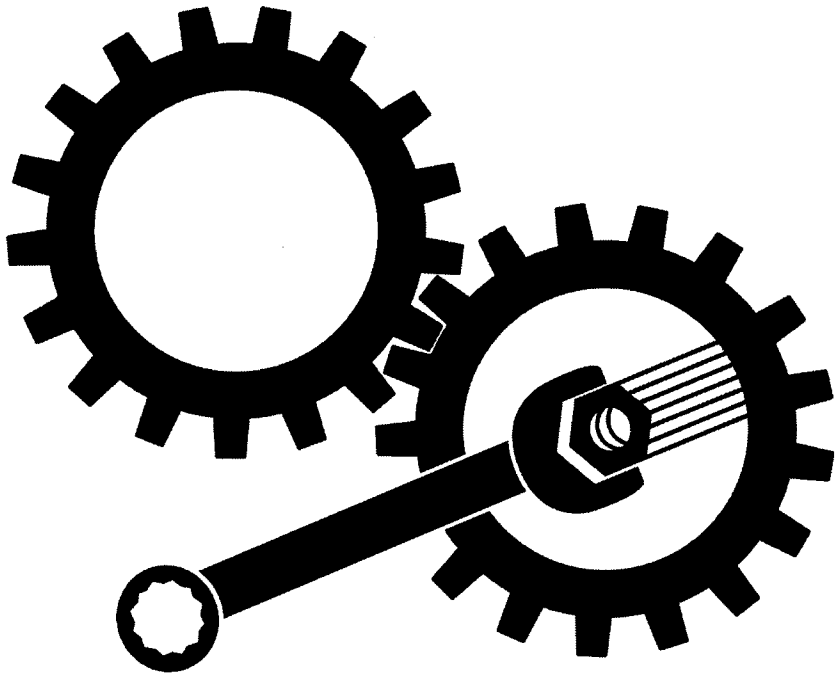
GRAVELY™

Professional G Series

Service Manual

Models 987066-072



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SECTION 1 - INTRODUCTION

1.1 THE MANUAL

The purpose of this manual is to provide complete instructions for service, maintenance, disassembly, repair, and installation of the mechanical components for the unit.

Dealer trained service personnel should use this manual as a supplement to and reminder of the training sessions conducted by the company.

Read all information for servicing a part or system before repair work is started to avoid needless disassembly.

Operation

Before operation of the unit, carefully and completely read manuals supplied with the unit. The contents will provide you with an understanding of safety instructions and controls during normal operation and maintenance.

Safety Messages

For your safety and the safety of others always read, understand, and follow all DANGER, WARNING, and CAUTION messages found in manuals and on safety decals.

Directional Reference

All reference to left, right, front, or rear are given from the operator in the operator position and facing the direction of forward travel.

1.2 SERVICE AND REPLACEMENT PARTS

When ordering publications, replacement parts, or making service inquiries, know the Model and Serial numbers of your unit and engine.

Numbers are located on the product registration form in the unit literature package. They are printed on a serial number label, located on the right instrument panel brace under the hood.

1.3 PRODUCT REGISTRATION

A warranty registration card must be filled out, signed, and returned at time of purchase. This card activates the warranty. Claims meeting requirements during limited warranty period will be honored.

1.4 UNAUTHORIZED REPLACEMENT PARTS

Use only Gravely replacement parts. The replacement of any part on this vehicle with anything other than a Gravely authorized replacement part may adversely affect the performance, durability, or safety of this unit and may void the warranty. Gravely disclaims liability for any claims or damages, whether warranty, property damage, personal injury, or death arising out of the use of unauthorized replacement parts.

1.5 DISCLAIMER

Gravely reserves the right to discontinue, make changes to, and add improvements upon its products at any time without public notice or obligation. The descriptions and specifications contained in this manual were in effect at printing. Equipment described within this manual may be optional. Some illustrations may not be applicable to your unit.

1.6 TECHNICAL SERVICE COMMUNICATIONS

Gravely Technical Service communicates information to the field using Service Letters, Service Bulletins, Product Notices, and Campaigns. Each communication signifies a type of information and priority. The dealer is responsible to carry out the directive provided in the communication. The types of communication are:

Service Letter - General technical information for the dealer. Technical information on how to service the product and product improvements.

Service Bulletin - Notification to update products to resolve certain issues or a notification of a policy change.

Product Notices - Notification of limited product located in a certain region. This is a limited distribution to only those who received the product involved.

Campaigns - Notification of a safety related issue. All products must be updated and are tracked by the factory until all units are corrected.

1.7 PREPARATION

Before starting any removal of parts, proper preparation is very important for efficient work. A clean work area at the start of each job will allow you to perform service repairs easily and quickly.

To reduce the incidence of misplaced tools or parts, place removed components with all attaching hardware in the disassembly order on a clean work surface. Organization is a key part of proper reassembly.

Tools, instruments, and parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a needless delay.

SECTION 2 - SAFETY

2.1 SAFETY ALERTS

Look for these symbols to point out important safety precautions. They mean:

Attention!

Personal Safety Is Involved!

Become Alert!

Obey The Message!

2.2 SIGNAL WORDS

The safety alert symbol is used in decals on the unit and with proper operation procedures in this manual. They alert you to the existence and relative degree of hazards.

Understand the safety message. It contains important information about personal safety on or near the unit.

DANGER: IMMINENTLY HAZARDOUS SITUATION! If not avoided, WILL RESULT in death or serious injury.

WARNING: POTENTIALLY HAZARDOUS SITUATION! If not avoided, COULD RESULT in death or serious injury.

CAUTION: POTENTIALLY HAZARDOUS SITUATION! If not avoided, MAY RESULT in minor or moderate injury. It may also be used to alert against unsafe practices.

2.3 NOTATIONS

NOTE: General reference information for proper operation and maintenance practices.

IMPORTANT: Specific procedures or information required to prevent damage to unit or attachment.

2.4 PRACTICES AND LAWS

Practice usual and customary safe working precautions, for the benefit of yourself and others. Understand and follow all safety messages. Be alert to unsafe conditions and the possibility of minor, moderate, or serious injury or death. Learn applicable rules and laws in your area.

2.5 REQUIRED OPERATOR TRAINING

Original purchaser of this unit was instructed by the seller on safe and proper operation. If unit is to be used by someone other than original purchaser; loaned, rented or sold, ALWAYS provide the Operator's Manual and any needed safety training before operation.

2.6 PREPARATION

Before starting any removal of parts, proper preparation is very important for efficient work. A clean work area at the start of each job will allow you to perform service repairs easily and quickly.

To reduce the incidence of misplaced tools or parts, place removed components with all attaching hardware in the disassembly order on a clean work surface. Organization is a key part of proper reassembly.

Tools, instruments, and parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a needless delay. A list of required special tools has been included in this manual.

CAUTION: Remove enough fuel so that no spillage will occur. Remove battery to prevent spillage of electrolyte.

2.7 SERVICE POSITION

WARNING: Always block wheels and know that jack stands or blocks used are stable, strong, or secure and will hold the weight of the unit during maintenance.

To ensure the unit is positioned in the proper service position:

1. Place jack stands under rear transaxles only.
2. If jacks are not available, place support blocks under both transaxles at the rear of unit.

2.8 CLEANING AND STORAGE

IMPORTANT: Never spray unit with water or store unit outdoors.

A unit that is excessively dirty should be cleaned before work starts. Cleaning will occasionally uncover trouble sources. Dirt and abrasive dust reduce the efficient work life of parts and can lead to costly replacement.

Brush grass, dirt and debris off of unit with a soft brush. Clean packed grass out from under mower deck. Apply paint or oil to exposed, bare metal surfaces to prevent rust.

Inspect unit for visible signs of wear, breakage, or damage. Order any parts required and make necessary repairs to avoid delays when beginning use again.

Transaxle cooling fins must be kept clean to prevent damage from overheating. Use a cloth or brush to remove grass, chaff and debris.

Unless there are indications of leakage, transaxle does not have to be checked for proper oil level. If leak occurs, have it repaired by your Gravely Dealer.

When taking unit out of extended storage:

1. Check for any damage or loose parts. Repair replace, or tighten hardware before operation.
2. If a preservative fluid was used in fuel tank, drain and discard. Fill fuel tank with fresh new fuel.

2.9 SAFETY RULES

Walk Around Inspection

Complete a walk around inspection of unit and work area to understand:

- Work area.
- Your unit.
- All safety decals.

Work Area

ALWAYS check overhead and side clearances carefully before operation. ALWAYS be aware of traffic when operating along streets or curbs.

ALWAYS keep hands and feet within the limits of the unit.

Keep children, people, and animals away. Keep children out of work area and under watchful care of a responsible adult.

Keep area of operation clear of all toys, pets, and debris. Objects can cause vehicle instability and injury.

Check for weak spots on dock, ramps or floors. Avoid uneven work areas and rough terrain. Stay alert for hidden hazards.

DO NOT run engine in an enclosed area. Always provide good ventilation.

Unit

ALWAYS keep protective structures, guards, and panels in good condition, in place and securely fastened. NEVER modify or remove safety devices.

Check Safety Interlock System for proper operation daily (see Operation section). Do not operate unless system operates properly.

Operation

Understand:

- How to operate all controls
- The functions of all controls
- How to STOP in an Emergency
- Speed ranges

Do not operate any of the control levers or power take-off unless both feet are resting on the platform.

DO NOT travel at too fast a rate. DO NOT change engine governor settings or over-speed engine.

Always back up slowly. Always look down and behind before and while backing.

Never leave a running unit unattended. ALWAYS shut off power take off, lower throttle setting, and stop engine before leaving unit. ALWAYS remove key to prevent unauthorized use.

Never carry passengers on any part of unit.

Avoid uneven and rough terrain. DO NOT operate near drop offs, ditches, or embankments. Unit can suddenly turn over if a wheel is over the edge of a cliff or ditch, or if an edge caves in.

If tires lose traction, turn off power take off and proceed slowly straight down slope. Avoid wet surfaces.

Avoid parking on a slope. If necessary, use wheel chocks.

DO NOT leave unit unattended on a slope. ALWAYS use wheel chocks when leaving unit.

ALWAYS operate unit in good visibility and light.

Fuel is highly flammable and its vapors can explode.
Use ONLY approved fuel containers.
NO Smoking!
NO Sparks!
NO Flames!
Allow engine to cool before servicing.
NEVER fill fuel tank when engine is running, hot, or unit is indoors.

Abnormal Vibrations are a warning of trouble. Striking a foreign object can damage unit. Immediately stop unit and engine. Remove key and wait for all moving parts to stop. Remove wire from spark plug. Inspect unit and make any necessary repairs before restart.

Hazardous Slopes

DO NOT operate on steep slopes. Avoid operating on slopes. When you must operate on a slope, travel up and down the slope. Never operate across a slope. Never operate on a slope greater than 10 degrees.

Child Safety

NEVER allow children to operate or play on or near unit. Be alert and shut off unit if children enter area.

Personal Safety

Read and obey all warning, caution, and instructions on the unit and in provided manuals.

- Only trained adults may operate unit.
- Training includes actual operation.
- Clearly understand instructions.
- Be alert! Conditions can change.

NEVER operate unit after or during the use of medication, drugs or alcohol. Safe operation requires your complete and unimpaired attention at all times.

NEVER allow anyone to operate the unit when their alertness or coordination is impaired.

DO NOT operate unit without wearing adequate outer garments. Wear adequate safety gear and protective gloves. Wear proper footwear to improve footing on slippery surfaces.

Protect eyes, face, and head from objects that may be thrown from unit. Wear appropriate hearing protection.

Avoid Sharp Edges. Sharp edges can cut. Moving parts can cut or amputate fingers or a hand. Wear gloves to service unit when handling sharp edges.

ALWAYS keep hands away from any pinch points.

ALWAYS keep hands and feet away from all moving parts during operation. Moving parts can cut off body parts.

DO NOT touch unit parts which might be hot from operation. Allow parts to cool before attempting to maintain, adjust, or service.

Controls

Come to a complete stop before reversing.

Never jerk the control levers. Always use a steady even action to achieve smooth control.

Always be aware of obstructions that may cause injury to operator or damage to the unit.

Service Position

WARNING: ALWAYS block wheels and know that jack stands or blocks used are stable, strong, or secure and will hold the weight of the unit during maintenance.

WARNING: ROTATING PARTS can amputate body parts. Keep hands and feet away. Loose clothing, long hair or scarves can get caught in rotating parts and cause death or serious injury.

Place unit on flat, level surface. ALWAYS stop engine and disengage clutches. Assure unit is secure and will not tip over. Strap and clamp onto lift, if used.

To ensure the unit is positioned in the proper service position:

1. Place jack stands under rear transaxles only.
2. If jacks are not available, place support blocks under both transaxles at the rear of unit.

CAUTION: Remove enough fuel so that no spills will occur.

Maintenance

ALWAYS maintain unit in safe operating condition. Damaged or worn out muffler can cause fire or explosion.

Check the conditions of the unit at the end of each day and repair any damage or defects.

ALWAYS block wheels and know all jack stands are strong and secure and will hold weight of unit during maintenance.

Keep nuts and bolts tight and keep equipment in safe operating conditions.

Before maintenance, adjustments, or service (except where specifically recommended), shut off engine.

Allow hot parts to cool.

Keep unit free of dirt, stones, and other debris. Clean up oil or fuel spills.

Storage

DO NOT store unit inside a building with fuel in the fuel tank where any ignition sources are present. Allow unit to cool completely.

ALWAYS clean unit before extended storage. See Engine Manual for proper storage.

Spark Arrester

This product is equipped with an internal combustion engine. DO NOT use on or near any unimproved, forest covered or brush covered land unless the exhaust system is equipped with a spark arrester meeting applicable local, state or federal laws. A spark arrester, if used, must be maintained in effective working order by the operator.

Battery

Avoid Electric Shock. DO NOT reverse battery connections.

Explosive Gases! Poisonous battery fluid contains sulfuric acid and its contact with skin, eyes, or clothing can cause severe burns.

No flames. No sparks. No smoking near battery.

Always wear safety glasses and protective gear near battery.

DO NOT TIP battery beyond a 45^{o} angle in any direction.

ALWAYS KEEP BATTERIES OUT OF REACH of children.

Transport

Use extra care when loading or unloading unit onto trailer or truck. Secure unit chassis to transport vehicle. NEVER secure from rods or linkages that could be damaged.

DO NOT transport with attachment in raised position.

Lower attachment when unit is parked or stored unless a positive mechanical lock is used.

Attachments and Accessories

Use only attachments or accessories designed for your unit.

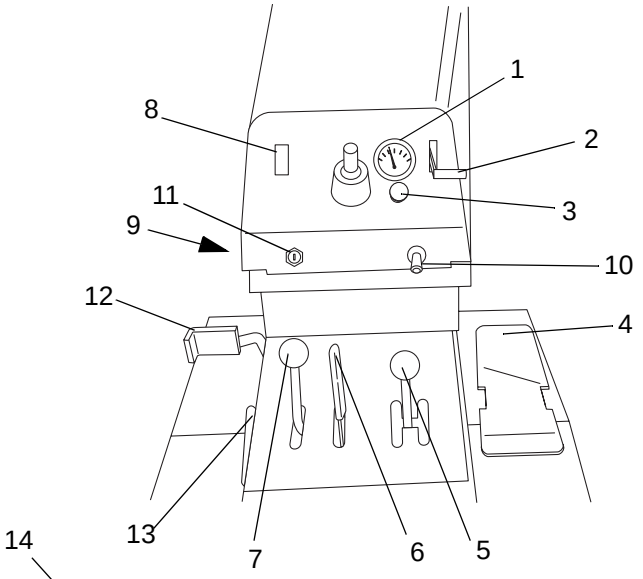
SECTION 3 - SPECIFICATIONS

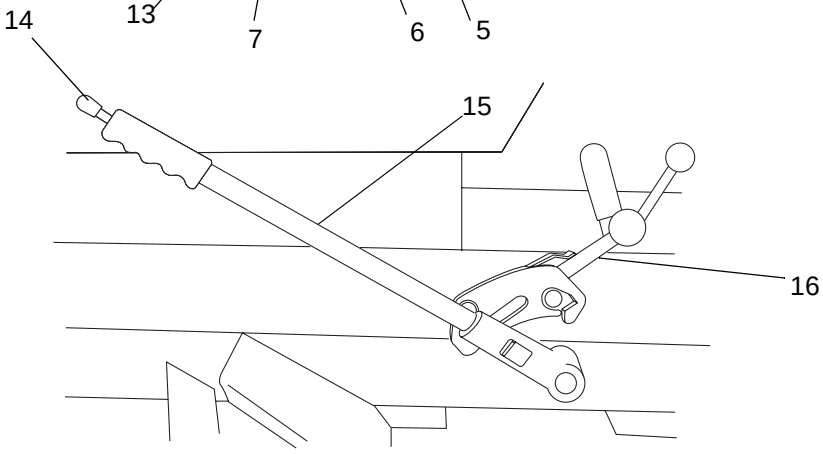
Model Number	987066	987067	987068
Description	16 HP Kohler Manual & Hydraulic Lift	16 HP Kohler Manual & Hydraulic Lift	18 HP Kohler & Hydraulic Lift
Battery	12 Volt	12 Volt	12 Volt
Hour Meter	Standard	Standard	Standard
Brakes	External Band Brake on Transmission	External Band Brake on Transmission	External Band Brake on Transmission
Steering	Rack & Pinion	Rack & Pinion	Rack & Pinion w/Heavy Tie Rods
Turning Radius - in (cm)	26.5 (67.3)	26.5 (67.3)	26.5 (67.3)
Tire Size - Front Rear	16 x 6.5 - 8 23 x 8.5 - 12	16 x 6.5 - 8 23 x 8.5 - 12	16 x 7.5 - 8 23 x 10.5 - 12
Engine	16 HP	16 HP	18 HP
Manufacturer	Kohler	Kohler	Kohler
Width of Cut	40" (102 cm), 50" (127 cm), or 60" (152 cm) w/optional mowers		
Fuel and Capacity-gal (L)	Unleaded-5.3 (20)	Unleaded-5.3 (20)	Unleaded-5.3 (20)
Idle RPM.	1600	1600	1600
Governed RPM (No Load)	3300	3300	3300
Crank Case Capacity-oz (L) Oil Filter	1.75 qt (1.66 L) w/Filter 1.5 qt (1.42 L) w/o Filter Yes		
Air Cleaner	Dual element	Dual element	Dual element
Charging Capacity	15 amp	15 amp	15 amp
Fuel Filter	Yes	Yes	Yes
Engine Oil	See Engine Manual	See Engine Manual	See Engine Manual
Spark Plug Gap	0.025 "	0.025 "	0.025"
Speed - Forward Lo Range -mph (kph) Hi Range-mph (kph)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)
Speed - Reverse Lo Range -mph (kph) Hi Range-mph (kph)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)
Drive Clutch	Individual forward/reverse friction		
Transmission Lube	API Service SC10W-30 Motor Oil	API Service SC10W-30 Motor Oil	API Service SC10W-30 Motor Oil
Transaxle Capacity	6 qt. (5.7 L)	6 qt. (5.7 L)	6 qt. (5.7 L)
Tire Pressure-Front -Rear	14 PSI/18 PSI 14 PSI/16 PSI	14 PSI/18 PSI 14 PSI/16 PSI	14 PSI/18 PSI 14 PSI/16 PSI
Lift System - Manual -Hydraulic	60 Only 61 Only	60 Only 61 Only	60 Only 61 Only
Hydraulics-Type -Capacity, qt (L)	ATF Dextron II 1 (0.9)	ATF Dextron II 1 (0.9)	ATF Dextron II 1 (0.9)
Power Take Off,	Internal, twin clutch cups Center standard/front optional		

Model Number	987069	987070	987071
Description	20 HP Kohler & Hydraulic Lift	16 HP Briggs & Stratton Hydraulic Lift	13.5 HP Robin Manual LIft
Battery	12 Volt	12 Volt	12 Volt
Hour Meter	Standard	Standard	Standard
Brakes	External Band Brake on Transmission	External Band Brake on Transmission	External Band Brake on Transmission
Steering	Rack & Pinion w/Heavy Tie Rods	Rack & Pinion	Rack & Pinion
Turning Radius - in (cm)	26.5 (67.3)	26.5 (67.3)	26.5 (67.3)
Tire Size - Front Rear	16 x 7.5 - 8 23 x 10.5 - 12	16 x 6.5 - 8 23 x 8.5 - 12	16 x 6.5 - 8 23 x 8.5 - 12
Engine	20 HP	16 HP	13.5 HP
Manufacturer	Kohler	Briggs & Stratton	Robin
Width of Cut - in (cm)	40" (102 cm), 50" (127 cm), or 60" (152 cm) w/optional mowers		
Fuel and Capacity-gal (L)	Unleaded-5.3 (20)	Unleaded-5.3 (20)	Unleaded-5.3 (20)
Idle RPM.	1600	1600	1600
Governed RPM Hi/Low	3300	3300	3300
Crank Case Capacity- Oil Filter	1.75 qts (1.66 L) w/o Filter Yes	3.5 pints (1.66 L) w/Filter 3 pints (1.42 L) w/o Filter Yes	1.27 qts (1.2 L)
Air Cleaner	Dual element	Dual element	Dual element
Charging Capacity	15 amp	16 amp	12.5 amp
Fuel Filter	Yes	Yes	Yes
Engine Oil	See Engine Manual		
Spark Plug Gap	0.025"	0.030"	0.030"
Speed - Forward Lo Range -mph (kph) Hi Range-mph (kph)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)
Speed - Reverse Lo Range -mph (kph) Hi Range-mph (kph)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)
Drive Clutch	Individual forward/reverse friction		
Transmission Lube	API Service SC10W-30 Motor Oil	API Service SC10W-30 Motor Oil	API Service SC10W-30 Motor Oil
Transaxle Capacity	6 qt. (5.7 L)	6 qt. (5.7 L)	6 qt. (5.7 L)
Tire Pressure-Front -Rear	14 PSI/18 PSI 14 PSI/16 PSI	14 PSI/18 PSI 14 PSI/16 PSI	14 PSI/18 PSI 14 PSI/16 PSI
Lift System - Manual -Hydraulic	 Yes	64 Only 65 Only	64 Only 65 Only
Hydraulics-Type -Capacity, qt (L)	ATF Dextron II 1 (0.9)	ATF Dextron II 1 (0.9)	N/A N/A
Power Take Off	Internal twin clutch cups Center standard/front optional		

Model Number	987072		
Description	20.5 HP Robin Manual LIft		
Battery	12 Volt		
Hour Meter	Standard		
Brakes	External Band Brake on Transmission		
Steering	Rack & Pinion		
Turning Radius - in (cm)	26.5 (67.3)		
Tire Size - Front Rear	16 x 7.5 - 8 23 x 8.5 - 12		
Engine	20.5 HP		
Manufacturer	Robin		
Width of Cut - in (cm)	40" (102 cm), 50" (127 cm), or 60" (152 cm) w/optional mowers		
Fuel and Capacity-gal (L)	Unleaded-5.3 (20)		
Idle RPM.	1600		
Governed RPM Hi/Low	3300		
Crank Case Capacity-oz (L) Oil Filter	1.64 qt (1.55 L) Yes		
Air Cleaner	Dual element		
Charging Capacity	15 amp		
Fuel Filter	Yes		
Engine Oil	See Engine Manual		
Spark Plug Gap	0.030"		
Speed - Forward Lo Range -mph (kph) Hi Range-mph (kph)	 0 -1.7 (0-2.7) 0 - 8.5 (0-13.7)		
Speed - Reverse Lo Range -mph (kph) Hi Range-mph (kph)	 0 - 3.8 (0 - 6.1) 0 - 3.8 (0 - 6.1)		
Drive Clutch	Individual forward/reverse friction		
Transmission Lube	API Service SC10W-30 Motor Oil		
Transaxle Capacity	6 qt (5.7 L)		
Tire Pressure-Front -Rear	14 PSI/18 PSI 14 PSI/16 PSI		
Lift System - Manual -Hydraulic	64 Only 65 Only		
Hydraulics-Type -Capacity, qt (L)	N/A N/A		
Power Take Off	Internal twin clutch cups Center standard/front optional		

4.1 CONTROLS AND FEATURES





1. Ammeter
2. Throttle Control
3. Choke Control
4. Direction Control Pedal
5. Gear Selector
6. Range Selector
7. PTO Control
8. Warning Light (Oil Pressure)
9. Hourmeter (side of panel)
10. Attachment Lift Switch
11. Ignition Switch
12. Brake Pedal
13. Brake Lock Lever
14. Release Button
15. Manual Lift Lever
16. Lift Range Control

Figure 1

4.2 FILLING THE FUEL TANK

WARNING: Use caution with fuel. Fuel is very flammable. Keep fuel in a clean and tight container. Keep fuel away from fire and heat. Never put fuel in the fuel tank while the engine is running or hot. Clean up any spilled fuel before starting the engine.

Add fuel to the fuel tank as needed. See your engine manual for the correct type and grade of fuel to be used.

Put the unit in an open and well ventilated area prior to refueling.

Stop the engine and set the parking brake.

Clean the fuel cap and in the area around the fuel cap. Remove the cap from the fuel tank.

Fill the fuel tank with the proper grade of fuel recommended by the engine manufacturer. Be careful not to spill any fuel.

Install fuel cap on the fuel tank and tighten.

4.3 CLEAN AIR INTAKE/COOLING AREAS

To ensure proper cooling, make sure the grass screen, cooling fins, and other external surfaces of the engine are kept clean **at all times**.

Every **50 hours** of operation (more often under extremely dusty, dirty conditions) remove the blower housing and other cooling shrouds. Clean the cooling fins and external surfaces as necessary. Make sure the cooling shrouds are reinstalled.

NOTE: Operating the engine with a blocked grass screen, dirty, or plugged cooling fins, and/or cooling shrouds removed, will cause engine damage due to overheating.

4.4 GENERAL LUBRICATION

There are seven grease fittings to be greased at 25-hour intervals.

IMPORTANT: Wipe each fitting clean before and after lubrication.

Apply Sten Mix Hi-Temp Grease or equivalent to the lube fittings. Order P/N: 00036800 - Three pack of 3 oz. cartridges or 00036700 - ten pack of 14 oz. cartridges.

Add grease until it appears at the ends of the bearings. The locations of the seven fittings are:

- On the direction control pedal
- On the front axle at each king pin
- On the front axle (Figure 2)
- On the steering mechanism (Figure 3)

Every 25 hours, apply motor oil to all pin connections, pivot points and areas where sliding occurs in the clutch, transmission, PTO, and lift control systems.

Every 25 hours of operation, put a drop of engine oil on the pivots of the throttle lever, the direction control lever, the gear shift lever, the PTO control, and range shift handle

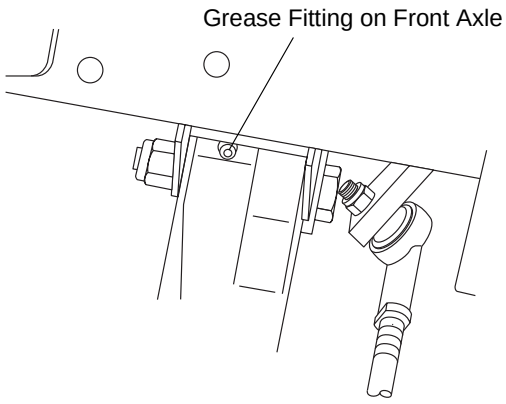


Figure 2

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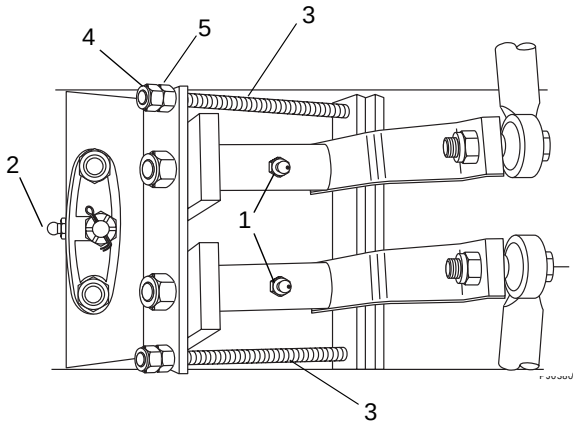


1. Grease Fittings for Steering Arms
2. Grease Fittings for Steering Columns
3. Adjusting Bolt
4. Lock Nut
5. Adjusting Nut

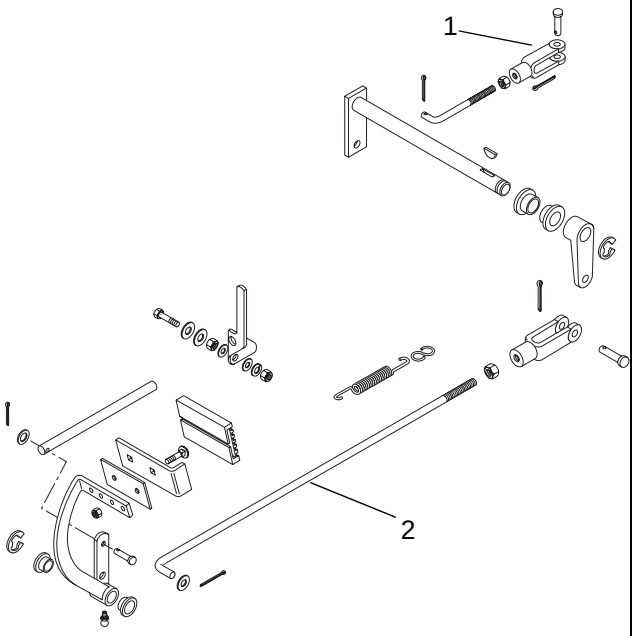
Figure 3

PJ0370

4.5 ADJUSTING THE BRAKES

Brake service is required if the brake does not stop and hold the tractor effectively. the brake should be effective enough to cause the rear wheels to slide if applied suddenly on a concrete or asphalt surface.

CAUTION: Replace the brake band when the lining is as thin as the ignition key. Replace the brake drum if it is visibly worn or rough.



1. Yoke
2. Left Hand Brake Rod

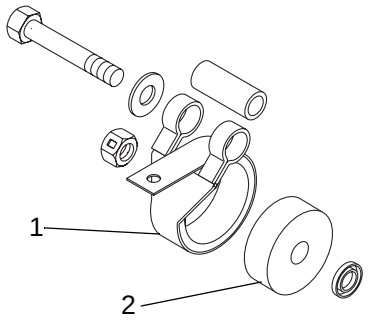
Figure 4

To adjust the brake:

1. Stop the unit on a level surface.
2. Stop the engine and block the wheels so the unit cannot roll.
3. Loosen the jam nut and remove the clevis pin (at the brake band).

NOTE: Do not adjust the brake rod on the left hand side which attaches to the brake pedal. This rod is for adjusting the direction control pedal only.

4. Turn the clevis clockwise to tighten or counterclockwise as needed.
5. To check the adjustment, reconnect the clevis and brake band with the pin.
6. Push the direction control pedal all the way forward.



1. Brake Band Assembly
2. Brake Drum

Figure 5

7. Push the brake pedal by hand while watching the motion of the brake band. The brake is correctly adjusted when the band becomes tight on the drum as the direction control pedal moves to "neutral". If the band is tight before the pedal moves to "neutral", the brake is too tight. If too tight or too loose, repeat steps 4, 5, 6 and 7 until the correct adjustment is obtained.
8. Install the cotter pin in the clevis pin and tighten the jam nut.
9. Check the effectiveness of the brake while operating the unit.

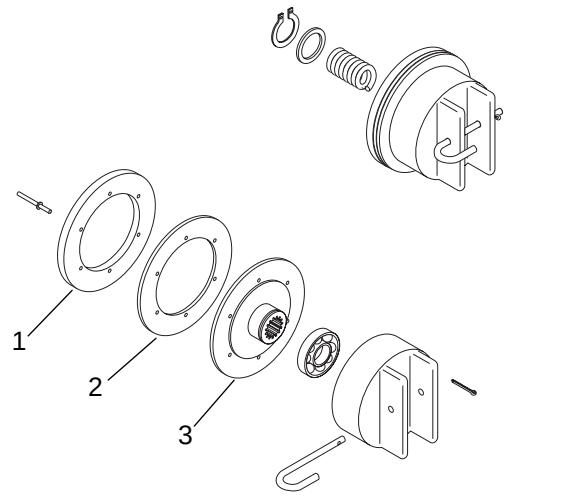
4.6 ADJUSTING THE FORWARD AND REVERSE CLUTCHES

The forward and reverse clutches must be checked every 100 hours. If the lining has worn to a thickness of less than 0.150 inch (3.8 mm), replace the lining. The forward clutch is on the right side of the transmission and the reverse clutch is on the left side of the transmission.

NOTE: Damage will occur if the unit is operated with a lining thickness of less than 0.150 inch (3.8 mm).

Inspect and adjust the clutches as follows:

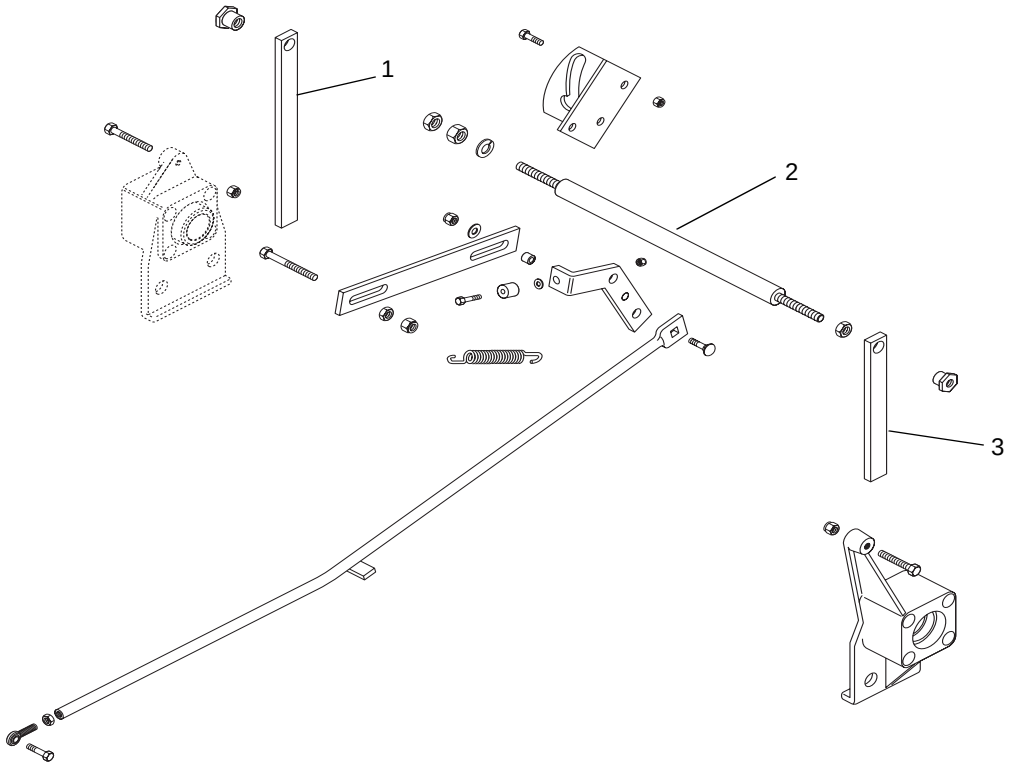
1. Stop the engine and place the direction control pedal in the "neutral" position.
2. Raise the rear fender.
3. Measure the clearance in the slot. The correct clearance is 0.030 inch (0.76 mm) to 0.060 inch (1.5 mm) for the forward clutch and 0.010 inch (0.25 mm) to 0.030 inch (0.76 mm) for the reverse clutch.



1. Clutch Lining
2. Clutch Ring
3. Clutch Disc

Figure 6

PJ0170



1. Reverse Clutch Spring
2. Forward-Reverse Slide Rod
3. Forward-Reverse Clutch Spring

Figure 7

4. Adjust the bolts which go through the flange on the axle bearing retainer so that the forward-reverse clutch springs are straight up and down when the clutches have zero clearance. Lock the bolt in place with the jam nut. Loosen the jam nut which holds the slide rod bushing in place. Adjust the bushing on the slide rod until the clearance is correct. Lock the bushing in place with the jam nut.

5. Lubricate the clutch once each season. Remove the clutch and apply a film of high quality lithium base grease to the splined clutch shaft. While the clutch is off, check the lining wear. If the lining has worn near the rivet heads, replace the lining. Readjust the clutch as described above.

4.7 ADJUSTING THE PTO CLUTCH

The PTO clutch should be adjusted whenever there is less than 0.5 inches of free travel in the clutch lever when it is in the "On" position. See Figure 8 to see where this free travel is measured. The free travel should be between 0.5 inch (12.7 mm) and 1.0 inch (25.4 mm).

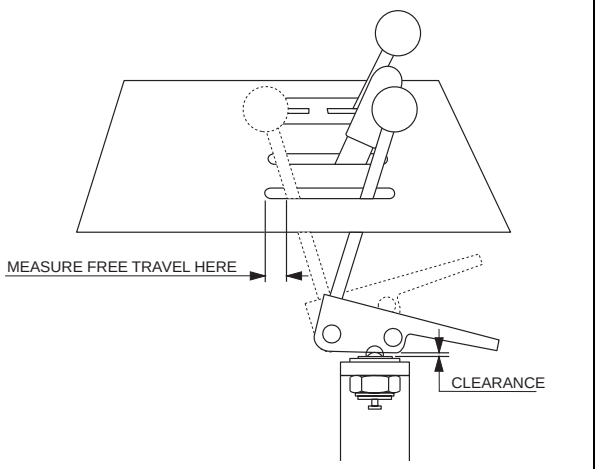


Figure 8

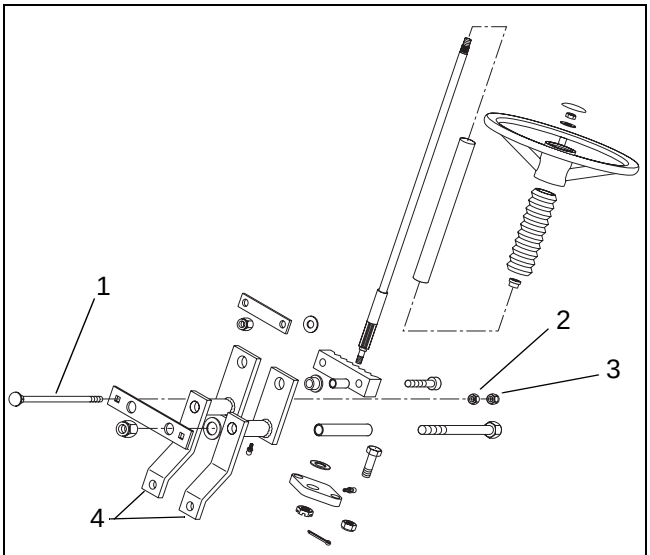
1. Stop the engine and lock the brake.
2. Loosen the bolts holding the switch bracket and push the bracket down.
3. Raise the rear fender.
4. Push the PTO lever to "On".
5. Disconnect the PTO control from the transmission lever.
6. Turn the control rod to change the free travel. Each turn will change it by about 0.25 inch. Turn clockwise to increase and counterclockwise to decrease the free travel.
7. Reconnect the control rod to the transmission lever. Check for correct free travel. Repeat steps 4 through 6 as necessary.
8. Put the PTO control in the "Off" position.
9. Move the switch bracket up until the switch closes (makes a circuit). Tighten the switch bracket hardware.

CAUTION: Make sure the PTO control assembly does not rest on the switch body.

4.8 ADJUSTING THE STEERING

Adjustment of the steering gear is usually needed whenever there is more than 2 inches of free play in the steering wheel. To adjust the steering gear:

1. Loosen the lock nuts on both adjusting bolts.



1. Adjusting Bolt
2. Adjusting Nut
3. Lock Nut
4. Steering Arm Weldments

Figure 9

2. Turn the steering wheel to the right as far as it will go.
3. Turn the adjusting nut on the left side adjusting bolt clockwise with your fingers until it is tight. Then back the nut off one fourth turn.
4. Tighten the lock nut against the adjusting nut being careful not to move the adjusting nut.
5. Turn the steering wheel to the left as far as it will go.
6. Repeat the above two steps for the right side adjusting nut.
7. Check for tightness or backlash in the steering gear through the full range of the steering wheel rotation. There should be no noticeable tightness or backlash in the rack and pinion mesh. If there is, repeat above steps as required.

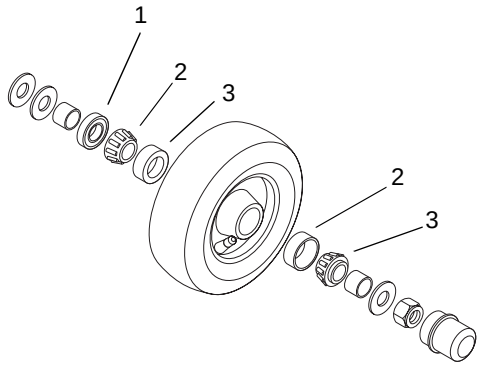
Upon completion of the steering gear adjustment, recheck the steering wheel free play. If the free play is still excessive, look for loose steering arms on the king pins, loose or worn ball joints, or other signs of wear. Tighten or replace as required.

4.9 ADJUSTING FRONT WHEELS

Adjust the front wheel toe-in as follows:

1. Rotate the steering wheel until the two steering arm weldments are parallel to the frame side (Figure 9).
2. On 13.5 HP and 16 HP engine units, loosen the jam nuts on the tie rods and disconnect the outside ball joint. Position the front tires by hand so that the distance between the front centerline of the tire is 1/8" to 1/2" less than the distance between the rear centerline. Adjust the tie rods so that the ball joint can be connected to the tie rod arm without moving the tire and so that the tie rods are the same length. Tighten the jam nuts.
3. On 20.5 HP units, loosen the jam nuts on the tie rods and rotate the tire rod tube so that the front centerline of the tire is 1/8" to 1/2" closer than the rear centerline and so that the tie rods are the same length. Tighten the jam nuts.

4.10 FRONT WHEEL BEARINGS



1. Seal
2. Cone Bearing
3. Cup Bearing

Figure 10

PJ0220

CAUTION: To prolong bearing life, repack the bearings with grease once a year.

Removal

1. Jack up the front of the unit.
2. Remove the caps.
3. Remove the nut, washer, spacer, bearing, and wheel assembly for each spindle.
4. Use a piece of clean bar stock and a hammer to tap out the inside bearing and seal.

Inspection and Repair

1. Thoroughly clean the wheel hub and other parts.
2. Replace any part which is worn or damaged.
3. If a bearing is replaced, also replace the bearing cup. Use a bearing puller to remove the bearing cups.

Installation

1. If removed, install new bearing cups with a driver. Pack the bearings with wheel bearing grease.
2. Lay the inside bearing in the cup and press a new seal in place.
3. Put a film of grease on the lip of the seal.
4. Clean the spindles.
5. Slide a spacer on the spindle followed by the wheel assembly.
6. Fill the wheel hub cavity with grease. Put the outside bearing in the cup followed with a spacer, flatwasher, and a nut.
7. Tighten the nuts, back off until the wheel turns freely. Replace the caps with the driver.

4.11 ADJUSTING THE RANGE SELECTOR

Move the Hi-Lo shift lever as far as it will go in both directions. Measure the distance between the lever and the end of the slot. This distance would not be less than 5/16 inch (7.9 mm).

Adjust the clevis so that the clearance between the Hi-Lo shift lever and the control cover plate slot is equal for both positions of the lever.

4.12 HYDRAULIC LIFT

WARNING: Keep body and hands away from pin holes or nozzles which eject hydraulic fluid under pressure. Use paper or cardboard and not hands to search for leaks.

Be sure to stop the engine and put the attachment in the down position before doing any work on hydraulic parts.

WARNING: Make sure all hydraulic fluid connections are tight and all hydraulic hoses and lines are in good condition before applying pressure to the system.

Hydraulic fluid escaping under pressure may have sufficient force to penetrate skin and cause serious injury. Foreign fluid injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

Check the hydraulic fluid level when the hydraulic lift will not raise the attachment or leaks are observed.

To check the hydraulic fluid level:

1. Clean the area around the reservoir and cap.
2. Remove the cap.
3. The correct hydraulic fluid level is one inch from the top of the reservoir. Add Dextron II ATF to maintain this level.

4.13 CHECK TIRES

NOTE: Keep tires properly inflated at all times. For proper tire inflation when working under various conditions, refer to chart below. Use a low pressure tire gauge for accurate pressure readings.

Loading	Light & Medium	Heavy (Sno-Thro)
Front	10 psi	14 psi
Back	10 psi	

Check tire pressure at least once a month. Over-inflation may cause operator discomfort and excessive tire tracks on lawns or soft surfaces. Under-inflation causes short tire life.

NOTE: After checking and/or inflating, replace and tighten valve caps to prevent air loss.

SECTION 5 - ENGINE

5.1 ENGINE TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate engine problems and give possible causes and corrective action responses.

The troubleshooting key is generic and can be used for several types of engines. Use only those possible causes and corrective actions that apply to the unit.

TROUBLE	POSSIBLE CAUSES (Refer to Key Below)	CORRECTIVE ACTION
Black Exhaust	1, 20, 22, 25, 29, 31, 32, 33	repair or replace
Blue/White Exhaust	4, 20, 25, 31, 33, 34	repair or replace
Difficult Starting	1, 5, 7, 8, 9, 10, 20, 21, 22, 29, 31, 32, 33	repair or replace
Erratic Running	1, 7, 8, 9, 10, 20, 21, 23, 26, 29, 33, 59, 62	repair or replace
Excessive Fuel Consumption	1, 20, 22, 23, 25, 29, 31, 32, 33	repair or replace
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55	
High Oil Pressure	4, 41	repair or replace
Knocking	22, 26, 29, 31, 33, 36, 46, 59	repair or replace
Loss of Power or System	1, 8, 10, 20, 21, 22, 23, 25, 26, 31, 32, 33	repair or replace
Low Cranking Power	2, 3, 4, 11	repair or replace
Low Oil Pressure	4, 36, 37, 39	repair or replace
Misfiring	10, 20, 25, 26, 28, 29, 32	repair or replace
Overheating	1, 19, 25,	repair or replace
Poor Compression	25, 28, 29, 31, 32, 33, 34,59,	repair or replace
Starts and Stops	1, 6, 10, 62	repair or replace see electrical systems see engine service manual
Vibration	20, 23, 25, 26, 29, 33, 45, 49	repair or replace
Will Not Crank	2, 11, 45	charge battery or replace
Will Not Start	1, 10, 62	repair or replace see electrical systems see engine service manual

TROUBLESHOOTING KEY

1	Restriction in air cleaner	22	Incorrect grade of fuel	43	Faulty suction pipe
2	Bad electrical connection	23	Sticking throttle/restricted movement	44	Choked oil filter
3	Faulty starter motor	24	Exhaust pipe restriction	45	Bad solenoid switch
4	Incorrect grade of lubricating oil	25	Leaking cylinder head gasket	46	Incorrect piston height
5	Low cranking speed	26	Overheating	47	Damaged fan
6	Fuel tank empty	27	Cold running	48	Faulty engine mounting
7	Controls not in correct operation position	28	Incorrect tappet adjustment	49	Incorrectly aligned flywheel and/or flywheel housing
8	Blocked fuel feed line	29	Sticking valves	50	Faulty thermostat
9	Faulty fuel lift pump	30	Incorrect high pressure pipes	51	Restriction in water jacket
10	Choked fuel filter	31	Worn cylinder bores	52	Loose fan belt
11	Battery capacity low	32	Pitted valves and seats	53	Choked radiator
12	Air in fuel system	33	Broken, worn or sticking piston ring(s)	54	Faulty water pump
13	Faulty fuel injection pump	34	Worn valve stems and guides	55	Choked breather pipe
14	Faulty fuel injectors or incorrect type	35	Restriction in air cleaner	56	Damaged valve stem oil deflector (if fitted)
15	Incorrect use of cold start equipment	36	Worn or damaged bearings	57	Coolant level too low
16	Faulty cold start equipment	37	Insufficient oil in sump	58	Blocked sump strainer
17	Broken fuel injection pump drive	38	Bad/defective oil temperature switch	59	Broken valve spring
18	Incorrect fuel pump timing	39	Oil pump worn	60	Exhaust or vacuum pipe leak
19	Incorrect valve timing	40	Pressure relief valve sticking open	61	Bad or defective water temperature switch
20	Poor compression	41	Pressure relief valve sticking closed	62	Bad spark plug(s)
21	Blocked fuel tank vent	42	Broken relief valve spring		

5.2 CHECKING ENGINE OIL

Check the engine oil BEFORE EACH USE OR TWICE DAILY ON COMMERCIAL USE as follows.

1. Make sure the engine is stopped, level, and is cool so the oil has had time to drain into the sump.
2. To keep dirt, grass clippings, etc., out of the engine, clean the area around the oil fill cap or dipstick before removing it.
3. Remove the dipstick; wipe oil off. Reinsert the dipstick and push it all the way down into the tube.
4. Remove the dipstick and check the oil level. The oil level should be up to, but not over, the "F" mark on the dipstick.
5. If the level is low, add oil of the proper type, up to the "F" mark on the dipstick. Always check the level with the dipstick before adding more oil.

NOTE: To prevent extensive engine wear or damage, always maintain the proper oil level in the crankcase. Never operate the engine with the oil level below the "L" mark or over the "F" mark on the dipstick.

5.3 OIL SENTRY™

Some engines are equipped with an optional Oil Sentry oil pressure switch. If the oil pressure decreases below an acceptable level, the Oil Sentry will either shut off the engine or activate a warning signal, depending on the application.

NOTE: Make sure the oil level is checked BEFORE EACH USE and is maintained up to the "F" mark on the dipstick. This includes engines equipped with Oil Sentry.

5.4 CHANGING OIL

For a new engine, change oil after the first 5 hours of operation. Thereafter, change oil as shown in the "Oil Change Intervals" table.

Oil Change Intervals

Oil Type	Engine Type	Interval
Temperature ABOVE 32°F (0°C)		
SAE 30	With Filter	50 Hours*
	Without Filter	25 Hours
Multiviscosity	With Filter	25 Hours
	Without Filter	25 Hours
Temperature BELOW 32°F (0°C)		
Multiviscosity	With Filter	50 Hours
	Without Filter	25 Hours

* NOTE: 25 hours for continuous and/or heavy duty operation.

Change the oil while the engine is still warm. The oil will flow freely and carry away more impurities. Make sure the engine is level when filling, checking, or changing the oil.

Change the oil as follows:

1. Remove the oil drain plug and oil fill cap. Tilt the engine slightly towards the oil drain to obtain better drainage.
2. Reinstall the drain plug. Make sure it is tightened securely.
3. Fill with new oil of the proper type to the "F" mark on the dipstick. Always check the level on the dipstick before adding more oil.
4. Reinstall the oil fill cap. Make sure it is tightened securely.

5.5 CHANGING OIL FILTER

Some engines are equipped with an oil filter. Replace the oil filter every other oil change, in accordance with the "Oil Change Intervals" table. See engine manufacturers manual for proper type. Replace as follows:

1. Drain the oil from the engine crankcase.
2. Allow the oil filter to drain.
3. Remove the old filter and wipe the filter adapter gasket surface.
4. Place a new replacement filter in a shallow pan with the open end up. Pour new oil of the proper type, in through the threaded center hole. Stop pouring when the oil reaches the bottom of the threads.
5. Put a drop of oil on your fingertip and wipe it on the rubber gasket. Allow a minute or two for the oil to be absorbed by the filter material then install in on the engine. Turn the oil filter clockwise until rubber gasket contacts the filter adapter, then tighten filter an additional 1/2 turn.
6. Reinstall drain plug. Make sure it is tight.
7. Fill the crankcase with new oil of the proper type to the "F" mark on the dipstick. Add an additional 1/2 pint of oil for the filter capacity.
8. Test run the engine to check for leaks. Stop the engine, allow a minute for the oil to drain down, and recheck the level on the dipstick. Make sure oil level is up to but not over the "F" mark on the dipstick.

5.6 AIR CLEANER

This engine is equipped with a replaceable, high density paper air cleaner element. Some engines are also equipped with an oiled, foam precleaner which surrounds the paper element.

Check the air cleaner **daily or before starting the engine**. Check for buildup of dirt and debris around the air cleaner system. Keep this area clean. Also check

for loose or damaged components. Replace all bent or damaged air cleaner components.

Service Precleaner

If so equipped, wash and reoil the precleaner every 25 hours of operation (more often under extremely dusty or dirty conditions).

1. Remove wing nuts, air cleaner cover, element cover, seals, and element cover.
2. Remove the precleaner from paper element. Wash the precleaner in warm water with detergent.
3. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Air dry.
4. Saturate precleaner in clean, fresh engine oil and squeeze out excess oil.
5. Reinstall precleaner over paper element.

Service Paper Element

Every 100 hours of operation (more often under extremely dusty or dirty conditions), check the paper element. Replace the element as necessary.

1. Remove the precleaner (if so equipped) from the paper element.
2. Do not wash the paper element or use pressurized air, as this will damage the element. Replace a dirty, bent, or damaged element. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.
3. With the air cleaner disassembled, check the base plate. Make sure it is secured and not bent or damaged. Also check the element cover, seals, and breather tube for damage or improper fit. Replace all damaged components.

NOTE: Operating the engine with damaged or loose components could allow unfiltered air into the engine causing premature wear and failure.

4. Reinstall the paper element.
5. If so equipped, install the precleaner (washed and oiled) over paper element.
6. Reinstall element cover, seals, air cleaner cover, and wing nuts. Tighten wing nuts 1/2 to 1 full turn after nuts contact cover. Do not overtighten.

5.7 CHECK SPARK PLUG

Every 100 hours or operation, remove the spark plugs, check condition, and reset gaps or replace with new plugs as necessary.

1. Before removing spark plugs, clean the area around base of plugs to keep dirt and debris out of the engine.
2. Remove plugs and check condition. Replace plugs when worn or reuse is questionable.

NOTE: Do not clean the spark plug in a machine using abrasive grit. Some grit could remain in the spark plug and enter the engine causing extensive wear and damage.

5.8 ENGINE REMOVAL

1. Disconnect battery cables. Remove negative cable first.
2. Turn off fuel at fuel tank.
3. Remove the rear deck.
4. Disconnect the choke and throttle cables.
5. Disconnect the engine harness plug, oil sensor switch, and starter cable.
6. Disconnect the fuel line at the engine.
7. Remove rear hitch assembly: 4 bolts, 2 at each bearing retainer.
8. Place a jack under the engine to provide support during removal.
9. Remove the four bolts holding the engine to the frame.
10. Slide the engine rearward out of the transmission. Take care to keep the gear and bearing set on the crankshaft.

5.9 ADAPTOR PLATE

Removal and Installation

1. Remove the gear, key, and bearing set.
2. Remove the four bolts which mount the adaptor plate to the pilot.
3. Use a soft hammer to remove the adapter plate to the pilot.
4. Inspect the adaptor plate, bearing set and gear for damage and wear.
5. Replace any worn or damaged parts.
6. Remove all residue off the adaptor gasket from the engine and adaptor plate. Check oil seal for damage. If damaged replace seal. Put a film of grease on a new gasket and put it in place on the engine.
7. Slide the adaptor plate in place with the assistance of a soft hammer.
8. Start all four bolts and then tighten.
9. Replace the bearing set, key, and gear.

5.10 ENGINE INSTALLATION

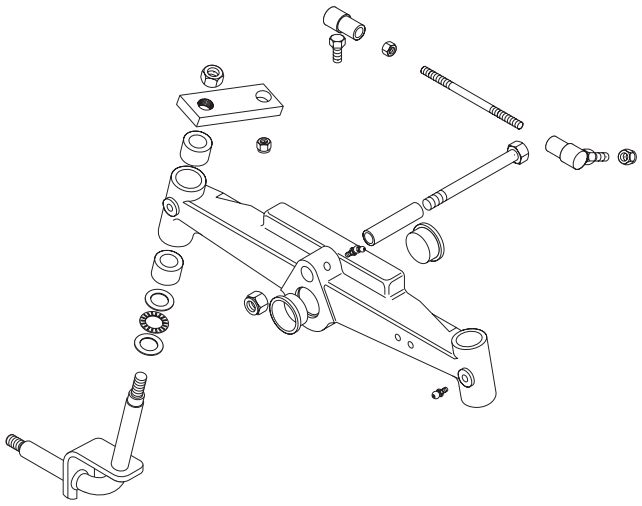
1. Coat the engine pilot with gasket eliminator, making sure the surface is clean and free of oil.
2. Set the engine on a jack. Adjust the jack so the crankshaft is on the centerline of the hole in the transmission.
3. Slide the engine into the transmission. Rotate the forward clutch to mesh the bevel gears.
4. Install the four bolts and tighten.
5. Reverse the disassembly process for engine connections and replacement of rear deck and hood.

The steering wheel operates through a rack to pivot two weldments. Each front king-pin is controlled separately through a tie-rod from the weldment.

The king-pins should be checked for looseness. Replace the lower thrust bearing if it becomes rusted or worn. The upper and lower bushing sleeves should be replaced when shaft play becomes excessive.

NOTE: The larger units will have a different design tie rod and tie rod ends. the adjustment procedure is the same. See section on *Adjustments*.

13.5 and 16 HP Units



20.5 HP Units

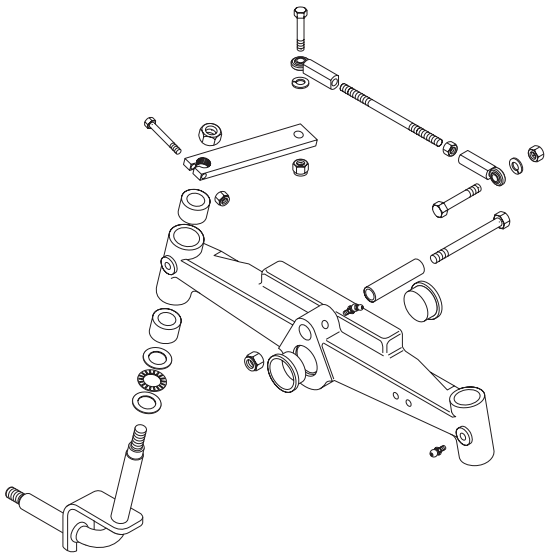
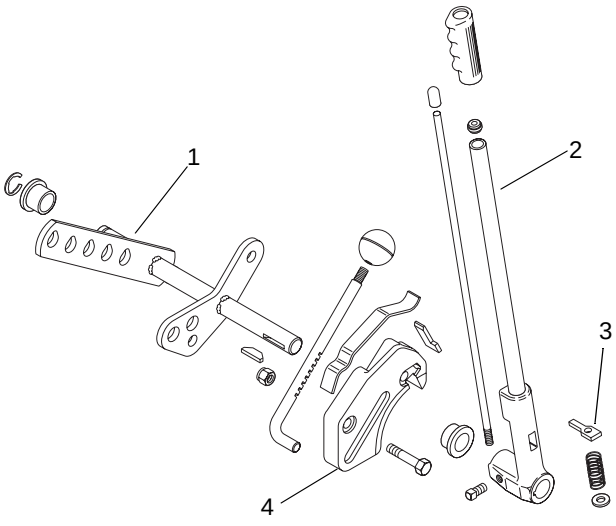


Figure 11

7.1 MANUAL LIFT



1. Lift Lever Shaft
2. Lift Lever Assembly
3. Lever Pawl
4. Locator Casting

Figure 12

PJ0230

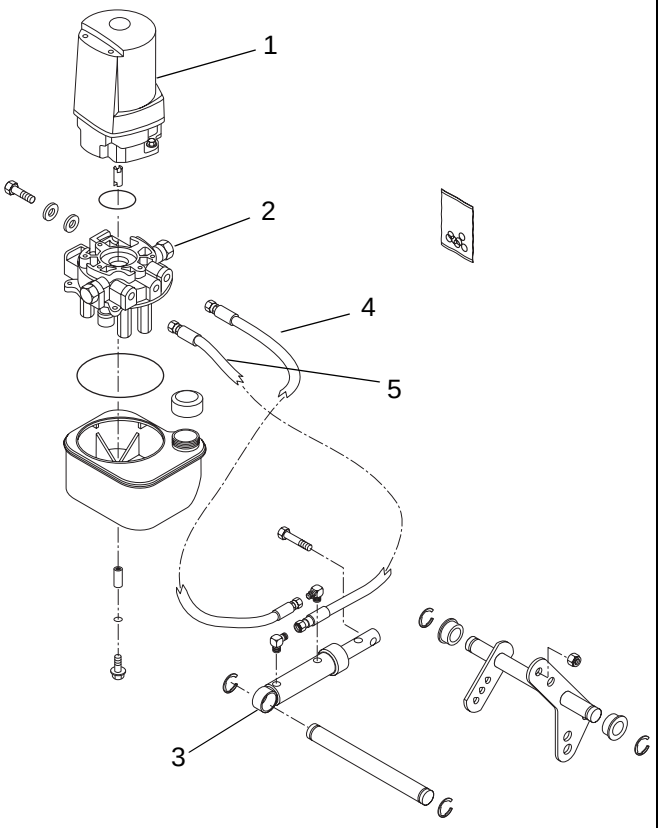
Disassembly

1. Remove the set screw in the lift lever assembly.
2. Apply liquid wrench to the shaft through the hole where the pawl is positioned.
3. Loosen the two bolts holding the locator casting and remove.
4. Disassemble the lift lever assembly by removing the grip and rotate the push rod counterclockwise to disengage the pawl.
5. Remove the key and the snap ring from the shaft.
6. Using a punch and hammer, drive the pivot bushing outward from the frame.
7. Slide the lift lever shaft weldment to the left. Lift up on the right end and pull from the frame.
8. Inspect and replace all worn or damaged parts.

Assembly

1. Slide the left end of the lift lever shaft weldment into the frame hole and move to the left. Lower the right end and slide into the right hole.
2. Slide new pivot bushings on the shaft and start in the holes. Slide the lift lever on the shaft and drive the bushings into the frame.
3. Put the snap ring on the key in the shaft.
4. Reassemble the lift lever.
5. Reassemble the locator casting and mount to the frame.
6. Put the lift lever assembly on the shaft so as to align with the key. Use a soft hammer to drive in place while holding down on the push rod.
7. Install the set screw and tighten the jam nut.

7.2 ELECTRIC/HYDRAULIC PUMP



1. Motor Assembly
2. Adapter
3. Hydraulic Cylinder
4. Fluid Flows Both Ways, High Pressure, 400 psi
5. Fluid Flows both Ways, High Pressure, 1000 psi

Figure 13

PJ0030

CAUTION: Disconnect negative battery terminal first.

Removal

1. Disconnect black ground wire at frame.
2. Remove switch from dash; leave the three leads connected to switch.

3. Clean hydraulic fittings and mark hoses to insure proper routing when pump is installed.
4. Disconnect hydraulic hoses from pump.

CAUTION: Support electric/hydraulic lift pump when removing mounting bolts.

5. Remove the two mounting bolts and lift pump out of unit.
6. Drain hydraulic fluid through reservoir cap.
7. The pump is not repairable. If it is not functioning properly, replace it.

Installation

1. Install pump with the two mounting bolts.
2. Reconnect hydraulic hoses. Refer to Figure 13 for proper routing.
3. Install switch into dash with green terminal to the top and blue terminal to the bottom.
4. Reconnect black ground wire to frame.
5. Remove cap and service hydraulic reservoir with Dextron II or Dextron III to full line. Install cap.
6. Reconnect battery, negative terminal first.

7.3 ELECTRIC/HYDRAULIC PUMP SWITCH

Removal

CAUTION: Disconnect negative battery terminal first.

1. Remove switch from dash and disconnect the three leads.

Installation

1. The switch can only be installed one way. Check orientation of switch for proper load hookup.
2. Connect the three leads to the switch: green - top, red- middle, and blue-bottom.
3. Install switch into dash, reconnect the battery, negative terminal first, and check operational function of the switch.

7.4 HYDRAULIC HOSE

Removal

CAUTION: When hydraulic pump is operated, hydraulic fluid is under high pressure. To avoid injury disconnect battery (negative terminal first) prior to working on hoses.

1. Clean hydraulic fittings prior to removing hoses.
2. Disconnect hydraulic hose(s) from cylinder end first.
3. Disconnect hydraulic hose(s) from pump end.
4. Replace hoses as needed.

Installation

1. Connect hydraulic hose(s) to pump first.
2. Connect hydraulic hose(s) to cylinder.
3. Connect battery, negative terminal first.
4. Cycle unit up and down a few times to bleed the system.
5. Add Dextron II or Dextron III to the full line on the reservoir if servicing is needed.

7.5 HYDRAULIC CYLINDER

Removal

CAUTION: When hydraulic pump is operated, hydraulic fluid is under high pressure. To avoid injury disconnect battery (negative terminal first) prior to working on hoses.

1. Clean hydraulic fittings prior to removing the hydraulic hoses.
2. Disconnect hydraulic hoses. Note orientation of hydraulic hoses.
3. Disconnect cylinder from mower lift weldment. Note which hole the cylinder is connected to.
4. Remove the left side retaining ring from the hydraulic cylinder shaft.
5. Support hydraulic cylinder and slide hydraulic cylinder shaft out on the right side far enough to clear cylinder.
6. Remove cylinder from tractor.

Installation

NOTE: Hydraulic ports for fittings need to be facing up.

1. Slide cylinder shaft through hydraulic cylinder and out through left side of unit frame.
2. Install left side retaining ring on cylinder shaft.
3. Reconnect hydraulic cylinder to mower lift weldment, noting where it was previously connected.
4. Connect hydraulic hoses.

SECTION 8 - DRIVE TRAIN

8.1 TRANSMISSION TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate transmission problems and give possible causes and corrective action responses.

Problem	Possible Cause
1. Unit will not move.	Axle key sheared Clutch - lining worn - linkage broken Shifting fork dowel pin sheared in slide rod Broken axle Crankshaft key sheared Differential failure (check to see if brake drum turns)
2. Unit will move only in reverse	Adjustment of range linkage Hi-lo range in neutral Forward clutch - lining worn or linkage broken
3. Unit will move only in forward	Reverse clutch - lining worn or linkage broken
4. Attachment does not operate	PTO linkage out of adjustment PTO clutch lining worn out Crankshaft key sheared
5. Attachment will not stop	PTO clutch stuck PTO linkage out of adjustment
6. Difficult or impossible to shift Hi/Low Range	Control linkage Roll pin in shifter arm sheared Broken shifter fork Burred hi-lo shifting gear
7. Gear shift lever will not go in 1, 3 position or 4, 2 position	1, 3 or 4, 2 gears not in neutral Gears not aligned, rock tractor, or momentarily engaged clutch #6 shaft bent
8. #6 shaft turns but not wheels	Shafts 1 thru 6 are likely okay. Problem is probably in #7 (final pinion) or #8 (differential). Possible broken axle.

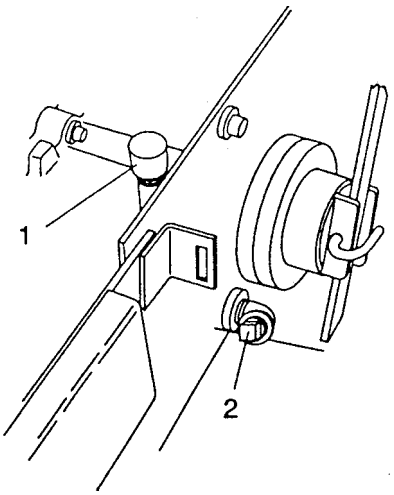
8.2 CHECKING THE TRANSMISSION OIL

To check the transmission oil level:

1. Move the unit to a level area. Stop the engine and lock the brake.
2. Raise the rear fender. Clean the check plug and remove it.
3. The oil level is correct when oil is at the bottom of the hole.
4. If the level is correct, reinstall and tighten the plug. If the level is low, add oil.

To add oil:

1. Remove the fill tube cap. Add oil until it reaches the bottom of the check plug hole.
2. Reinstall and tighten the fill tube cap and check plug.



1. Fill Tube
2. Check Plug

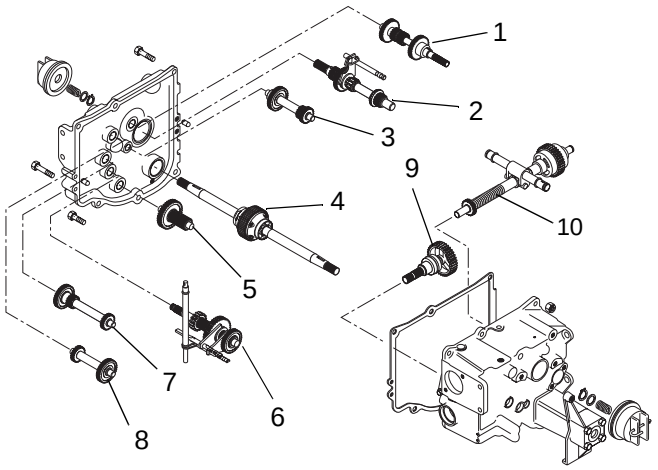
Figure 14

8.3 TRANSMISSION REMOVAL

NOTE: It is not necessary to remove the engine unless the PTO clutch assembly (#9 Shaft) is to be removed. The engine was removed for the total tear-down of the transmission.

1. Remove rear deck.
2. Disconnect the battery ground cable.
3. Drain transmission fluid.
4. Turn off fuel at fuel tank and disconnect fuel line at engine.
5. Jack unit to lift rear wheels. (Do not use engine as a jack point.) Block front wheels. Position jack stands at the rear of the frame. It may be convenient to disconnect the brake linkage to position the jack stands.
6. Remove the right tire assembly. Loosen the 3/4" lock nut. Use gear puller to loosen hub. Remove lock nut, washer, hub, and key. Repeat on left side if the differential #8 shaft assembly is to be removed.
7. Disconnect the Fwd/Rev neutral switch.
8. Remove forward and reverse clutch springs.
9. Disconnect the Fwd/Rev shifter rod from the Fwd/Rev clutch roll arm. Disconnect the neutral detent strap and neutral detent spring.
10. Remove the left and right side, lower forward-reverse mounting plate bolts.
11. Swing both plates up and out of the way.
12. Disconnect ground wires from transmission.
13. Clean the right axle and remove the axle bearing retainer.
14. Remove the forward clutch assembly. Remove the spring, flat washer, and retaining ring from the forward clutch (#1 shaft assembly). Repeat on the other side if the reverse shaft (#2 shaft assembly) is to be removed.
15. Remove the brake band and brake drum.
16. Remove the E-ring on the PTO yoke shaft. Remove all visible paint and debris from PTO yoke shaft.
17. Put the gear shift lever in the "Neutral" position, the PTO control in the "On" position, and the Hi-Lo lever in the "Lo" position.

8.4 TRANSMISSION DISASSEMBLY

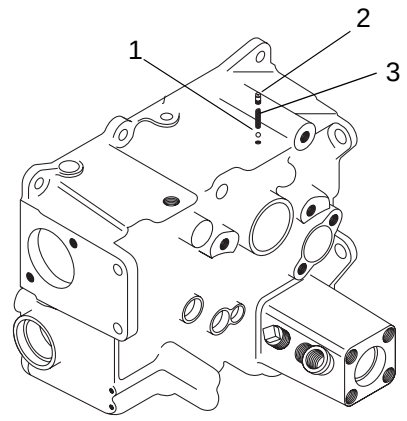


1. Forward Clutch Shaft #1
2. Reverse Clutch Shaft #2
3. 3rd & 4th Gear Shaft #3
4. Differential Assy Shaft #8
5. Final Drive Pinion Shaft #7
6. Sliding Gear Brake Shaft #6
7. 1st & 2nd Gear Shaft #5
8. Idler Shaft #4
9. PTO Drive Assy Shaft #10
10. PTO CLutch Shaft #9

Figure 15

PJ0060

1. Remove the cover bolts.
2. Place a clean cloth or box under the transmission to catch any parts that might fall out.
3. Clean paint and debris off the exposed part of #1, #6 and #8 shafts. Tap the cover with a soft hammer and pry off with two screwdrivers or pry bars. Tap #1, #6 and #8 shafts, and the PTO yoke shaft as the cover is worked off.

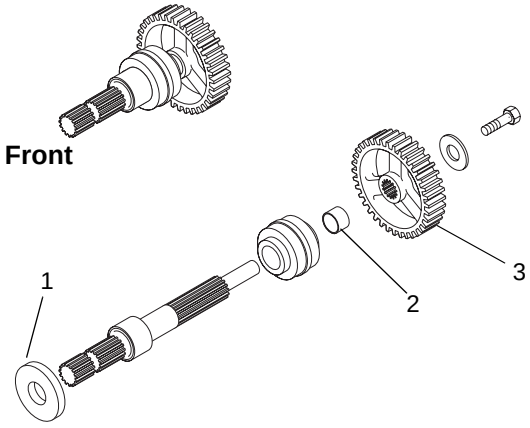


1. Ball
2. Plug
3. Spring

Figure 16

8.5 GEAR AND SHAFT REMOVAL

1. Remove idler gear assembly and races from #2 shaft assembly.
2. Remove #7 shaft assembly.
3. Remove #5 shaft assembly.
4. Remove #4 shaft assembly.
5. Remove the hi-lo detent spring and ball. A magnet can be used to lift the ball out of the case (Figure 17).
6. Remove #1 shaft assembly along with hi-lo shift fork.
7. Remove #3 shaft assembly.
8. Remove #6 shaft assembly.
9. Remove #8 shaft assembly.
10. Remove #2 shaft. Slide races towards reverse drive to clear #9 shaft.
11. Removal of #9 shaft assembly (PTO clutch):
    a. Remove engine.
    b. Disconnect PTO lever.
    c. Remove E-ring, PTO lever and key.
    d. Pull yoke shaft out and remove PTO yoke. (Note orientation of yoke.)
    e. Remove front PTO cap.
    f. Remove retaining ring on rear clutch cup.
    g. Slide assembly forward. Swing rear outward and pull out of case.
12. Removal of #10 shaft assembly (PTO shaft):
    a. Put the male universal shaft on the PTO shaft. Rotate the U-joint to 90^{o} and rotate against the unit frame (right side).
    b. Use a 15/16 wrench to remove the lock nut on the end of the shaft.
    c. Pull shaft forward out of the transmission case.
    d. Drive out seal and remove bearing.
    e. Inspect bearing races and remove if worn or damaged. Use a bearing puller to remove the races.
    f. Use the snap ring clamp and snap ring pliers to remove the snap ring.



1. Seal
2. Sleeve Bushing
3. PTO Spur Gear

Figure 17 #10 Shaft

PJ0161

12. Inspect all parts for wear and damage.
13. Replace all worn or damaged parts.

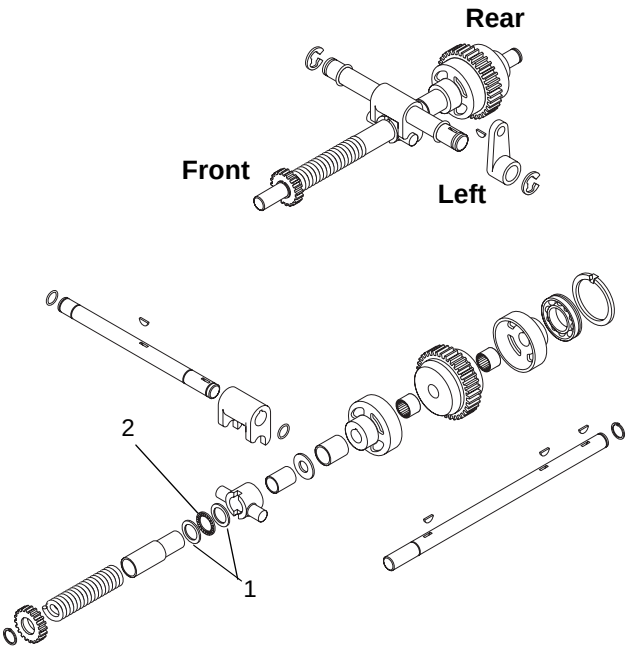
8.6 ASSEMBLY OF #10 SHAFT (PTO SHAFT)

1. If bearings are to be replaced, secure a complete new bearing set as the parts are matched.
2. Put snap ring in the groove and press races from either side using a driver.
3. Put cone in front race and press seal into position.
4. Put cone spacer, bearing cone, spacer, and gear in position and slide shaft into place.
5. Put a hardened washer (33845) next to the gear and secure assembly with "new" lock nut. Use the U-joint assembly to hold the shaft.

8.7 DISASSEMBLY OF #9 SHAFT ASSEMBLY (PTO CLUTCH)

CAUTION: PTO spring is under high pressure. Use extreme caution when disassembling.

1. Use a bearing puller with long legs in a push-puller to compress the spring.
2. Compress spring until the clutch cup clears the retaining ring.
3. Remove the retaining ring.
4. Remove the rear clutch cup and key.
5. Remove the cone gear, front clutch cup, and key.
6. Release the spring, slide remaining parts off the shaft while noting their position.
7. Inspect all parts for damage and wear.
8. Replace all parts damaged or worn. The retaining rings should be replaced.



1. Thrust Washer
2. N-Thrust Bearing

Figure 18 #9 Shaft

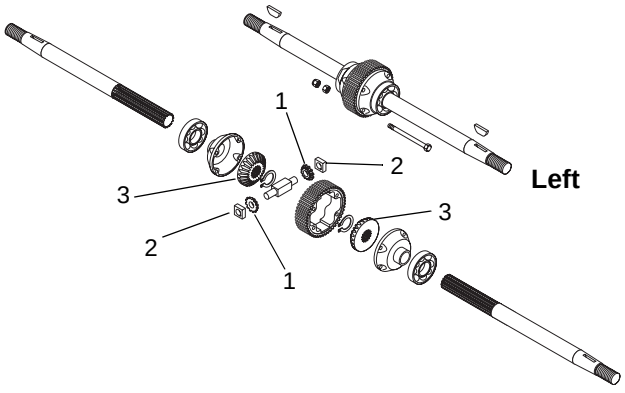
PJ0150

8.8 ASSEMBLY OF #9 SHAFT (PTO CLUTCH)

Reverse the disassembly procedure. Be sure the retaining ring is in place before releasing the spring pressure. Use plenty of 30-W engine oil on clutch parts. Failure to do so will cause the PTO clutch to stick in the "On" position.

8.9 DISASSEMBLY OF #8 SHAFT (DIFFERENTIAL-AXLE)

1. Remove the four bolts holding the assembly.
2. Use a soft hammer to loosen the assembly and pull apart.
3. Remove the axle retaining rings.
4. Remove bearings from the end cap with a soft hammer.



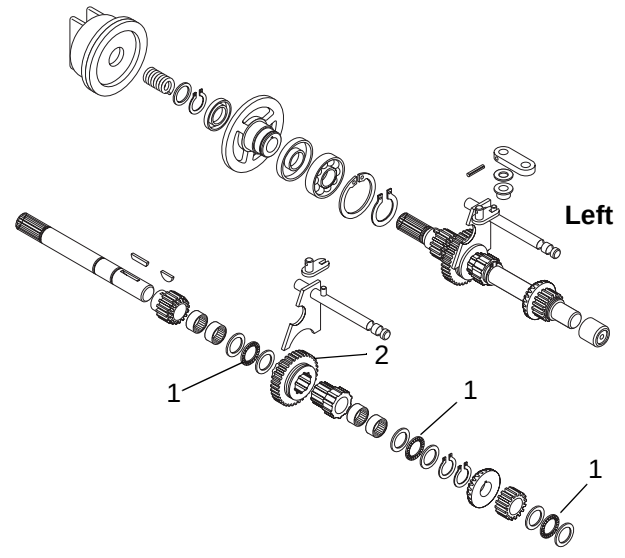
1. Bevel Pin
2. Drive Block
3. Final Drive Gear

Figure 19 #8 Shaft

PJ0140

8.10 ASSEMBLY OF #8 (DIFFERENTIAL-AXLE)

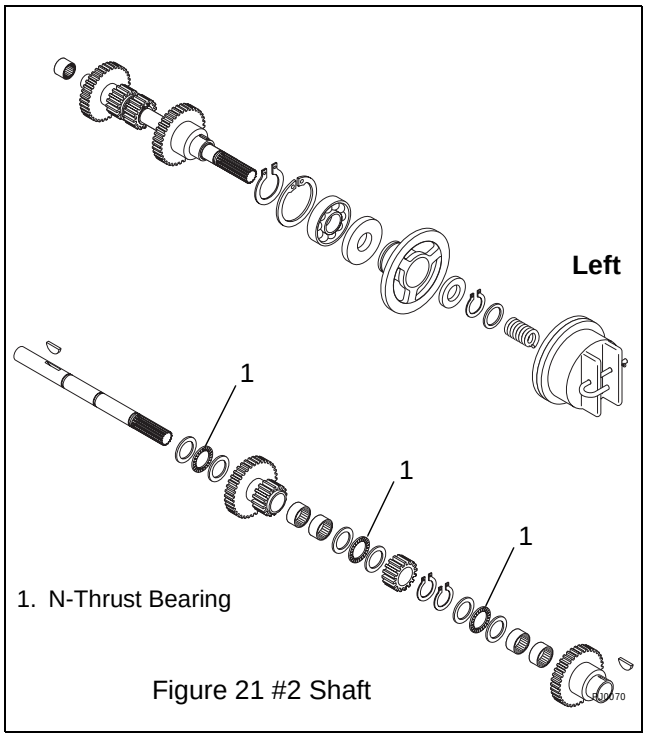
Reverse the disassembly procedure. Use nut retaining compound on the four bolts and tighten to a torque of 25 ft-lbs (33.8 Nm).



1. N-Thrust Bearing
2. Spur Gear

Figure 20 #1 Shaft

PJ0070



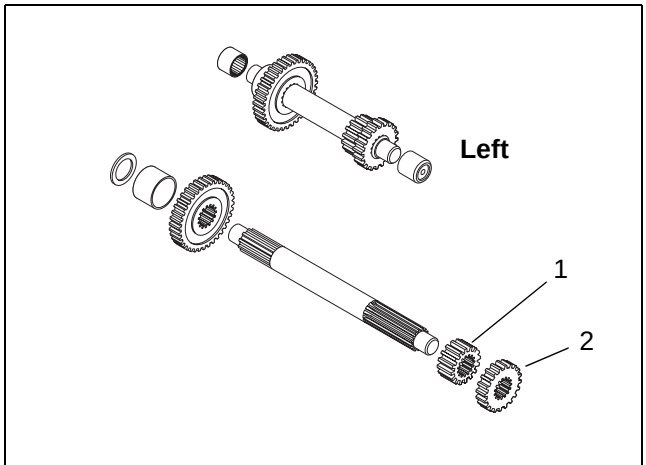
1. N-Thrust Bearing

Figure 21 #2 Shaft

PJ0070

8.11 INSPECTION & REPAIR #1 AND #2 SHAFT

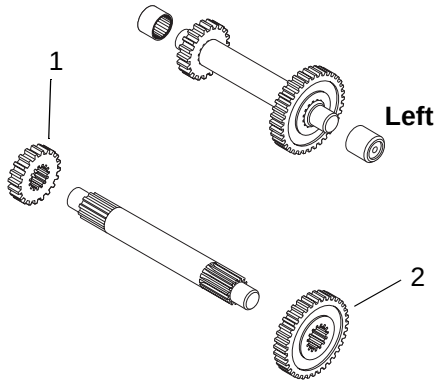
Inspect all parts for wear and damage. Replace any worn or damaged parts. If a bearing or thrust race is damaged, replace the bearing and both thrust races.



1. 16 Teeth 10 DP Gear
2. 20 Teeth 10 DP Gear

Figure 22 #3 Shaft

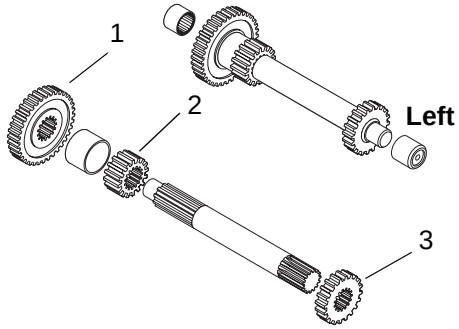
PJ0090



1. 20 Teeth 10 DP Gear
2. 30 Teeth 10 DP Gear

Figure 23 #4 Shaft

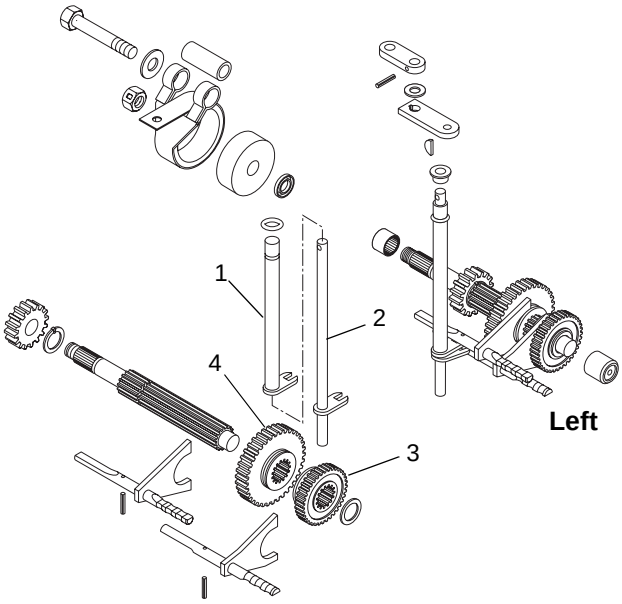
PJ0090



1. 30 Teeth 10 DP Gear
2. 26 Teeth 10 DP Gear
3. 20 Teeth 10 DP Gear

Figure 24 #5 Shaft

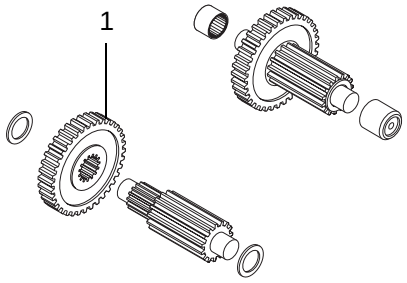
PJ0110



1. 1st & 3rd Shifter
2. 2nd & 4th Shifter
3. 30 Teeth 10 DP Sliding Gear
4. 36 Teeth 10 DP Sliding Gear

Figure 25 #6 Shaft

PJ0120



1. 30 Teeth 8 DP Gear

Figure 26 #7 Shaft

PJ0130

8.12 GEAR AND SHAFT INSTALLATION

1. Put the key in the hub of the gear-bearing assembly which goes on the right end of the #1 shaft. Put grease on the hub and slide the gear-bearing assembly into the clutch hub (forward clutch) in the cover.
2. Put the key in the hub of the reverse gear and bearing assembly which goes on the left end of #2 shaft. Put grease on the bug and slide the reverse gear and bearing assembly into the clutch hub (reverse).

3. Position the controls.

   PTO to "On"

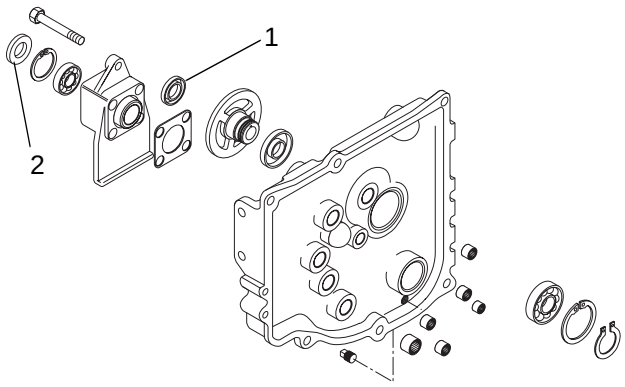
   Hi-Lo to "Lo"

   Gear to "Neutral"

   Fwd-Rev to "Neutral"

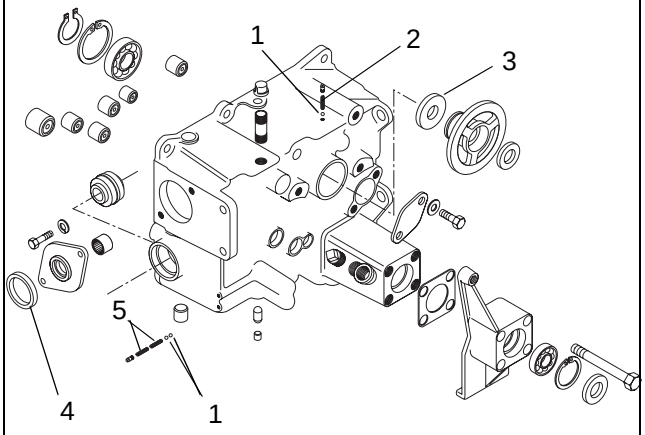
4. Installation of #9 shaft assembly (PTO clutch).
   a. Put the front of the assembly through the front hole of the case. Move rearward into the bearing. Tap the bearing with a soft hammer until the shaft is in place.
   b. Install the square retaining ring.
   c. Slide the front PTO cap coated with gasket eliminator in place and secure with two bolts.
   d. At the rear, rotate the bearing snap ring gap to the top position.
   e. Put O-rings and a key in the PTO yoke shaft. Coat the O-rings with grease.
   f. Slide the PTO yoke in position over the key and into the case. Note orientation of yoke—heavy side to rear.
   g. Install woodruff key, PTO lever (flat side inward) and E-ring.
   h. Connect PTO lever to the PTO rod with a washer and cotter pin.
5. Install the shaft assemblies in the following order:
   a. #6 shaft. Install interlock pin, detent balls, detent spring, and shift forks if removed. If removed, replace the shifter weldments and associated parts first.
   b. #8 shaft (differential).
   c. #1 shaft with 2-speed shift rail, detent ball, detent spring, and plug. Reconnect 2-speed linkage.
   d. #3 shaft.
   e. #2 shaft. Put the bearing and bearing race near the end of the shaft so as to clear the PTO assembly.
   f. #4 shaft.
   g. #5 shaft.
   h. #7 shaft.

8.13 TRANSMISSION ASSEMBLY



1. Clutch Seal
2. Seal

Figure 27 Transmission Cover Assembly PJ0190



1. Ball
2. Compression Spring
3. Clutch Seal
4. Seal
5. Compression Spring

Figure 28 Transmission Case Assembly PJ0120

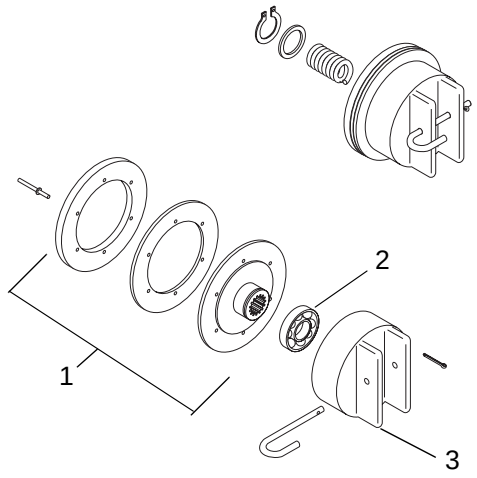
1. Coat the case and cover with gasket eliminator and place new gasket on the case. Slide the cover in place by tapping with a soft hammer.
2. Start all of the cover bolts, then tighten the cover bolts. Install the two engine mounting bolts. Tighten all four (if engine wasn't removed).
3. Install the E-ring on the PTO yoke shaft.
4. Install the brake drum and brake band.
5. Put a seal protector coated with oil on the axle in the axle bearing retainer assembly. Coat a new gasket with grease and stick it to the axle bearing retainer. Slide the assembly in place on the axle

and install the four bolts. Remove the seal protector. Repeat on the other side if removed.

6. Put the snap rings on #1 and #2 shafts and coat the splines with grease. Put the flat washer, spring and clutch assembly(s) in place.
7. Reconnect the ground wires to the transmission case.
8. Swing the forward-reverse mounting plates back down into place. Install bolts and tighten. Retighten front mounting bolts.
9. Reconnect the direction control lever, neutral detent spring and detent stop.
10. Install forward-reverse neutral switch.
11. Reconnect the forward-reverse neutral switch.
12. Coat the axle(s) with grease, put the key(s) in place and put the wheel hub(s) on the axle(s). Install washer and lock nut.
13. To adjust the clutch, see section on *Clutch Adjustment*.
14. If the engine was removed, see section on *Engine Installation*.
15. If the engine was not removed:
    a. Replace the rear hitch arm.
    b. Mount the tire assembly(s).
    c. Remove jack stands.
    d. Reconnect engine cables, wiring harness, oil sensor switch, and fuel line.
    e. Put new fluid in transmission.

8.14 FORWARD-REVERSE CLUTCH BEARING

1. Remove the trunnion, bearing, disc assembly from the transmission.
2. Use a flange puller with three bolts positioned to fit the trunnion lip to press the trunnion off the bearing.
3. Turn the assembly over and remove the snap ring (older style clutch).
4. Readjust the position of the three bolts to fit the bearing. Press the bearing off the disc assembly.
5. Inspect all parts. Replace any worn or damaged parts.
6. Press the bearing on the disc assembly.
7. Turn the assembly over and press the trunnion on the bearing.



1. Clutch Ring Assembly
2. Ball Bearing
3. Fwd-Rev Clutch Trunnion

Figure 29

PJ0170

8.15 FORWARD-REVERSE CLUTCH SEAL REPLACEMENT

Small Seal

1. Remove the trunnion, bearing and disc assembly.
2. Carefully remove the old seal with a small punch.
3. Put a film of grease on the lip of the new seal and slide it on the thimble. Coat outer area of seal with Loctite.
4. Put the thimble over the shaft and seat the seal with a driver.

Large Seal

1. The inside clutch hub must be removed to install this seal. Follow the procedure for removal of the clutch shaft in the transmission disassembly.
2. Remove the old seal.
3. Install the new seal with a driver. Coat outer area of seal with Loctite.
4. Assemble transmission.

SECTION 9 - FUEL SYSTEM

9.1 FUEL SYSTEM TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate fuel system problems and give possible causes are corrective action responses

The troubleshooting key is generic and can be used for several types of transmissions. Use only those possible causes and corrective actions that apply to the unit.

TROUBLE	POSSIBLE CAUSES (Refer to Key Below)	CORRECTIVE ACTION
Hard Starting	1, 3, 4, 6, 11, 12, 14, 16, 17, 18	clean, repair or replace
Fuel Leak at Carburetor	5, 7, 17	repair or replace
Engine Floods	5, 15, 17	repair or replace
Will not idle	1, 2, 3, 6	repair or replace
Rich idle	1, 6, 14	repair or replace
idles with Needle Closed	14	repair or replace
Hunts Erratic Idle	2, 3, 6, 7, 12, 13, 14, 15, 18	repair or replace
Idles Fast Lean	2, 3, 7	repair or replace
Will Not Accelerate	1, 6, 11, 12, 14, 15, 16	repair or replace
Over Rich Acceleration	1, 15	repair or replace
Hesitates	2, 6, 11, 12, 16	repair or replace
Will Not Run at High Speed	1, 11, 12, 14, 16	repair or replace
Low Power	1, 3, 11, 14, 15, 16, 17, 18	repair or replace
Hunts at High Speed	3, 6, 7, 12, 14, 15, 16, 18	repair or replace
Runs With Needle Closed	14	repair or replace
Engine Overspeeds	2, 3, 7, 14	repair or replace

TROUBLESHOOTING KEY	
1	Plugged Air Filter
2	Leaky Carburetor Gasket
3	Throttle or Choke Shaft Worn
4	Choke Not Functioning Properly
5	Plugged Atmospheric Vent
6	Air Bleed Restricted
7	Damaged or Leaky "O" Rings
8	Damaged Diaphragm
9	Stuck or Dirty Ball Check
10	Diaphragm Upside Down
11	Plugged Tank or Vent
12	Fuel Pick-up Restricted
13	Idler Port Restricted
14	Damaged Adjustment Needle and Seat
15	Incorrect Float Height
16	Main Nozzle Restricted
17	Dirty, Stuck Needle and Seat
18	Fuel Inlet Plugged

9.2 FUEL PUMP

The impulse style fuel pump is the most commonly used fuel pump. Impulse fuel pumps may either be mounted externally onto the carburetor fuel inlet or remotely mounted. These pumps are connected in the fuel line between the fuel supply and the carburetor or directly to the fuel inlet.

Impulse fuel pumps are operated by crankcase impulses created by the up and down movement of the piston. A hose called a pulse line connects the fuel pump diaphragm chamber and transmits the impulses to the pump diaphragm. The impulses actuate the diaphragm and the flap valves to lift the fuel from the fuel tank to the carburetor.

9.3 FUEL SYSTEM CONTAMINATION

Any time fuel contamination is found in the fuel system (dirt, water algae, etc.) replace the fuel, fuel filter and flush the fuel lines. Remove the carburetor bowl and clean. Replace all items that cannot be cleaned. Reassemble the fuel system and check for proper operation.

9.4 FUEL TANK

The fuel tank is made of composite material for long life without breaking down from the additive used in today’s blended fuels.

10.1 TOOLS

There are some specialized tools and test equipment that are needed for electrical repair work. A brief description of these follows.

Long or needle nose pliers - used to connect or bend wires and connectors in close quarters.

Diagonal cutters - used to cut wires or trim connections.

Wire stripper/crimping tool - available separately or as a combination tool. Used to strip insulation from wires of various sizes, crimp terminals and connector or wires.

Soldering gun or soldering iron - used to solder all splices and connections to terminals, connector, etc. A soldering gun is faster and more convenient that waiting for a soldering iron to heat.

Multimeter - analog or digital, to measure voltage, amperage and ohms.

Tachometer - used to measure engine speed. Required to properly test alternator and charging circuits where output is dependent upon engine speed.

Heat gun - used to shrink insulated tubing in place. Used to replace electrical tape or insulated sleeving. To use, place a piece of shrink tubing over a wire joint, heat with the heat gun, until it shrinks slightly around the joint.

Supplies - electrical tape, rosin core solder (never use acid or acid core solder on electrical joints), an assortment of various size terminals, connectors, insulated or heat shrink tubing (for use on joints and connections), and an assortment of automotive type wire (in several colors).

Gravely Company recommends that all work be done in a professional manner. The use of the tubing to cover joints and the soldering of connections contribute to a professional looking job. In addition to a pleasing appearance, repairs made in this manner are more likely to withstand vibration. (The weakest points in an electrical system are the joints where wires are attached.)

Replace all defective components with Gravely replacement parts only. Engine parts, such as rectifiers or alternator components should be secured through the nearest engine service center.

Gravely Company does not recommend attempting to repair electrical components. Most do not lend themselves to repair and you would have more money invested in "time of repair" than the part would cost and the results may not be as good.

10.2 ELECTRICAL MEASUREMENTS

In many electrical circuits, there is some visible effect which indicates that the circuit is functioning properly. A switch is turned "ON" and a lamp lights. A key is turned, a starter motor runs and cranks the engine. If the lamp does not light, or the starter motor does not run, some means of measuring voltage, current flow, resistance and continuity is needed, (continuity means there is a complete electrical path through the circuit or component.)

To know exactly what conditions exist in an electrical circuit requires AC and DC Voltmeter, AC and DC Ammeter, and an Ohmmeter.

Multimeter

A single combination meter that does all of these things is available. Such a meter is called a Multimeter or Volt-Ohm-multitester (VOM). Meters of this kind are available in many forms and all change functions and ranges with switches, or by plugging test leads into different jacks. Multimeters are available in two basic types, Analog and Digital.

Analog Meters

Analog Meters have a needle that moves across a scale to give a reading. The longer the scale, the easier it is to read and more accurate the reading will be. A jeweled movement is used in this type of meter is more likely to be damaged through rough handling (except for overloaded Protected Meters) or by measuring high values that exceed the range set on the meter than a digital meter. They provide excellent service for the money as long as they are used with care.

Digital Meters

Digital Meters do not have a movement and are therefore more rugged. The reading shows up directly on a display window of some type. Since they read direct, no skill in reading the scale is required, nor is it necessary to set the range. The meter switches the ranges automatically. One has only to select the function DC Volts, AC Ampere, Ohms, etc.,) connect the test leads, and the reading is shown on the display. Because of the internal circuitry and the lack of a movement, these meters are not likely to be damaged by overloads.

In the discussions that follow, either type of meter may be used. Test procedures are the same. It is best to learn proper procedures, even though some meters may be more forgiving of mistakes. Where differences in use may occur, they will be covered in the discussion.

Voltage Measurement

There are two basic rules to be remembered when using a voltmeter. A voltmeter measures the voltage difference between the test leads and the voltmeter is always connected across the circuit under test.

Current Measurement

The two rules to remember when measuring current with an ammeter are; an ammeter measures the current that flows through the meter, and to measure current an ammeter must be connected into the circuit. The latter rule means that the circuit must be opened, and the ammeter wired into it. Because this procedure is usually difficult, an ammeter is seldom used for troubleshooting.

Resistance Measurement

An ohmmeter is used to make resistance measurements and to check continuity through wires and electrical components.
There is one rule to keep in mind when using an ohmmeter. The ohmmeter has a self contained battery and requires no electrical power. Using the ohmmeter on a circuit that has power applied may result in damage to the meter.

IMPORTANT: Disconnect the equipment battery when making Ohmmeter test or damage to the Ohmmeter may result.

IMPORTANT: An ohmmeter reads the resistance of whatever component is connected between the test leads. It can be used to check wires, coils, light bulbs, or any item that conducts current.

10.3 BATTERY

When charging battery, remove it from unit first. Keep batteries out of reach of children. ALWAYS follow information provided on battery by battery manufacturer. Lead acid batteries generate explosive gases. Severe chemical burns can result from improper handling of battery electrolyte. Wear safety glasses and proper protective gear when handling batteries to prevent electrolyte from coming in contact with eyes, skin or clothing.

WARNING: ELECTRIC SHOCK may result in injury and/or damage to unit.

DO NOT allow tools or other objects to come into contact with both terminal at the same time. ALWAYS remove Negative (-) Cable first to reduce risk of sparks when removing battery. ALWAYS connect Positive (+) Cable first, then connect Negative (-) Cable when installing battery.

WARNING: EXPLOSIVE GASES can result in serious injury or death. ALWAYS keep open flames, sparks, or smoking materials away from battery.

POISONOUS BATTERY FLUID contains sulfuric acid and its contact with skin, eyes or clothing can cause severe chemical burns. ALWAYS wear safety glasses and protective gear near battery.
DO NOT TIP any battery beyond 45 degree angle in any direction.
ALWAYS KEEP BATTERIES OUT OF REACH of children.

WARNING: REVERSE CONNECTIONS may result in sparks which may result in injury. ALWAYS connect/disconnect cables in proper order.

Set-Up

The new battery is dry charged. The dealer or customer must add electrolyte (sulfuric acid and water).

1. Remove the battery from the unit.
2. Remove all the vent caps from the battery and set the caps to one side.
3. Take the electrolyte which should be 1.265 specific gravity at 80^{o}F, and fill each cell so that the electrolyte is level with the bottom of the fill ring.
4. The battery should stand for 1/2 hour. Now check electrolyte level in each cell again. If necessary add more electrolyte to bring the level up to the bottom of the ring.
5. Charge until all cells are gassing freely, and the specific gravity is constant over three successive readings taken at 30 minute intervals.
6. Immediately after charging check level of electrolyte. If the level is low add distilled water to bring it up to the required level.
7. Replace the vent caps. It is not necessary to tighten more than finger tight.
8. Wash off the battery to remove electrolyte which may have spilled.

Battery Electrolyte First Aid

External contact: Flush with water.

Eyes: Flush with water for at least 15 minutes and get medical attention immediately!

I**nternal contact:** Drink large quantities of water. Follow with Milk of Magnesia, beaten egg or vegetable oil. Get medical attention immediately!

IMPORTANT: In case of internal contact, DO NOT induce vomiting!

Clean Battery

Corrosion and dirt on the battery and terminals can cause the battery to "leak" power.

- Remove battery. (See *Battery Removal and Installation*)
- Rinse the battery with plain water and dry.
- Clean terminals and battery cable ends with wire brush until bright.
- Coat terminals with grease or petroleum jelly.
- Reinstall battery.

Inspection, Cleaning, Drying, and Maintenance

Inspect the top of battery, terminals, cables, terminal posts, and case for any accumulation of dirt, corrosion cracks or loose or broken parts. Keep battery and its terminals clean. Inspect monthly to maintain best performance. Replace battery if damaged.

Remove hold down and bolt and lift battery out. Clean or service battery away from unit. Remove corrosion from battery terminals and cable connections with wire brush, then wash with a weak baking soda solution.

Scrub the exterior of the battery and cable terminals with a nonmetallic brush which has been dipped into a mixture of baking soda and water.

After cleaning, apply a thin coat of grease or petroleum jelly to terminals and cable ends to retard corrosion. Reinstall battery.

Check the alternator voltage regulator output (if used) at every periodic maintenance inspection. Over charging is a common cause of battery failure.

Electrolyte Level

Every 25 hours of operation, check electrolyte level of each cell by removing caps one at a time. The electrolyte level should be at level indicated. Use distilled water to fill each cell if needed. Install and tighten each cap after checking.

IMPORTANT: When distilled water is added to battery during freezing weather, battery must be charged to mix water with electrolyte, or water will remain at top and freeze.

Charging

ALWAYS follow information provided on battery by battery manufacturer. Contact battery manufacturer for extensive instructions to charge battery.

Place unit on a level surface, shut off engine and open battery compartment to gain access to battery.

Disconnect negative (-) cable first, then positive (+) cable.

To charge battery:

1. Loosen strap and remove battery from unit.
2. Place battery on bench or other well ventilated place where electrolyte spill will not create damage.
3. Remove caps and fill each cell to level indicated with electrolyte at 1.230 specific gravity and 80^{o}F (27^{o}C).
4. Let battery stand for one half hour.
5. Check electrolyte level and add more if necessary.
6. Connect positive (+) lead of charger to positive (+) terminal, and negative (-) lead to negative (-) terminal.
7. Charge the battery at two and a half amps for ten hours or until all cells are gassing freely and the specific gravity is constant over three 30 minute intervals.

Specific Gravity Check

The specific gravity should be checked with a hydrometer.

NOTE: The specific gravity should be checked in each cell and should be the same for all cells. A variation in a cell reading could be an indication of a problem. Subtract .004 from 1.265 for each 10^{o}F below 80^{o}F (27^{o}C) or add .004 to 1.265 for each 10^{o}F above 80^{o}F (27^{o}C).

A special temperature compensated hydrometer is used to read the battery's state of charge.

The reading on the hydrometer gauge should be above 1.225. If the reading falls below 1.225 specific gravity there will be an insufficient charge.

ALWAYS charge the battery until the specific gravity of 1.265 is reached over 3 successive readings. Check monthly to ensure charge is maintained. The approximate state of charge can be determined by the cell specific gravity of the rested open circuit voltage at room temperature and the charging time can be estimated. For example:

OCV	Specific Gravity	% of Charge	Charging Time
12.60	1.265	100%	---
12.4	1.225	75%	3 hours
12.20	1.180	50%	7 hours
12.00	1.130	25%	10 hours
11.80	1.100	0%	12 hours

If using an automatic tapering 12 volt charger, choosing a good quality 5 to 10 amps 15VDC minimum output charger and charge for 3 to 12 hours according to the battery state of charge (see table above) or until the specific gravity in each cell reaches 1.255 - 1.265 specific gravity at 80^{o}F (27^{o}C).

If using a constant current charger, charge at 1 to 2 amperes for the time given on the table above or until full specific gravity is reached.

IMPORTANT: Charging at higher rates will damage the battery and cause excessive gassing and acid spewing.

Battery Charger

Under normal conditions the engine alternator will keep the battery charged. When unit has set for an extended period of time without operation and the battery has been completely discharged, a battery charger will be required for recharging.

Before using a charger, an attempt can be made to recharge the battery using the engine alternator by jump starting the unit and allowing the engine to run.

Jump Starting

Jump starting, battery charging, or replacement is required when the starter motor will not crank the engine.

The unit used for jump starting should have a 12 volt battery with at least 500 cold cranking amperes, and a negatively grounded system.

> **WARNING:** FROZEN BATTERIES CAN EXPLODE and result in death or serious injury. DO NOT charge a frozen battery. Let the battery thaw out before putting on a charger.
> UNIT MOVEMENT can result in death or serious injury. NEVER jump start unit directly to the starter or starter solenoid. Unit can move forward or backward and injure the person jump starting unit.

To jump start the battery:

1. Ensure battery is not frozen. If the fluid is frozen, remove battery from unit and allow to thaw before charging.
2. Connect the positive (+) jumper cable to the positive (+) terminal of the discharged battery.
3. Connect the other end of the same jumper cable to the positive (+) terminal of the booster battery.
4. Connect one end of the second jumper cable to the negative (-) terminal of the booster battery.
5. Make the final jumper cable connection to the engine block or the furthest ground point away from the discharged battery.

> **WARNING:** Make sure cables are clear of any moving engine parts before starting engine.

6. Start engine (refer to Owner's Manual). If engine will not start after several tries, unit or battery may need service.
7. After engine starts, leave cables connected for one to two minutes.
8. Disconnect cables in reverse order.
9. Operate unit as normal to charge battery.

Storage

The battery is a perishable item and it should be stored properly to obtain a long, useful life. Batteries not in use will self discharge.

If the battery will not be used for more than three months, it should be removed and stored in a cool, dry place.

Any collection of dirt, grease, or electrolyte should be removed from the top of the battery.

The battery must be recharged monthly or when the cell specific gravity reads less than 1.255 specific gravity. Before reinstalling the battery in the spring, it should always be fully recharged.

10.4 SWITCHES

Switches either open a circuit to stop current flow or close and allow current to flow through.

A normally open (N.O.) switch prevents current flow until the switch is actuated, completing the circuit and allowing current to flow through it. An example is a light switch - the lights are off until the switch is actuated and the lights go on.

A normally closed (N.C.) switch allows current to flow until the switch is actuated, breaking the circuit and stopping current flow through it. An example is an ignition switch that grounds the magneto when in the off position (completing the circuit) but opens the circuit when in the ON position allowing the engine to operate.

Switches are selected with regard to Current rating (contacts must be of sufficient size to carry the required current), Voltage rating (switches insulated for specific voltages), Case or housing (switches that are exposed to moisture and must be sealed to prevent moisture from entering), and Actuating type (push, pull, rotary, momentary contact, or micro switches).

NOTE: Check that the connections to the switches are secure and that a switch is being activated properly before performing electrical test on switches. (Safety switches on speed selector and clutch levers may be out of adjustment and not activating.)

IMPORTANT: When checking switches, remove them from their respective circuit by disconnecting the wires from the switch at the connector(s). Damage could result to the meter or machine components if switches are left in.

Normally Open Switch

To test a normally open switch (key, headlight, safety, or seat) connect the ohmmeter across the switch terminals. Meter should indicate open circuit (infinite resistance). Activate the switch. The ohmmeter should read up scale to zero resistance (Close Circuit). This indicates the switch is operating properly. Also check from each terminal to the switch case (if case is metal).

Reading should show infinite resistance indicating no short to ground.

Variation from test results described indicates a defective switch.

Normally Closed Switch

To test a normally closed switch connect the ohmmeter across the switch terminals. Meter should indicate a closed circuit (zero resistance). Activate the switch and the meter should move to open circuit (infinite resistance). Check from each terminal to ground (switch case). Meter should show open circuit (infinite resistance).

Variation from test results described indicates a defective switch.

Ignition Switch

NOTE: Refer to the wiring diagram of the unit involved to determine switch functions and test using the methods described.

The ignition switch incorporates a number of functions, although not all functions are used on all equipment. The switch has three positions: OFF, RUN, and a momentary contact START position. Use an ohmmeter to check the continuity of the switch in each position.

OFF Position - Should be continuity between contacts G and M. These connections ground the engine magneto and stop the engine in the OFF position.

RUN Position - Should be continuity between contacts B and A. These connections supply power to the rest of the wiring harness. Connections G and M open to each other.

START Position - Hold switch in START position while testing. There should be continuity between contacts S1 and S2. These connections apply power to close the solenoid contacts and operate the starter motor.

In addition to the above test, place the switch in the run position and check between each contact and ground (metal case) to be sure no terminals are grounded. If the switch is operating properly, there will be no continuity between contacts other that those described.

10.5 SOLENOID AND RELAYS

Solenoid and relays are both magnetically operated devices. Both devices operate on the principle that passing a current of electricity through a coil of wire will create a magnetic field strong enough to attract a piece of iron or steel. Each device uses this principle in a slightly different manner.

Relay - A basic relay consists of a coil of wire wound around a soft iron (magnetic) core. When current is passed through the coil, the core is magnetized and pulls down on a magnetic lever. The lever in turn is attached to several switch contacts which open or close other electrical circuits. In this fashion, a small current can control one or more larger electrical currents and actuate several other devices. In most cases a relay contact moves only a fraction of an inch and the magnetic pull is small.

Solenoid - A basic solenoid consists of a coil of wire wound around a hollow tube. A magnetic core slides inside the tube. When current is passed through the coil, the core is pulled into the solenoid with considerable force. With proper design, a solenoid can exert considerable force over a distance of several inches. A solenoid can therefore, pull a lever, close a heavy contact, or perform other jobs that require a straight line pull.

If a relay or solenoid fails to operate, the cause may be either electrical or mechanical.

To check electrically, connect a voltmeter across the coil of the device and activate the circuit that operates the relay or solenoid. If the meter indicates no voltage is applied, the cause is in the control circuit.

If the meter indicates proper voltage across the coil but the device does not function, remove the power, disconnect the wiring and check the continuity of the coil with an ohmmeter. The meter should indicate resistance, in the order of 3 to 5 ohms, if the coil is intact. A high resistance indicates an open coil and a defective device.

There are also a number of mechanical problems that may cause the problem.

The starter solenoid in the Gravely equipment is a sealed unit used to actuate the starter motor on the engines. These solenoids may have three or four connections. The two large connections carry high current to operate the starter motor. The small connections are connected to the coil and carry the control current.

To check the solenoid, disconnect the cables to the starter motor, turn the ignition switch to the start position, and listen for the solenoid to snap inside contacts closed.

If no snap is heard, check across the coils with a voltmeter. The voltage should read 12 volts with the ignition switch in the start position. If no voltage appears, the defect is in the start circuit.

If the voltage is correct, turn off the power and check continuity of the coil with an ohmmeter. If the coil is open, the solenoid is defective and must be replaced.

If the coil has the proper voltage applied, and the continuity check indicates the coil is intact, the solenoid plunger is stuck or the contacts are welded shut and the solenoid must be replaced.

If the solenoid snaps shut, but the start does not operate, check across the large contacts with an ohmmeter. If there is no continuity when the solenoid snaps shut, the contacts are defective and the solenoid must be replaced.

10.6 LIGHTING CIRCUITS

Lighting circuits are simple circuits and easiest to trouble shoot in most equipment. They consist of the lights connected in parallel; a normally open switch, a protective fuse and a source of power (battery or engine alternator).

If only one light is out, check the connector, then check the bulb for continuity (high resistance indicates a defective or burned out bulb).

If all the lights are out, check the fuse for continuity (high resistance indicates a defective or blown fuse). If the fuse is blown, check for a short in the wiring and correct before replacing the fuse.

If the fuse and lamps are good, check the circuit with an AC/DC voltmeter.

10.7 FUSES

Fuses are connected in electrical circuits to protect the circuits from damage due to overload or short circuits. Fuses are a "weak link" in the circuit. They contain a metal link designed to melt when a certain current value is exceeded thus opening or disconnecting the wiring. Once a fuse blows or melts it must be discarded and replaced with a new fuse of the same value.

Since the function of the fuse is to protect the circuit, NEVER attempt to defect the protective device by bridging or replacing with a device of a higher current rating.

Electrical testing of these devices is simple. Since the device either conducts current (and is therefore functioning) or the device is open and is therefore defective. Use an ohmmeter to check for continuity.

10.8 DIODES AND RECTIFIERS

Diodes are solid state, semiconductor devices. They contain no moving parts and conduct current better in one direction than the other.

Diodes allow current to flow through one circuit without "backing up" into another. In engine alternator circuits, a diode is used to convert current which flows back and forth (AC) in a circuit to current which flows only in one direction (DC). A device which converts alternating current to a direct current is called a RECTIFIER. A diode is one type of rectifier.

To check a diode, isolate if from the circuit by disconnecting one end. With a multitester set on the lowest ohms scale setting, measure the resistance in one direction, reverse the test leads, and measure in the other direction. Readings should be high in one direction and low in the other. (If the readings are low in both directions, the diode is shorted, and if the readings are high, the diode is open.) If the readings are the same in both directions, the diode is defective and must be replaced.

IMPORTANT: Diodes are marked to indicate polarity (a band on one end, an arrow on the side, or they fit on a holder only one way.

Rectifiers

A battery is charged through the use of an alternator located in or on the engine. A charging circuit contains a rectifier because alternators produce alternating current (AC) and batteries require direct current (DC) for charging.

The rectifier may be built into the engine or it may be an external part. It may also contain a regulator to prevent overcharging the battery. (Servicing of rectifiers built into the engine should be done by an approved engine manufacturer’s service center. Such a service center has access to the information and parts required to test and repair or replace engine components, including rectifiers and regulators.)

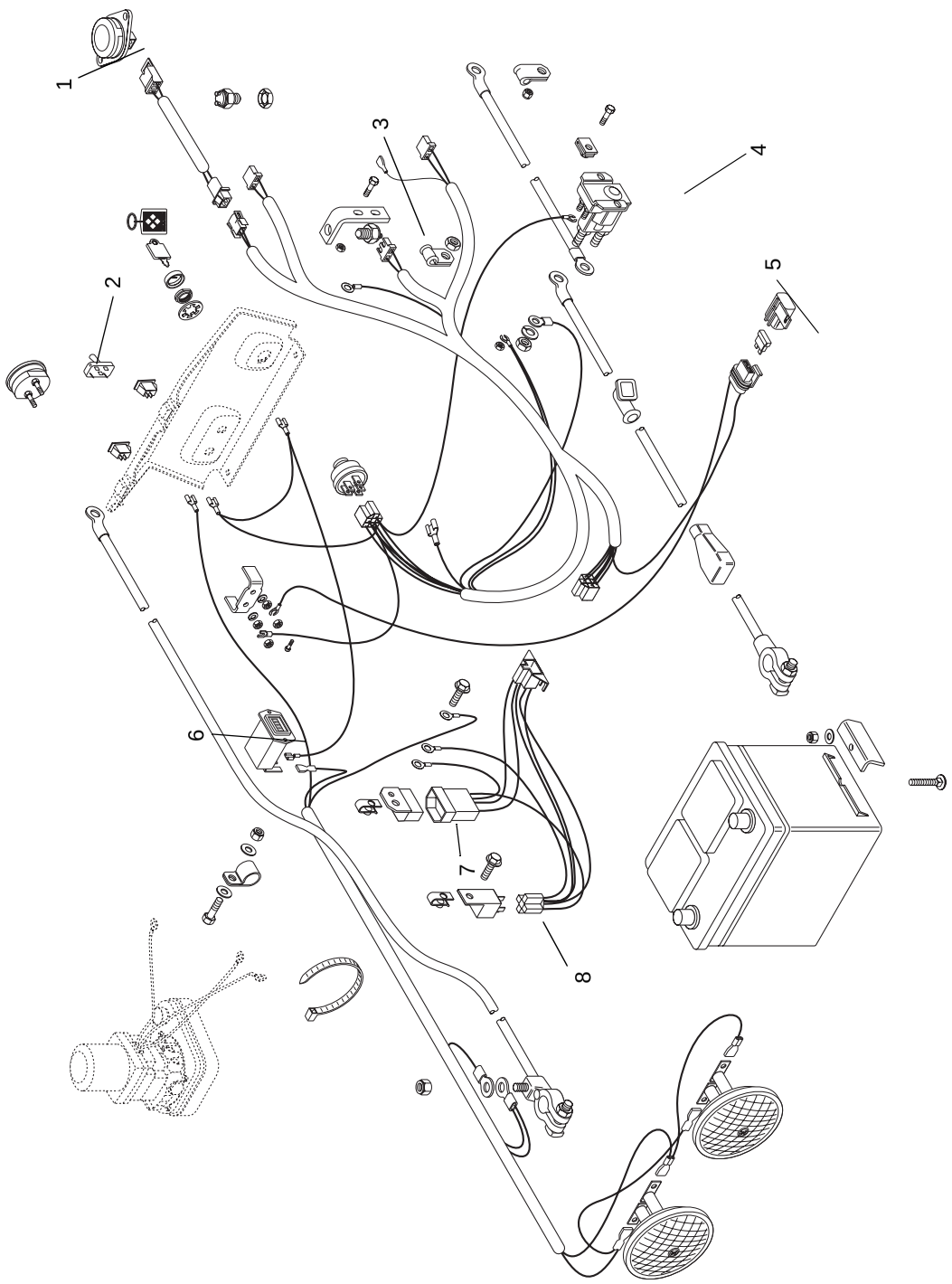
Units that contain both a rectifier and regulator are tested in a working circuit to make sure the regulator portion of the device is operating.

Engine Electrical Components

Engine servicing and repair should be referred to local engine manufacturer’s service centers that have the service information and parts available to properly service the engine. Gravely dealers should be able to test engines and engine components to pinpoint troubles and narrow them down to properly advise the engine serviceman.

10.9 ELECTRICAL SYSTEM

Models 987066-072



1. Seat Switch
2. Ammeter Gauge
3. Neutral Start Switch
4. Solenoid
5. Fuse
6. Hour Meter
7. Delay Interlock Module
8. Relay

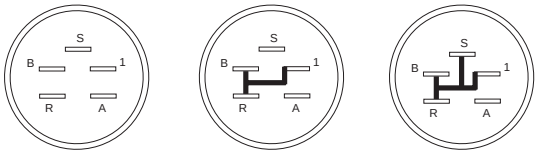
PJ0022

10.10 CONTINUITY DIAGRAMS

Models 987066, 067, 068, 069

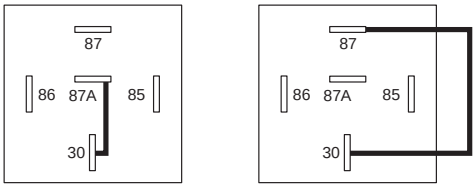
The diagrams below show the various states of connection for electrical components.
The solid lines on switches show continuity.
NOTE: All switches are viewed from the rear.

Key Switch
(0115200)



OFF RUN START

Relay
(03042800)

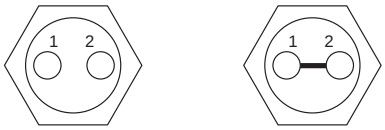


NOT ENERGIZED ENERGIZED

Seat Switch
(03654200)

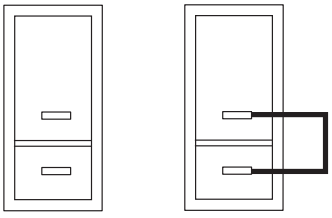
OPERATOR OFF SEAT
OPERATOR ON SEAT

PTO & FWD/REV Interlock Switch
(02913100)



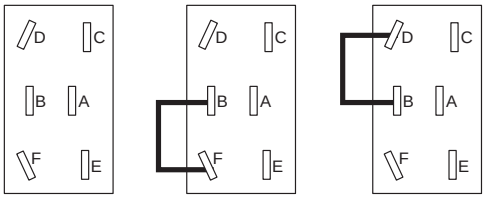
(BUTTON UP) (BUTTON DOWN)

Light Switch
(08973300)



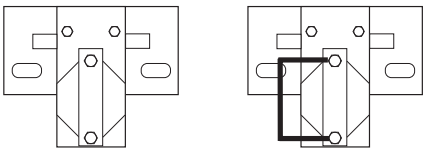
OFF ON

Lift Pump Switch
(03437900)



OFF UP DOWN

Solenoid
(03492300)

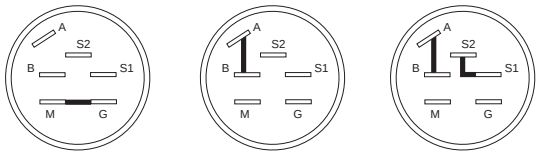


NOT ENERGIZED ENERGIZED

PT0861

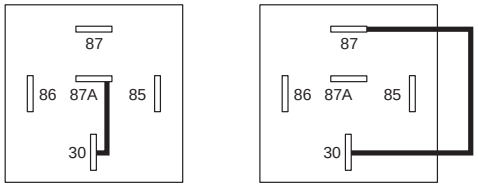
The diagrams below show the various states of connection for electrical components.
The solid lines on switches show continuity.
NOTE: All switches are viewed from the rear.

Key Switch
(03602300)



OFF RUN START

Relay
(03042800)

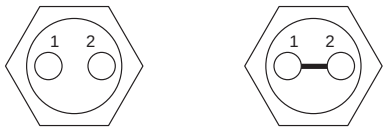


NOT ENERGIZED ENERGIZED

Seat Switch
(03654200)

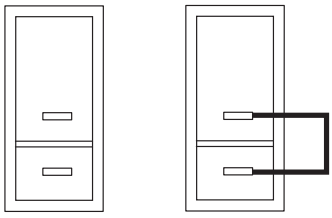
OPERATOR OFF SEAT OPERATOR ON SEAT

PTO & FWD/REV Interlock Switch
(02913100)



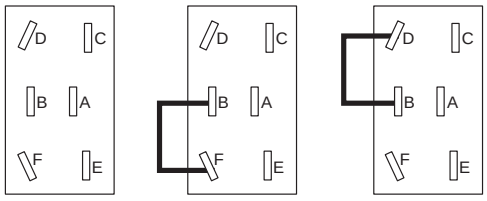
(BUTTON UP) (BUTTON DOWN)

Light Switch
(08973300)



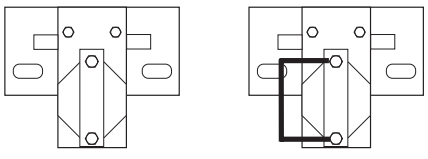
OFF ON

Lift Pump Switch
(03437900)



OFF UP DOWN

Solenoid
(03492300)



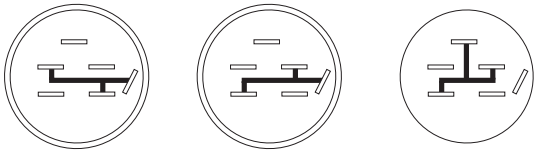
NOT ENERGIZED ENERGIZED

PJ0440

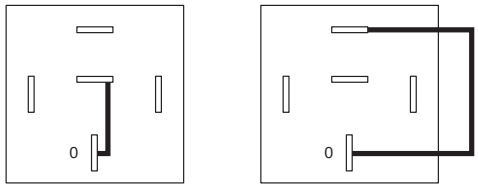
Model 987070

NOTE:

Key Switch
000

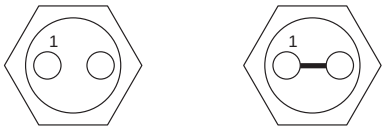


Relay
00400

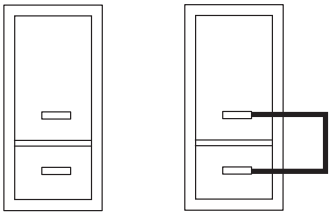


Seat Switch
0400

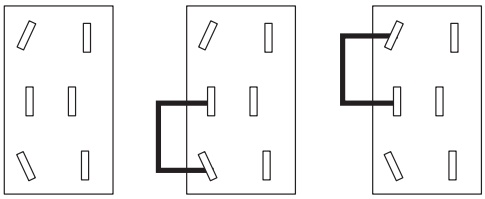
PTO & FWD/REV Interlock Switch
01100



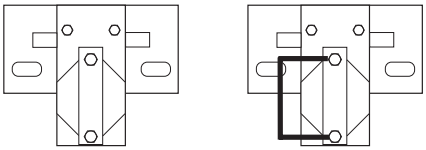
Light Switch
000



Lift Pump Switch
0400



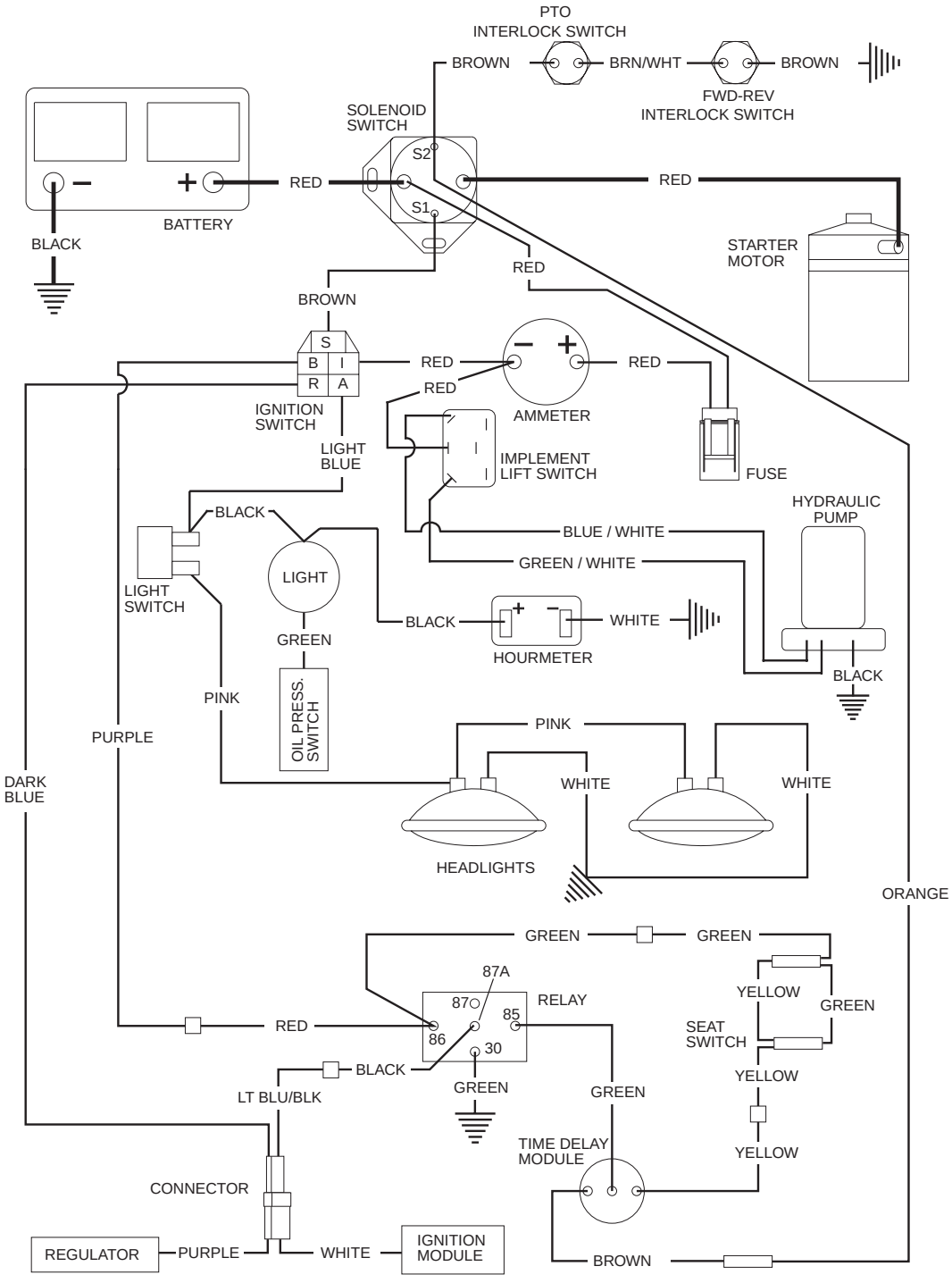
Solenoid
0400



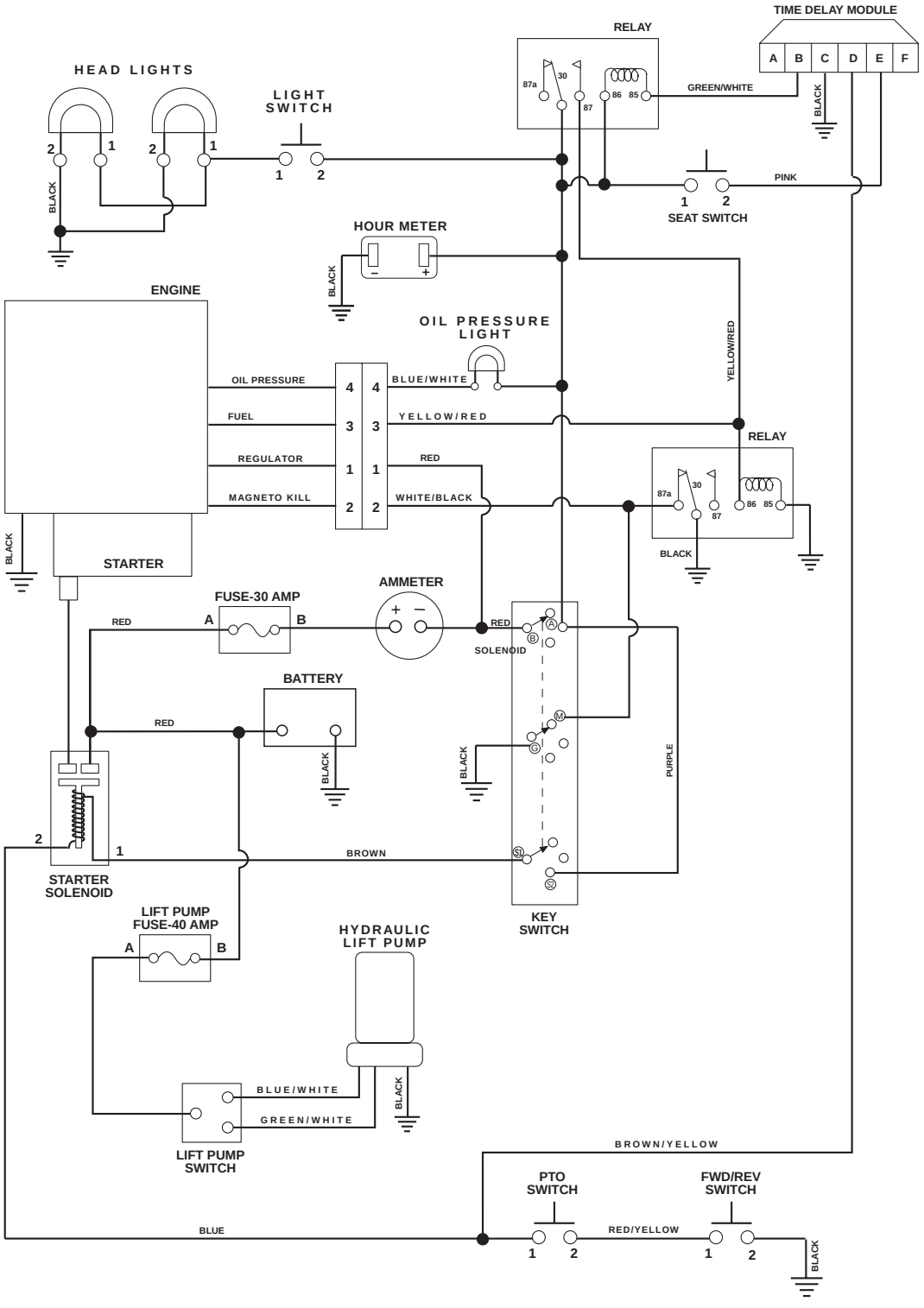
PJ0451

10.11 WIRING DIAGRAMS

Models 987066, 067, 069

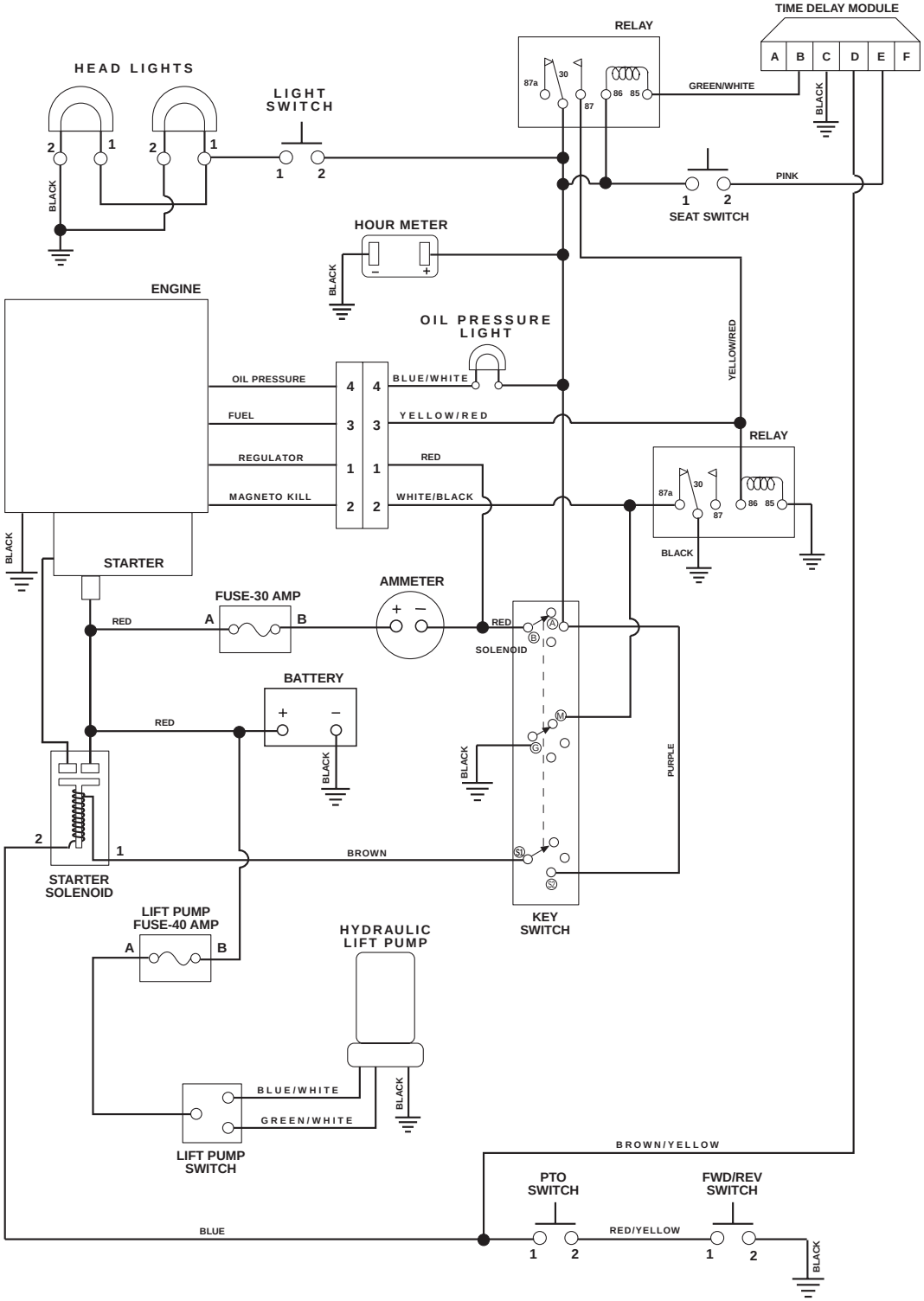


Model 987071 - S/N 000101 and up
Model 987072 - S/N 000101-000214



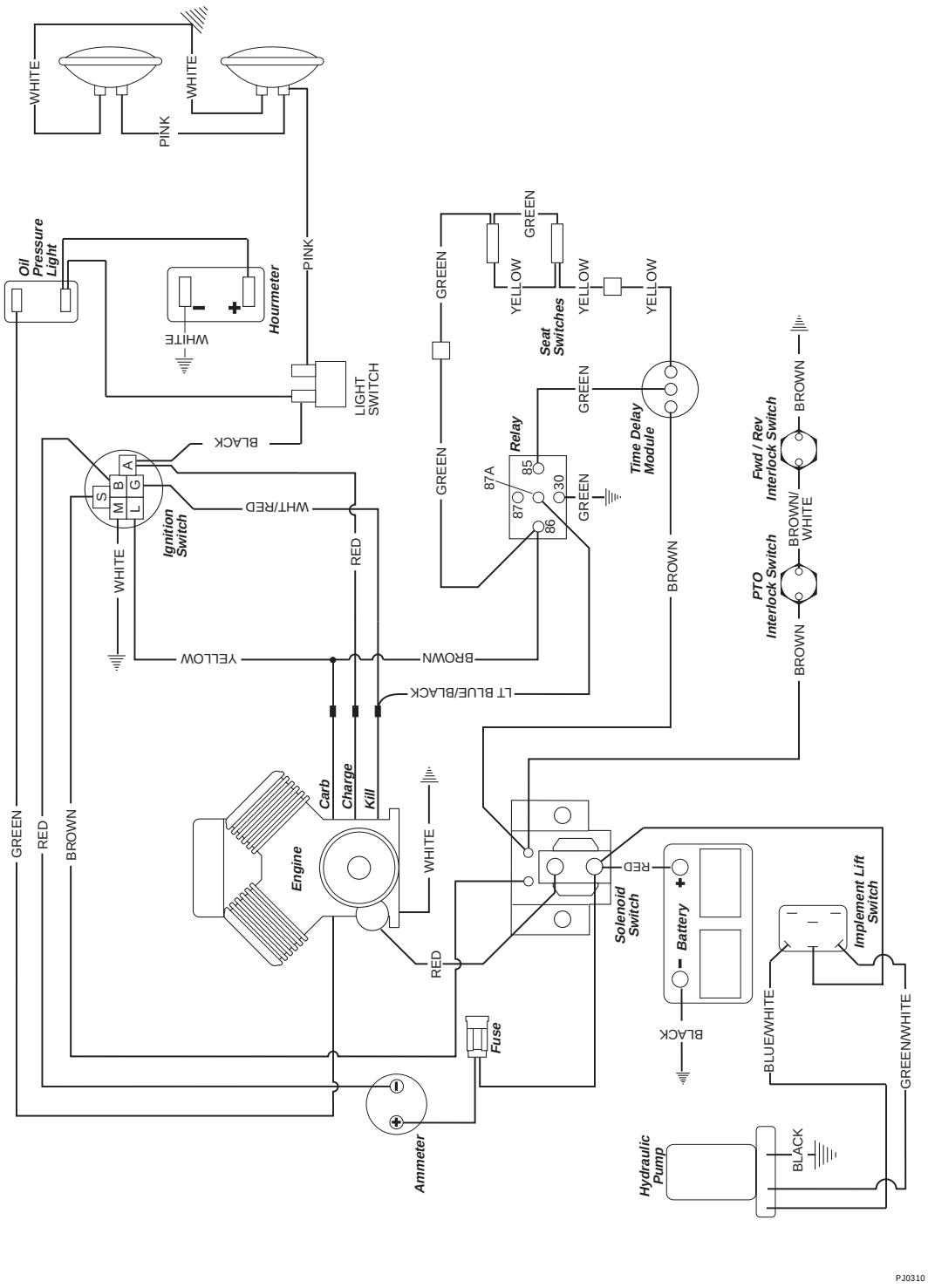
PJ0431

Model 987072 - S/N 000215 and up



PJ0432

Model 987070



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