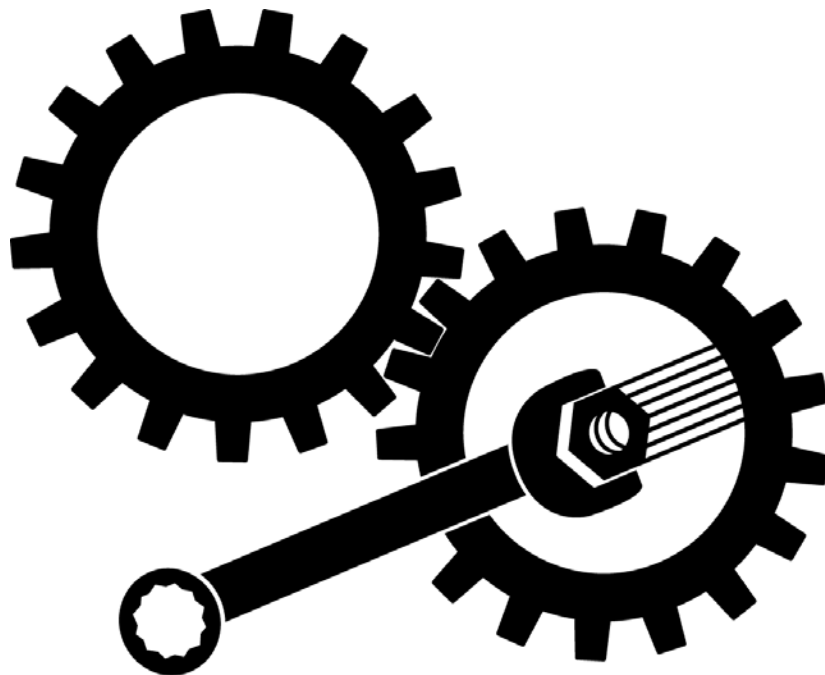




Professional 2-Wheel Tractor

Service Manual

Models 985103, 104, 105, 107 - 115, 117



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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 under the hood of your unit.

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.

Specific Model and Serial Numbers are on a label located on the frame of your Tractor and on a label located on the product registration form. Record those numbers below and transfer the label from the product registration to place indicated below. Use these numbers whenever parts or service is required.

1.4 UNAUTHORIZED REPLACEMENT PARTS

Use only Gravelly replacement parts. The replacement of any part on this vehicle with anything other than a Gravelly authorized replacement part may adversely affect the performance, durability, or safety of this unit and may void the warranty. Gravelly 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

Gravelly 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

Gravelly 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 MAINTENANCE AND STORAGE

Keep the equipment in good condition. Maintain it as directed in this manual. Check all hardware at regular intervals.

Use only Gravely accessories, attachment and replacement parts.

Do not overspeed the engine. Do not override the governor.

Before making any repairs, adjustments inspections or cleaning unit disengage the PTO, turn off and remove the ignition key and wait for all motion to stop.

To reduce fire hazard and overheating, keep equipment free of grass, leaves, debris or excessive lubricants.

Worn out mufflers can result in fire or explosion and should be replaced immediately.

Never store equipment with gasoline in tank inside a building where fumes may reach an open flame or spark. Allow engine to cool before storing in any enclosure.

2.6 SAFETY RULES

Improper use of this tractor can injure people and damage the equipment. People using or servicing this tractor must read and follow the instructions in this manual.

It is important to understand that this manual and any other Gravely instruction manuals do not cover every possible danger. It is impossible for Gravely to know of all possible dangers in operating and servicing the tractor and attachments.

The purchaser must give these instructions to the people operating and maintaining this tractor. These people must use eye and foot protection.

2.7 TRAINING

Read this manual, the attachment manual and the engine manual carefully before operating unit.

Learn the location and function of all controls.

Learn how to use the controls to stop the wheels and attachment quickly in an emergency.

Understand and follow each danger, warning, caution and instruction decal installed on this product.

Never permit children to operate the Two-Wheel Tractor. Do not allow adults to operate it without proper instruction. Safe operation of this equipment requires your complete and unimpaired attention at all times. Do not operate unit after or during the consumption of drugs or alcohol.

Keep all people and animals away from the operating area.

2.8 PREPARATION

Use caution with gasoline. Gasoline is very flammable and its vapors are explosive. Keep it in a clean, tight and approved (Red) container. Never put gasoline in the fuel tank while the engine is running or hot. Clean up spilled gasoline before starting engine. Do not fill fuel tank indoors. Never allow smoking materials, sparks or flame (match, pilot light, etc.) near mower or fuel container. Replace fuel tank cap and fuel container cap securely.

Inspect area of operation and remove all material which could be thrown by the attachment such as stones, sticks, wires and other foreign objects.

When hauling the equipment, connect the chassis to the transporting vehicle. Never connect from control levers, rods, or like items that could be damaged.

Replace all parts that become damaged or lost.

Wear hand, foot, head, ear and eye protection. Do not wear loose clothing, which might get caught in rotating parts of the unit.

Before making adjustments, cleaning, removing obstructions or servicing the tractor or attachment move the PTO to "OFF", turn the ignition switch to "OFF", remove the ignition key and wait until all moving parts completely stop.



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.

2.9 OPERATION

Be certain that all shields, guards, and interlock switches are in the correct position and operating properly.

Before starting the engine, put the PTO lever in the "OFF" position and the gear shift lever in the neutral "N" position.

Check the operation of the operator presence controls before operating the tractor. With either the PTO or the direction control lever engaged, the engine should run

only if at least one of the operator presence switches is depressed.

Do not use the equipment in the dark without adequate lighting.

Keep away from moving parts. Stay clear of the attachment whenever the engine is running.

Do not let people other than the operator near the operating equipment. Never direct disengage the attachment drive when moving the tractor to and from work areas.

Use a slow speed and engage the shift lever slowly when operating on slopes.

Travel across slopes, not up and down. Use extreme caution when changing direction on slopes. Do not operate on steep slopes.

Look for and keep away from hazards, such as dropoffs. Stay alert for holes, rocks and other hidden hazards in the area of operation.

After hitting an object, disengage the PTO, turn off and remove the ignition key and wait for all motion to stop. Check for damage. Repair any damage before restarting unit.

Look behind when operating in reverse. Look for people and hazards.

Operate only from the operator's position, just behind the handlebars.

If there is a sudden change in the sound or vibration of the equipment, disengage the PTO, turn off and remove the ignition key, wait for all motion to stop and check for damage. Repair any damage or failure before restarting unit.

Never run the engine indoors except to move it outside. Exhaust fumes are dangerous.

Go slowly on slick surfaces. Always be sure of your footing, keep a firm grip on the handlebars and walk, never run.

Follow traffic laws when operating on or near a road.

Before leaving the operator's position, put the PTO lever in the "OFF" position, turn off and remove ignition key. Move the shift control to first gear position.

Do not touch parts which might be hot from operation. Before attempting to maintain, adjust or service allow such parts to cool.

SECTION 3 - SPECIFICATIONS

Model Number	985103	985104	985105	985107
Description	8HP Gear Drive	8HP Gear Drive	8HP Gear Drive	12 HP Gear Drive
Brakes	Optional, individual, 7" (17.8 cm) x 1.75" (4.4 cm) drum type			
Steering	Manual, optional power steering kit available			
Turning Radius	Zero (with steering kit)			
Minimum Uncut Circle	Zero	Zero	Zero	Zero
Optional Tire Sizes				
-Stud Tread	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply
-Trac Tread	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply
-Turf-Chief	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply
-Turf-Saver	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply
-Semi-Pneumatic	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply
Tire Pressure	18 psi	18 psi	18 psi	18 psi
Battery	12 volt, BCI group	12 volt, BCI group	12 volt, BCI group	12 volt, BCI group
Engine	Kohler	Kohler	Kohler	Kohler
-Type	K181T	K181T	K181S	M12T (PS471525)
-Horsepower	8HP at 3600 RPM	8HP at 3600 RPM	8HP at 3600 RPM	12HP at 3600 RPM
-Number of Cylinders	One	One	One	One
-Displacement	18 cu. in. (305.4 cc)	18 cu. in. (305.4 cc)	18 cu. in. (305.4 cc)	29 cu. in. (476.5 cc)
-Fuel	Gasoline, 87 minimum octane	Gasoline, 87 minimum octane	Gasoline, 87 minimum octane	Gasoline, 87 minimum octane
-Fuel Capacity	1.25 gals. (4.7 L)	1.25 gals. (4.7 L)	1.25 gals. (4.7 L)	2.0 gals. (4.7 L)
-Cooling	Air	Air	Air	Air
-Air Filter	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner
-Lubrication	Splash System	Splash System	Splash System	Splash System
-Oil Type	See Engine Manual	See Engine Manual	See Engine Manual	See Engine Manual
-Oil Capacity	2.5 pts. (1.2 L)	2.5 pts. (1.2 L)	2.5 pts. (1.2 L)	2.5 pts. (1.2 L)
-Oil Filter	N/A	N/A	N/A	Spin on oil filter
-Charging System	Recoil	Recoil	12 volt, 15 amp	12 volt, 15 amp
Transmission				
-Type	All gear planetary transmission with fully enclosed PTO and immersion clutch			
-Oil Type	SAE 30W API service class SF or higher			
-Oil Capacity	5 qts (4.7 L)	5 qts (4.7 L)	5 qts (4.7 L)	5 qts (4.7 L)
-Cooling	Air	Air	Air	Air
-Number of Speeds	2 forward/2 reverse	4 forward/4 reverse	4 forward/4 reverse	4 forward/4 reverse
Speeds (with 18" tires)				
-Forward	1st - 2.0 mph (3.2 kph) 2nd - 2.5 mph (4.0 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.4 mph (5.5 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	
-Reverse	1st - 1.9 mph (3.1 kph) 2nd - 2.4 mph (3.9 kph)	1st - 1.2 mph (2.0 kph) 2nd - 1.6 mph (2.6 kph) 3rd - 2.4 mph (3.9 kph) 4th - 3.1 mph (5.0 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	
PTO				
-Type	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch
-Drive	All gear shaft driven off high/low planetary			
-Output Speeds	High - 1179 RPM, low - 888 RPM at 3300 engine RPM			
Construction	Cast-iron transmission case with 7-gauge framing			

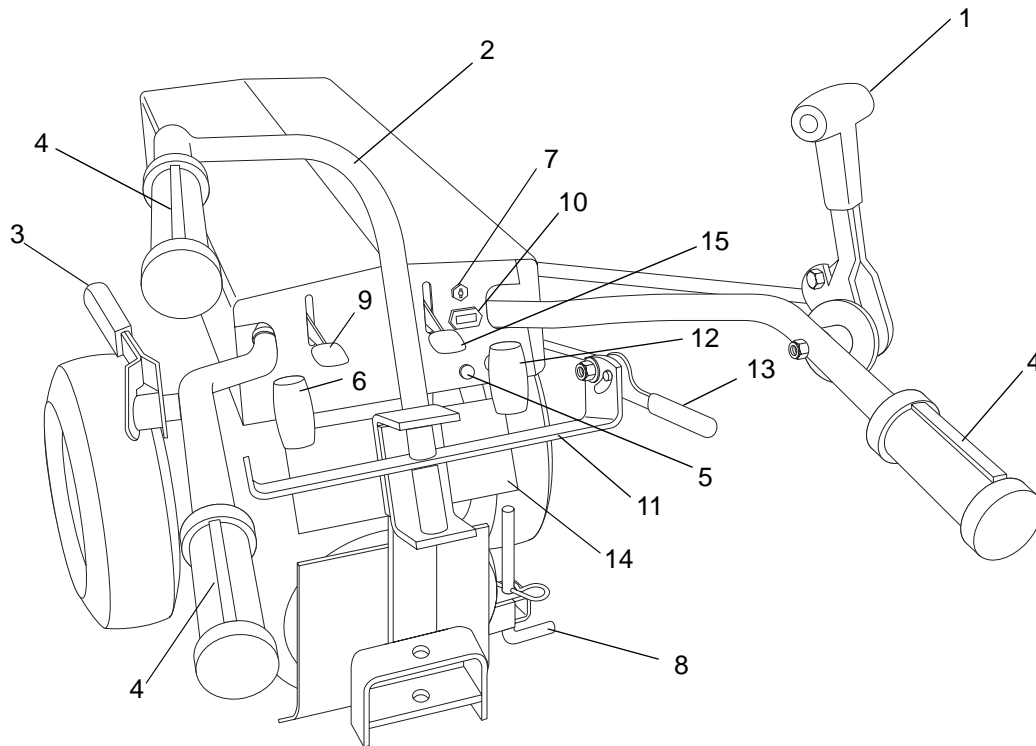
Model Number	985108	985109	985110	985111
Description	12HP Gear Drive	16HP Gear Drive	8HP Gear Drive	8HP Gear Drive
Brakes	Optional, individual, 7" (17.8 cm) x 1.75 (4.4 cm) drum type			
Steering	Manual, optional power steering kit available			
Turning Radius	Zero (with steering kit)			
Minimum Uncut Circle	Zero			
Optional Tire Sizes				
-Stud Tread	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply
-Trac Tread	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply	4" x 8", 4 ply
-Turf-Chief	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply	18" x 6.5" x 8", 4 ply
-Turf-Saver	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply	18" x 8.5" x 8", 4 ply
-Semi-Pneumatic	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply	16" x 5" x 3", 4 ply
Tire Pressure	18 psi	18 psi	18 psi	18 psi
Battery	12 volt, BCI group	12 volt, BCI group	None	12 volt, BCI group
Engine	Kohler	Briggs & Stratton	Kohler	Kohler
-Type	M12S (PS471529)	303447	PS-301058	PS-30159
-Horsepower	12HP at 3600 RPM	16 HP at 3600 RPM	8 HP at 3600 RPM	8 HP at 3600 RPM
-Number of Cylinders	One	Two	One	One
-Displacement	29 cu. in. (477 cc)	29.3 cu. in. (480 cc)	18 cu. in. (305.4 cc)	18 cu. in. (305.4 cc)
-Fuel	Gasoline, 87 minimum octane	Gasoline, 87 minimum octane	See Engine Manual	See Engine Manual
-Fuel Capacity	2.0 gals. (7.5 L)	1.5 gals. (5.7 L)	1.25 gals. (4.7 L)	1.25 gals. (4.7 L)
-Cooling	Air	Air	Air	Air
-Air Filter	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner
-Lubrication	Splash System	Full pressure pump with oil filter	Splash System	Splash System
-Oil Type	See Engine Manual	See Engine Manual	See Engine Manual	See Engine Manual
-Oil Capacity	2.5 pts. (1.2 L)	3.0 pts. (1.4 L)	2.5 pts. (1.2 L)	2.5 pts. (1.2 L)
-Oil Filter	Spin on oil filter	Spin on oil filter	Spin on oil filter	Spin on oil filter
-Charging System	12 volt, 15 amp	12 volt, 16 amp	Recoil	12 volt, 15 amp
Transmission				
-Type	All gear planetary transmission with fully enclosed PTO and immersion clutch			
-Oil Type	SAE 30W API service class SF or higher			
-Oil Capacity	5 qts (4.7 L)	5 qts (4.7 L)	5 qts (4.7 L)	5 qts (4.7 L)
-Cooling	Air	Air	Air	Air
-Number of Speeds	2 forward/2 reverse	4 forward/4 reverse	4 forward/4 reverse	4 forward/4 reverse
Speeds				
-Forward	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)
-Reverse	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)
PTO				
-Type	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch
-Drive	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary
Output Speeds	High - 1179 RPM, low - 888 RPM at 3300 engine RPM			
Construction	Cast-iron transmission case with 7-gauge framing			

Model Number	985112	985113	985114	985115
Description	12 HP Gear Drive	12 HP Gear Drive	16 HP Gear Drive	8.5 HP Gear Drive
Brakes			7 x 1.75" Drum Type	N/A
Steering	Manual, optional power steering kit available			
Turning Radius	Zero (with steering kit)			
Minimum Uncut Circle	Zero			
Optional Tire Sizes				
-Stud Tread	4.00-8	4.00-8	4.00-8	4.00-8
-Trac Tread	4.00-8	4.00-8	4.00-8	4.00-8
-Turf-Chief	18" x 6.50"-8"	18" x 6.50"-8"	18" x 6.50"-8"	18" x 6.50"-8"
-Turf-Saver	18" x 8.50"-8"	18" x 8.50"-8"	18" x 8.50"-8"	18" x 8.50"-8"
-Semi-Pneumatic	N/A	N/A	16" x 5" x 3"	16" x 5" x 3"
Tire Pressure	18 psi (124 Kn/m2)	18 psi (124 Kn/m2)	See Tire Sidewall	See Tire Sidewall
Battery	12V BCI Group	12V BCI Group	12V BCI Group	12V BCI Group
Engine	Kohler	Kohler	Briggs & Stratton	Robin
-Type	PS-471529	PS-471529	303447	EH252-0225T
-Horsepower	12 HP	12 HP	16 HP	8.5 HP
-Number of Cylinders	One	One	Two	One
-Displacement			29.3 cu. in. (480 cc)	15.31 cu. in. (251 cc)
-Fuel	See Engine Manual	See Engine Manual	Auto Gasoline	Auto Gasoline
-Fuel Capacity	2.0 gals. (7.5 L)	2.0 gals. (7.5 L)	1.5 gals. (5.7 L)	1.5 gals. (5.7 L)
-Cooling	Air	Air	Air	Air
-Air Filter	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner	Dual Element with PreCleaner
-Lubrication	Splash Type	Splash Type	Pump w/oil filter	Splash Type
-Oil Type	See Engine Manual	See Engine Manual	See Engine Manual	SAE 20#, 30# 10W-30
-Oil Capacity	2.5 pts. (1.2 L)	2.5 pts. (1.2 L)	3.0 pts. (1.4 L)	2.1 pts. (1.0 L)
-Oil Filter	Spin on oil filter	Spin on oil filter	Spin on oil filter	Spin on oil filter
-Charging System	12 volt, 15 amp	12 volt, 15 amp	12 volt, 16 amp	13 volt, 11.5 amp
Transmission				
-Type	All gear transmission w/fully enclosed PTO and immersion clutch			
-Oil Type	SAE 30W API service class SF or higher			
-Oil Capacity	5 qts. (4.7 L)	5 qts. (4.7 L)	5 qts. (4.7 L)	5 qts. (4.7 L)
-Cooling	Air	Air	Air	Air
-Number of Speeds	4 forward/4 reverse	4 forward/4 reverse	4 forward/4 reverse	4 forward/4 reverse
-Direction Control				
Speeds (with 18" tires)				(with 14" tires)
-Forward	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.4 mph (5.5 kph)
-Reverse	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)
PTO				
-Type	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch	Internal Slip Clutch
-Drive	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary	All gear shaft driven off high/low planetary
-Output Speeds	High - 1179 RPM, low - 888 RPM at 3300 engine RPM			
Construction	Cast-iron transmission case with 7-gauge framing			

Model Number	985117			
Description	13.5 HP Gear Drive			
Brakes	7 x 1.75" Drum Type			
Steering	Manual, optional power steering kit available			
Turning Radius	Zero (with steering kit)			
Minimum Uncut Circle	Zero			
Optional Tire Sizes				
-Stud Tread	4.00"-8"			
-Trac Tread	4.00"-8"			
-Turf-Chief	18" x 6.50"-8"			
-Turf-Saver	18" x 8.50"-8"			
-Semi-Pneumatic	16" x 5" x 3"			
Tire Pressure	See Tire Sidewall			
Battery	12V BCI Group			
Engine	Robin			
-Type	EH410-0226T			
-Horsepower	13.5 HP			
-Number of Cylinders	One			
-Displacement	24.67 cu. in. (440 cc)			
-Fuel	Auto gasoline			
-Fuel Capacity	1.5 gal. (5.7 L)			
-Cooling	Air			
-Air Filter	Dual element			
-Lubrication	Splash Type			
-Oil Type	See Engine Manual			
-Oil Capacity	5 qts. (4.7 L)			
-Oil Filter	Spin on filter			
-Charging System	12 volt, 12.5 amp			
Transmission				
-Type	Gear transmission			
-Oil Type	SAE 30W API service class SF or higher			
-Oil Capacity	5 qts. (4.7 L)			
-Cooling	Air			
-Number of Speeds	4 forward/4 reverse			
-Direction Control				
Speeds (with 18" tires)				
-Forward	1st - 1.4 mph (2.3 kph) 2nd - 1.8 mph (2.9 kph) 3rd - 2.7 mph (4.4 kph) 4th - 3.7 mph (6.0 kph)			
-Reverse	1st - 1.3 mph (2.1 kph) 2nd - 1.7 mph (2.7 kph) 3rd - 2.6 mph (4.2 kph) 4th - 3.3 mph (5.3 kph)			
PTO				
-Type	Internal Slip Clutch			
-Drive	All gear shaft driven off high/low planetary			
-Output Speeds	High - 1179 RPM, Low - 888 RPM at 3300 engine RPM			
Construction	Cast-iron transmission case with 7-gauge framing			

SECTION 4 - GENERAL MAINTENANCE & ADJUSTMENTS

4.1 CONTROLS AND FEATURES



OH0160

- | | |
|---|--|
| 1. Direction Control Lever | 8. Kick Stand |
| 2. Steering Brake Handlebar (Optional) | 9. Throttle Control |
| 3. Gear Shift Lever (Hi/Low Gear) | 10. Hour meter |
| 4. Operator Presence Control | 11. Brake Handle Cross Bar |
| 5. Choke Control Knob (Models with Briggs & Stratton Engines) | 12. Range Shift Handle (Two Speed Axle) |
| 6. PTO Control | 13. Parking Brake Handle (Optional on 8.5 HP) |
| 7. Ignition Switch | 14. Instruction Plate |
| | 15. Choke Lever (Models with Robin Engines) |
| | 16. Choke Control Knob (Models with Briggs & Stratton) |

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 or heat. Never put fuel in the fuel tank while the engine is running or hot. Clean up any spilled fuel before starting engine.

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

Put the unit in an open area. Stop the engine and lock the brake. Clean the fuel cap and the area around the fuel cap to prevent dirt from entering the fuel tank. Remove the cap from the fuel tank. Fill the fuel tank. Be careful not to spill the fuel. Install the cap on the fuel tank and tighten. Clean up any spilled fuel before starting the engine.

4.3 GENERAL LUBRICATION

Control Linkage Lubrication

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.

NOTE: There are no grease fittings on the tractor.

Transmission

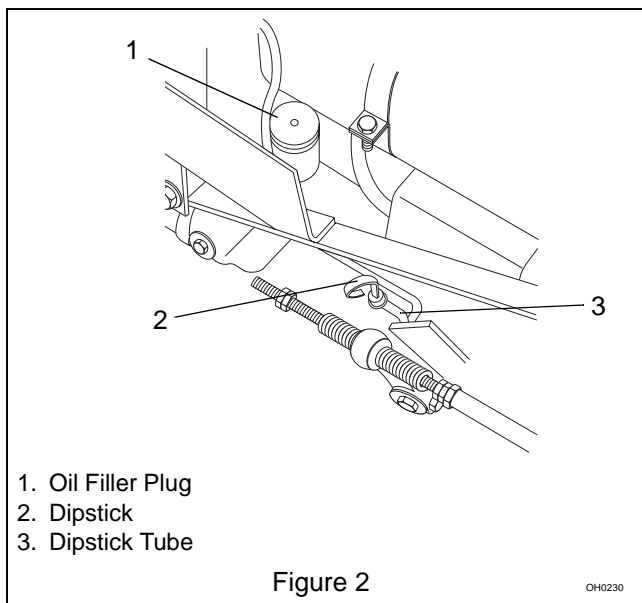
Capacity: 5 U.S. Quarts (4.7 liters)

Grade: SAE 30W API service class SF or higher

Viscosity: Summer: SAE 30W or SAE 10W-30

Winter: (32°F or below) SAE 10W or SAE 10W-30

- After every 100 hours of operation, check the level of the lubricant in the transmission. Never operate the tractor when the transmission oil level is below the "LOW" mark on the dipstick.
- Stop the engine and raise the hood. Make sure that the tractor is level. Clean the dipstick tube and the dipstick (Figure 2). Remove the dipstick, wipe it with a clean cloth or towel and put it back in the tube. Pull the dipstick out again and look at the oil.
- If the oil level is below the low mark on the dipstick, clean the area around the filler plug and remove the filler plug. Add new clean lubricant until the dipstick indicates that the oil level is correct. See specification. Install the filler plug and dipstick.



CAUTION: Before performing any service or adjustments:

- Turn PTO switch "OFF".
- Park mower on a hard, flat, level surface.
- Place steering control levers in neutral lock (fully outward) position.
- Set parking brake.
- Turn ignition switch "OFF" and remove key.
- Wait for all moving parts to stop.

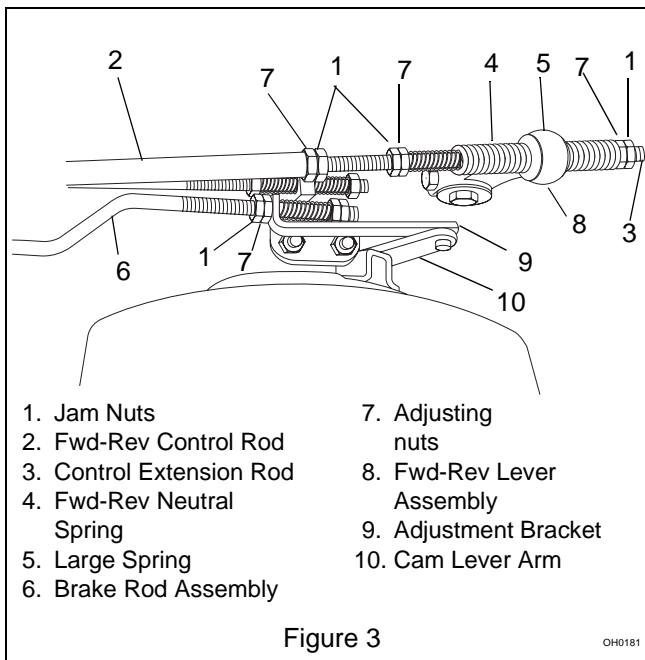
4.4 FORWARD-REVERSE CLUTCH ADJUSTMENT

- After 25 hours of operation, check the adjustment of the forward-reverse clutch.



WARNING: Stop the engine before adjusting the forward-reverse clutch.

- The reverse clutch is adjusted correctly when the direction control lever stops 15 degrees past vertical to the rear. The lever should return to neutral position from reverse when adjusted correctly.
- To adjust the reverse clutch, loosen the control extension rod jam nuts on the end of the fwd-rev control rod. Adjust the rear nut so that the direction control lever stops 15 degrees past vertical to the rear. Hold the rear nut and jam with the forward nut (Figure 3).
- The forward clutch is adjusted correctly when the direction control lever is in the full forward position and the large spring has a coil clearance of .010" (.254 mm).



- To adjust the forward clutch, put the direction control in the forward position. Loosen the control extension rod rear set of jam nuts on the fwd-rev control rod. Adjust the forward nut until the large spring coils are .010" (.254mm) apart. Hold the forward nut and jam with the rear nut.

4.5 HI/LOW GEAR CLUTCH ADJUSTMENT

- After every 25 hours of operation, check the adjustment of the gear clutch.



WARNING: Stop the engine before adjusting the gear clutch.

- The clutch is adjusted correctly when the gear shift lever is in the "HIGH" or "LOW" position and the spring coils are .010" (.254 mm) apart.
- To adjust the "HIGH" clutch, loosen and separate the hi-low control rod jam nuts on the rear of the control extension rod. Put the gear shift lever in the "HIGH" position. Adjust the nut (front) near the spring until the spring coils are .010" (.254 mm) apart. Move the gear shift lever to the "NEUTRAL" position. Hold the nut adjusted to the spring and jam with the other (rear) nut (Figure 4).
- To adjust the "LOW" clutch, loosen and separate the hi-lo control rod jam nuts on the end of the control extension rod. Put the gear shift lever in the "LOW" position. Adjust the nut (rear) near the spring until the spring coils are 0.10" (.254 mm) apart. Move the gear shift lever to the "NEUTRAL" position. Hold the nut adjusted to the spring and jam with the other (front) nut.

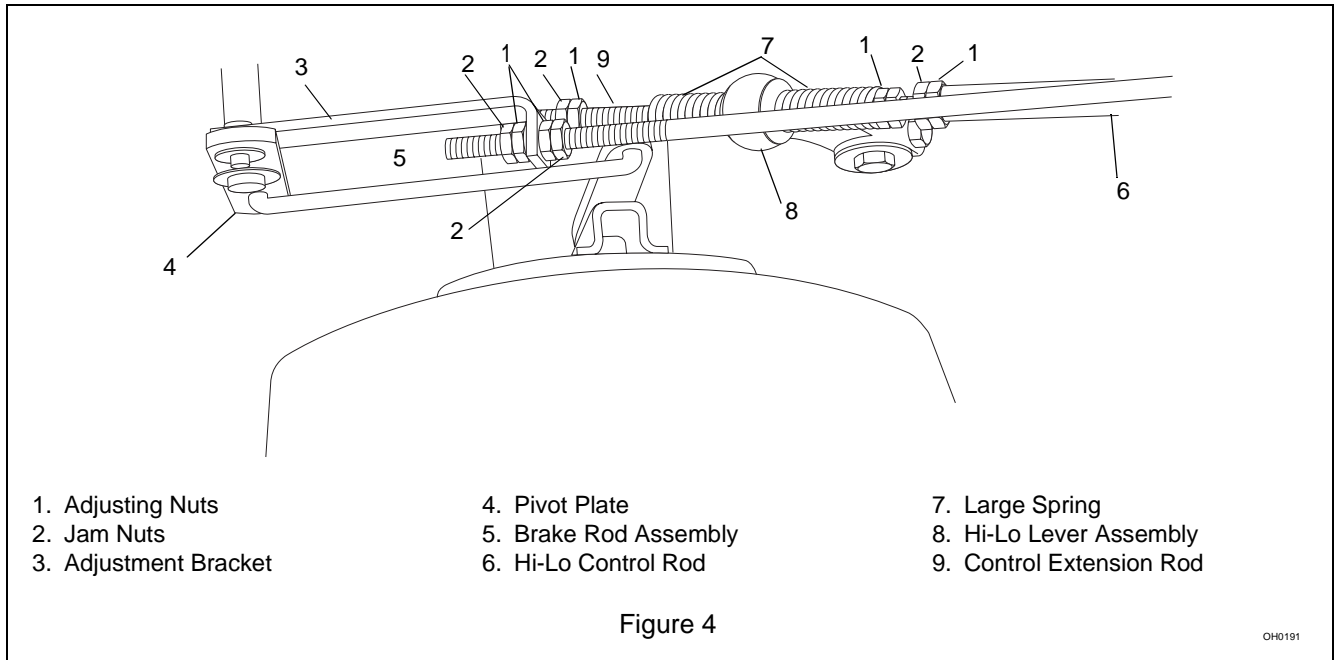
4.6 STEERING BRAKE ADJUSTMENT (APPLICABLE MODELS)

- Park the unit in a level area. Put the parking brake handle in the "OFF" (down) position. Loosen the jam nuts on the right and left brake rod assemblies (Figures 2 & 3). Turn the adjusting nuts until the brake handle cross bar is parallel with the instrument panel (Figure 1).
- Move the brake handlebar all the way to the right and measure the distance from the right end edge of the brake handle cross bar to the right side of the instrument panel. Move the brake handlebar all the way to the left and make the same measurement on the left.
- Adjust the nuts until the difference between the two measurements is 1/2" to 3/4" (13 to 19 mm). Turn both adjusting nuts the same amount, clockwise to increase the measurement difference or counterclockwise to decrease the measurement difference. Tighten the jam nuts.
- Loosen the jam nuts below the compression spring (Figure 4) on the right side of the tractor and adjust until one has the desired tension for the right brake. Tighten the jam nuts.

IMPORTANT: Replace brake shoes before lining is worn to rivet heads.

If correct braking action cannot be achieved after performing the above procedures, do the following:

- Loosen the 5/16-24 nut and bolt which fastens cam lever arm to brake cam.
- Remove cam lever arm from the brake cam. Rotate the cam lever arm one spine to the rear and put back on brake cam. Tighten nut and bolt.



4.7 PTO BRAKE ADJUSTMENT

- Adjust the PTO brake after every 100 hours of operation.

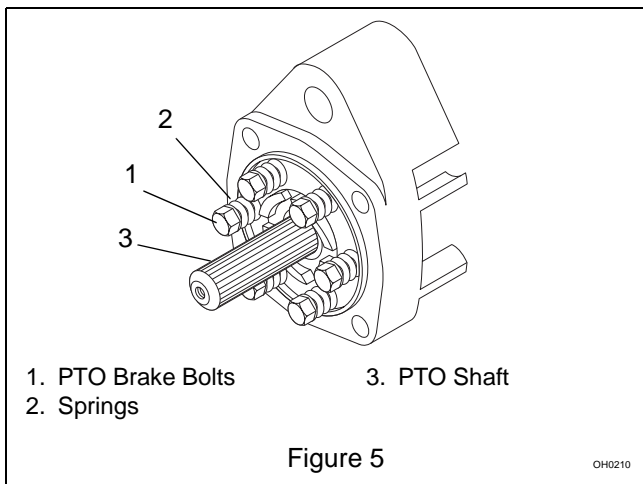


WARNING: Stop the engine before adjusting the PTO brake.

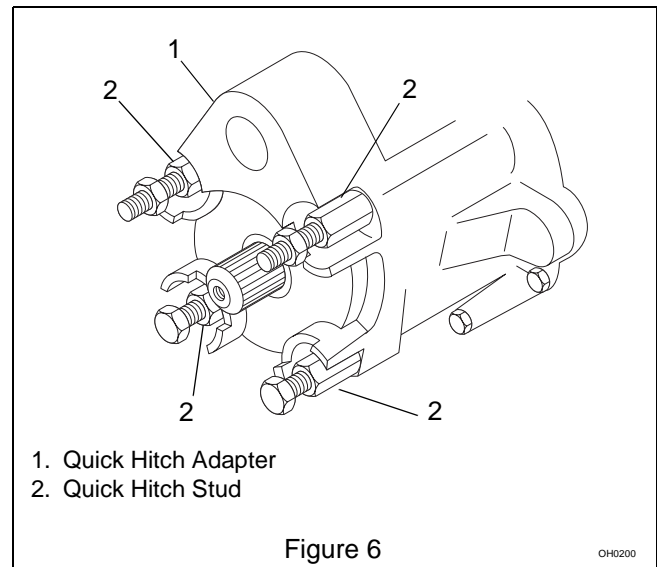
- Remove the attachment and lower the rear of the tractor to the ground. Carefully clean the front of the transmission. Remove the quick hitch studs from the transmission and remove the quick hitch casting and PTO brake assembly (Figure 5).

NOTE: The attachment gasket must be replaced if damaged.

- Tighten all PTO brake bolts until the springs are solid. Back all bolts up 1/2 turn (Figure 5).



NOTE: Do not tighten the bolts in a circular sequence, by tightening the bolt next to one which was just tightened. The bolts should be tightened in a cross sequence, by tightening one bolt, then tightening the bolt which is across from it on the plate. Continue tightening the bolts in this sequence until all the bolts are tightened.



- Make sure the trunnion block is on the shipper shaft and held in place by the dog. The dog should rest on the spiral teeth of the clutch dog plate. Install the gasket.
- Align the splines on the quick hitch shaft with those in the dog. Slide the quick hitch casting and PTO brake assembly back into the place on the front of the transmission. Install the quick hitch studs and tighten.

4.8 SLIP CLUTCH ADJUSTMENT

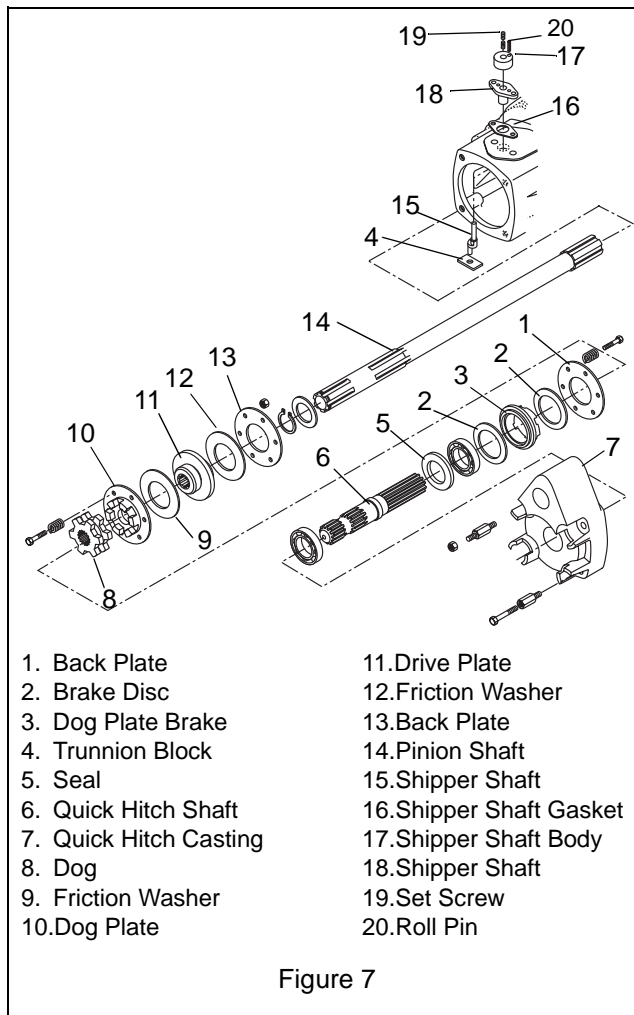
- Adjust the slip clutch after every 100 hours of operation.



WARNING: Stop the engine before adjusting the slip clutch.

- Remove the attachment and lower the rear of the tractor to the ground. Carefully clean the front of the transmission. Remove the quick hitch studs from the transmission and remove the quick hitch PTO assembly and PTO brake assembly (Figures 5 & 6).

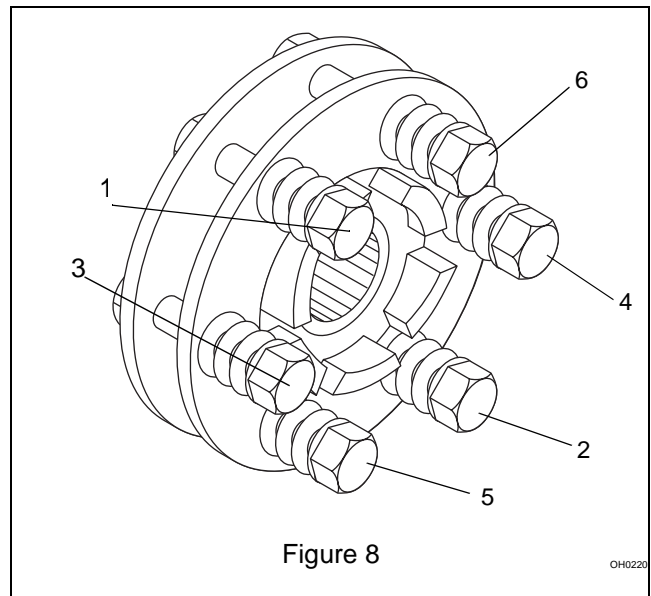
NOTE: The attachment gasket must be replaced if damaged.



- Remove the dog and trunnion block. Disconnect the wiring harness from the PTO brake interlock switch and remove the shifter parts. Slide the shipper shaft assembly through the top of the advance casting. Slide the clutch assembly and pinion shaft out of the transmission. Remove the retaining ring and slide the clutch assembly off of the pinion shaft. Turn all of the jam nuts counterclockwise to loosen.

- Torque bolts in stages using the pattern shown in Figure 8:

- Tighten bolts down until the spring starts to compress.
- Tighten bolts to 80-85 in-lbs (9-9.6 Nm).
- Tighten nuts to 165-170 in-lbs (18.6-19.2 Nm).
- Finish tightening the nuts to 100-150 ft-lbs (136-203 Nm).



NOTE: Do not tighten the bolts in a circular sequence, that is, by tightening the bolt next to one which was just tightened. The bolts should be tightened in a cross sequence, that is, by tightening one bolt, then tightening the bolt which is across from it on the plate. Continue tightening the bolts in this sequence until all the bolts are tightened. (Figure 8)

- Slide the clutch assembly back onto the pinion shaft, install the retaining ring and slide the pinion shaft completely into the transmission. Install the shipper shaft and other parts that were removed previously. Make sure the trunnion block is on the shipper shaft and held in place by the dog. The dog should rest on the spiral teeth of the clutch dog plate. Install the gasket. Align the splines on the quick hitch shaft with those in the dog. Slide the quick hitch casting and PTO brake assembly back into place on the front of the transmission. Install the quick hitch studs and tighten.

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	repair or replace
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 daily prior to use.

IMPORTANT: Never operate the engine with the oil below the low mark on the dipstick.

See the engine manual for oil specifications and oil filter service instructions.

To check oil level:

1. Move the unit to level location.
2. Clean around the dipstick and filler tube to prevent dirt from entering the engine.
3. Remove the dipstick and wipe off the oil on the depth stick.
4. Put the dipstick back into the engine, and remove again.
5. When the dipstick is removed, note the oil level. Oil should be between the full and add mark.
6. Replace dipstick.
7. If required, add 5W30 below 40° or 30W above 40°. Do not overfill.
8. Clean up any spillage that may have occurred.

5.3 CHANGING OIL



WARNING: Do NOT touch parts which are hot. Allow parts to cool before servicing.

Engine muffler and other parts will be hot if unit has been running.

1. Engine oil should be changed after the first five hours of operation and every 25 hours there after.
2. Move the unit to a level, well ventilated area and set the parking brake.
3. If the engine is cold, let the unit run for five minutes.
4. When the engine is warm, stop the engine.
5. Clean the area around the dipstick and drain.
6. Put an open container that will hold one gallon of oil under the drain.
7. Open the drain.
8. Allow the engine oil to drain completely into the one gallon container. Remove container and contents for future recycling as required.
9. Close the oil drain.
10. If used; remove the oil filter.
11. Clean the oil filter port and install a new oil filter according to the instructions on the oil filter. Fill with new oil to the "full" mark on the dipstick.
12. Start and run the engine for one minute. Stop the engine and recheck the oil level and add as necessary.

13. Check for leakage at the drain plug and oil filter if used. Tighten the fittings as necessary if leakage occurs.

14. Release the parking brake.

15. Return the unit into service.

5.4 AIR CLEANER

Dry type air cleaner elements should be replaced after 100 to 200 hours if engine is normally operated under good clean air conditions. Service and replace element more frequently under dusty or dirty conditions.

To clean the element remove and tap lightly on a flat surface to remove loose surface dirt. Replace element if dirt does not drop off easily. Do not wash or dry elements in any liquid or attempt to blow dirt off with air hose as this will puncture the filter element.

Carefully handle new element. Do not use if gasket surfaces are bent or twisted. Check the following when installing new element (Figure 9).

1. Back plate must be securely tightened to carburetor. Replace back plate if bent or cracked.
2. Gasket surfaces of element must be flat against back plate and cover to seal effectively.
3. Washer must be in place between cover and wing nut to seal and prevent unfiltered air from entering through hole in cover. If washer is not used, make sure wing nut (special) properly seals area around cover hole.
4. Wing nut must be finger tight.

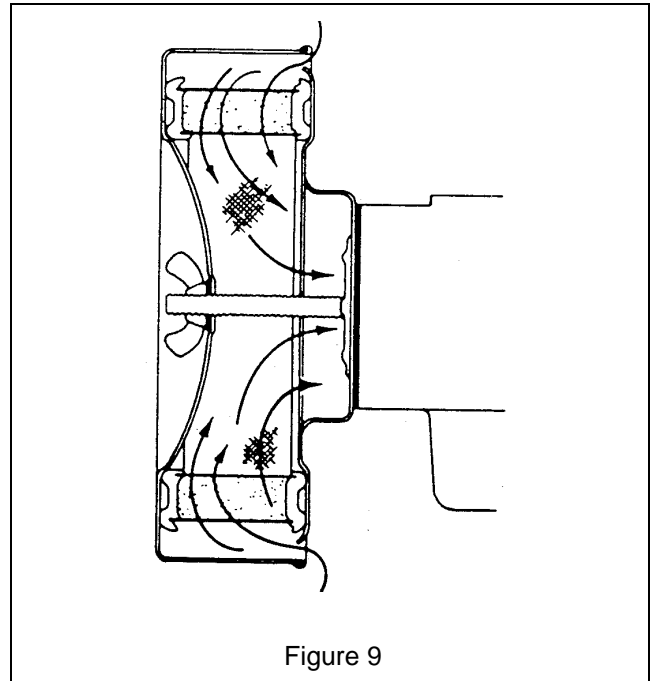


Figure 9

5.5 ENGINE REMOVAL AND INSTALLATION

1. Remove ground cable from battery.
2. Drain Transmission oil.
3. Turn off fuel at fuel tank. Remove fuel line from fuel pump.
4. Remove the choke cable from carburetor.
5. Remove the throttle cable from the linkage.
6. Separate wiring harness at connector
7. Remove cable from starter motor.
8. Remove rear hitch from tractor.
9. Remove 2 lower bolts securing engine to the chassis casting.
10. Remove the 2 upper bolts from the engine but leave in place the casting to support the braces.
11. Remove engine from tractor.

Install engine in reverse order.

5.6 ENGINE MAINTENANCE

See the engine manual for maintenance instructions. Check the air cleaner and engine oil daily. Check the cooling system every 25 hours. Clean all of the grass and other material from the cooling fins and intake screen of the engine. If necessary, remove the engine shrouds to clean the engine. See the engine manual for the type of oil, oil change, etc. Never operate the engine when the oil level is below the low mark on the dipstick. See the engine manual for air cleaner maintenance instructions.

5.7 ENGINE STORAGE

If engine is to be out of service for a considerable length of time, the following steps are recommended:

1. Drain oil from crankcase while engine is still hot and flush with clean, light oil. Refill crankcase.
2. Drain fuel tank and carburetor.
3. Clean exterior of engine.
4. Spread a light film of oil over any exposed surfaces of engine subject to corrosion.
5. Pour tablespoon of oil into spark plug hole, crank engine slowly by hand and replace spark plug.
6. Store in dry place.

SECTION 6 - STEERING & CONTROLS

6.1 HANDLEBAR ASSEMBLY



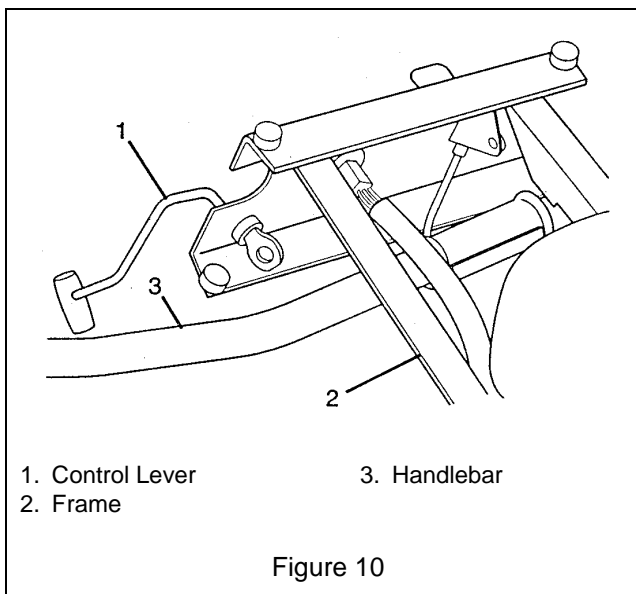
CAUTION: Before performing any service or adjustments:

- Turn PTO switch "OFF".
- Park mower on a hard, flat, level surface.
- Place steering control levers in neutral lock (fully outward) position.
- Set parking brake.
- Turn ignition switch "OFF" and remove key.
- Wait for blades and all moving parts to stop.
- Disconnect spark plug wire(s) from spark plug(s) and place wire(s) away from plug.



WARNING: MOVING PARTS can cut or amputate body parts. ALWAYS wait for moving parts to stop before unit maintenance or service.

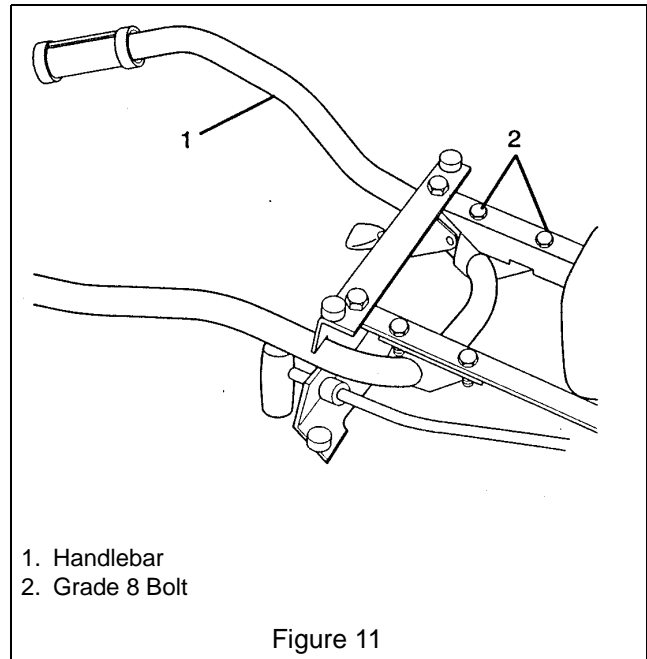
1. On Swiftamatic tractors, disconnect the cotter pin that holds the Swiftamatic control lever to the shifter weldment. Disconnect the extension spring from the control lever and slide the control lever rearward until it stops against the instrument panel. See Figure 10.



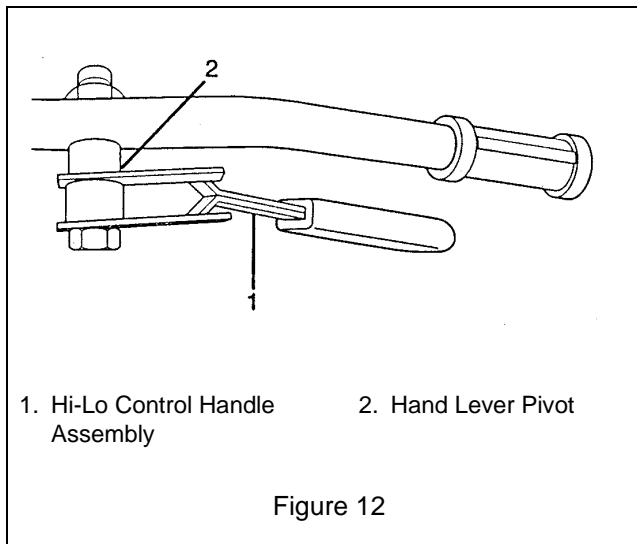
2. Position the handlebar right side up. Move the left handle of the handlebar under the right side of the frame and the wiring harness. Proceed across the

engine and out between the left side of the frame and the PTO control. Rotate the handlebar into the mounting position.

3. Retain the handlebar in position with four 3/8-16 x 1.25 Grade 8 bolts and lock nuts. The Grade 8 bolt has six marks on the head. See Figure 11.



4. Reassemble the Swiftamatic control lever linkage and connect the wiring harness.
5. Mount the Hi-Lo gear control handle assembly and hand lever pivot to the left handle with a 1/2-13 x 3.50 bolt and 1/2-13 thin lock nut. See Figure 12.



6.2 STEERING BRAKES (OPTIONAL)

The steering brake is designed to stop one wheel from rotating. The opposite wheel continues to drive forward and the unit pivots on the stopped wheel.

Connect the adjustment bracket to the cam lever arm with a clevis pin.

1. Park the tractor in a level area. Put the parking brake handle in the "OFF" (down) position. Loosen the jam nuts on the right and left brake rod assemblies. Turn the adjusting nuts until the brake handle cross bar is parallel with the instrument panel.
2. Move the brake handlebar all the way to the right and measure the distance from the right end edge of the brake handle cross bar to the right side of the instrument panel. Move the brake handlebar all the way to the left and make the same measurement on the right.
3. Adjust the nuts until the difference between the two measurements is 1/2" to 3/4" (13 to 19 mm). Turn both adjusting nuts the same amount, clockwise to increase the measurement difference or counterclockwise to decrease the measurement difference.
4. Tighten the jam nuts. Loosen the jam nuts below the compression spring on the right side of the tractor and adjust until one has the desired tension for the right brake. Tighten the jam nuts.

6.3 ADJUSTING BRAKES

After each use wash dirt from the brakes with water. Each day before operating, check all nuts, bolts, and other fasteners. Replace missing or damaged pieces.

Brake service is required if the brakes do not stop and hold the unit effectively.

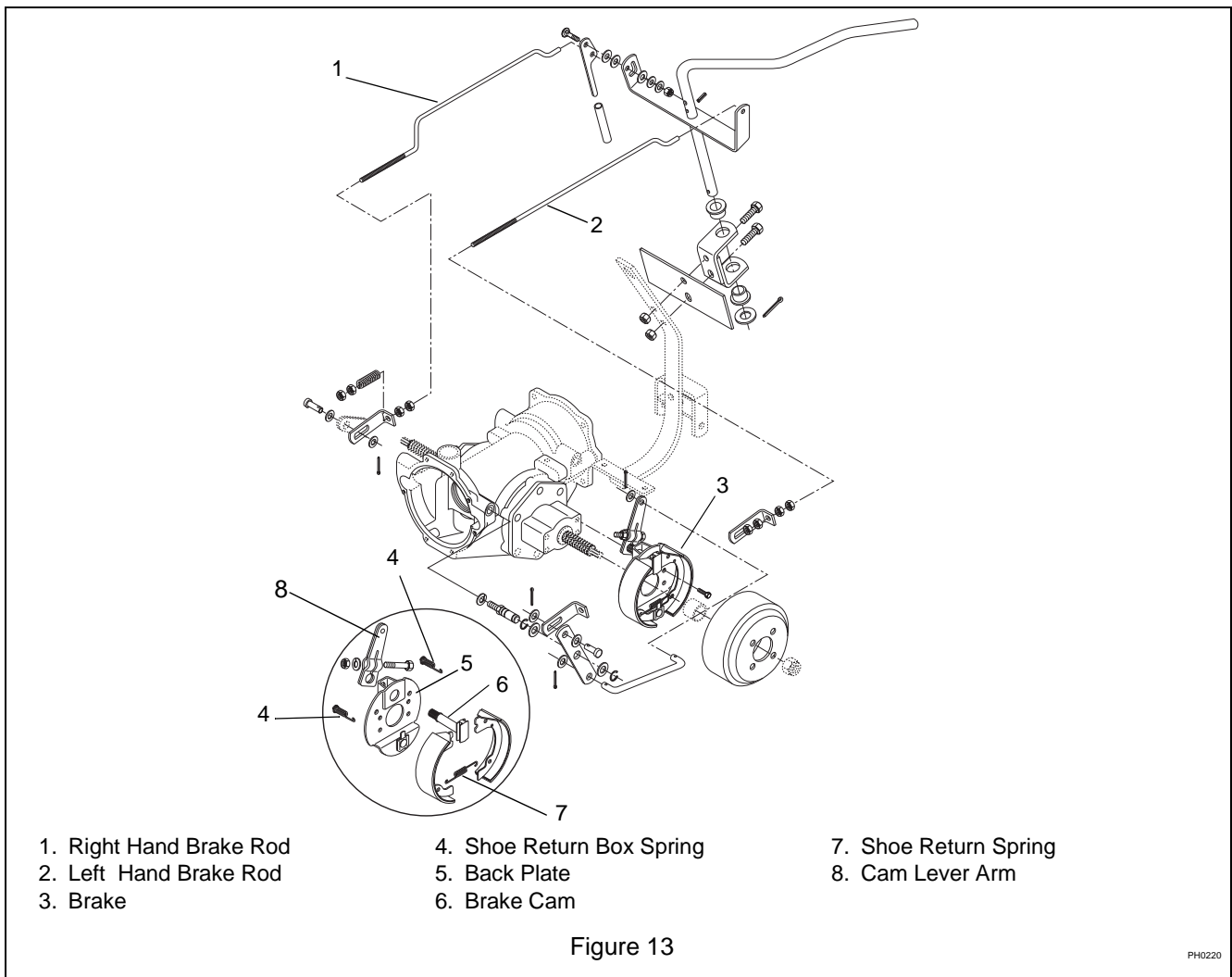
Adjust the brake linkage as follows:

1. Stop the unit on a level surface.
2. Stop the engine and block the wheels so the unit cannot roll.
3. Remove wheels and brake drums.
4. Inspect brakes and drum.
5. Loosen the jam nuts at the ends of right and left brake rods or whichever side needs adjusting.
6. Turn bottom nuts a couple of turns clockwise to shorten travel a bit.
7. Tighten all jam nuts.
8. Carefully test the operation of the wheel brakes. If necessary, repeat the above procedures to get the correct brake action.

IMPORTANT: Replace brake shoes before lining is worn to rivet heads.

If correct braking action cannot be achieved after performing the above procedure, do the following:

9. Loosen the 5/16-24 nut and bolt which fastens the cam lever arm to brake cam.
10. Remove cam lever arm from the brake cam. Rotate the cam lever arm one spine to the rear and put back on brake cam. Tighten nut and bolt.



Fasten the instruction plate and the brake handle brackets to the rear hitch with the 1/2-13 x 2.00 bolts and 1/2" lock nuts.

Right Side Installation:

1. Raise and block the right side of the tractor.
2. Unbolt the tire assembly from the wheel hub and remove.
3. Remove the axle nut, flat washer and spacer. Remove the wheel hub set screw.
4. Use a puller and remove the wheel hub.
5. Remove the four bolts that retain the end plate to the axle housing.

NOTE: Do not remove the end plate.

6. Slide the brake assembly over the axle. Rotate until the holes in the back plate align with the holes in the end plate and axle housing (cam lever arm at 2 o'clock position). Retain with four 3/8-16 x 7/8" bolts. If necessary, turn the bolt in the cam lever arm to where the lock washer and nut face away from the axle housing.

7. Slide the brake handle onto the rear of the right hand brake rod assembly and insert the rod into the slot of the brake handlebar weldment. Place the carriage bolt through the brake handle, and put two nylon washers on the bolt between the handle and the handlebar weldment. Push the bolt through the handlebar weldment and retain with another nylon washer, rubber washer, steel washer, and lock nut. Connect the adjustment bracket to the cam lever arm with a clevis pin, two .406 x .812 x .065 flat washers and a .09 x .75 cotter pin.

8. Put both spacers on the axle.

NOTE: The short spacer is used with the wheel hub for the 8.50 x 8 tire assembly.

9. Replace the set screw in the wheel hub with a 7/16-14 x 3/4 set screw.

10. Mount the brake drum to the wheel hub with four 1/2-13 x 1-3/8" bolts and 1/2-13 lock nuts. Four 1/2-13 x 1-5/8" bolts are required when the wheel hub for the 8.50 x 8 tire assembly is used.

NOTE: The valve stem is turned to the outside, and the 1/2-13 lock nuts should be on the outside.

11. Put a film of grease on the axle splines. Slide the wheel hub on the axle followed by a flat washer and lock nut. Tighten the nut to a torque of 80 ft.-lb. (108 Nm). Tighten the set screw.
12. Mount the tire assembly to the wheel hub.

Left Side Installation:

1. Raise and block the left side of the tractor.
2. Unbolt the tire assembly from the wheel hub and remove.
3. Remove the axle nut, flat washer and spacer. Remove the wheel hub set screw.
4. Use a puller and remove the wheel hub.
5. Remove the four bolts that retain the end plate to the axle housing.

NOTE: Do not remove the end plate.

6. Slide the brake assembly over the axle. Rotate until the holes in the end plate align with the holes in the axle housing (cam lever arm at the 12 o'clock position). Retain with four 3/8-16 x 7/8" bolts.
7. Remove the bolt which attaches the left handlebar support to the advance casting. Install the pivot stud in the same location. See Figure 14.

.065" flat washer and a .09" x .75" cotter pin at each end.

10. Slide the rear of the left hand brake rod assembly into the left end of the handlebar weldment from the front. Connect the adjustment bracket to the pivot plate with a .375" x .75" clevis pin, two .406" x .812" x .065" flat washers, and a .09" x .75" cotter pin.

11. Put both spacers on the axle.

NOTE: The short spacer only is used with the wheel hub for the 8.50 x 8 tire assembly.

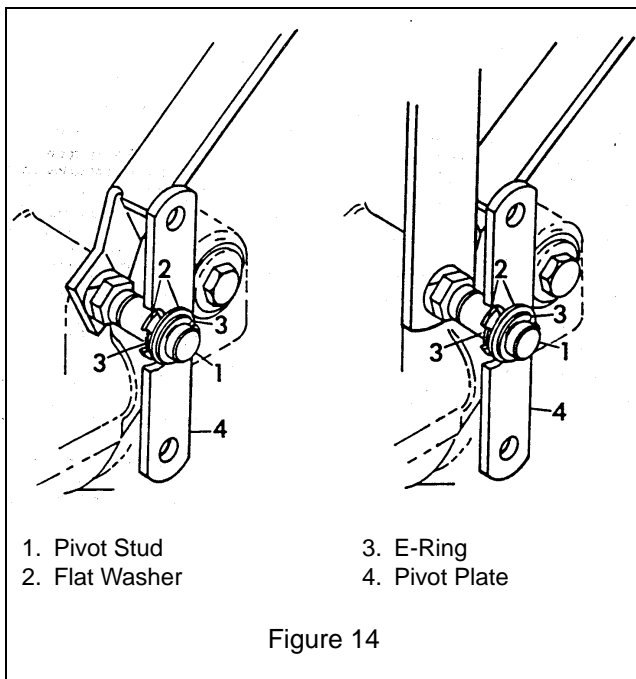
12. Replace the set screw in the wheel hub with a 7/16-14 x 3/4" set screw.

13. Mount the brake drum to the wheel hub with four 1/2-13 x 1-3/8" bolts and 1/2-13 lock nuts. Four 1/2-13 x 1-5/8" bolts are required when the wheel hub for the 8.50 x 8 tire assembly is used.

NOTE: The valve stem is turned to the outside, and the 1/2-13 lock nuts should be on the outside.

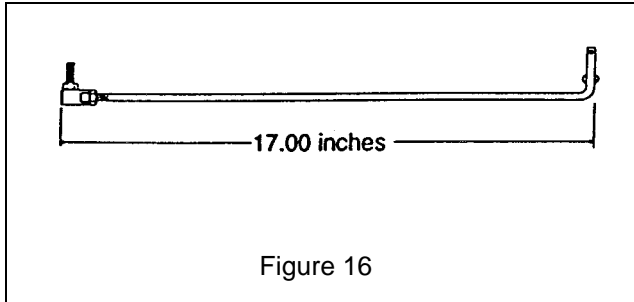
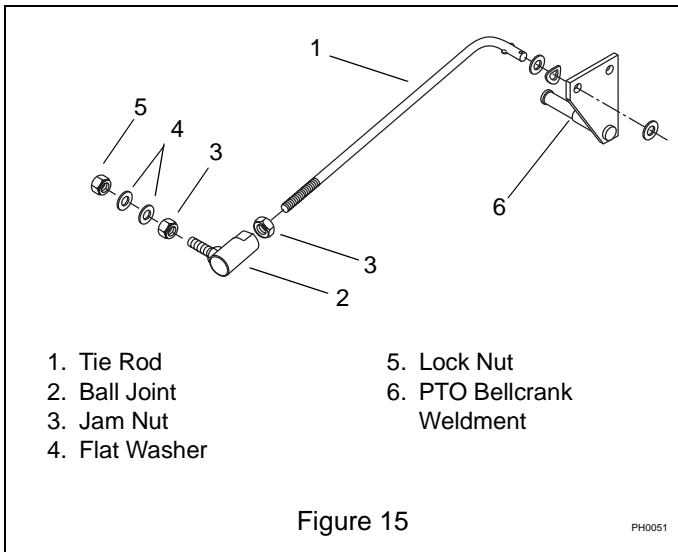
14. Put a film of grease on the axle splines. Slide the wheel hub on the axle followed by a flat washer and lock nut. Tighten the nut to a torque of 80 ft.-lb. (108 Nm). Tighten the set screw

15. Mount the tire assembly to the wheel hub.



8. Place the following on the pivot stud:
 - E-Ring
 - .656" x 1.312" x .095" Flat Washer
 - Pivot Plate
 - .656" x 1.312" x .095" Flat Washer
 - E-Ring
9. Connect the brake link rod to the pivot plate and the cam lever arm. Retain with a .406" x .812" x

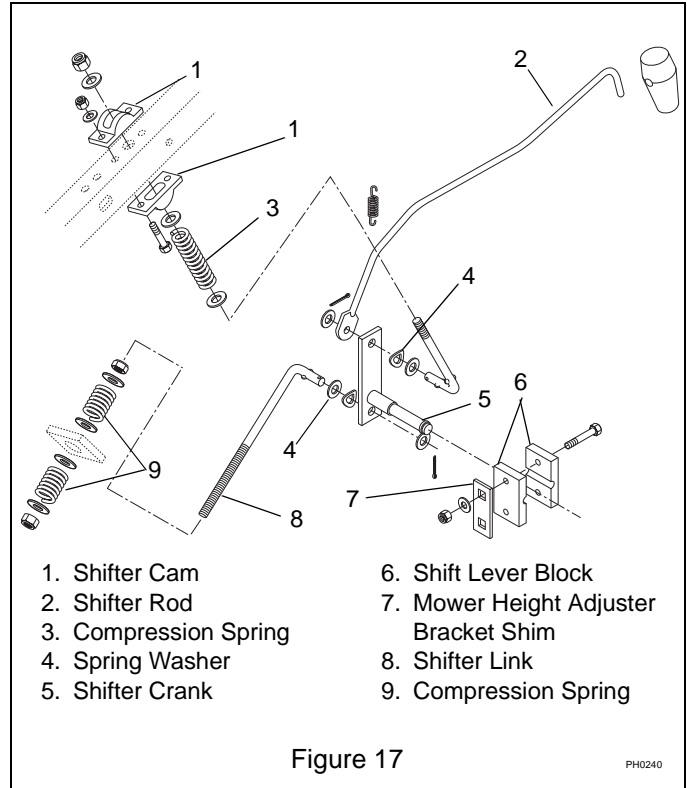
6.4 POWER TAKE OFF CONTROL



1. Thread jam nut onto PTO shaft (supplied). Thread ball joint (supplied) onto PTO shaft until overall length of shaft and ball joint is 17.00 inches, Figure 16.
2. Install rod/ball joint assembly onto tractor, Figure 15.
3. Start unit and test operation of PTO. Test to ensure that all interlocks function as described in the owner's manual.

NOTE: Slight adjustment of the PTO rod length may be necessary to achieve proper operation.

6.5 RANGE SHIFT CONTROL (TWO SPEED AXLE)



SECTION 7 - DRIVE TRAIN

7.1 TRANSMISSION TROUBLE ANALYSIS

The following troubleshooting chart is to be used to isolate hydro transmission problems and give possible causes and 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
Axles Will Not Turn	1, 7, 8, 12, 16, 18, 28, 32, 38, 42, 46	repair or replace
Difficult Starting	1, 6, 7, 8, 12, 16, 25, 26, 28, 38, 42, 46	repair or replace
Erratic Running	1, 4, 6, 7, 8, 12, 18, 25, 26, 28, 42, 46, 55	repair or replace
Jerky When Starting	1, 4, 7, 8, 12, 18, 28, 38, 46	repair or replace
Jumps Out of Gear	N/A	repair or replace
Knocking	4, 8, 12, 18, 28, 37, 42	repair or replace
Loss of Power or System	4, 12, 18, 28, 37, 42, 46	repair or replace
Noisy	4, 12, 18, 26, 28, 32, 37, 42	repair or replace
Oil Leakage	4, 22, 51, 16	repair or replace
Operates Hot	4, 16, 28, 32, 35, 42	repair or replace
Operates in One Direction Only	1, 8, 12, 30, 46	repair or replace
Pump Failure	4, 12, 37	repair or replace
Speed Loss Under Load	1, 6, 11, 28, 37, 46, 51	repair or replace
Speed Loss Under Load	1, 4, 7, 12, 18, 28, 26	repair or replace
Will Not Drive	1, 7, 8, 18, 28, 37, 38, 46, 48	repair or replace
Will Not Shift		repair or replace

TROUBLESHOOTING KEY					
1	Inspect control linkage	22	Inspect hoses and lines for wear	43	Burrs on gearing
2	Inspect acceleration valves	23	Inspect implement relief valve	44	Gears improperly installed
3	Inspect charge check valves	24	Inspect charge pump	45	Forks & rod assembly incorrectly installed
4	Incorrect grade of lubricating oil	25	Bad transmission pump	46	Shifting keys broken or damaged
5	Low cranking speed	26	Overheating	47	Shifting washer in backwards
6	Controls not in correct operation position	27	Cold running	48	Shifter/Brake shaft keyways damaged
7	Belts are missing, to tight, loose or glazed	28	Bad transmission motor	49	Unit clutch not disengaging
8	Overload of vehicle	29	Check system pressure	50	Shifter stop assembled backwards
9	Replacement parts damaged	30	Shift rod grooves worn	51	Improper fit of case to cover
10	Replacement parts improperly installed	31	Reverse chain broken	52	Dowel pins not installed
11	Improperly torqued attaching screws	32	Damaged cooling fan	53	Differential bevel gears broken
12	Air in hydraulic system	33	Inspect auxiliary relief valve	54	Spring in shifter weak or broken
13	Broken shifter stop	34	Inspect cooling fan	55	Worn or stripped gear teeth
14	Inspect charge check valves	35	Inspect transmission cooling fins		
15	Inspect acceleration valves	36	Worn or damaged bearings		
16	Check oil level-gear box sump or reservoir	37	Metallic pieces or foreign objects in unit		
17	Inspect heat exchanger	38	Inspect for loosely mounted components		
18	Inspect by-pass valve	39	Steering column loose or binding		
19	Inspect charge pressure	40	Pressure relief valve sticking open		
20	Inspect inlet filter	41	Pressure relief sticking closed		
21	Inspect charge relief valve	42	Broken relief valve spring		

Before assuming that internal transmission problems exist, check all external linkage. Inspect the shifting linkage beginning with the control lever and work towards the transmission. Check for binding. Look for broken or missing cotter pins and sheared keys.

7.2 CLUTCH ADJUSTMENT

Clutch adjustment is necessary anytime clutch slippage occurs.

Clutch rods when engaged should just completely compress the springs on the clutch actuating lever when fully engaged.

To adjust, tighten the jam nuts until proper adjustment is obtained.

If external adjustments do not correct problems, internal examination may be necessary.

7.3 TRANSMISSION REMOVAL

1. Remove engine from tractor.
2. Remove battery.
3. Remove capscrews holding the handles, fuel tank, and battery box assembly to the chassis, and lift assembly off chassis.
4. Remove wheels and wheel hubs.

7.4 FORWARD-REVERSE CLUTCH & PLANETARY SYSTEM

To gain access to the forward-reverse clutch and planetary system, remove advance housing and rotate actuating rod with the lever until entire planetary system is released. All components of the forward-reverse clutch assembly are now ready for inspection.

1. Examine all parts for excessive wear or play.
2. Pay particular attention to the orbit gears and the orbit gear pins. If the bores of the gears are scored or out-of-round, replace gears and pins.
3. Check internal gear teeth for wear.
4. If friction surface of clutch cup is worn or damaged, replace cup.
5. Check the friction surfaces of the reverse cone and internal gear for scoring. If surfaces are damaged, replace parts to prevent rapid wear of a new clutch.

When replacing the forward-reverse clutch unit, the planetary gears must be timed.

Time planetary gears as follows:

1. Place sun pinion in bore of front pin plate.
2. Secure pin-plate quill to the pin plate with three quill-securing bolts.
3. Place the orbit gear pins in orbit gears.
4. Mesh the three gears with sun pinion so that the timing marks form an equal sided triangle. Timing marks (Figure 19) are white paint marks on the opposite side of gears.

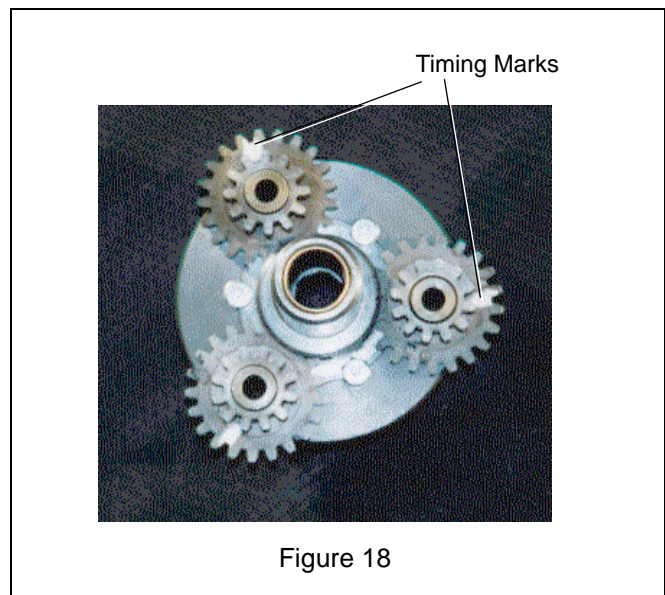


Figure 18

When replacing this unit in the transmission it is necessary to mesh the teeth on the actuating rod and the clutch slide rods (Figure 19) to accept the assembly.

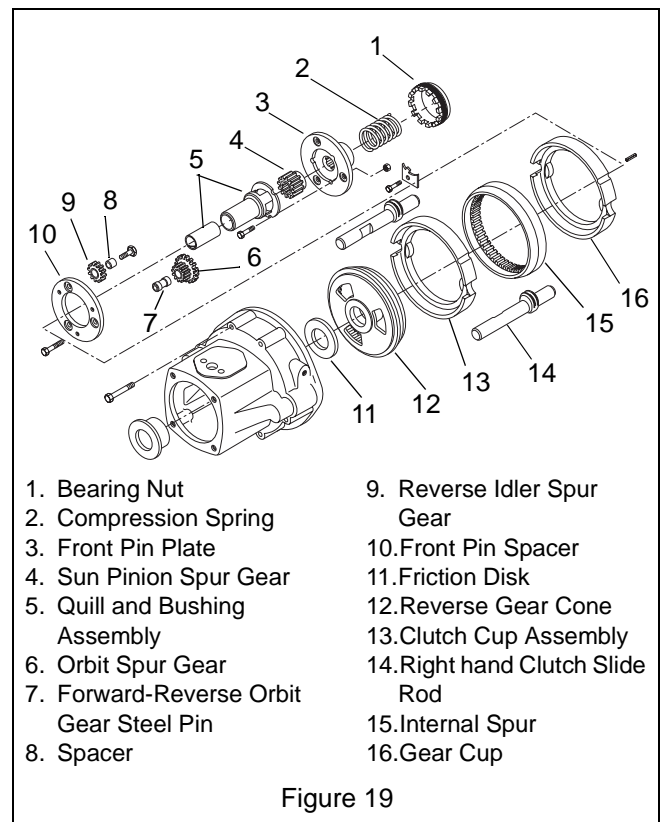


Figure 19

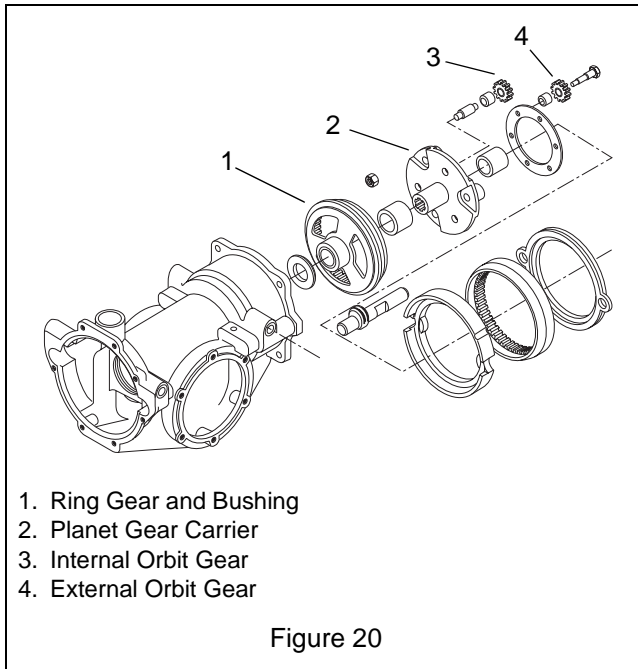
7.5 FIRST -SECOND GEAR, CLUTCH AND PLANETARY

To examine the first-second clutch and planetary, remove engine and release unit by turning the actuating shaft.

To avoid damage to the rear pin plate bushing, it is not recommended that planetary system be further disassembled unless definite problems exist.

If an unreasonable amount of play is noticed in the system:

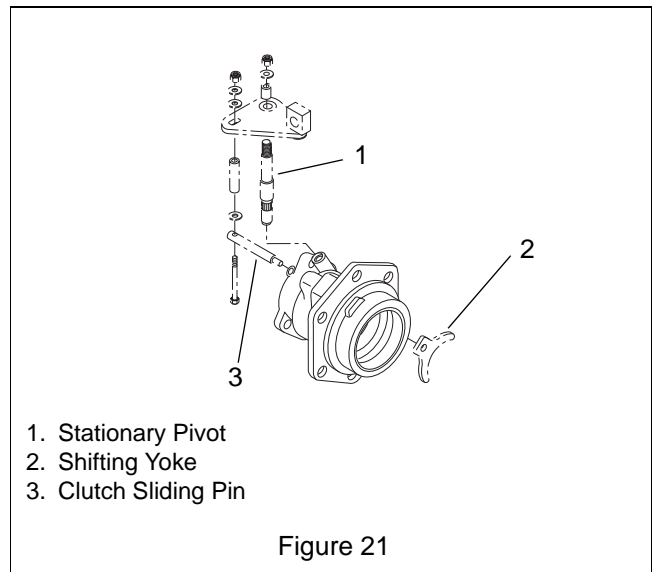
1. Inspect orbit gear pins and bushings for wear.
2. Inspect the orbit gear carrier bushing for wear.
3. Check for worn or damaged gearing.



1. Ring Gear and Bushing
2. Planet Gear Carrier
3. Internal Orbit Gear
4. External Orbit Gear

Figure 20

6. Carefully examine the shifting yoke, shifting clutch, stationary clutch and clutch housing. Particular attention should be given to see that the stationary clutch is properly secured against rotation. Also make sure the shifting clutch slides freely on the shifting gear.



1. Stationary Pivot
2. Shifting Yoke
3. Clutch Sliding Pin

Figure 21

7. If no discrepancies have been found at this point or if the failure is obviously a part of the differential assembly, remove the differential assembly.
8. Remove left hand wheel hub.
9. Remove left hand axle housing with axle.

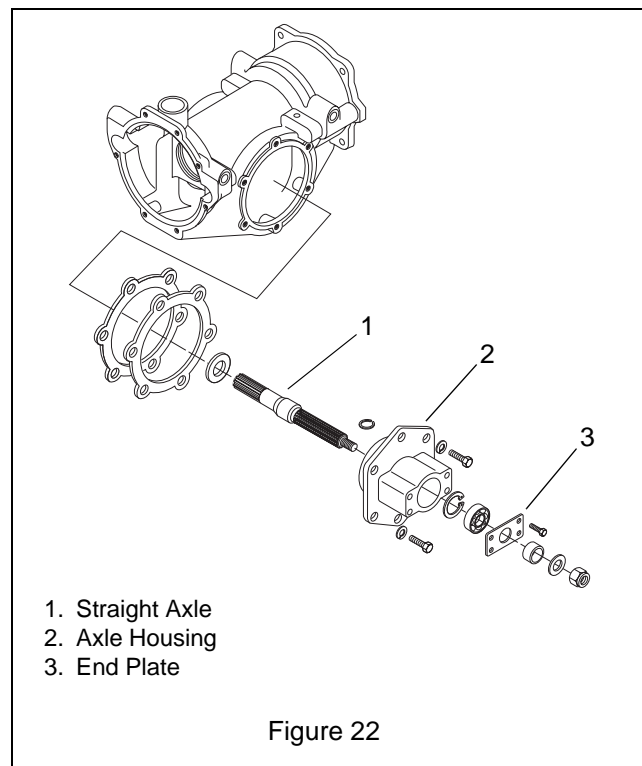
7.6 DIFFERENTIAL

Before assuming internal Swiftamatic difficulties, inspect the external linkage and parts for binding. Carefully check the following:

1. Check linkage for binding, sheared spring pin, loose nuts or debris build up.
2. Check to see that the shifter arm is not binding on the stationary pivot.
3. Check to see that the clutch sliding pivot is free.
4. Check to see that the extension spring is in place.
5. Check stationary clutch bolt. Be sure it is not sheared.
6. Raise tractor wheels. Turn one wheel by hand. The other wheel should turn in the opposite direction. Check for tightness and rough spots while turning.

7.7 DIFFERENTIAL REMOVAL

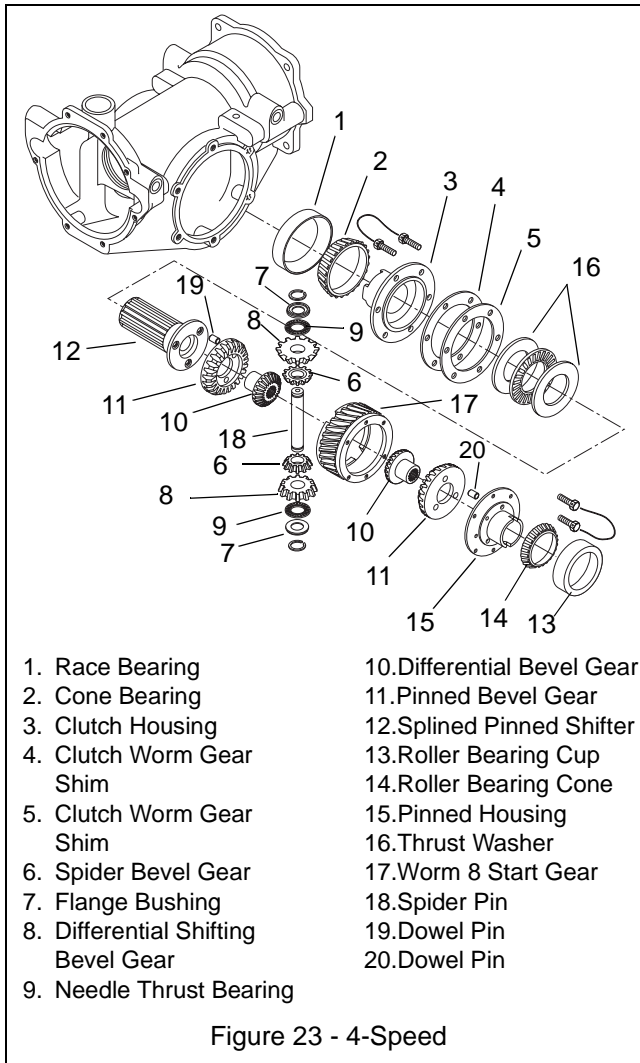
1. Drain oil from transmission.
2. Raise tractor and remove wheels.
3. Remove right hand wheel hub.
4. Disconnect Swiftamatic shift linkage.
5. Remove right hand axle housing with axle.



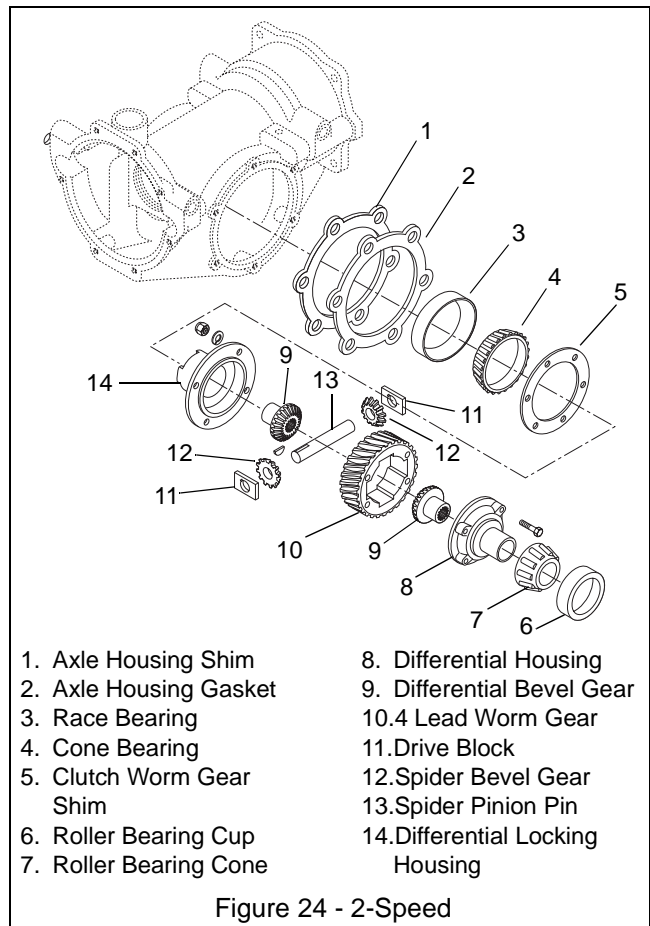
1. Straight Axle
2. Axle Housing
3. End Plate

Figure 22

10. Remove the differential assembly from the tractor.
11. Using wire cutters, remove wire securing bolts on each side of worm gear. Secure differential assembly upright in vise. (4 Speed Swiftamatic only).



12. Remove bolts securing clutch housing to worm gear. Remove clutch housing, gears, and shims.
13. Turn worm gear over and remove pinned housing and gears.
14. Tilt differential mechanism and remove from worm gear. The mechanism does not ride on the inside surface of the gear.



15. Disassemble the differential mechanism-carefully checking the bore of the gears and the spider arms for scoring. Check the backs of the shifting train pinions.
16. Reassemble the differential mechanism using new thrust needle bearings if any other parts were replaced. On the two spider arms with snap ring grooves at the end, assemble in this sequence: spider gear, shifting train pinion, bearing, spacer and snap ring. On the other two arms assemble in this sequence: spider gear, race, bearing, spacer and snap ring.
17. Tilt the differential mechanism and install it in the worm gear.

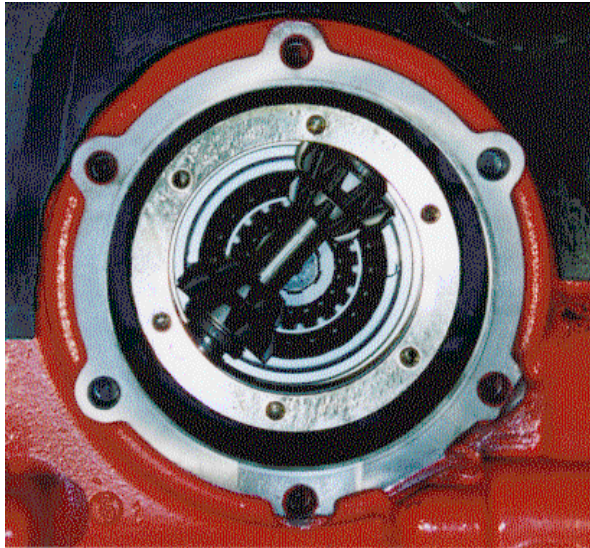


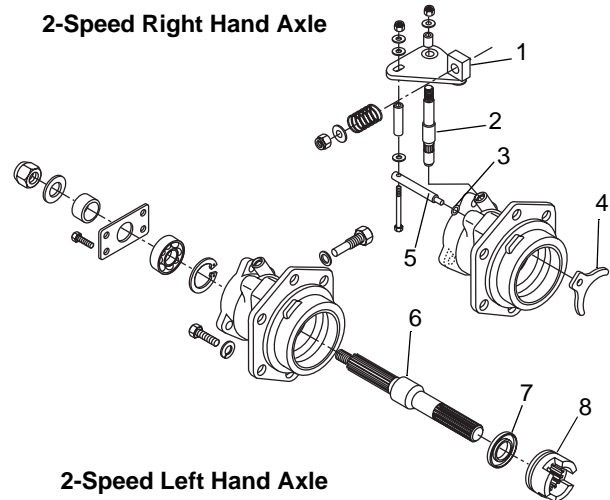
Figure 25

18. Install the pinned gear and differential gear on the pinned housing and install it on the worm gear. Use new drilled bolts (4 Speed Swiftamatic); clean bolts and apply a stud locking preparation to the bolt threads. Torque bolts to 17-20 ft-lbs (23 - 27 Nm)
19. Turn worm gear over and install the clutch housing, with differential gear, shifting gear and shims on the worm gear. Torque bolts to 20 ft-lbs (27 Nm). Replace with new bolts.
20. Check end play of shifting gear .00 - .010 maximum. Remove clutch housing and adjust shims as necessary. Torque bolts to 20 ft-lbs (27 Nm).
21. For the 4 Speed Swiftamatic, insert wire through one bolt head, cross and insert through other, then twist ends together securely. Trim twist to 1/2 inch length. Repeat, securing other bolts on other side of gear (Figure 27).
22. Install differential on L.H. axle in L.H. axle housing. (Pinned housing side of differential assembly in axle housing.) Be sure thrust pin is in place in the differential assembly so it will be between the axles.

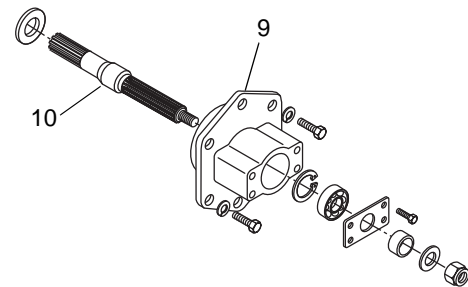


Figure 26

2-Speed Right Hand Axle

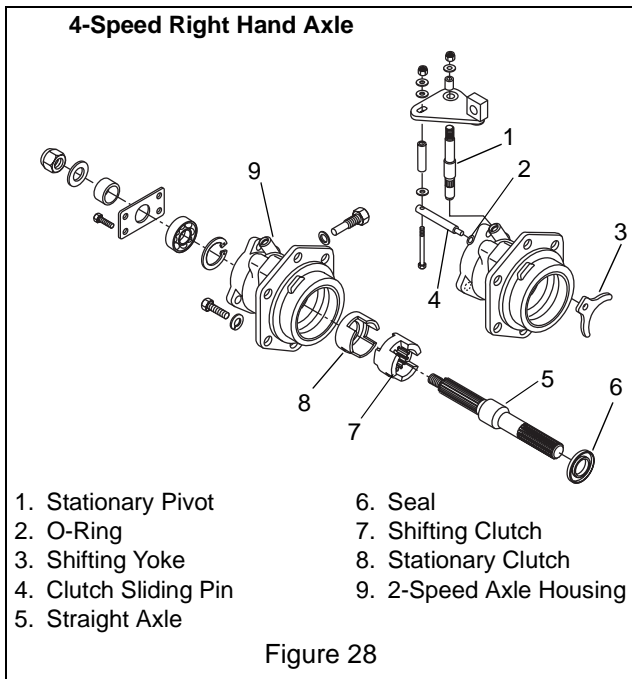


2-Speed Left Hand Axle



- | | |
|---------------------------------------|--|
| 1. Arm Shifter | 7. Seal |
| 2. Stationary Pivot | 8. Sliding Differential Locking Clutch |
| 3. O-Ring | 9. Housing Axle |
| 4. Shifting Yoke | 10. Straight Axle |
| 5. Clutch Sliding Pin | |
| 6. Straight Differential Locking Axle | |

Figure 27



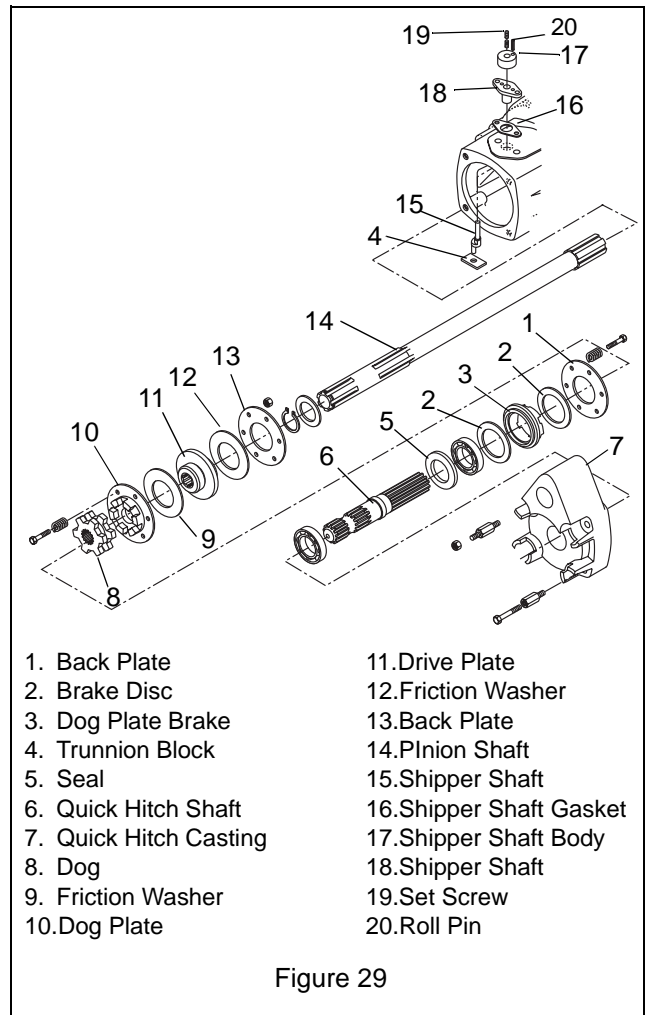
23. Place equal amount of shims and a shellacked gasket on each axle housing. Install L.H. axle housing and differential assembly in tractor. Secure axle housing to tractor.
24. Install R.H. axle housing on tractor, being sure the shifting clutch fits on the shifting gear. Secure axle housing to tractor. Torque bolts to 45 ft-lbs (61 Nm).
25. Remove the engine and high-low planetary or the advance casting and the forward-reverse planetary.
26. Using a screwdriver or similar tool, check the differential assembly for play. Running clearance should be .008" - .012". Adjust by adding or removing an equal amount of shims from each axle housing.
27. Adjust axles for .008" - .012" end play. Add or remove shims behind the bearing cap.

7.8 POWER TAKE OFF (PTO)

If it becomes difficult to shift the power takeoff in and out of gear, check external linkage for binding.

To examine the PTO, remove attachment boss plate on the front of advance casting. At this point the dog gear and shifting eccentrics are exposed (Figure 30).

Proceed as follows:



1. Check the dog block for wear.
2. Examine shifter shaft for wear.
3. For closer inspection of the shifter assembly, remove the assembly by removing jam nut inside of advance casting and then removing the shoulder bolt.
4. Inspect shifter body and its components for damage.
5. Check for bearing failures.
6. Examine pinion shaft for twisting.
7. Replace worn or damaged parts.

SECTION 8 - FUEL SYSTEM

8.1 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

8.2 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.

8.3 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.

8.4 FUEL TANK

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

SECTION 9 - ELECTRICAL

9.1 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 than 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.

9.2 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.

9.3 SAFETY INTERLOCK SYSTEM

The tractor has an electrical interlock system. Several switches need to be engaged for the engine to start and run. The switches in the system are:

- PTO Interlock
- Forward/Reverse Interlock
- Left and Right presence on handlebars (only one needs to be engaged)
- Steering Brake Presence (Optional) electrically has the same function as the right hand presence switch.

The PTO, forward/reverse and one of the presence switches must be closed for the engine to start. Once the engine is running only one of the presence switches needs to be closed.

9.4 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°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!

Internal 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!

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

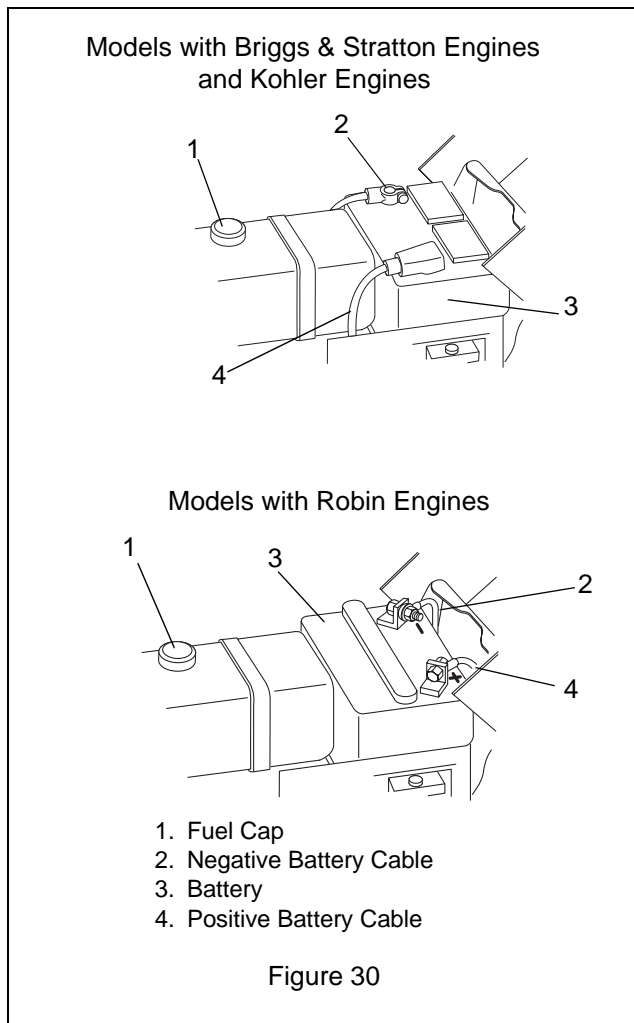
ALWAYS follow information provided on battery by battery manufacturer. Contact battery manufacturer for extensive instructions to charge battery.

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 1.265 specific gravity at 80°F (27°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°F below 80°F (27°C) or add .004 to 1.265 for each 10°F above 80°F (27°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°F (27°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.

9.5 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 than those described.

9.6 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 Gravelly 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.

9.7 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.

9.8 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 it from the circuit by disconnecting one end. With a multimeter 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).

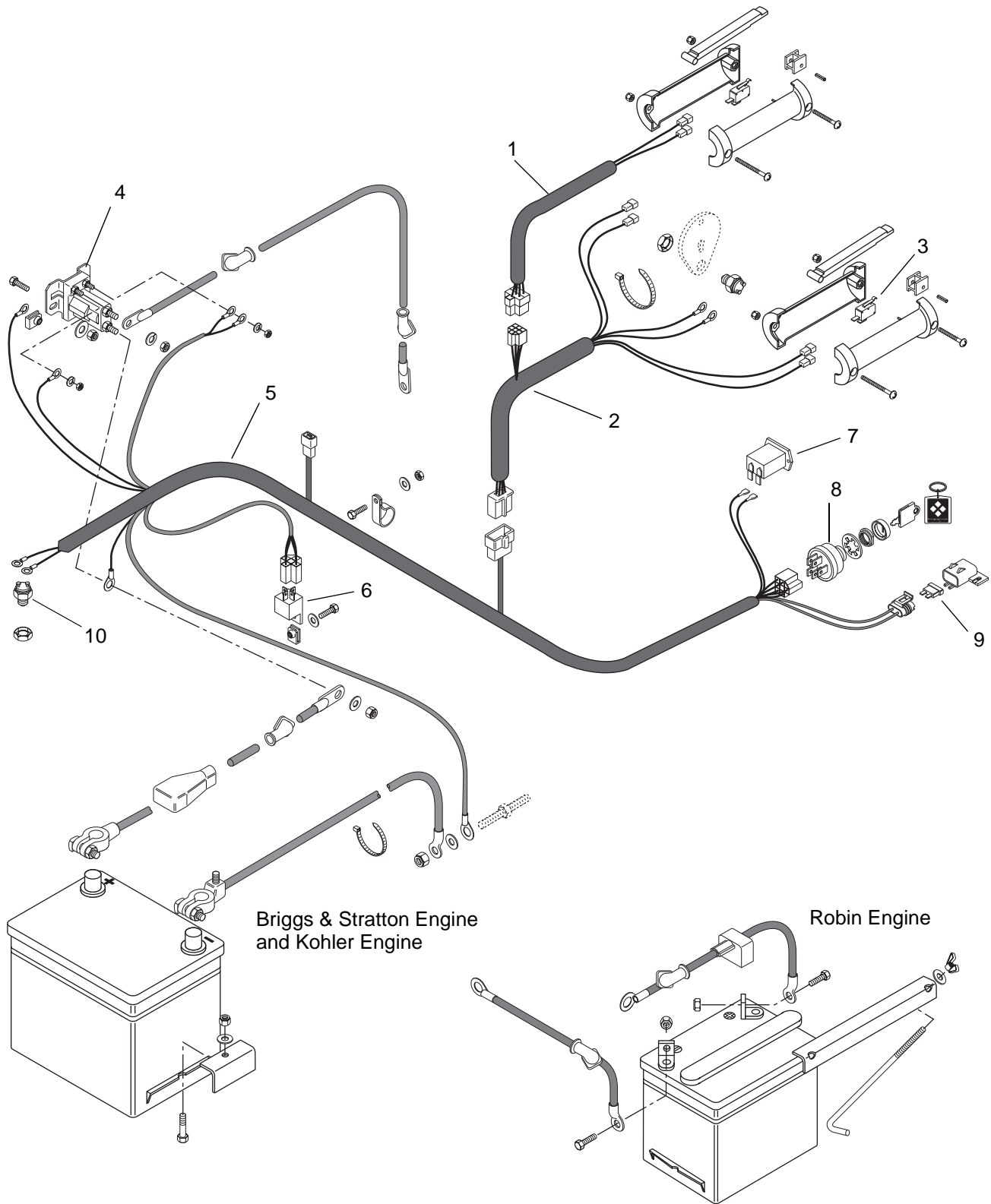
Rectifiers

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.

9.9 WIRING DIAGRAM



- 1. Steering Brake Harness
- 2. Handlebar Wiring Harness

- 3. Switch
- 4. Solenoid
- 5. Wiring Harness
- 6. Relay

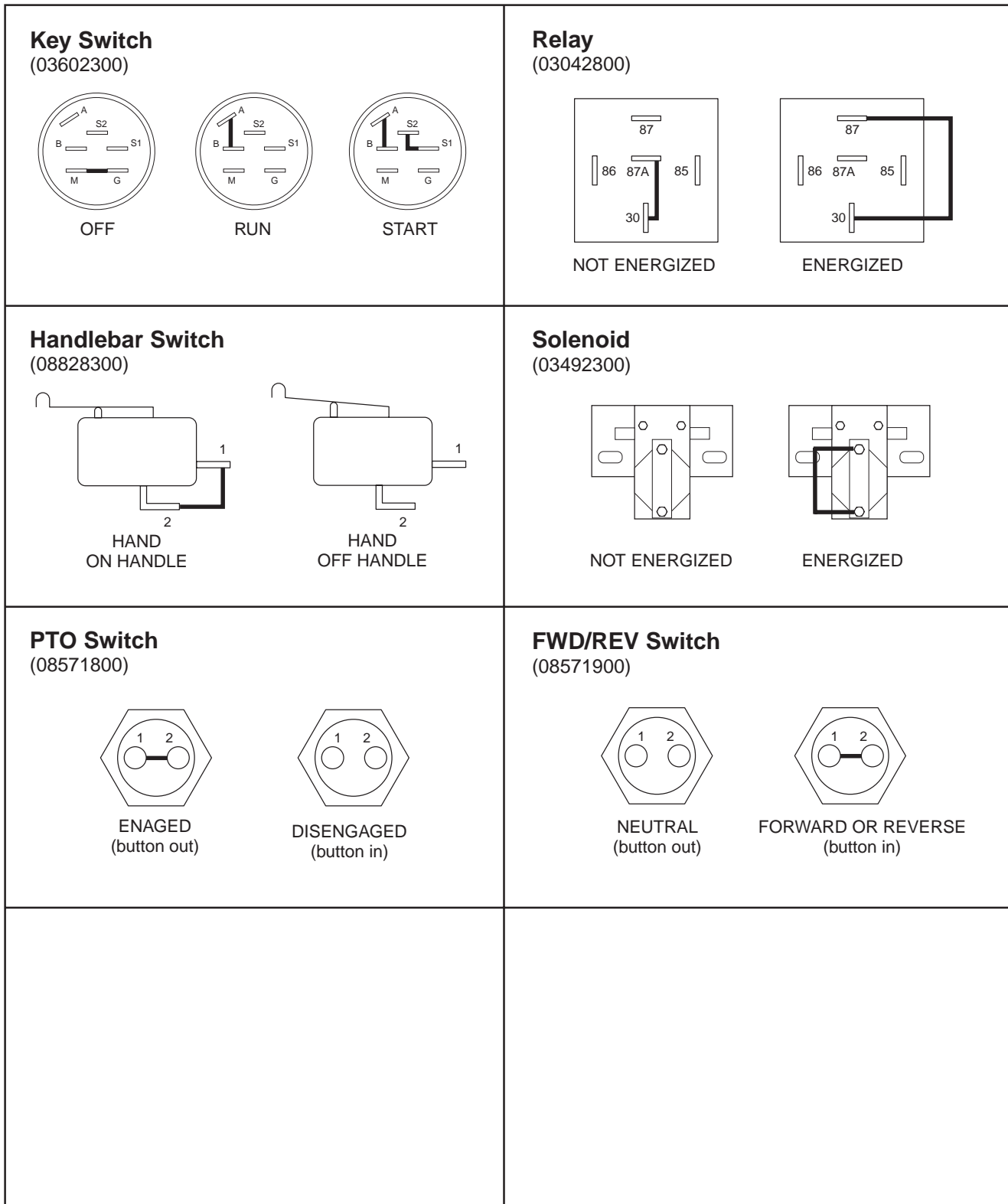
- 7. Hourmeter
- 8. Ignition Switch
- 9. Fuse
- 10. Interlock Open Switch

9.10 CONTINUITY DIAGRAM

The diagrams below show the various states of connection for electrical components.

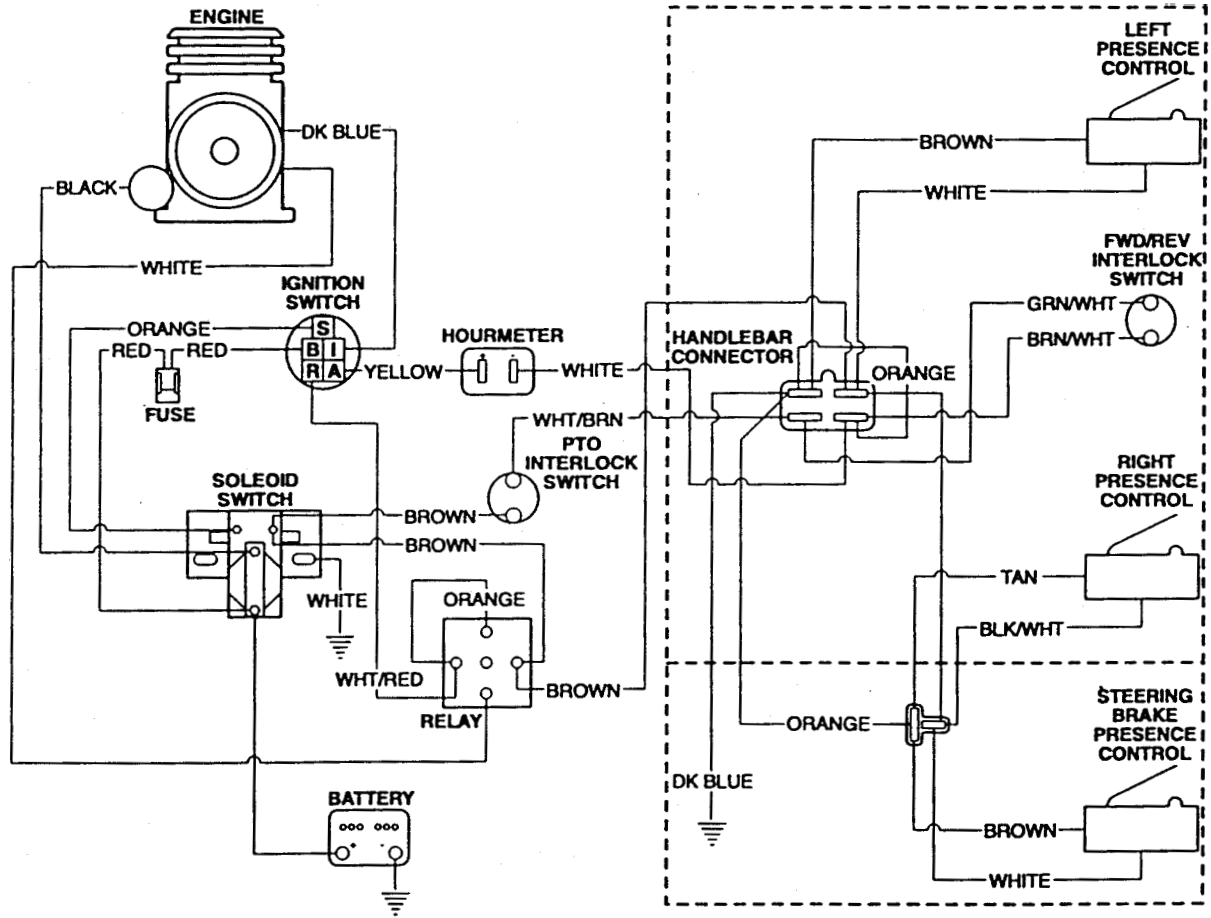
The solid lines on switches show continuity.

NOTE: All switches are viewed from the rear.

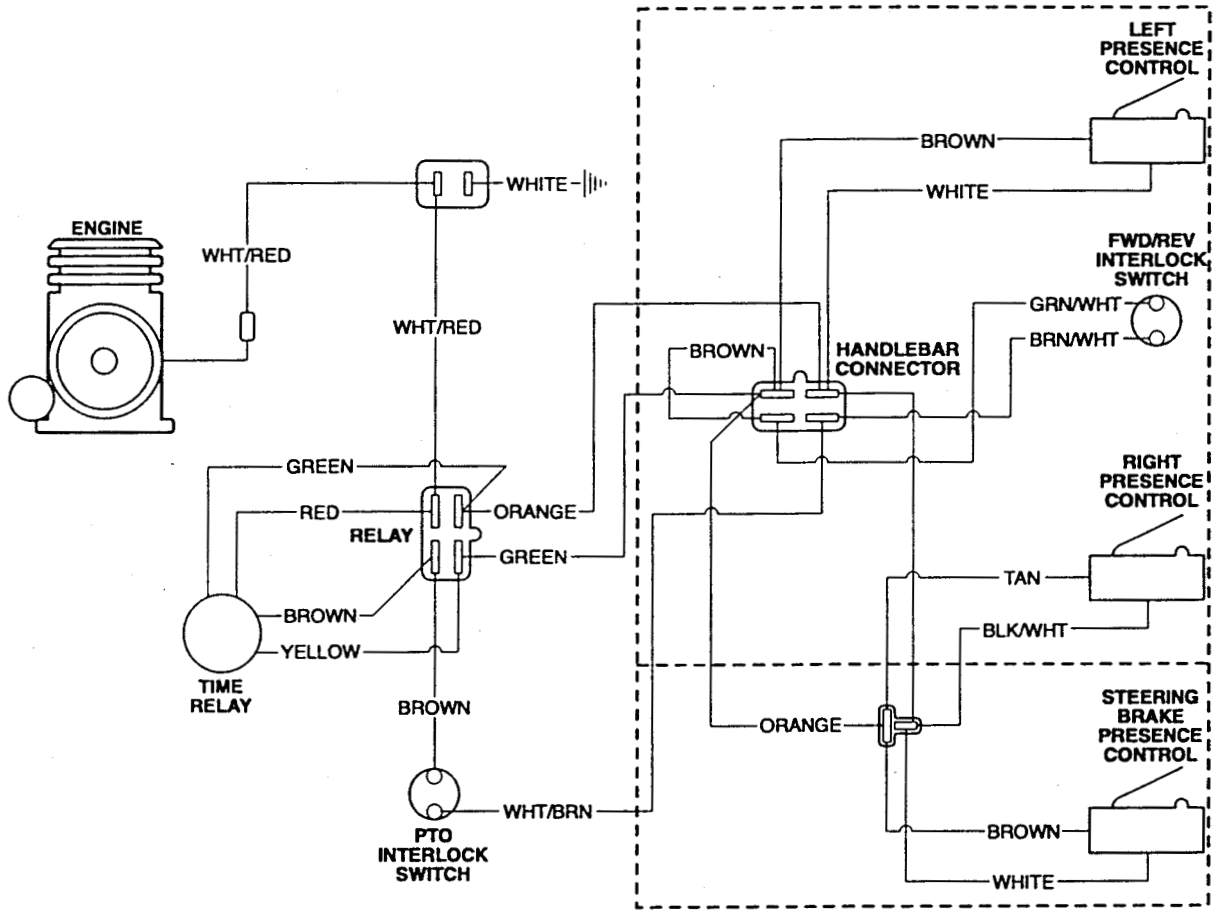


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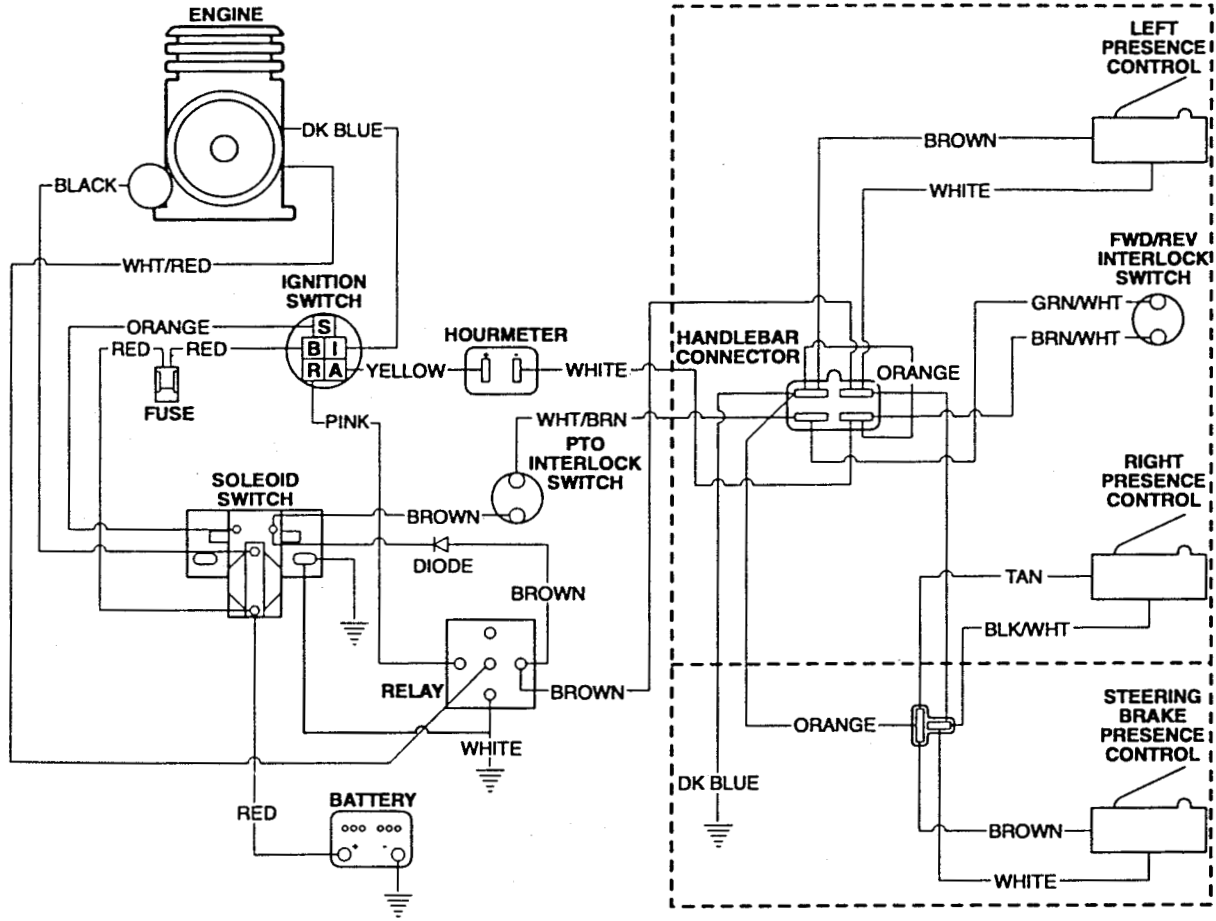
9.11 12 HP ELECTRIC START - KOHLER



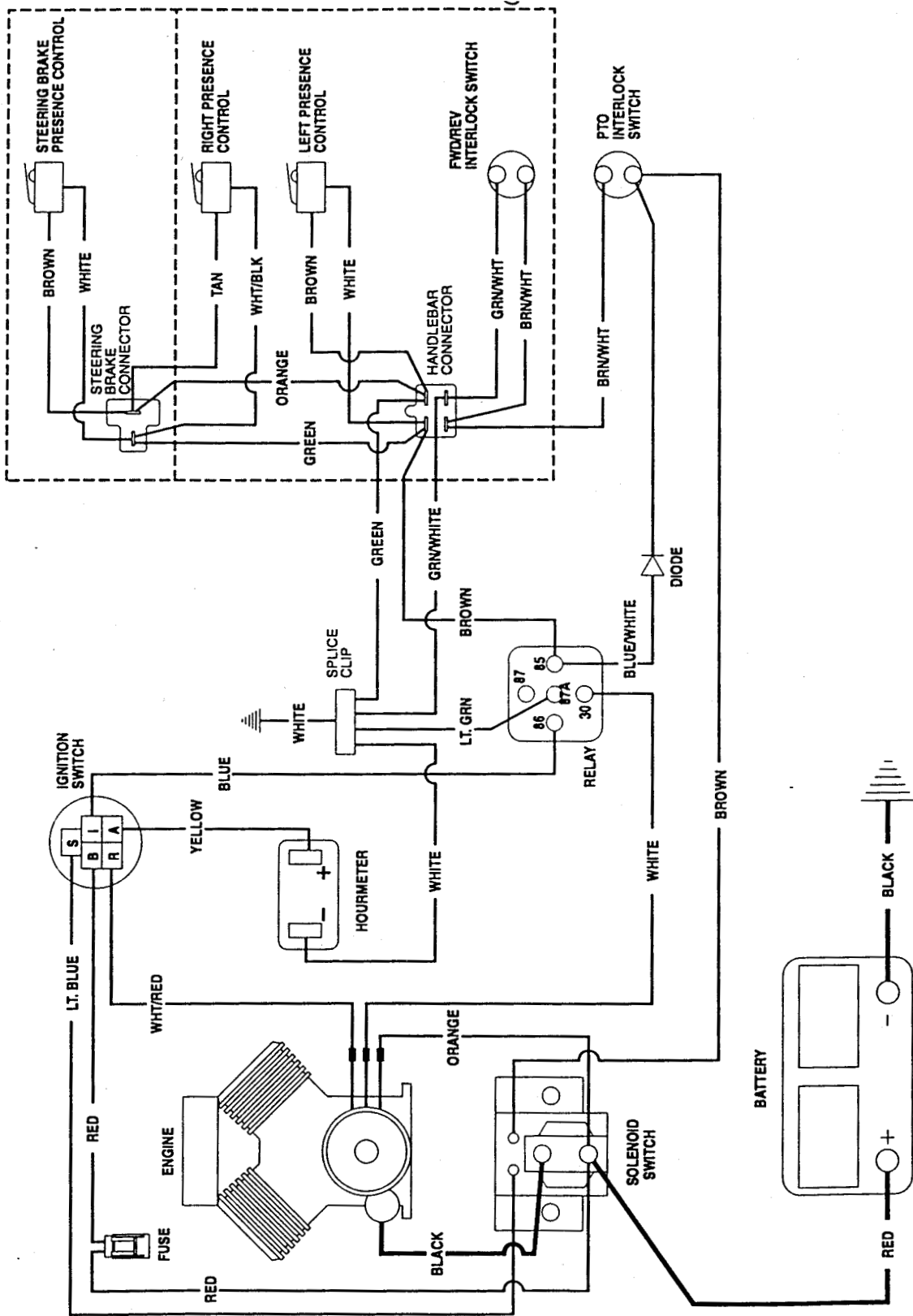
9.12 8 HP MANUAL START - KOHLER



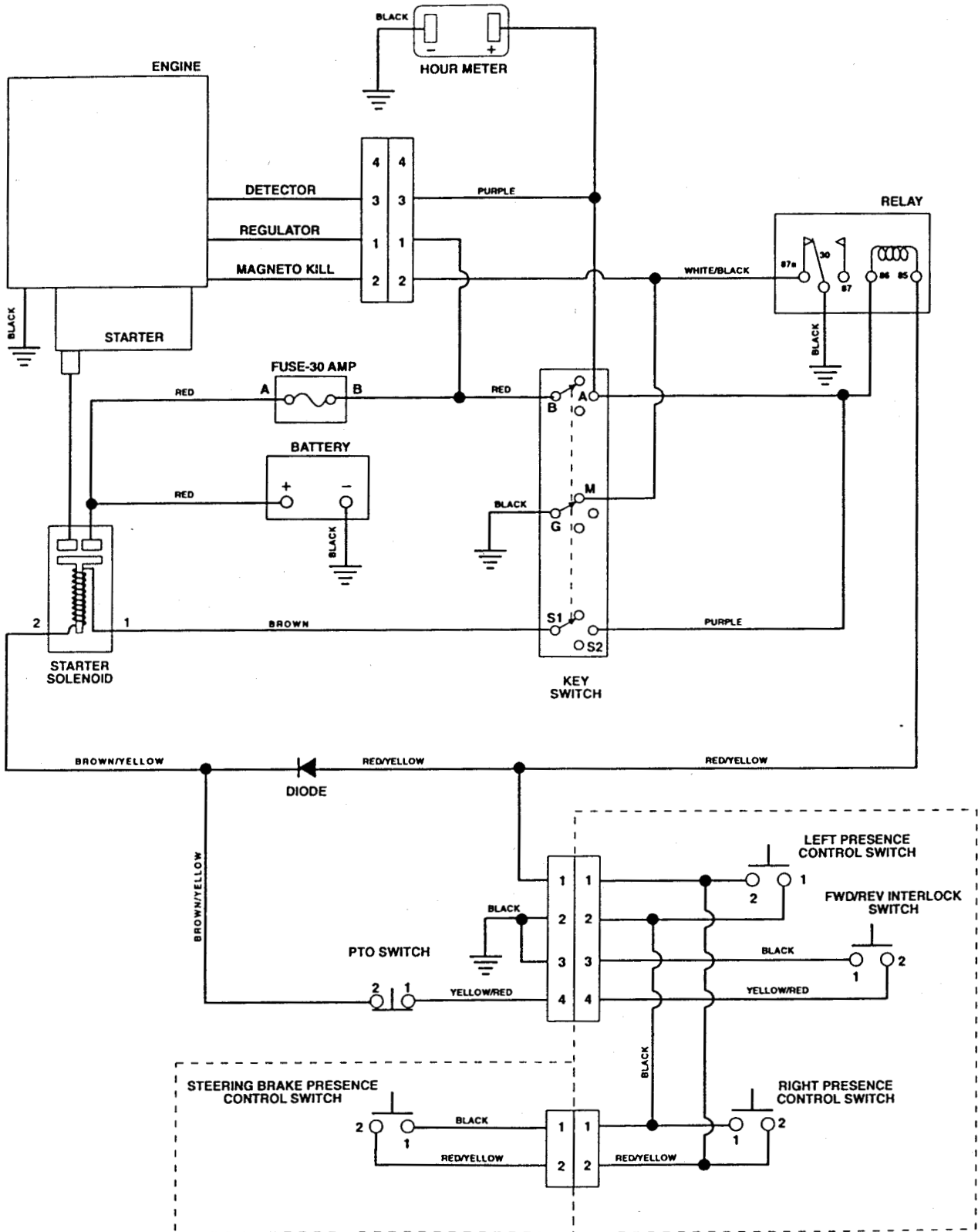
9.13 8 HP ELECTRIC START - KOHLER



9.14 16 HP ELECTRIC START - BRIGGS



9.15 ROBIN ENGINES





Gravelly
A division of Ariens Company
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Brillion, WI 54110-0157
920-756-2141
Fax 920-756-2407
www.gravelly.com

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