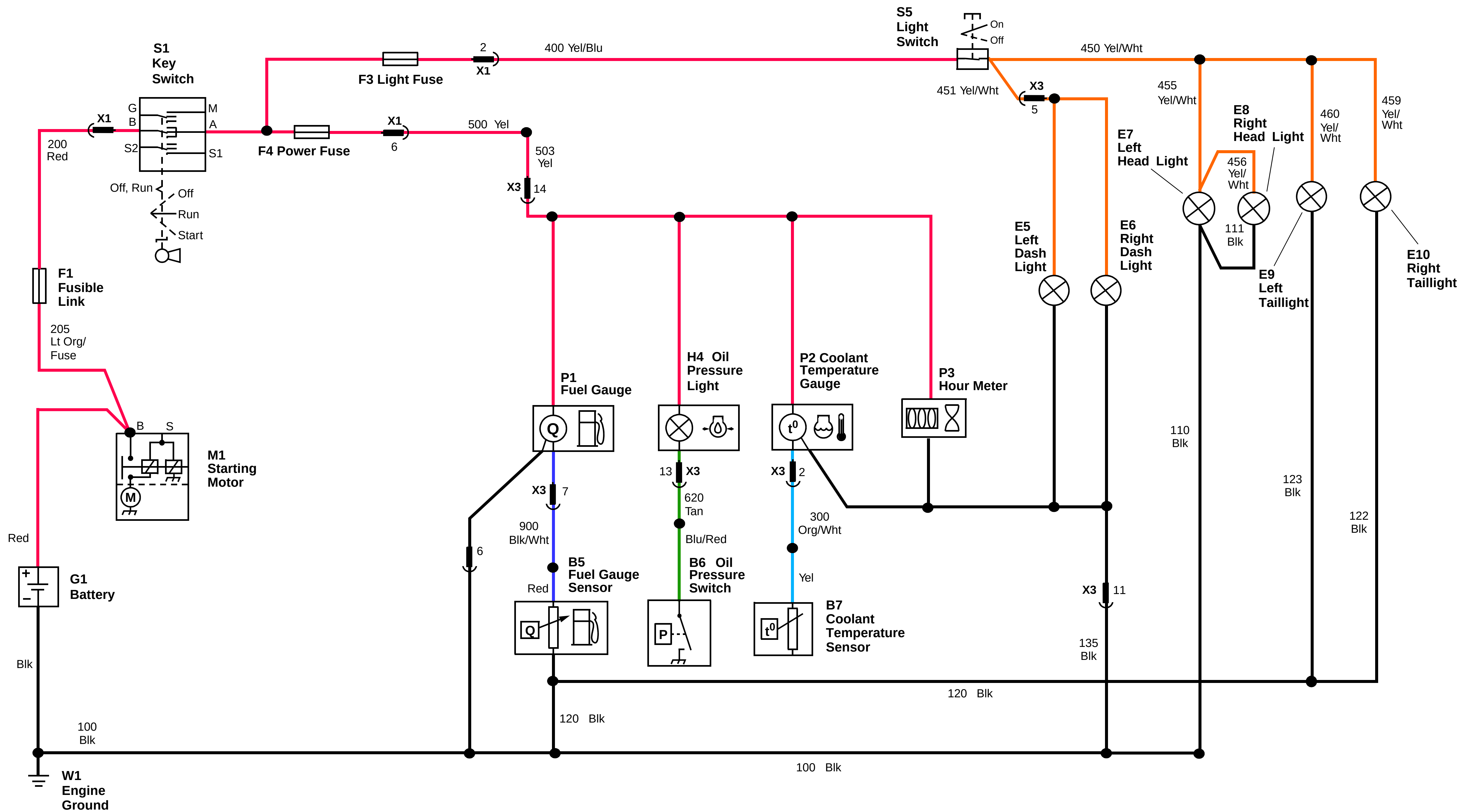
C Fuel Gauge Circuit

D Oil Pressure Light Ground Circuit

E Coolant Temperature Gauge Circuit

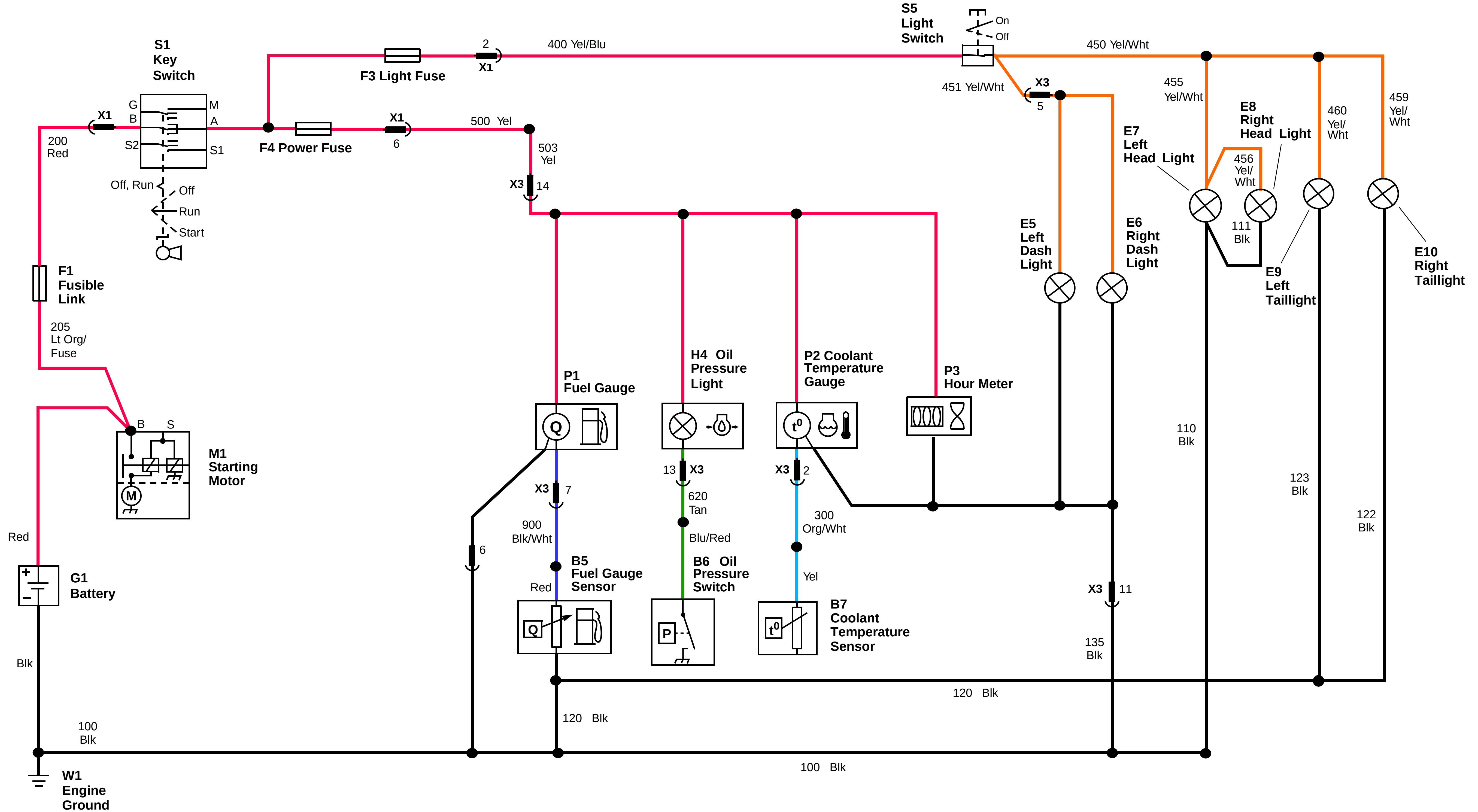
F Ground Circuit

INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. —070000)



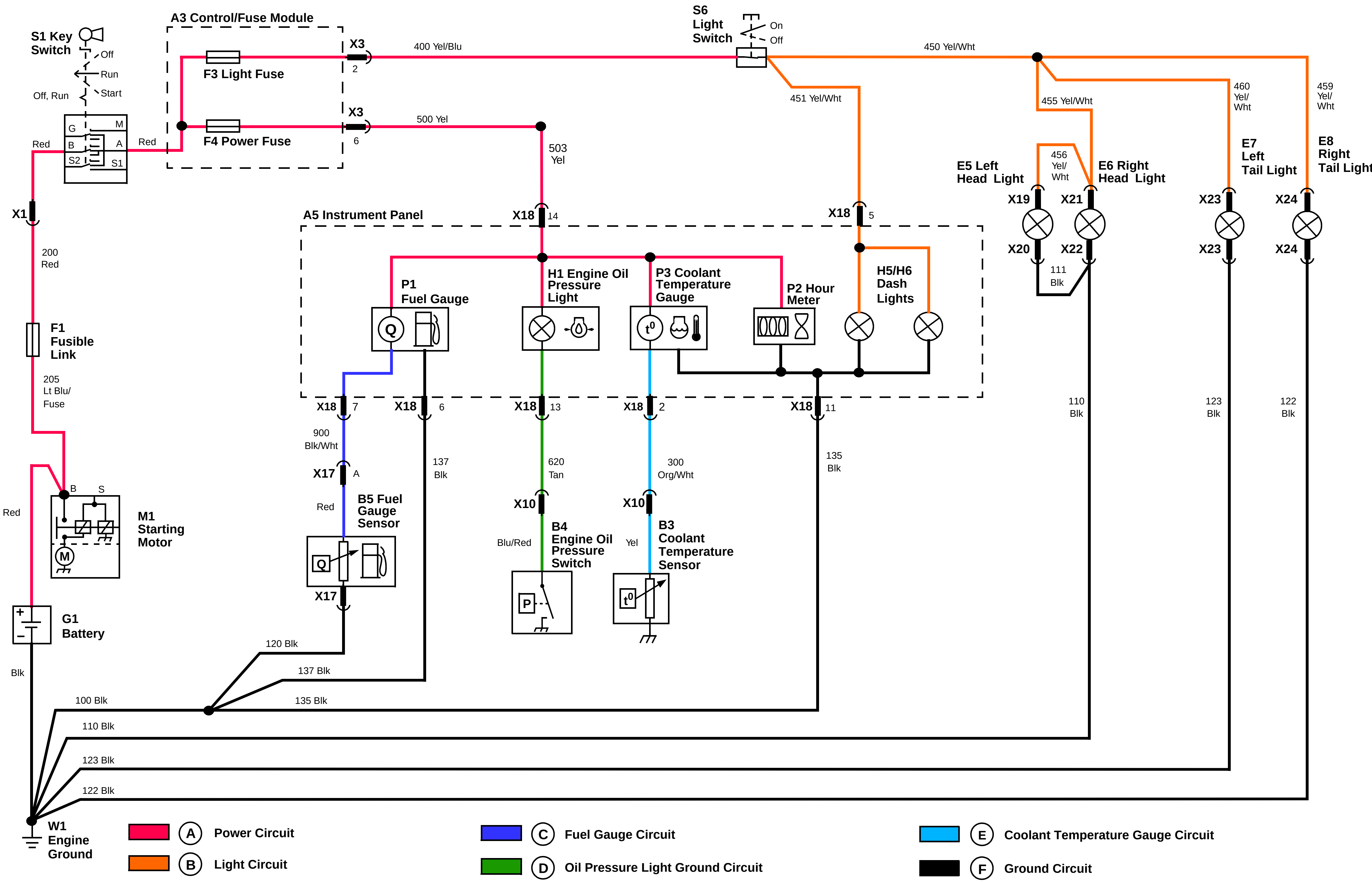
A Power Circuit
B Light Circuit
C Fuel Gauge Circuit
D Oil Pressure Light Ground Circuit
E Coolant Temperature Gauge Circuit
F Ground Circuit

INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. —070000)

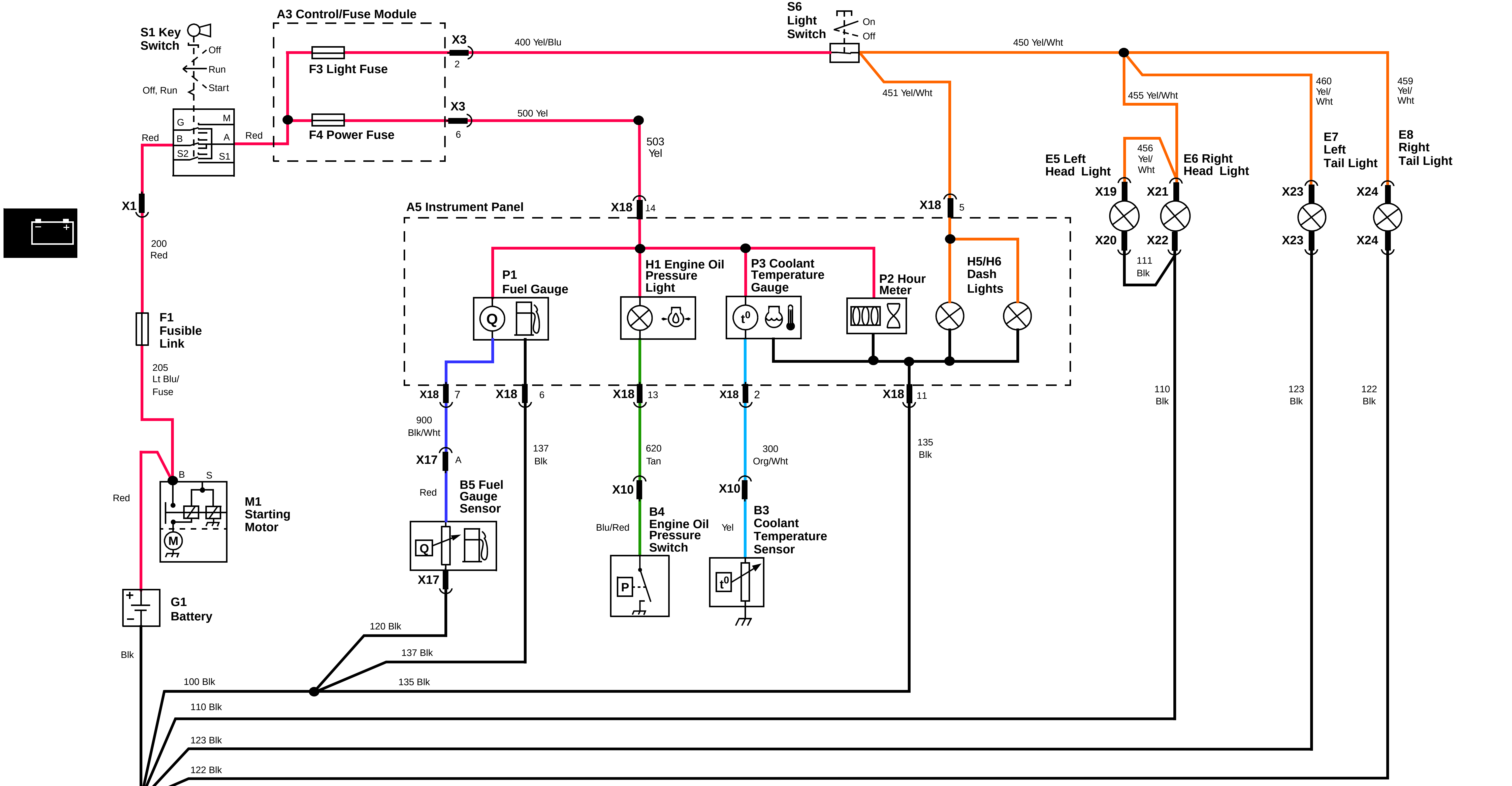


- A — Power Circuit
- B — Light Circuit
- C — Fuel Gauge Circuit
- D — Oil Pressure Light Ground Circuit
- E — Coolant Temperature Gauge Circuit
- F — Ground Circuit

INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. 070001—)

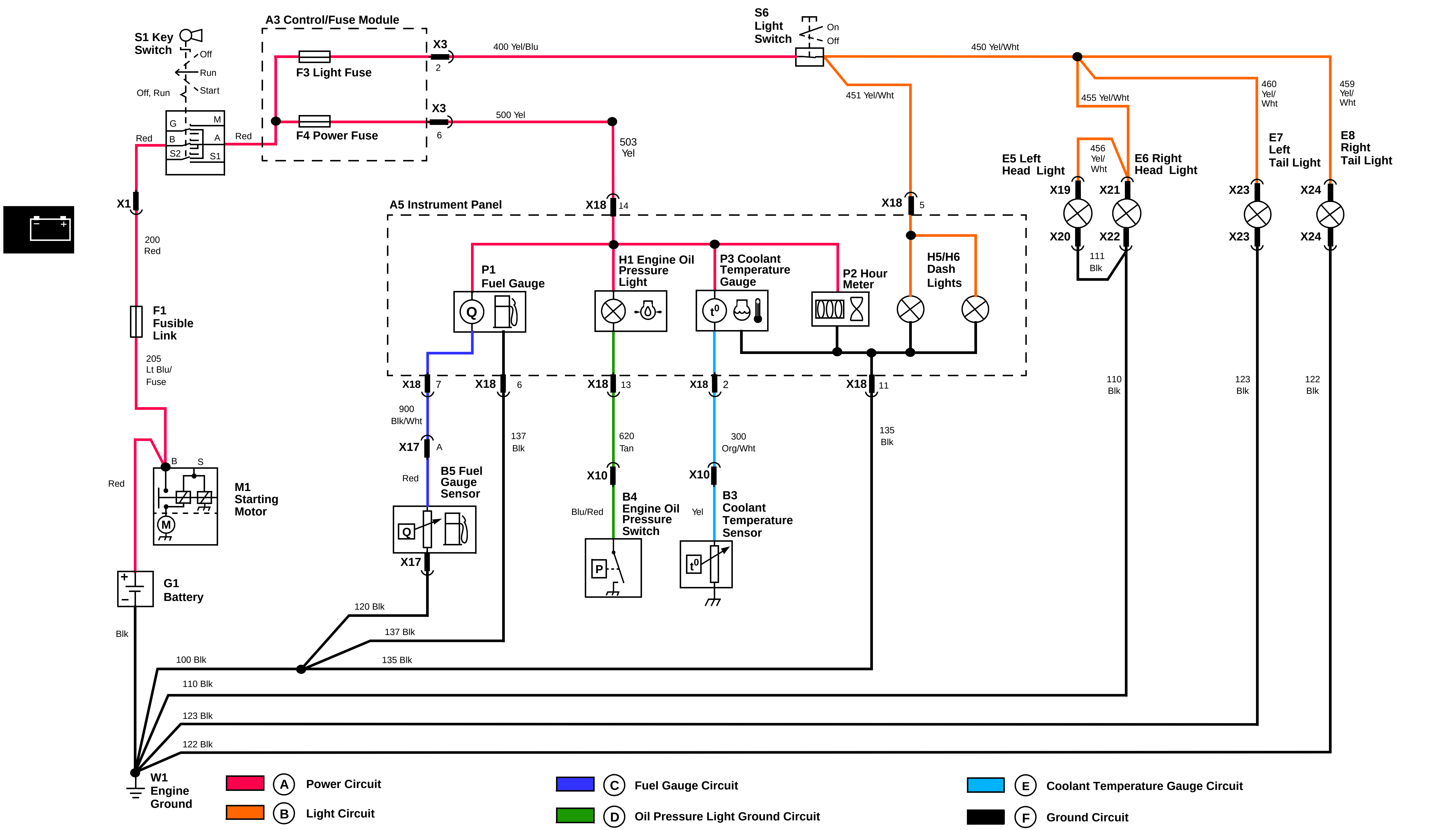


INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. 070001—)



A Power Circuit	C Fuel Gauge Circuit	E Coolant Temperature Gauge Circuit
B Light Circuit	D Oil Pressure Light Ground Circuit	F Ground Circuit

INDICATOR LIGHTS, GAUGES, HOUR METER, AND LIGHTS CIRCUIT SCHEMATIC—425 (S.N. 070001—)



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OIL PRESSURE LIGHT AND HOURMETER CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- PTO switch off position.
- Park brake engaged.
- Oil pressure sensor lead (A) disconnected.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

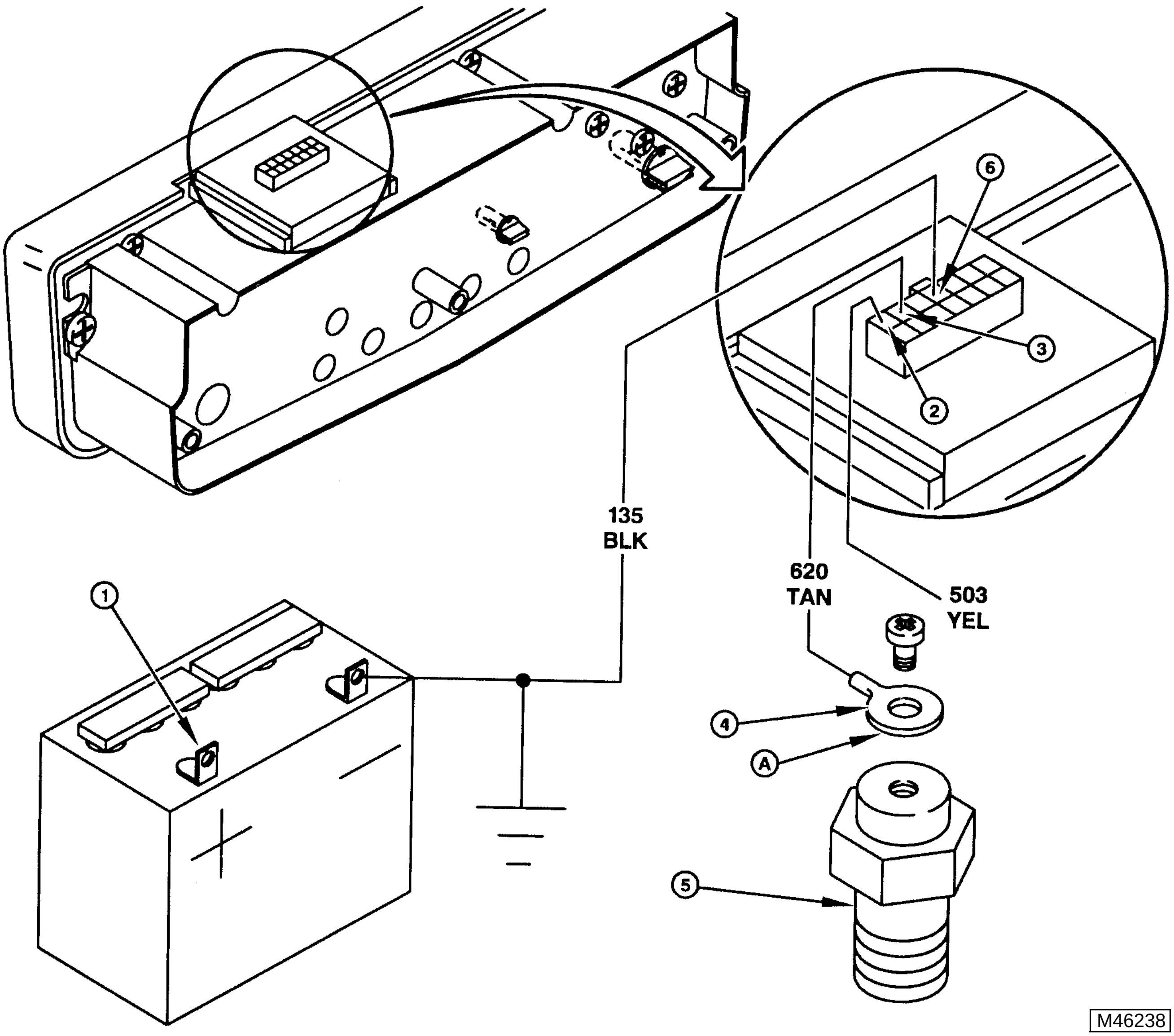
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Dash panel module terminal 14.	Battery voltage.	Check power circuit test points.
3. Dash panel module terminal 13.	Battery voltage.	Replace oil pressure light bulb.
4. Oil pressure sensor lead.	Battery voltage.	Check 620 tan wire and blu/red wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Oil pressure sensor.	Continuity to ground Maximum 0.1 ohms resistance.	Check engine ground, if ok replace oil pressure sensor.
6. Dash panel module terminal 11—Hourmeter check.	Maximum 0.1 ohms resistance.	Check engine ground connection, 100 and 135 blk wires, if ok replace dash panel module.

OIL PRESSURE LIGHT AND HOURMETER CIRCUIT TEST POINTS—425 (S.N. —070000)



OIL PRESSURE LIGHT AND HOURMETER CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- PTO switch in off position.
- Park brake engaged.
- Oil pressure sensor lead (A) disconnected.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and lose terminals when testing.

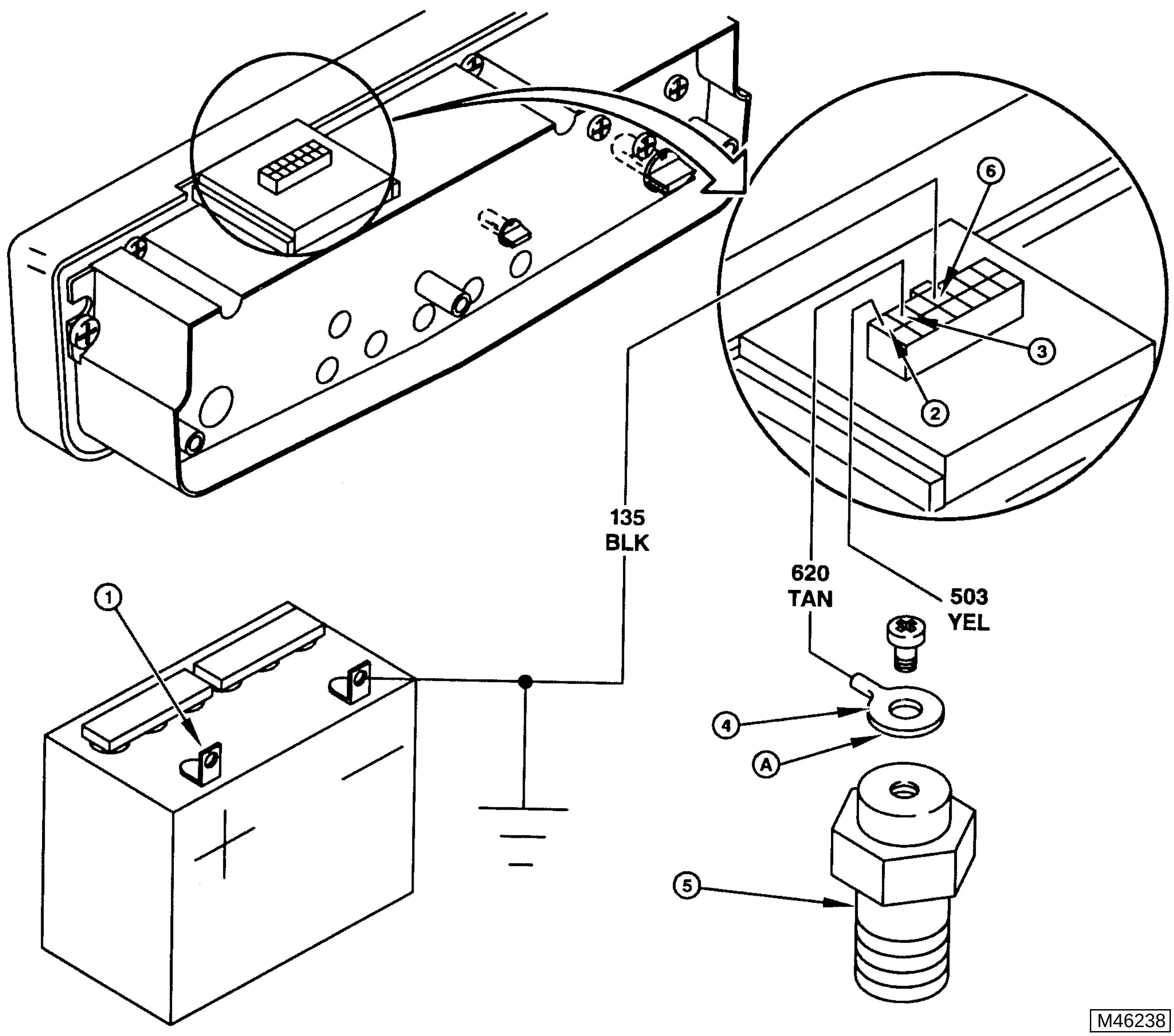
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Instrument panel connector terminal 14.	Battery voltage.	Check power circuit test points.
3. Instrument panel connector terminal 13.	Battery voltage.	Replace engine oil pressure light bulb.
4. Oil pressure switch lead.	Battery voltage.	Check 620 tan wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Oil pressure sensor.	Continuity to ground. Maximum 0.1 ohms resistance.	Check engine ground, if ok replace oil pressure sensor.
6. Instrument panel connector terminal 11—Hourmeter check.	Maximum 0.1 ohms resistance.	Check engine ground connection. 100 and 135 blk wires, if ok replace instrument panel.

OIL PRESSURE LIGHT AND HOURMETER CIRCUIT TEST POINTS—425 (S.N. 070001—)



COOLANT TEMPERATURE GAUGE CIRCUIT DIAGNOSIS— 425 (S.N. —070000)

Test Conditions:

- PTO switch off position.
- Park brake engaged.
- Coolant temperature sensor lead (A) disconnected.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Dash panel module terminal 14.	Battery voltage.	Check power circuit diagnosis.
3. Dash panel module terminal 2.	Battery voltage.	Replace dash panel module.
4. Coolant temperature sensor.	Battery voltage.	Check 300 org/wht wire and yel wire lead.

Test Conditions:

Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Dash panel module terminal 11.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100 and 135 blk wires.

Test Conditions:

- Key switch in run position.
- Check coolant temperature gauge needle position with coolant temperature sensor lead disconnected and then grounded.

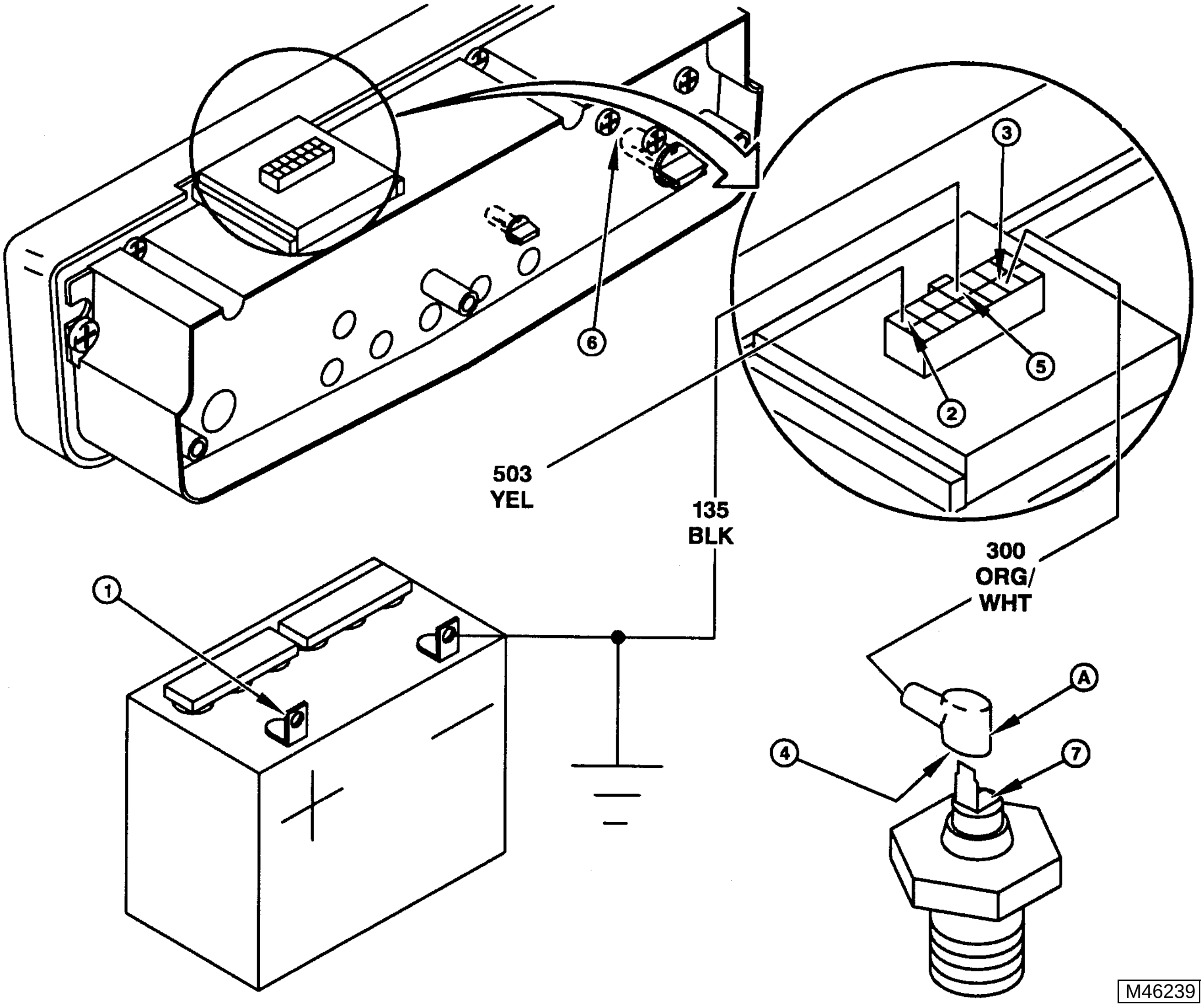
Test/Check Point	Normal	If Not Normal
6. Coolant temperature gauge.	Needle at cold position with lead disconnected and hot position with lead grounded.	Replace dash panel module.

Test Conditions:

- Key switch in off position.
- Coolant temperature sensor lead disconnected.

Test/Check Point	Normal	If Not Normal
7. Coolant temperature sensor.	Continuity to ground—resistance depends on engine temperature. Sensor threads not corroded.	Replace coolant temperature sensor.

COOLANT TEMPERATURE GAUGE CIRCUIT TEST POINTS— 425 (S.N. —70000)



COOLANT TEMPERATURE GAUGE CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- PTO switch in off position.
- Park brake engaged.
- Coolant temperature sensor lead (A) disconnected.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Instrument panel connector terminal 14.	Battery voltage.	Check power circuit diagnosis.
3. Instrument panel connector terminal 2.	Battery voltage.	Replace instrument panel
4. Coolant temperature sensor.	Battery voltage.	Check 300 org/wht wire and yel wire lead.

Test Conditions:

Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Instrument panel connector terminal 11.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100 and 135 blk wires.

Test Conditions:

- Key switch in run position.
- Check coolant temperature gauge needle position with coolant temperature sensor lead disconnected and then grounded.

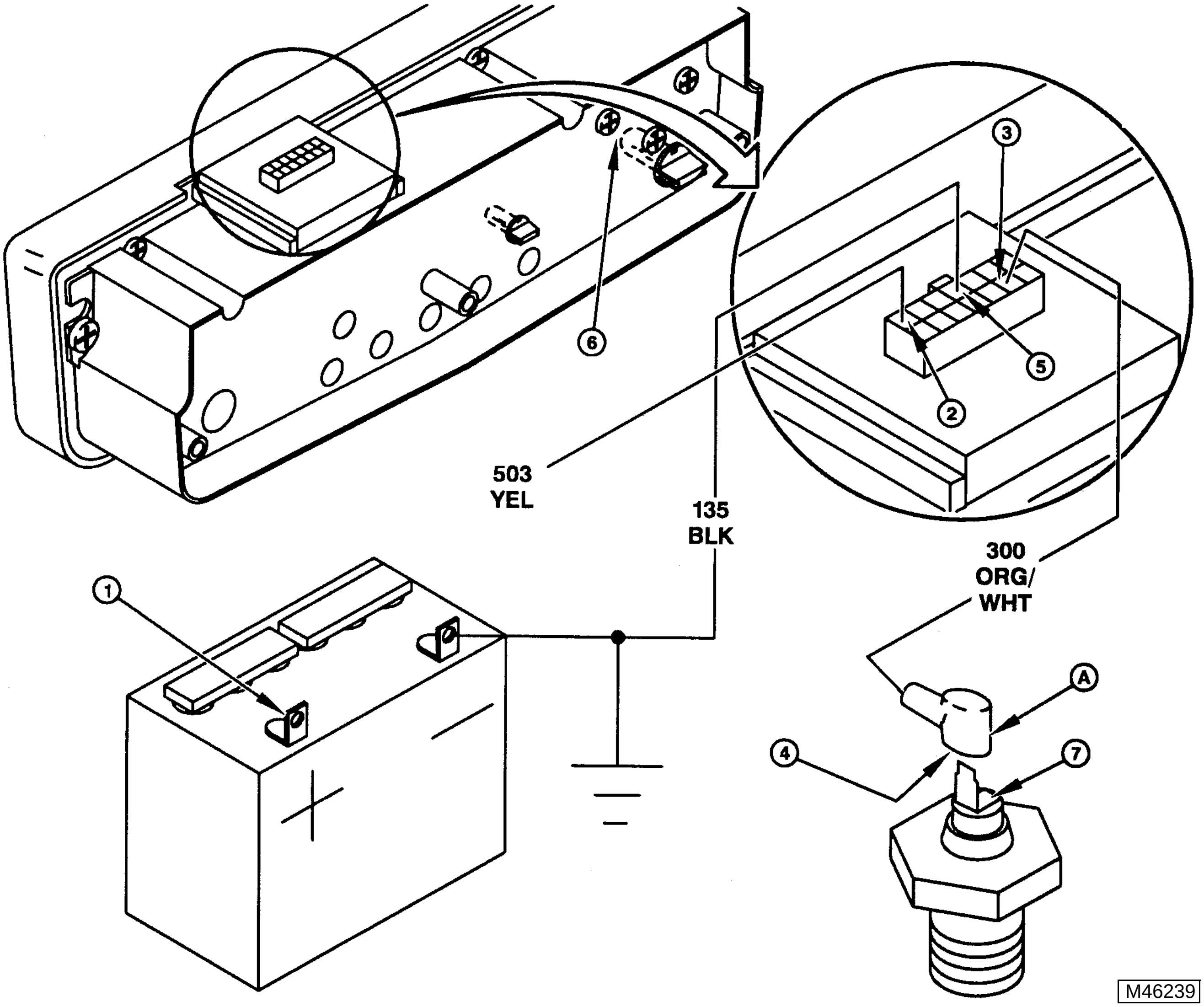
Test/Check Point	Normal	If Not Normal
6. Coolant temperature gauge.	Needle at cold position with lead disconnected and hot position with lead grounded.	Replace instrument panel.

Test Conditions:

- Key switch in off position.
- Coolant temperature sensor lead disconnected.

Test/Check Point	Normal	If Not Normal
7. Coolant temperature sensor.	Continuity to ground—resistance depends on engine temperature. Sensor threads not corroded.	Replace coolant temperature sensor.

COOLANT TEMPERATURE GAUGE CIRCUIT TEST POINTS—425 (S.N. —070001)



FUEL GAUGE CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- PTO switch off position.
- Park brake engaged.
- Fuel gauge sensor connector (A) disconnected.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	Battery voltage.	Test battery.
2. Dash panel module terminal 14.	Battery voltage.	Check power circuit diagnosis.
3. Dash panel module terminal 7.	0.69—4.5 volts.	Replace dash panel module.
4. Fuel gauge sensor lead.	0.69—4.5 volts.	Check 900 blk/wht wire and red wires.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Fuel gauge sensor ground lead.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100 and 120 blk wires.
6. Dash panel module terminal 6.	Maximum 0.1 ohms resistance.	Check 137 blk wire.

Test Conditions:

- Key switch in run position.
- Check fuel gauge needle position with fuel gauge.
- Sensor lead (blk/wht wire) disconnected and then grounded.

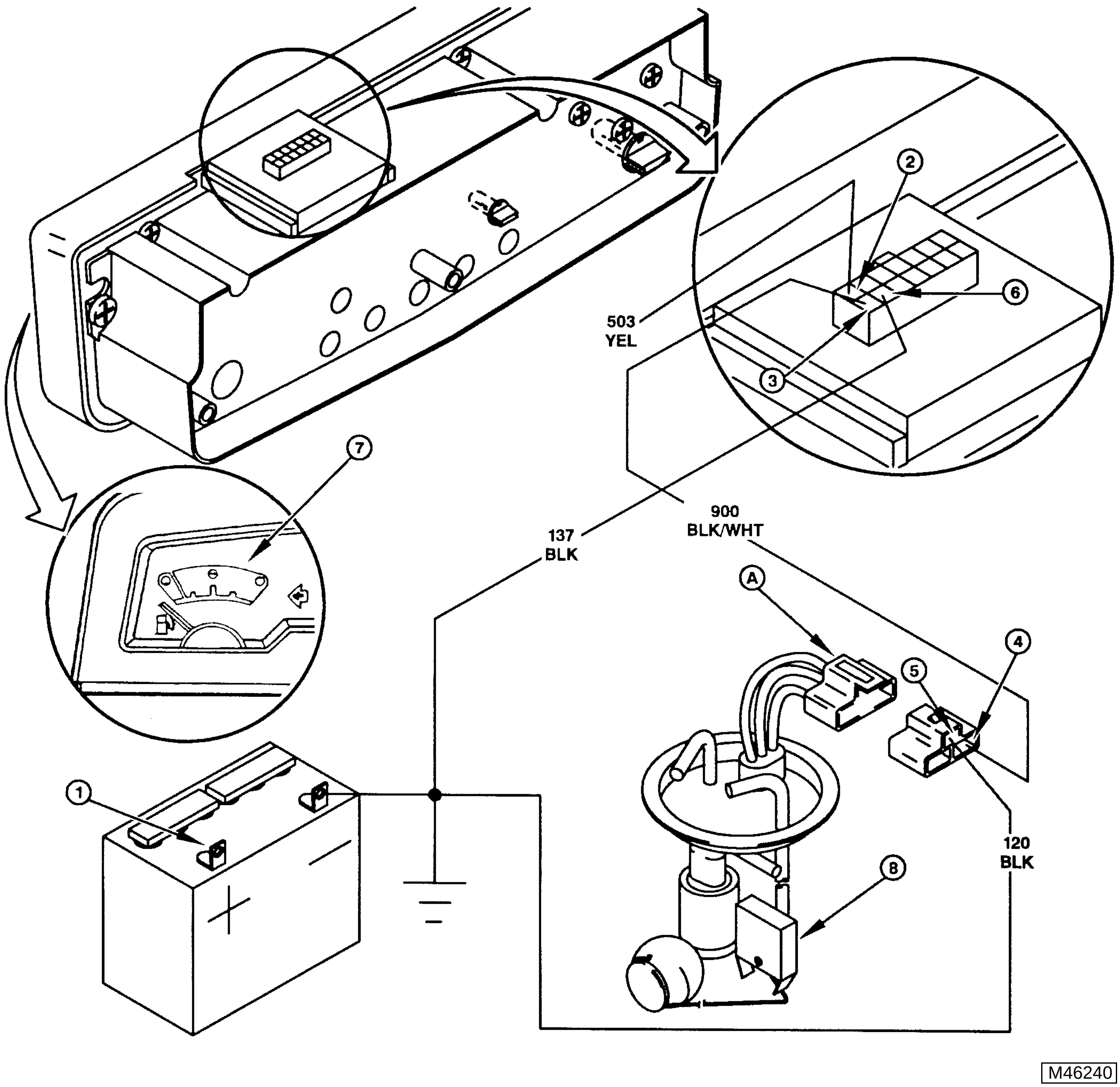
Test/Check Point	Normal	If Not Normal
7. Fuel gauge.	Full position with lead disconnected and “empty” position with lead grounded.	Replace dash panel module.

Test Conditions:

- Key switch in off position.
- Disconnect fuel gauge sensor connector.
- Remove fuel gauge sensor from tank so float can be raised and lowered.

Test/Check Point	Normal	If Not Normal
8. Fuel gauge sensor float (check between red and blk wires on sensor side).	Resistance increases as float is raised and decreases as float is lowered. Resistance about 6—200 ohms.	Replace fuel gauge sensor.

FUEL GAUGE CIRCUIT TEST POINTS—425 (S.N. —070000)



FUEL GAUGE CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- PTO switch in off position.
- Park brake engaged.
- Fuel gauge sensor connector (A) disconnected.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Instrument panel connector terminal 14.	Battery voltage.	Check power circuit diagnosis.
3. Instrument panel connector terminal 7.	0.69—4.5 volts.	Replace instrument panel.
4. Fuel gauge sensor lead.	0.69—4.5 volts.	Check 900 blk/wht wire and red wires.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
5. Fuel gauge sensor ground lead.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100 and 120 blk wires.
6. Instrument panel connector terminal 6.	Maximum 0.1 ohms resistance.	Check 137 blk wire.

Test Conditions:

- Key switch in run position.
- Check fuel gauge needle position with fuel gauge sensor lead (blk/wht wire) disconnected and then grounded.

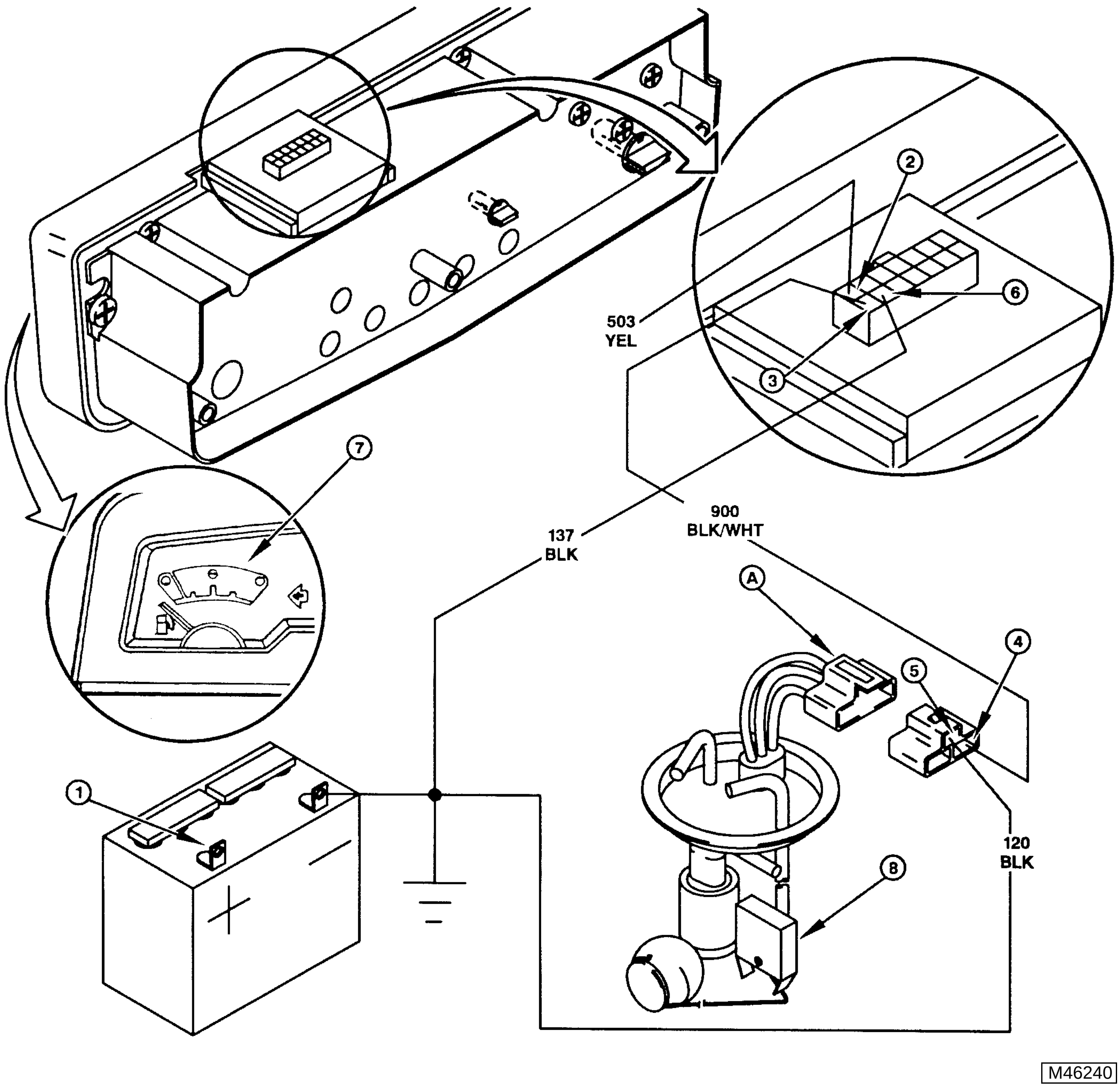
Test/Check Point	Normal	If Not Normal
7. Fuel gauge.	Full position with lead disconnected and “empty” position with lead grounded.	Replace instrument panel.

Test Conditions:

- Key switch in off position.
- Disconnect fuel gauge sensor connector.
- Remove fuel gauge sensor from tank so float can be raised and lowered.

Test/Check Point	Normal	If Not Normal
8. Fuel gauge sensor float (check between red and blk wires on sensor side).	Resistance increases as float is raised and decreases as float is lowered. Resistance about 6—200 ohms.	Replace fuel gauge sensor.

FUEL GAUGE CIRCUIT TEST POINTS—425 (S.N. 070001—)



LIGHTS CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- Light bulb continuity is ok or light bulb replaced.
- PTO switch off position.
- Park brake engaged.
- Key switch run position.
- Light switch in on position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

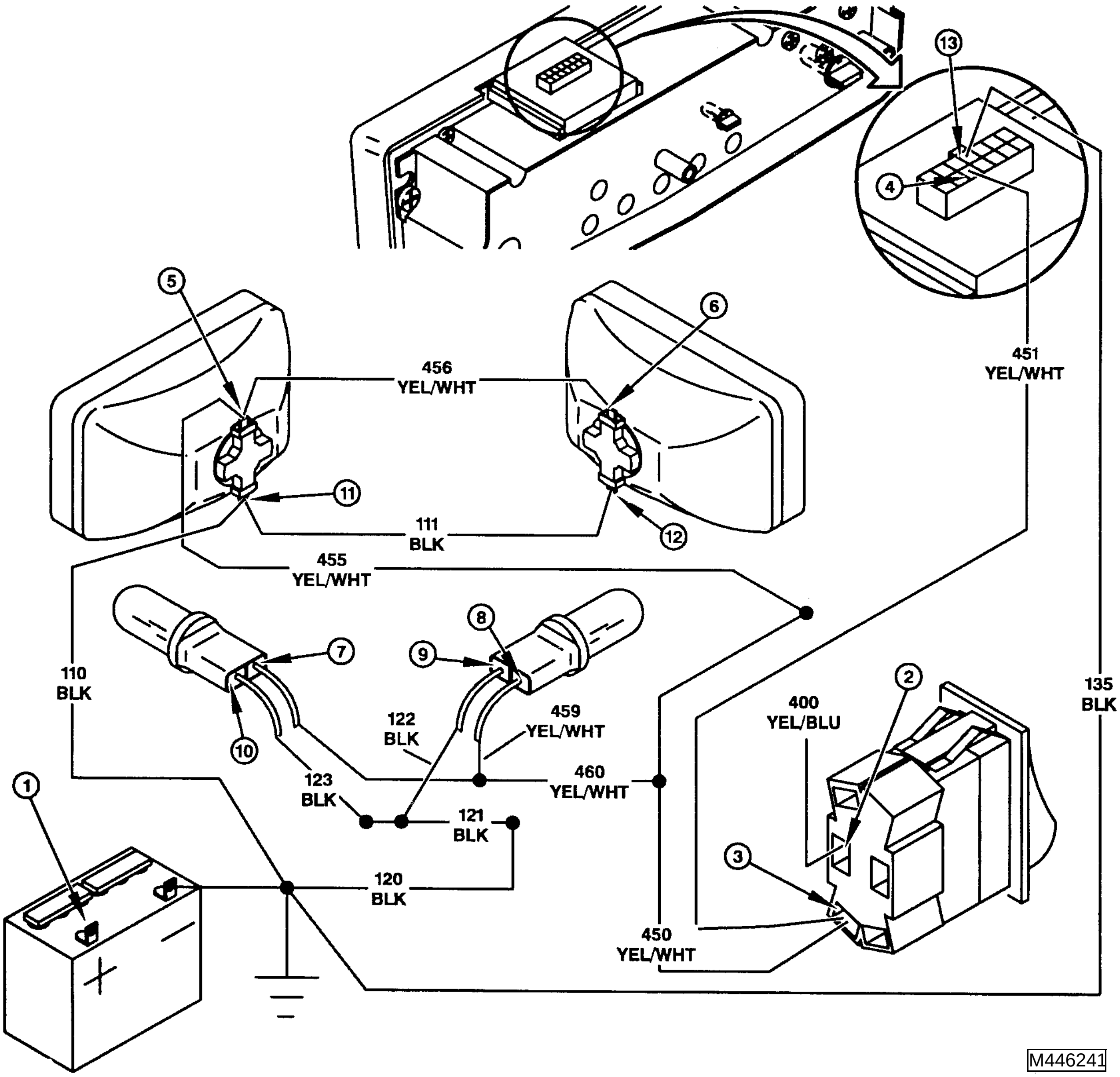
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Light switch.	Battery voltage.	Check power circuit test points.
3. Light switch.	Battery voltage.	Test light switch.
4. Dash panel module terminal 5.	Battery voltage.	Check 451 yel/wht wire.
5. Left head light.	Battery voltage.	Check 455 yel/wht wire.
6. Right head light.	Battery voltage.	Check 456 yel/wht wire.
7. Left tail light.	Battery voltage.	Check 460 yel/wht wire.
8. Right tail light.	Battery voltage.	Check 459 yel/wht wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
9. Right tail light.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100, 120, 121 and 122 blk wires
10. Left tail light.	Maximum 0.1 ohms resistance.	Check 123 blk wire.
11. Left head light.	Maximum 0.1 ohms resistance.	Check 110 blk wire.
12. Right head light.	Maximum 0.1 ohms resistance.	Check 111 blk wire.
13. Dash panel module terminal 11.	Maximum 0.1 ohms resistance.	Check 135 blk wire, if ok replace dash panel module.

LIGHTS CIRCUIT TEST POINTS—425 (S.N. —070000)



LIGHTS CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Light bulb continuity is ok or light bulb replaced.
- PTO switch in off position.
- Park brake engaged.
- Key switch in run position.
- Lights switch in on position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

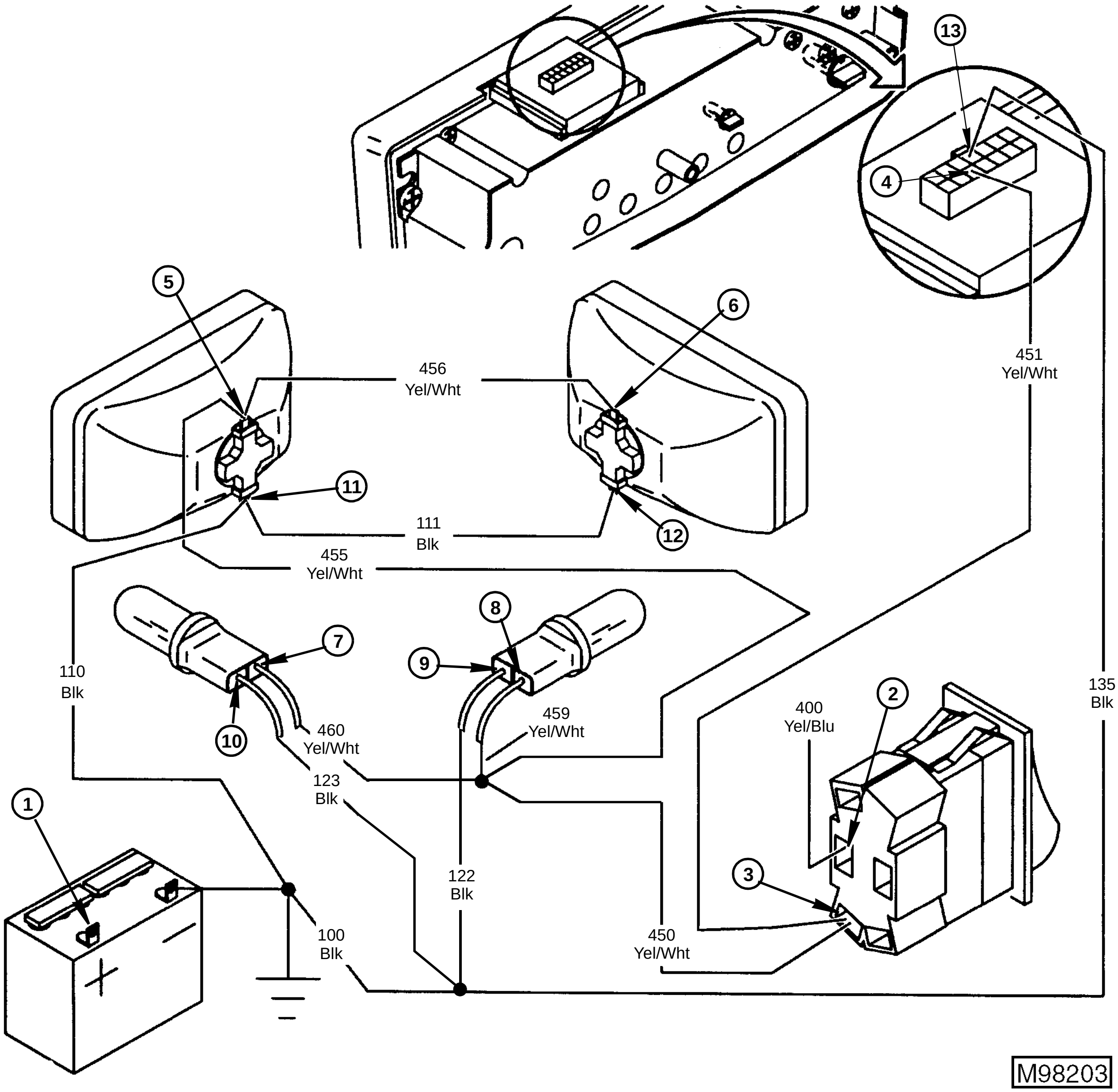
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Light switch.	Battery voltage.	Check power circuit test points.
3. Light switch.	Battery voltage.	Test light switch.
4. Instrument panel connector terminal 5.	Battery voltage.	Check 451 yel/wht wire.
5. Left head light.	Battery voltage.	Check 455 yel/wht wire.
6. Right head light.	Battery voltage.	Check 456 yel/wht wire.
7. Left tail light.	Battery voltage.	Check 460 yel/wht wire.
8. Right tail light.	Battery voltage.	Check 459 yel/wht wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
9. Right tail light.	Maximum 0.1 ohms resistance.	Check battery negative cable, engine ground connection, 100, 120, 121 and 122 blk wires
10. Left tail light.	Maximum 0.1 ohms resistance.	Check 123 blk wire.
11. Left head light.	Maximum 0.1 ohms resistance.	Check 110 blk wire.
12. Right head light.	Maximum 0.1 ohms resistance.	Check 111 blk wire.
13. Instrument panel connector terminal 11.	Maximum 0.1 ohms resistance.	Check 135 blk wire, if ok replace instrument panel.

LIGHTS CIRCUIT TEST POINTS—425 (S.N. 070001—)



FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT OPERATION—425 (S.N. —070000)

IMPORTANT: (S.N. —033626) use carburetor vent solenoid. (S.N. 033627—) fuel shut-off solenoid.

Function:

FUEL PUMP—To provide pressurized fuel to the carburetor.

CARBURETOR VENT SOLENOID—To equalize air pressure on both sides of the carburetor venturi, when the key is turned off, which stops fuel flow out of the carburetor to prevent backfire.

FUEL SHUT-OFF SOLENOID—Stops fuel to the main jet to prevent backfire. Does not use atmospheric pressure (vent tubes are eliminated).

Operating Conditions:

The key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) or with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off (PTO switch closed).

System Operation:

The carburetor vent solenoid (Y1) connects both sides of the carburetor venturi through the lower and upper vent hoses when the solenoid is de-energized. In this condition, no vacuum is present in the carburetor to draw fuel out of the main nozzle, so the fuel flow is stopped very quickly. Models with fuel shut-off solenoid (Y1) stop fuel to the main nozzle electronically. The ignition delay module (A1) is used with the carburetor vent/fuel shut-off solenoid to prevent backfire. The ignition delay module allows the spark plugs to fire for 1 additional second after the key switch (S1) is turned off to burn any remaining fuel in the cylinder. When the key switch is turned off, current flow from the ignition relay (K2) stops and the fuel pump (M2) and carburetor vent /fuel shut-off solenoid are de-energized. A timer in the ignition delay module allows current from the starting motor B terminal to flow to the ignition module and both ignition coils for the extra 1 second spark.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and key switch terminal B (S1). Current cannot flow to the fuel pump or carburetor vent/fuel shut-off solenoid until the ignition relay (K2) is energized. With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, brake switch (S3) (brake pedal depressed), PTO switch (S4) (PTO disengaged), ignition relay coil terminal 85, and ignition LED (E1). The ignition LED indicates that power is available to the ignition relay coil. With the ignition relay energized, current (C) flows to the PTO switch, fuel pump, and the carburetor vent/fuel shut-off solenoid, energizing the pump and solenoid. The carburetor vent solenoid closes the venturi vent tubes, so a vacuum can be created for fuel flow. Models with fuel shut-off solenoid do not use vent tubes.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S2) closed), current (E) flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition relay opens, which stops current flow to the fuel pump and carburetor vent/fuel shut-off solenoid, stopping the engine. A delay capacitor in the control/fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

FUEL PUMP AND FUEL SHUT-OFF SOLENOID CIRCUIT OPERATION—425 (S.N. 070001—)

Function:

FUEL PUMP—To provide pressurized fuel to the carburetor.

FUEL SHUT-OFF SOLENOID—Stops fuel to the main jet to prevent backfire. Does not use atmospheric pressure (vent tubes are eliminated).

Operating Conditions:

The key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) or with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off (PTO switch closed).

System Operation:

The fuel shut-off solenoid (Y1) is used to stop fuel to the main nozzle. The ignition delay module (A1) is used with the fuel shut-off solenoid to prevent backfire. The ignition delay module allows the spark plugs to fire for 1 additional second after the key switch (S1) is turned off to burn any remaining fuel in the cylinder. When the key switch is turned off, current flow from the ignition relay (K2) stops and the fuel pump (M2) and fuel shut-off solenoid are de-energized. A timer in the ignition delay module allows current from the starting motor B terminal to flow to the ignition module and both ignition coils for the extra 1 second spark.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and terminal B of key switch (S1). Current cannot flow to the fuel pump or fuel shut-off solenoid until the ignition relay (K2) is energized. With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, brake switch (S5) (brake pedal depressed), PTO switch (S2) (PTO disengaged), ignition relay coil terminal 85, and ignition LED (E1). The ignition LED indicates that power is available to the ignition relay coil. With the ignition relay energized, current (C) flows to the PTO switch, fuel pump, and the carburetor vent/fuel shut-off solenoid, energizing the pump and solenoid.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S2) closed), current (D) flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition relay opens, which stops current flow to the fuel pump and fuel shut-off solenoid, stopping the engine. A delay capacitor in the control/ fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

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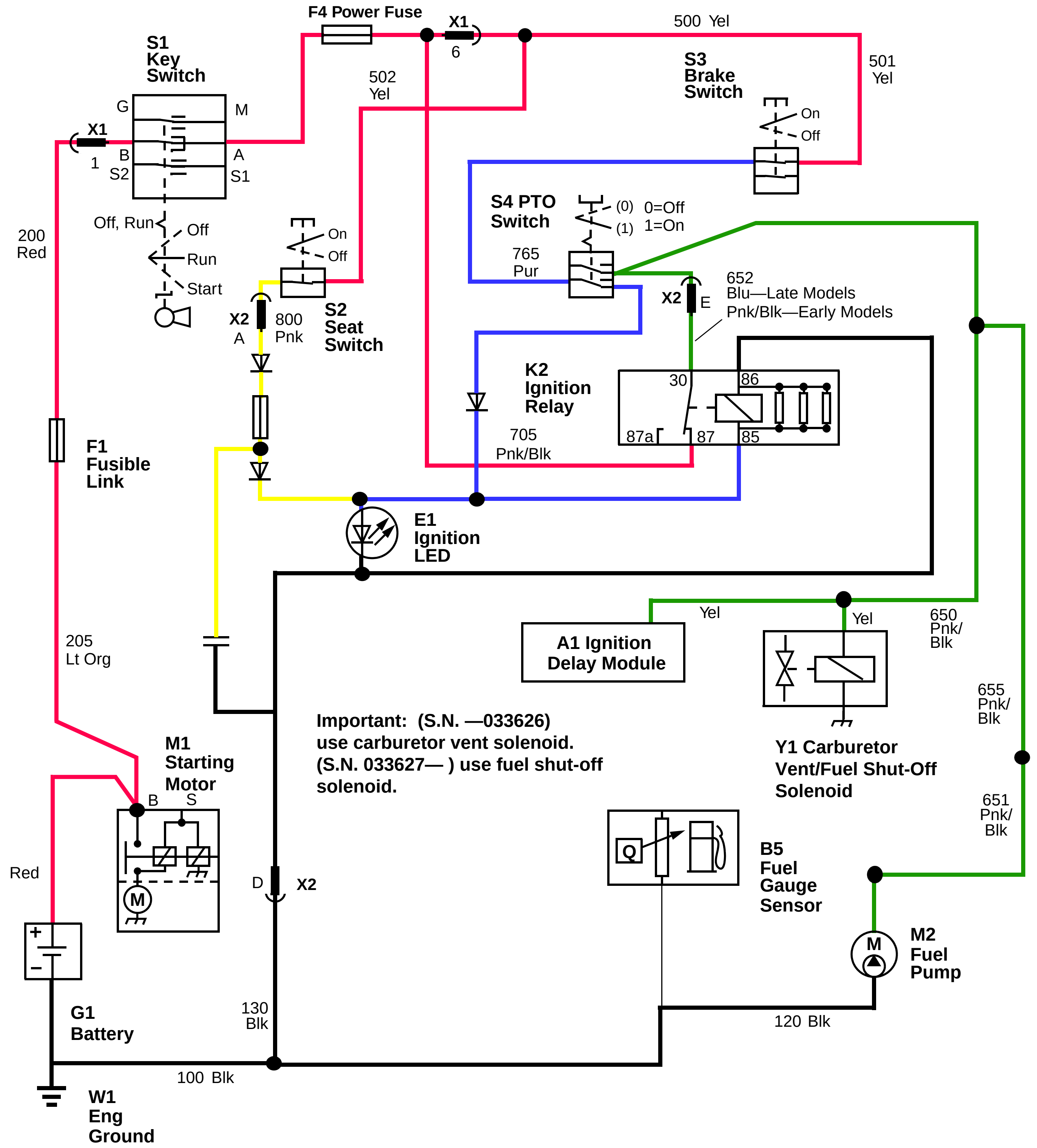
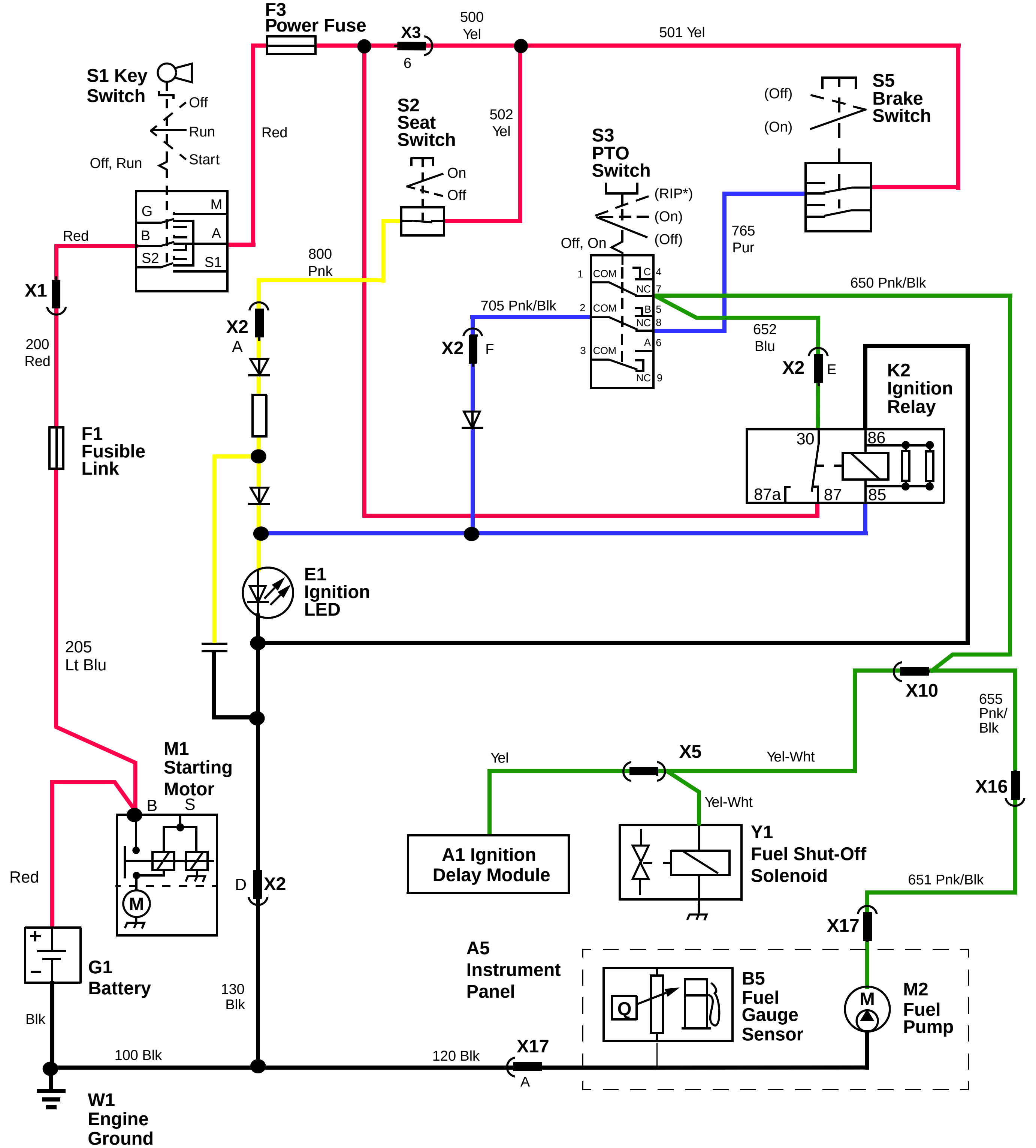
FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT SCHEMATIC—425 (S.N. —070000)



(Red)	A	Power Circuit
(Blue)	B	Ignition Relay Engagement Circuit
(Green)	C	Ignition Relay Circuit
(Yellow)	D	Seat Switch Circuit
(Black)	E	Ground Circuit

FUEL PUMP AND FUEL SHUT-OFF SOLENOID CIRCUIT SCHEMATIC—425 (S.N. 070001—)



- (A) Power Circuit
- (B) Ignition Relay Engagement Circuit
- (C) Ignition Relay Circuit
- (D) Seat Switch Circuit
- (E) Ground Circuit

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FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT DIAGNOSIS—425 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3 Light on—go to step 12.
3. Brake switch, seat switch.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position

Test/Check Point	Normal	If Not Normal
10. Engine ground .	Maximum 0.1 ohms resistance.	Check battery negative cable and engine ground connection.
11. Control/fuse module resistance terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. (S.N. —033626) Carburetor vent solenoid. 12a.(S.N. 033627—) Fuel shut-off solenoid.	Maximum 0.1 ohms resistance.	Check terminal ground connection and blk wire.
13. Fuel pump.	Maximum 0.1 ohms resistance.	Check fuel pump blk wire, 120 and 100 blk wires.

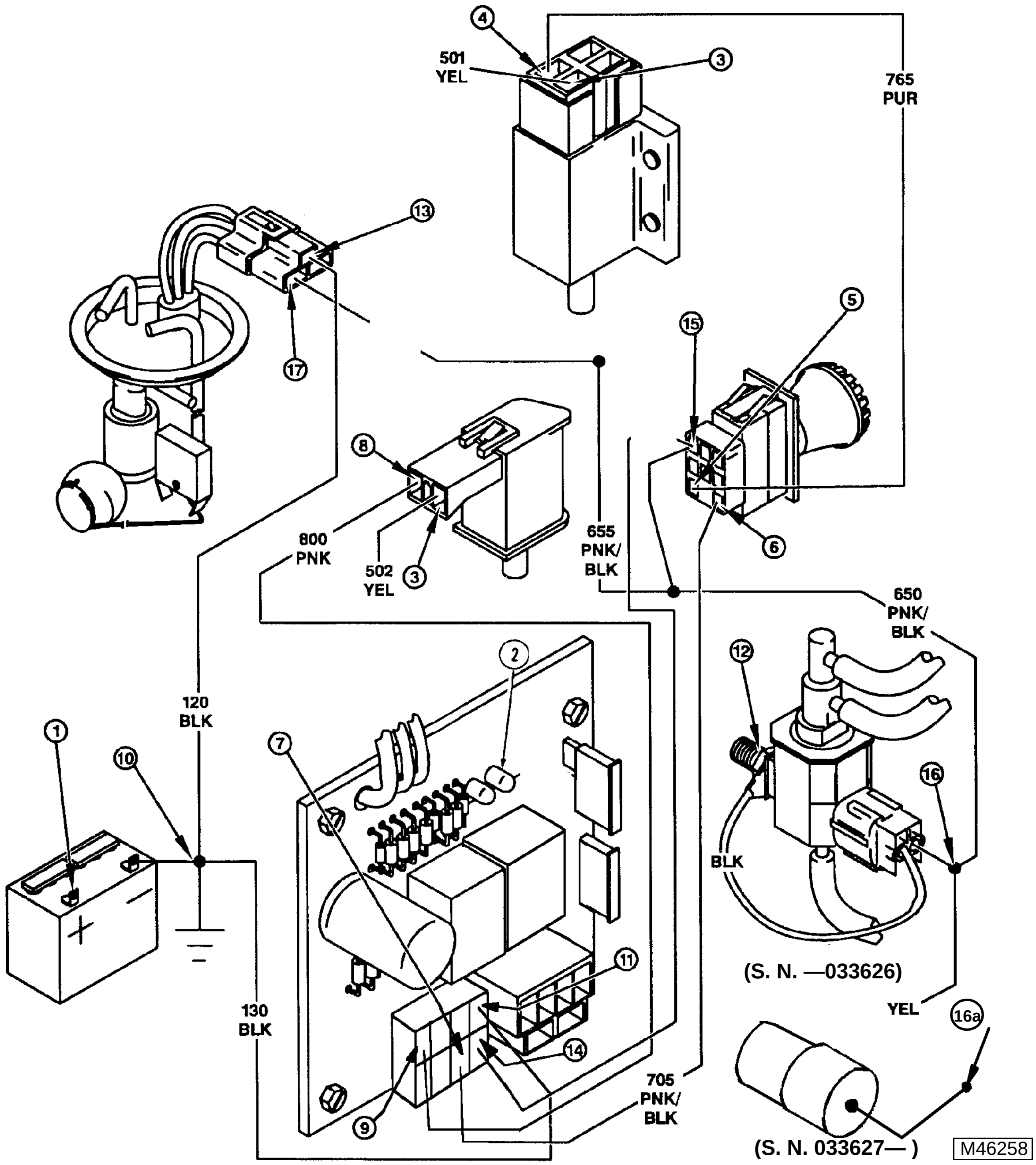
Test Conditions:

- Key switch in run position

Test/Check Point	Normal	If Not Normal
14. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.

Test/Check Point	Normal	If Not Normal
15. PTO switch.	Battery voltage.	Check 652 pnk/blk (blu) wire.
16. (S.N. —033626) Carburetor vent solenoid. 16a. (S.N. 033627—) Fuel shut-off solenoid.	Battery voltage.	Check 650 pnk/blk and yel wires, if ok, replace carburetor vent solenoid.
17. Fuel pump wire.	Battery voltage.	Check 655 and 651 pnk/blk wires, gry wire and terminal connections, if ok, replace fuel pump.

FUEL PUMP AND CARBURETOR VENT/FUEL SHUT-OFF SOLENOID CIRCUIT TEST POINTS—425 (S.N. —070000)



FUEL PUMP AND FUEL SHUT-OFF SOLENOID CIRCUIT DIAGNOSIS—425 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3 Light on—go to step 12.
3. Brake switch, seat switch.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position

Test/Check Point	Normal	If Not Normal
10. Engine ground.	Maximum 0.1 ohms resistance.	Check battery negative cable and engine ground connection.
11. Control/fuse module resistance terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. Fuel shut-off solenoid.	Maximum 0.1 ohms resistance.	Check terminal ground connection and blk wire.
13. Fuel pump.	Maximum 0.1 ohms resistance.	Check fuel pump blk wire, 120 and 100 blk wires.

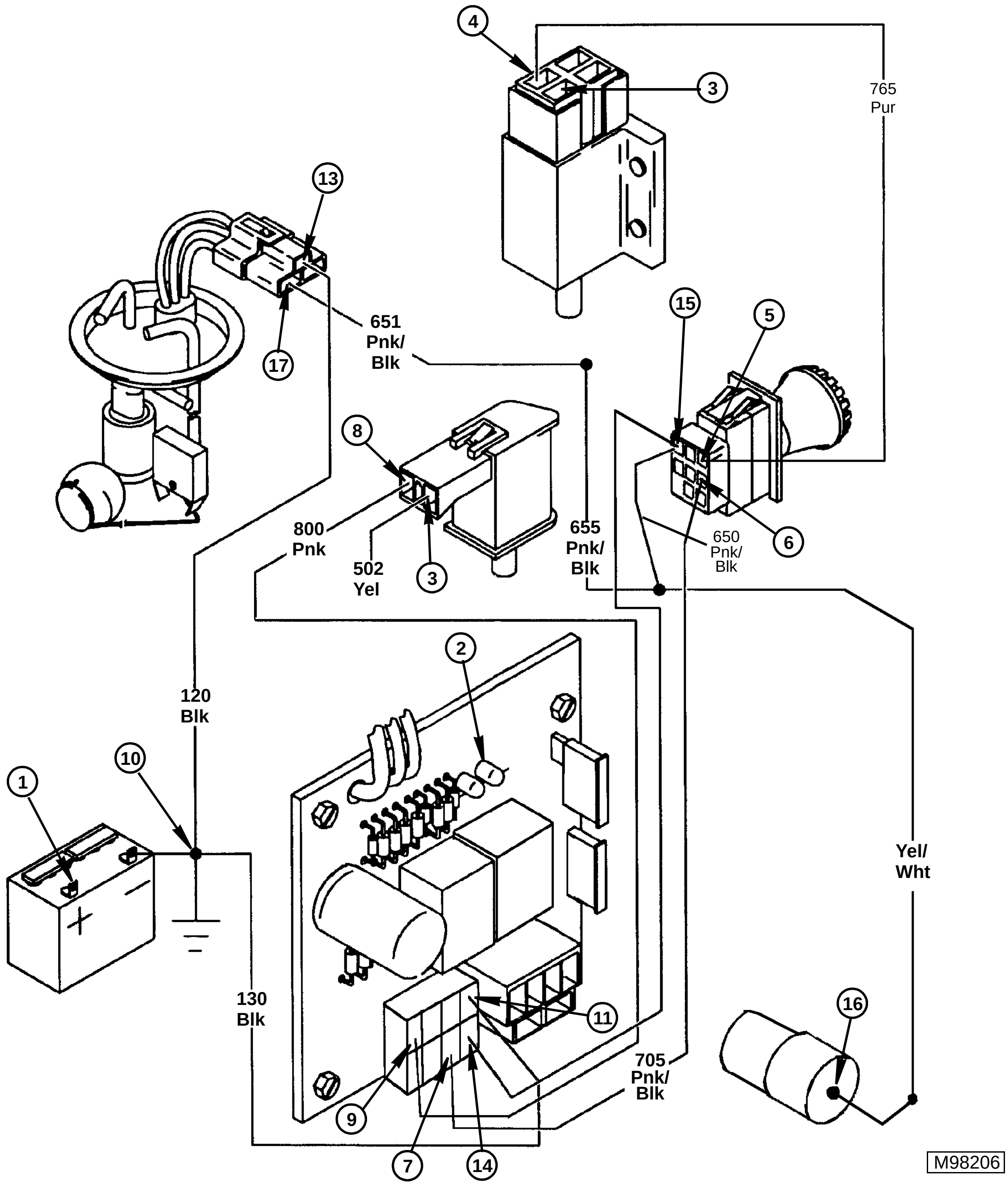
Test Conditions:

- Key switch in run position

Test/Check Point	Normal	If Not Normal
14. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
15. PTO switch.	Battery voltage.	Check 652 pnk/blk (blu) wire.

Test/Check Point	Normal	If Not Normal
16. Fuel shut-off solenoid.	Battery voltage.	Check 650 pnk/blk and yel/wht wires, if ok, replace fuel shut-off solenoid.
17. Fuel pump wire.	Battery voltage.	Check 655 and 651 pnk/blk wires, gry wire and terminal connections, if ok, replace fuel pump.

FUEL PUMP AND FUEL SHUT-OFF SOLENOID CIRCUIT TEST POINTS—425 (S.N. 070001—)



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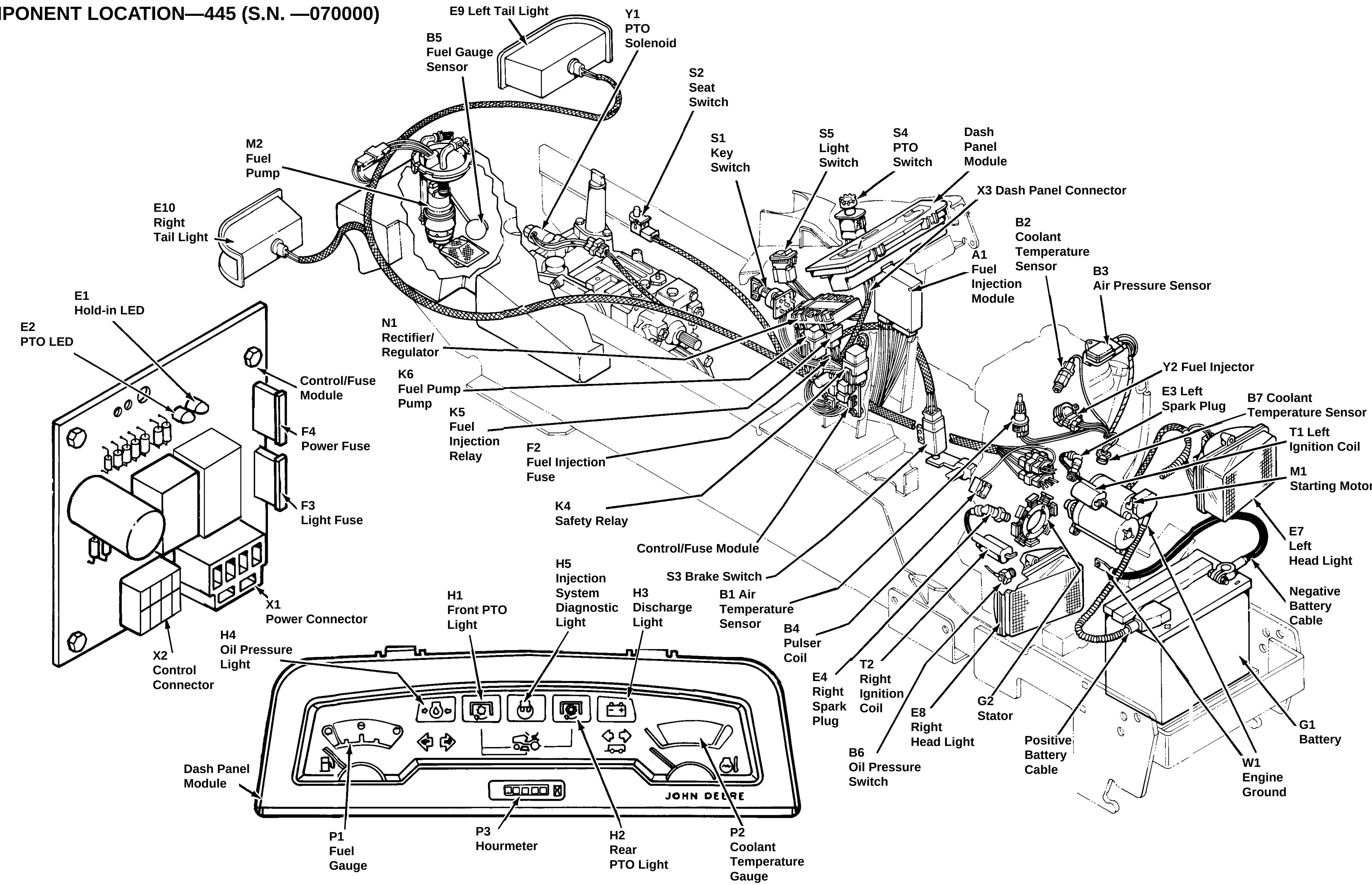
COMPONENT LOCATION—445

COMPONENT LOCATION—445 (S.N. —070000)



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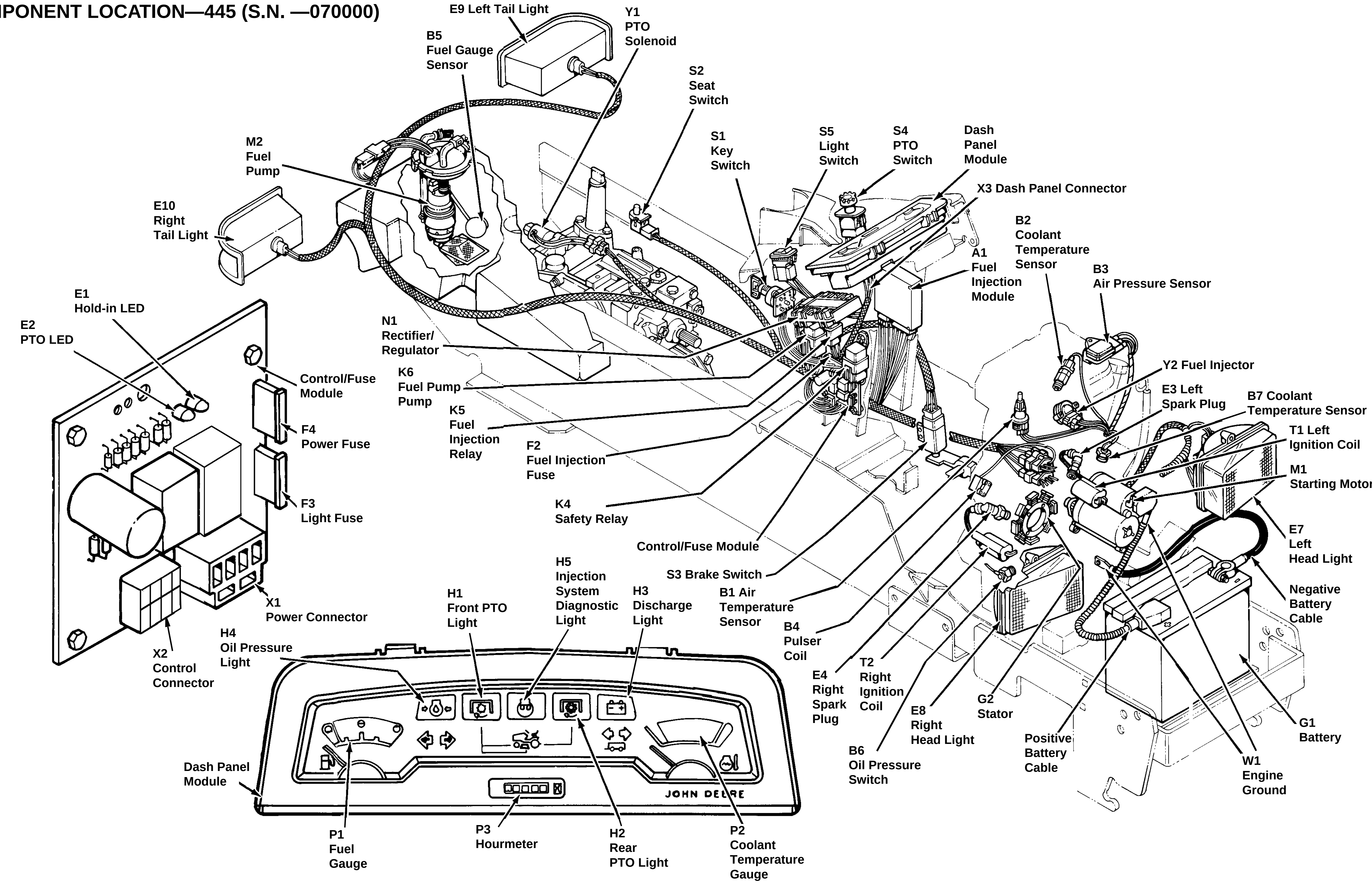
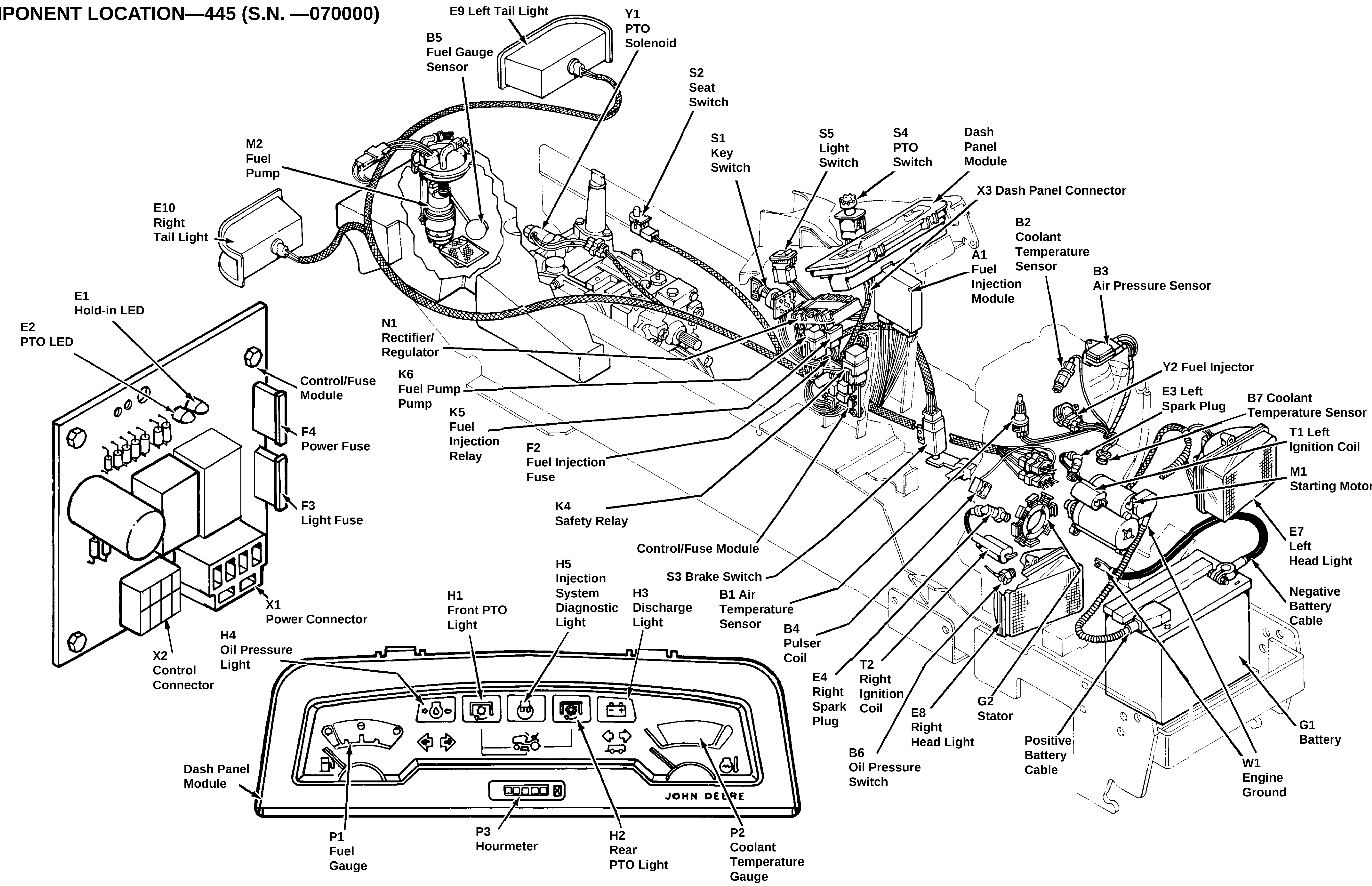
COMPONENT LOCATION—445

COMPONENT LOCATION—445 (S.N. —070000)



COMPONENT LOCATION—445

COMPONENT LOCATION—445 (S.N. —070000)



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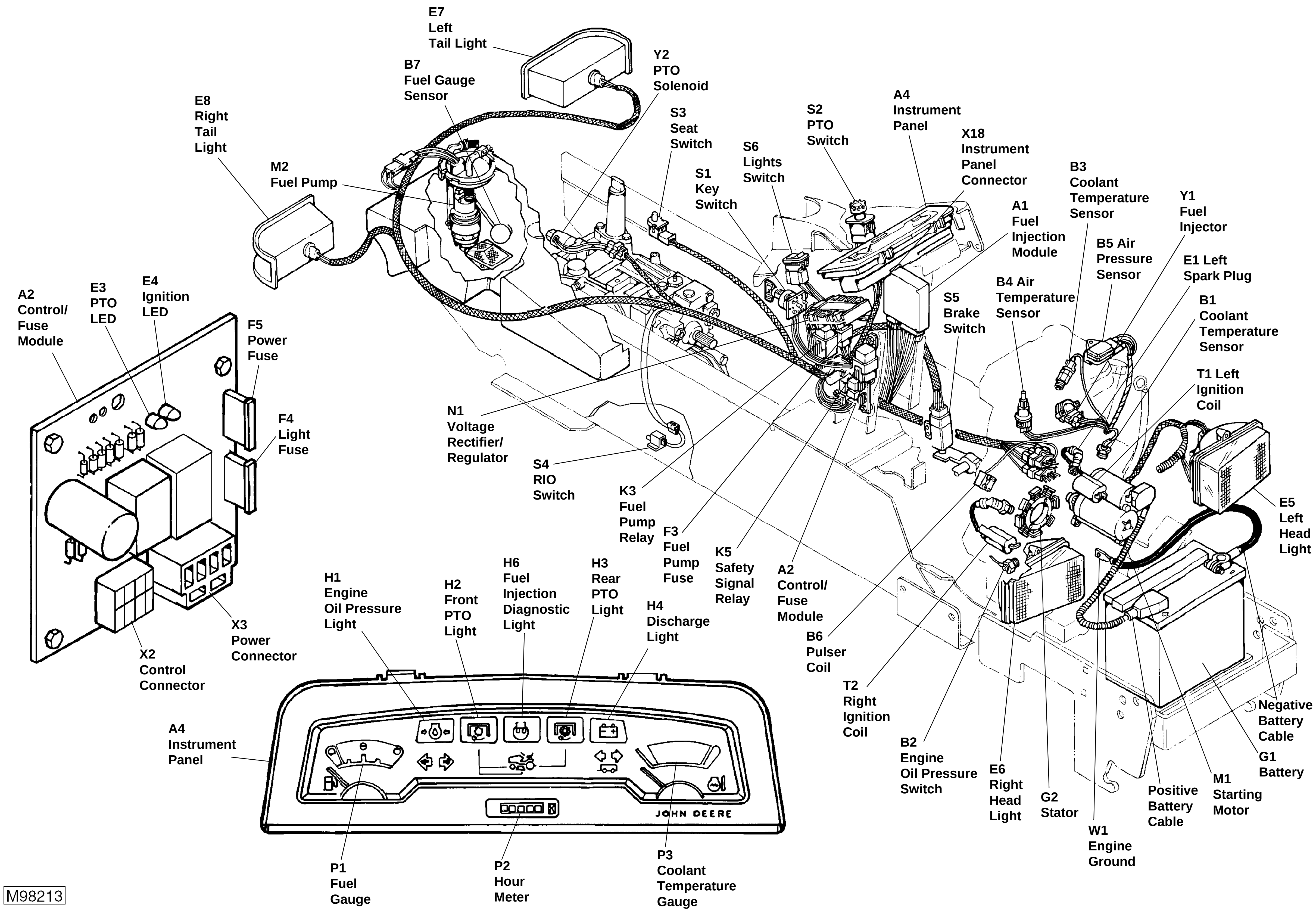

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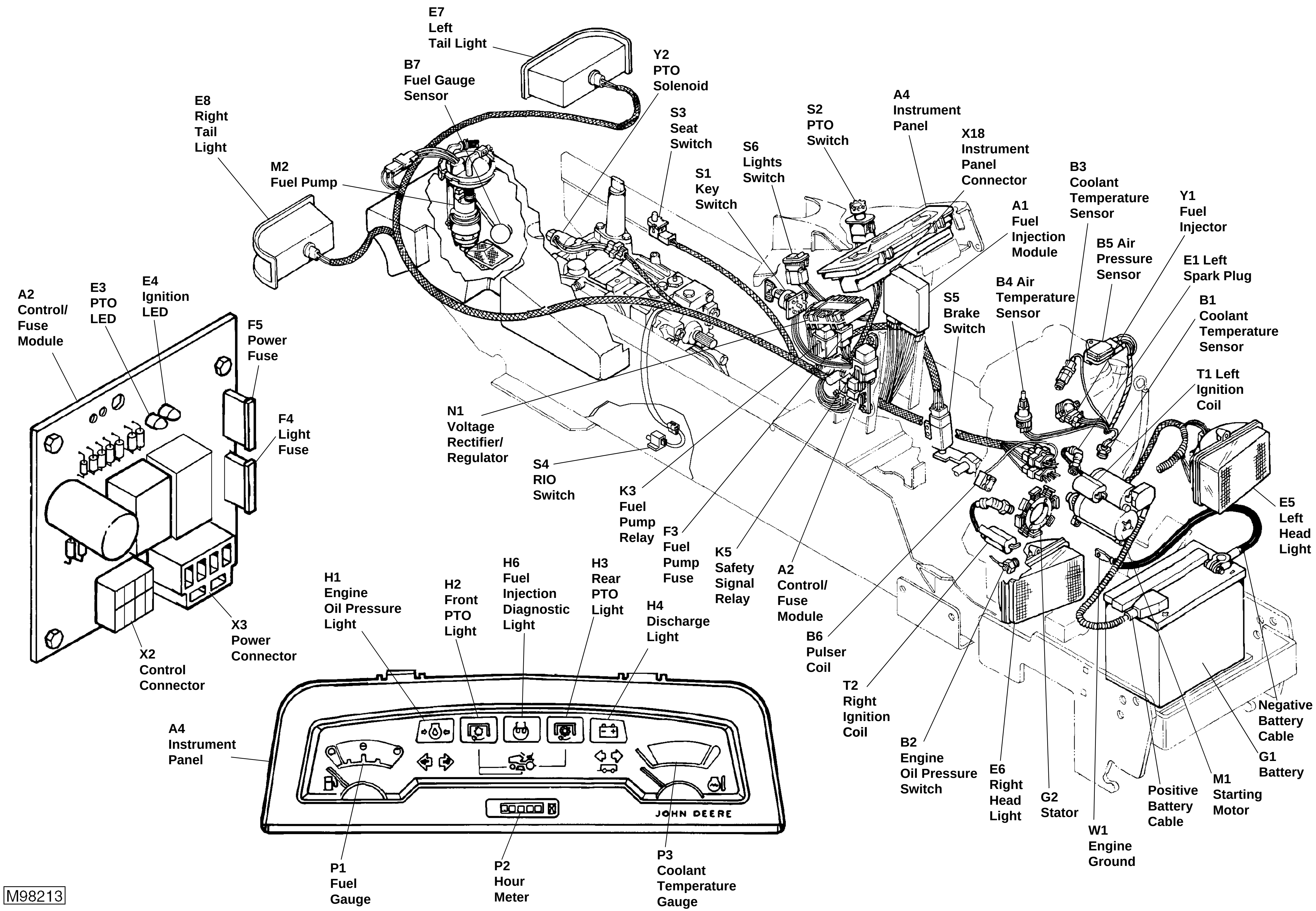

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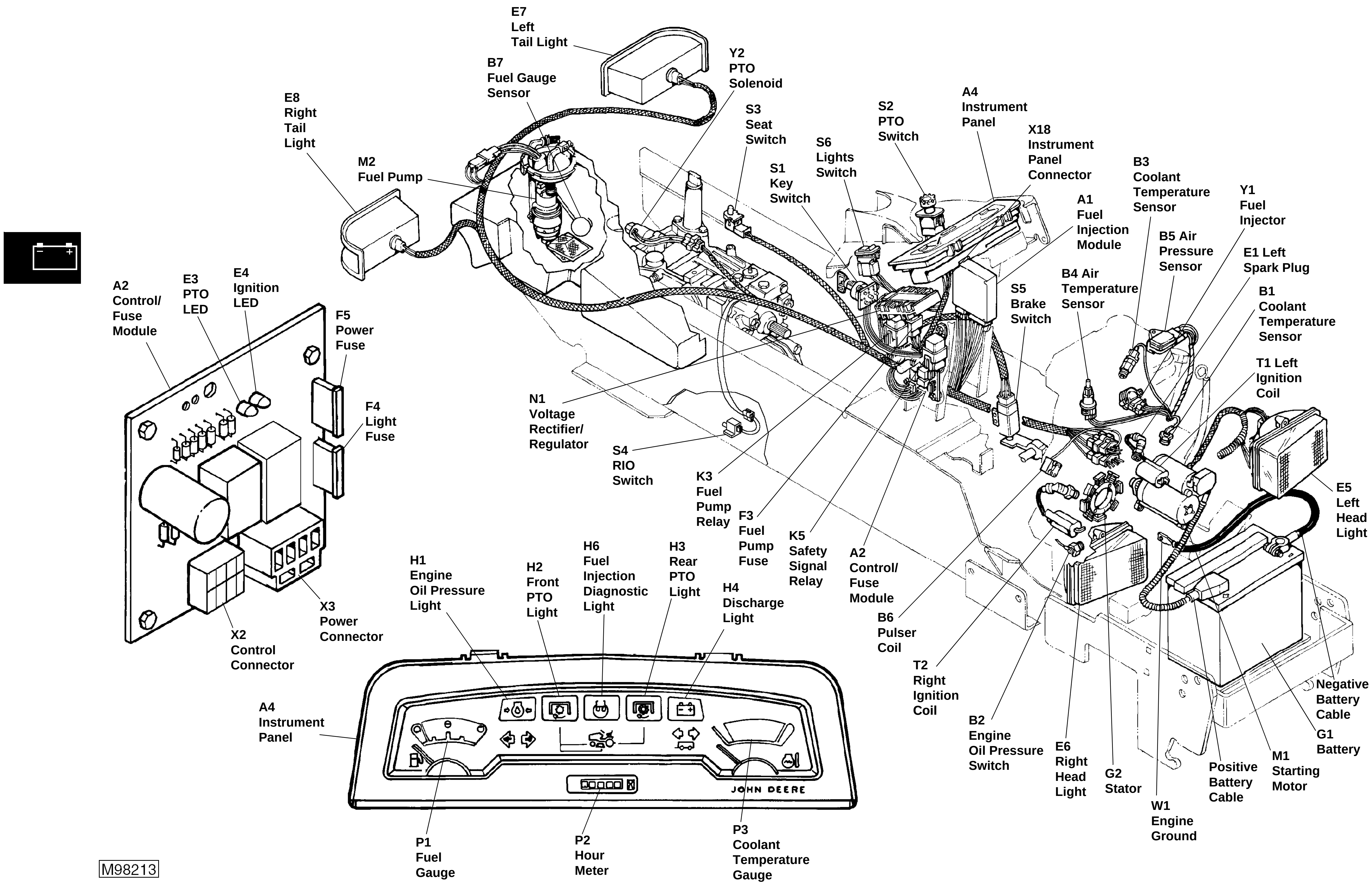
COMPONENT LOCATION—445 (S.N. 070001—)



LEGENDS FOR ELECTRICAL COMPONENTS—445

LEGEND FOR ELECTRICAL COMPONENTS—445 (S.N. —070000)

A1—Fuel Injection Module (SE3, W1)
B1—Air Temperature Sensor (SE3)
B2—Coolant Temperature Sensor (SE3)
B3—Air Pressure Sensor (SE3)
B4—Pulser Coil (SE3)
B5—Fuel Gauge Sensor (SE5)
B6—Oil Pressure Switch (SE6)
B7—Coolant Temperature Gauge Sensor (SE6)
E1—Ignition LED (SE2)
E2—Left Spark Plug (SE3)
E3—Right Spark Plug (SE3)
E4—PTO LED
E5—Left Dash Light (SE6)
E6—Right Dash Light (SE6)
E7—Left Head Light (SE6, W1)
E8—Right Head Light (SE6, W1)
E9—Left Tail Light (SE6, W1)
E10—Right Tail Light (SE6, W1)
F1—Fusible Link (SE1, W1)
F2—Fusible Link (SE1, W1)
F3—Light Fuse (SE2, W1)
F4—Power Fuse (SE2, W1)
G1—Battery (SE1, W1)
G2—Stator (SE4)
H1—Front PTO Light (SE2)
H2—Rear PTO Light (SE2)
H3—Discharge Light (SE4)
H4—Oil Pressure Light (SE6)
H5—Fuel Injection Diagnostic Light (SE6)
K1—Start Relay (SE1)
K2—Ignition Relay (SE3)
K3—PTO Relay (SE3)
K4—Safety Relay (SE3, W1)
K5—Fuel Injection Relay (SE3, W1)
K6—Fuel Pump Relay (SE3, W1)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE6, W1)
N1—Rectifier/Regulator (SE4, W1)
P1—Fuel Gauge (SE5)
P2—Coolant Temperature Gauge (SE6)
P3—Hourmeter (SE6)
S1—Key Switch (SE1)
S2—Seat Switch (SE1, W1)
S3—Brake Switch (SE3, W1)
S4—PTO Switch (SE2, W1)
S4—Light Switch (SE7, W1)
T1—Left Ignition Coil (SE3)
T2—Right Ignition Coil (SE3)
W1—Main Wiring Harness
W2—Rear PTO Wiring Harness
X1—Power Connector (SE1, SE2, SE3, W1)
X2—Control Connector (SE1, SE2, SE3, W1)
X3—Dash Panel Connector (SE2, SE3, SE4, SE5, SE6, W1)
X4—Rear PTO Connector (SE1, SE3, W1)
X5—Front PTO Light Connector (SE2, W1)
X6—Rear PTO Connector (SE1, W1)
X7—Rear PTO Connector (SE1, W1)
X8—Fuel Pump Shut-Off Connector (SE5, W1)
X9—Engine Connector (W1)
Y1—Fuel Injector (SE3)
Y2—PTO Solenoid (SE2, W1)

LEGEND FOR ELECTRICAL COMPONENTS—445 (S.N. 070001—)

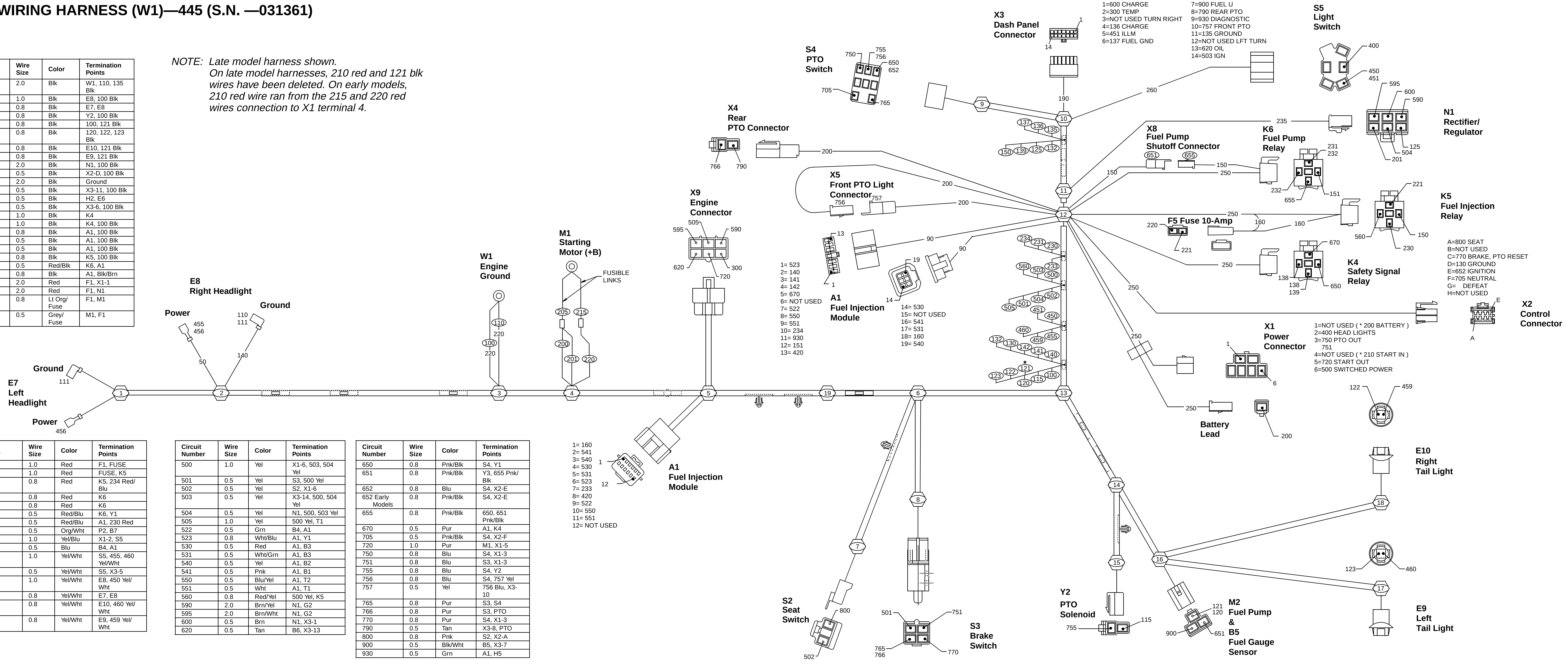
A1—Fuel Injection Module (SE1, W1)
A2—Control/Fuse Module (SE1, SE2)
B1—Coolant Temperature Gauge Sensor (SE1)
B2—Engine Oil Pressure Switch (SE1)
B3—Coolant Temperature Sensor (SE1)
B4—Air Temperature Sensor (SE1)
B5—Air Pressure Sensor (SE1)
B6—Pulser Coil (SE1)
B7—Fuel Gauge Sensor (SE3)
E1—Left Spark Plug (SE1)
E2—Right Spark Plug (SE1)
E3—PTO LED (SE1)
E4—Ignition LED (SE1)
E5—Left Head Light (SE3, W1)
E6—Right Head Light (SE3, W1)
E7—Left Tail Light (SE3, W1)
E8—Right Tail Light (SE3, W1)
F1—Fusible Link (SE1, W1)
F2—Fusible Link (SE1, W1)
F3—Fuel Pump Fuse (SE1, W1)
F4—Fuse-15A (SE2, W1)
F5—Fuse-15A (SE2, W1)
G1—Battery (SE1, W1)
G2—Stator (SE1)
H1—Engine Oil Pressure Light (SE3)
H2—Front PTO Light (SE3)
H3—Rear PTO Light (Option) (SE3)
H4—Discharge Light (SE3)
H5—Dash Light (SE3)
H6—Dash Light (SE3)
K1—Start Relay (SE1)
K2—Ignition Relay (SE1)
K3—PTO Relay (SE2)
K4—Fuel Injection Relay (SE1)
K5—RIO Latch Relay (SE1, W1)
K6—RIO Unlatch Relay (SE1)
K7—Safety Signal Relay (SE2, W1)
K8—Fuel Pump Relay (SE3, W1)
M1—Starting Motor (SE1, W1)
M2—Fuel Pump (SE3, W1)
N1—Rectifier/Regulator (SE1, W1)
P1—Fuel Gauge (SE3)
P2—Hourmeter (SE3)
S1—Key Switch (SE1)
S2—PTO Switch (SE2, W1)
S3—Seat Switch (SE2, W1)
S4—RIO Switch (SE2, W1)
S5—Brake Switch (SE3, W1)
S6—Light Switch (SE3, W1)
T1—Left Ignition Coil (SE1)
T2—Right Ignition Coil (SE1)
W1—MainWiring Harness
W2—Rear PTO Wiring Harness
X1—Key Switch Power Connector (SE1, W1)
X2—Control Connector (SE1, W1)
X3—Power Connector (SE1, W1)
X4—Not Used
X5—Engine I Connector (SE1, W1)
X6—Not Used
X7—Not Used
X8—Engine II Connector (SE1, W1)
X9—Fuel Injection Module Connector (SE1, W1)
X10—Fuel Injection Module Connector (SE1, W1)
X11—Rear PTO (Option) Connector (SE2, W1)
X12—Rear PTO (Option) Connector (SE2, W1)
X13—Rear PTO (Option) Connector (SE2, W1)
X14—Front PTO Light Connector (SE2, W1)
X15—PTO Solenoid Connector (SE2, W1)
X16—Fuel Pump Shut-Off Connector (SE3, W1)
X17—Fuel Pump and Fuel Gauge Sensor Connector (SE3, W1)
X18—Instrument Panel Connector (SE3, W1)
X19—Left Head Light Power Connector (SE3, W1)
X20—Left Head Light Ground Connector (SE3, W1)
X21—Right Head Light Power Connector (SE3, W1)
X22—Right Head Light Ground Connector (SE3, W1)
X23—Left Tail Light Connector (SE3, W1)
X24—Right Tail Light Connector (SE3, W1)

ELECTRICAL WIRING HARNESSES—445

MAIN WIRING HARNESS (W1)—445 (S.N. —031361)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
121 Early Models	0.8	Bik	120, 122, 123 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
150	0.8	Blk	K5, 100 Blk
151	0.5	Red/Blk	K6, A1
160	0.8	Blk	A1, Blk/Brn
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	F1, M1
215	0.5	Grey/ Fuse	M1, F1

NOTE: *Late model harness shown. On late model harnesses, 210 red and 121 blk wires have been deleted. On early models, 210 red wire ran from the 215 and 220 red wires connection to X1 terminal 4.*



Circuit Number	Wire Size	Color	Termination Points
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/ Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/ Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/ Wht

Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
620	0.5	Tan	B6, X3-13

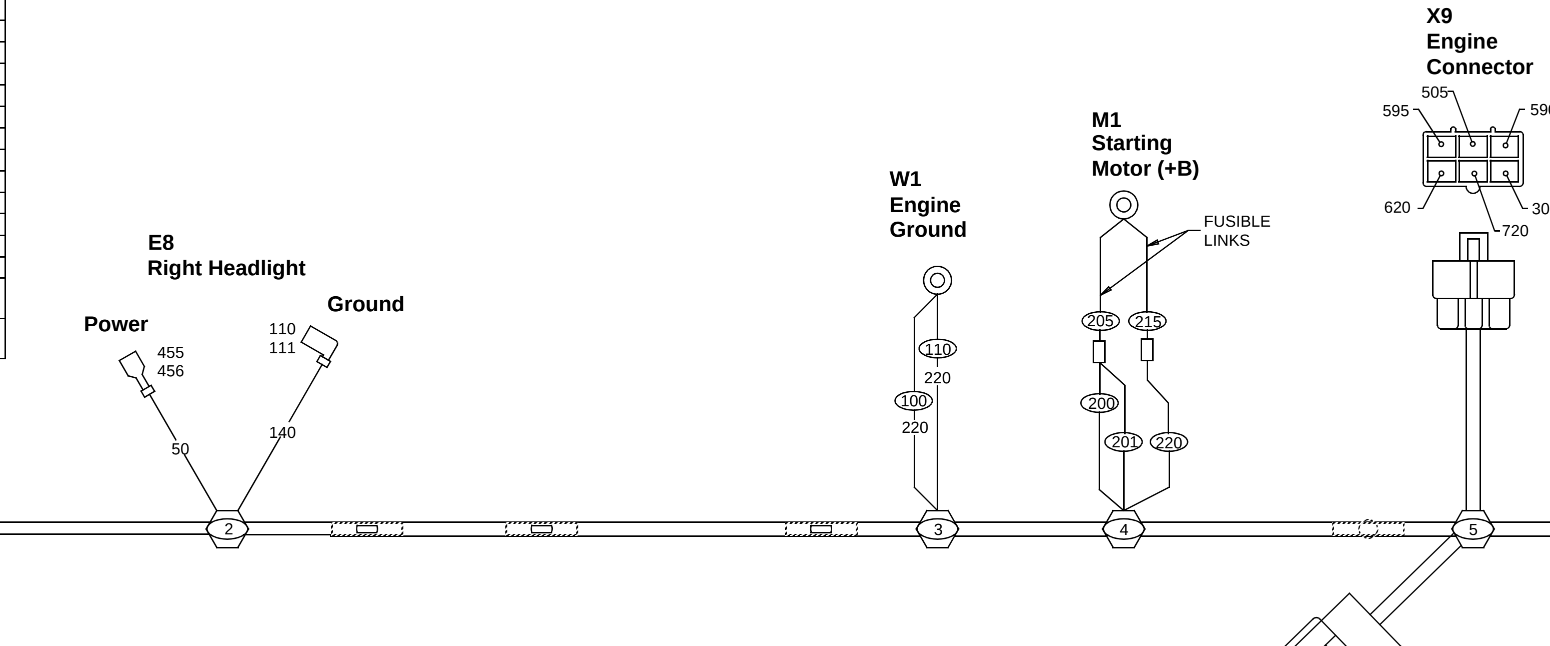
Circuit Number	Wire Size	Color	Termination Points
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
652 Early Models	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

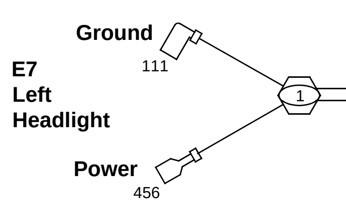
ELECTRICAL WIRING HARNESSES—445

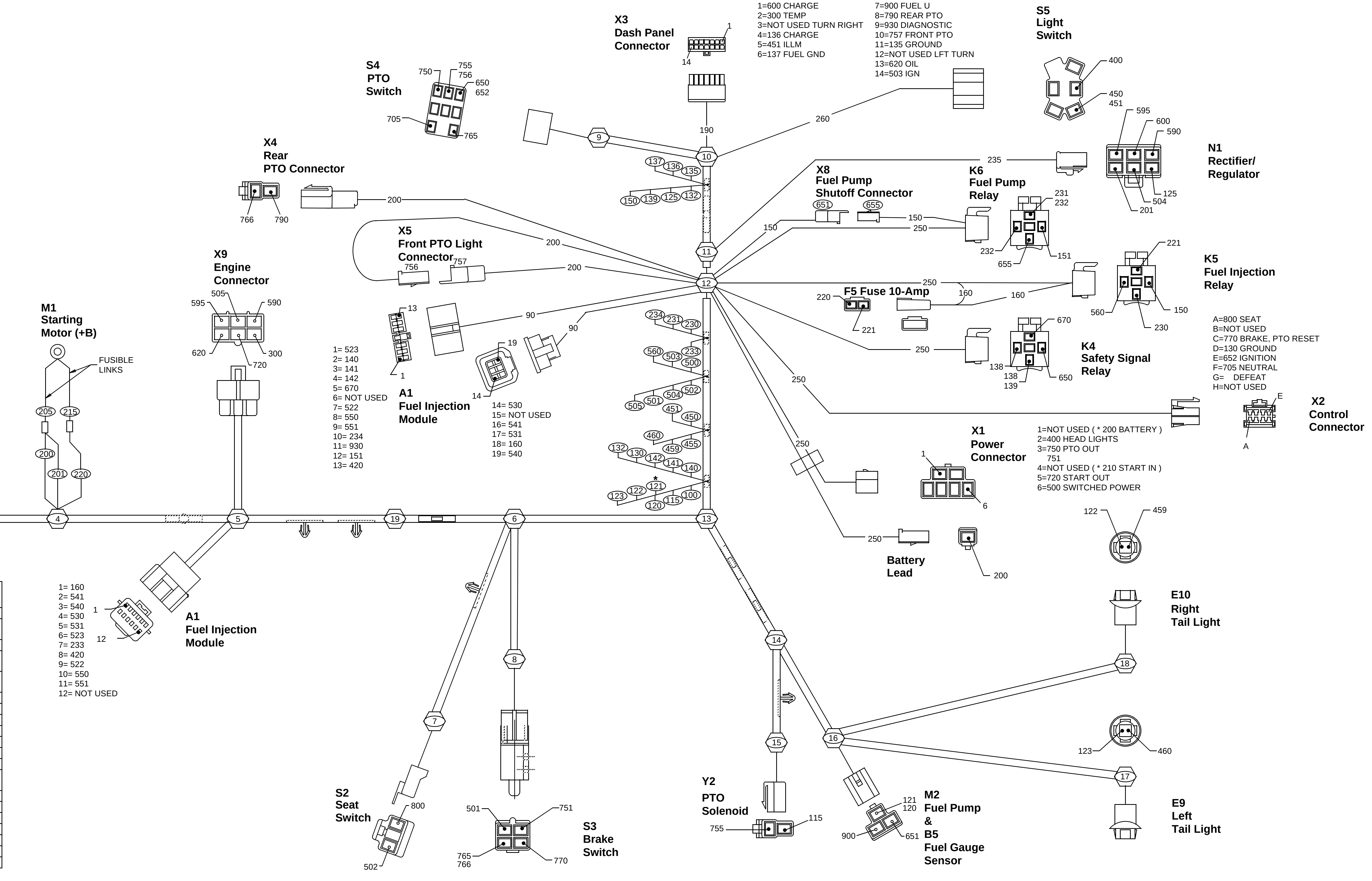
MAIN WIRING HARNESS (W1)—445 (S.N. —031361)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
121 Early Models	0.8	Bik	120, 122, 123 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
150	0.8	Blk	K5, 100 Blk
151	0.5	Red/Blk	K6, A1
160	0.8	Blk	A1, Blk/Brn
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	F1, M1
215	0.5	Grey/ Fuse	M1, F1

NOTE: *Late model harness shown. On late model harnesses, 210 red and 121 blk wires have been deleted. On early models, 210 red wire ran from the 215 and 220 red wires connection to X1 terminal 4.*







Circuit Number	Wire Size	Color	Termination Points
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/ Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/ Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/ Wht

Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
620	0.5	Tan	B6, X3-13

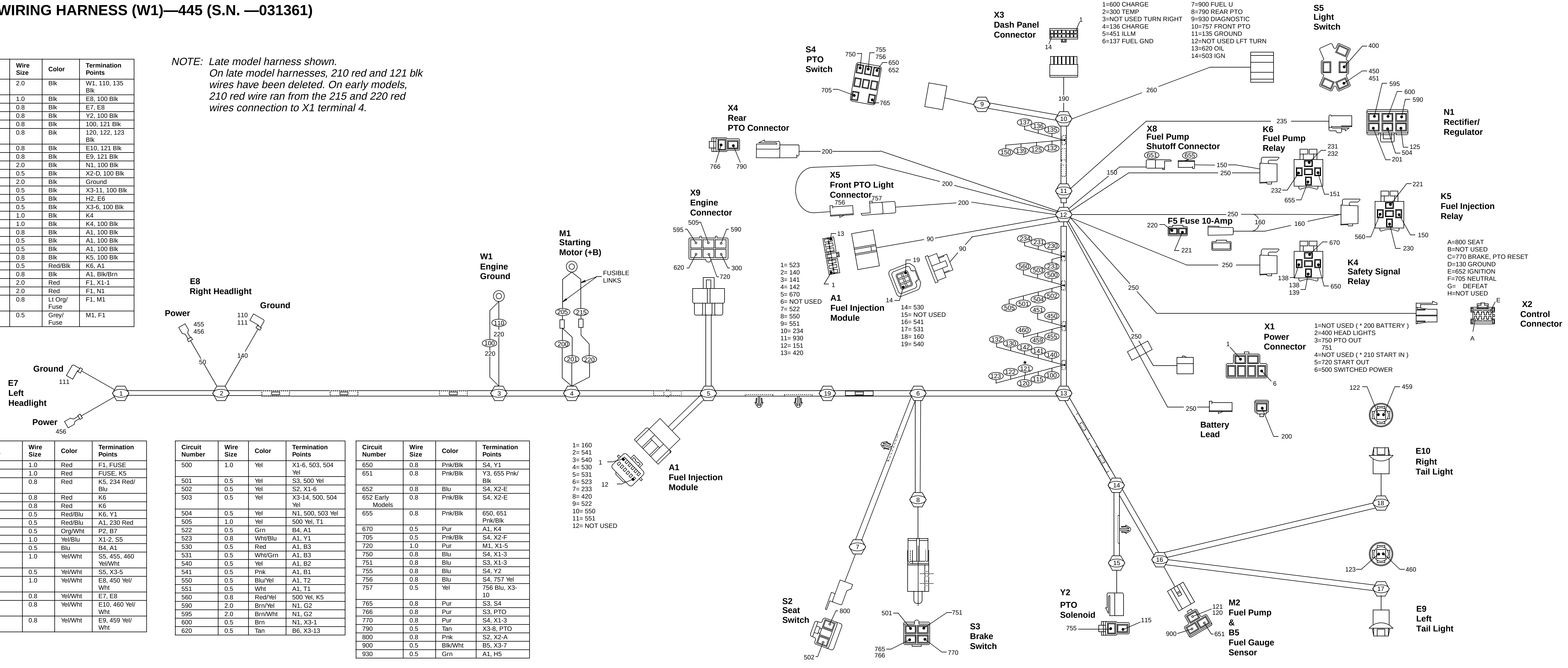
Circuit Number	Wire Size	Color	Termination Points
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
652 Early Models	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

ELECTRICAL WIRING HARNESSES—445

MAIN WIRING HARNESS (W1)—445 (S.N. —031361)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
121 Early Models	0.8	Bik	120, 122, 123 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
150	0.8	Blk	K5, 100 Blk
151	0.5	Red/Blk	K6, A1
160	0.8	Blk	A1, Blk/Brn
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	F1, M1
215	0.5	Grey/ Fuse	M1, F1

NOTE: *Late model harness shown. On late model harnesses, 210 red and 121 blk wires have been deleted. On early models, 210 red wire ran from the 215 and 220 red wires connection to X1 terminal 4.*



Circuit Number	Wire Size	Color	Termination Points
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/ Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/ Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/ Wht

Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
620	0.5	Tan	B6, X3-13

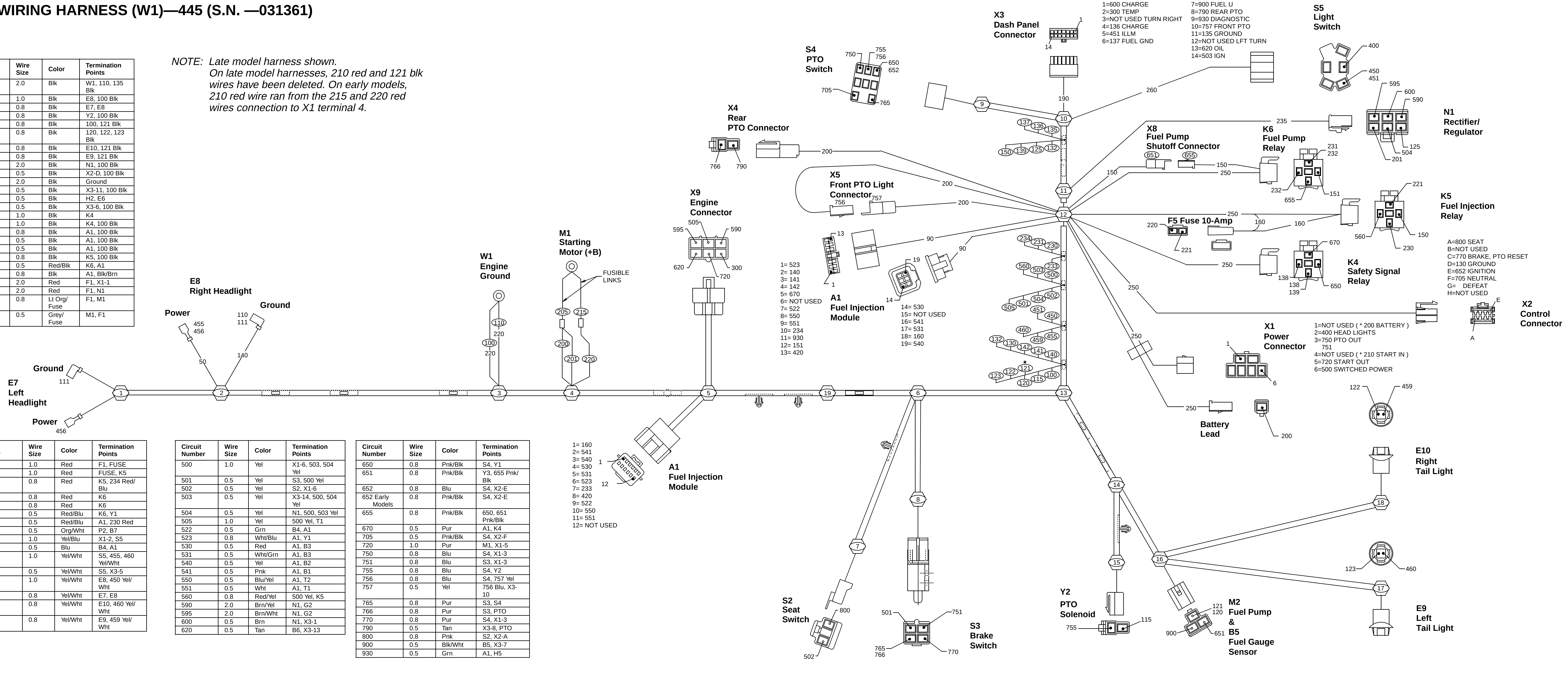
Circuit Number	Wire Size	Color	Termination Points
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
652 Early Models	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3- 10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

ELECTRICAL WIRING HARNESSES—445

MAIN WIRING HARNESS (W1)—445 (S.N. —031361)

NOTE: *Late model harness shown.*
On late model harnesses, 210 red and 121 blk wires have been deleted. On early models, 210 red wire ran from the 215 and 220 red wires connection to X1 terminal 4.

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
121 Early Models	0.8	Bik	120, 122, 123 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
150	0.8	Blk	K5, 100 Blk
151	0.5	Red/Blk	K6, A1
160	0.8	Blk	A1, Blk/Brn
200	2.0	Red	F1, X1-1
201	2.0	Red	F1, N1
205	0.8	Lt Org/ Fuse	F1, M1
215	0.5	Grey/ Fuse	M1, F1



Circuit Number	Wire Size	Color	Termination Points
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/ Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/ Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/ Wht

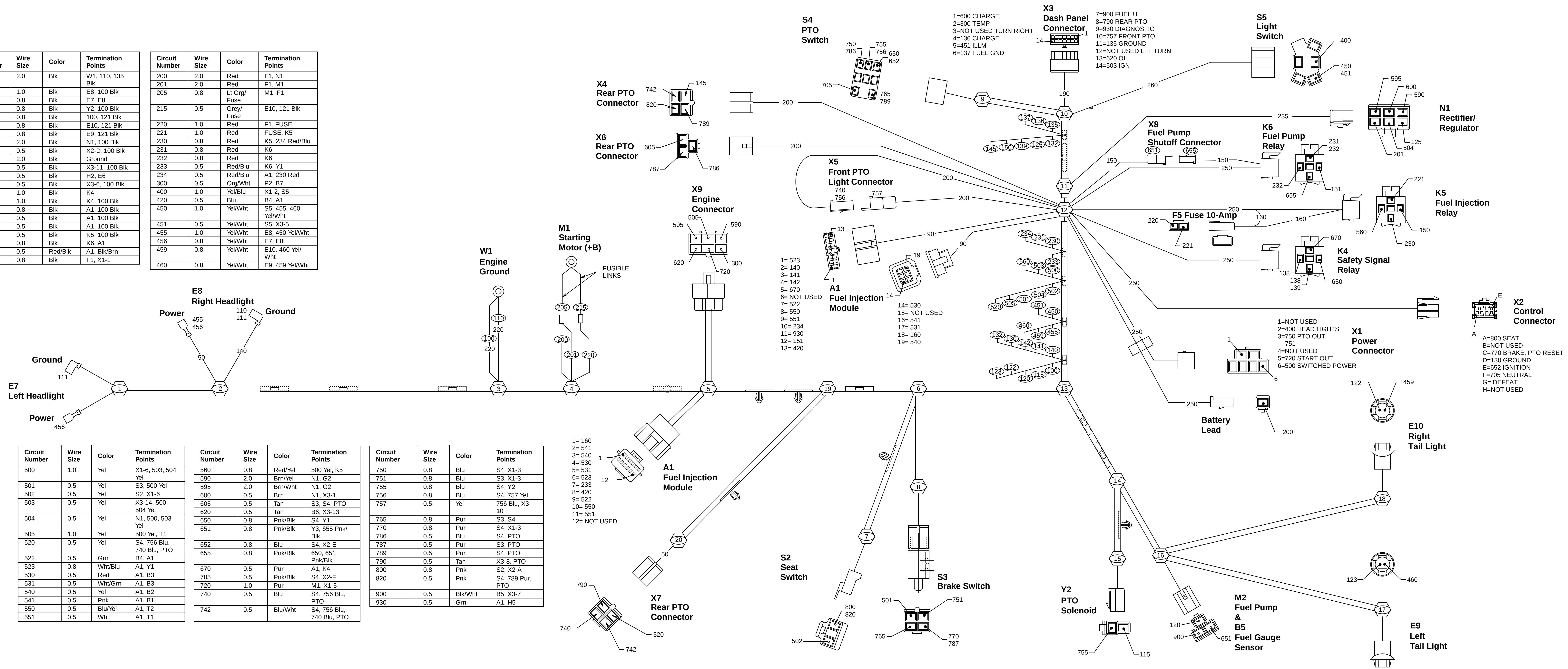
Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
620	0.5	Tan	B6, X3-13

Circuit Number	Wire Size	Color	Termination Points
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
652 Early Models	0.8	Pnk/Blk	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
766	0.8	Pur	S3, PTO
770	0.8	Pur	S4, X1-3
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

MAIN WIRING HARNESS (W1)—445 (S.N. 031362—070000)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
145	0.5	Blk	K5, 100 Blk
150	0.8	Blk	K6, A1
151	0.5	Red/Blk	A1, Blk/Brn
160	0.8	Blk	F1, X1-1

Circuit Number	Wire Size	Color	Termination Points
200	2.0	Red	F1, N1
201	2.0	Red	F1, M1
205	0.8	Lt Org/ Fuse	M1, F1
215	0.5	Grey/ Fuse	E10, 121 Blk
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht



Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
520	0.5	Yel	S4, 756 Blu, 740 Blu, PTO
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1

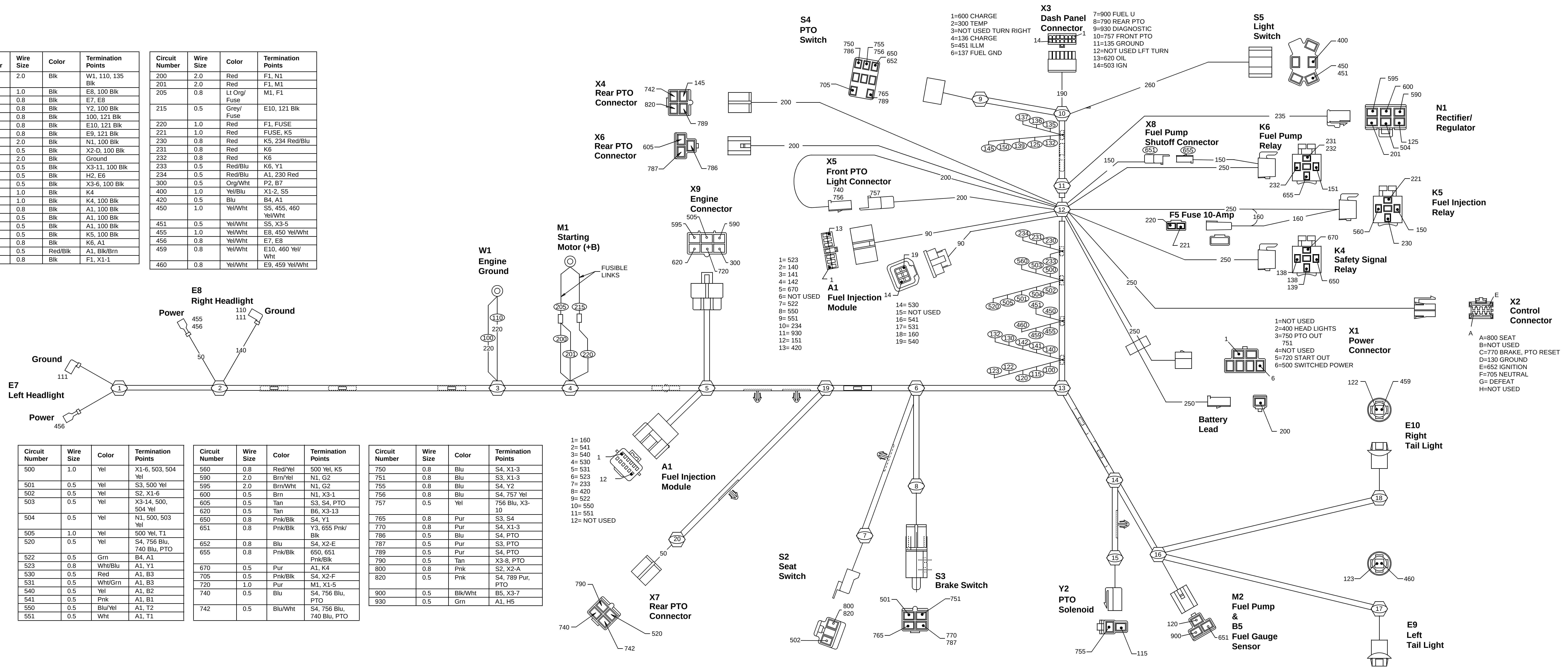
Circuit Number	Wire Size	Color	Termination Points
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
605	0.5	Tan	S3, S4, PTO
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
740	0.5	Blu	S4, 756 Blu, PTO
742	0.5	Blu/Wht	S4, 756 Blu, 740 Blu, PTO

Circuit Number	Wire Size	Color	Termination Points
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
770	0.8	Pur	S4, X1-3
786	0.5	Blu	S4, PTO
787	0.5	Pur	S3, PTO
789	0.5	Pur	S4, PTO
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
820	0.5	Pnk	S4, 789 Pur, PTO
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

MAIN WIRING HARNESS (W1)—445 (S.N. 031362—070000)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
145	0.5	Blk	K5, 100 Blk
150	0.8	Blk	K6, A1
151	0.5	Red/Blk	A1, Blk/Brn
160	0.8	Blk	F1, X1-1

Circuit Number	Wire Size	Color	Termination Points
200	2.0	Red	F1, N1
201	2.0	Red	F1, M1
205	0.8	Lt Org/ Fuse	M1, F1
215	0.5	Grey/ Fuse	E10, 121 Blk
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht



Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
520	0.5	Yel	S4, 756 Blu, 740 Blu, PTO
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1

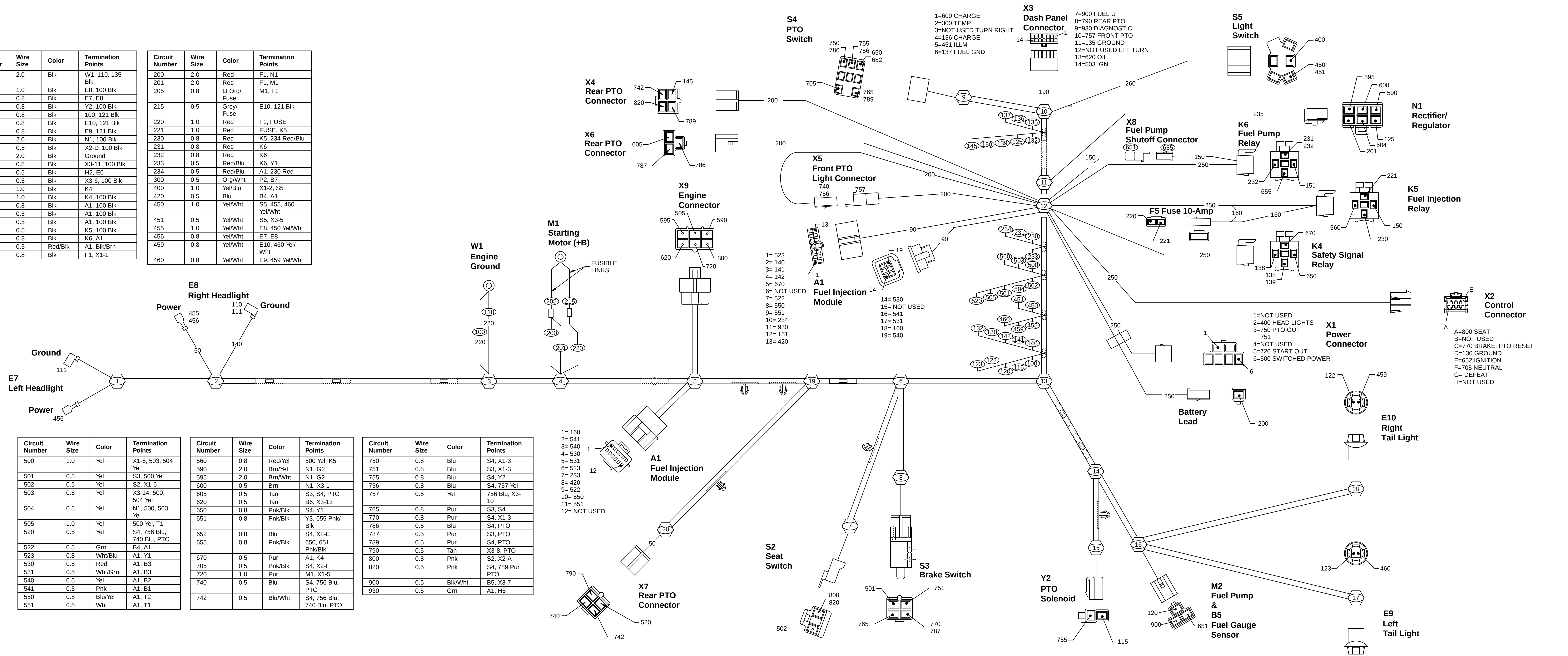
Circuit Number	Wire Size	Color	Termination Points
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
605	0.5	Tan	S3, S4, PTO
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
740	0.5	Blu	S4, 756 Blu, PTO
742	0.5	Blu/Wht	S4, 756 Blu, 740 Blu, PTO

Circuit Number	Wire Size	Color	Termination Points
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
770	0.8	Pur	S4, X1-3
786	0.5	Blu	S4, PTO
787	0.5	Pur	S3, PTO
789	0.5	Pur	S4, PTO
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
820	0.5	Pnk	S4, 789 Pur, PTO
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

MAIN WIRING HARNESS (W1)—445 (S.N. 031362—070000)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
145	0.5	Blk	K5, 100 Blk
150	0.8	Blk	K6, A1
151	0.5	Red/Blk	A1, Blk/Brn
160	0.8	Blk	F1, X1-1

Circuit Number	Wire Size	Color	Termination Points
200	2.0	Red	F1, N1
201	2.0	Red	F1, M1
205	0.8	Lt Org/ Fuse	M1, F1
215	0.5	Grey/ Fuse	E10, 121 Blk
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht



Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
520	0.5	Yel	S4, 756 Blu, 740 Blu, PTO
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1

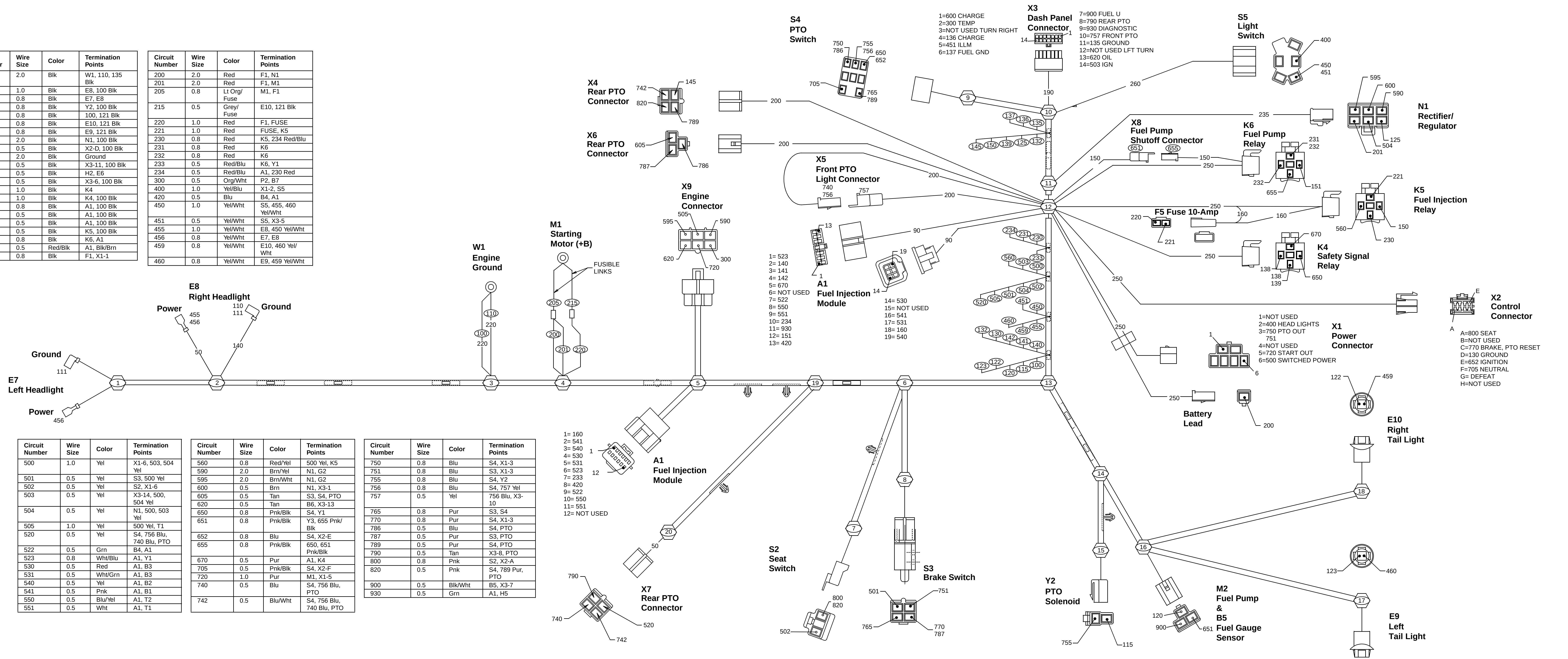
Circuit Number	Wire Size	Color	Termination Points
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
605	0.5	Tan	S3, S4, PTO
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
740	0.5	Blu	S4, 756 Blu, PTO
742	0.5	Blu/Wht	S4, 756 Blu, 740 Blu, PTO

Circuit Number	Wire Size	Color	Termination Points
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
770	0.8	Pur	S4, X1-3
786	0.5	Blu	S4, PTO
787	0.5	Pur	S3, PTO
789	0.5	Pur	S4, PTO
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
820	0.5	Pnk	S4, 789 Pur, PTO
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

MAIN WIRING HARNESS (W1)—445 (S.N. 031362—070000)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1, 110, 135 Blk
110	1.0	Blk	E8, 100 Blk
111	0.8	Blk	E7, E8
115	0.8	Blk	Y2, 100 Blk
120	0.8	Blk	100, 121 Blk
122	0.8	Blk	E10, 121 Blk
123	0.8	Blk	E9, 121 Blk
125	2.0	Blk	N1, 100 Blk
130	0.5	Blk	X2-D, 100 Blk
132	2.0	Blk	Ground
135	0.5	Blk	X3-11, 100 Blk
136	0.5	Blk	H2, E6
137	0.5	Blk	X3-6, 100 Blk
138	1.0	Blk	K4
139	1.0	Blk	K4, 100 Blk
140	0.8	Blk	A1, 100 Blk
141	0.5	Blk	A1, 100 Blk
142	0.5	Blk	A1, 100 Blk
145	0.5	Blk	K5, 100 Blk
150	0.8	Blk	K6, A1
151	0.5	Red/Blk	A1, Blk/Brn
160	0.8	Blk	F1, X1-1

Circuit Number	Wire Size	Color	Termination Points
200	2.0	Red	F1, N1
201	2.0	Red	F1, M1
205	0.8	Lt Org/ Fuse	M1, F1
215	0.5	Grey/ Fuse	E10, 121 Blk
220	1.0	Red	F1, FUSE
221	1.0	Red	FUSE, K5
230	0.8	Red	K5, 234 Red/Blu
231	0.8	Red	K6
232	0.8	Red	K6
233	0.5	Red/Blu	K6, Y1
234	0.5	Red/Blu	A1, 230 Red
300	0.5	Org/Wht	P2, B7
400	1.0	Yel/Blu	X1-2, S5
420	0.5	Blu	B4, A1
450	1.0	Yel/Wht	S5, 455, 460 Yel/Wht
451	0.5	Yel/Wht	S5, X3-5
455	1.0	Yel/Wht	E8, 450 Yel/Wht
456	0.8	Yel/Wht	E7, E8
459	0.8	Yel/Wht	E10, 460 Yel/ Wht
460	0.8	Yel/Wht	E9, 459 Yel/Wht



Circuit Number	Wire Size	Color	Termination Points
500	1.0	Yel	X1-6, 503, 504 Yel
501	0.5	Yel	S3, 500 Yel
502	0.5	Yel	S2, X1-6
503	0.5	Yel	X3-14, 500, 504 Yel
504	0.5	Yel	N1, 500, 503 Yel
505	1.0	Yel	500 Yel, T1
520	0.5	Yel	S4, 756 Blu, 740 Blu, PTO
522	0.5	Grn	B4, A1
523	0.8	Wht/Blu	A1, Y1
530	0.5	Red	A1, B3
531	0.5	Wht/Grn	A1, B3
540	0.5	Yel	A1, B2
541	0.5	Pnk	A1, B1
550	0.5	Blu/Yel	A1, T2
551	0.5	Wht	A1, T1

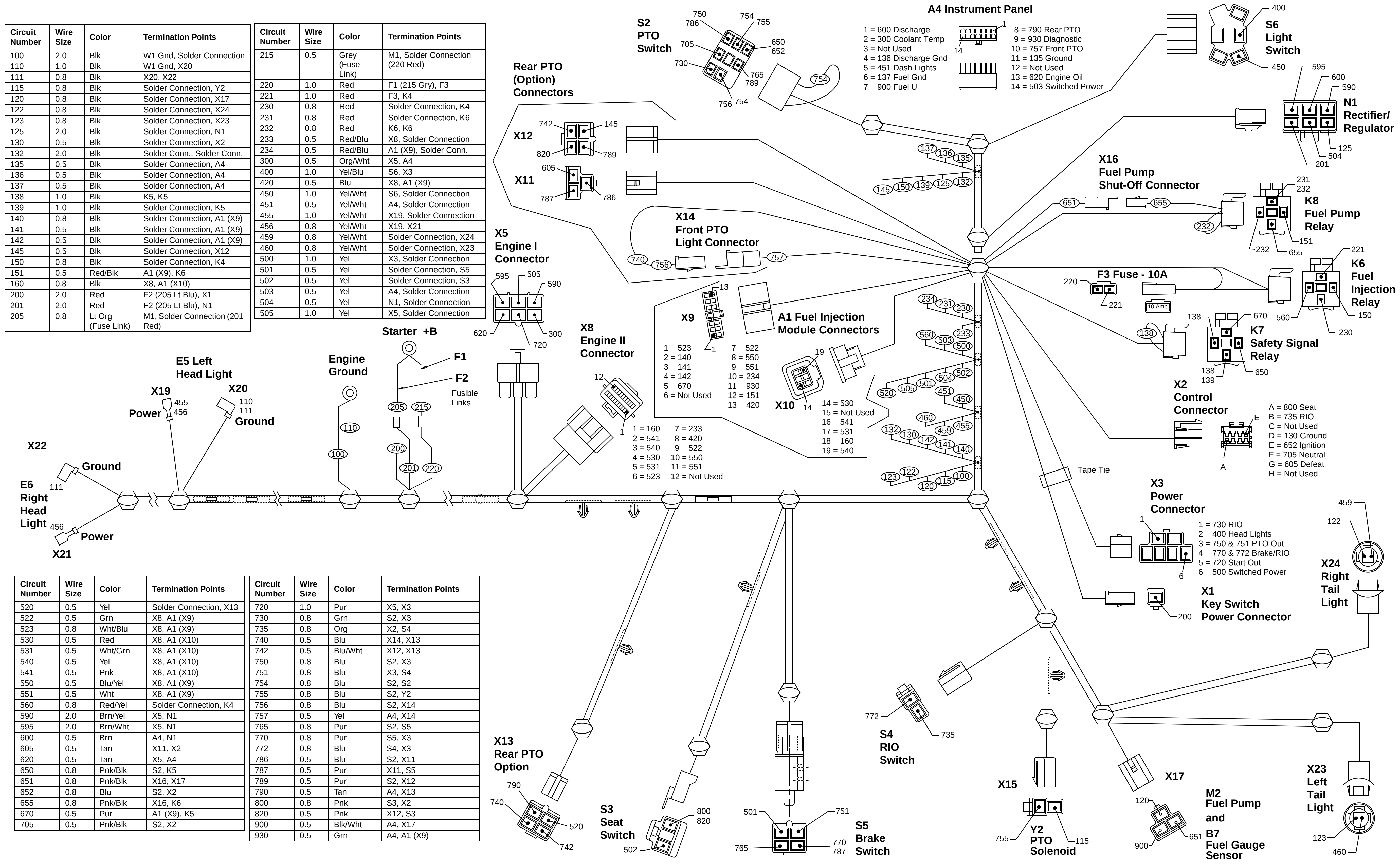
Circuit Number	Wire Size	Color	Termination Points
560	0.8	Red/Yel	500 Yel, K5
590	2.0	Brn/Yel	N1, G2
595	2.0	Brn/Wht	N1, G2
600	0.5	Brn	N1, X3-1
605	0.5	Tan	S3, S4, PTO
620	0.5	Tan	B6, X3-13
650	0.8	Pnk/Blk	S4, Y1
651	0.8	Pnk/Blk	Y3, 655 Pnk/ Blk
652	0.8	Blu	S4, X2-E
655	0.8	Pnk/Blk	650, 651 Pnk/Blk
670	0.5	Pur	A1, K4
705	0.5	Pnk/Blk	S4, X2-F
720	1.0	Pur	M1, X1-5
740	0.5	Blu	S4, 756 Blu, PTO
742	0.5	Blu/Wht	S4, 756 Blu, 740 Blu, PTO

Circuit Number	Wire Size	Color	Termination Points
750	0.8	Blu	S4, X1-3
751	0.8	Blu	S3, X1-3
755	0.8	Blu	S4, Y2
756	0.8	Blu	S4, 757 Yel
757	0.5	Yel	756 Blu, X3-10
765	0.8	Pur	S3, S4
770	0.8	Pur	S4, X1-3
786	0.5	Blu	S4, PTO
787	0.5	Pur	S3, PTO
789	0.5	Pur	S4, PTO
790	0.5	Tan	X3-8, PTO
800	0.8	Pnk	S2, X2-A
820	0.5	Pnk	S4, 789 Pur, PTO
900	0.5	Blk/Wht	B5, X3-7
930	0.5	Grn	A1, H5

MAIN WIRING HARNESS (W1)—445 (S.N. 070001—)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, Y2
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
132	2.0	Blk	Solder Conn., Solder Conn.
135	0.5	Blk	Solder Connection, A4
136	0.5	Blk	Solder Connection, A4
137	0.5	Blk	Solder Connection, A4
138	1.0	Blk	K5, K5
139	1.0	Blk	Solder Connection, K5
140	0.8	Blk	Solder Connection, A1 (X9)
141	0.5	Blk	Solder Connection, A1 (X9)
142	0.5	Blk	Solder Connection, A1 (X9)
145	0.5	Blk	Solder Connection, X12
150	0.8	Blk	Solder Connection, K4
151	0.5	Red/Blk	A1 (X9), K6
160	0.8	Blk	X8, A1 (X10)
200	2.0	Red	F2 (205 Lt Blu), X1
201	2.0	Red	F2 (205 Lt Blu), N1
205	0.8	Lt Org (Fuse Link)	M1, Solder Connection (201 Red)

Circuit Number	Wire Size	Color	Termination Points
215	0.5	Grey (Fuse Link)	M1, Solder Connection (220 Red)
220	1.0	Red	F1 (215 Gry), F3
221	1.0	Red	F3, K4
230	0.8	Red	Solder Connection, K4
231	0.8	Red	Solder Connection, K6
232	0.8	Red	K6, K6
233	0.5	Red/Blu	X8, Solder Connection
234	0.5	Red/Blu	A1 (X9), Solder Conn.
300	0.5	Org/Wht	X5, A4
400	1.0	Yel/Blu	S6, X3
420	0.5	Blu	X8, A1 (X9)
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A4, Solder Connection
455	1.0	Yel/Wht	X19, Solder Connection
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	X3, Solder Connection
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A4, Solder Connection
504	0.5	Yel	N1, Solder Connection
505	1.0	Yel	X5, Solder Connection



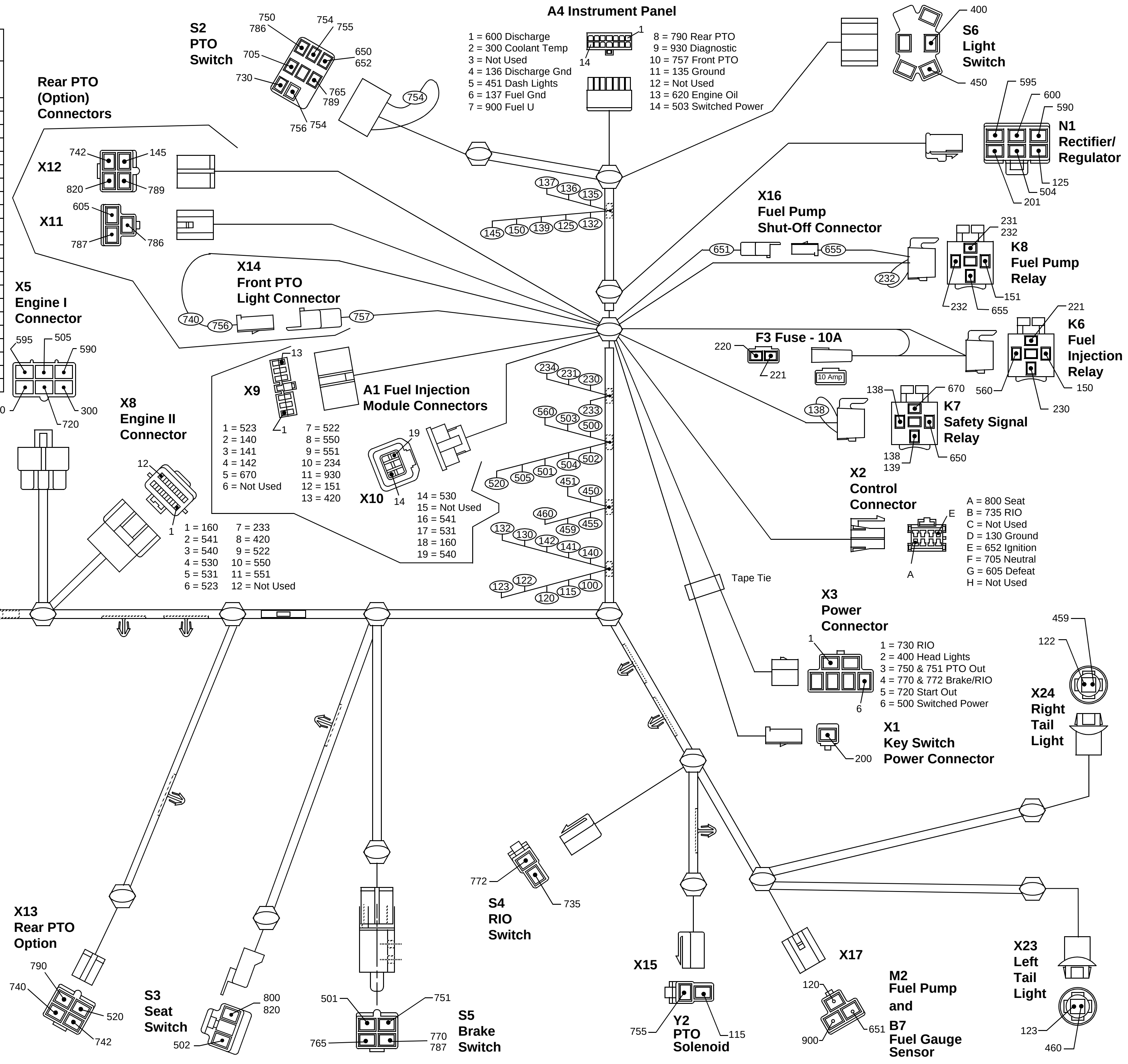
Circuit Number	Wire Size	Color	Termination Points
520	0.5	Yel	Solder Connection, X13
522	0.5	Grn	X8, A1 (X9)
523	0.8	Wht/Blu	X8, A1 (X9)
530	0.5	Red	X8, A1 (X10)
531	0.5	Wht/Grn	X8, A1 (X10)
540	0.5	Yel	X8, A1 (X10)
541	0.5	Pnk	X8, A1 (X10)
550	0.5	Blu/Yel	X8, A1 (X9)
551	0.5	Wht	X8, A1 (X9)
560	0.8	Red/Yel	Solder Connection, K4
590	2.0	Brn/Yel	X5, N1
595	2.0	Brn/Wht	X5, N1
600	0.5	Brn	A4, N1
605	0.5	Tan	X11, X2
620	0.5	Tan	X5, A4
650	0.8	Pnk/Blk	S2, K5
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X16, K6
670	0.5	Pur	A1 (X9), K5
705	0.5	Pnk/Blk	S2, X2

Circuit Number	Wire Size	Color	Termination Points
720	1.0	Pur	X5, X3
730	0.8	Grn	S2, X3
735	0.8	Org	X2, S4
740	0.5	Blu	X14, X13
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	X3, S4
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A4, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	S2, X11
787	0.5	Pur	X11, S5
789	0.5	Pur	S2, X12
790	0.5	Tan	A4, X13
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A4, X17
930	0.5	Grn	A4, A1 (X9)

MAIN WIRING HARNESS (W1)—445 (S.N. 070001—)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, Y2
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
132	2.0	Blk	Solder Conn., Solder Conn.
135	0.5	Blk	Solder Connection, A4
136	0.5	Blk	Solder Connection, A4
137	0.5	Blk	Solder Connection, A4
138	1.0	Blk	K5, K5
139	1.0	Blk	Solder Connection, K5
140	0.8	Blk	Solder Connection, A1 (X9)
141	0.5	Blk	Solder Connection, A1 (X9)
142	0.5	Blk	Solder Connection, A1 (X9)
145	0.5	Blk	Solder Connection, X12
150	0.8	Blk	Solder Connection, K4
151	0.5	Red/Blk	A1 (X9), K6
160	0.8	Blk	X8, A1 (X10)
200	2.0	Red	F2 (205 Lt Blu), X1
201	2.0	Red	F2 (205 Lt Blu), N1
205	0.8	Lt Org (Fuse Link)	M1, Solder Connection (201 Red)

Circuit Number	Wire Size	Color	Termination Points
215	0.5	Grey (Fuse Link)	M1, Solder Connection (220 Red)
220	1.0	Red	F1 (215 Gry), F3
221	1.0	Red	F3, K4
230	0.8	Red	Solder Connection, K4
231	0.8	Red	Solder Connection, K6
232	0.8	Red	K6, K6
233	0.5	Red/Blu	X8, Solder Connection
234	0.5	Red/Blu	A1 (X9), Solder Conn.
300	0.5	Org/Wht	X5, A4
400	1.0	Yel/Blu	S6, X3
420	0.5	Blu	X8, A1 (X9)
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A4, Solder Connection
455	1.0	Yel/Wht	X19, Solder Connection
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	X3, Solder Connection
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A4, Solder Connection
504	0.5	Yel	N1, Solder Connection
505	1.0	Yel	X5, Solder Connection



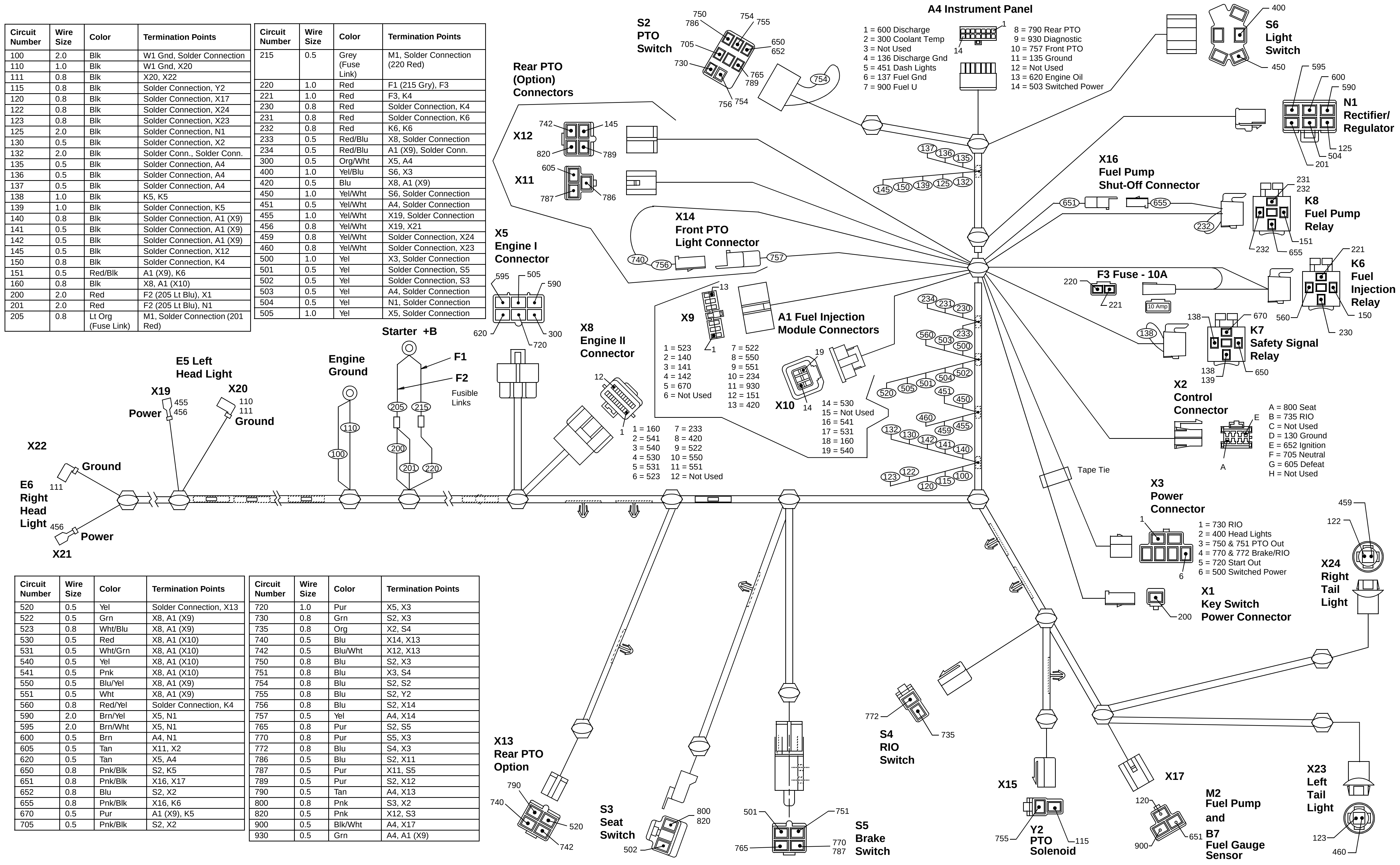
Circuit Number	Wire Size	Color	Termination Points
520	0.5	Yel	Solder Connection, X13
522	0.5	Grn	X8, A1 (X9)
523	0.8	Wht/Blu	X8, A1 (X9)
530	0.5	Red	X8, A1 (X10)
531	0.5	Wht/Grn	X8, A1 (X10)
540	0.5	Yel	X8, A1 (X10)
541	0.5	Pnk	X8, A1 (X10)
550	0.5	Blu/Yel	X8, A1 (X9)
551	0.5	Wht	X8, A1 (X9)
560	0.8	Red/Yel	Solder Connection, K4
590	2.0	Brn/Yel	X5, N1
595	2.0	Brn/Wht	X5, N1
600	0.5	Brn	A4, N1
605	0.5	Tan	X11, X2
620	0.5	Tan	X5, A4
650	0.8	Pnk/Blk	S2, K5
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X16, K6
670	0.5	Pur	A1 (X9), K5
705	0.5	Pnk/Blk	S2, X2

Circuit Number	Wire Size	Color	Termination Points
720	1.0	Pur	X5, X3
730	0.8	Grn	S2, X3
735	0.8	Org	X2, S4
740	0.5	Blu	X14, X13
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	X3, S4
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A4, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	S2, X11
787	0.5	Pur	X11, S5
789	0.5	Pur	S2, X12
790	0.5	Tan	A4, X13
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A4, X17
930	0.5	Grn	A4, A1 (X9)

MAIN WIRING HARNESS (W1)—445 (S.N. 070001—)

Circuit Number	Wire Size	Color	Termination Points
100	2.0	Blk	W1 Gnd, Solder Connection
110	1.0	Blk	W1 Gnd, X20
111	0.8	Blk	X20, X22
115	0.8	Blk	Solder Connection, Y2
120	0.8	Blk	Solder Connection, X17
122	0.8	Blk	Solder Connection, X24
123	0.8	Blk	Solder Connection, X23
125	2.0	Blk	Solder Connection, N1
130	0.5	Blk	Solder Connection, X2
132	2.0	Blk	Solder Conn., Solder Conn.
135	0.5	Blk	Solder Connection, A4
136	0.5	Blk	Solder Connection, A4
137	0.5	Blk	Solder Connection, A4
138	1.0	Blk	K5, K5
139	1.0	Blk	Solder Connection, K5
140	0.8	Blk	Solder Connection, A1 (X9)
141	0.5	Blk	Solder Connection, A1 (X9)
142	0.5	Blk	Solder Connection, A1 (X9)
145	0.5	Blk	Solder Connection, X12
150	0.8	Blk	Solder Connection, K4
151	0.5	Red/Blk	A1 (X9), K6
160	0.8	Blk	X8, A1 (X10)
200	2.0	Red	F2 (205 Lt Blu), X1
201	2.0	Red	F2 (205 Lt Blu), N1
205	0.8	Lt Org (Fuse Link)	M1, Solder Connection (201 Red)

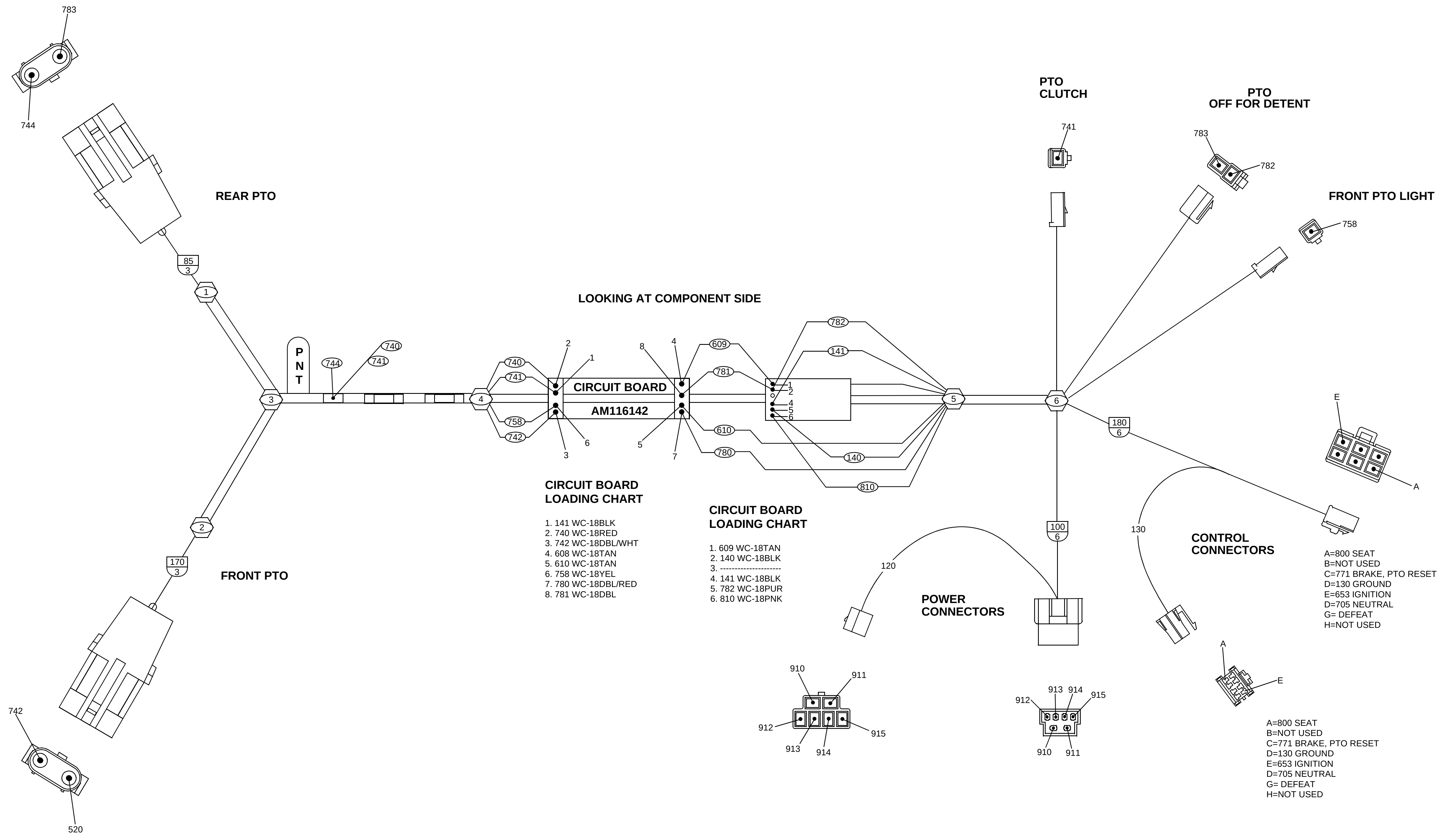
Circuit Number	Wire Size	Color	Termination Points
215	0.5	Grey (Fuse Link)	M1, Solder Connection (220 Red)
220	1.0	Red	F1 (215 Gry), F3
221	1.0	Red	F3, K4
230	0.8	Red	Solder Connection, K4
231	0.8	Red	Solder Connection, K6
232	0.8	Red	K6, K6
233	0.5	Red/Blu	X8, Solder Connection
234	0.5	Red/Blu	A1 (X9), Solder Conn.
300	0.5	Org/Wht	X5, A4
400	1.0	Yel/Blu	S6, X3
420	0.5	Blu	X8, A1 (X9)
450	1.0	Yel/Wht	S6, Solder Connection
451	0.5	Yel/Wht	A4, Solder Connection
455	1.0	Yel/Wht	X19, Solder Connection
456	0.8	Yel/Wht	X19, X21
459	0.8	Yel/Wht	Solder Connection, X24
460	0.8	Yel/Wht	Solder Connection, X23
500	1.0	Yel	X3, Solder Connection
501	0.5	Yel	Solder Connection, S5
502	0.5	Yel	Solder Connection, S3
503	0.5	Yel	A4, Solder Connection
504	0.5	Yel	N1, Solder Connection
505	1.0	Yel	X5, Solder Connection



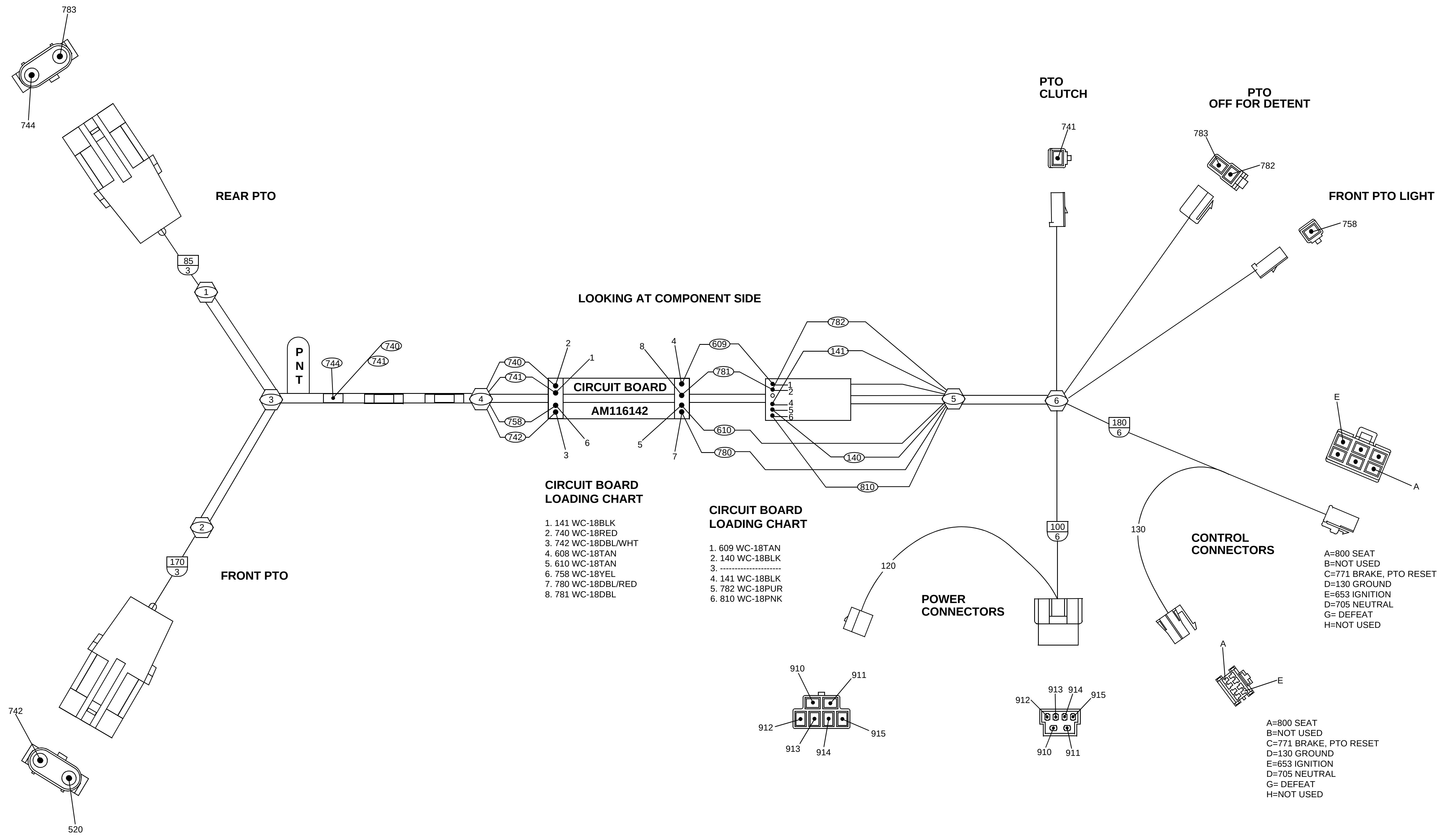
Circuit Number	Wire Size	Color	Termination Points
520	0.5	Yel	Solder Connection, X13
522	0.5	Grn	X8, A1 (X9)
523	0.8	Wht/Blu	X8, A1 (X9)
530	0.5	Red	X8, A1 (X10)
531	0.5	Wht/Grn	X8, A1 (X10)
540	0.5	Yel	X8, A1 (X10)
541	0.5	Pnk	X8, A1 (X10)
550	0.5	Blu/Yel	X8, A1 (X9)
551	0.5	Wht	X8, A1 (X9)
560	0.8	Red/Yel	Solder Connection, K4
590	2.0	Brn/Yel	X5, N1
595	2.0	Brn/Wht	X5, N1
600	0.5	Brn	A4, N1
605	0.5	Tan	X11, X2
620	0.5	Tan	X5, A4
650	0.8	Pnk/Blk	S2, K5
651	0.8	Pnk/Blk	X16, X17
652	0.8	Blu	S2, X2
655	0.8	Pnk/Blk	X16, K6
670	0.5	Pur	A1 (X9), K5
705	0.5	Pnk/Blk	S2, X2

Circuit Number	Wire Size	Color	Termination Points
720	1.0	Pur	X5, X3
730	0.8	Grn	S2, X3
735	0.8	Org	X2, S4
740	0.5	Blu	X14, X13
742	0.5	Blu/Wht	X12, X13
750	0.8	Blu	S2, X3
751	0.8	Blu	X3, S4
754	0.8	Blu	S2, S2
755	0.8	Blu	S2, Y2
756	0.8	Blu	S2, X14
757	0.5	Yel	A4, X14
765	0.8	Pur	S2, S5
770	0.8	Pur	S5, X3
772	0.8	Blu	S4, X3
786	0.5	Blu	S2, X11
787	0.5	Pur	X11, S5
789	0.5	Pur	S2, X12
790	0.5	Tan	A4, X13
800	0.8	Pnk	S3, X2
820	0.5	Pnk	X12, S3
900	0.5	Blk/Wht	A4, X17
930	0.5	Grn	A4, A1 (X9)

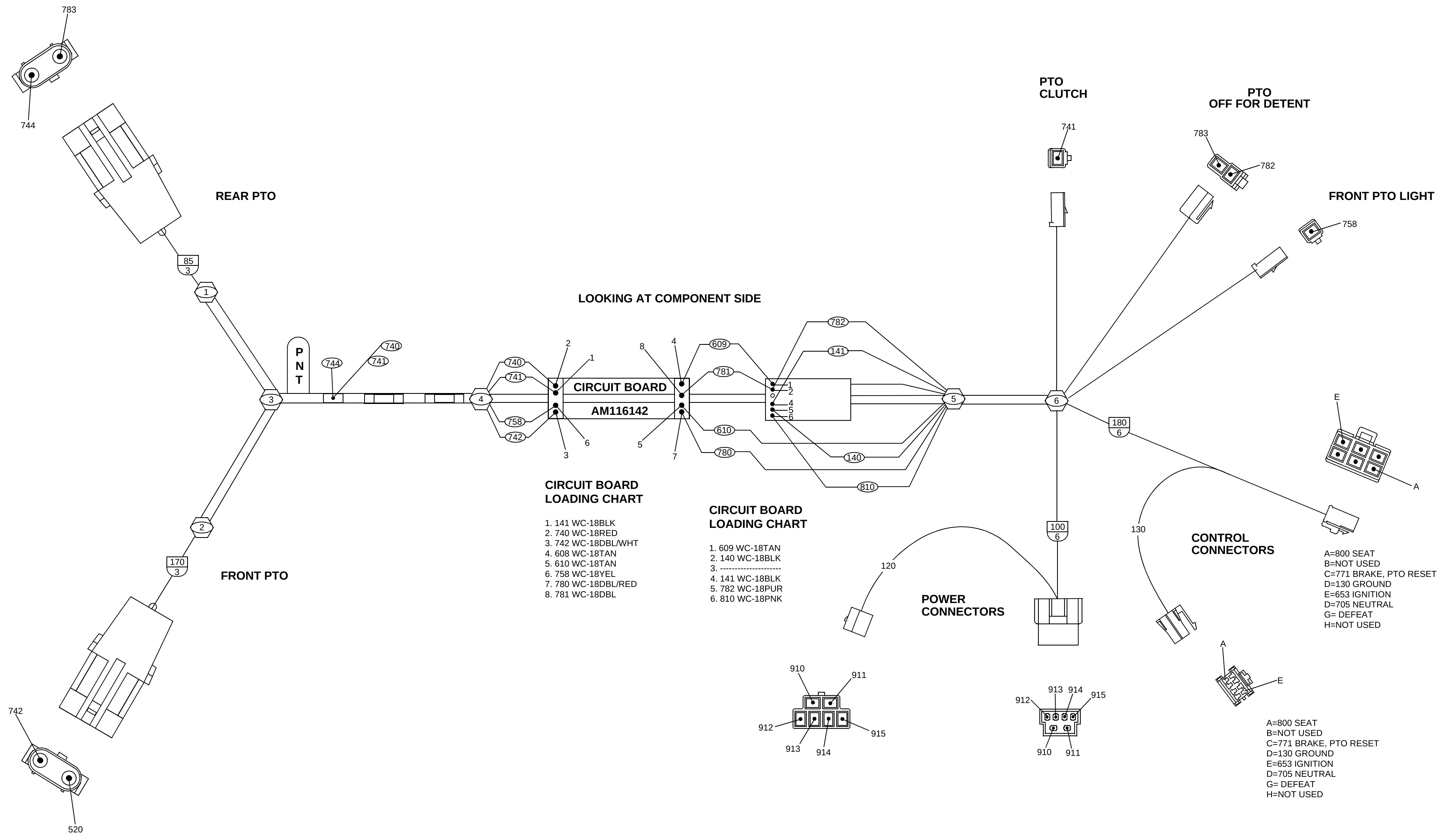
REAR PTO WIRING HARNESS (W2)—445 EARLY MODELS



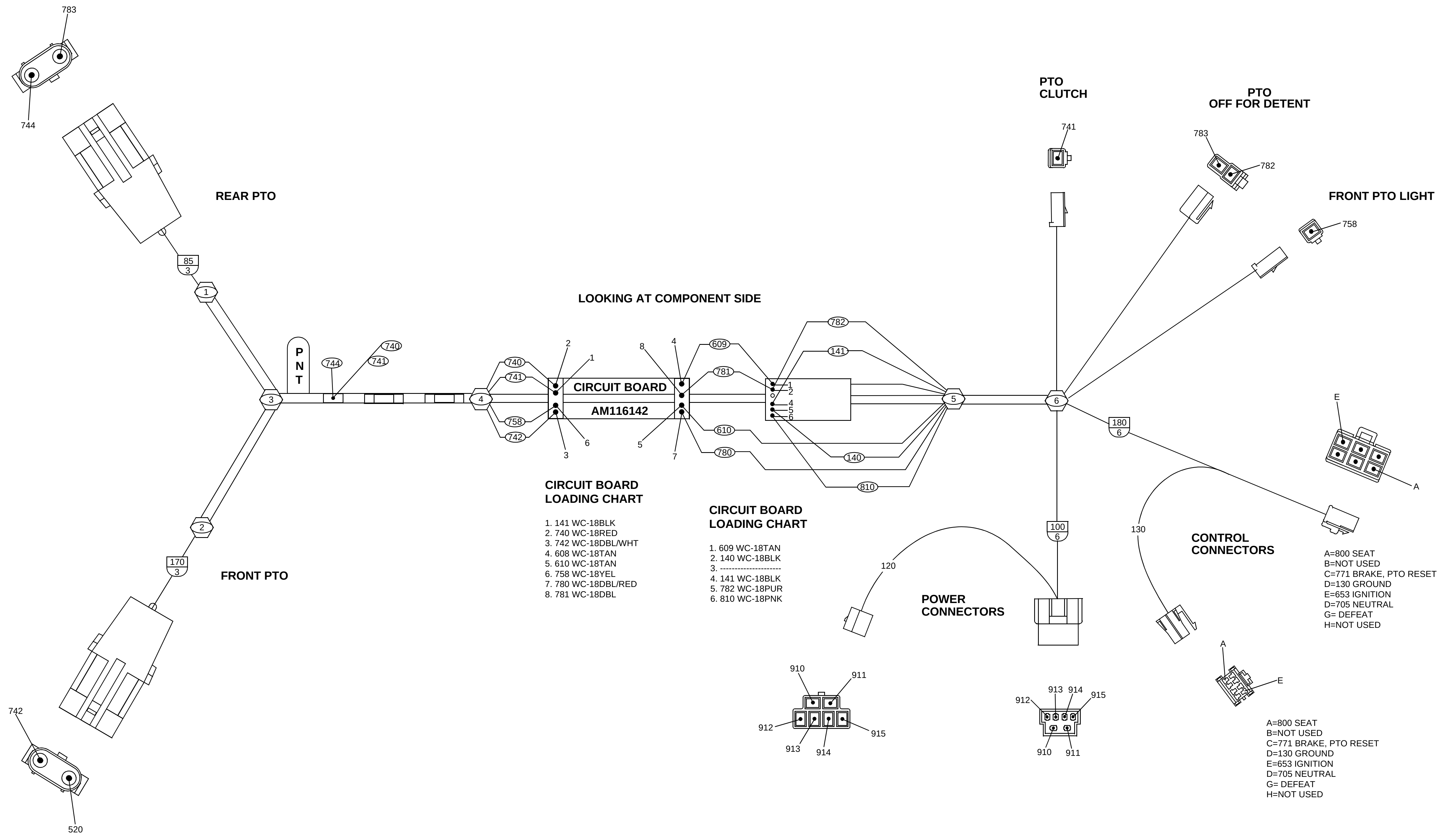
REAR PTO WIRING HARNESS (W2)—445 EARLY MODELS



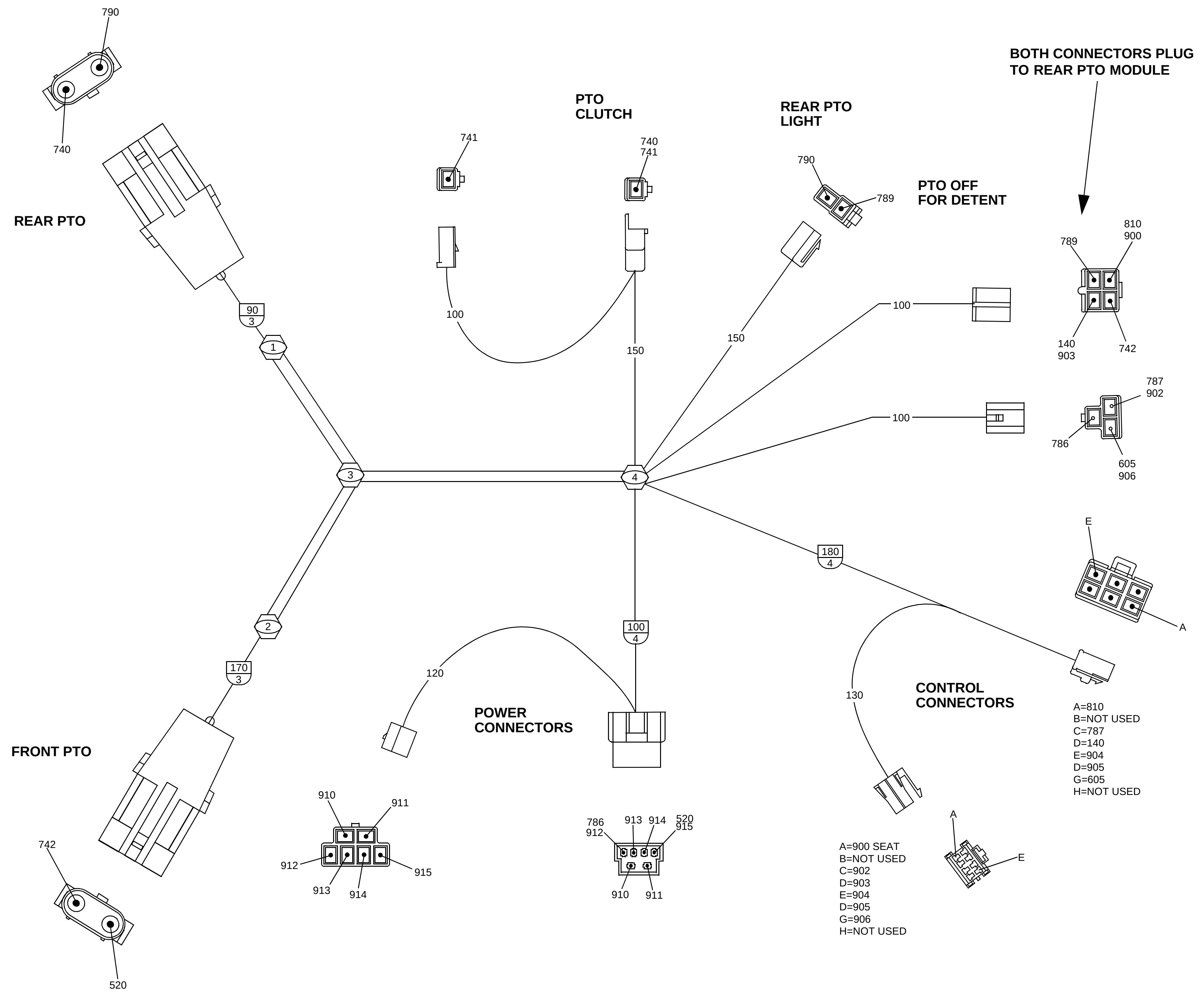
REAR PTO WIRING HARNESS (W2)—445 EARLY MODELS



REAR PTO WIRING HARNESS (W2)—445 EARLY MODELS

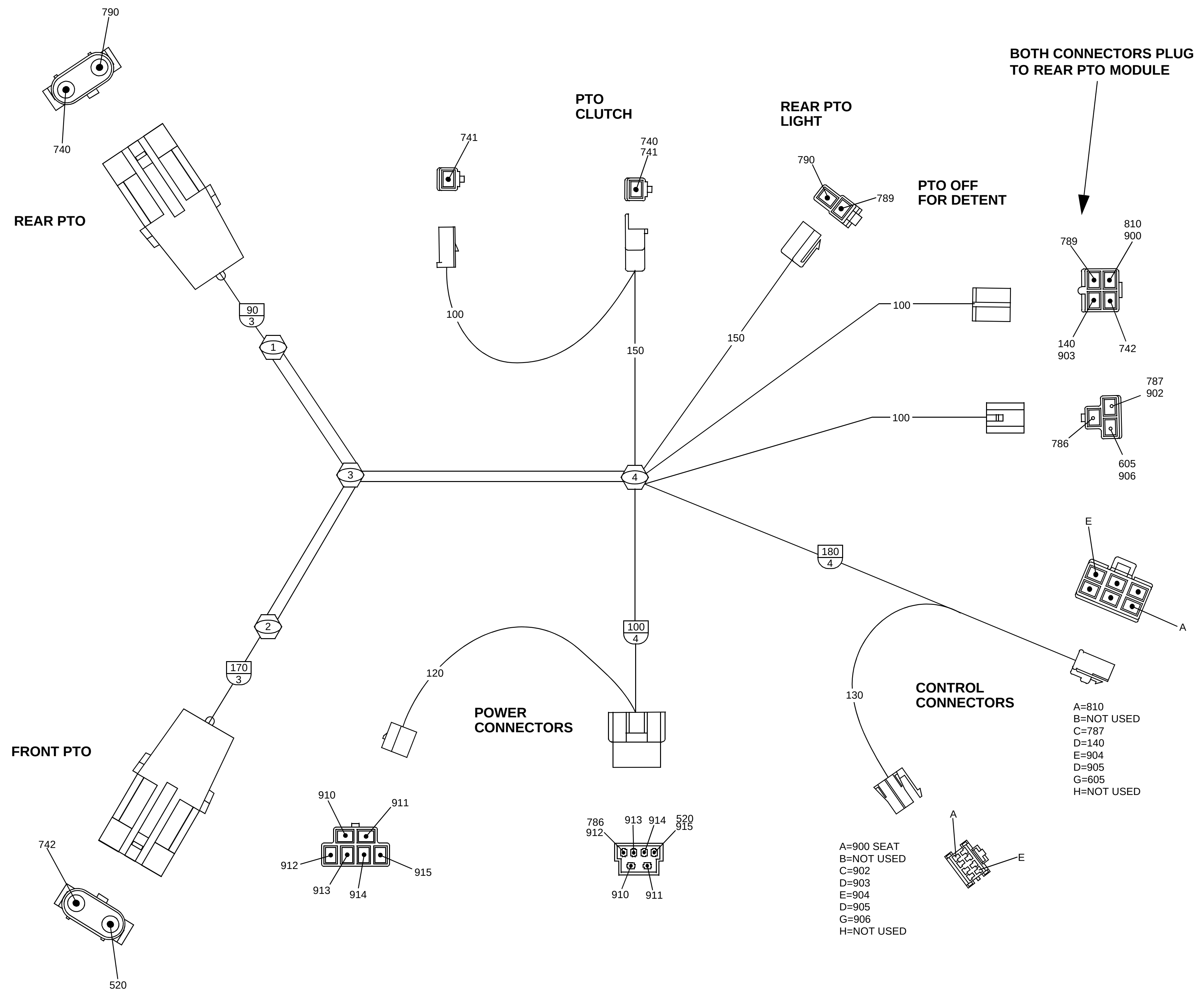


REAR PTO WIRING HARNESS (W2)—445 (S.N. —031361)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
140	0.8	BLK	902	0.8	PUR
520	0.8	YEL	903	0.8	BLK
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—445 (S.N. —031361)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
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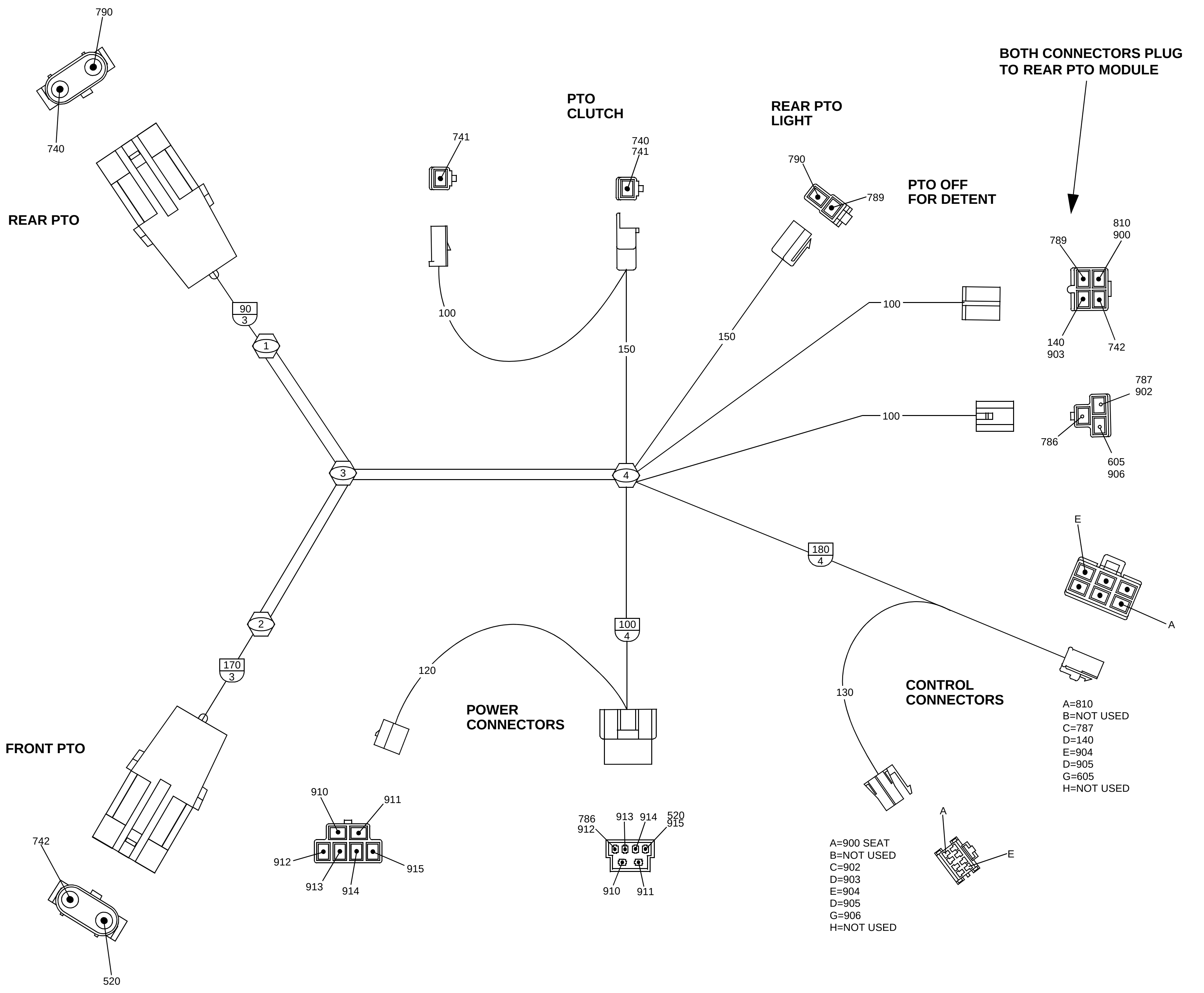
520	0.8	YEL	903	0.8	BLK
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—445 (S.N. —031361)



CIR NUM	WIRE SIZE	COLOR	CIR NUM	WIRE SIZE	COLOR
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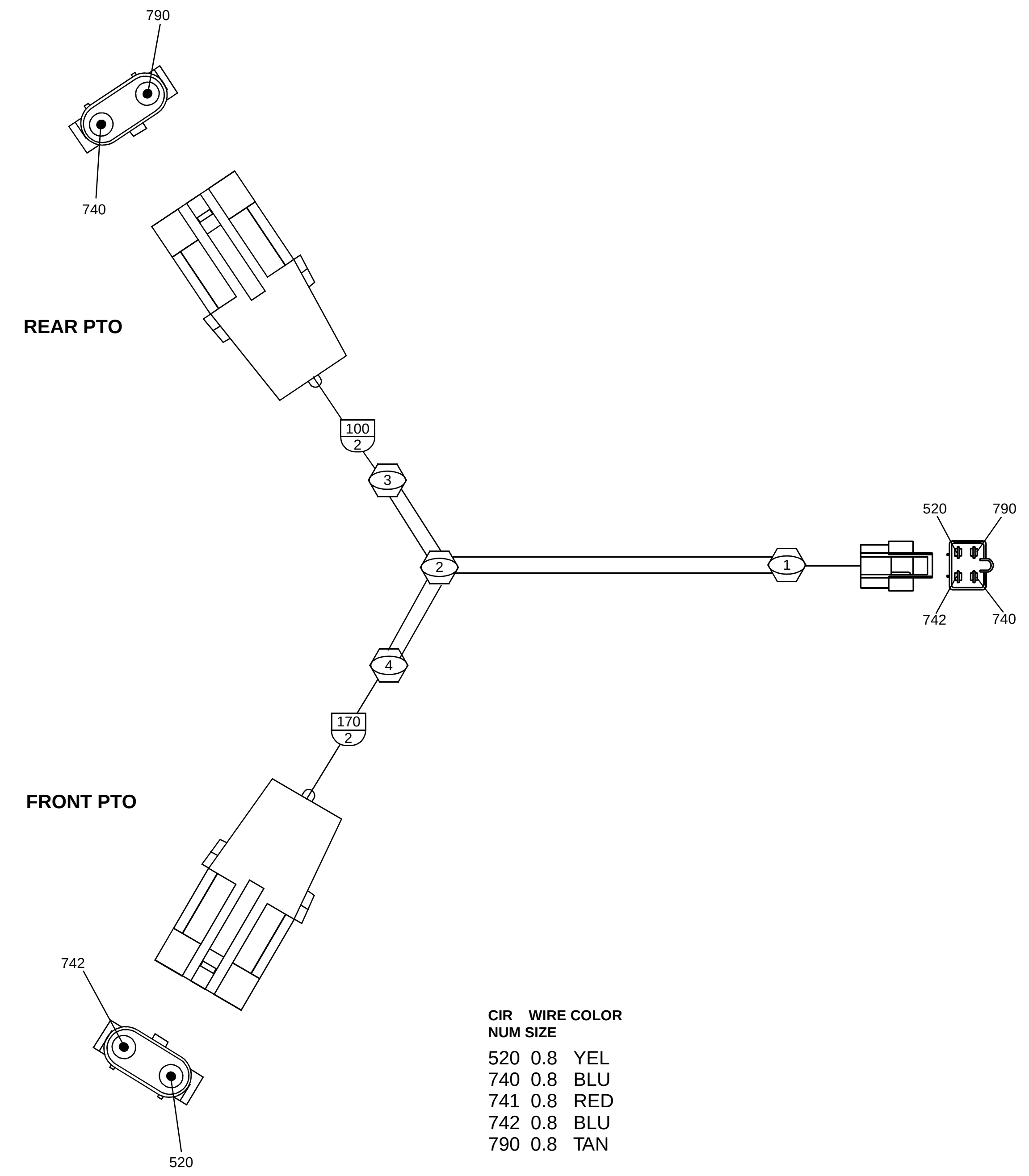
605	0.8	TAN	904	0.8	PNK
740	0.8	BLU	905	0.8	PUR
741	0.8	RED	906	0.8	TAN
742	0.8	BLU	910	0.8	RED/BLK
786	0.8	BLU	911	0.8	BLU
787	0.8	PUR	912	0.8	BLU/WHT
789	0.8	PUR	913	0.8	RED
790	0.8	TAN	914	0.8	PUR
810	0.8	PNK	915	0.8	YEL
900	0.8	PNK/BLK			

REAR PTO WIRING HARNESS (W2)—445 (S.N. 031362—)



CIR NUM	WIRE SIZE	COLOR
520	0.8	YEL
740	0.8	BLU
741	0.8	RED
742	0.8	BLU
790	0.8	TAN

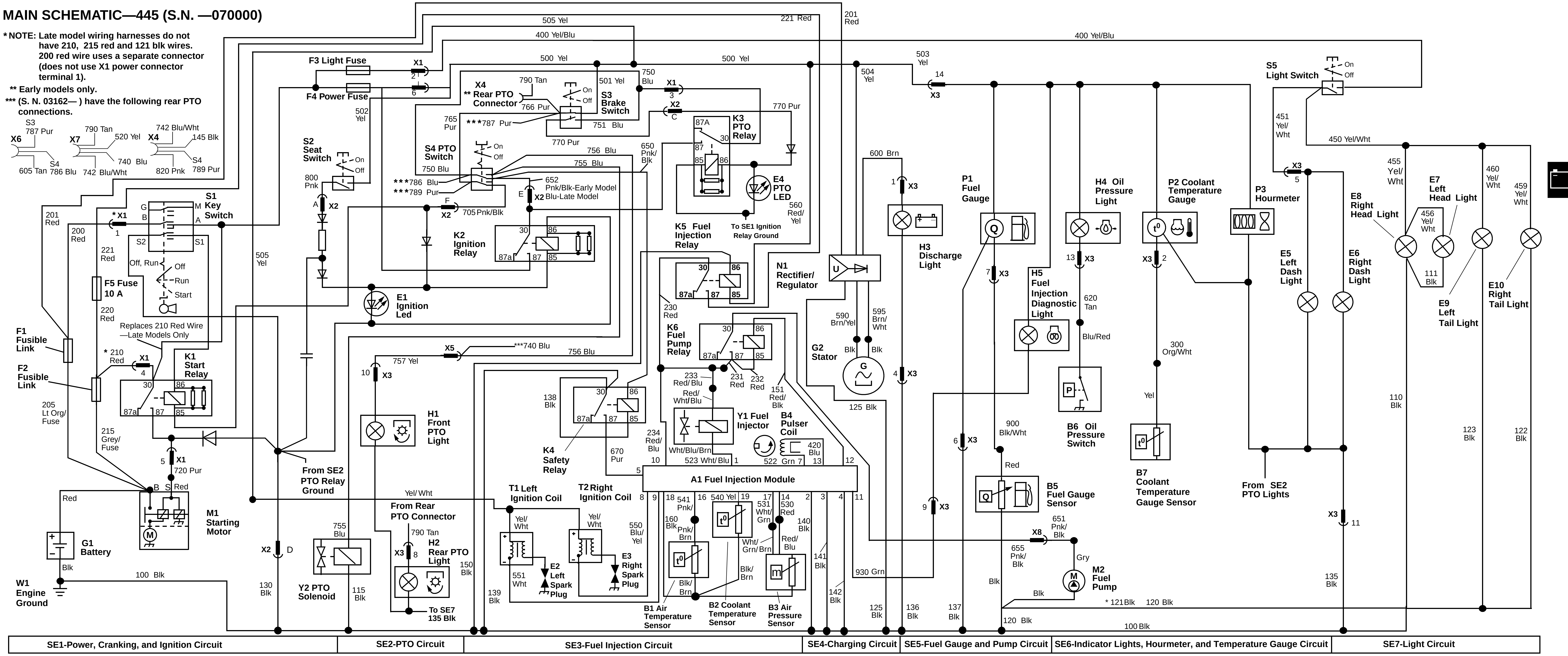
ELECTRICAL SCHEMATICS—445

MAIN SCHEMATIC—445 (S.N. —070000)

* NOTE: Late model wiring harnesses do not have 210, 215 red and 121 blk wires. 200 red wire uses a separate connector (does not use X1 power connector terminal 1).

** Early models only.

*** (S. N. 03162—) have the following rear PTO connections.



ELECTRICAL SCHEMATICS—445

MAIN SCHEMATIC—445 (S.N. —070000)

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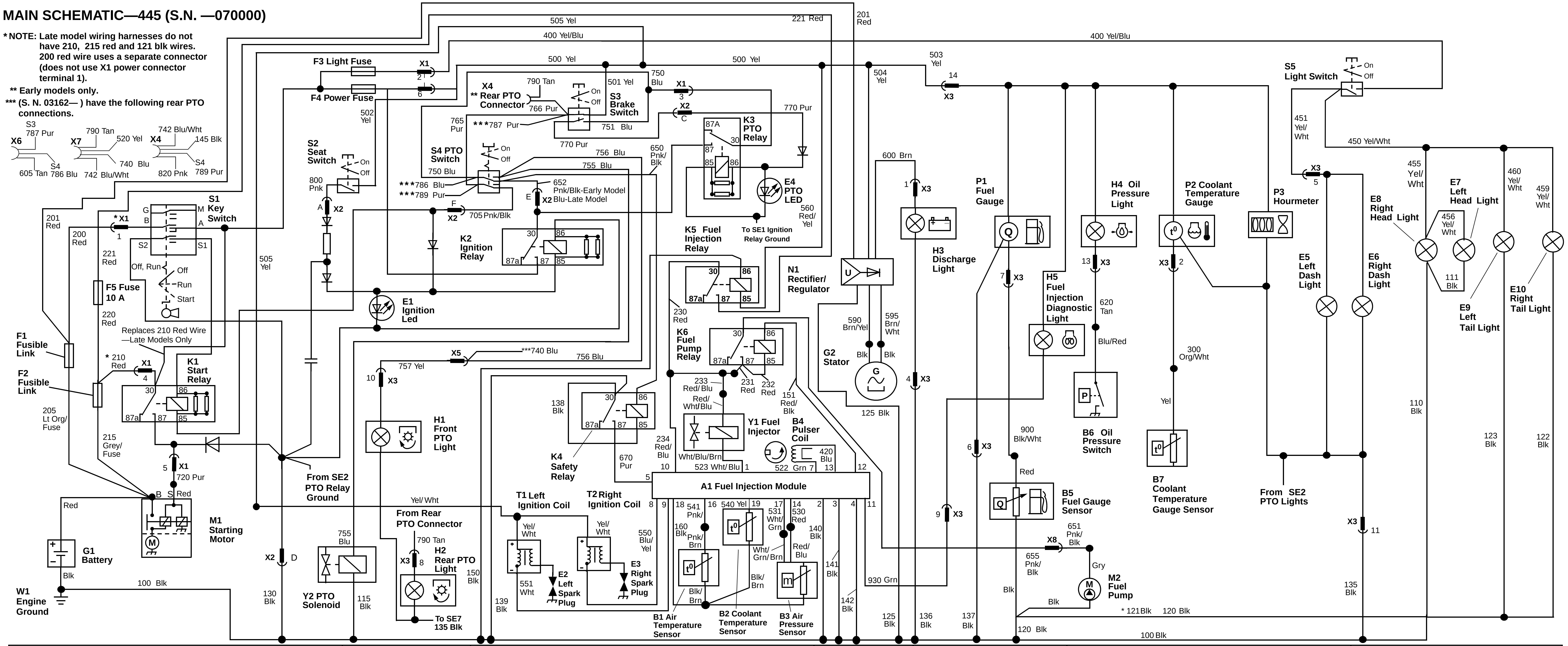

SE1-Power, Cranking, and Ignition Circuit	SE2-PTO Circuit	SE3-Fuel Injection Circuit	SE4-Charging Circuit	SE5-Fuel Gauge and Pump Circuit	SE6-Indicator Lights, Hourmeter, and Temperature Gauge Circuit	SE7-Light Circuit

ELECTRICAL SCHEMATICS—445

MAIN SCHEMATIC—445 (S.N. —070000)

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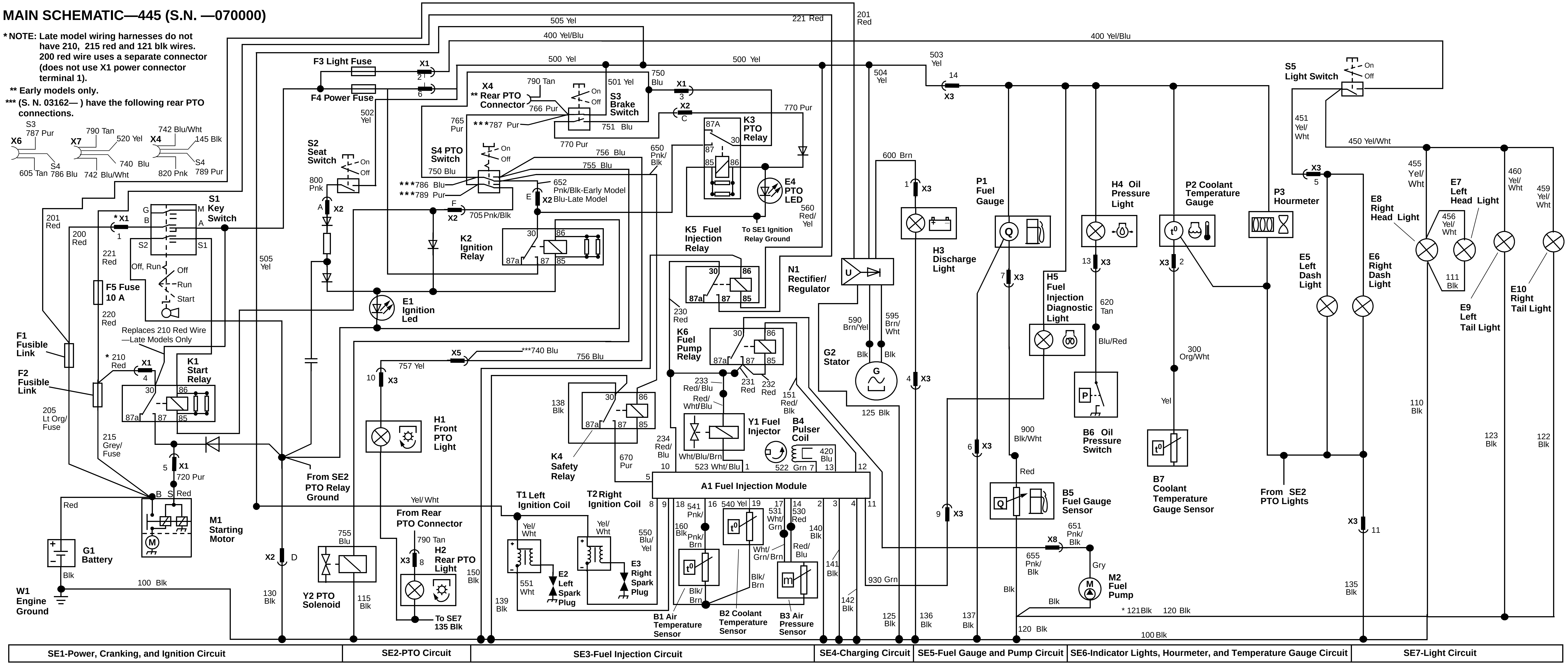

ELECTRICAL SCHEMATICS—445

MAIN SCHEMATIC—445 (S.N. —070000)

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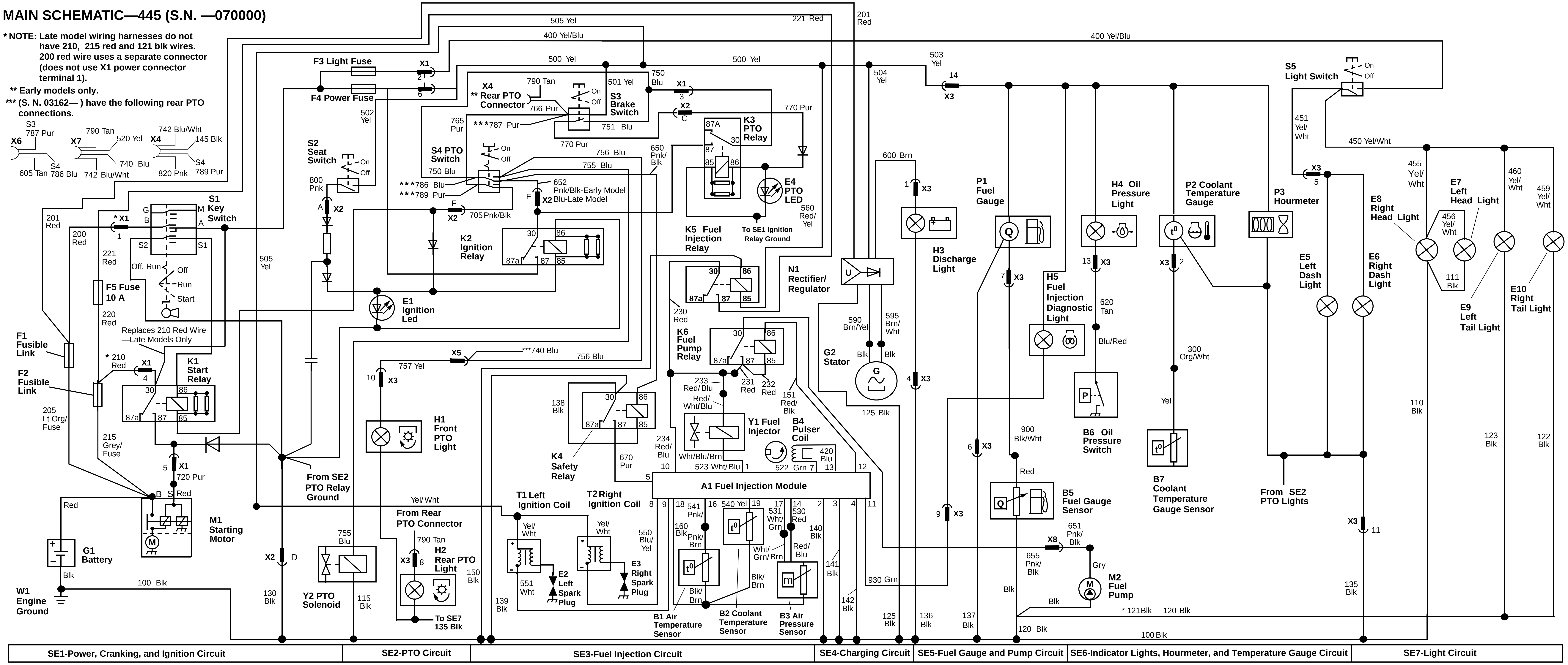
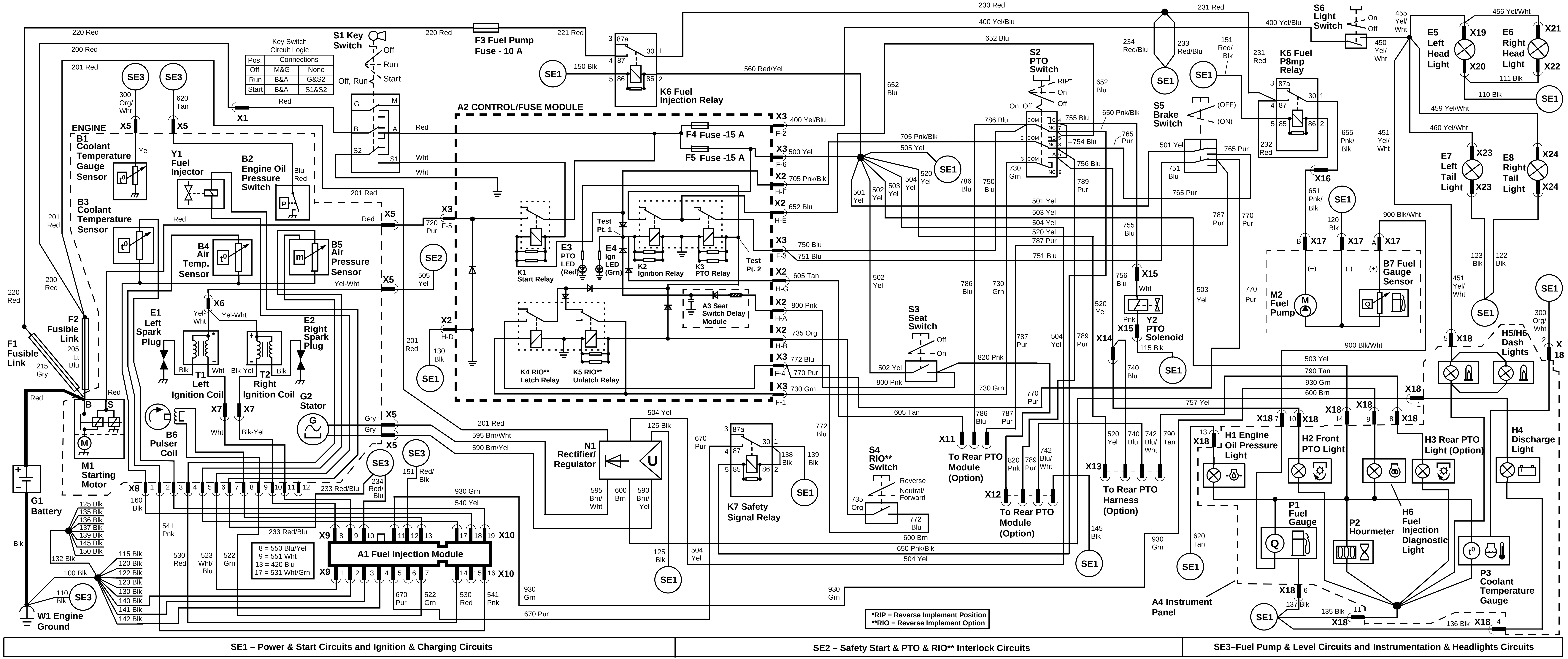
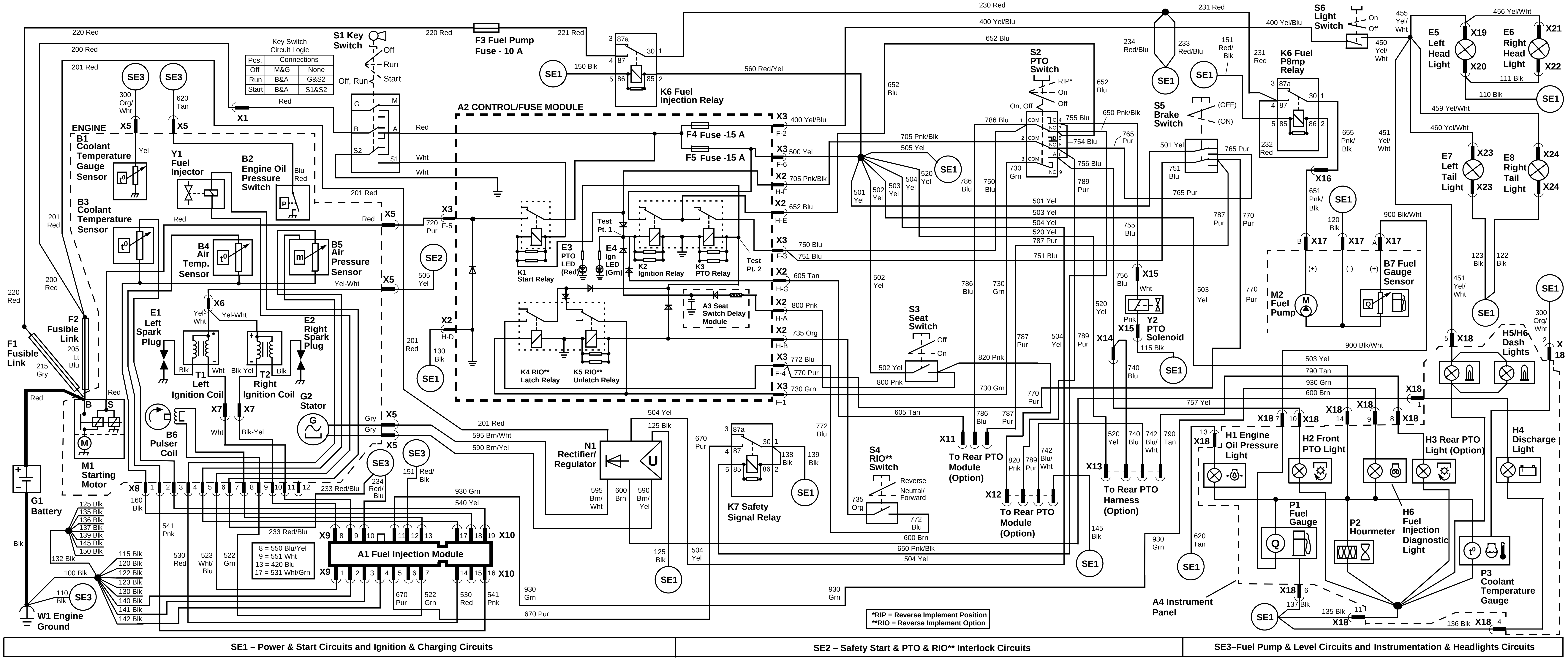


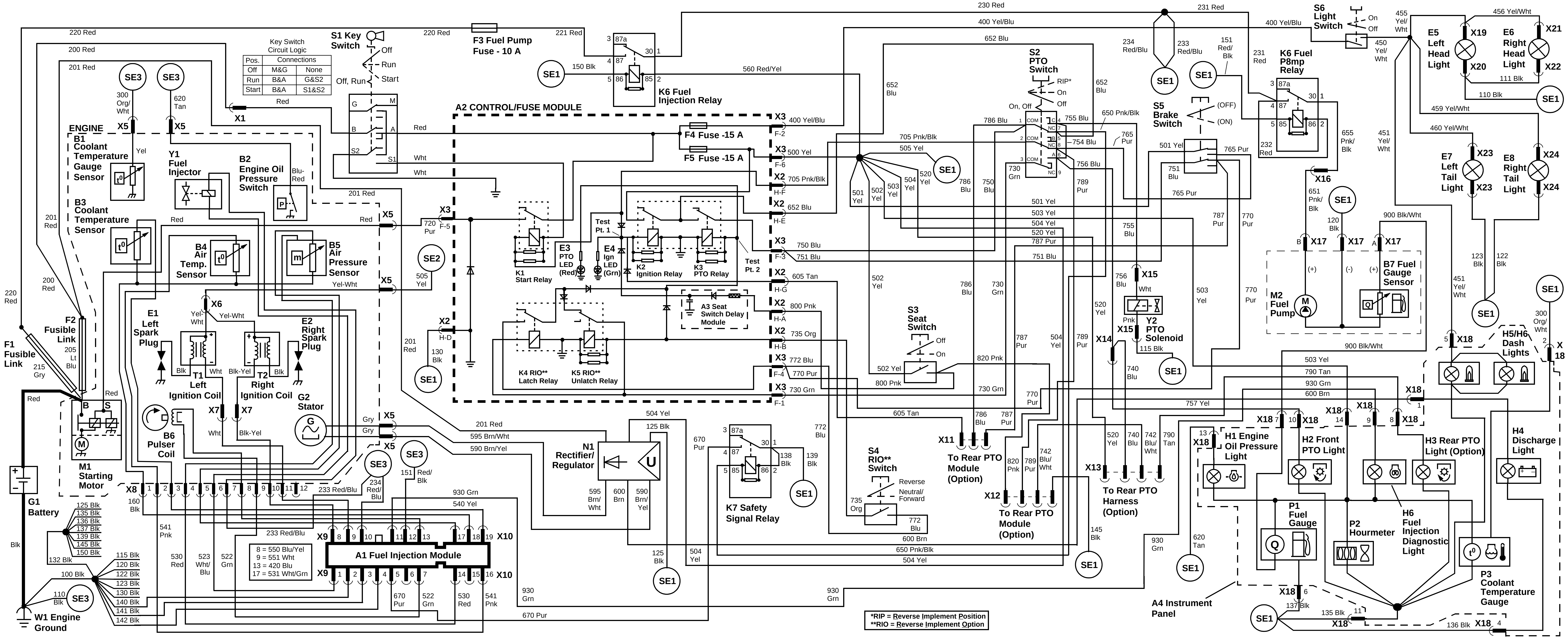
MAIN ELECTRICAL SCHEMATIC (S.N. 070001—)



MAIN ELECTRICAL SCHEMATIC (S.N. 070001—)

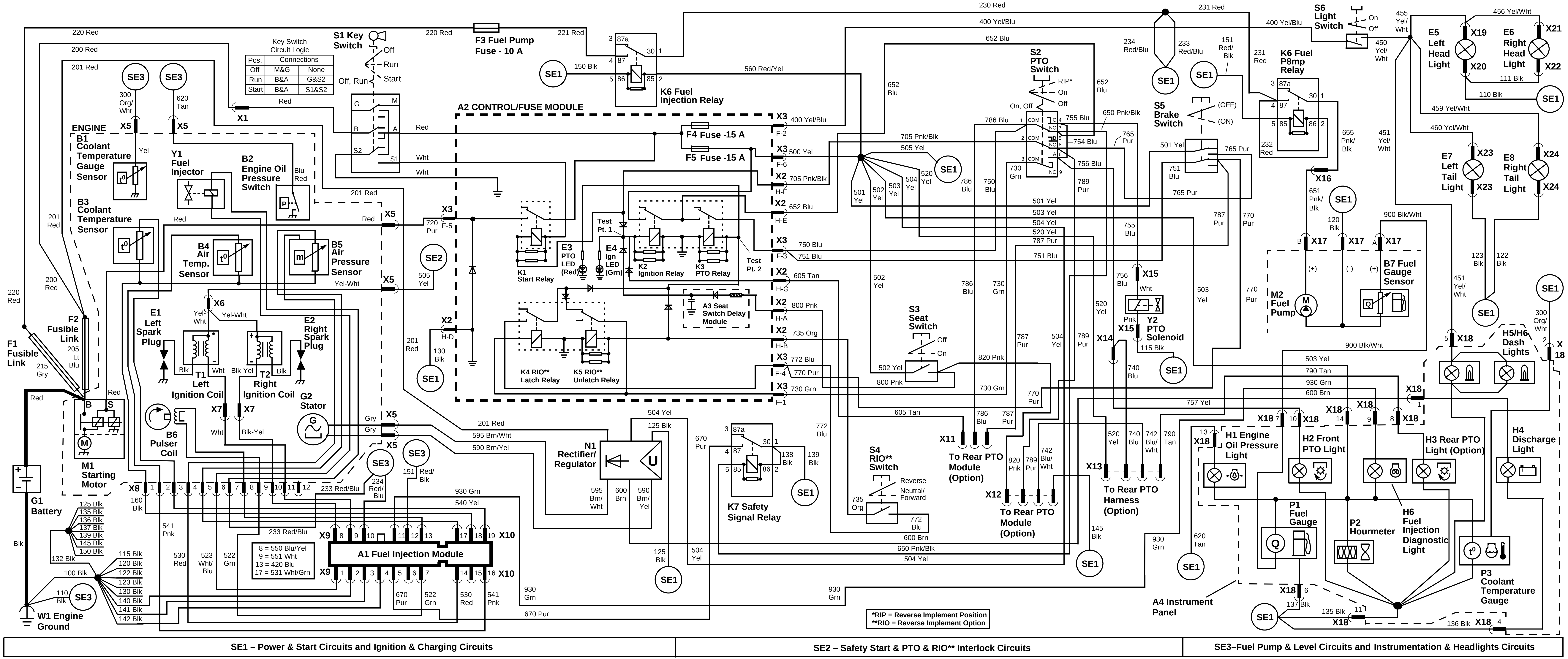


MAIN ELECTRICAL SCHEMATIC (S.N. 070001—)



SE1 – Power & Start Circuits and Ignition & Charging Circuits	SE2 – Safety Start & PTO & RIO** Interlock Circuits	SE3–Fuel Pump & Level Circuits and Instrumentation & Headlights Circuits

MAIN ELECTRICAL SCHEMATIC (S.N. 070001—)



TROUBLESHOOTING—445

ELECTRICAL SYSTEM QUICK TEST—445

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch off position.
- Check connections for corrosion and loose terminals.
- Battery fully charged and in good condition.
- Fuel tank full of fresh clean fuel.

Test/Check Point	Normal	If Not Normal
1. Injection system failure light—turn key switch to run position.	Light on for about 2 seconds and then goes out. Light does not blink—injector sensor diagnostic codes.	Check injection system failure light bulb continuity, if ok, check fuel injection sensor circuit test points. Light blinks diagnostic codes: Long, short, short—check air temperature sensor circuit. Long, short, short, short—check coolant temperature sensor circuit. Long, long, short—check air pressure sensor circuit. Long, long, short, short—key switch turned to start position before light was off, turn key off, then on, wait for light to go off—if light still blinks, check air pressure sensor circuit. Short, long continuously—several sensors have failed at same time—check air temperature, coolant temperature, and air pressure sensor circuits.
2. Fuel pump—turn key switch to off and then to on position, listen for fuel pump operation.	Fuel pump must run for about 2 seconds, listen for humming or ticking noise near injector.	Check fuel pump circuit test points.
3. Dash panel—key switch on.	Oil pressure and charge light on, fuel and temperature gauge needle movement indicates fuel level and engine temperature.	See troubleshooting chart and check problem circuit.
4. Engine starting—turn key switch to start position.	Engine must start.	Engine will not crank—check cranking circuit test points. Engine cranks but will not start—check wiring harness is grounded to engine block, spark, engine speed sensor circuit, injector circuit, and compression. Refer to troubleshooting charts.
5. Engine operation.	Engine must run smoothly.	Check air temperature, coolant temperature, and air pressure sensor circuits. Refer to troubleshooting charts.

ELECTRICAL SYSTEM TROUBLESHOOTING CHART—445

Problem or Symptom / Check or Solution	Engine will not crank	Engine cranks but will not start	Charge light stays on, will not come on, battery over-charges or discharges	415 and 455—Glow plug light does not go on or off; glow plugs do not operate	PTO clutch will not engage PTO light not on	PTO clutch will not disengage	Fuel gauge does not show correct level	No spark
See power circuit diagnosis	●	●	●	●	●		●	●
See charging circuit diagnosis	●		●	●				●
See PTO circuit diagnosis					●	●		
See cranking circuit diagnosis	●							
See fuel gauge circuit diagnosis							●	
See glow plug circuit diagnosis		●		●				
See fuel pump circuit diagnosis		●						
See ignition circuit diagnosis		●						●
Check ground circuit	●	●	●		●		●	●
Check for shorted circuit	●	●	●		●		●	●

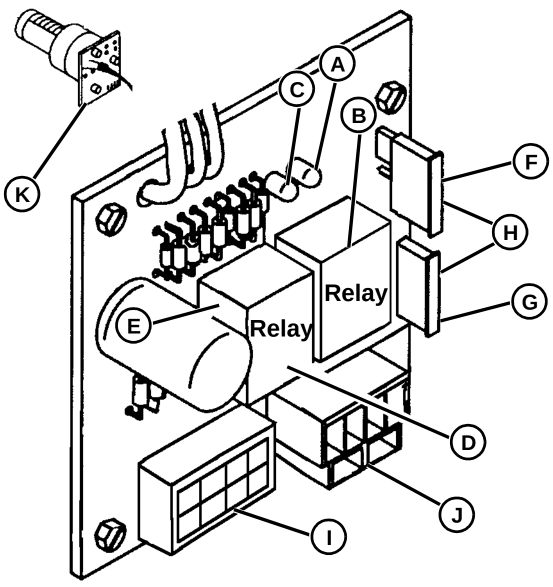
ELECTRICAL SYSTEM TROUBLESHOOTING CHART—445 (continued)

Problem or Symptom / Check or Solution	Coolant temperature gauge problem	Oil pressure light stays on, or will not come on	Hourmeter does not run	Head lights, tail lights, or dash lights do not come on	Engine stops when PTO is engaged or when brake pedal is released	No indicator lights come on	ignition LED or PTO LED lights not on	No components operate	Ignition or PTO continues to run with operator off seat
See power circuit diagnosis	●		●	●	●	●	●	●	
See charging circuit diagnosis						●		●	
See PTO circuit diagnosis					●	●	●		
See coolant temperature gauge circuit diagnosis	●								
See oil pressure light circuit diagnosis		●				●			
See hourmeter circuit diagnosis			●						
See lights circuit diagnosis				●					
See ignition circuit diagnosis					●				
Check ground circuit					●				
Check for shorted circuit					●				

NOTES

CONTROL/FUSE MODULE—445

IMPORTANT: The only way to determine the actual cause of a problem is to conduct the system and component tests.



M46304a

The two small LEDs (light emitting diodes) that are a part of the control/fuse module can be used to make a quick check of some of the circuits of the machine. The LEDs will not determine the exact location of the problem. When the LEDs are on, this indicates power is available to the ignition and PTO relays. When the LEDs are off, no power is present at the ignition and PTO relays. If the LEDs are off, they are not an indicator of the failure of the printed circuit board.

The ignition green LED (A) indicates that there is power to the ignition relay (B) coil through either of the following circuits:

- Key switch on and operator on seat (run circuit).
- Key switch on, PTO turned off, and park brake engaged (neutral start circuit).

The PTO red LED (C) indicates that there is power to the PTO relay (D) coil through either of the following circuits:

- Key switch on, operator on seat, park brake disengaged, and PTO turned off (PTO pre-operation circuit).
- Key switch on, operator on seat, PTO turned on, park brake disengaged, and ignition relay engaged (PTO operation circuit).

When diagnosing a problem using the LED's, and the LED's are off, check that part of the circuit before the control/fuse module LED's (neutral start or PTO pre-operation circuit). When the LED's are on, check that part of the circuit after the control/fuse module LED's. Tests for voltage or ground will be at the control connector (I) or the power connector (J) of the control/fuse module and not on the printed circuit board paths.

The ignition relay (B), PTO relay (D), start relay (E), fuse terminals (H), key switch (K), ignition LED (A), and PTO LED (C) are mounted on a printed circuit board. The components are solid state and are not serviced separately except for the 15 amp fuses.

A—Ignition or Hold-In LED

B—Ignition Relay (K2)

C—PTO Red LED

D—PTO Relay (K3)

E—Start Relay (K1)

F—Ignition Hold-In Fuse

G—Head Light Fuse

H—Fuse Terminals

I—Control Connector (X1)

J—Power Connector (X2)

K—Key Switch (S1)

CIRCUIT OPERATION AND DIAGNOSIS—445

POWER CIRCUIT OPERATION—445 (S.N. —070000)

Function:

To provide battery power to the primary machine components through main current paths.

Operating Conditions:

Voltage must be present at the following components for the other circuits to operate:

- B Terminal of Starting Motor
- Fusible Links
- B Terminal of Key Switch
- Control/fuse Module
- Control/fuse Module Fuses
- Fuel Injection Fuse

System Operation:

With the key switch (S1) in the off position, unswitched current from the battery positive terminal flows to the starter solenoid battery terminal (M1), fusible links (F1), key switch battery terminal, start relay (K1), fuel injection fuse (F1), fuel injection relay (K5), and the rectifier/regulator (N1). With the key switch in the run position, current flows from key switch B to A terminal, fuses (F3, F4), seat switch (S2), ignition relay (K2), brake switch (S3), fuel injection relay (K5), left ignition coil (T1), right ignition coil (T2), rectifier/regulator (N1), oil pressure light (H4), coolant temperature gauge (P2), fuel gauge (P1), injection system failure light (H5), and light switch (S5). With the key switch in the start position, terminals S1 and S2 provide a path to ground for the start relay.

POWER CIRCUIT OPERATION—445 (S.N. 070001—)

Function:

To provide battery power to the primary machine components through main current paths.

Operating Conditions:

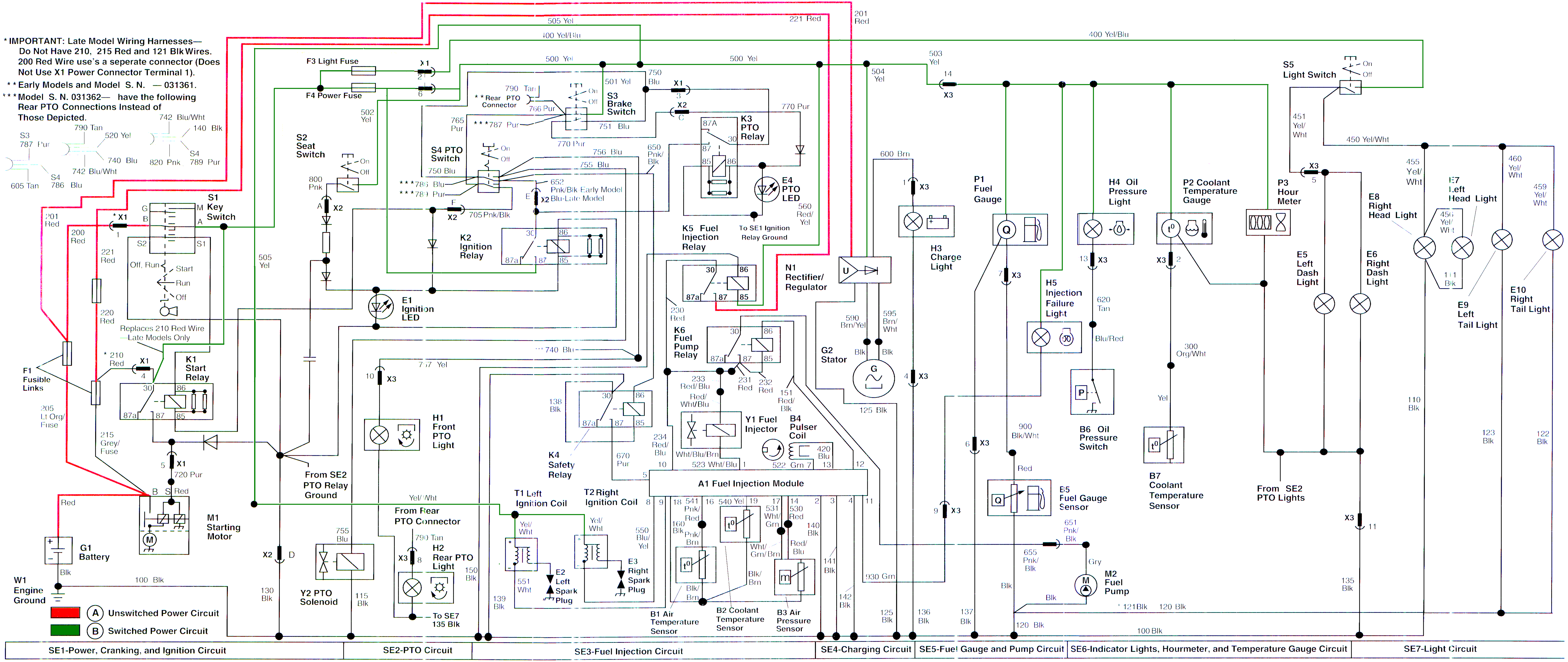
Voltage must be present at the following components for the other circuits to operate:

- B Terminal of Starting Motor
- Fusible Links
- B Terminal of Key Switch
- Control/fuse Module
- Control/fuse Module Fuses
- Ignition Delay Module

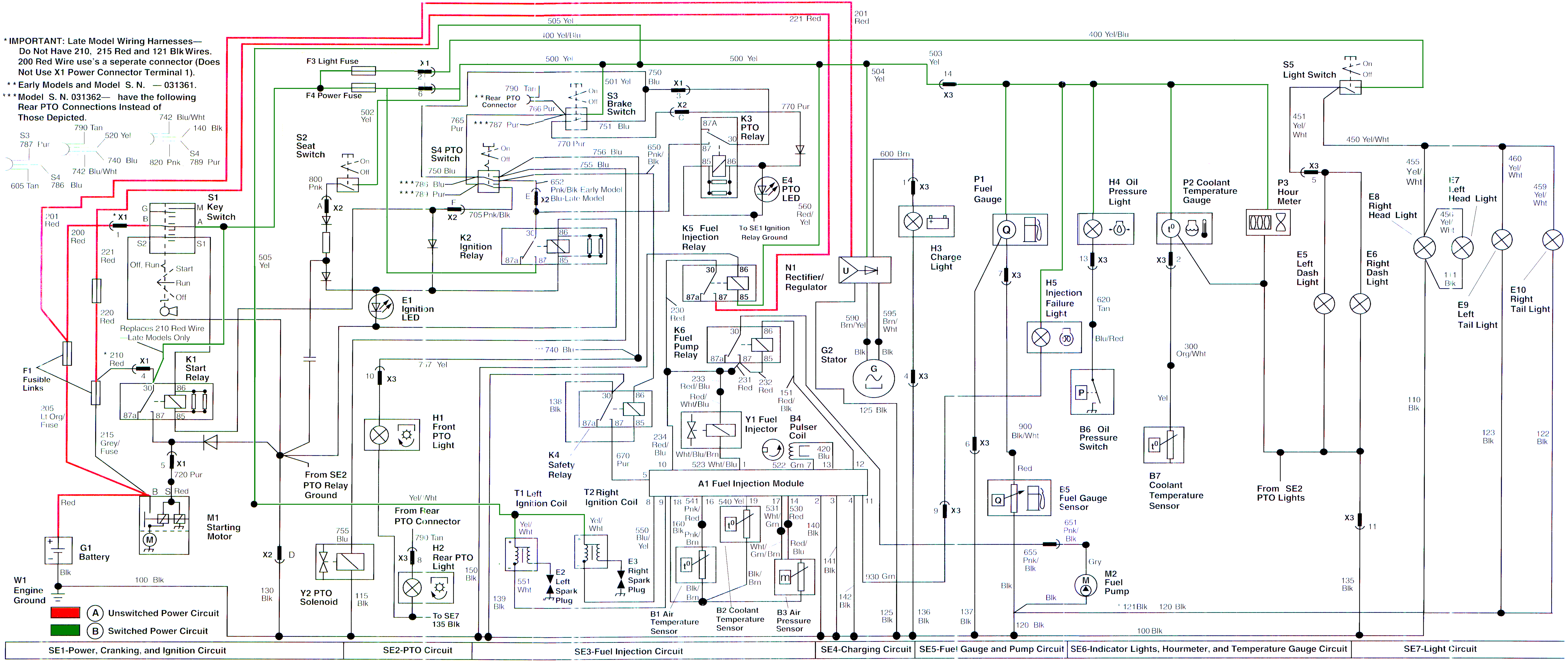
System Operation:

With the key switch (S1) in the off position, unswitched current from the battery positive terminal flows to the battery terminal (B) of starting motor (M1), fusible links (F1, F2), battery terminal on key switch (S1), rectifier/regulator (N1), start relay (K1), ignition delay module (A1), rectifier/regulator (N1), fuel pump fuse (F3), and contacts of fuel injection relay (K6). With the key switch in the run position, current flows from terminal B to terminal A of the key switch and then to fuses (F4, F5), lights switch (S6), ignition relay (K2), brake switch (S5), seat switch (S3), instrument panel (A4), rear PTO harness connector (X13), ignition coils (T1, T2), and the coil of fuel injection relay (K6). With the fuel injection relay energized, current flows through the relay contacts to fuel pump relay (K3), fuel injector (Y1), and fuel injection module (A1).

POWER CIRCUIT SCHEMATIC—445 (S.N. —070000)



POWER CIRCUIT SCHEMATIC—445 (S.N. —070000)



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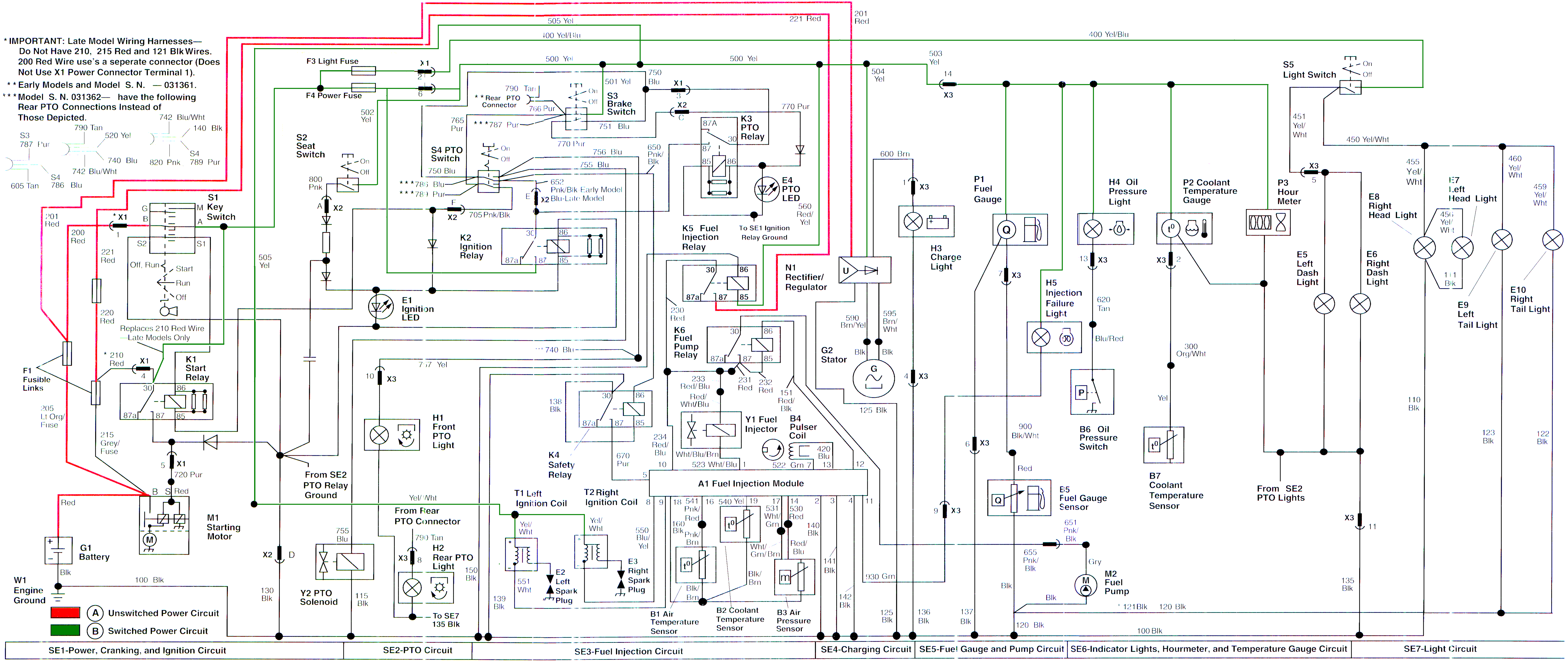
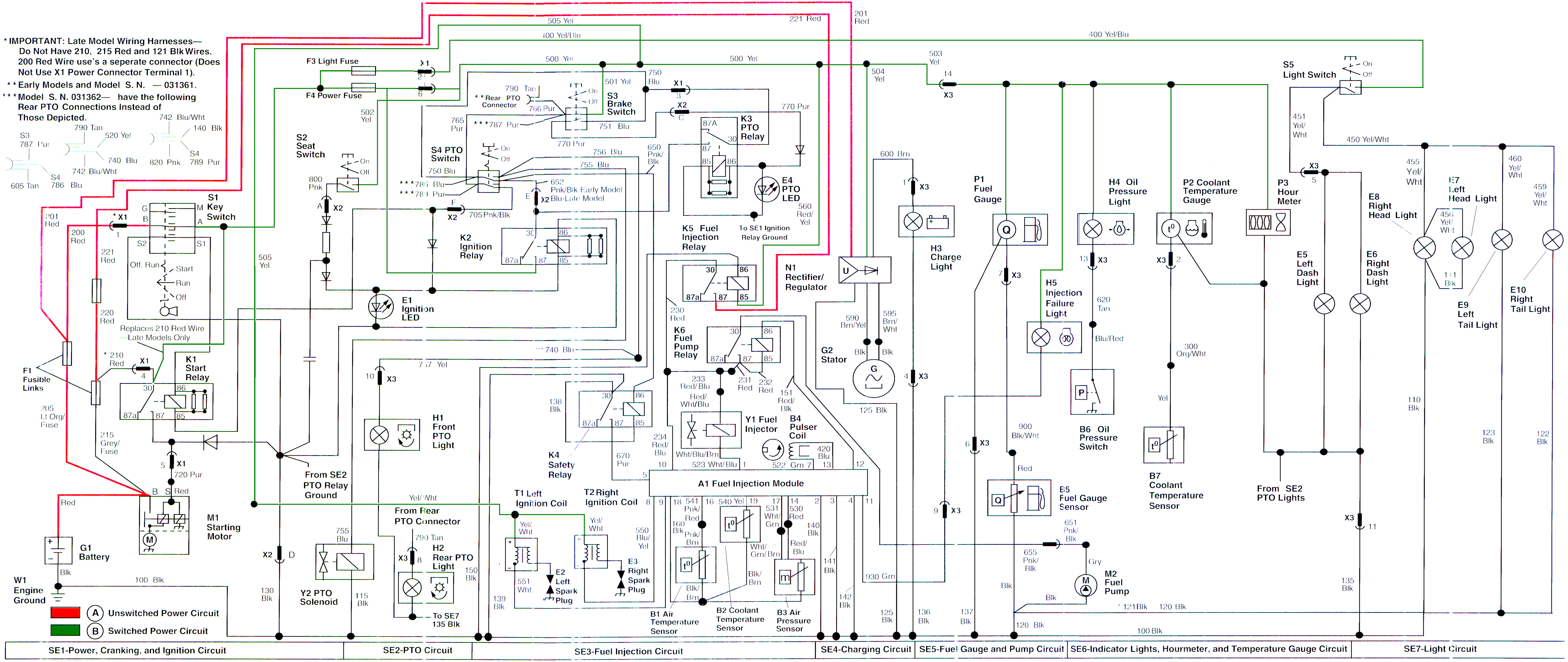
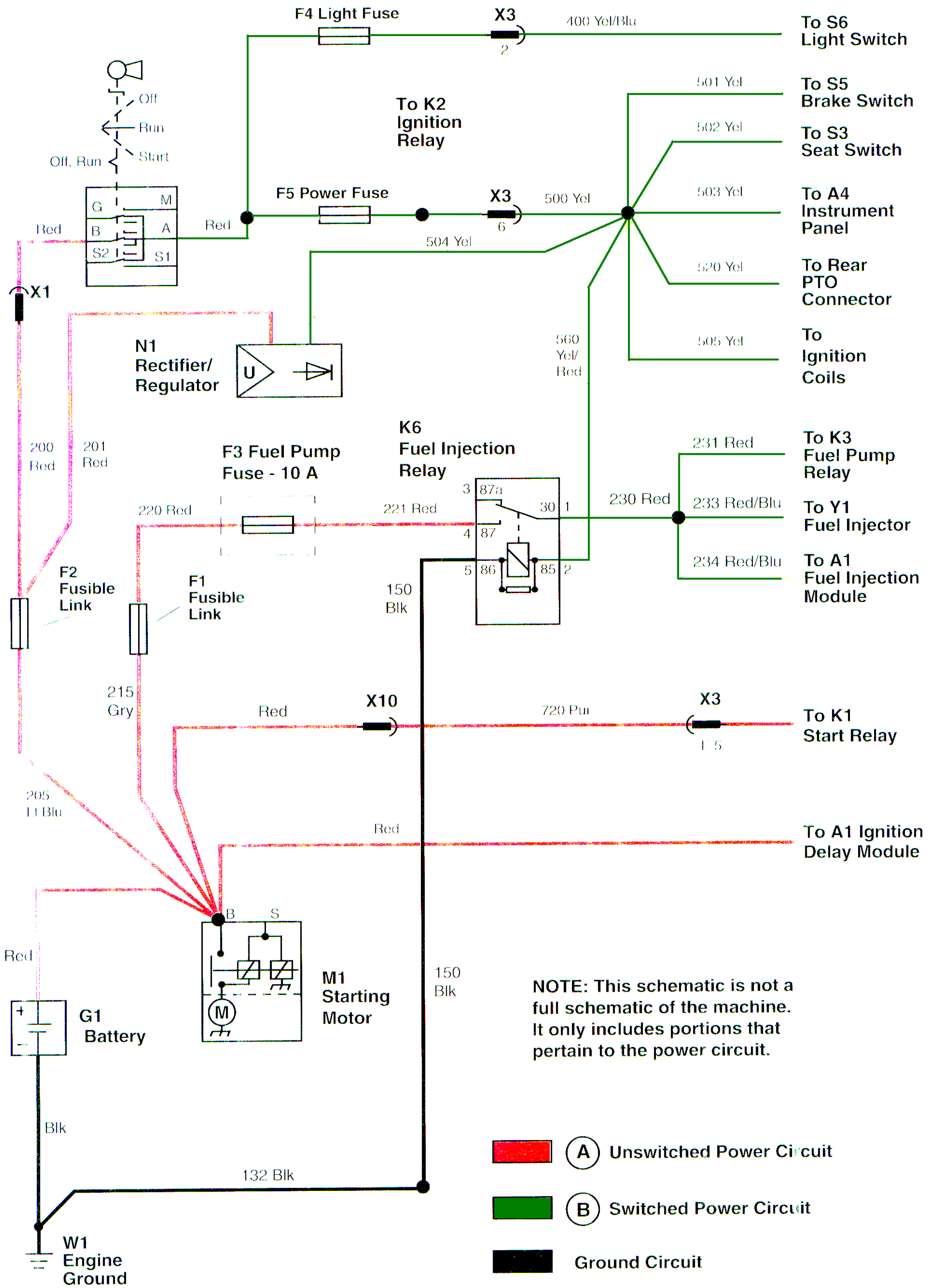


POWER CIRCUIT SCHEMATIC—445 (S.N. —070000)



POWER CIRCUIT SCHEMATIC—445 (S.N. 070001—)



NOTE: This schematic is not a full schematic of the machine. It only includes portions that pertain to the power circuit.

A Unswitched Power Circuit

B Switched Power Circuit

Ground Circuit

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POWER CIRCUIT DIAGNOSIS—445 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

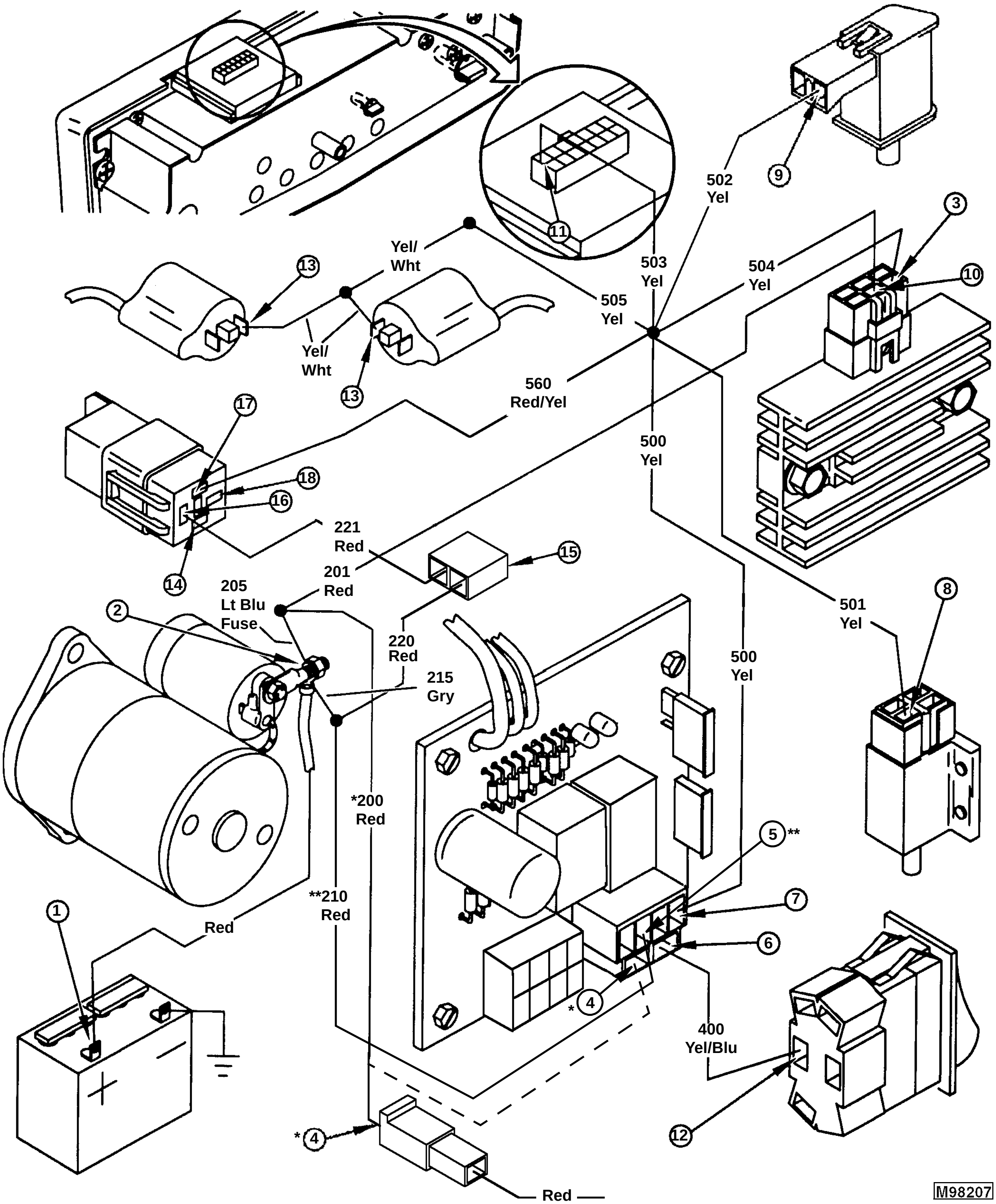
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Rectifier/regulator.	Battery voltage.	Check 201 red wire, and 205 lt blu wire (fusible link).
4. Early models—Control/fuse module terminal 1. Late models—Key switch power connector.	Battery voltage.	Check 200 red wire.
5. early models only—Control/fuse module terminal 4.	Battery voltage.	Check 210 red wire.
6. Control/fuse module terminal 2.	Battery voltage.	Check light fuse (F4), if ok replace control/fuse module.
7. Control/fuse module terminal 6.	Battery voltage.	Check power fuse (F5), if ok replace control/fuse module.
8. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
9. Seat switch.	Battery voltage.	Check 502 yel wire.
10. Rectifier/regulator.	Battery voltage.	Check 504 yel wire.
11. Instrument panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
12. Lights switch.	Battery voltage.	Check 400 yel/blu wire.
13. Ignition coils.	Battery voltage.	Check 500 yel, and yel/wht wire connections.

Test Conditions:

- Key switch in off position.
- Fuel injection relay disconnected.

Test/Check Point	Normal	If Not Normal
14. Fuel injection relay, terminal 86.	Maximum 0.1 ohms resistance.	Check 150, 132, and 100 blk wires.

POWER CIRCUIT TEST POINTS—445 (S.N. —070000)



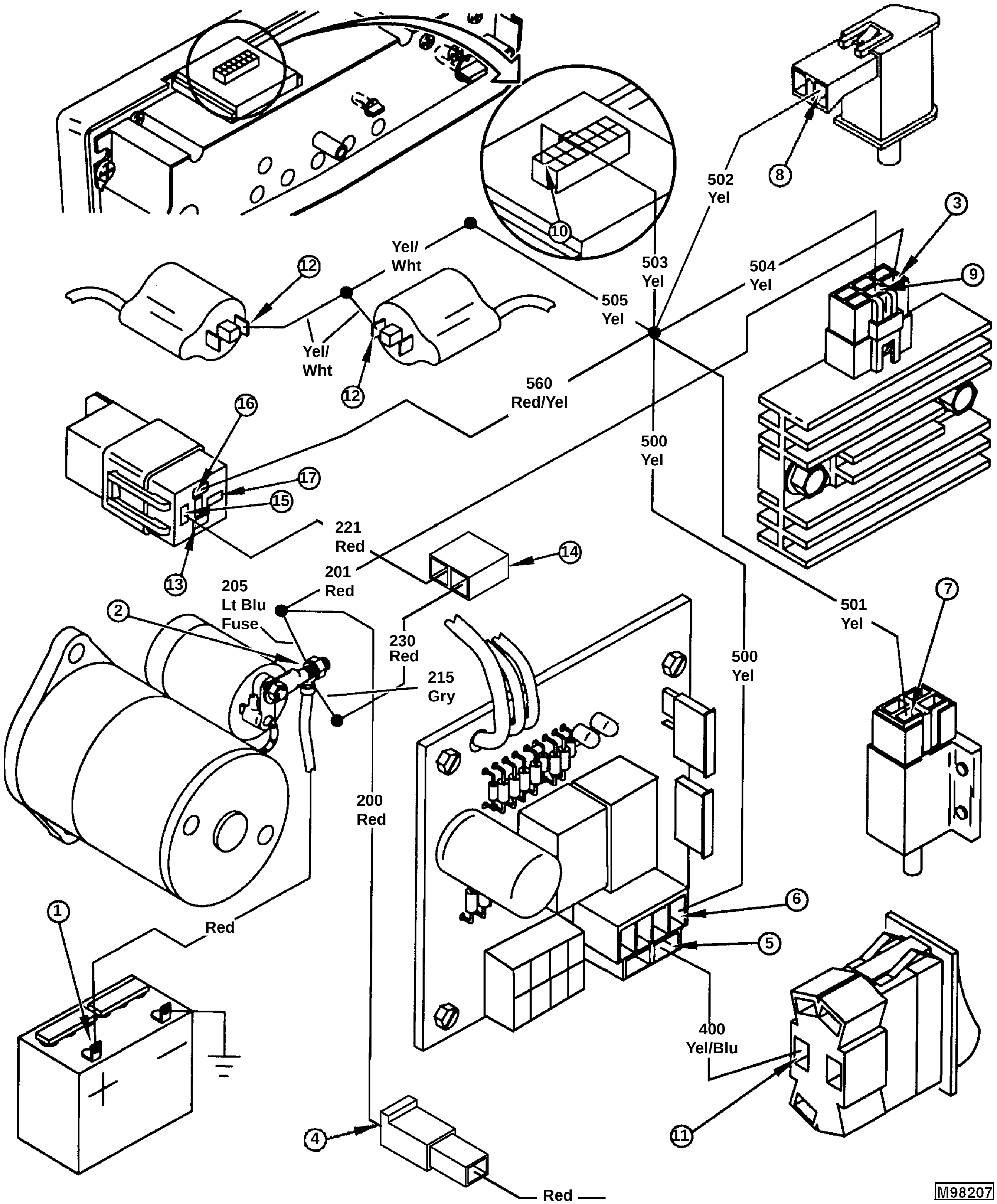
POWER CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)

Test Conditions:

- Key switch in run position.
- Fuel injection relay connected.

Test/Check Point	Normal	If Not Normal
15. F3 fuse - 10 A.	Battery voltage.	Check 220 red wire, and 215 Gry wire (fusible link).
16. Fuel injection relay, terminal 87.	Battery voltage.	Check fuel injection fuse and 221 red wire.
17. Fuel injection relay, terminal 85.	Battery voltage.	Check 560 yel/red wire.
18. Fuel injection relay, terminal 30.	Battery voltage.	Check fuel injection relay.

POWER CIRCUIT TEST POINTS—445 (S.N. —070000) (continued)



POWER CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

Test Conditions:

- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

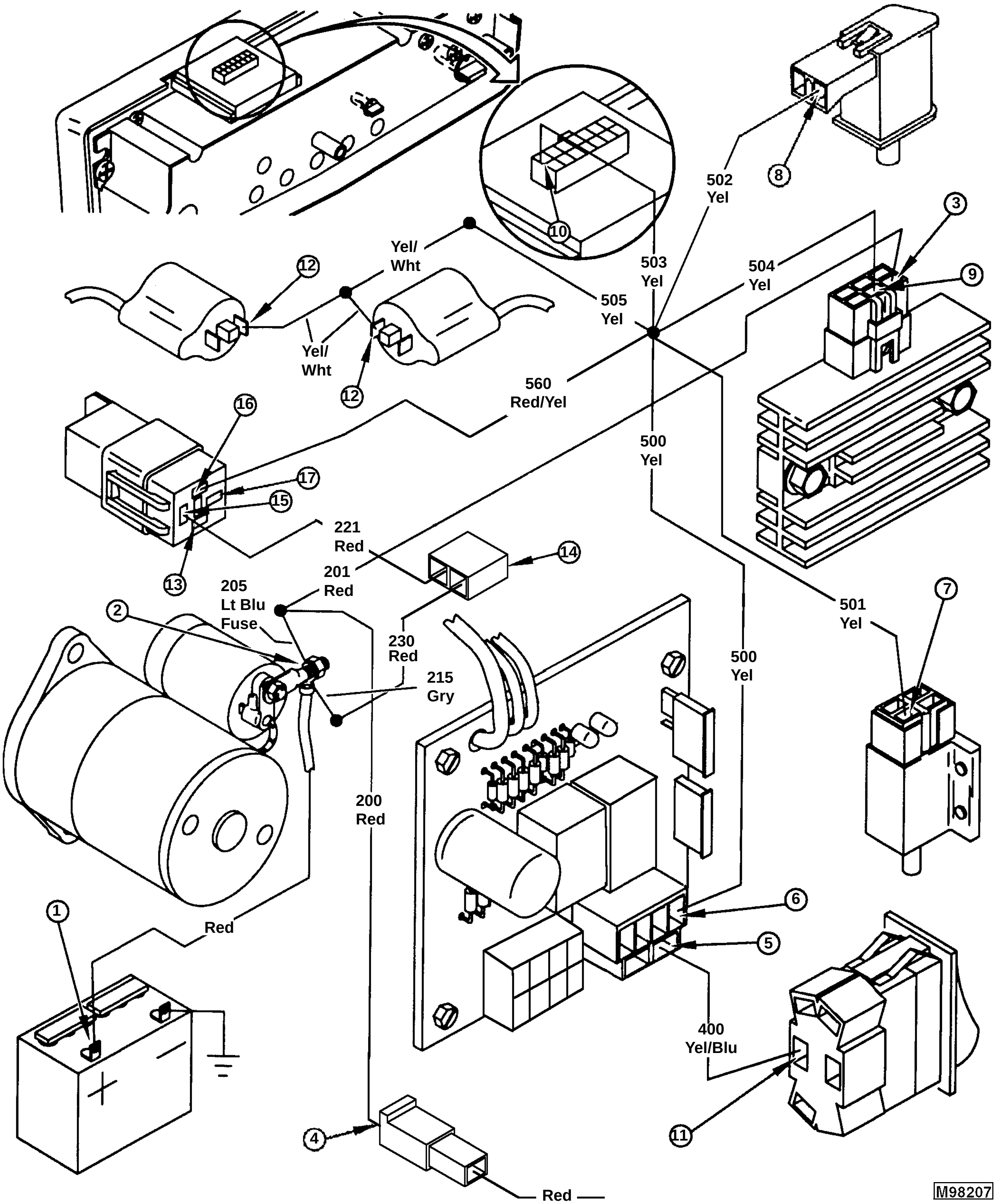
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Starter solenoid terminal B.	Battery voltage.	Check battery cable and connection.
3. Rectifier/regulator.	Battery voltage.	Check 201 red wire, and 205 lt blu wire (fusible link).
4. Key switch power connector.	Battery voltage.	Check 200 red wire.
5. Control/fuse module terminal 2.	Battery voltage.	Check light fuse (F4), if ok replace control/fuse module.
6. Control/fuse module terminal 6.	Battery voltage.	Check power fuse (F5), if ok replace control/fuse module.
7. Brake switch.	Battery voltage.	Check 500 and 501 yel wire.
8. Seat switch.	Battery voltage.	Check 502 yel wire.
9. Rectifier/regulator.	Battery voltage.	Check 504 yel wire.
10. Instrument panel connector terminal 14.	Battery voltage.	Check 503 yel wire.
11. Lights switch.	Battery voltage.	Check 400 yel/blu wire.
12. Ignition coils.	Battery voltage.	Check 500 yel, and yel/wht wire connections.

Test Conditions:

- Key switch in off position.
- Fuel injection relay disconnected.

Test/Check Point	Normal	If Not Normal
13. Fuel injection relay, terminal 86.	Maximum 0.1 ohms resistance.	Check 150 blk and 132 blk wires.

POWER CIRCUIT TEST POINTS—445 (S.N. 070001—)



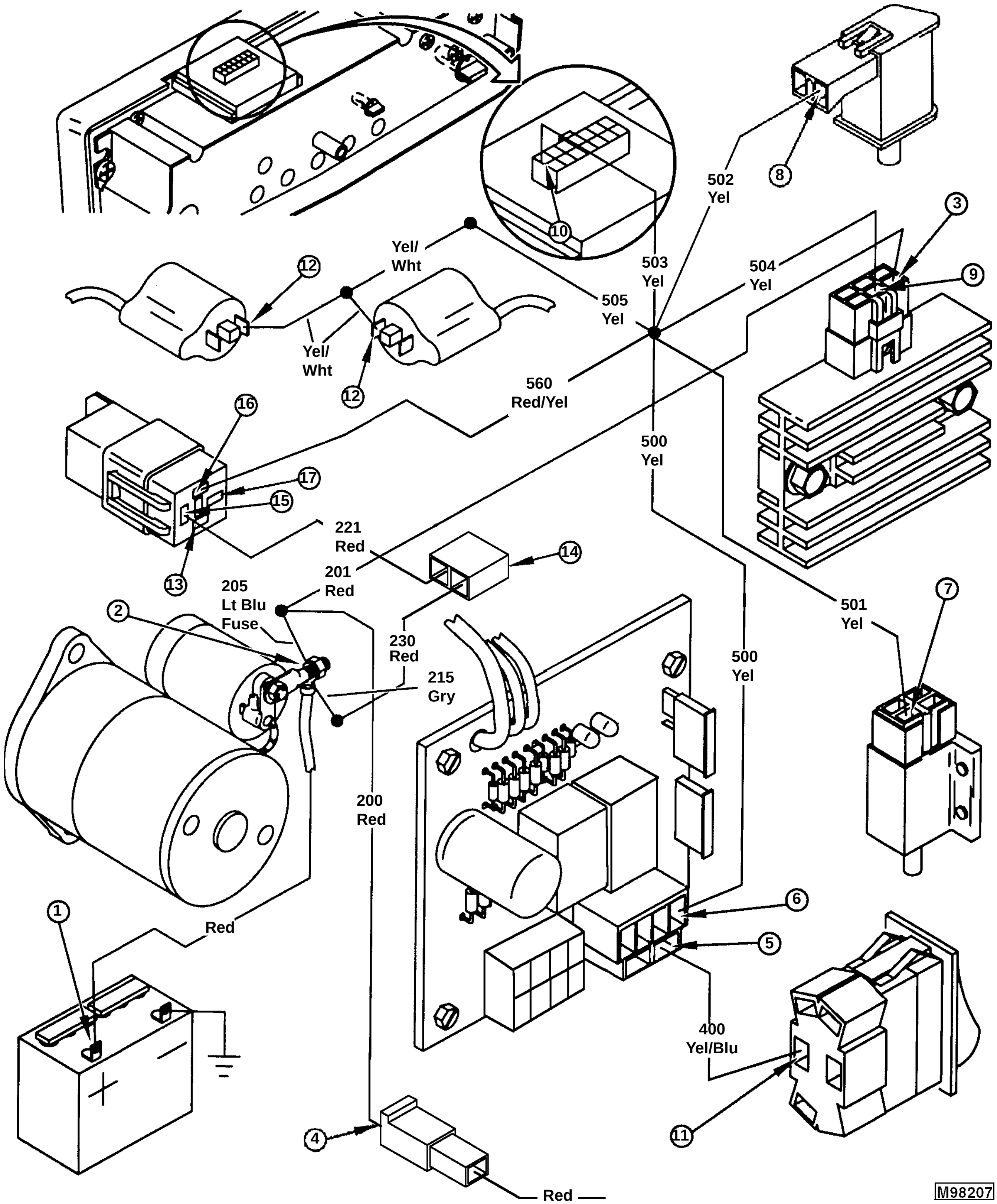
POWER CIRCUIT DIAGNOSIS—445 (S.N. 070001—) (continued)

Test Conditions:

- Key switch in run position.
- Fuel injection relay connected.

Test/Check Point	Normal	If Not Normal
14. F3 fuse - 10 A.	Battery voltage.	Check 220 red wire, and 215 Gry wire (fusible link).
15. Fuel injection relay, terminal 87.	Battery voltage.	Check fuel injection fuse and 221 red wire.
16. Fuel injection relay, terminal 85.	Battery voltage.	Check 560 yel/red wire.
17. Fuel injection relay, terminal 30.	Battery voltage.	Check fuel injection relay.

POWER CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



CRANKING CIRCUIT OPERATION—445 (S.N. —070000)

Function:

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

Operation Conditions:

To crank the engine, the key switch must be in the start position, with the PTO switch off (PTO switch closed), and the park brake engaged (brake switch closed).

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1), key switch terminal B (S1), and start relay (K1). Current from the start relay cannot flow to the starter solenoid until the relay is energized. The start relay receives the energizing current from the neutral start circuit.The neutral start circuit prevents the engine from cranking if the PTO is engaged, or the park brake is not engaged.

With the key switch in the start position, current flows from terminal B to terminal A, 15-amp fuse (F4), park brake switch (S3) (park brake pedal engaged), PTO switch (S4) (PTO disengaged), and start relay coil terminal (K1).

A ground circuit for the start relay coil must be provided for the relay to energize. With the key switch in the start position, current flows to ground through the key switch terminals S1 and S2, energizing the start relay coil which closes the relay.

With the relay closed, current flows to the starter solenoid, engaging the solenoid. The solenoid is engaged by current flowing through both the pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in winding stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

CRANKING CIRCUIT OPERATION—445 (S.N. 070001—)

Function:

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

Operation Conditions:

To crank the engine, the key switch must be in the start position, with the PTO switch off (PTO switch closed), and the park brake engaged (brake switch closed).

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F2), key switch terminal B (S1), and start relay (K1). Current from the start relay cannot flow to the starter solenoid until the relay is energized. The start relay receives the energizing current from the neutral start circuit.The neutral start circuit prevents the engine from cranking if the PTO is engaged, or the park brake is not engaged.

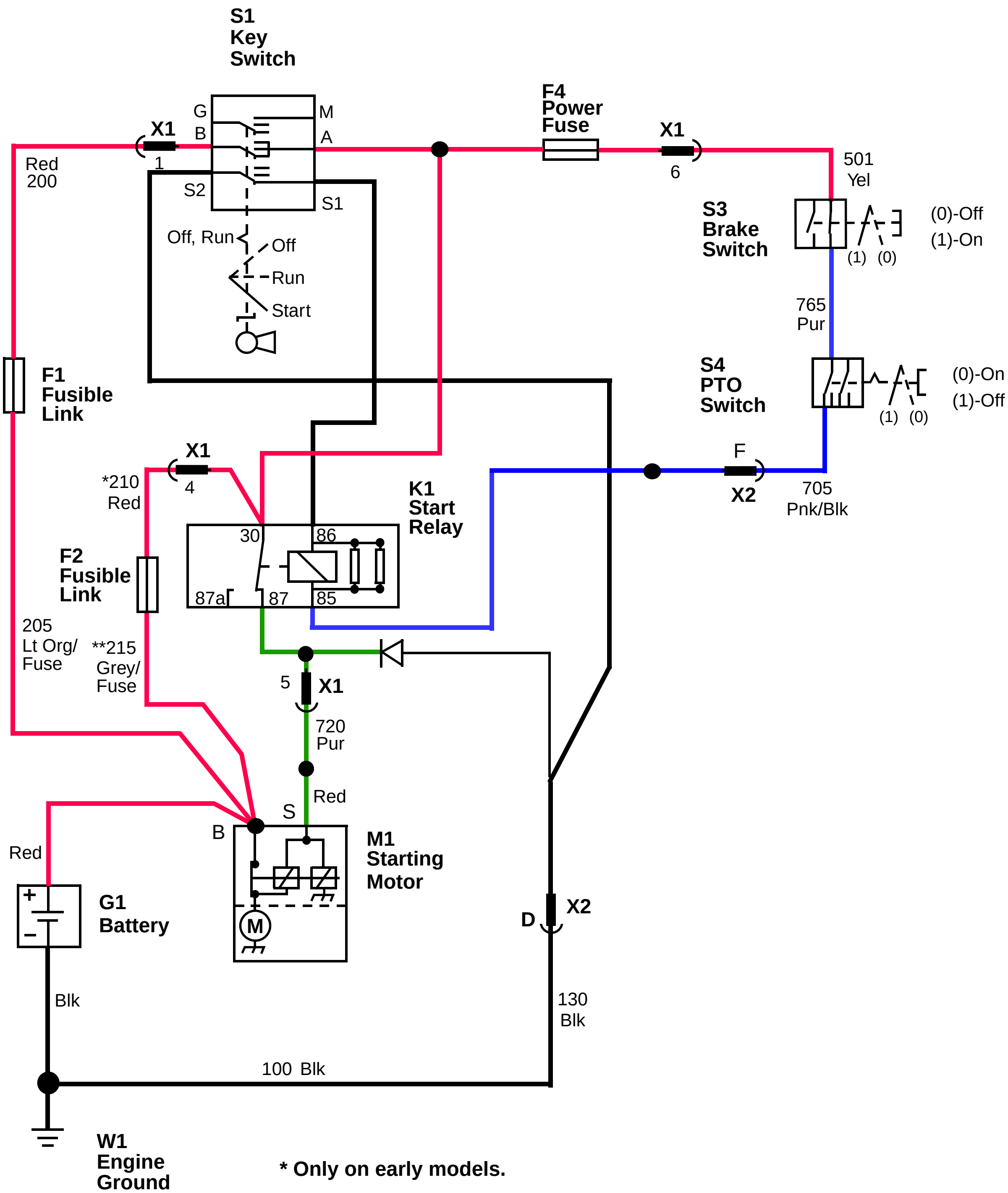
With the key switch in the start position, current flows from terminal B to terminal A, 15-amp fuse (F4), brake switch (S5) (brake pedal engaged), PTO switch (S2) (PTO disengaged), and start relay coil terminal (K1).

A ground circuit for the start relay coil must be provided for the relay to energize. With the key switch in the start position, current flows to ground through the key switch terminals S1 and S2, energizing the start relay coil which closes the relay.

With the relay closed, current flows to the starter solenoid, engaging the solenoid. The solenoid is engaged by current flowing through both the pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in winding stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starting motor (M1) causing it to turn.

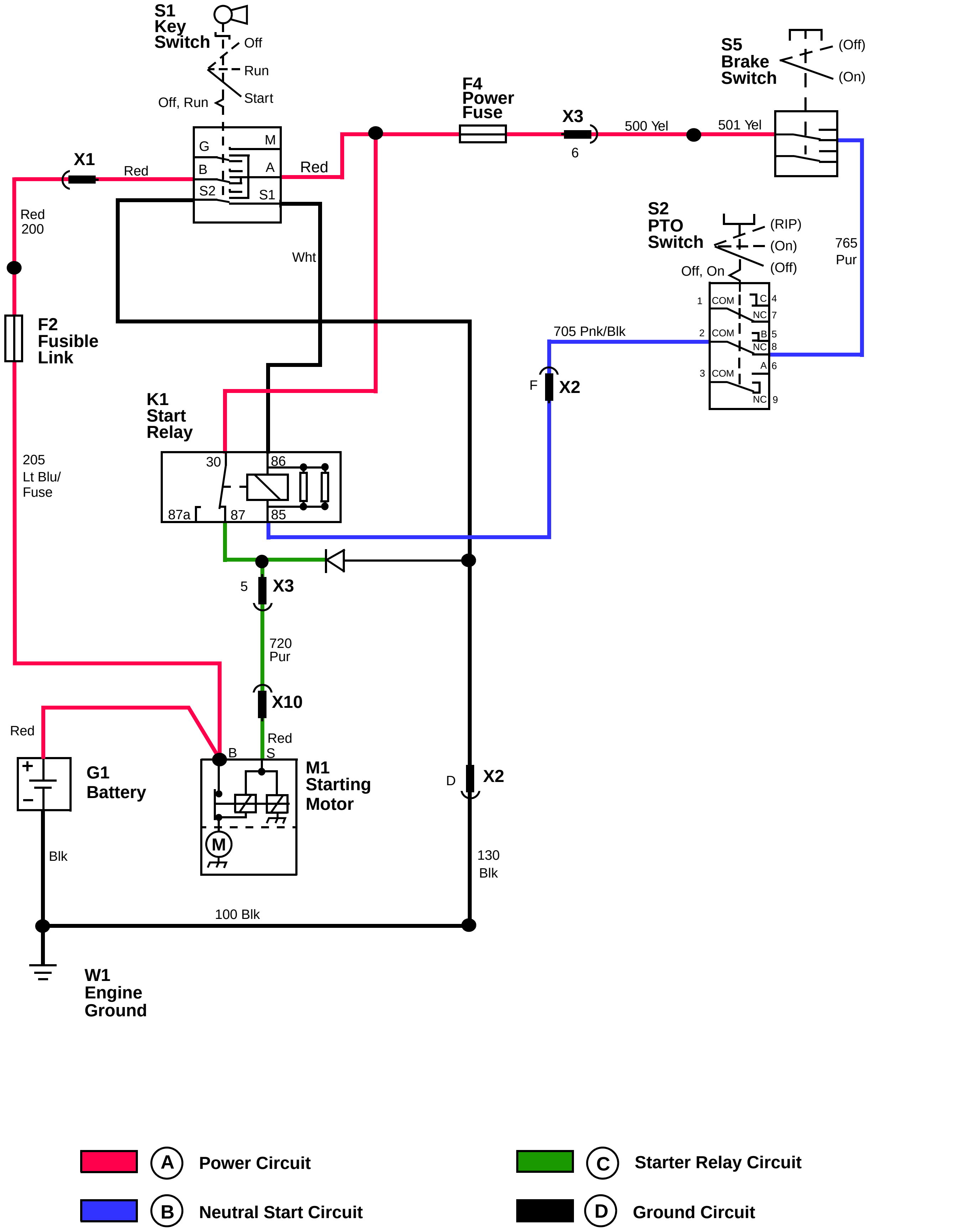
CRANKING CIRCUIT SCHEMATIC—445 (S.N. —070000)



* Only on early models.

** 215 red on early models.

CRANKING CIRCUIT SCHEMATIC—445 (S.N. 070001—)



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CRANKING CIRCUIT DIAGNOSIS—445 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch in off position.
- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Check neutral start circuit, go to step 5.

Test Conditions:

- Key switch in start position.

Test/Check Point	Normal	If Not Normal
3. Starter solenoid terminal S.	Minimum 10 volts.	No voltage—go to step 4. Low voltage—check neutral start circuit for voltage drop, go to step 5. Voltage ok—test starter solenoid and motor.

Test Conditions:

- Disconnect starter solenoid connector (A).
- Turn key switch from on to start repeatedly while holding relay.

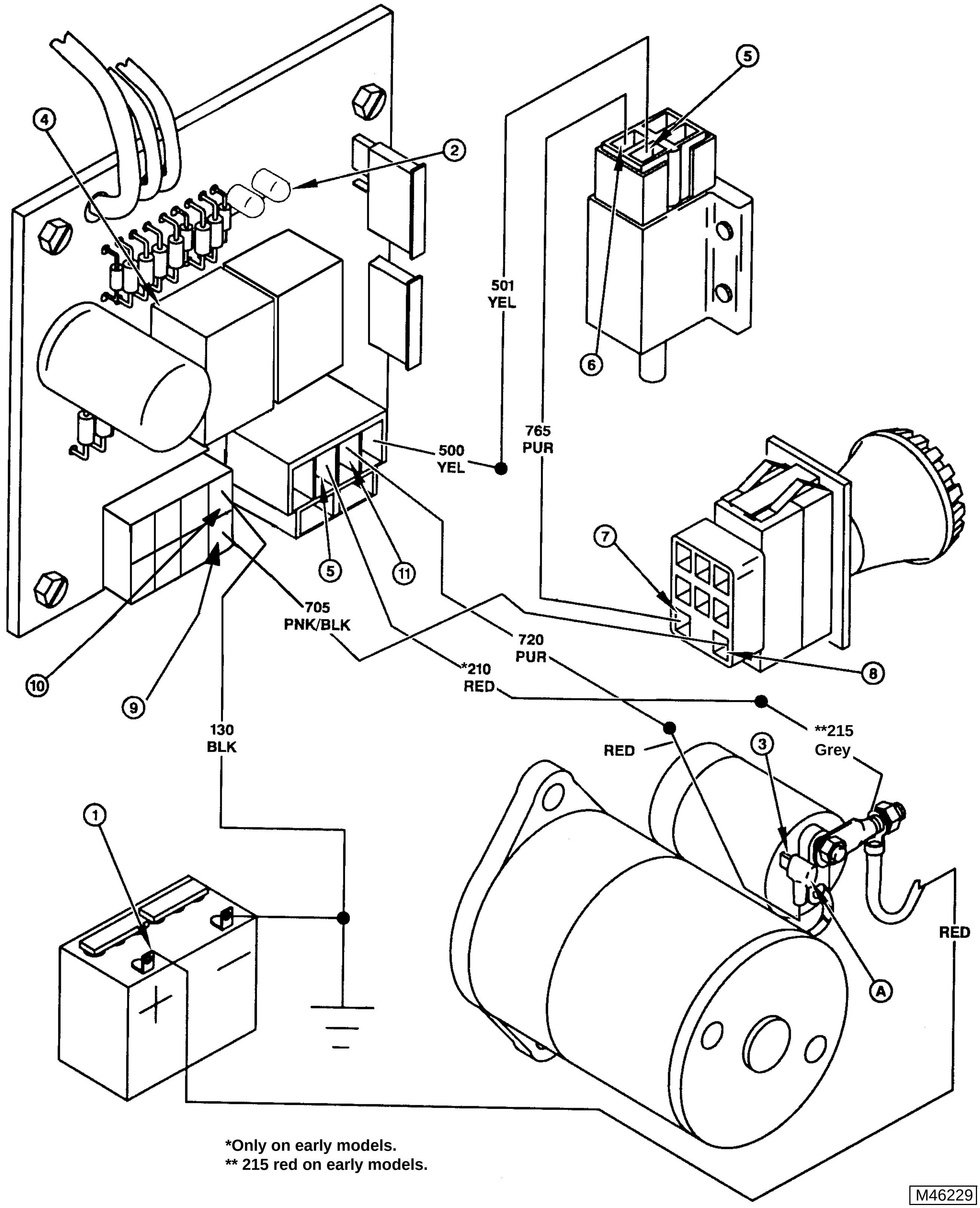
Test/Check Point	Normal	If Not Normal
4. Start relay.	Relay clicks.	Relay does not click or cannot feel, go to step 5. Relay clicks, go to step 11.

Test Conditions:

- Connect starter solenoid connector (A).
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
5. Key switch power connector and control/fuse switch module terminal 4.	Battery voltage.	Check power circuit test points from battery to key switch power connector and control/fuse module terminal 4.
6. Brake switch.	Battery voltage.	Test brake switch.
7. PTO switch.	Battery voltage.	Test 765 pur wire.

CRANKING CIRCUIT TEST POINTS—445 (S.N. —070000)



CRANKING CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)

Test/Check Point	Normal	If Not Normal
8. PTO switch.	Battery voltage.	Test PTO switch.
9. Control/fuse module terminal F.	Battery voltage.	Test 705 pnk/red wire.

Test Conditions:

- Control/fuse module fuses removed.
- Key switch in start position.

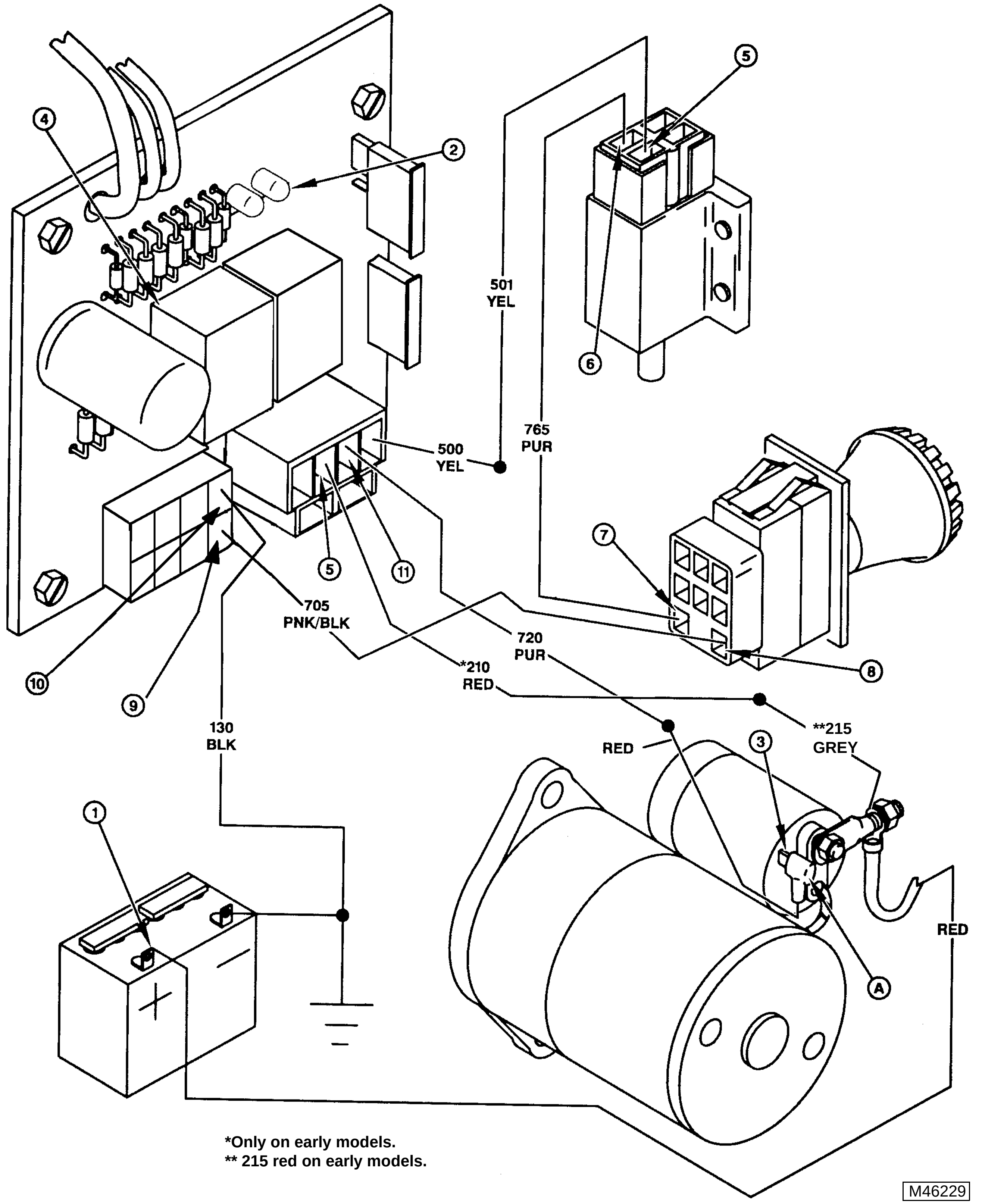
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check control/fuse module ground circuit, 130 and 100 blk wires.

Test Conditions:

- Control/fuse module fuses installed.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
11. Control/fuse module terminal 5.	Battery voltage.	No voltage—replace control/fuse module. Voltage—check 720 pur and red wires.

CRANKING CIRCUIT TEST POINTS—445 (S.N. —070000) (continued)



*Only on early models.
** 215 red on early models.

CRANKING CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch in off position.
- Park brake engaged.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Check neutral start circuit, go to step 5.

Test Conditions:

- Key switch in start position.

Test/Check Point	Normal	If Not Normal
3. Starter solenoid terminal S.	Minimum 10 volts.	No voltage—go to step 4. Low voltage—check neutral start circuit for voltage drop, go to step 5. Voltage ok—test starter solenoid and motor.

Test Conditions:

- Disconnect starter solenoid connector (A).
- Turn key switch from on to start repeatedly while holding relay.

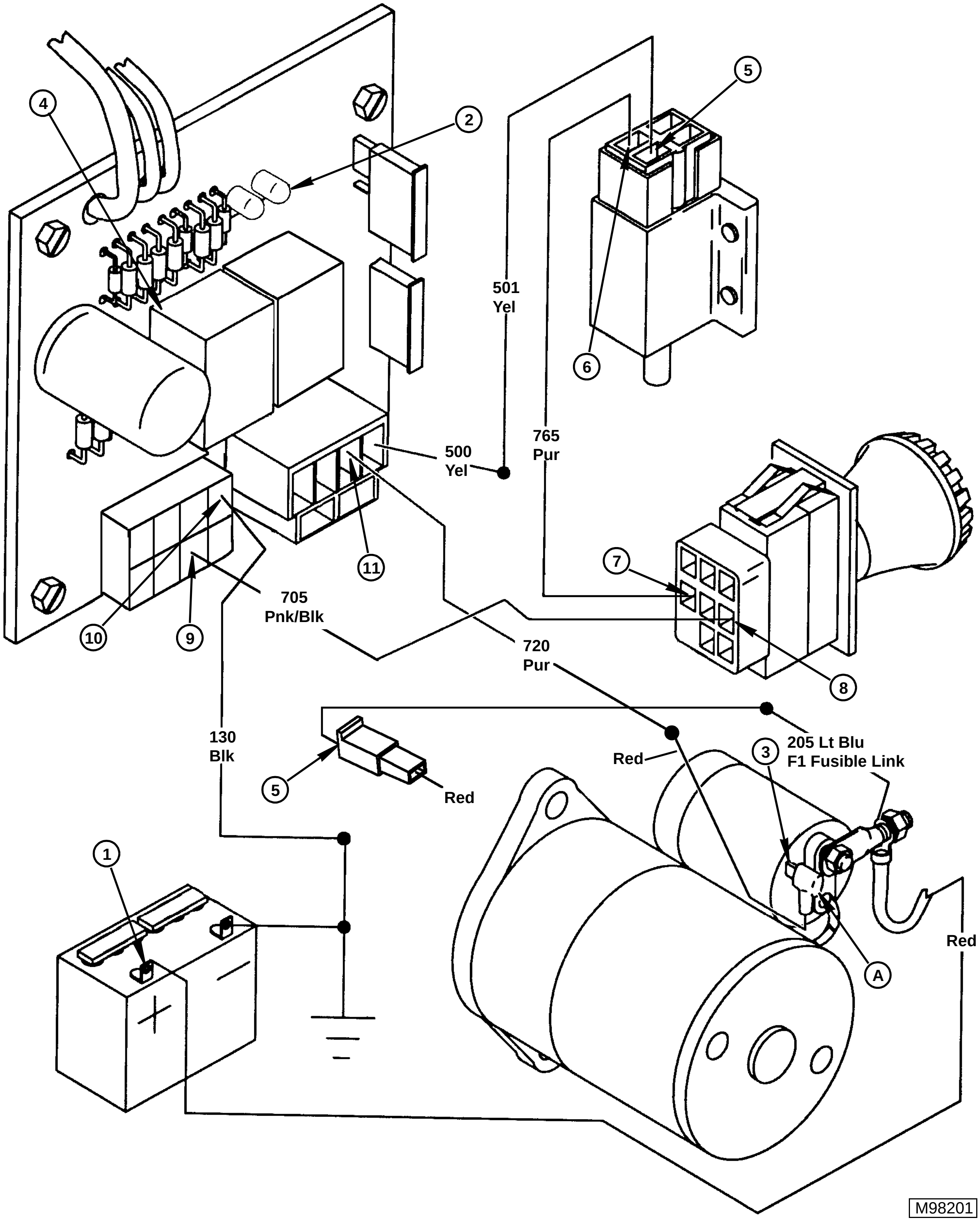
Test/Check Point	Normal	If Not Normal
4. Start relay.	Relay clicks.	Relay does not click or cannot feel, go to step 5. Relay clicks, go to step 11.

Test Conditions:

- Connect starter solenoid connector (A).
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
5. Key switch power connector and control/fuse switch module terminal 4.	Battery voltage.	Check power circuit test points from battery to key switch power connector and control/fuse module terminal 4.
6. Brake switch.	Battery voltage.	Test brake switch.
7. PTO switch.	Battery voltage.	Test 765 pur wire.

CRANKING CIRCUIT TEST POINTS—445 (S.N. 070001—)



CRANKING CIRCUIT DIAGNOSIS—445 (S.N. 070001—) (continued)

Test/Check Point	Normal	If Not Normal
8. PTO switch.	Battery voltage.	Test PTO switch.
9. Control/fuse module terminal F.	Battery voltage.	Test 705 pnk/red wire.

Test Conditions:

- Control/fuse module fuses removed.
- Key switch in start position.

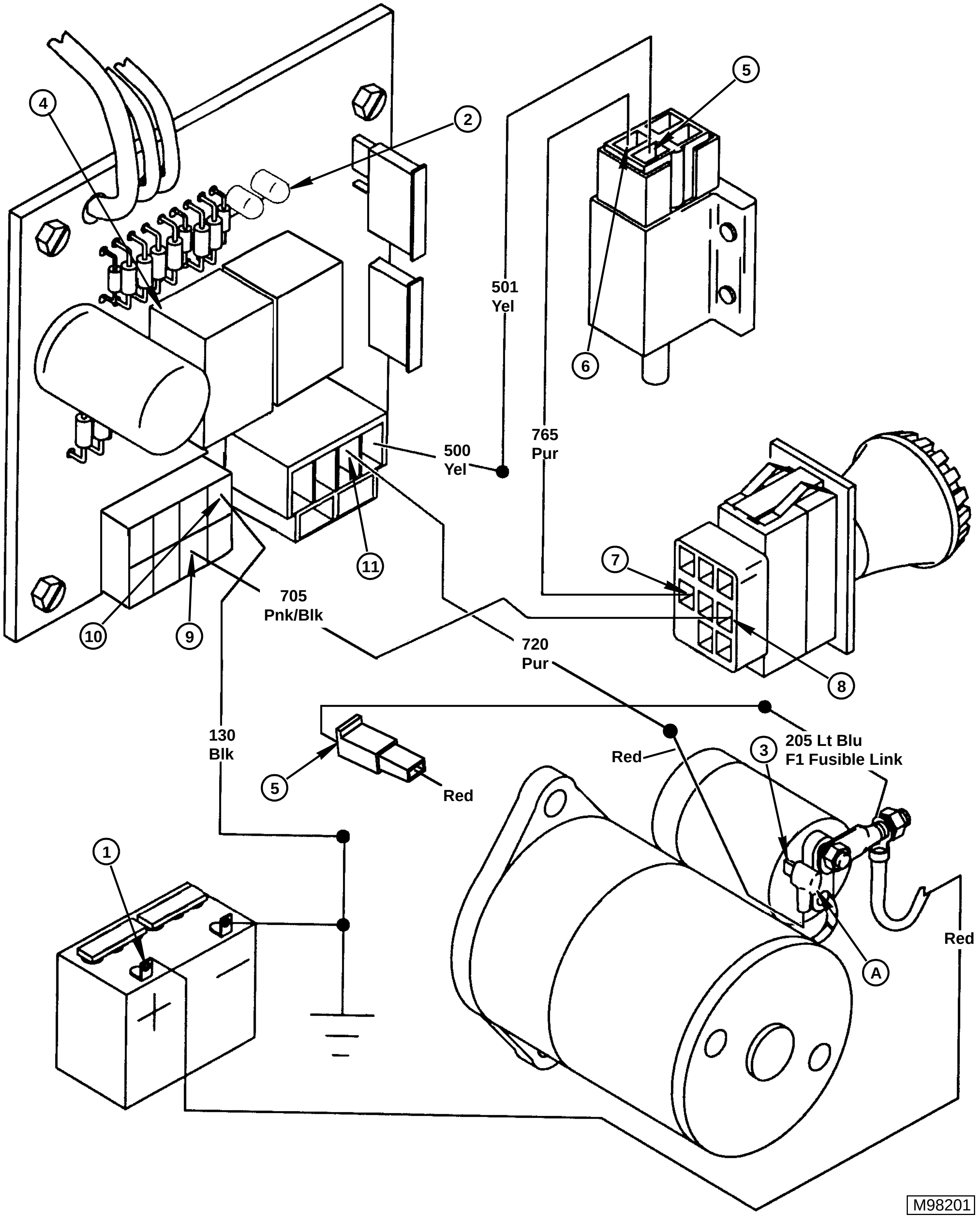
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check control/fuse module ground circuit, 130 and 100 blk wires.

Test Conditions:

- Control/fuse module fuses installed.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
11. Control/fuse module terminal 5.	Battery voltage.	No voltage—replace control/fuse module. Voltage—check 720 pur and red wires.

CRANKING CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



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IGNITION CIRCUIT OPERATION—445 (S.N. —070000)

Function:

To create a spark at the correct time, based on engine sensor input, that ignites the fuel/air mixture in the cylinders.

Operating Conditions:

To produce a spark, the key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) OR with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off (PTO switch closed).

System Operation:

The ignition system is a transistor controlled battery ignition design. The battery (G1) supplies current to the ignition coils (T1 and T2), and energizes the ignition relay (K2), safety relay (K4), fuel injection relay (K5) and the fuel injection module (A1). Ignition timing is controlled by the fuel injection module and is not adjustable. The fuel injection module retards or advances timing based on input received from the engine sensors (pulser coil (B4), coolant temperature sensor (B2), and air pressure sensor (B3)). The ignition timing is retarded when the starting motor is cranking, and for a short time after the engine starts. The engine is shut off by de-energizing the ignition and safety relay which breaks the path to ground for the fuel injection module.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1, F2), key switch terminal B (S1), fuel injection fuse (F5), and the fuel injection relay terminal 87 (K5). Current from the fuel injection relay cannot flow to the fuel injection module (A1) until the relay is energized.

With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, brake switch (S3) (brake pedal depressed), PTO switch (S4) (PTO disengaged), ignition relay coil terminal 85, ignition LED (E1), and fuel injection relay coil terminal 85 (K5). The ignition LED indicates that power is available to the ignition relay coil.

With the fuel injection relay energized, current (D) flows to the fuel injection module. With the ignition relay energized, current (C) flows to the PTO switch and safety relay terminal 86, energizing the relay. When the relay is energized a path to ground is provided for the fuel injection module.

An alternate current path is provided to keep the ignition and the safety relay relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S2) closed), current (E) flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition and safety relays open, which opens the fuel injection module ground and the engine stops. A delay capacitor in the ignition module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

The fuel injection module uses engine operating information from the pulser coil (B4), coolant temperature sensor (B2), and the air pressure sensor (B3) to calculate the correct ignition timing. As the flywheel turns, four tabs on the flywheel travel past the pulser coil and produce current in the pulser coil by electromagnetic induction. Four current pulses per one crankshaft revolution flow from the pulser coil to the fuel injection module providing piston position (top dead center) and engine speed information. The coolant temperature sensor and the air pressure sensor are variable resistors that change the fuel injection module output voltage based on engine temperature and air pressure.

The ignition coils (T1 and T2) consist of iron cores with two sets of wires wound around them. The primary windings are connected to the fuel injection module. The secondary windings connect to the spark plugs (E3 and E4) through the high tension leads. There are more windings in the secondary coil than in the primary coil.

The fuel injection module provides a path to ground for ignition coil current flow through the primary windings. As the flywheel rotates prior to spark plug firing, the fuel injection module allows battery current flow through the primary windings (F) of the coil. At the correct time, the fuel injection module breaks the path to ground for ignition coil primary current. When the current flow stops, the primary coil electromagnetic field collapses and induces high voltage current in the secondary coil (G). The high voltage current flows through the ignition coil wire to the spark plug. The voltage is now high enough to jump the spark plug gap and a spark is produced.

IGNITION CIRCUIT OPERATION—445 (S.N. 070001—)

Function:

To create a spark at the correct time, based on engine sensor input, that ignites the fuel/air mixture in the cylinders.

Operating Conditions:

To produce a spark, the key switch must be in the run or start position, and the operator must be on the seat (seat switch closed) OR with the operator off the seat, the brake pedal must be depressed (brake switch closed) and the PTO switch must be off.

System Operation:

The ignition system is a transistor controlled battery ignition design. The battery (G1) supplies current to the ignition coils (T1 and T2), and energizes the ignition relay (K2), safety signal relay (K7), fuel injection relay (K6) and the fuel injection module (A1). Ignition timing is controlled by the fuel injection module and is not adjustable. The fuel injection module retards or advances timing based on input received from the engine sensors (pulser coil (B6), coolant temperature sensor (B3), and air pressure sensor (B5)). The ignition timing is retarded when the starting motor is cranking, and for a short time after the engine starts. The engine is shut off by de-energizing the ignition and safety signal relay which breaks the path to ground for the fuel injection module.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible links (F1, F2), terminal B of key switch (S1), fuel injection fuse (F3), and the fuel injection relay terminal 87 (K6). Current from the fuel injection relay cannot flow to the fuel injection module (A1) until the relay is energized.

With the operator off the seat and the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F5), ignition relay terminal 87, brake switch (S5) (brake pedal depressed), PTO switch (S2) (PTO disengaged), ignition relay coil terminal 85, ignition LED (E4), and fuel injection relay coil terminal 85 (K6). The ignition LED indicates that power is available to the ignition relay coil.

With the fuel injection relay energized, current (D) flows to the fuel injection module. With the ignition relay energized, current (C) flows to the PTO switch and safety relay terminal 86, energizing the relay. When the relay is energized a path to ground is provided for the fuel injection module.

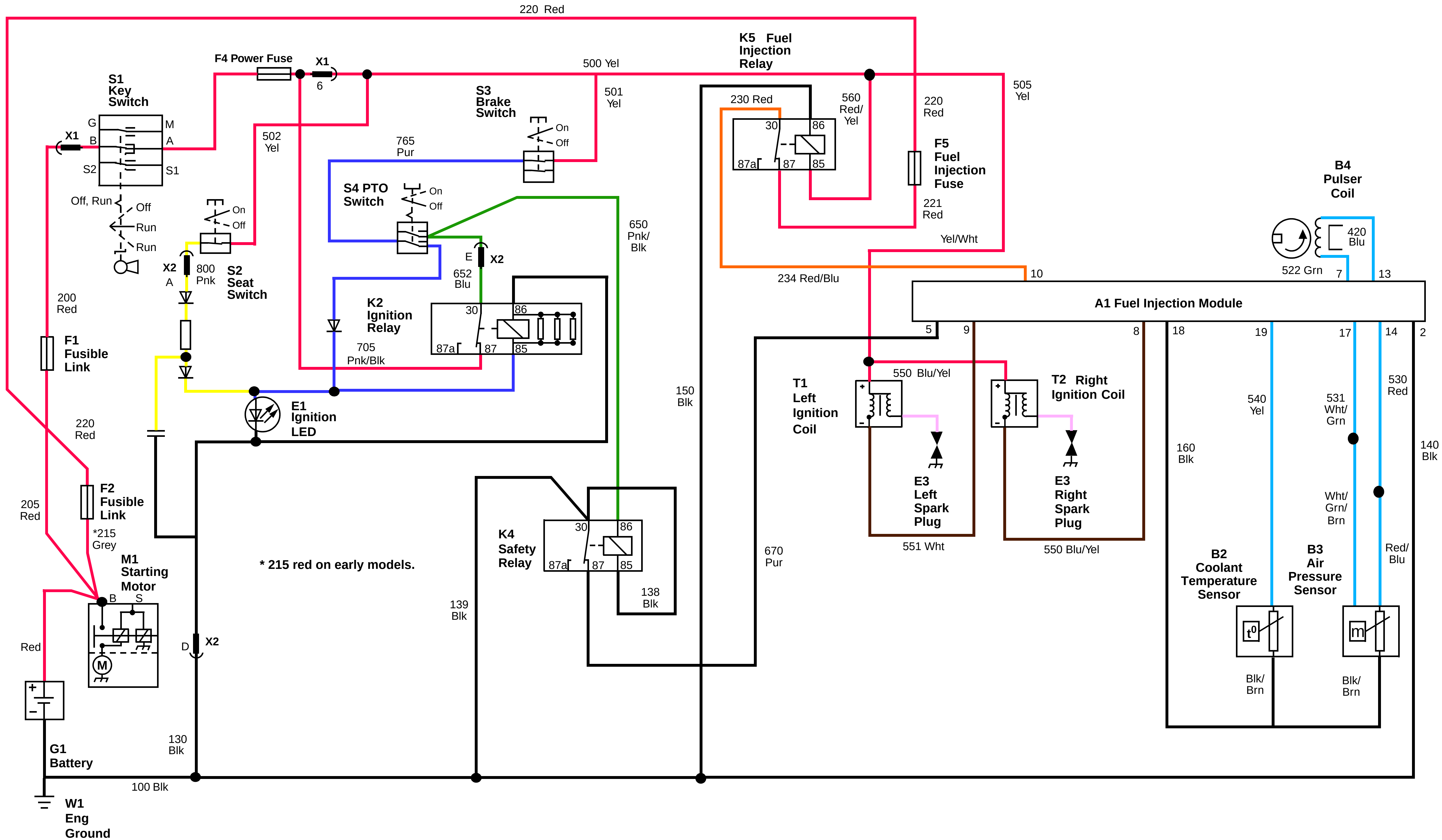
An alternate current path is provided to keep the ignition and the safety relay energized when the PTO is engaged or the brake pedal is released. With the operator on the seat (seat switch (S3) closed), current (E) flows to the ignition relay coil, keeping the relay energized. If the operator leaves the seat with the PTO engaged or the brake pedal released, current to the ignition relay coil is stopped. The ignition and safety relays open, which opens the fuel injection module ground and the engine stops. A delay capacitor in the ignition module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

The fuel injection module uses engine operating information from the pulser coil (B6), coolant temperature sensor (B3), and the air pressure sensor (B5) to calculate the correct ignition timing. As the flywheel turns, four tabs on the flywheel travel past the pulser coil and produce current in the pulser coil by electromagnetic induction. Four current pulses per one crankshaft revolution flow from the pulser coil to the fuel injection module providing piston position (top dead center) and engine speed information. The coolant temperature sensor and the air pressure sensor are variable resistors that change the fuel injection module output voltage based on engine temperature and air pressure.

The ignition coils (T1 and T2) consist of iron cores with two sets of wires wound around them. The primary windings are connected to the fuel injection module. The secondary windings connect to the spark plugs (E1 and E2) through the high tension leads. There are more windings in the secondary coil than in the primary coil.

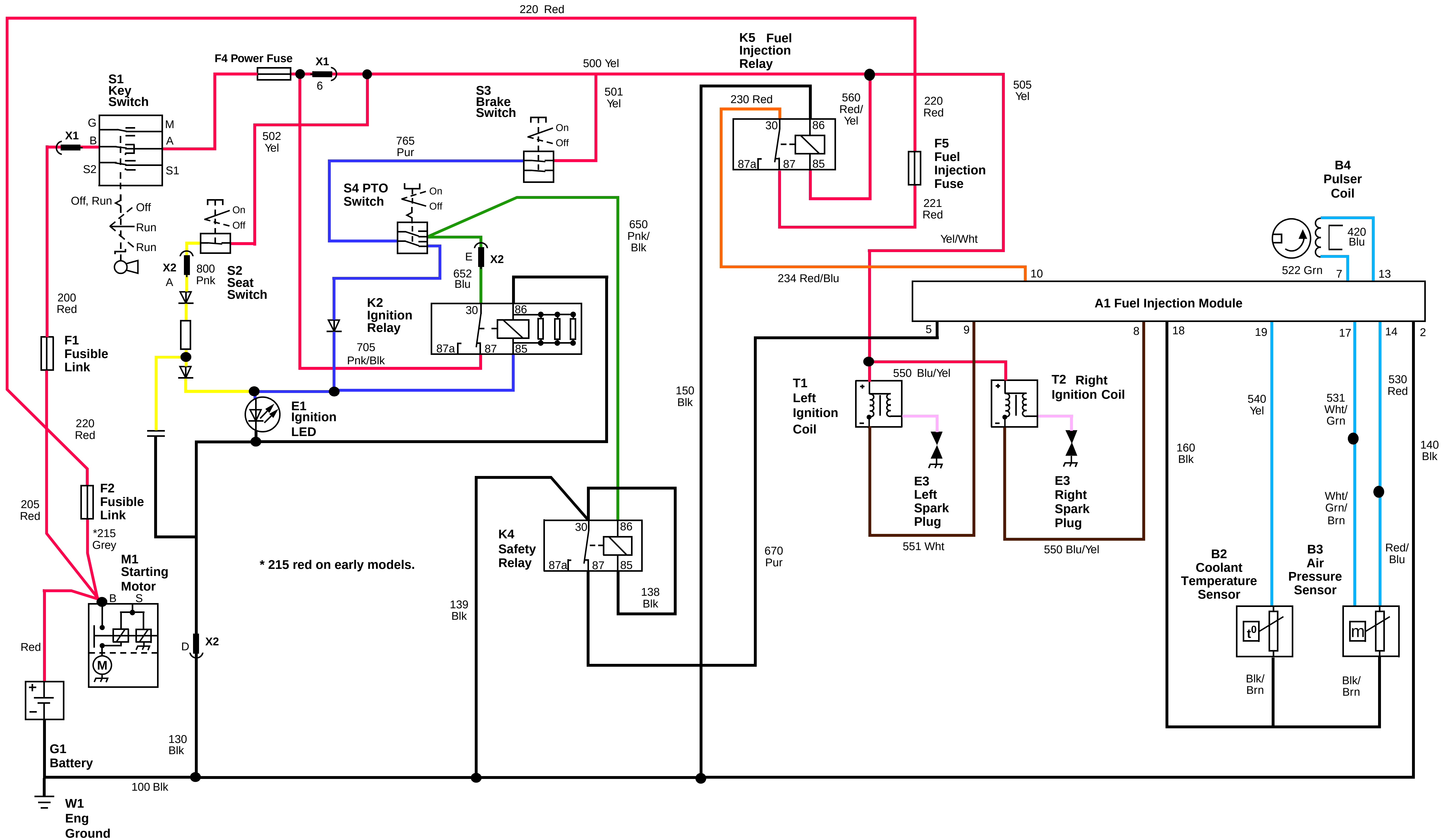
The fuel injection module provides a path to ground for ignition coil current flow through the primary windings. As the flywheel rotates prior to spark plug firing, the fuel injection module allows battery current flow through the primary windings (F) of the coil. At the correct time, the fuel injection module breaks the path to ground for ignition coil primary current. When the current flow stops, the primary coil electromagnetic field collapses and induces high voltage current in the secondary coil (G). The high voltage current flows through the ignition coil wire to the spark plug. The voltage is now high enough to jump the spark plug gap and a spark is produced.

IGNITION CIRCUIT SCHEMATIC—445 (S.N. —070000)



- (A) Power Circuit
- (B) Ignition Relay Engagement Circuit
- (C) Ignition Relay Circuit
- (D) Fuel Injection Relay Circuit
- (E) Seat Switch Circuit
- (F) Primary Coil Circuit
- (G) Secondary Coil Circuit
- (H) Sensor Circuit
- (I) Ground Circuit

IGNITION CIRCUIT SCHEMATIC—445 (S.N. —070000)



A	Power Circuit
B	Ignition Relay Engagement Circuit
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D	Fuel Injection Relay Circuit
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F	Primary Coil Circuit
G	Secondary Coil Circuit
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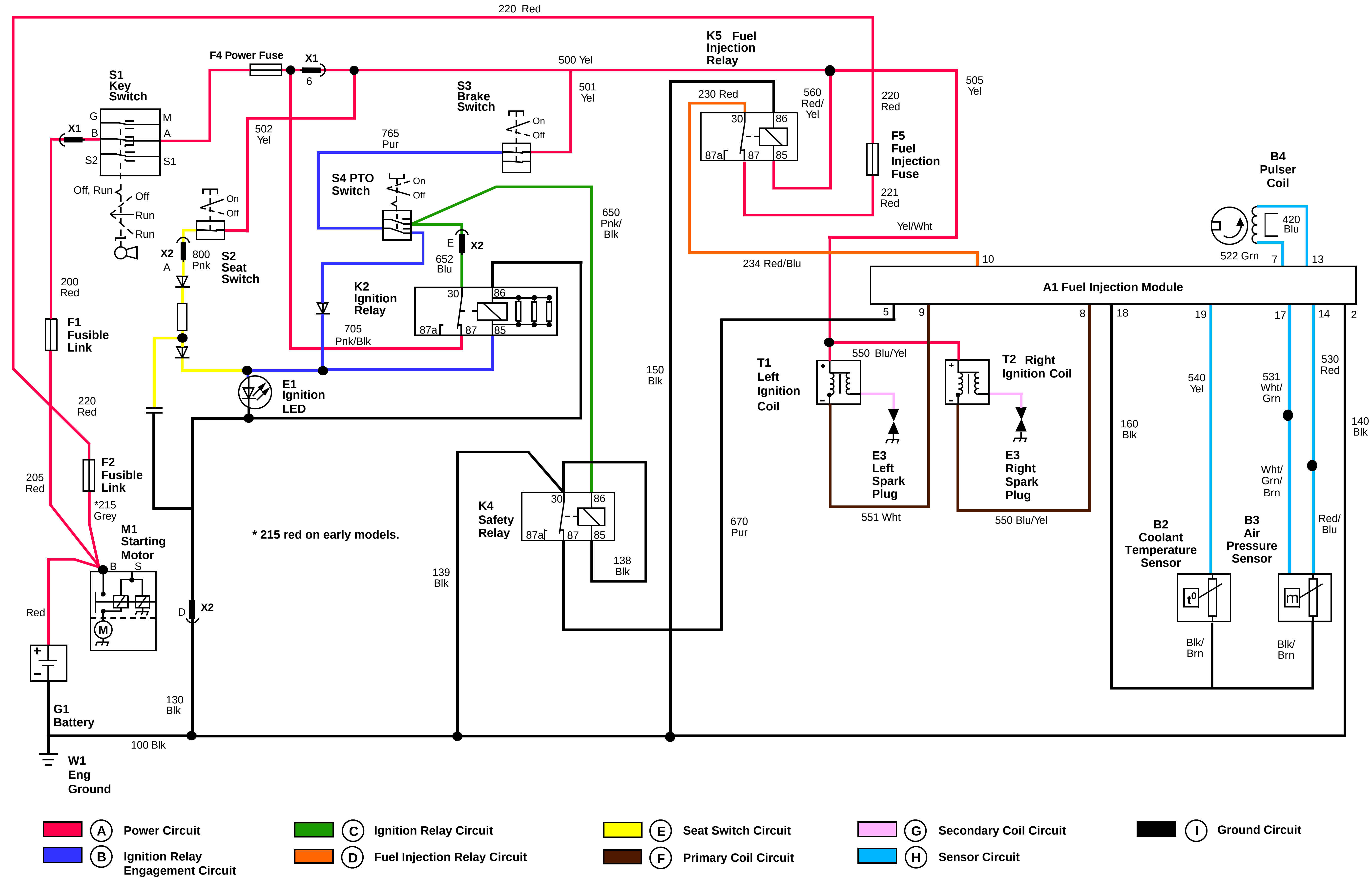
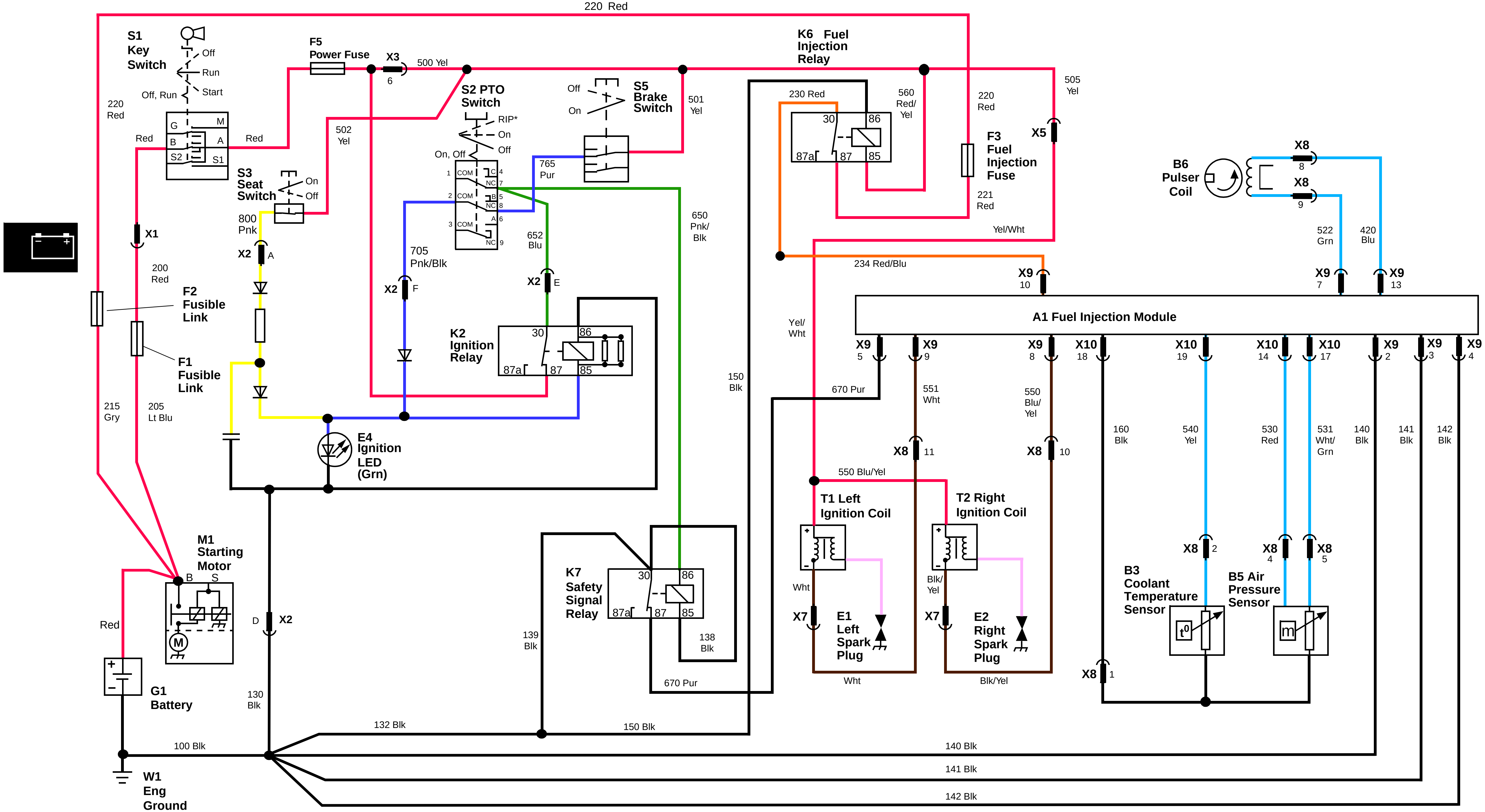
IGNITION CIRCUIT SCHEMATIC—445 (S.N. —070000)



IGNITION CIRCUIT SCHEMATIC—445 (S.N. 070001—)



- (A) Power Circuit
- (B) Ignition Relay Engagement Circuit
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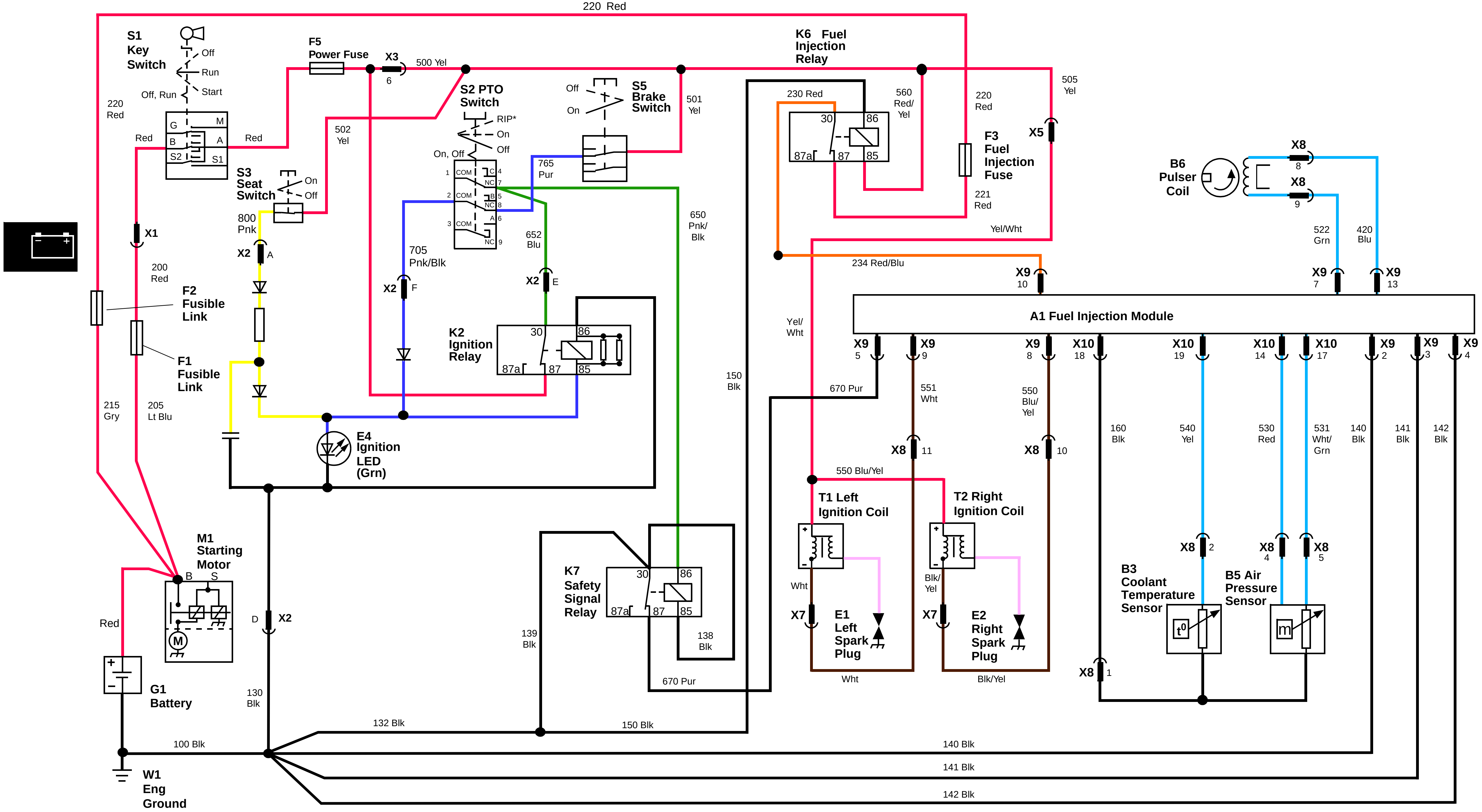
IGNITION CIRCUIT SCHEMATIC—445 (S.N. 070001—)



A Power Circuit
B Ignition Relay Engagement Circuit
C Ignition Relay Circuit
D Fuel Injection Relay Circuit
E Seat Switch Circuit
F Primary Coil Circuit
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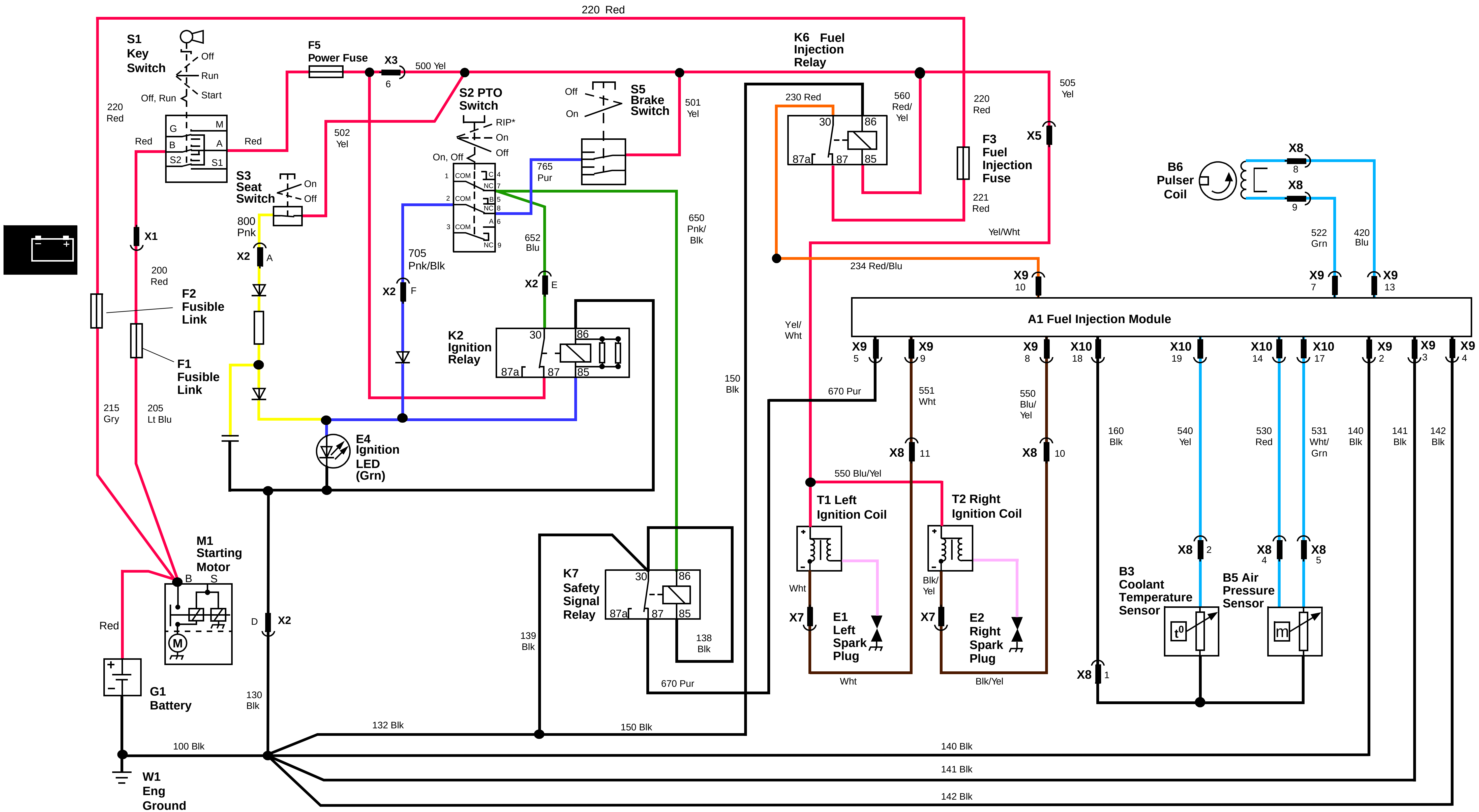
I Ground Circuit

IGNITION CIRCUIT SCHEMATIC—445 (S.N. 070001—)



- (A) Power Circuit
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- (D) Fuel Injection Relay Circuit
- (E) Seat Switch Circuit
- (F) Primary Coil Circuit
- (G) Secondary Coil Circuit
- (H) Sensor Circuit
- (I) Ground Circuit

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IGNITION CIRCUIT DIAGNOSIS—445 (S.N. —070000)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

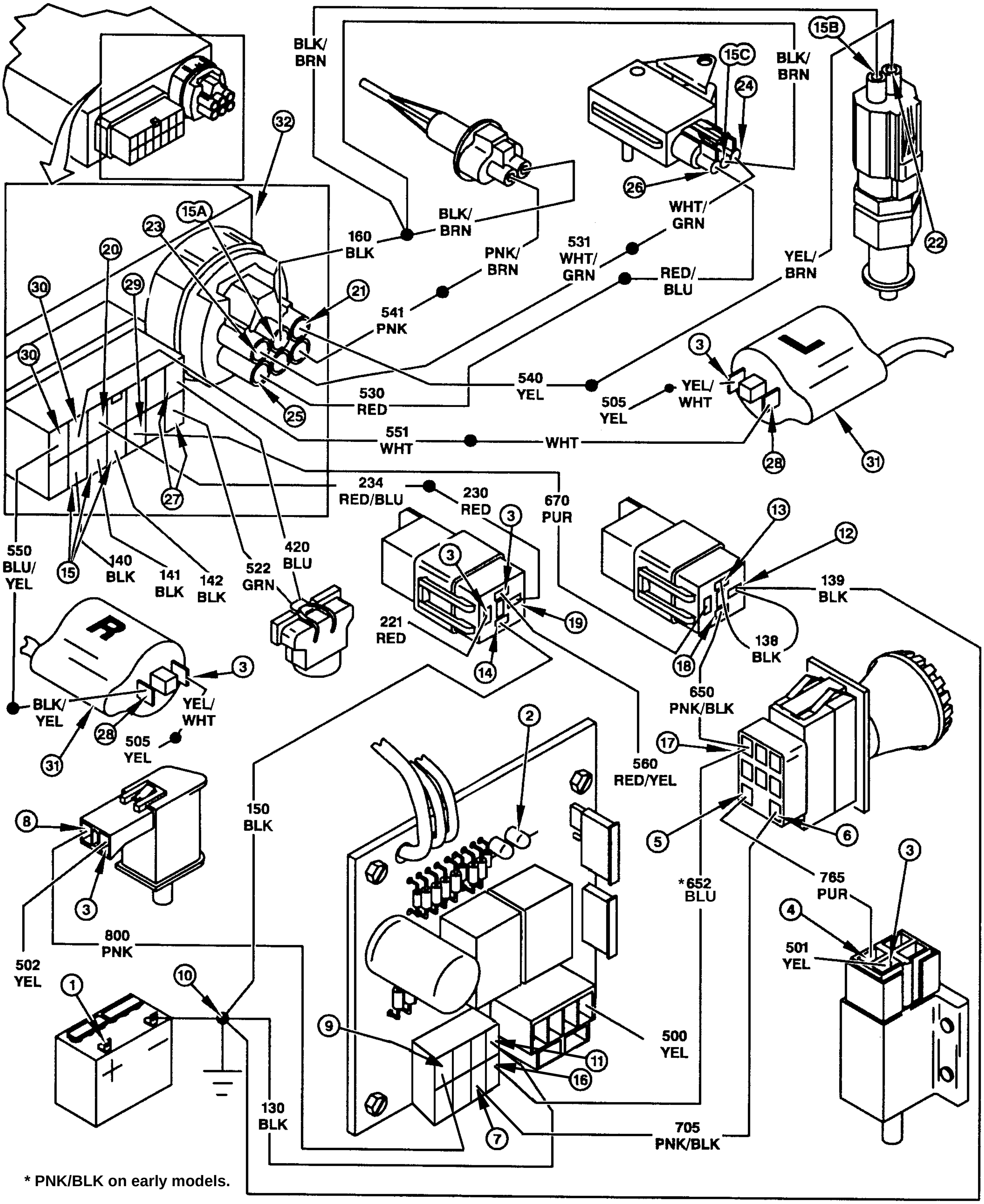
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3. Light on—go to step 12.
3. Brake switch, seat switch, and fuel injection relay terminals 87 and 85.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position

Test/Check Point	Normal	If Not Normal
10. Engine ground connection.	Maximum 0.1 ohms resistance.	Check battery negative cable and engine.
11. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. Safety relay terminal 30.	Maximum 0.1 ohms resistance.	Check 139 blk wire.
13. Safety relay terminal 85.	Maximum 0.1 ohms resistance.	Check 138 blk wire.
14. Fuel injection relay terminal 86.	Maximum 0.1 ohms resistance.	Check 150 blk wire.

IGNITION CIRCUIT TEST POINTS—445 (S.N. —070000)



* PNK/BLK on early models.

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IGNITION CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)

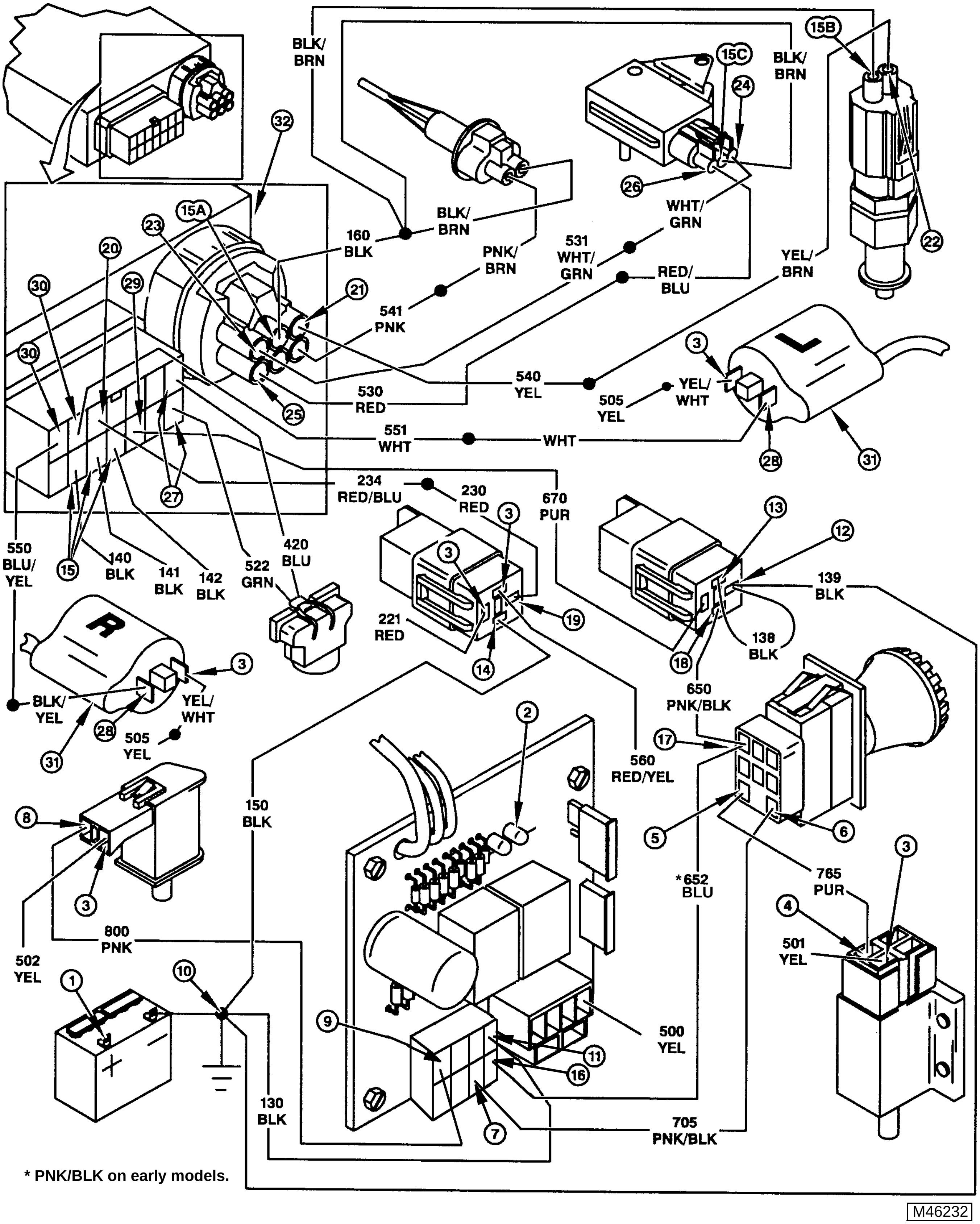
Test/Check Point	Normal	If Not Normal
15. Fuel injection module.	Maximum 0.1 ohms resistance.	Check 140, 141, and 142 blk wires.
15A. Fuel injection module terminal 18.	Maximum 0.1 ohms resistance.	Replace fuel injection module.
15B. Coolant temperature sensor.	Maximum 0.1 ohms resistance.	Check coolant temperature sensor ground (blk/brn wire) and 160 blk wire.
15C. Air pressure sensor.	Maximum 0.1 ohms resistance.	Check air pressure sensor ground blk/brn wire.

Test Conditions:

- Key switch in run position.

Test/Check Point	Normal	If Not Normal
16. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
17. PTO switch.	Battery voltage.	Check 652 blu (652 pnk/blk on early models) wire.
18. Safety relay terminal 86.	Battery voltage.	Check 650 pnk/blk wire.
19. Fuel injection relay terminal 30.	Battery voltage.	Test fuel injection relay.
20. Fuel injection module terminal 10.	Battery voltage.	Check 234 red/blu wire.
21. Fuel injection module terminal 19.	1—5 volts.	Replace fuel injection module.
22. Coolant temperature sensor.	1—5 volts.	Check 540 yel wire and yel/brn wire.
23. Fuel injection module terminal 17.	1—5 volts.	Replace fuel injection module.
24. Air pressure sensor.	1—5 volts.	Check 531 wht/grn and wht/grn/brn wire.
25. Fuel injection module terminal 14.	1—5 volts.	Replace fuel injection module.
26. Air pressure sensor.	1—5 volts.	Check 530 red and red/blu wires.

IGNITION CIRCUIT TEST POINTS—445 (S.N. —070000) (continued)



* PNK/BLK on early models.

IGNITION CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)

Test Conditions:

- Meter set for AC voltage for step 27.
- Key switch in start position.
- Voltage test light connected to battery negative terminal (checking for current pulses) for step 28.

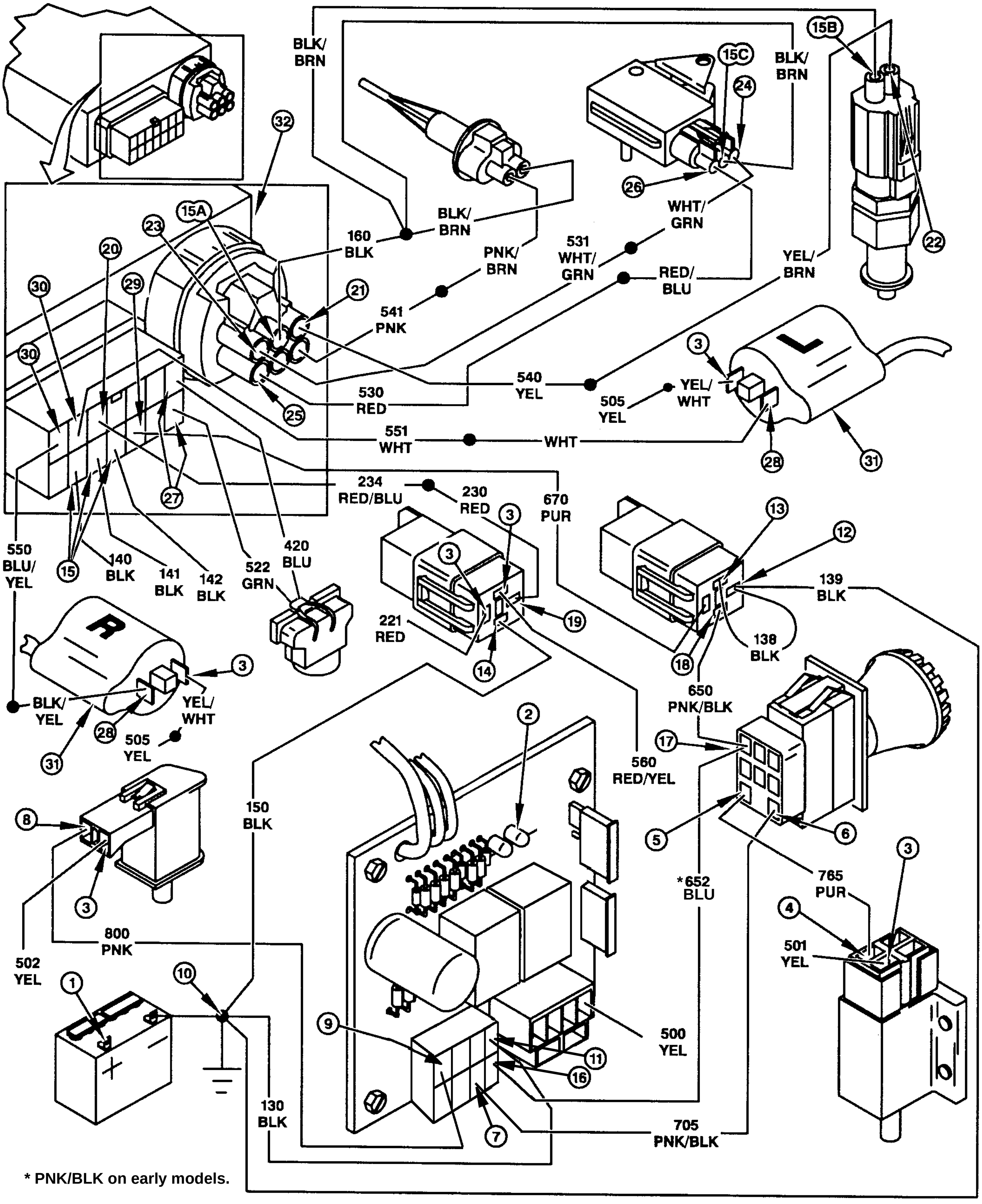
Test/Check Point	Normal	If Not Normal
27. Fuel injection module terminals 7 and 13.	0.1—1.0 VAC.	Check 522 grn and 420 blu wires, and test pulser coil resistance.
28. Ignition coil negative terminal.	Rapidly flashing light, not steady glow. Check ignition coil—go to step 31.	Light is steady glow—check ignition coil ground circuit, step 29.

Test Conditions:

- Key switch in run position

Test/Check Point	Normal	If Not Normal
29. Fuel injection module terminal 5.	0.0—0.2 volts.	Greater than 0.2 volts—check 670 pur wire and test safety relay. 0.0 volts—continue testing.
30. Fuel injection module terminals 8 and 9.	Battery voltage.	Check 551 wht and 550 blu/yel wires.
31. Ignition coil—resistance.	Primary—3.4—4.6 ohms. Secondary—10.4—15.5 k-ohms. Core—infinite.	Replace ignition coil.
32. Fuel injection module-replace with known good module.	Spark produced.	Replace fuel injection module.

IGNITION CIRCUIT TEST POINTS—445 (S.N. —070000) (continued)



IGNITION CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

Test Conditions:

- Transmission in neutral.
- PTO switch off position.
- Park brake engaged.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

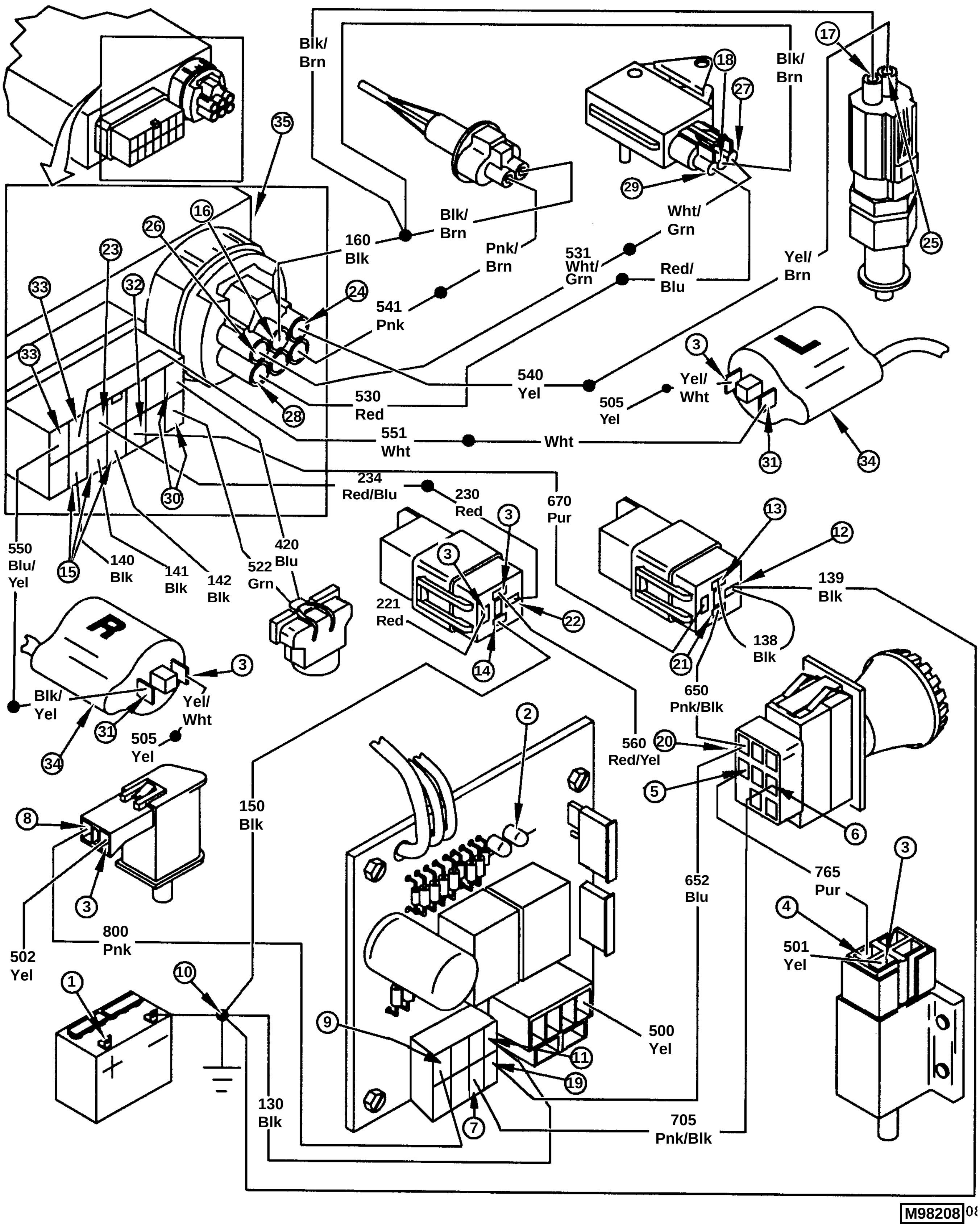
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition LED.	Light on.	Light off—check ignition relay engagement circuit, go to step 3. Light on—go to step 12.
3. Brake switch, seat switch, and fuel injection relay terminals 87 and 85.	Battery voltage.	Check power circuit test points.
4. Brake switch.	Battery voltage.	Test brake switch.
5. PTO switch.	Battery voltage.	Check 765 pur wire.
6. PTO switch.	Battery voltage.	Test PTO switch.
7. Control/fuse module terminal F.	Battery voltage.	Check 705 pnk/blk wire.
8. Seat switch.	Battery voltage.	Test seat switch.
9. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
10. Engine ground connection.	Maximum 0.1 ohms resistance.	Check battery negative cable and engine.
11. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check 100 and 130 blk wires and harness to engine ground connection.
12. Safety relay terminal 30.	Maximum 0.1 ohms resistance.	Check 139 blk wire.
13. Safety relay terminal 85.	Maximum 0.1 ohms resistance.	Check 138 blk wire.
14. Fuel injection relay terminal 86.	Maximum 0.1 ohms resistance	Check 150 blk wire.

IGNITION CIRCUIT TEST POINTS—445 (S.N. 070001—)



IGNITION CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

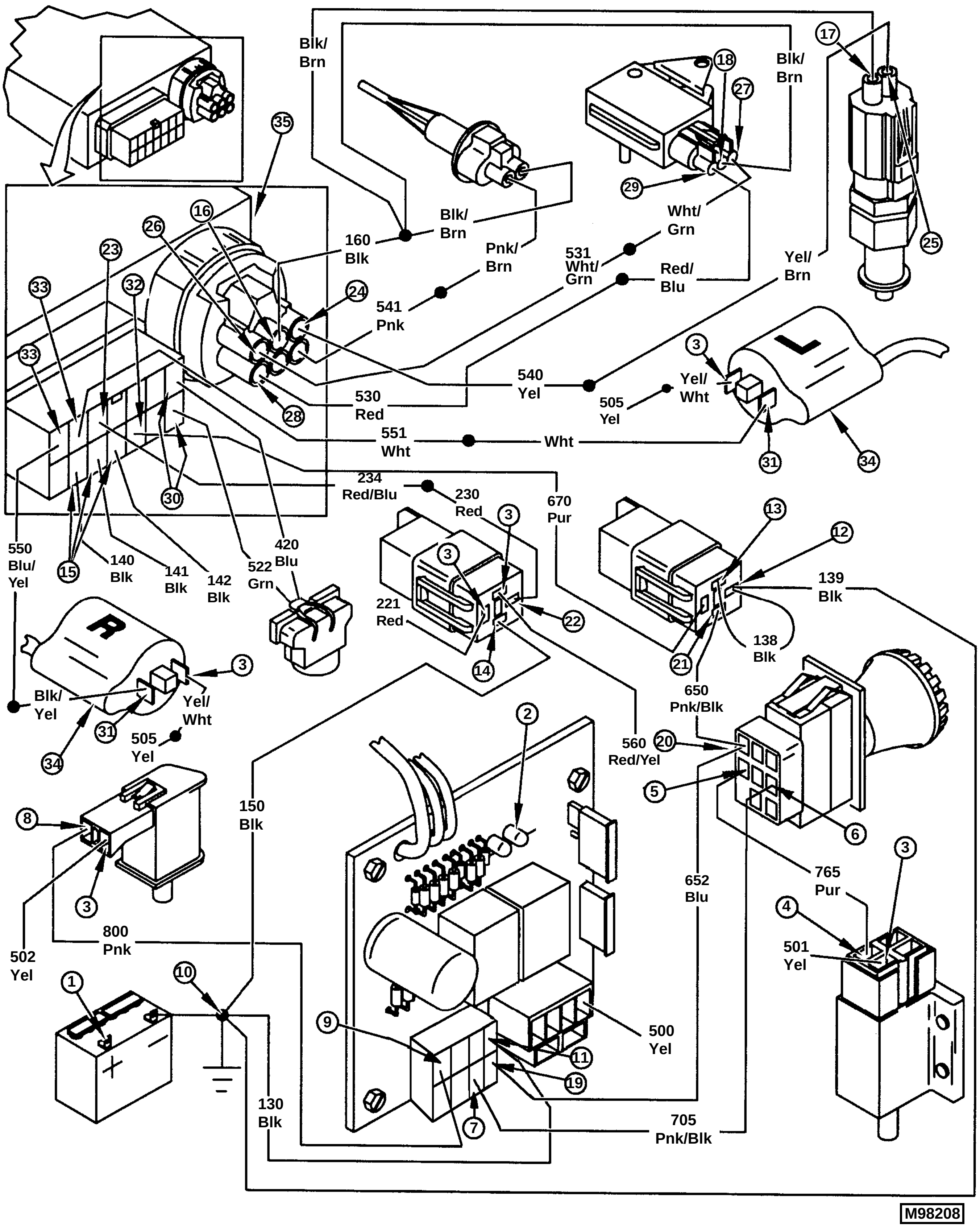
Test/Check Point	Normal	If Not Normal
15. Fuel injection module terminals 2, 3, and 4.	Maximum 0.1 ohms resistance.	Check 140, 141, and 142 blk wires.
16. Fuel injection module terminal 18.	Maximum 0.1 ohms resistance.	Replace fuel injection module.
17. Coolant temperature sensor.	Maximum 0.1 ohms resistance.	Check coolant temperature sensor ground (blk/brn wire) and 160 blk wire.
18. Air pressure sensor.	Maximum 0.1 ohms resistance.	Check air pressure sensor ground blk/brn wire.

Test Conditions:

- Key switch in run position.

Test/Check Point	Normal	If Not Normal
19. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
20. PTO switch.	Battery voltage.	Check 652 blu wire.
21. Safety signal relay terminal 86.	Battery voltage.	Check 650 pnk/blk wire.
22. Fuel injection relay terminal 30.	Battery voltage.	Test fuel injection relay.
23. Fuel injection module terminal 10.	Battery voltage.	Check 234 red/blu wire.
24. Fuel injection module terminal 19.	1-5 volts.	Replace fuel injection module.
25. Coolant temperature sensor.	1-5 volts.	Check 540 yel wire and yel/brn wire.
26. Fuel injection module terminal 17.	1-5 volts.	Replace fuel injection module.
27. Air pressure sensor.	1-5 volts.	Check 531 wht/grn and wht/grn/brn wire.
28. Fuel injection module terminal 14.	1-5 volts.	Replace fuel injection module.
29. Air pressure sensor.	1-5 volts.	Check 530 red and red/blu wires.

IGNITION CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



IGNITION CIRCUITS DIAGNOSIS—445 (S.N. 070001—) (continued)

Test Conditions:

- Meter set for AC voltage for step 27.
- Key switch in start position.
- Voltage test light connected to battery negative terminal (checking for current pulses) for step 31.

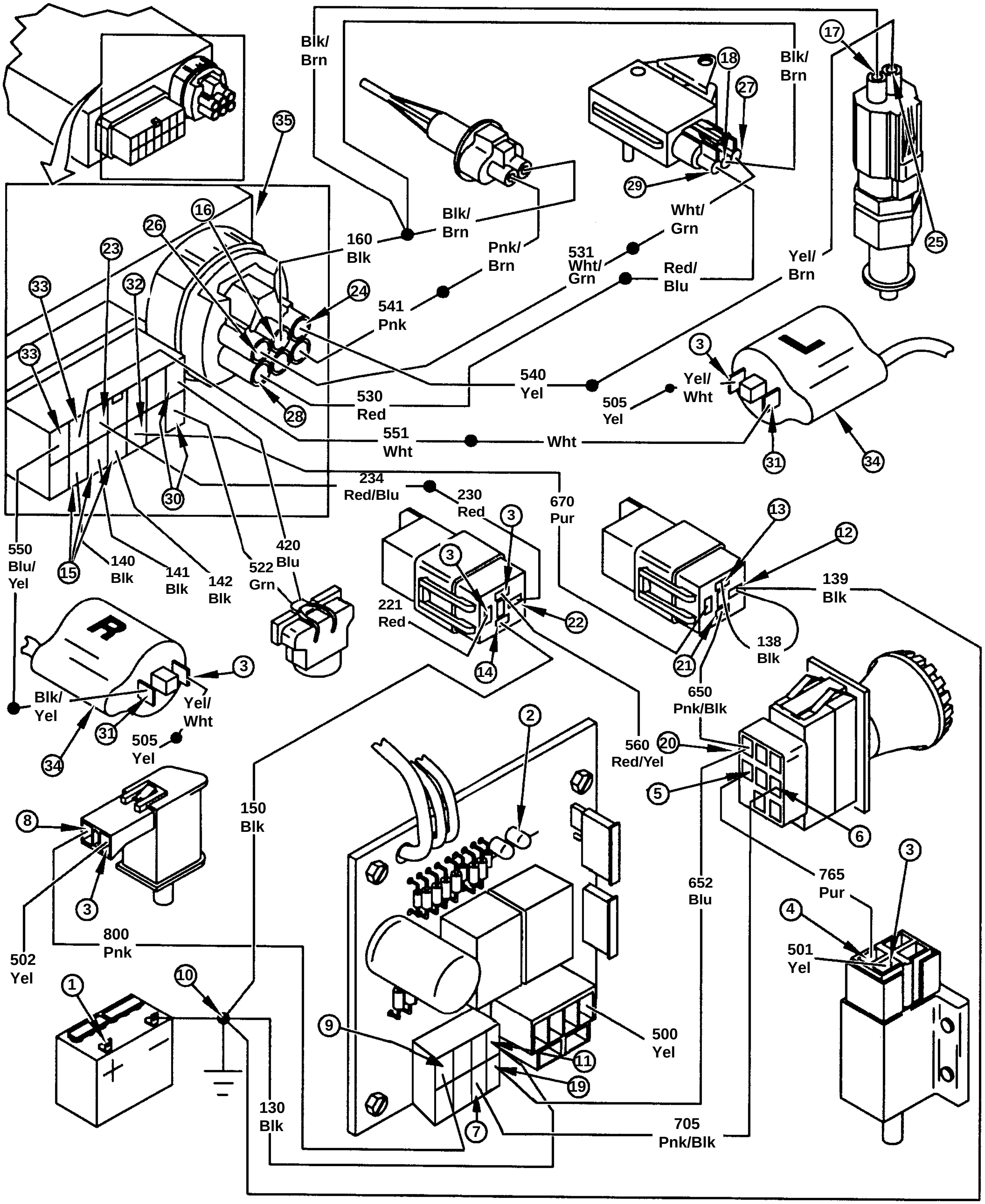
Test/Check Point	Normal	If Not Normal
30. Fuel injection module terminals 7 and 13.	0.1—1.0 VAC.	Check 522 grn and 420 blu wires, and test pulser coil resistance.
31. Ignition coil negative terminal.	Rapidly flashing light, not steady glow.	Flashing light—check ignition coil—go to step 31. Light steady glow—check ignition coil ground circuit-step 29.

Test Conditions:

- Key switch in run position

Test/Check Point	Normal	If Not Normal
32. Fuel injection module terminal 5.	0.0—0.2 volts.	Greater than 0.2 volts—check 670 pur wire and test safety signal relay. 0.0 volts—continue testing.
33. Fuel injection module terminals 8 and 9.	Battery voltage.	Check 551 wht and 550 blu/yel wires.
34. Ignition coil—resistance.	Primary—3.4—4.6 ohms. Secondary—10.4—15.5 k-ohms. Core—infinite.	Replace ignition coil.
35. Fuel injection module-replace with known good module.	Spark produced.	Replace fuel injection module.

IGNITION CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



M98208

CHARGING CIRCUIT OPERATION—445 (S.N. —070000)

Function:

To maintain battery voltage between 11.8 and 13.2 volts.

Operating Conditions:

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

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a rectifier/regulator. A discharge light (H3) warns the operator if the stator stops charging. The discharge light circuit monitors stator output, not battery voltage.

The power circuit (A) provides current to the key switch (S1) battery terminal and protects the charging circuit with a fusible link (F1). With the key switch in the run position, current flows from battery (G1) positive terminal to fusible link, key switch, power fuse (F4), and rectifier/regulator (N1). The voltage sensing circuit allows the rectifier/regulator to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the rectifier/regulator. The rectifier/regulator converts AC current to DC current needed to charge the battery. If battery voltage is low, the rectifier/regulator allows DC current to flow to the battery to charge it through the battery charging circuit (B). When the battery is fully charged, the regulator stops current flow to the battery.

If stator output current to the rectifier/regulator stops, the rectifier/regulator provides current to the discharge light (H3) to light the lamp.

The ground circuit (E) provides a path to ground for the rectifier/regulator.

CHARGING CIRCUIT OPERATION—445 (S.N. 070001—)

Function:

To maintain battery voltage between 11.8 and 13.2 volts.

Operating Conditions:

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

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a rectifier/regulator. A discharge light (H4) warns the operator if the stator stops charging. The discharge light circuit monitors stator output, not battery voltage.

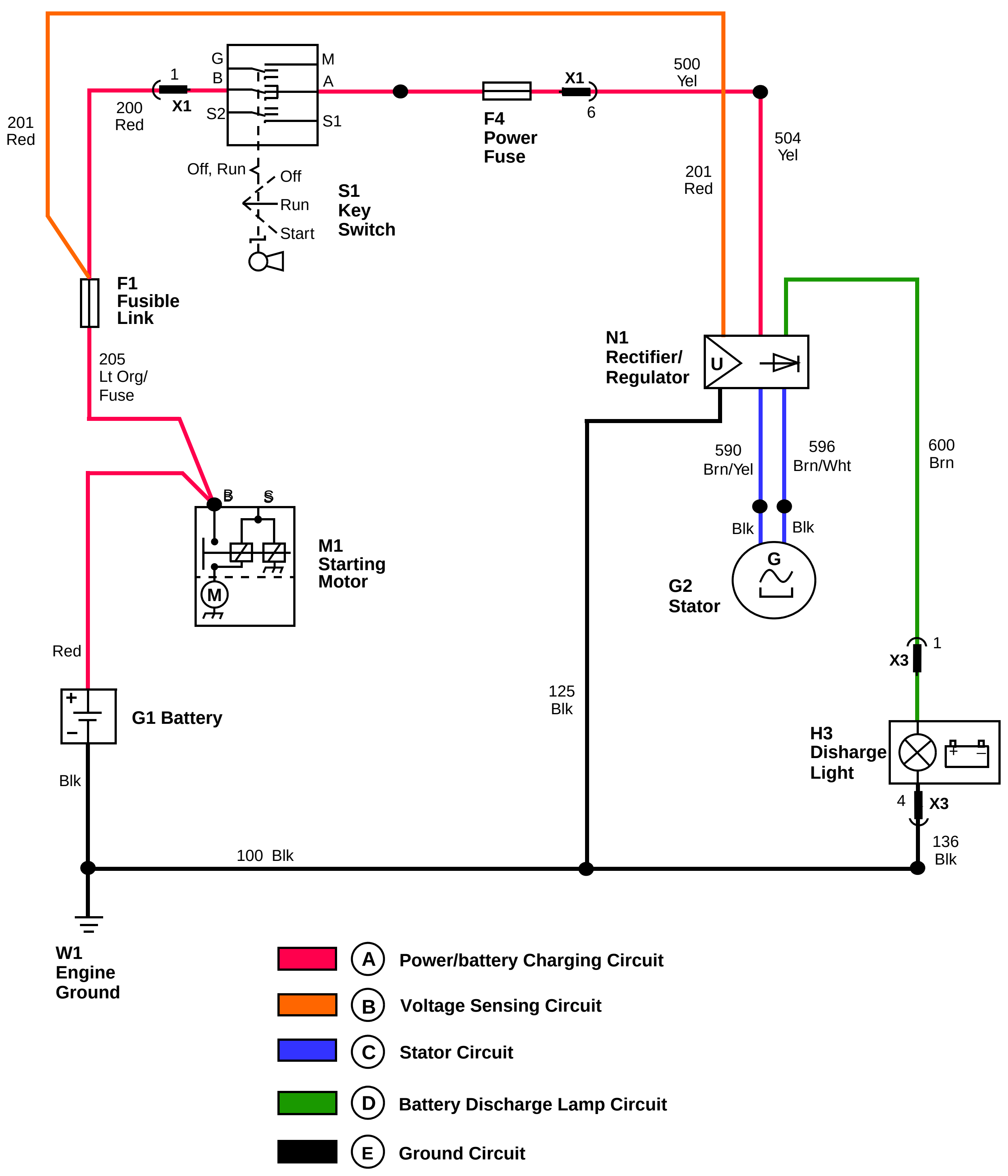
The power circuit (A) provides current to the key switch (S1) battery terminal and protects the charging circuit with a fusible link (F2). With the key switch in the run position, current flows from battery (G1) positive terminal to fusible link, key switch, fuse (F5), and rectifier/regulator (N1). The voltage sensing circuit allows the rectifier/regulator to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the rectifier/regulator. The rectifier/regulator converts AC current to DC current needed to charge the battery. If battery voltage is low, the rectifier/regulator allows DC current to flow to the battery to charge it through the battery charging circuit (B). When the battery is fully charged, the regulator stops current flow to the battery.

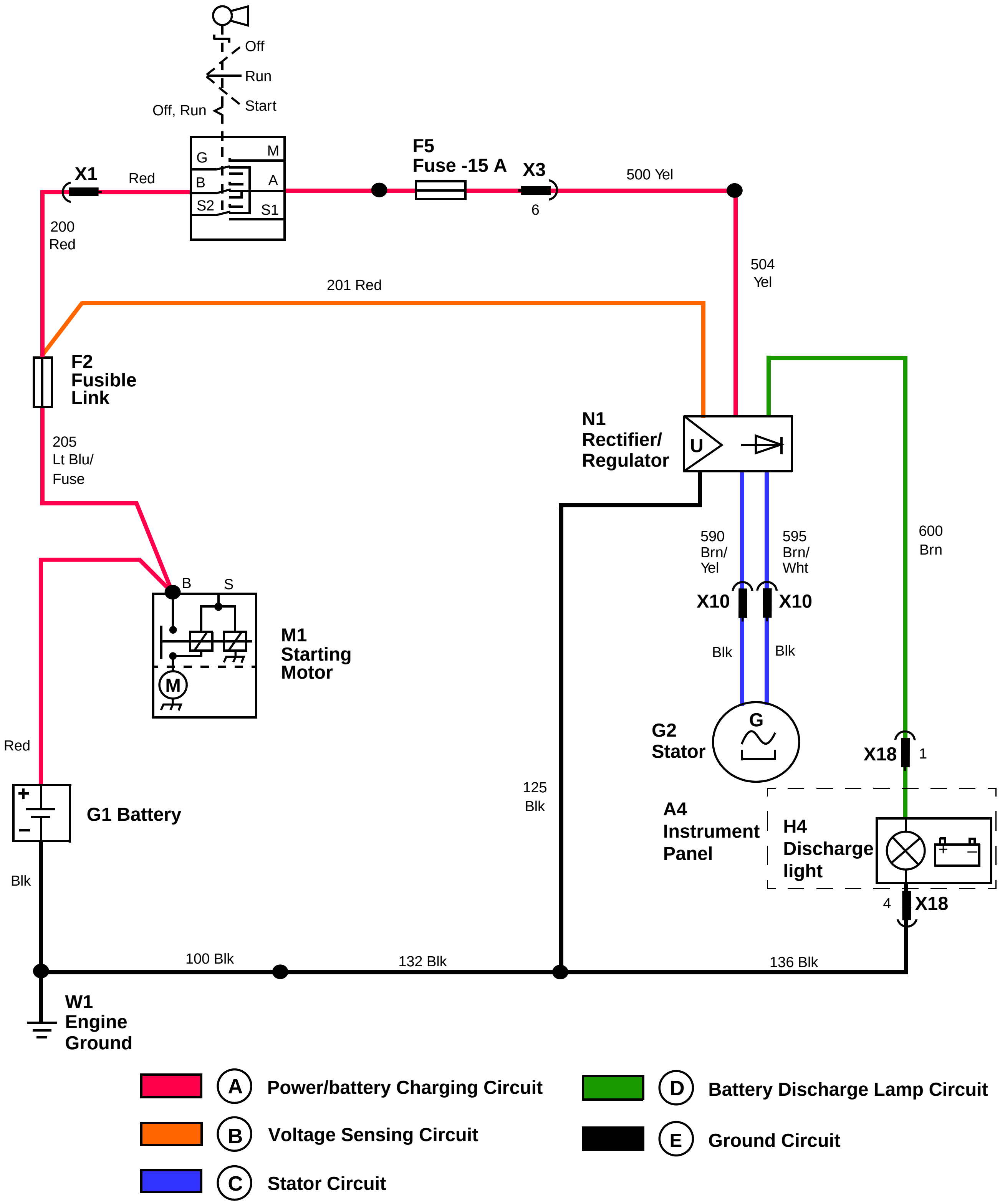
If stator output current to the rectifier/regulator stops, the rectifier/regulator provides current to the discharge light (H3) to light the lamp.

The ground circuit (E) provides a path to ground for the rectifier/regulator.

CHARGING CIRCUIT SCHEMATIC—445 (S.N. —070000)



CHARGING CIRCUIT SCHEMATIC—445 (S.N. 070001—)



CHARGING CIRCUIT DIAGNOSIS—445 (S.N. —070000)

Test Conditions:

- Park brake engaged.
- Transaxle/Transmission in neutral.
- Regulator/Rectifier connector disconnected.
- Key switch in run position.
- Engine running at fast idle.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Regulator/rectifier connector.	Minimum unregulated voltage output— 26 VAC.	Test stator, check flywheel magnets, 595 brn/wht and 590 brn/yel wires.

Test Conditions:

- Regulator/rectifier connector connected.

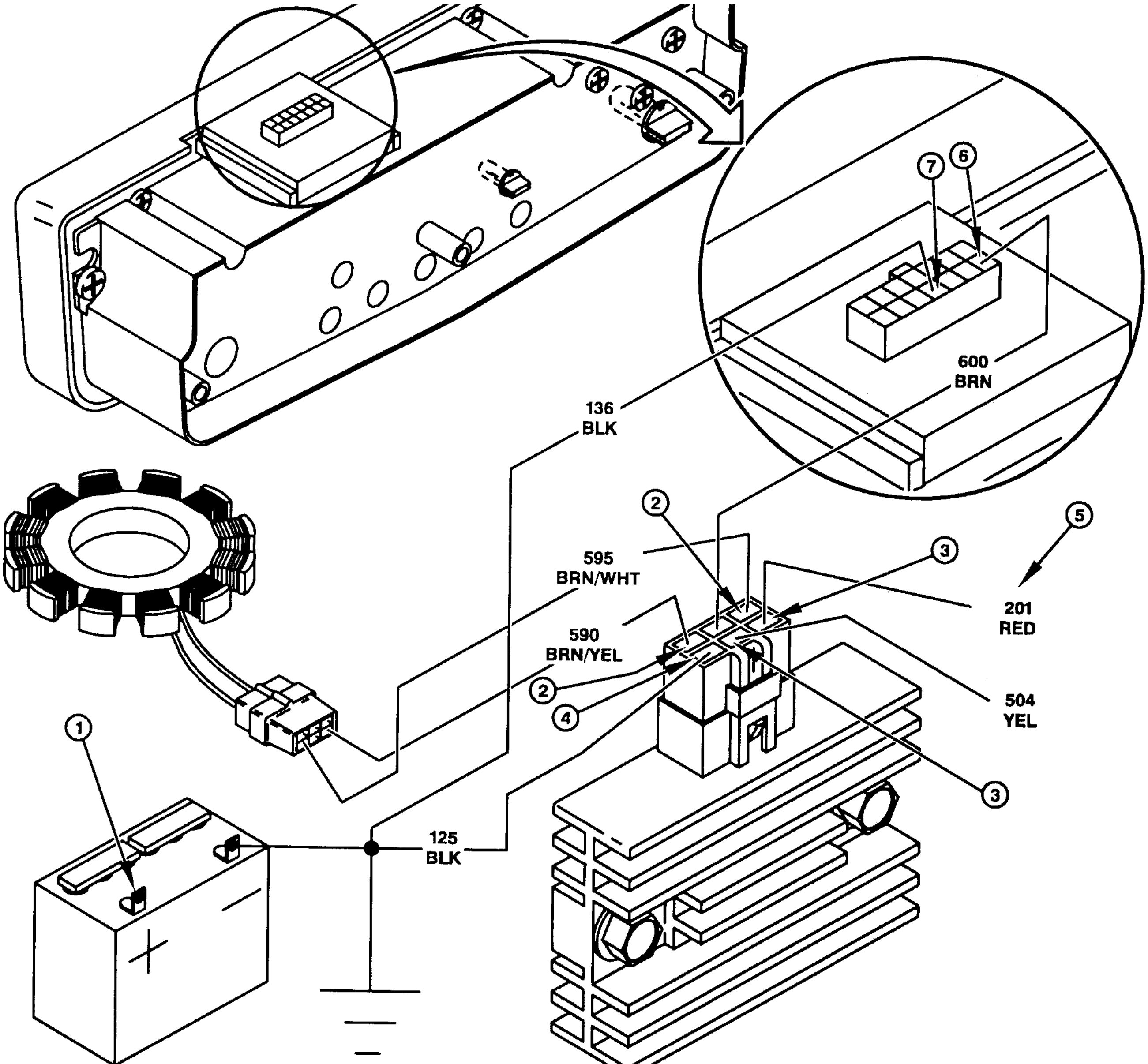
Test/Check Point	Normal	If Not Normal
3. Regulator/rectifier.	Battery voltage.	Check power circuit.
4. Regulator/rectifier.	0.0—0.2 volts.	Greater than 0.2 volts—test regulator/rectifier ground circuit (125 and 100 blk wires). 0.0 volts—Replace regulator/ rectifier.
5. Regulator/rectifier wire.	Minimum regulated output—13 A.	Replace regulator/rectifier.

Test Conditions:

- Engine off.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
6. Discharge light.	Battery voltage.	Check 600 brn wire then replace regulator/rectifier.
7. Discharge light.	0.0—0.2 volts.	Greater than 0.2 volts—test charge light ground circuit—136 blk wire. 0 volts—replace bulb.

CHARGING CIRCUIT TEST POINTS—445 (S.N. —070000)



CHARGING CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

Test Conditions:

- Park brake engaged.
- Transaxle/Transmission in neutral.
- Rectifier/regulator connector disconnected.
- Key switch in run position.
- Engine running at fast idle.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Rectifier/regulator connector.	Minimum unregulated voltage output— 26 VAC.	Test stator, check flywheel magnets, 595 brn/wht and 590 brn/yel wires.

Test Conditions:

- Rectifier/regulator connector connected.

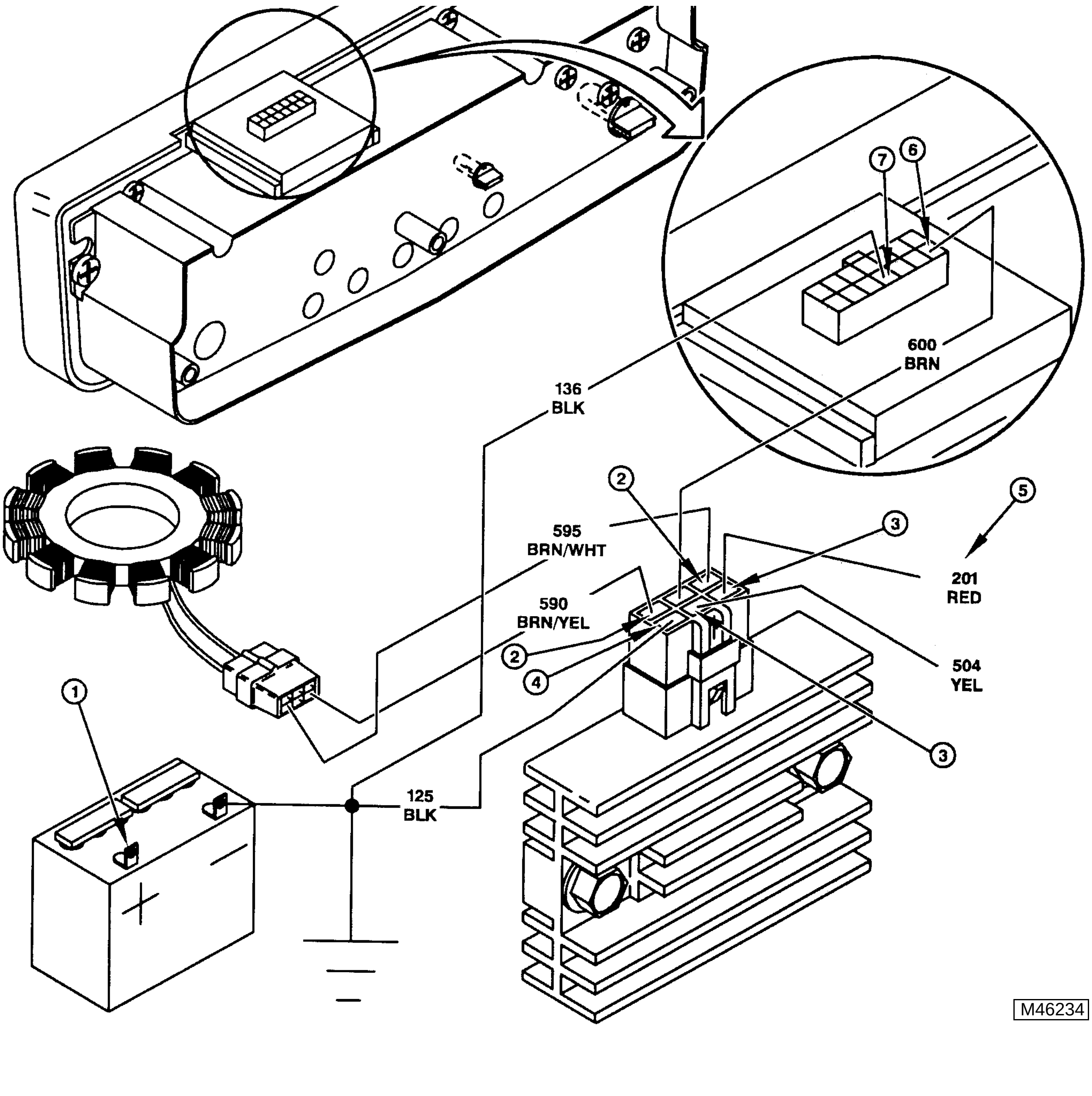
Test/Check Point	Normal	If Not Normal
3. Rectifier/regulator.	Battery voltage.	Check power circuit.
4. Rectifier/regulator.	0.0—0.2 volts.	Greater than 0.2 volts—test rectifier/regulator ground circuit (125 and 100 blk wires). 0.0 volts—Replace regulator/ rectifier.
5. Rectifier/regulator wire.	Minimum regulated output—13 A.	Replace rectifier/regulator.

Test Conditions:

- Engine off.
- Key switch in run position.

Test/Check Point	Normal	If Not Normal
6. Discharge light.	Battery voltage.	Check 600 brn wire then replace rectifier/regulator.
7. Discharge light.	0.0—0.2 volts.	Greater than 0.2 volts—test charge light ground circuit—136 blk wire. 0 volts—replace bulb.

CHARGING CIRCUIT TEST POINTS—445 (S.N. 070001—)



PTO CIRCUIT OPERATION—445 (S.N. —070000)

Function:

To provide power to energize or de-energize the PTO solenoid when desired by the operator.

Operating Conditions:

The key switch must be in the run position, with the brake pedal released (brake switch closed), the PTO switch off, and the operator on the seat to initially provide power to the PTO switch for PTO solenoid operation.

System Operation:

The PTO circuit uses the seat switch (S2), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO solenoid (Y1) if the operator gets off the seat with the PTO engaged. Also, the PTO will be disengaged if the brake pedal is depressed with the PTO switch on.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and key switch terminal B (S1). With the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F4), ignition relay terminal 87, and the seat switch. Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay must come from the seat switch circuit (B). With the seat switch closed, current flows to the ignition relay coil terminal, and the ignition relay LED (E1). The ignition relay LED indicates that power is available to the ignition relay coil.

With the ignition relay energized, current (C) flows to the PTO relay terminal 87. Current cannot flow to the PTO switch (S4) until the PTO relay is energized. Energizing current for the PTO relay must come from the PTO switch and the brake switch (S3). The PTO switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO switch is in the ON position. The brake switch prevents the PTO relay from energizing if the brake pedal is depressed. With the PTO switch off, current flows to the PTO relay terminal 30, brake switch (brake pedal released), PTO LED (E2), PTO relay coil and energizes the coil, closing the relay. PTO relay circuit current (D) is available to operate the PTO solenoid (Y1) and lamp (H1) when the PTO switch is turned on. The PTO relay LED indicates that power is available to the PTO relay coil.

If the operator leaves the seat or depresses the brake pedal with the PTO engaged, current to the ignition and PTO relay coil is stopped. The relays open and current flow to the PTO solenoid stops, disengaging the PTO clutch. The operator must return to the seat, release the brake pedal, and turn the PTO switch OFF before the PTO relay will energize again. A delay capacitor in the control/fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

When the PTO switch is moved to the ON position, current flows to the PTO solenoid and energizes the solenoid to engage the clutch. At the same time, current also flows to the PTO light. An alternate path for PTO relay coil energizing current must be provided when the PTO switch is on. With the brake pedal released, PTO relay circuit current (D) from terminal 30 flows to the brake switch, and PTO relay coil, keeping the relay energized.

PTO CIRCUIT OPERATION—445 (S.N. 070001—)

Function:

To provide power to energize or de-energize the PTO solenoid when desired by the operator.

Operating Conditions:

The key switch must be in the run position, with the brake pedal released (brake switch closed), the PTO switch off, and the operator on the seat to initially provide power to the PTO switch for PTO solenoid operation.

System Operation:

The PTO circuit uses the seat switch (S3), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO solenoid (Y2) if the operator gets off the seat with the PTO engaged. Also, the PTO will be disengaged if the brake pedal is depressed with the PTO switch on.

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F2), and terminal B of key switch (S1). With the key switch in the run position, current flows from key switch terminal B to terminal A, power fuse (F5), ignition relay terminal 87, and the seat switch. Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay comes from the seat switch circuit (B). With the seat switch closed, current flows to the ignition relay coil terminal, and the ignition LED (E4). The ignition LED indicates that power is available to the ignition relay coil.

With the ignition relay energized, current (C) flows to the PTO relay terminal 87. Current cannot flow to the PTO switch (S2) until the PTO relay is energized. Energizing current for the PTO relay must come from the PTO switch, the brake switch (S5), and RIO switch (S4). The PTO safety circuit is used to prevent the PTO relay from energizing, if the PTO switch is in the ON position. The brake switch prevents the PTO relay from energizing if the brake pedal is depressed. With the PTO switch off, current flows to the PTO relay terminal 30, brake switch (brake pedal released), RIO switch, PTO LED (E3), PTO relay coil and energizes the coil, closing the relay. PTO relay circuit current (D) is available to operate the PTO solenoid (Y2) and front PTO light (H2) when the PTO switch is turned on. The PTO LED indicates that power is available to the PTO relay coil.

When the PTO switch is moved to the ON position, current flows to the PTO solenoid and energizes the solenoid to engage the clutch. At the same time, current also flows to the front PTO light.

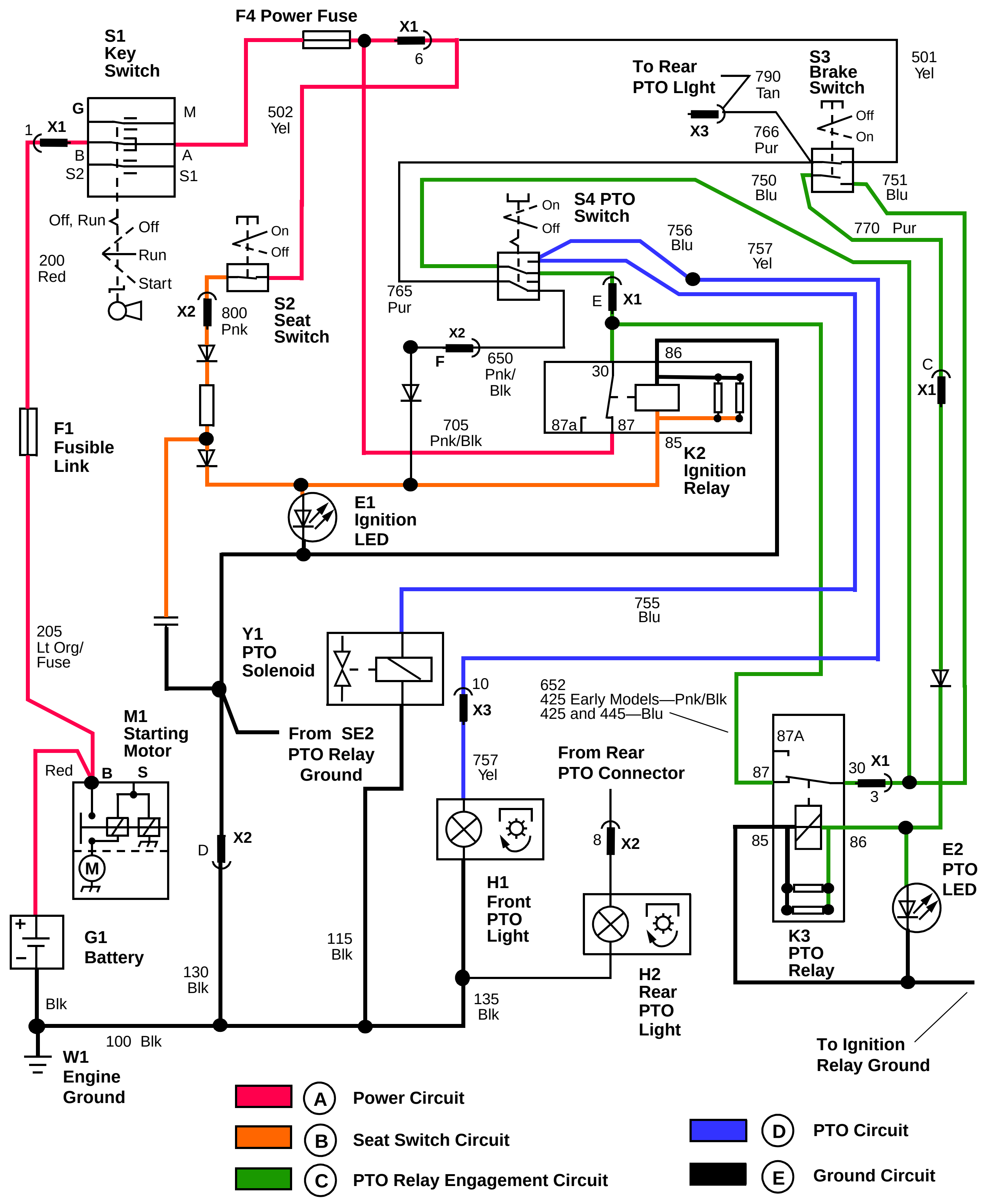
If the operator leaves the seat or depresses the brake pedal with the PTO engaged, current to the ignition and PTO relay coil is stopped. The relays open and current flow to the PTO solenoid stops, disengaging the PTO clutch. The operator must return to the seat, release the brake pedal, and turn the PTO switch to OFF before the PTO relay will energize again. A delay capacitor in the control/fuse module provides current for 1/2 second to keep the ignition relay coil energized if the operator bounces on the seat.

When the PTO is engaged and the operator changes to reverse, current flow to the PTO relay coil is stopped, de-energizing the relay. With the PTO relay de-energized, current flow to the PTO switch and PTO solenoid is also stopped, preventing the PTO solenoid from energizing and the PTO is disengaged.

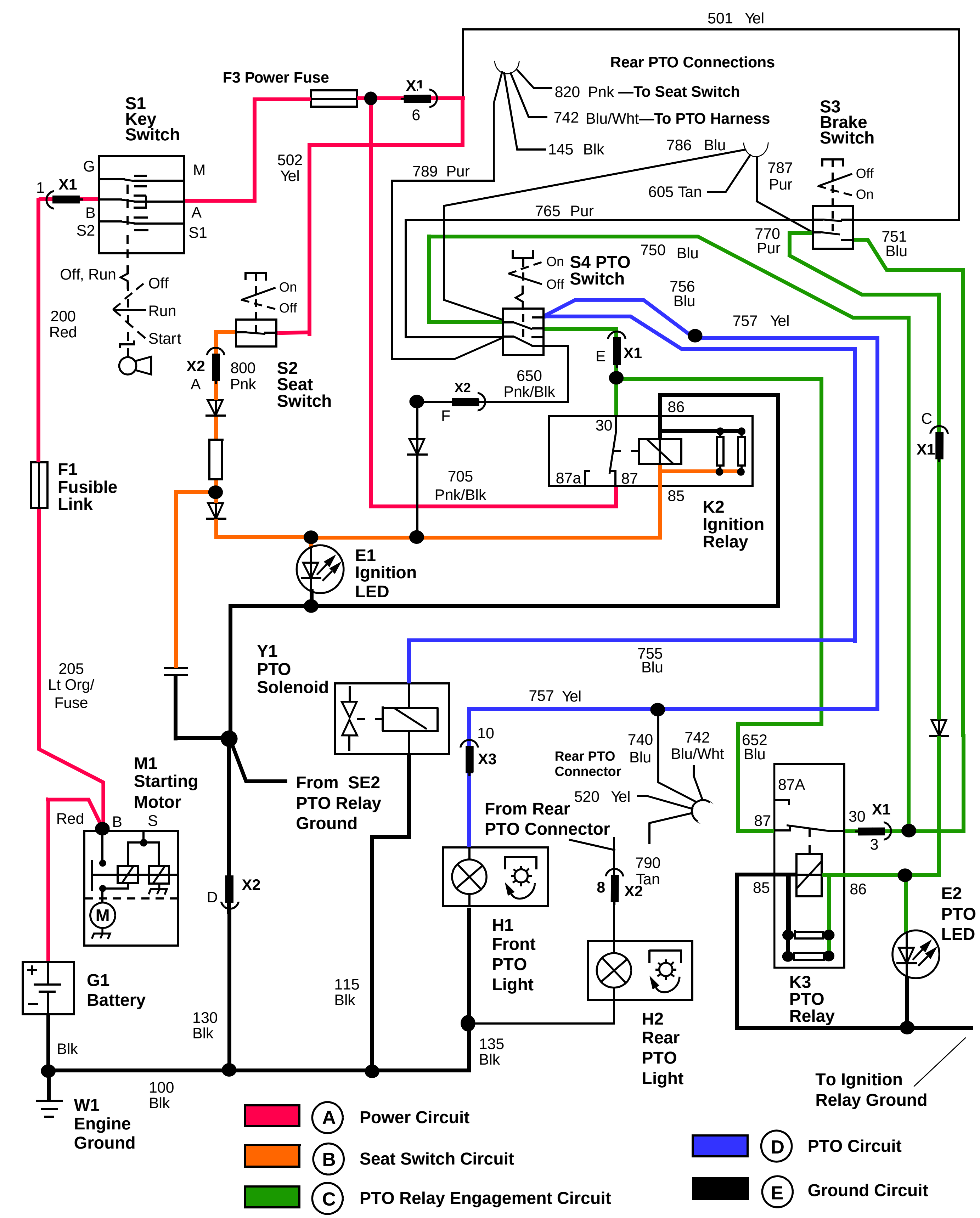
If the PTO switch is placed in the RIP position before changing to reverse, current will flow to the RIO latch relay coil. The RIO latch relay allows current to flow to the PTO relay. Once reverse motion has begun the RIO switch is open, current to the RIO latch relay must come from the brake switch and is routed through the RIO latch relay contacts and RIO unlatch relay contacts back to the RIO latch relay coil to keep it latched.

When forward or neutral is resumed, the RIO switch closes and current flows to the RIO unlatch relay coil and energizes the relay, stopping current flow to the RIO latch coil and de-energizes it and stops current flow to the PTO relay, PTO switch, and PTO solenoid. After the PTO relay is de-energized by changing to reverse, it cannot be energized again until the PTO switch is returned to the OFF position.

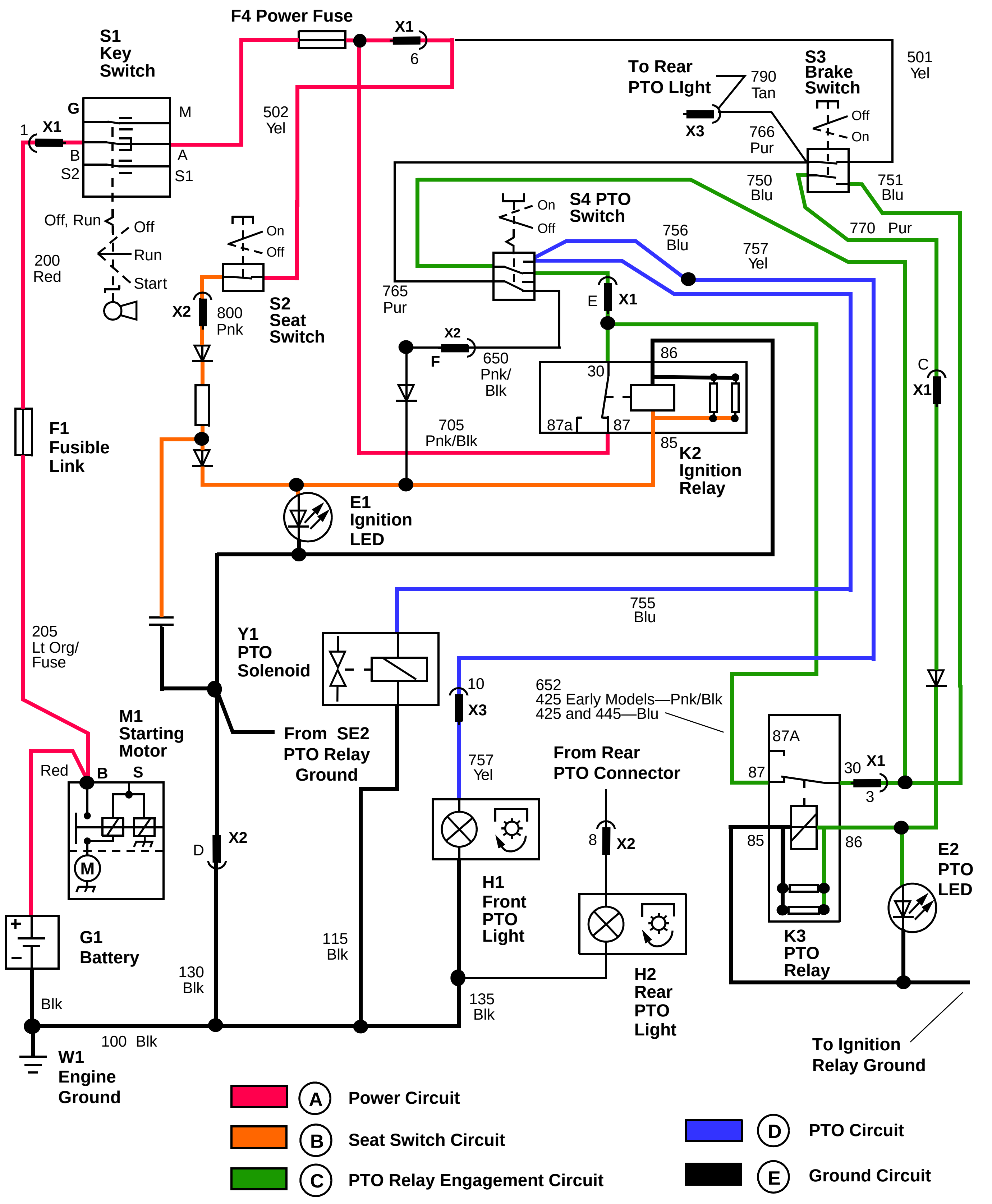
PTO CIRCUIT SCHEMATIC—445 (S.N. —031361)



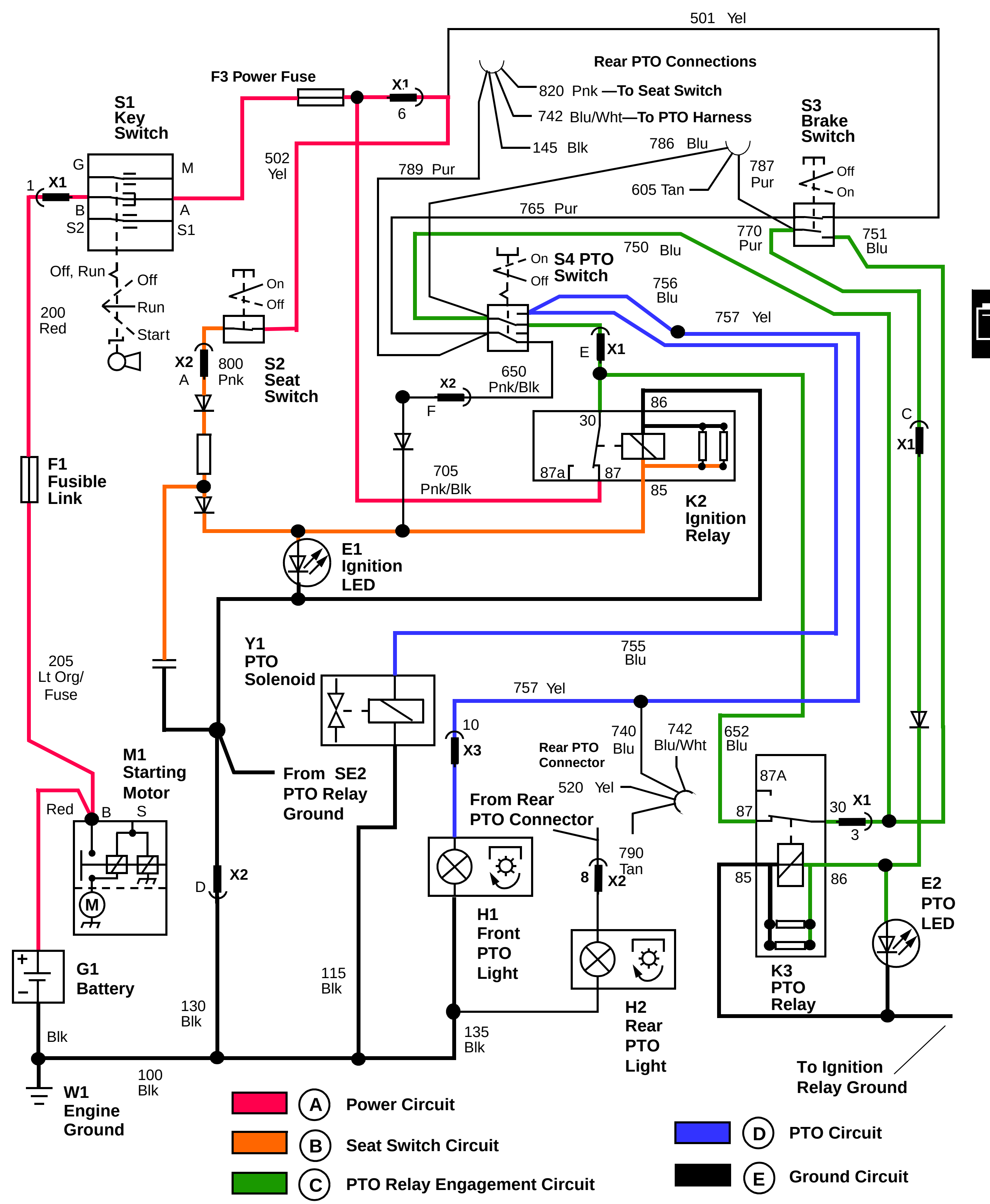
PTO CIRCUIT SCHEMATIC—445 (S.N. 031362—070000)



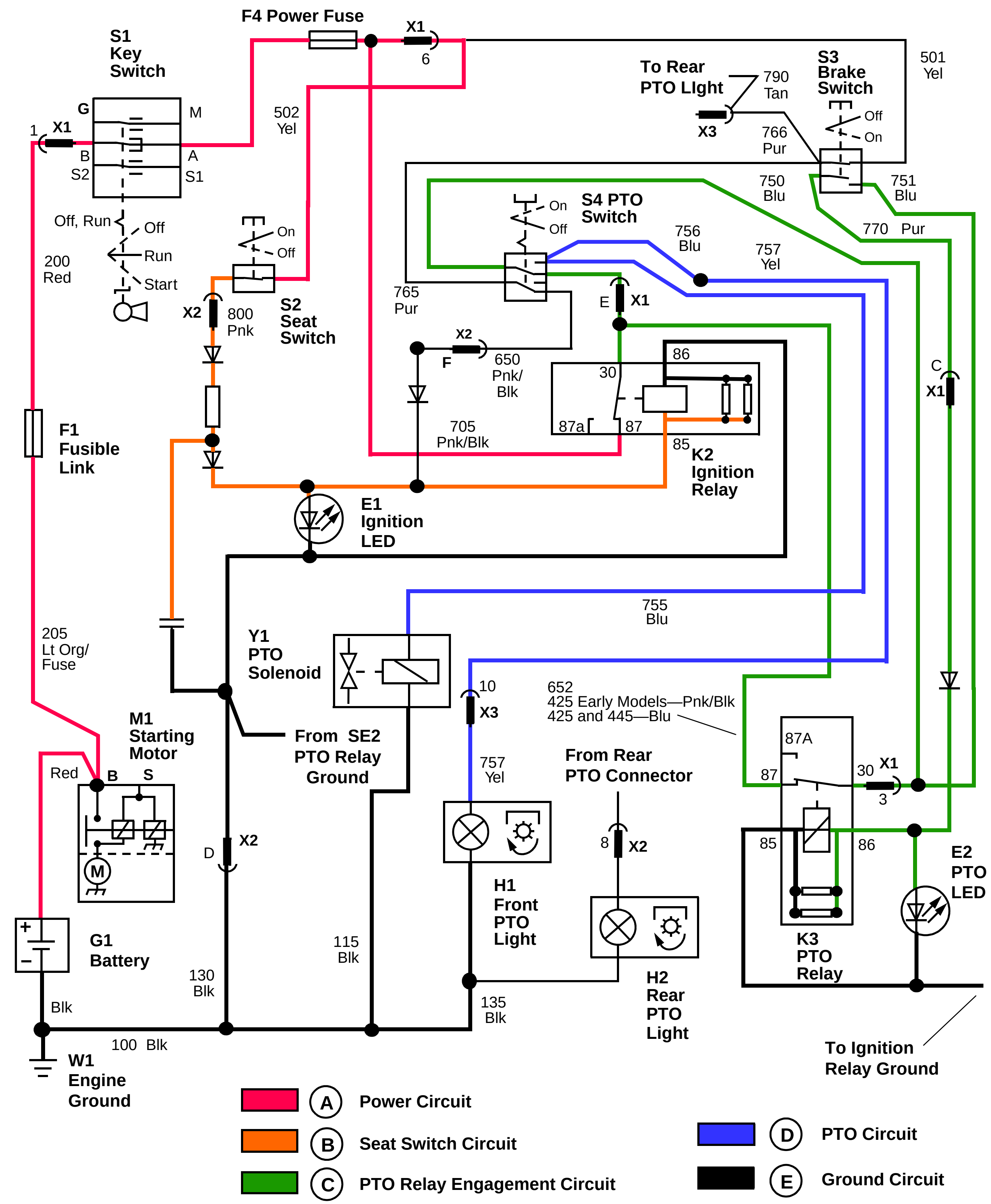
PTO CIRCUIT SCHEMATIC—445 (S.N. —031361)



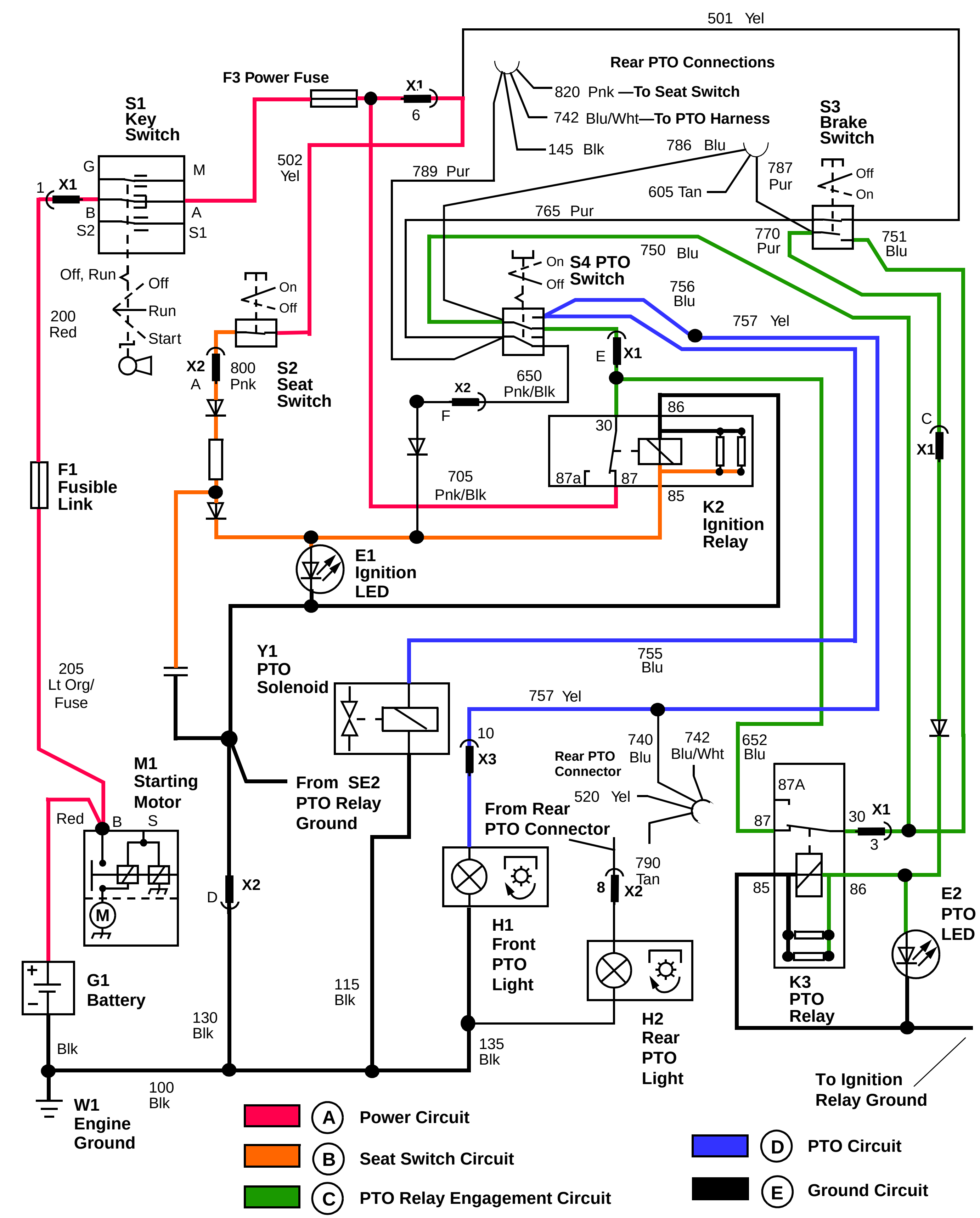
PTO CIRCUIT SCHEMATIC—445 (S.N. 031362—070000)



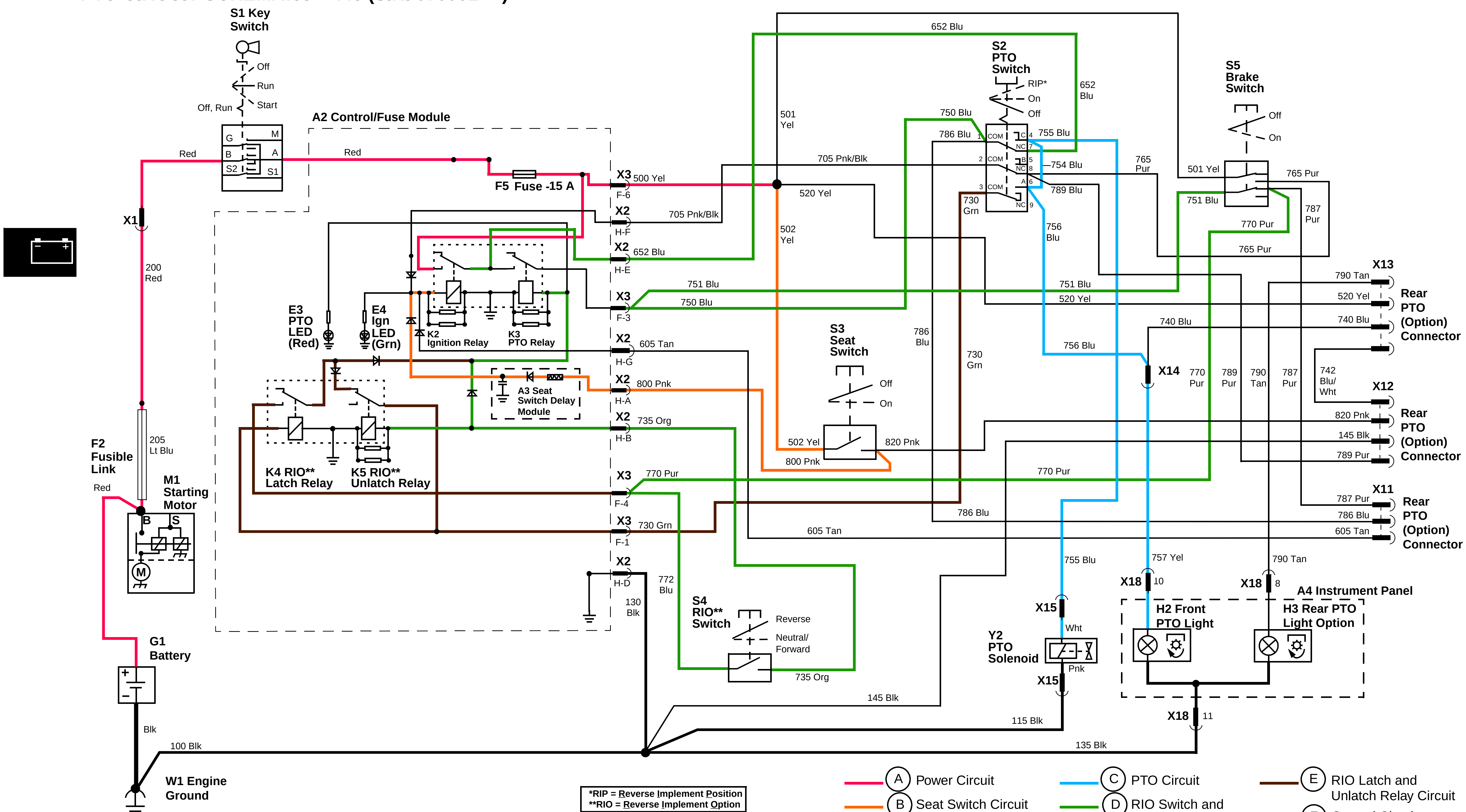
PTO CIRCUIT SCHEMATIC—445 (S.N. —031361)



PTO CIRCUIT SCHEMATIC—445 (S.N. 031362—070000)

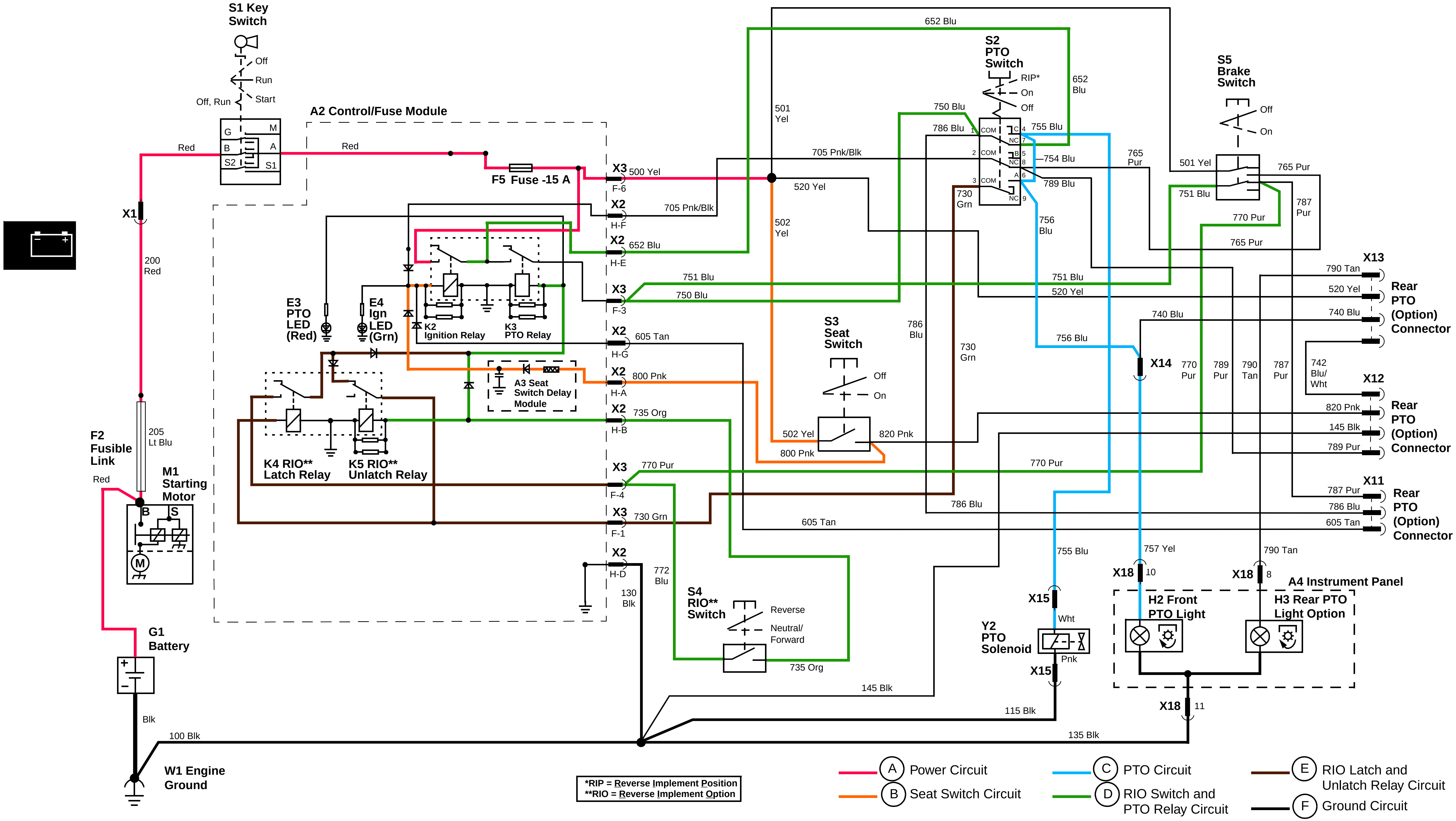


PTO CIRCUIT SCHEMATIC—445 (S.N. 070001—)

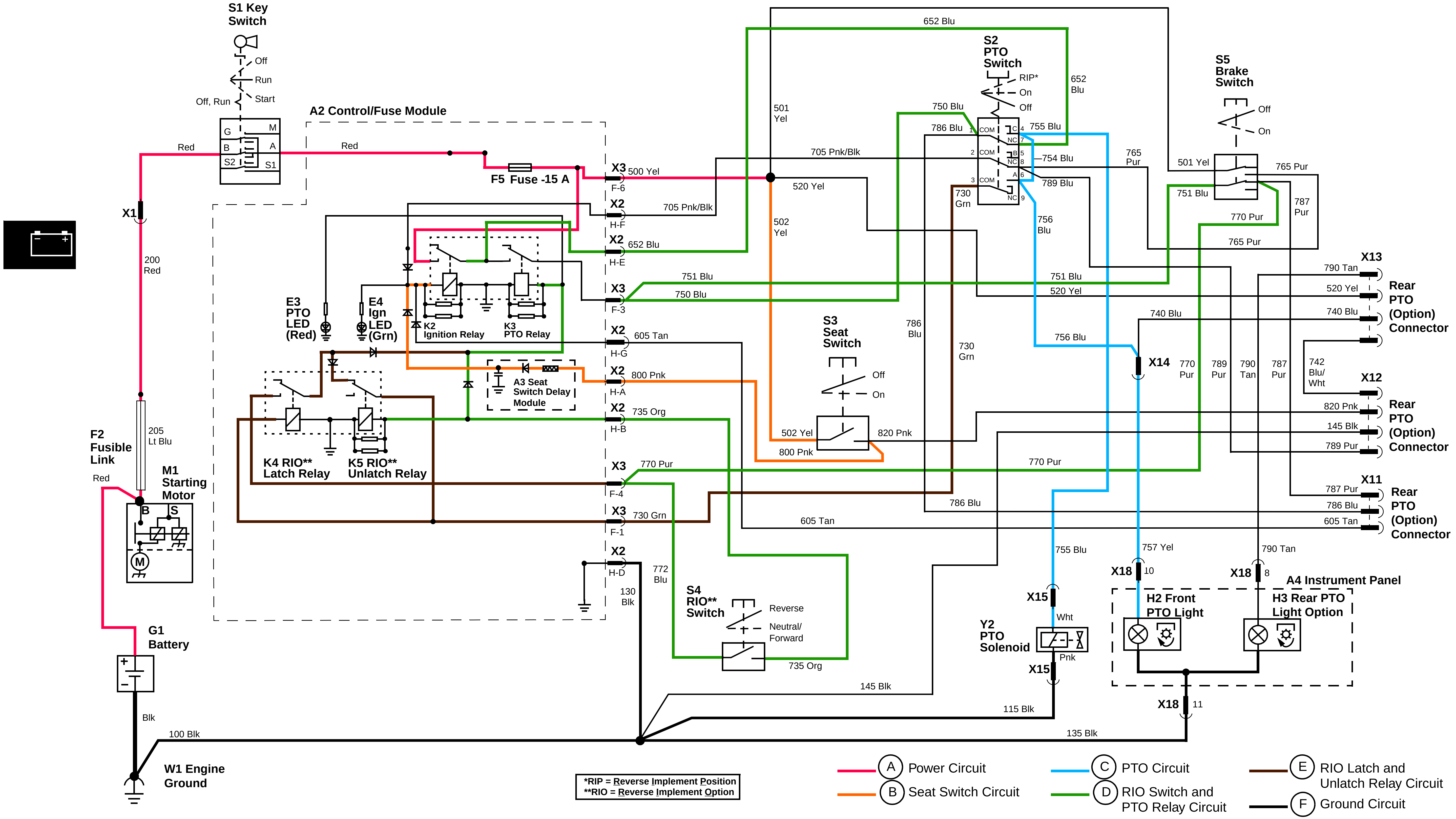


A	Power Circuit
B	Seat Switch Circuit
C	PTO Circuit
D	RIO Switch and PTO Relay Circuit
E	RIO Latch and Unlatch Relay Circuit
F	Ground Circuit

PTO CIRCUIT SCHEMATIC—445 (S.N. 070001—)



PTO CIRCUIT SCHEMATIC—445 (S.N. 070001—)



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PTO CIRCUIT DIAGNOSIS—445 (S.N. —070000)

Test Conditions:

- PTO switch off position.
- Brake pedal released.
- Seat switch depressed or jumper wire installed in connector.
- Key switch run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

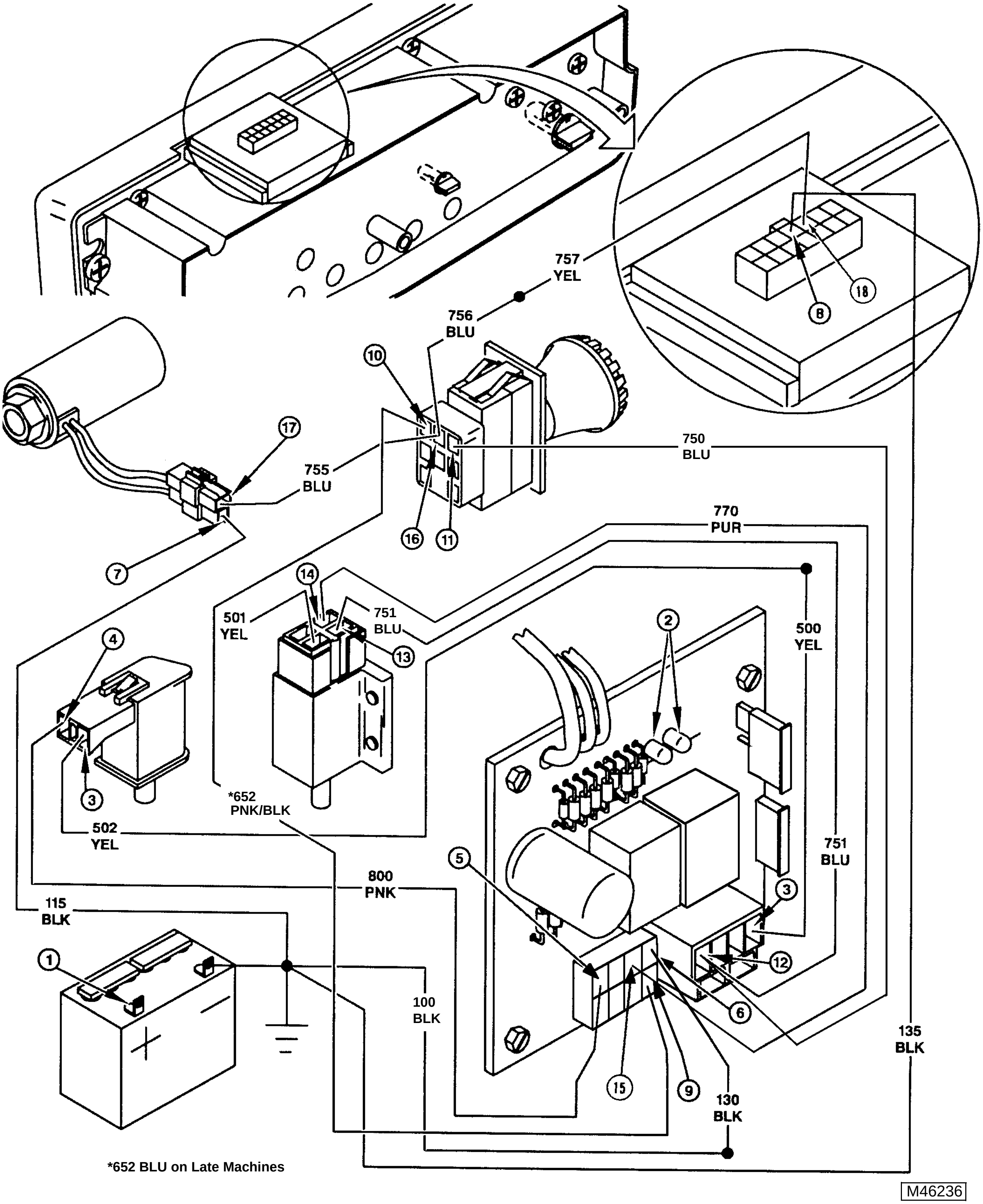
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition and PTO LED.	Lights on.	Lights off—check relay engagement circuit—go to step 3. Lights on—go to step 7.
3. Seat switch and control/fuse module terminal 6.	Battery voltage.	Check power circuit test points from battery to control fuse module.
4. Seat switch.	Battery voltage.	Test seat switch.
5. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
6. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check battery negative cable and harness ground connection, 100 and 130 blk wires.
7. PTO solenoid.	Maximum 0.1 ohms resistance.	Check 115 blk wire.
8. Dash panel.	Maximum 0.1 ohms resistance.	Check 135 blk wire.

PTO CIRCUIT TEST POINTS—445 (S.N. —070000)



PTO CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)

Test Conditions:

- Key switch in run position.

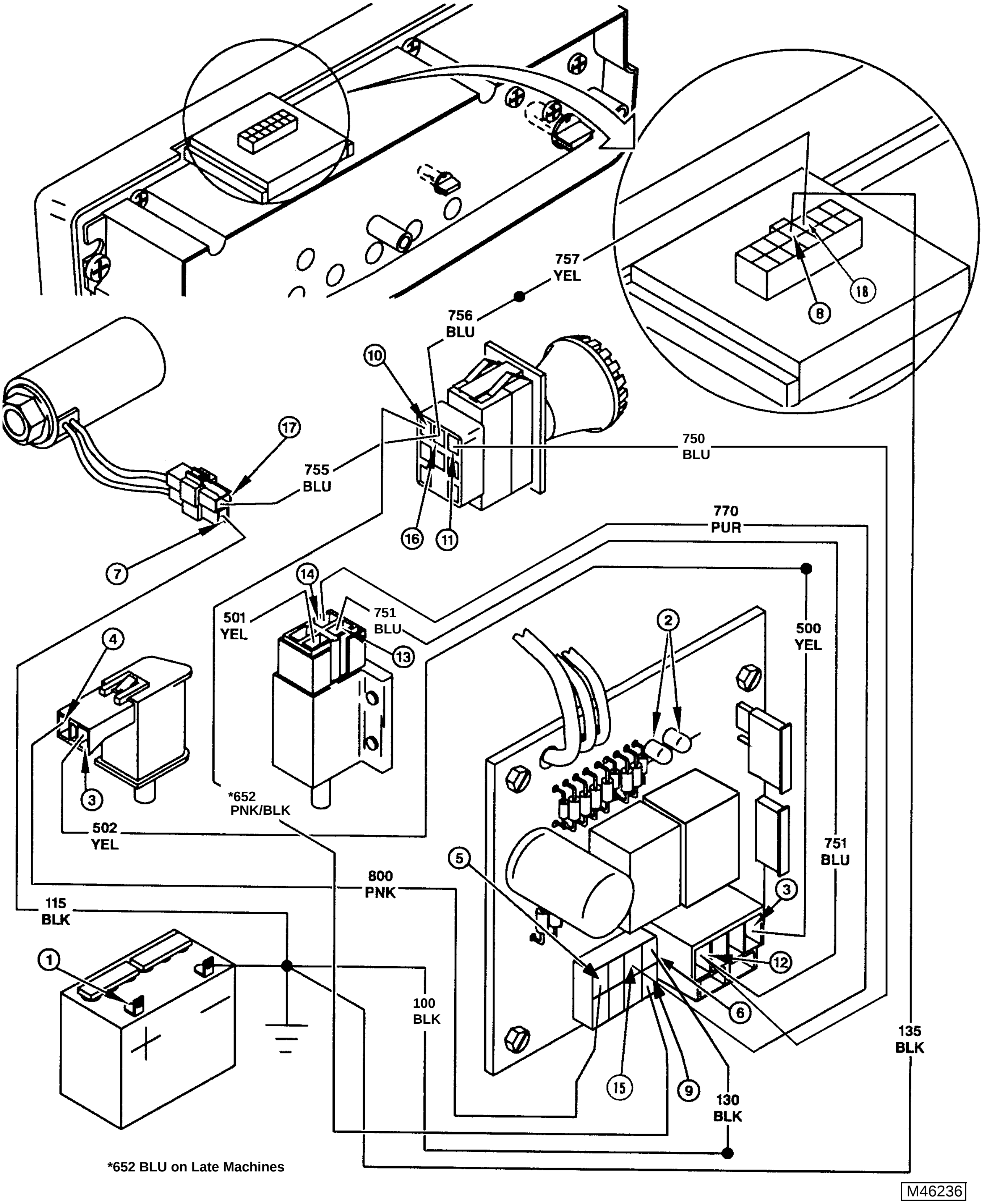
Test/Check Point	Normal	If Not Normal
9. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
10. PTO switch.	Battery voltage.	Check 652 blu wire.
11. PTO switch.	Battery voltage.	Test PTO switch.
12. Control/fuse module terminal 3.	Battery voltage.	Check 750 blu wire.
13. Brake switch.	Battery voltage.	Check 751 blu wire.
14. Brake switch.	Battery voltage.	Test brake switch.
15. Control/fuse module terminal C.	Battery voltage.	Check 770 pur wire.

Test Conditions:

- PTO switch on.

Test/Check Point	Normal	If Not Normal
16. PTO switch.	Battery voltage.	Test PTO switch.
17. PTO solenoid.	Battery voltage.	Check 755 blu wire, if ok replace PTO solenoid.
18. Dash panel.	Battery voltage.	Check 756 blu, 757 yel wire, and PTO light, if ok replace dash panel module.

PTO CIRCUIT DIAGNOSIS—445 (S.N. —070000) (continued)



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PTO CIRCUIT DIAGNOSIS—445 (S.N. 070001—)

Test Conditions:

- PTO switch in off position.
- Brake pedal released.
- Seat switch depressed or jumper wire installed in connector.
- Key switch in run position.
- Meter negative (–) lead on battery negative (–) terminal.
- Meter positive (+) lead on numbered test point.
- Check connection for corrosion and loose terminals when testing.

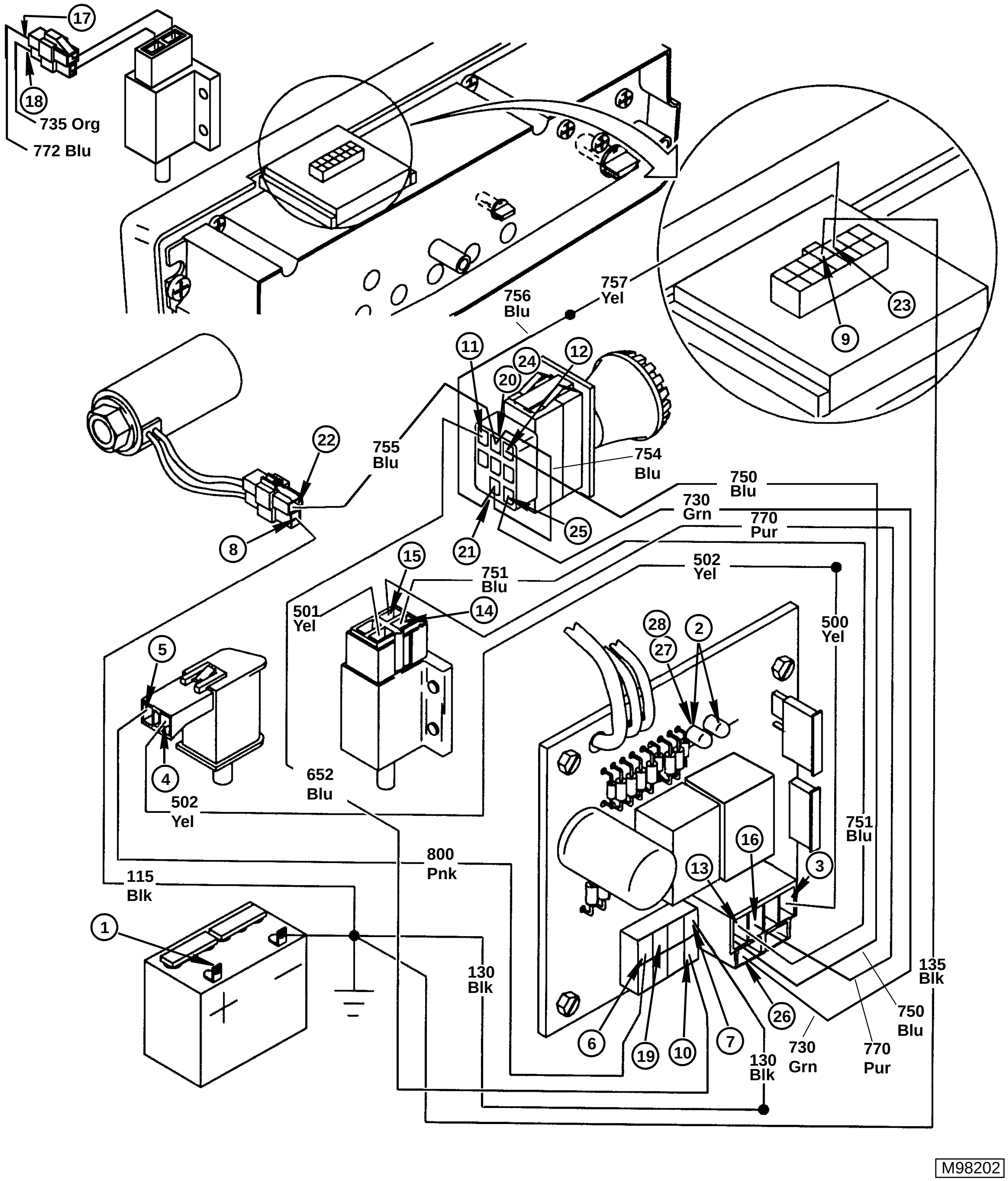
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal.	11.8—13.2 volts.	Test battery.
2. Ignition and PTO LED.	Lights on.	Lights off—check relay engagement circuit—go to step 3. Lights on—go to step 7.
3. Control/fuse module terminal 6.	Battery voltage.	Check power circuit test points from battery to control/fuse module.
4. Seat switch.	Battery voltage.	Check 502 yel wire.
5. Seat switch.	Battery voltage.	Test seat switch.
6. Control/fuse module terminal A.	Battery voltage.	Check 800 pnk wire.

Test Conditions:

- Key switch in off position.

Test/Check Point	Normal	If Not Normal
7. Control/fuse module terminal D.	Maximum 0.1 ohms resistance.	Check battery negative cable and harness ground connection, 100 and 130 blk wires.
8. PTO solenoid.	Maximum 0.1 ohms resistance.	Check 115 blk wire.
9. Instrument panel.	Maximum 0.1 ohms resistance.	Check 135 blk wire.

PTO CIRCUIT TEST POINTS—445 (S.N. 070001—)



PTO CIRCUIT DIAGNOSIS—445 (S.N. 070001—) (continued)

Test Conditions:

• Key switch in run position.

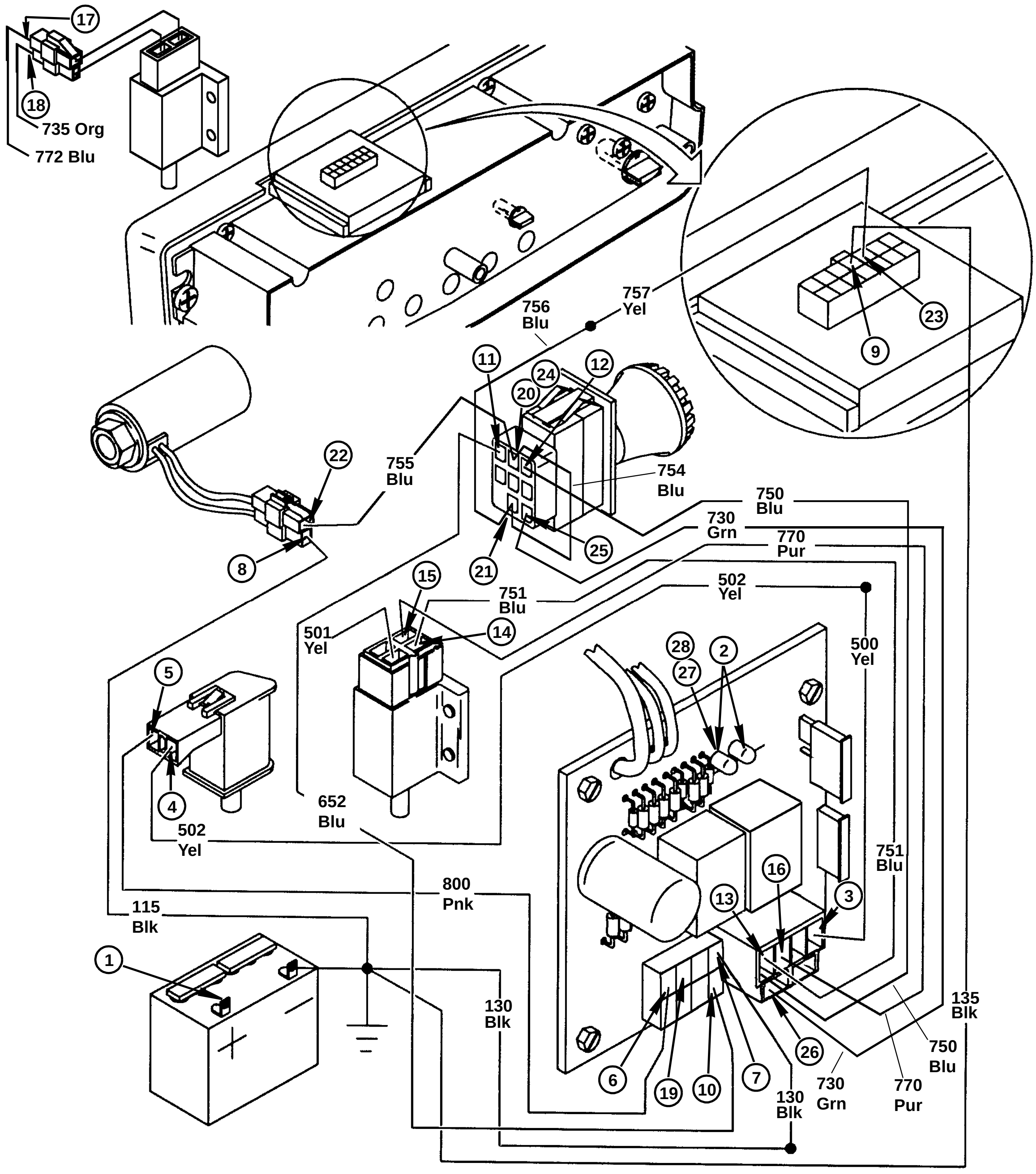
Test/Check Point	Normal	If Not Normal
10. Control/fuse module terminal E.	Battery voltage.	Replace control/fuse module.
11. PTO switch.	Battery voltage.	Check 652 blu wire.
12. PTO switch.	Battery voltage.	Test PTO switch.
13. Control/fuse module terminal 3.	Battery voltage.	Check 750 blu wire.
14. Brake switch.	Battery voltage.	Check 751 blu wire.
15. Brake switch.	Battery voltage.	Test brake switch.
16. Control/fuse module terminal 4.	Battery voltage.	Check 770 pur wire.

Test Conditions:

• PTO switch in on position.

Test/Check Point	Normal	If Not Normal
17. RIO switch.	Battery voltage.	Check 772 blu wire.
18. RIO switch.	Battery voltage.	Test RIO switch.
19. Control/fuse module terminal B.	Battery voltage.	Check 735 org wire.
20. PTO switch.	Battery voltage.	Replace control/fuse module.
21. PTO switch.	Battery voltage.	Check 754 blu wire.
22. PTO solenoid.	Battery voltage.	Check 755 blu wire, if ok replace PTO solenoid.
23. Instrument panel connector terminal 10.	Battery voltage.	Check 756 blu, 757 yel wire, and PTO light, if ok replace instrument panel.

PTO CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



PTO CIRCUIT DIAGNOSIS—445 (S.N. 070001—) (continued)

Test Conditions:

- PTO switch in RIP position.
- Forward/reverse pedal in reverse.

Test/Check Point	Normal	If Not Normal
24. PTO switch.	Battery voltage.	Test PTO switch.
25. PTO switch.	Battery voltage.	Test PTO switch.
26. Control/fuse module terminal 1.	Battery voltage.	Check 730 grn wire.

Test Conditions:

- Release the PTO switch to on.

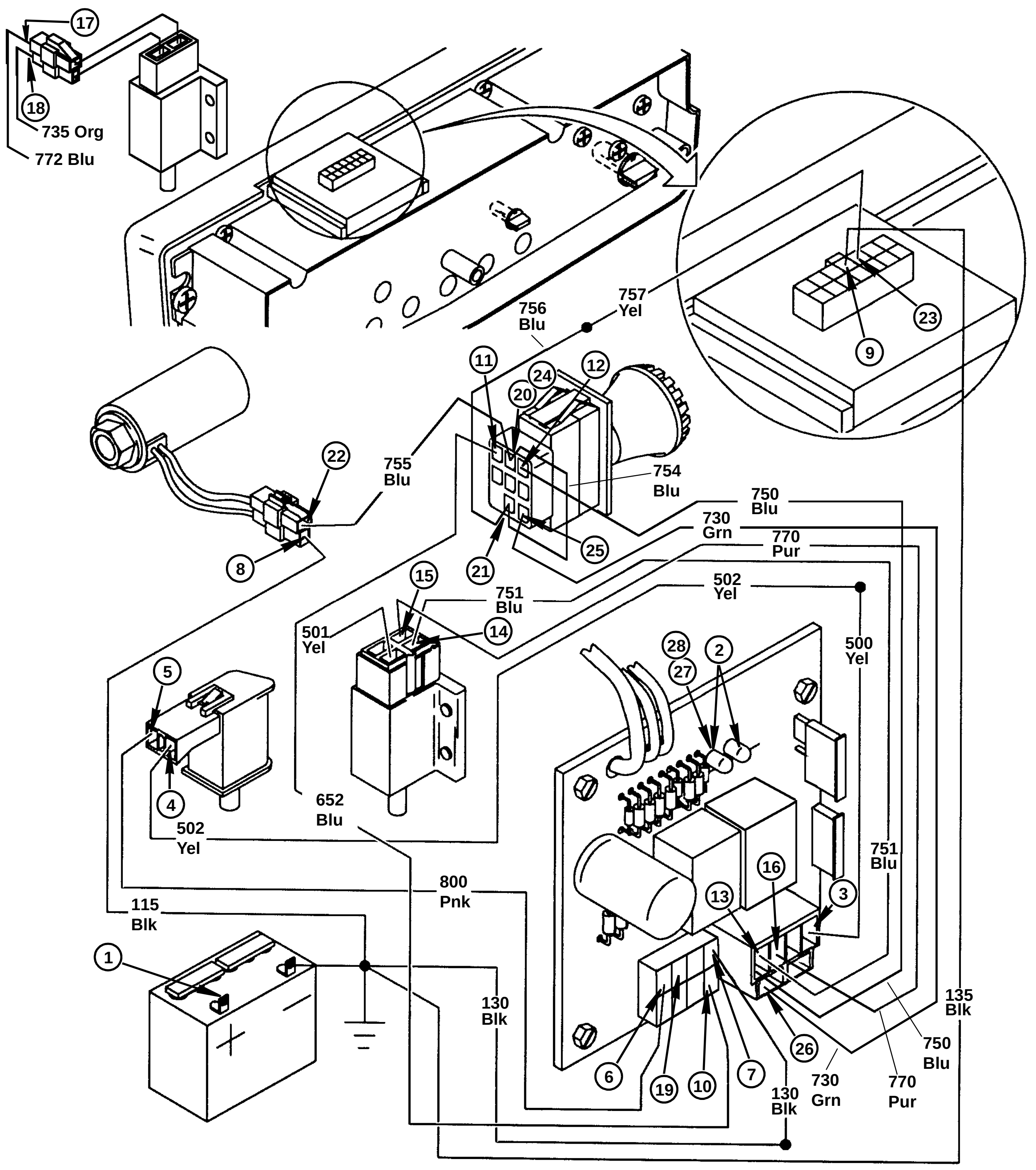
Test/Check Point	Normal	If Not Normal
27. PTO LED.	Light on.	Test RIO latch relay.

Test Conditions:

- Forward/reverse pedal in forward.

Test/Check Point	Normal	If Not Normal
28. PTO LED.	Light off.	Test RIO unlatch relay.

PTO CIRCUIT TEST POINTS—445 (S.N. 070001—) (continued)



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INDICATOR LIGHTS, GAUGES, HOURMETER, AND LIGHTS CIRCUIT OPERATION—445 (S.N. —070000)

Function:

OIL PRESSURE LIGHT:

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

FUEL GAUGE:

To inform the operator of the fuel level in the tank.

COOLANT TEMPERATURE GAUGE:

To inform the operator of the engine coolant temperature.

HOURMETER:

To record the number of hours the engine is running.

HEADLIGHTS:

To provide power to the headlights, taillights, and dash panel lights for illumination if desired by the operator.

Operating Conditions:

The key switch must be in the run position; and the oil pressure switch, or light switch closed.

System Operation:

Current (A) flows from the battery (G1) to the starting motor (M1), fusible link (F1), and key switch (S1) B terminal. With the key switch in the run position, current flows through the switch to the light and power fuses (F3 and F4), fuel gauge (P1), oil pressure light (H4), coolant temperature gauge (P2), hourmeter (P3), and light switch (S5).

OIL PRESSURE LIGHT:

When the oil pressure switch (B6) is closed a path to ground (D) is made which illuminates the indicator light. The oil pressure switch will be closed if the engine is not running or the oil pressure is below 28 kPa (4 psi). With the key switch in the run position, the oil pressure light will be on. This is to inform the operator that the light is functioning. The warning light will go out after a normal engine start-up.

FUEL GAUGE:

Current (C) flows from the gauge (P1) to the fuel gauge sensor (B5). Current flow through the sensor is controlled by a variable resistor. As the sensor float moves to agree with the fuel level, the amount of resistance increases/decreases accordingly. This change in resistance is sensed back at the gauge needle which moves to indicate fuel level.

COOLANT TEMPERATURE GAUGE:

Current (E) flows from the gauge (P2) to the coolant temperature gauge sensor (B7). Current flow through the sensor is controlled by a temperature sensitive variable resistor. As the coolant temperature increases or decreases, the amount of resistance in the sensor increases/decreases accordingly. This change in resistance is sensed back at the gauge needle which moves to indicate coolant temperature.

HOURMETER:

Power for the hourmeter (P3) comes from the key switch (S3). When the key switch is in the run position, the hourmeter will be operating.

HEADLIGHTS:

With the light switch (S5) on (switch closed), current flows to the headlights (E7 and E8), taillights (E9 and 10), and dash lights (E5 and E6) and illuminates the lamps. The circuit is protected by a 15-amp fuse in the control/fuse module.