# JOHN DEERE WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

# Bunker and Field Rake 1200 Hydro

TM2193 DEC05
TECHNICAL MANUAL



North American Version Litho in U.S.A.

# INTRODUCTION

### **Manual Description**

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

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

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

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

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

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

Safety

Specifications and Information

Engine

Electrical

Hydraulics

Steering

Brakes

Attachments

Miscellaneous

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

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# **Recognize Safety Information**



This is the safety-alert symbol. When you see this symbol

on your machine or in this manual, be alert to the potential for personal injury.

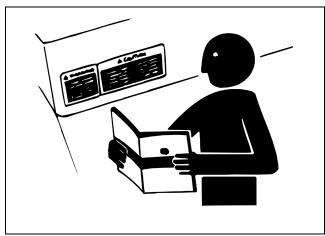
Follow recommended precautions and safe servicing practices.

# **Understand Signal Words**

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

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

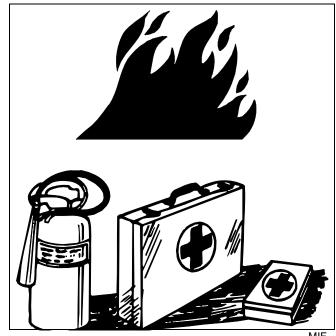
# Replace Safety Signs



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

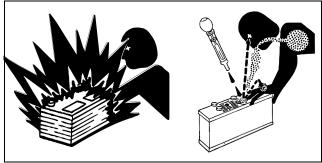
# **Handle Fluids Safely - Avoid Fires**

### **Be Prepared For Emergencies**



- · When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.
- Be prepared if a fire starts.
- Keep a first aid kit and fire extinguisher handy.
- Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

### Use Care In Handling and Servicing Batteries



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### **Prevent Battery Explosions**

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.
- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

# **Prevent Acid Burns**

• Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

### Avoid acid burns by:

- 1. Filling batteries in a well-ventilated area.
- 2. Wearing eye protection and rubber gloves.
- 3. Avoiding breathing fumes when electrolyte is added.
- 4. Avoiding spilling or dripping electrolyte.
- 5. Use proper jump start procedure.

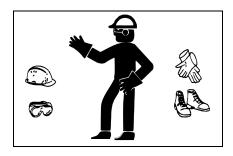
### If you spill acid on yourself:

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

### If acid is swallowed:

- 1. Drink large amounts of water or milk.
- 2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
- 3. Get medical attention immediately.

### **Wear Protective Clothing**



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

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

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

### **Use Care Around High-pressure Fluid Lines**

### **Avoid High-Pressure Fluids**



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

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

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

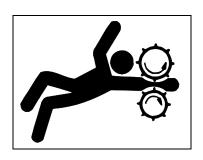
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

### **Avoid Heating Near Pressurized Fluid Lines**



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

### **Service Machines Safely**



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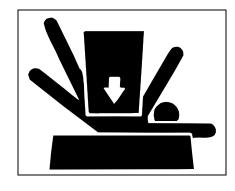
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

# **Use Proper Tools**

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

# **Support Machine Properly and Use Proper Lifting Equipment**



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

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

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

### Work In Clean Area

### Before starting a job:

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

### **Using High Pressure Washers**

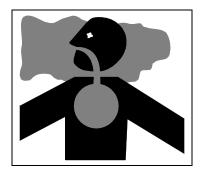
Directing pressurized water at electronic/electrical components or connectors, bearings, hydraulic seals, fuel injection pumps or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

### **Illuminate Work Area Safely**

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

# SAFETY

### Work In Ventilated Area



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

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

# **Warning: California Proposition 65 Warning**

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

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

# **Remove Paint Before Welding or Heating**

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

### **Avoid Harmful Asbestos Dust**

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

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

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

### Service Tires Safely



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

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

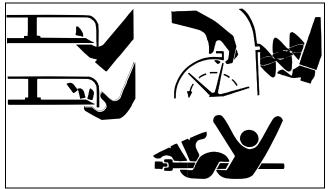
Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

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

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

### SAFETY

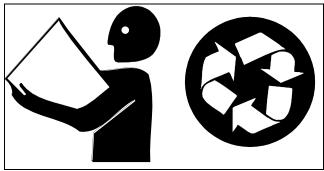
# **Avoid Injury From Rotating Blades, Augers and PTO Shafts**



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

### **Handle Chemical Products Safely**



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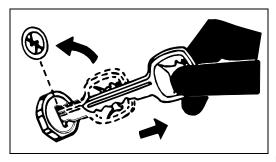
Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

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

# **Dispose of Waste Properly**

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries. Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

### **Parking Safely**



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- 1. Stop machine on a level surface, not on a slope.
- 2. Disengage and stop attachments.
- 3. Lower attachments to the ground.
- 4. Lock park brake.
- Stop engine.
- 6. Remove key.
- 7. Wait for engine and all moving parts to stop before you leave the operator's station.
- 8. Close fuel shut-off valve, if your machine is equipped.

# **SAFETY**

# **Live With Safety**



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

# **SPECIFICATIONS & INFORMATION TABLE OF CONTENTS**

# **Table of Contents**

Fastener Torques	9
Metric Fastener Torque Values	
Inch Fastener Torque Values	10
O-Ring Seal Service Recommendations	
Face Seal Fittings	
With Inch Stud Ends Torque	11
Face Seal Fittings	
With Metric Stud Ends Torque	12
O-Ring Face Seal Fittings	13
O-Ring Boss Fittings	13
Straight Fitting or Special Nut Torques	14
Metric Fastener Torque Value -	
Grade 7 (Special)	14
General Information	14
Gasoline	
Gasoline Storage	
4 - Cycle Gasoline Engine Oil	15
Break-In Engine Oil - 4-Cycle Gasoline	16
Hydrostatic Transmission	
and Hydraulic Oil	
Alternative Lubricants	
Synthetic Lubricants	
Lubricant Storage	
Mixing of Lubricants	
Oil Filters	
Serial Number Locations	
Product Serial Number	18

SPECIFICATIONS & INFORMATION	TABLE OF CONTENTS

# **SPECIFICATIONS & INFORMATION SPECIFICATIONS**

# **Specifications**

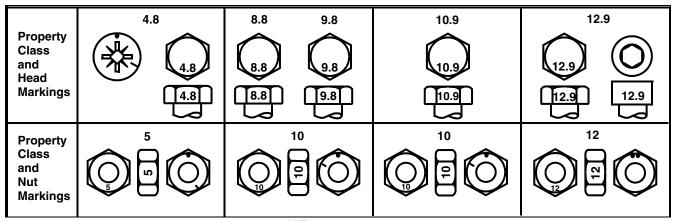
# **General Vehicle Specifications**

Engine
Make Briggs and Stratton Vanguard
Type
Model
Cylinders
Displacement
Stroke/Cycle 4 Cycle
Bore
Stroke 66 mm (2.60 in.)
Compression Ratio
Valving
Lubrication
Oil Filter Full Flow Spin On Filter
Engine Oil Capacity
Cooling System Air Cooled
Air Cleaner
Muffler Horizontal Discharge
Fuel Filter
Fuel Gasoline (minimum 87 octane)
Fuel Tank Capacity
Electrical
Ignition Electronic CD
Type of Starter
Charging System
Battery Type
Alternator16 amp flywheel alternator
Drive Train
Type
Hydraulic Fluid Capacity
Travel Speed (Forward)
Travel Speed (Reverse)
Steering
•
Type Mechanical, Roller-Chain and Sprocket
Ratio
Steering Wheel Diameter
Turns (Lock to Lock)
Maximum Torque Required to Turn
Expected Operating Grade
Brakes
Brake Location/Type
Parking Brake

# SPECIFICATIONS & INFORMATION FASTENER TORQUES

### **Fastener Torques**

# **Metric Fastener Torque Values**



N.	Л	1	г	
IV	1	1	r	7

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

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

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

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening. When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

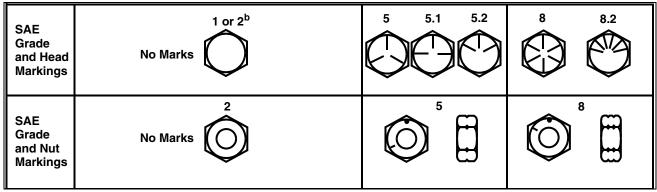
Tighten toothed or serrated-type lock nuts to the full torque value.

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

Reference: JDS - G200.

# SPECIFICATIONS & INFORMATION FASTENER TORQUES

# **Inch Fastener Torque Values**



N	Λ	1	_

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

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

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

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

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

head.

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

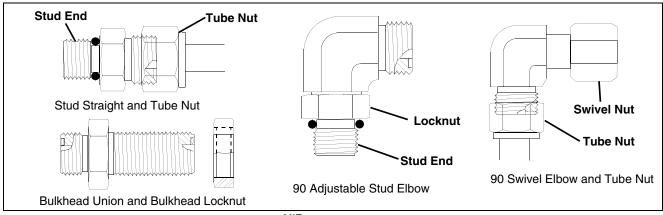
- a "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate Specification JDS117) without any lubrication.
- b "Grade 2" applies for hex cap screws (Not Hex Bolts) up to 152 mm (6 in.) long. "Grade 1" applies for hex cap screws over 152 mm (6 in.) long, and for all other types of bolts and screws of any length.

Reference: JDS - G200

# SPECIFICATIONS & INFORMATION O-RING SEAL SERVICE

# **O-Ring Seal Service Recommendations**

# **Face Seal Fittings With Inch Stud Ends Torque**



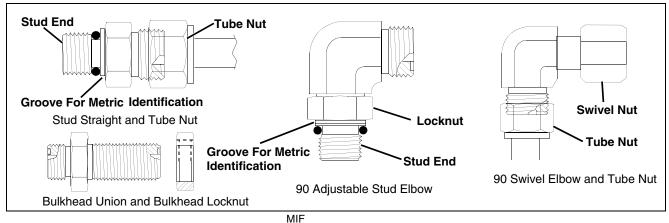
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Nomina	Nominal Tube OD/Hose ID			Face Seal 1	ube/Ho	se End	d	O-Ring Stud Ends			
Metric Tube OD	Tube			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
19	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

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

# SPECIFICATIONS & INFORMATION O-RING SEAL SERVICE

# **Face Seal Fittings With Metric Stud Ends Torque**

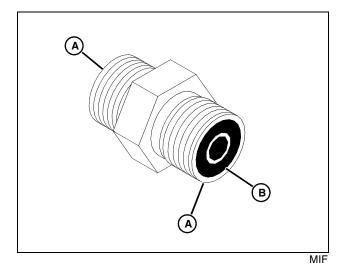


Nominal Tube OD/Hose ID				Face Seal	O-Ring Stud Ends, Straight Fitting or Lock Nut										
Metric Tube OD OD		Thread Size	Hex Size			Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel Gray Torqu	Iron	Alum Torqu			
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250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

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

# SPECIFICATIONS & INFORMATION O-RING SEAL SERVICE

# **O-Ring Face Seal Fittings**



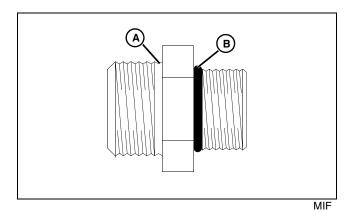
- 1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.
- 2. Inspect the O-ring (B). It must be free of damage or defects.
- 3. Lubricate O-rings and install into groove using petroleum jelly to hold in place during assembly.
- 4. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.

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

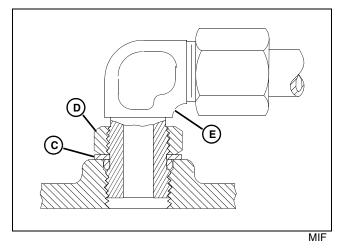
5. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

### **O-Ring Boss Fittings**

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



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



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

# SPECIFICATIONS & INFORMATION GENERAL INFORMATION

# **Straight Fitting or Special Nut Torques**

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

<sup>&</sup>lt;sup>a</sup>Torque tolerance is ± 10 percent.

# Metric Fastener Torque Value - Grade 7 (Special)

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

### **General Information**

### Gasoline

### 4 - Cycle Engines



CAUTION: Avoid Injury! Gasoline is HIGHLY FLAMMABLE, handle it with care. DO NOT refuel machine while: indoors, always fill gas tank outdoors; machine is near an open flame or sparks; engine is running, STOP engine; engine is hot, allow it to cool sufficiently first; smoking.

Help prevent fires: fill gas tank to bottom of filler neck only; be sure fill cap is tight after fueling; clean up any gas spills IMMEDIATELY; keep machine clean and in good repair - free of excess grease, oil, debris, and faulty or damaged parts; any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light. To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:•ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.

### To avoid engine damage:

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

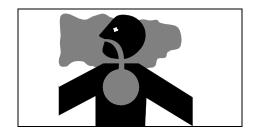
Use of alternative oxygenated, gasohol blended, unleaded gasoline is acceptable as long as:

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

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

<sup>&</sup>lt;sup>b</sup>To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss; then tighten special nut or straight fitting the number of flats shown.

# SPECIFICATIONS & INFORMATION GENERAL INFORMATION



MIF

IMPORTANT: Avoid damage! California Proposition 65 Warning: Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

# Gasoline Storage

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

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

### 4 - Cycle Gasoline Engine Oil

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

The following John Deere oils are PREFERRED:

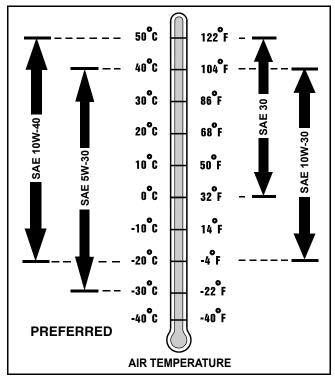
- PLUS 4® SAE 10W-40;
- TORQ GARD SUPREME® SAE 5W-30.

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

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

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

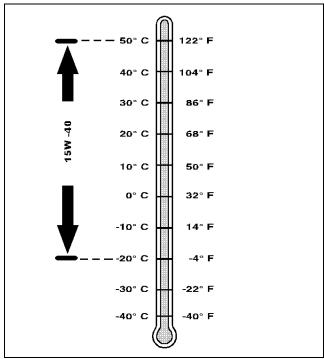
- SAE 10W-40 API Service Classifications SG or higher;
- SAE 5W-30 API Service Classification SG or higher;
- SAE 10W-30 API Service Classifications SG or higher;
- SAE 30 API Service Classification SC or higher.



MIF

# SPECIFICATIONS & INFORMATION GENERAL INFORMATION

# **Hydrostatic Transmission and Hydraulic Oil**



MX10362

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

IMPORTANT: Avoid damage! Only use a quality oil in this transmission. Do not mix any other oils in this transmission. Do not use BIO-HY-GARD® in this transmission. Do not use "Type F" (Red) Automatic Transmission Fluid in this transmission.

The following oil is preferred:

• JD Plus 50 15W-40

The following oil is also recommended:

SAE 15W-40

The following oil is allowable:

• JD Plus 50 0W-40 Synthetic

Oil must meet the following:

· API Service Classification SG or higher

### **Alternative Lubricants**

Use of alternative lubricants could cause reduced life of the component.

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

### **Synthetic Lubricants**

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

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

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

### **Lubricant Storage**

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

### **Mixing of Lubricants**

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

### **Oil Filters**

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

The following John Deere oil filters are PREFERRED:

 AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

Most John Deere filters contain pressure relief and antidrainback valves for better engine protection.

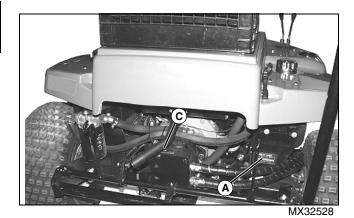
Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

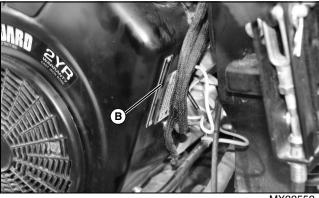
ASTB Tested In Accordance With SAE J806.

# **SPECIFICATIONS & INFORMATION SERIAL NUMBER LOCATIONS**

### **Serial Number Locations**

### **Product Serial Number**





MX32552

The product identification number (A) is located on the rear right-hand side frame.

Engine serial number (B) is located on the side of the engine housing.

Hydraulic pump product identification number (C) is located on the top of pump.

# **ENGINE - GAS TABLE OF CONTENTS**

Table of Contents
-------------------

Specifications	
General Specifications	
Test and Adjustment Specifications	21
Repair Specifications	
Torque Specifications (Alphabetical)	23
Diagnostics	25
Engine Will Not Start	
Tests and Adjustments	
Throttle Cable Adjustment	
Choke Cable Adjustment	
Fuel Shutoff Solenoid Test	
Carburetor Adjustment	
Governor Adjustment	
Compression Test	
Valve Clearance Adjustment	
Engine Oil Pressure Test	
Armature Air Gap Adjustment	
Repair	34
Blower Housing and Fan Removal and Installation	0.4
Air Cleaner Removal and Installation	34
Throttle and Choke Cable Removal	25
and Installation  Carburetor Removal and Installation	oo
Carburetor Inspection	
Carburetor Disassembly	
Carburetor Assembly	
Engine Removal and Installation	oə 11
Air Guides Removal and Installation	
Intake Manifold Removal and Installation	
Cylinder Head Removal and Installation	
Cylinder Head Inspection and Repair	
Valve Removal	
Valve Inspection and Repair	
Valve Guide Ream	
Valve Installation	
Piston, Rings & Rod Removal	0
and Installation	48
Piston Inspection	49
Connecting Rod Inspection	
Assemble Piston Rod	
Cylinder Bore Inspection	
Cylinder Bore Honing	
Cylinder Bore Cleaning	

Resizing Cylinder Bore	
Flywheel Removal and Installation	53
Crankshaft Removal and Installation	54
Magneto Bearing Inspection	57
PTO and Cam Bearing Inspection	58
Breather Valve Service	58
Oil Pump Removal	59
Starting Motor Removal and Installation	60
Starting Motor Disassembly	61
Starting Motor Assembly	63
Starting Motor Pinion Gear Replacement	64

 <b>ENGINE - GAS</b>	TABLE OF CONTENTS	

# **Specifications**

Make Briggs and Stratton Vanguard
Type
Model
Cylinders
Displacement
Stroke/Cycle
Bore
Stroke
Compression Ratio 8.4:1
ValvingOverhead Valves
Lubrication
Oil Filter Full Flow Spin On Filter
Engine Oil Capacity
Cooling System Air Cooled
Air CleanerDual Element; foam and paper
Muffler Horizontal Discharge
Fuel Filter
Fuel
Fuel Tank Capacity
Test and Adjustment Specifications
Armature Air Gap
Spark Plug Gap 0.76 mm (0.030 in.)
Valve Clearance
Valve Guide Depth
Slow Idle
Fast Idle
Choke Knob-to-Cable-Mount Clearance
Carburetor SLOW Idle Mixture Screw Initial Setting
Oil Pump Operating Pressure
on rump operating residue
Repair Specifications
Valves:
Valve Guide:
Standard Dimension
Wear Limit
Valve Stem Standard Dimension:
Intake
Exhaust
Extraust
Valve Stem Wear Limit:

Intake	,
Exhaust	5.91 mm (0.328 in.)
Valve Seat Width	1.2 - 1.6 mm (0.047 - 0.062 in.)
Valve Margin	0.8 mm (0.030 in.)
Valve Face Angle	
Valve Seat Narrowing Angle	30°
Cylinder Bore, Pistons and Rings:	
Cylinder Bore:	
Standard Dimension	,
Piston Pin:	
Standard Dimension	.07 - 17.08 mm (0.672 - 0.673 in.)
Wear Limit	17.06 mm (0.672 in.)
Piston Pin Bore:	
Standard Dimension	.09 - 17.10 mm (0.673 - 0.674 in.)
Wear Limit	` `
Ring End Gap:	, ,
Standard Dimension	0 20 - 0 40 mm (0 008 - 0 016 in )
Wear Limit	· · · · · · · · · · · · · · · · · · ·
	,
Compression Ring Groove Wear Limit (New Ring Installed)	,
	0.20 mm (0.006 m.)
Connecting Rod and Crankshaft:	
Connecting Rod Crankpin:	
Standard Dimension	.06 - 37.08 mm (1.459 - 1.460 in.)
Wear Limit	37.11 mm (1.461 in.)
Connecting Rod Piston Pin Bearing:	
Standard Dimension	- 17.10 mm (0.6728 - 0.6732 in.)
Wear Limit	17.12 mm (0.674 in.)
Crankshaft PTO Journal:	
Standard Dimension	.96 - 34.97 mm (1.376 - 1.377 in.)
Wear Limit	34.92 mm (1.375 in.)
Crankshaft Magneto Journal:	
Standard Dimension	99 - 35.01 mm (1.3776 - 1.378 in.)
Wear Limit	` ,
Magneto Bearing:	,
Standard Dimension	8 - 30 06 mm <i>(</i> 1 1825 - 1 1835 in )
Wear Limit	,
	20100 ( <b>0</b> )

PTO Bearing:
Standard Dimension
Wear Limit
Crankshaft Crankpin Journal:
Standard Dimension
,
Wear Limit
Crankshaft End Play 0.05 - 0.76 mm (0.002 - 0.030 in.)
Cam Gear PTO Journal:
Standard Dimension
Wear Limit
Cam Gear Magneto Journal:
Standard Dimension
Wear Limit
Cam Lobe:
Standard Dimension
Standard Dimension
wear Limit
Cam Bearing (Magneto Side):
Standard Dimension
Wear Limit
Cam Bearing (PTO Side):
Standard Dimension
Wear Limit
Torque Specifications (Alphabetical)
Alternator to Cylinder Block
Air Cleaner Base to Carburetor
Clutch to Crankshaft Bolt
Connecting Rod Cap Screws
Clutch Mounting Bolt
Crankcase Cover
Cylinder Head Cap Screws
Cylinder Shield
Engine Mounting Bolts
Exhaust Manifold
Flywheel Nut
Fuel Shutoff Solenoid
Oil Breather Mounting Bolt
Oil Filter Adaptor Mounting Bolts
Oil Pump Mounting Screws         7 N•m (62 lb-in.)

Rocker Arm Adjustment Lock Nut	. 7 N•m (62 lb-in.)
Rocker Mounting Studs	11 N•m (100 lb-in.)
Spark Plug	20 N•m (180 lb-in.)
Starting Motor Mounting Bolts	16 N•m (140 lb-in.)
Valve Cover Nuts	. 8 N•m (70 lb-in.)

# **ENGINE - GAS DIAGNOSTICS**

### **Diagnostics**

# **Engine Will Not Start**



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

NOTE: To test specific electrical components, see Electrical section and refer to either Diagnostics or Tests and Adjustments for further guidance.

### Symptom: Engine Will Not Crank

# (1) Is the operator seat switch closed and the park brake set?

**Yes -** Go to next step. See "Cranking Circuit Operation" on page 77 in the Electrical section.

No - Operator on seat and set park brake.

(2) Is battery voltage 12.4 volts or higher?

Yes - Go to next step.

**No -** Charge battery and perform no-load test. Go to next step.

(3) Is battery voltage 12.4 volts or higher?

Yes - Go to next step.

No - Replace battery.

(4) Does starter solenoid click when ignition switch is turned to start position?

Yes - Check starter motor.

No - Check electrical system.



CAUTION: Avoid Injury! Do not rotate engine with starter if the spark plugs are removed. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

NOTE: Perform a visual inspection first to determine if battery cables are tight and not corroded and if battery is of sufficient size to turn the engine over at minimum cranking speed of 350 rpm.

### Symptom: Engine Cranks But Will Not Start

(1) Is battery voltage 12.4 volts or higher?

Yes - Go to next step.

### **Symptom: Engine Cranks But Will Not Start**

**No -** Charge battery and perform no-load test. Go to next step.

(2) Does fuel shutoff solenoid click when ignition switch is turned to start/run?

Yes - Go to next step.

**No -** Defective fuel shutoff solenoid, switch or wiring. See Electrical section.

### (3) Does engine crank slow?

**Yes -** Remove spark plugs and turn the engine over by hand. Go to next step.

No - Go to next step.

### (4) Is the engine hard to turn over by hand?

Yes - Pistons or other internal components binding.

**No -** Starter motor possibly defective. Repair or replace as needed.

### (5) Is the choke operating properly?

Yes - Go to next step.

No - Adjust choke cable.

### (6) Do spark plugs have strong blue spark?

**Yes -** Go to next step.

**No -** Possible defective spark plugs, magneto shorted to ground, flywheel magnet weak, or ignition coil air gap not adjusted. See Electrical section.

### (7) Are tappets adjusted properly.

Yes - Go to next step.

No - Adjust tappets.

### (8) Is engine getting fuel?

**Yes -** Check air cleaner, fuel mixture, possible contaminated fuel, or stuck float needle.

**No -** Check fuel shutoff valve, fuel lines, fuel pump, and engine vacuum.

### **Symptom: Engine Makes High Whining Sound**

# (1) Are the starter gears engaging and disengaging correctly?

**Yes -** Go to next step.

**No -** Check starting motor gears for correct engagement and disengagement. See "Starting Motor Removal and Installation" on page 60.

# (2) Are the cam and crank gears engaging correctly?

# **ENGINE - GAS DIAGNOSTICS**

Symptom: Engine Makes High Whining	Sound	
No - Check cam shaft end play.		

### **Tests and Adjustments**

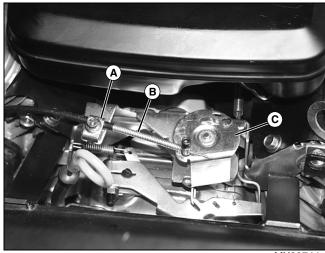
### **Throttle Cable Adjustment**

#### Reason:

To make sure the throttle cable moves the throttle through its full range of movement.

#### Procedure:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Move throttle lever to FAST idle position.



MX32744

3. Loosen throttle cable clamp (A).

NOTE: While cable is disconnected move throttle through full range of motion to check that cable is not binding. Lubricate or replace cable as necessary.

- 4. Move throttle cable (B) until governor control swivel (C) is at end of travel.
- 5. Tighten throttle cable clamp.

### Choke Cable Adjustment

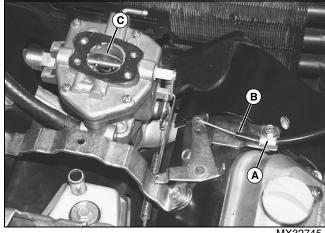
#### Reason:

To make sure the choke cable moves the choke through its full range of movement.

#### **Procedure:**

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove air cleaner assembly from carburetor.
- 3. Pull choke knob at dash completely outwards to the on position. Choke "butterfly" should be vertical or entirely closed.

4. If not:



- Push choke knob at dash completely inwards to the off position.
- Loosen cable clamp (A) and pull choke cable (B) so butterfly is in the horizontal position (C). Tighten clamp.
- 5. Move knob through full range of motion. Make sure choke is closed at full choke. Readjust if necessary.

#### Fuel Shutoff Solenoid Test

#### Reason:

To test proper operation of fuel shutoff solenoid.

### **Required Tools:**

Jumper wire

### Procedure:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Listen for an audible click when ignition switch is turned from OFF to ON.
- 3. If solenoid does not click, problem could be in equipment wiring.
- 4. Disconnect wire from solenoid.
- 5. Momentarily place a jumper wire from solenoid wire to battery positive terminal.
- 6. If solenoid now clicks, the solenoid is working properly.

NOTE: If battery voltage drops below 9 volts when cranking engine or while engine is running, the solenoid will not function.

#### Results:

 Solenoid is operating properly if a click is heard when ignition switched from off to on.

# **Carburetor Adjustment**

#### Reason:

To set the carburetor mixture screws for proper operation of the carburetor.



CAUTION: Avoid injury! DO NOT attempt to disassemble or adjust the engine CARB/EPA Certified Emissions Carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

### **Equipment:**

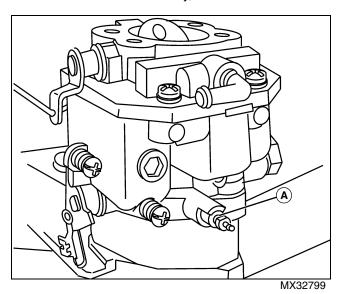
JT07270 Pulse Tachometer

IMPORTANT: Avoid damage! In order to obtain correct operation of the carburetor, the adjustment procedure must be performed in the sequence shown.

### **Initial Adjustment:**

### Procedure:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove air cleaner assembly, and base.

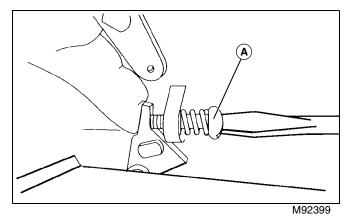


- Remove limiter cap.
- 4. Turn idle mixture screw (A) clockwise until it just seats. DO NOT FORCE.
- 5. Turn screw 1 3/8 turns counter-clockwise. This setting will allow the engine to start.

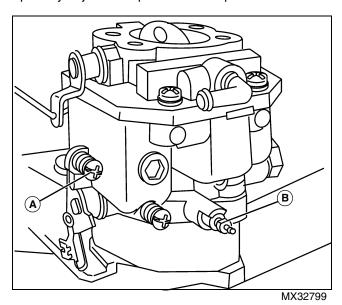
#### **Final Adjustment:**

NOTE: All carburetor adjustments with engine running must be made with the air cleaner installed.

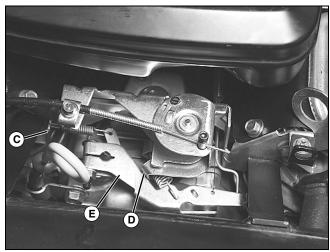
- Install air cleaner base and air cleaner.
- 2. Start and run engine for 5 minutes to allow engine to reach operating temperature.
- 3. Move throttle lever to SLOW idle position.
- 4. Install pulse tachometer.



5. Hold throttle lever against idle speed screw (A) and temporarily adjust idle speed to 1100 rpm.



- 6. Turn idle mixture screw (B) slowly clockwise until engine speed just starts to slow (Lean Mixture).
- 7. Turn idle mixture screw slowly counter-clockwise until engine speed just starts to slow (Rich Mixture).
- 8. Turn screw to the midpoint between rich and lean settings.
- 9. Hold throttle lever against idle speed adjustment screw and readjust idle speed to 900 rpm.
- 10. Release throttle lever and note rpm.



MX32747

- 11.If necessary bend idle tang (C) to obtain 1100 rpm.
- 12. Position limiter cap so that stops on limiter cap are at midpoint between stops on carburetor.
- 13. With throttle lever in the SLOW position and engine running at governed idle rpm, bend throttle restrictor tang (D) so that it just contacts governor lever (E).
- 14. Move throttle lever to FAST position.
- 15. Engine should accelerate smoothly. If necessary, readjust idle mixture screw 1/8 turn counter-clockwise (Richer Mixture).
- 16.With fine tuning adjustments complete, set slow idle to  $1900 \pm 50$  rpm.

### **Governor Adjustment**

#### Reason:

To make sure the governor shaft contacts the fly-weight plunger when the engine is stopped.



CAUTION: Avoid injury! Before starting or running engine, static adjustment of the governor must be made. Failure to make static adjustments first, could result in engine overspeeding, and may result in engine or equipment damage causing personal injury and/or property damage.

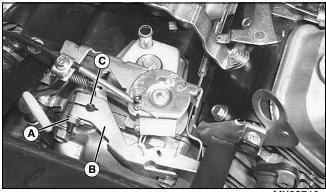
### Static Adjustment Procedure (Engine OFF):

NOTE: All linkage must be installed to make adjustment.

### Procedure:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.

2. Remove air cleaner assembly.



MX32746

3. Loosen governor lever bolt and nut (A).

IMPORTANT: Avoid damage! Do not bend governor link or distort governor lever (B).

- 4. Push on governor lever (B) until throttle is wide open.
- 5. Hold lever in this position and rotate governor shaft (C) counterclockwise with a screwdriver as far as it will go. Hold lever and shaft in position and tighten governor lever bolt and nut to 8 N•m (70 lb-in.).

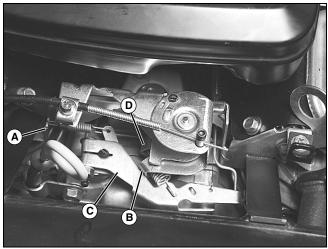
### **Dynamic Adjustment Procedure (Engine Running):**

### **Equipment:**

Pulse Tachometer JT07270

### **Procedure:**

NOTE: Carburetor mixture adjustments must be made before adjusting governed idle, throttle restrictor and top no load rpm adjustments.



MX32747

- 1. Move throttle lever to SLOW idle position.
- 2. Bend governor idle tang (A) to obtain specified slow idle speed.

- 3. With throttle lever in SLOW idle position and engine running at governed idle, bend throttle restrictor tang (B) so that it just contacts the governor lever (C).
- 4. Move throttle lever to FAST idle position and bend fast idle tang (D) to obtain specified top no load engine speed.

### **Specifications:**

### **Compression Test**

### Reason:

To determine the performance difference between cylinders.

### **Required Tools:**

JDM59 Compression Gauge

NOTE: Briggs & Stratton does not publish any compression pressures, as it is extremely difficult to obtain an accurate reading without special equipment. What is recommended is to calculate the difference in compression readings between the two cylinders. Two methods are given in the following: one without a cylinder leak tester and one with a cylinder leak tester.

### Procedure without cylinder leak tester:

IMPORTANT: Avoid damage! The battery must be fully charged for this test. Check and adjust the valves to ensure the valves have not been adjusted too tight. If either valve is off its seat the leak test will be invalid.

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32511

- 2. Disconnect spark plug wire (A).
- 3. Remove spark plug.

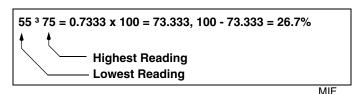
- 4. Insert a compression gauge into either cylinder.
- 5. Turn engine over with the starting motor until the highest pressure reading is obtained and record reading.
- 6. Repeat steps 3 & 4 with the next cylinder and record reading.
- 7. Use the following example and insert the recorded readings to determine the percent of leakage between cylinders.

### **Example:**

cyl #1 cyl #2

75 psi 55 psi

#### Formula:



#### Results:

 A difference of more than 25% indicates a loss of compression in the cylinder with the lowest reading.

### Procedure with cylinder leak tester:

### **Required Tools:**

- JT03502 Cylinder Leak Tester
- Breaker Bar & 30 mm Socket

IMPORTANT: Avoid damage! Check and adjust the valves to ensure the valves have not been adjusted too tight. If either valve is off its seat, the leak test will be invalid.

NOTE: If the directions that come with the tester being used are different than the following, use the directions that came with the tester.

1. The engine should be run for at least 5 minutes to bring the engine to operating temperature.



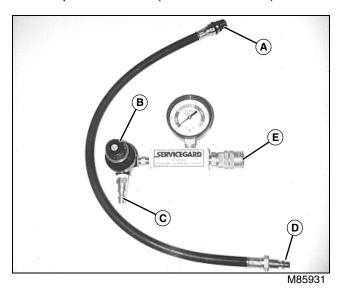
CAUTION: Avoid injury! With spark plugs removed, the magnetos must be grounded to the engine to prevent a spark that could ignite anything combustible.

2. Remove spark plugs, and ground the magnetos by attaching a jumper wire from the magneto kill circuit connector to the engine to prevent a spark that could ignite anything combustible.

- Remove valve covers.
- 4. Remove the rotating screen.

IMPORTANT: Avoid damage! The piston must be positioned at Top Dead Center (TDC) to ensure that the intake valves are away from the compression relief balls. If not, the intake valve will be open and the leak test will be invalid.

5. Turn crankshaft until piston is at Top Dead Center (TDC) on the compression stroke (both valves closed).



- 6. Screw the adaptor end (A) into the spark plug hole but do not attach it to the tester at this time.
- 7. Pull back the locking ring (B) and rotate the regulator knob fully counterclockwise. Connect an air line to the tester fitting end (C).

IMPORTANT: Avoid damage! The air supply must have enough supply pressure to calibrate the tester (Usually 586 - 655 kPa (85 - 95 psi).

- 8. Pull back the locking ring and rotate the regulator knob clockwise until the gauge needle rests in the SET range of the gauge. Push the locking ring towards the tester to lock it.
- 9. Connect the adaptor hose (D) to the tester female end (E), and record the needle position while holding the flywheel in position with a breaker bar.

#### Results:

# NOTE: A small amount of air escaping from the crankcase breather is normal.

- Excessive air escaping from the crankcase breather indicates worn piston rings or cylinder wall.
- Air escaping from the carburetor indicates a worn intake valve or seat.

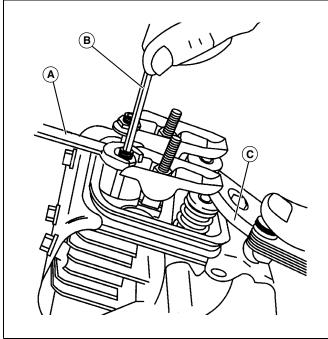
- Air escaping from the exhaust pipe indicates a worn exhaust valve or seat.
- Gauge reading in the Green (low) area indicates good compression. (Less than 25% is considered normal.)
- Gauge reading in the Yellow (moderate) area indicates borderline compression. The engine is still usable but an overhaul or replacement should be considered.
- Gauge reading in the Red (high) area indicates excessive compression loss and engine reconditioning or replacement is necessary.

### **Valve Clearance Adjustment**

NOTE: Correct position of crankshaft is necessary to eliminate interference by the compression release mechanism on the cam gear when adjusting valve clearance.

#### **Procedure:**

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove valve cover.
- 3. Turn crankshaft until piston is at Top Dead Center (TDC) on the compression stroke (both valves closed).
- 4. Insert a screwdriver through the spark plug opening until it touches the top of the piston.
- 5. Continue to turn the crankshaft clockwise until the piston has moved down 6.35 mm (0.25 in.).
- 6. Check valve clearance with a feeler gauge (C) between valve stem and rocker arm. Valve clearance should be 0.10 0.15 mm (0.004 0.006 in.).



- 7. If not, adjust as necessary using a 13 mm open end wrench (A) and a 5 mm hex wrench (B). Tighten lock nut to 7 N•m (60 lb-in.).
- 8. Recheck clearance and make adjustments if necessary.
- 9. Install valve cover.

### **Specifications:**

Lock nut...... 7 N•m (65 lb-in.) Valve Clearance . . . . 0.10 - 0.15 mm (0.004 - 0.006 in.)

### **Engine Oil Pressure Test**

#### Reason:

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

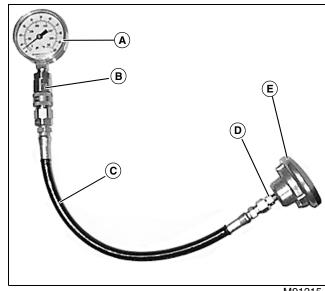
### **Equipment:**

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

- JT07262 Oil Pressure Test Adapter w/ O-ring (required) ONLY on engines without test ports)
- JT05847 Connector
- JT03017 Hose Assembly
- JT03262 Coupler
- JT07034 Gauge, 0 700 kPa (0 100 psi)

#### Test Procedure At Oil Filter Base:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Perform test procedure with engine level.
- 3. Drain engine oil from oil filter.
- 4. Remove oil filter and wipe filter base clean.



M91215

- A JT07034 Gauge
- B JT03262 Coupler
- C JT03017 Hose Assembly
- D JT05847 Connector
- E JT07262 Oil Pressure Adapter, w/O-Ring
- 5. Install pre-assembled adapter, connector, hose assembly, coupler, and gauge on to oil filter base. ONLY hand-tighten adapter to oil filter base.
- 6. Check crankcase oil level and adjust to full mark.
- 7. Monitor oil pressure during cranking, if oil pressure is below 28 kPa (4 psi) - STOP engine immediately and correct cause before continuing.
- 8. Connect spark plug wire.



**CAUTION: Avoid injury! Engine components are** HOT. DO NOT touch with bare skin. Wear protective eye glasses and clothing.

- 9. Warm-up engine by running at MEDIUM idle for five minutes.
- 10. Record oil pressure readings at SLOW and FAST idle.
- 11.Stop engine and allow to cool.
- 12. Remove adapter, connector, hose assembly, coupler, and gauge.

# **ENGINE - GAS TESTS AND ADJUSTMENTS**

- 13.Install new oil filter.
- 14. Run engine for 30 seconds and stop engine.
- 15. Check crankcase oil level and adjust to full mark.

#### Results:

- If oil pressure readings are not within 69 kPa 517 kPa (10 75 psi), inspect and/or replace the following:
  - · -Oil pump assembly.
  - Oil suction screen.
  - · -Oil passages
  - · -Bearing wear
  - · -Oil Seals

### **Armature Air Gap Adjustment**

#### Reason:

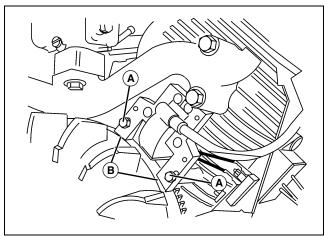
To verify that the engine has enough oil pressure to lubricate the internal engine components.

### **Equipment:**

• 0.20 - 0.30 mm (0.008 - 0.012 in.) feeler gauge

#### **Procedure:**

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32918

- 2. Loosen screws (A) holding armature in place. Slide armature away from flywheel and tighten one of the screws.
- 3. Turn flywheel so that the magnet is centered on armature.
- 4. Place 0.20 0.30 (0.008 0.010 in.) thickness gauge between flywheel and armature. Loosen screw on armature, and allow armature to be pulled against the gauge by the flywheel magnet. Tighten both armature screws to 3 N•m (25 lb-in.).

- 5. Turn flywheel to remove gauge.
- 6. Repeat procedure for other armature.

### **Specifications:**

Armature Air Gap . . . . 0.20 - 0.30 mm (0.008 - 0.010 in.) Armature Screws . . . . . . . . . . . 3 N•m (25 lb-in.)

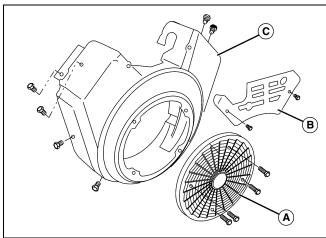


### Repair

# Blower Housing and Fan Removal and Installation

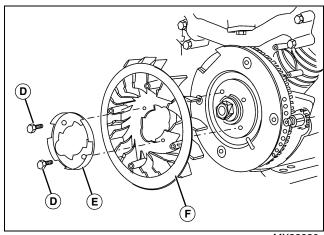
### Procedure:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove rotating screen.
- 3. Remove two screws holding fuel pump bracket to blower housing.



MX32796

- 4. Remove four screws and screen (A).
- 5. Remove six screws and blower housing (B).
- 6. Remove two screws and fuel pump bracket (C), if necessary.



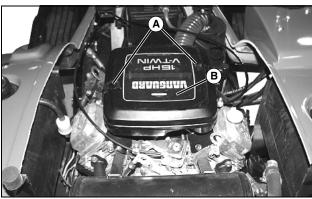
MX32920

7. Remove two screws (D), fan retainer (E) and fan (F).

### Installation is in reverse order of removal.

### Air Cleaner Removal and Installation

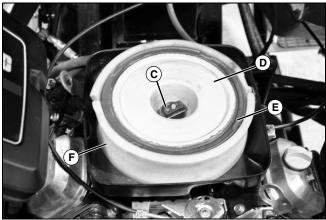
1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32512

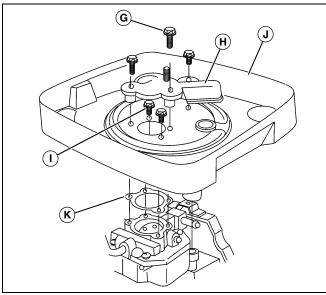
2. To replace secondary air filter, unhook clips (A) and remove cover (B).

IMPORTANT: Avoid damage! DO NOT use petroleum solvents, such as kerosene, to clean foam precleaner. They may cause foam to deteriorate. DO NOT oil paper cartridge. DO NOT use pressurized air to clean or dry paper cartridge. If paper cartridge is excessively dirty replace with new cartridge.



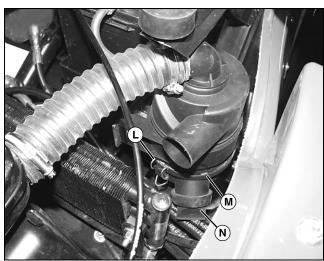
MX32515

3. Remove knob (C), plate (D), and air cleaner cartridge (E) with foam pre-cleaner (F).



MX32800

- 4. To remove air cleaner housing, remove three screws (G) and breather deflector (H).
- 5. Remove two air cleaner base mounting screws (I).
- 6. Remove hose on back of air cleaner connected to primary air cleaner element, and remove air cleaner base (J) and breather tube.
- 7. Remove and replace gasket (K).



MX32569

- 8. To replace primary air cleaner element, release latches (L) and remove air cleaner canister cover (M).
- 9. Remove and discard primary element. Replace with a new primary filter element.
- 10. Remove and clean rubber dust unloading valve (N).

### Installation:

1. Install primary air cleaner cover (M) with rubber dust unloading valve (N) pointing downward.

2. Hook latches (L) onto cover.

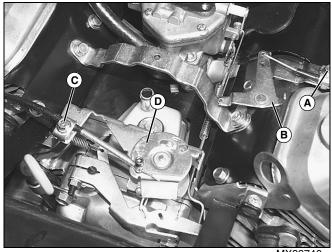
IMPORTANT: Avoid damage! Be sure breather tube is not kinked and that it is installed onto nipple as far as possible.

- 3. Install air cleaner base (J) with breather tube.
- 4. Install two air cleaner base mounting screws (I).
- 5. Install breather deflector (H) and three screws (G).
- 6. Wash secondary cleaner (F) in soap and water. Squeeze dry in a clean cloth. Saturate it in clean engine oil. Wrap it in clean absorbent cloth and squeeze to remove excess oil.
- 7. Clean cartridge (E) by tapping gently on a flat surface. If very dirty, replace.
- 8. Install pre-cleaner over cartridge.
- 9. Install cartridge (E) with pre-cleaner (F), plate (D), and secure with knob (C).

# Throttle and Choke Cable Removal and Installation

Procedure:

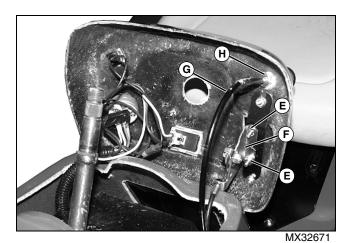
- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Raise rear body cowling.
- 3. Remove engine air cleaner assembly.



MX32746

- 4. Loosen clamp screw (A) and disconnect choke cable from choke control (B).
- 5. Loosen clamp screw (C) and disconnect throttle cable from control bracket (D).
- 6. Loosen dash panel to access throttle lever. See "Dash Panel Removal and Installation" on page 140 in the Miscellaneous section.

NOTE: Remove throttle knob on other side of front panel assembly before attempting to remove cable.



- 7. Remove two screws (E) attaching throttle cable bracket (F) to front panel assembly.
- 8. Remove choke cable (G) by loosening nut (H).
- 9. Pull cables out and inspect for damage. Replace if necessary.

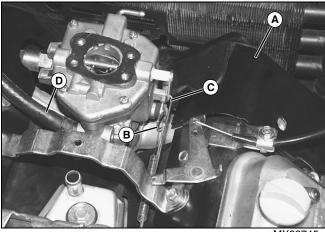
Installation is in reverse order of removal.

### **Carburetor Removal and Installation**

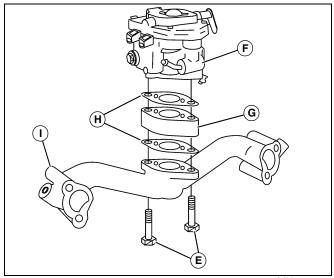
#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove engine air cleaner.
- 3. Remove air cleaner base and breather tube.

NOTE: The engine is equipped with fuel shutoff solenoid. The blower housing should be removed so that the solenoid wire can be properly routed during reassembly. Disconnect fuel shutoff solenoid wire from equipment switch wire.



- MX32745
- 4. Remove blower housing (A).
- 5. Remove throttle control bracket and disconnect throttle linkage (B) from carburetor.
- 6. Remove choke control bracket and disconnect choke linkage (C) from carburetor.
- 7. Remove fuel line (D) from carburetor.

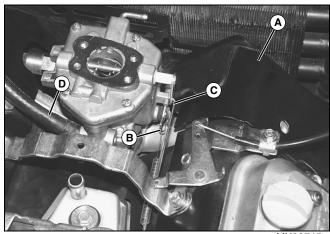


MX32801

8. Remove two capscrews (E), carburetor (F), spacer (G), and two gaskets (H) from manifold (I).

### Installation:

1. Install spacer, gaskets and carburetor. Tighten two capscrews to 7 N•m (65 lb-in.).



MX32745

- 2. Install fuel line (D) onto carburetor.
- 3. Install throttle linkage (B) and choke linkage (C) onto carburetor.
- 4. Install blower housing (A).
- 5. Install engine air cleaner. See "Air Cleaner Removal and Installation" on page 34.

IMPORTANT: Avoid damage! Be sure breather tube is not kinked and that it is installed onto nipple as far as possible.

6. Install air cleaner cartridge, pre-cleaner and cover.

NOTE: Make sure air inlet tube is installed correctly in air cleaner base.



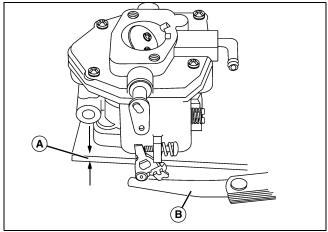
CAUTION: Avoid injury! Static governor adjustment must be made whenever carburetor or manifold has been removed from engine. Failure to make static adjustments first could result in engine overspeeding and may result in engine or equipment damage causing personal injury or property damage.

### **Specifications:**

### **Carburetor Inspection**

IMPORTANT: Avoid damage! A clean fuel system is necessary in order to maintain proper operation of the engine. Gummy or dirty fuel tanks and carburetors should be cleaned in a carburetor cleaner such as Bendix Carburetor cleaner or equivalent. DO NOT soak rubber, neoprene or plastic parts in cleaner.

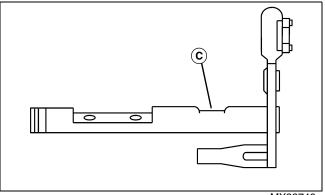
- 1. Check all moving parts for wear, nicks and burrs. Replace, if worn or damaged.
- 2. Check all mating surfaces for nicks, burrs, foreign material, or cracks. Replace all damaged parts.
- 3. Inspect throttle and choke shaft and bushings for wear. Wear between throttle shaft and bushing should not exceed 0.25 mm (0.010 in.).



M32748

- 4. Placing carburetor on a flat surface (plate carburetor is on shown above), check that wear measures 6.35 mm (0.25) (A)) or less. Measure the distance between the throttle lever and flat surface with a feeler gauge while moving shaft up and down.
- 5. If the difference is greater than 0.25 mm (0.010 in.) (B), this indicates that the throttle shaft and/or bushings are worn.

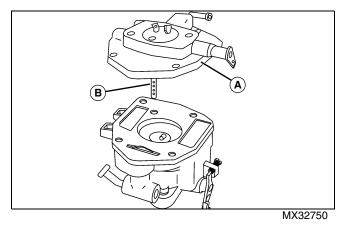
NOTE: The inspection in the next step is performed after the carburetor has been disassembled.



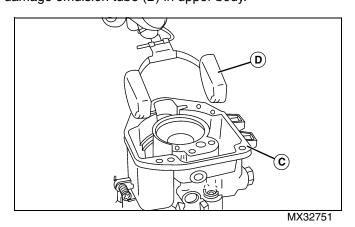
- 6. Throttle shaft wear can be checked by comparing the worn (C) and unworn portions of the shaft.
- 7. Choke shaft and bushings are checked in the same manner.
- 8. Throttle and choke shaft are replaceable. If throttle or choke shaft bushings are worn, replace carburetor.

### **Carburetor Disassembly**

#### **Procedure:**



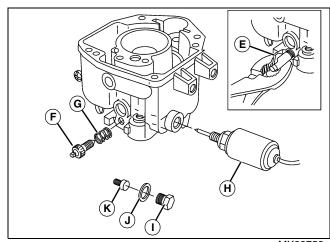
1. Remove four screws and upper body (A). Do not damage emulsion tube (B) in upper body.



2. Remove and discard gasket (C).

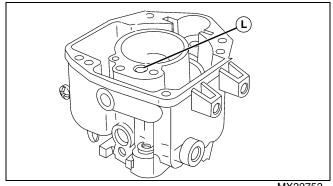
3. Remove float (D) and inlet needle.

NOTE: If idle mixture screw is equipped with adjustment limiter cap (E), use a pliers and remove it before removing idle mixture screw.



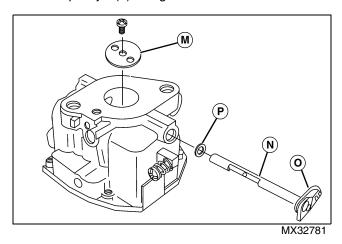
MX32752

- 4. Remove idle mixture screw (F) and spring (G).
- 5. Remove fuel shutoff solenoid (H), if equipped, or plug (I) and washer (J).
- 6. Remove fixed main jet (K) using a screwdriver.



MX32753

7. Remove pilot jet (L) using screwdriver.

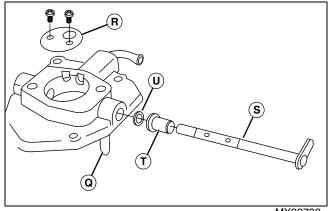


8. The top and bottom edges of the throttle plate are

beveled. Mark throttle plate (M) before removal to ensure reinstallation in the orginal position.

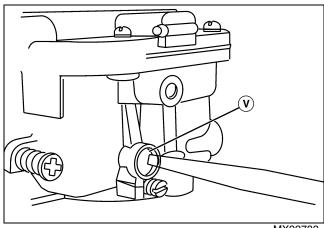
- 9. Remove throttle shaft (N) and spacer (O).
- 10. Remove throttle shaft seal (P).

NOTE: Support upper body on a vise or wood block so that emulsion tube (Q) will not be damaged.



MX32782

- 11. Mark choke plate (R) before removal to ensure reinstallation in the original position.
- 12. Remove choke shaft (S) and spacer (T).
- 13.Remove seal (U).



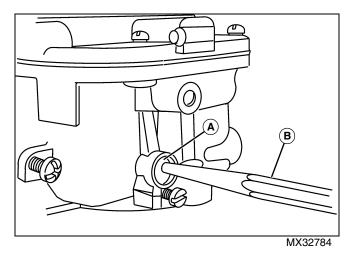
MX32783

14. Remove transitional hole welch plug (V) with a punch, as shown.

### **Carburetor Assembly**

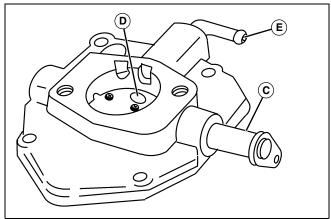
IMPORTANT: Avoid damage! When assembling the carburetor, use new seals and gaskets.

### Procedure:



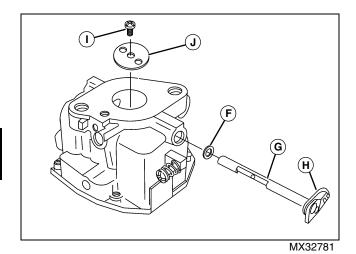
1. Install new transitional hole welch plug (A). Use a round punch (B) and tap in plug until it is flat. Use a sealant such as Permatex® #2 or nail polish on outside diameter of plug to prevent air leaks.

NOTE: Use Loctite® 222 on screw threads.



MX32785

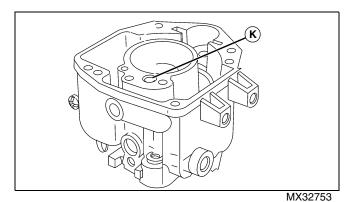
- 2. Install new choke shaft seal with sealing lip in.
- 3. Install choke shaft and spacer (C).
- 4. Install choke plate (D) with vent hole facing bowl vent nipple (E).



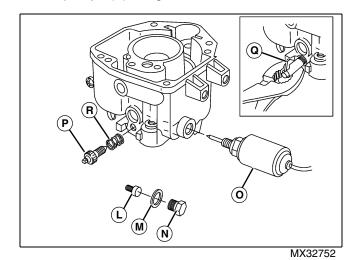
- 5. Install new throttle shaft seal (F) with sealing lip in.
- 6. Install throttle shaft (G) and spacer (H).

### NOTE: Use Loctite® 222 on screw threads (I).

7. Install throttle plate (J) to throttle shaft.



8. Install pilot jet (K) using screwdriver.



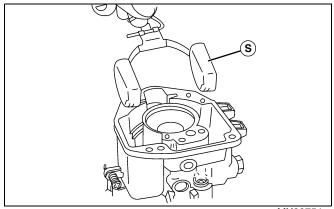
9. Install fixed main jet (L) using screwdriver.

10.Install washer (M) and plug (N) or fuel shutoff solenoid (O). Tighten to 5 N•m (45 lb-in.).

NOTE: Do not tighten screw (P). Do not install limiter cap (Q) at this time.

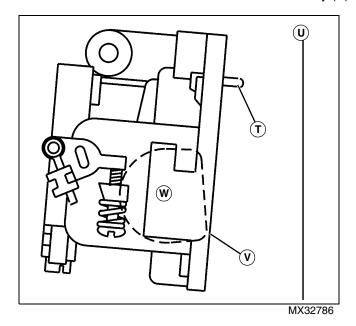
11.Install idle mixture screw (P) and spring (R).

NOTE: Use brass inlet needle for fuel pump carburetors.



MX32751

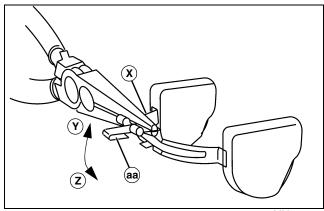
12. Assemble inlet needle to float. Install float assembly (S).



### 13.Set float height:

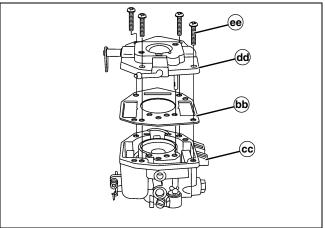
- a. Hold the carburetor in one hand and place the index finger on the float hinge pin (T).
- b. While holding the float hinge pin down, turn the carburetor to a position past vertical (U). This allows the weight of the float to close the inlet needle.
- c. Float height should be 1.6 mm (1/16 in.) below machined surface (V).

NOTE: Float height is the dimension between the top flat area of the float just before the radius (W) and the machined surface (V) of the carburetor.



MX32787

d. Adjust float level by holding float arm at (X) with needle nose pliers. Carefully bend tang clockwise (Y) to raise the float level, and counterclockwise (Z) to lower the float level. Do not collapse hooked end of float tang (aa).



MX32788

- 14.Place new gasket (bb) on lower carburetor body (cc). Make sure holes in body line up with holes in gasket.
- 15.Install upper carburetor body (dd). Tighten screws (ee) securely.

### **Specifications:**

Solenoid torque ...... 5 N•m (45 lb-in.)

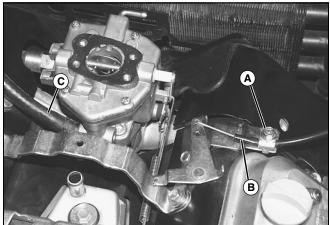
### **Engine Removal and Installation**

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Allow engine to cool before removing the engine.
- 3. Remove:
  - Mid-mount implement or rear implement (if equipped). See procedure in Attachments section.
  - Rear cowling. See "Hood Removal and Installation" on page 141 in the Miscellaneous section.

### NOTE: Engine oil capacity is 1.4 L (1.5 qt).

- 4. Drain engine oil.
- 5. Disconnect battery negative (-) terminal ground cable. Disconnect positive (+) battery cable. Remove battery.
- 6. Remove engine air cleaner. See "Air Cleaner Removal and Installation" on page 34.
- 7. Remove engine air cleaner base and breather tube.



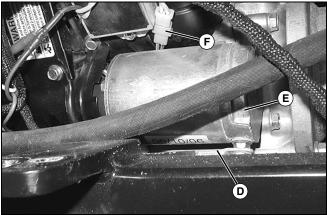
MY327/15

8. Loosen cap screw (A) and disconnect cable (B) from bracket.



CAUTION: Avoid Injury! Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.

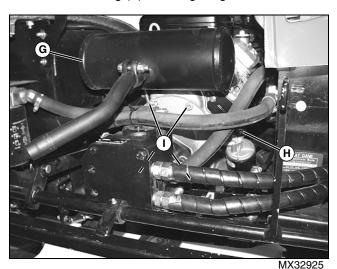
9. Remove fuel line (C) from carburetor. Plug fuel line.



MX32919

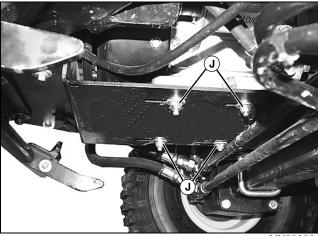
10.Disconnect positive wiring lead (D) from starting motor (E).

11. Disconnect wiring (F) to voltage regulator.



12.Remove muffler (G).

- 13.Disconnect wiring lead (H) for oil sender on oil filter flange.
- 14.Remove four capscrews (I) securing pump flange to engine.



MX32926

15.Remove four capscrews and nuts (J), and remove engine using a hoist suitable to load and safety needs.

### Installation:

Installation is the reverse of removal:

- Tighten four engine mounting bolts and flange nuts to specification.
- Apply MPG-2® Polymer Multipurpose Grease to engine crankshaft before installing pump flange.
- Fill engine to proper level with oil of correct specifications. See Specifications and General Information section.
- Inspect muffler flanges for flatness. Install muffler with new gaskets. Tighten exhaust manifold bolts to specification.
- · Adjust throttle and choke linkage

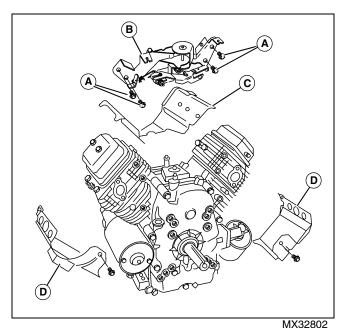
### **Specifications:**

<b>Engine Mounting Bolt Torque</b>	23 N•m (204 lb-in.)
Clutch Mounting Bolt Torque	75 N•m (55 lb-ft)
<b>Exhaust Manifold Bolt Torque</b>	20 N•m (180 lb-in.)
Oil Capacity With Filter	1.4 L (1.5 qt)

### Air Guides Removal and Installation

#### Removal:

- 1. Remove blower housing.
- 2. Remove engine air cleaner assembly.
- 3. Remove carburetor and carburetor linkage.



- 4. Remove screws (A) and governor control bracket (B).
- 5. Remove bolts securing valley cover (C) and right and left side air guides (D).

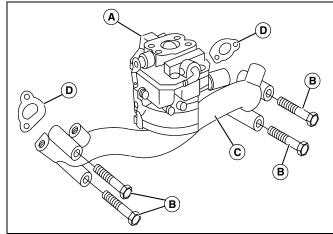
### Installation:

Installation is the reverse of removal.

### Intake Manifold Removal and Installation

#### Removal:

- 1. Remove upper blower housing.
- 2. Remove engine air filter assembly.



MX32803

- 3. Remove carburetor (A).
- 4. Remove intake manifold bolts (B) and intake manifold (C).

#### Installation:

NOTE: Use new intake manifold and carburetor gaskets (D).

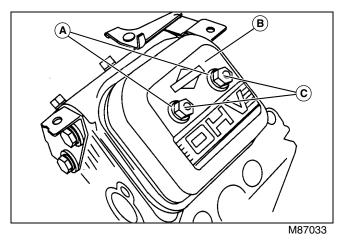
Installation is the reverse of removal.

### **Cylinder Head Removal and Installation**

IMPORTANT: Avoid damage! Mark all parts when disassembling cylinder heads to prevent interchanging.

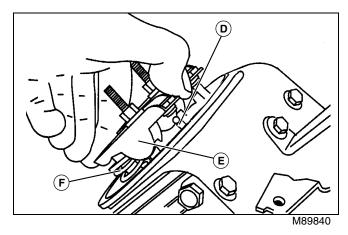
### Removal:

- 1. Disconnect spark plug leads and remove spark plugs.
- 2. Remove intake manifold.
- 3. Remove cylinder air guides.

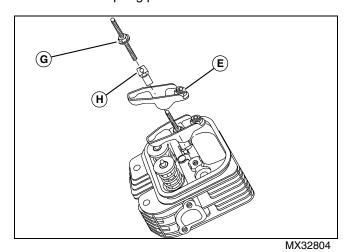


4. Remove nuts (C), seal washers (A), and valve cover (B).

NOTE: To release spring (F) pressure from rocker arm (E), rock the arm against spring pressure and allow push rod (D) to drop out of the rocker arm socket. Push rod will move out of position, releasing valve spring pressure.



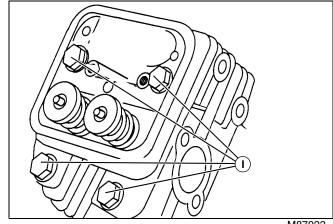
5. Release valve spring pressure.



6. Remove rocker studs (G), supports (H), and rocker arm assemblies (E). Use a 10 mm wrench for removing the studs.

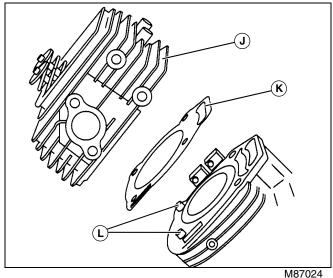
IMPORTANT: Avoid damage! Exhaust valve push rods are aluminum. Intake valve push rods are steel. Mark push rods for identification with tape or tags to prevent interchange.

7. Lift out push rods.



M87023

8. Remove cylinder head cap screws (I) and sealing washers.



9. Remove cylinder head (J) and gasket (K).

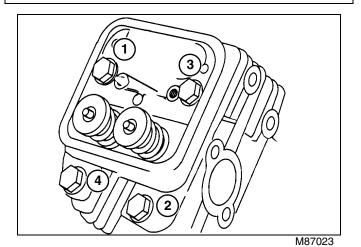
#### Installation:

1. Clean gasket surfaces.

IMPORTANT: Avoid damage! Do not use sealer of any kind on gaskets.

- 2. Place new gasket and cylinder head on cylinder. Align head with cylinder head alignment sleeves (L) located in the cylinder.
- 3. Apply approved lubricant to threads and install four cylinder head cap screws.

IMPORTANT: Avoid damage! Do not tighten one bolt down completely before the others, as it may cause a warped cylinder head.

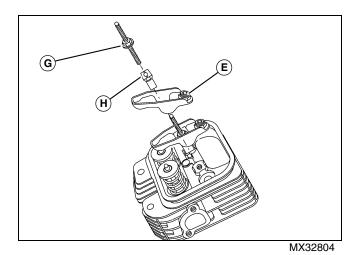


4. Tighten four bolts down evenly by hand. Then, using torque wrench, tighten cylinder head bolts in sequence shown in 6 N•m (55 lb-in.) increments to 19 N•m (165 lb-in.).

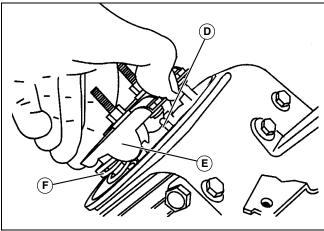
IMPORTANT: Avoid damage! Exhaust valve push rods are aluminum. Intake Valve push rods are steel. Mark push rods for identification with tape or tags to prevent interchange.

5. Insert push rods into recess in tappets.

NOTE: The holes in the rocker shaft supports (H) are offset. Install supports with holes toward the ends of the rocker shaft.

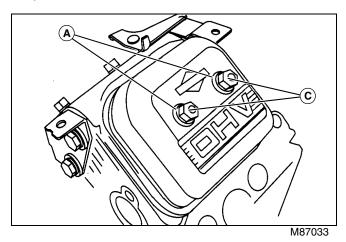


6. Assemble rocker arms (E), supports (H) and studs (G) and install on cylinder head.



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- 7. Compress valve spring (F) with rocker arm (E) and insert push rod (D) into rocker arm socket. Be sure push rods remain seated in recess in tappets.
- 8. Tighten rocker studs to 16 N•m (140 lb-in.).
- 9. Adjust valves.



10.Install gasket and valve cover. Place seal washers (A) and nuts (C) on studs.

11.Install intake and exhaust manifold, governor control bracket, cylinder air guides, valley cover, blower housing and air cleaner assembly.

12.Install spark plugs and tighten to specification.

13.Install spark plug leads.

**Torque Specification:** 

Rocker Studs . . . . . . . . . . . . . . . . . 20 N•m (180 lb-in.)

### Cylinder Head Inspection and Repair

#### Procedure:

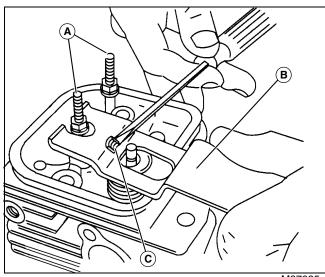
IMPORTANT: Avoid damage! Use care to prevent combustion chamber deposits from entering push rod or oil return cavity in cylinder. Take care not to damage cylinder, top of piston, cylinder head and cylinder head gasket surfaces. Remove only the combustion chamber deposits. It is not necessary to remove the discoloration marks on the piston, valves and cylinder head. These marks are normal and will not affect engine operation.

- 1. Remove combustion chamber deposits from combustion chamber and around valves using a soft, hand wire brush or scraper. With piston at top dead center, remove combustion chamber deposits from top of piston.
- 2. Inspect cylinder head for broken fins or cracks. Repeat procedure for other cylinder head and cylinder.

### Valve Removal

#### Procedure:

1. Remove the valves, place cylinder on workbench with support to hold valves in place.

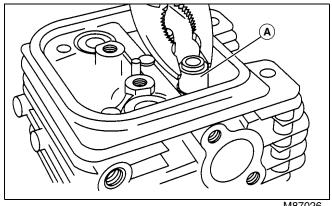


- 2. Reinstall rocker studs (A) into cylinder head. Do not tighten. Slip end of Valve Spring Compressor (B) under stud of valve spring. Press down on tool handle to compress valve spring and remove split retainers (C).
- 3. Release pressure and remove retaining washer and spring.
- 4. Remove rocker studs.
- 5. Repeat procedure on other cylinder head.

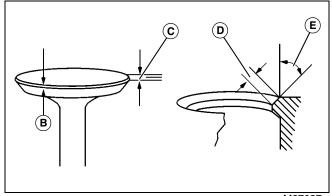
### Valve Inspection and Repair

#### Procedure:

IMPORTANT: Avoid damage! Always replace valve stem seals whenever valves are removed for servicing.



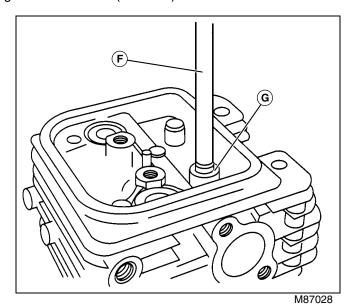
1. To remove valve stem seals (A), grasp seal with pliers and pull up on seal while turning.



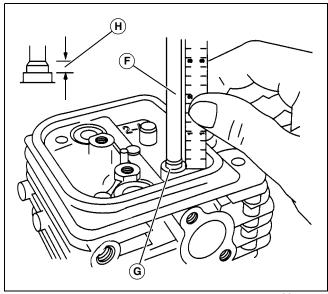
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- 2. Faces on valves may be resurfaced with a valve grinder to 45° (E). Valve seats can be reconditioned using Valve Seat Cutter. Valves and seats should then be lapped with Valve Lapping Tool and Valve Lapping Compound. Remove grinding marks and assure a good seal between valve and seat. Thoroughly clean lapping compound from valve seat and valve face.
- 3. Valve margin (B) should be 0.8 (0.030 in.) (C). If 0.4 mm (0.0156 in.) or less, resurface or replace valve.
- 4. Valve seat width (D) should be 1.2 1.6 mm (0.047 -0.062 in.).
- 5. If seat is wider, it may be narrowed using Valve Seat Cutter. Use 30° side of cutter to narrow the seats. If the valve is badly burned, it should be replaced. Replace valve if margin is badly burned; if damaged, replace cylinder head. Valve seats are not replaceable.
- 6. Inspect valve springs and replace if broken or worn.

7. Inspect valve guides by inserting plug gauge into valve guide. If plug gauge inserts 6.4 mm (0.250 in.) or more, the guide must be replaced. If plug gauge is not available, the rejection dimension for both intake and exhaust valve guides is 6.05 mm (0.238 in.).



8. To remove valve guides (G), use Bushing Driver (F). Support cylinder head and press out valve guide.



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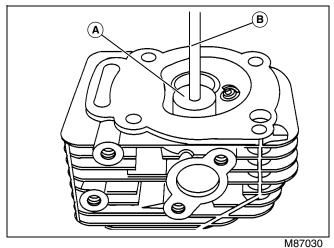
9. To install new valve guides (G), place new valve guide on Bushing Driver (F). Valve guide can be installed either way. Press in valve guide to dimension 7.0 mm (0.281 in.) (H).

### **Specifications:**

Valve margin . . . . . . . . . . . . 0.8 mm (0.030 in.) Valve seat width . . . . . 1.2 - 1.6 mm (0.047 - 0.062 in.)

### **Valve Guide Ream**

#### Procedure:



(B) and

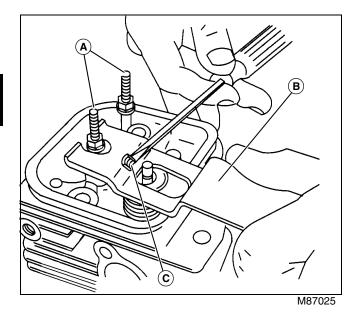
1. To ream valve guides, use Finish Reamer (B) and Reamer Pilot Guide (A) to finish ream valve guide. Use oil, Stanisol or kerosene to lubricate reamer. Ream through entire guide. Keep turning reamer clockwise when removing reamer. Flush out all chips.

IMPORTANT: Avoid damage! Insure Valve Guide lubricant is not on valve face, seat or end of valve stem.

2. Install new seals over valve guides. Press down on seal until it bottoms. Valve stems must be free of foreign material and burrs or sticking will occur and valve stem seals will be damaged. Be sure valve guides are free of foreign materials and burrs. Lightly coat valve stems with Valve Guide Lubricant and insert valves into valve guides.

### Valve Installation

#### Procedure:



- 1. Install springs and valve spring retainers over valve stems. Temporarily install rocker studs (A) in cylinder head.
- 2. With Valve Spring Compressor (B), compress spring and install split retainers (C). Repeat procedure for other valves.
- Remove rocker studs.

### Piston, Rings & Rod Removal and Installation

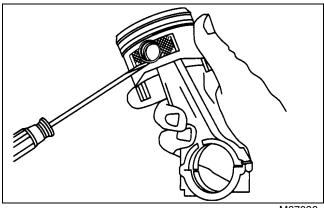
#### Procedure:

- 1. Remove air filter and bracket, upper blower housing, flywheel, alternator, carburetor, intake manifold and governor linkage.
- 2. Remove starting motor, cylinder heads and crankcase cover.

IMPORTANT: Avoid damage! When servicing pistons, rings, piston pins or rods, each rod, piston, piston pin and ring set must be kept as a set for the cylinder that it was removed from. Mark each set before removing from the engine.

NOTE: Remove any carbon or ridge at the top of the cylinder bore. This will prevent breaking the rings when removing the piston and connecting rod from the engine.

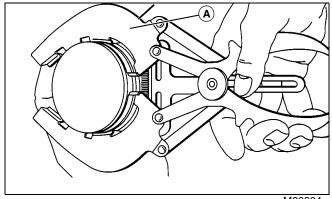
3. Remove the connecting rod cap. Then push the piston and connecting rod out through the top of the cylinder.



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4. To remove connecting rod from piston, remove piston pin locks with screwdriver. Piston pin is a push fit in piston and rod. Deposits may build up on piston pin and require the piston pin to be pressed out.

IMPORTANT: Avoid damage! Remove top and center compression rings using ring expander (A). New piston rings must be installed whenever the engine is disassembled for major servicing or overhaul, providing that cylinder bores are within specifications.



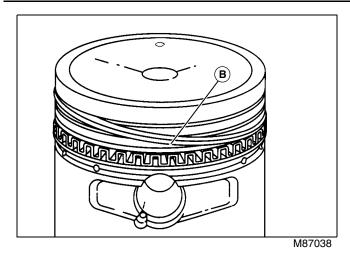
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5. Remove top and center compression rings.

NOTE: Measure cylinder bores before checking pistons and rings. If cylinder bores require re-sizing it will not be necessary to check pistons and rings since a new oversized piston assembly will be used.

6. If cylinder bore is more than 0.08 mm (0.003 in.) oversize, or 0.04 mm (0.0015 in.) out of round, it must be resized.

NOTE: Oil control ring (B) is shown being spiraled into compression ring groove.



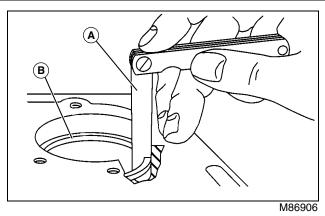
7. Spiral top oil control ring (B) from oil ring groove into center compression ring groove. Repeat into top compression ring groove, and then off piston. Repeat for bottom oil control ring.

### **Checking End Gap:**

NOTE: If the cylinder is to be resized, there is no reason to check the piston, since a new oversized piston assembly will be used. If however, the cylinder is not to be resized and the piston shows no signs of wear or scoring, the piston rings must be replaced.

1. Insert old rings one at a time approximately 25.4 mm (1.0 in.) down into a cylinder bore.

CAUTION: Avoid injury! The top and bottom edges of the ring may be extremely sharp. Never reuse worn piston rings.



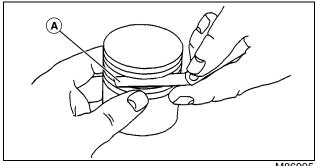
- 2. Check end gap with feeler gauge (A). If ring gap is greater than 0.76 mm (.030 in.) for compression and oil ring (B), the ring is worn and should be replaced.
- 3. A worn ring will usually show scratches caused by abrasives and/or have a shiny appearance. Never reuse worn piston rings.

NOTE: Before installing new piston rings, the cylinder bore should be reconditioned using a rigid hone with finishing stones. This will restore the proper cross hatch angle in the cylinder bores. The correct cylinder cross hatch ensures proper lubrication and piston ring rotation.

### **Piston Inspection**

#### **Procedure:**

- 1. Clean carbon from top two ring grooves.
- 2. Place a new ring in each piston groove.

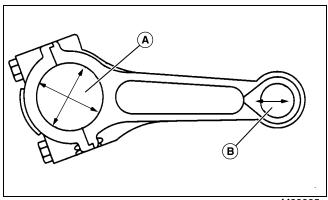


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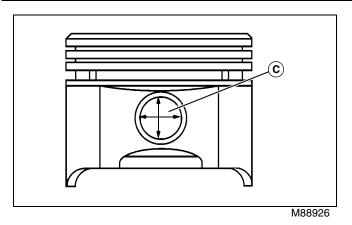
3. If a 0.10 mm (.004 in.) or larger feeler gauge (A) can be inserted in the compression ring grooves, or a 0.20 mm (.008 in.) or larger feeler gauge can be inserted in the oil ring grooves, the compression and ring grooves are worn and the piston should be replaced.

### **Connecting Rod Inspection**

### **Procedure:**



- 1. If the crankpin bearing (A) in the connecting rod is scored, the rod must be replaced. Reject size of crankpin bearing and piston pin bearing (B) is as follows:
- 2. Replace connecting rod if either bore is worn.
- 3. Reject sizes for piston pin and piston pin bore (C) are as follows:



4. If piston pin is worn 0.01 mm (0.005 in.) out of round or below reject size, it must be replaced.

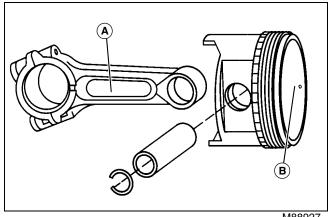
### **Specifications:**

### **Wear Limits**

**Crankpin bearing . . . . . . . . . . . . . . . . . 37.12 mm (1.4615 in.)** Piston pin . . . . . . . 17.07 - 17.08 mm (0.672 - 0.673 in.) Piston pin bore . . . 17.09 - 17.10 mm (0.673 - 0.674 in.)

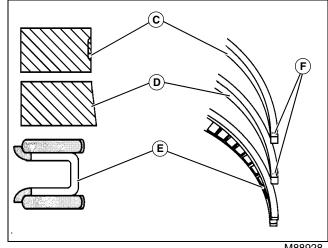
## **Assemble Piston Rod**

### Piston and Rod:

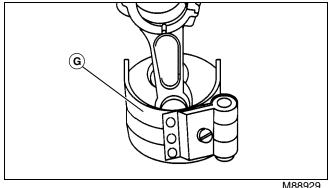


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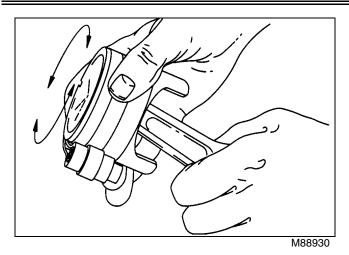
1. The piston pin is a slip fit in both piston and connecting rod. Use a thin nose pliers or screwdriver and install a piston pin lock in groove on one side of piston. Refer to above drawing to determine correct location of rod ("Out 1" Cylinder number one, or "Out 2" Cylinder number two) (A) in relation to notch or circle (B) on piston. Insert piston pin from opposite side of piston until pin stops against piston pin lock. Then install other piston pin lock. Be sure both locks are seated in grooves.



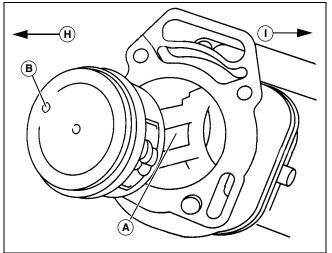
- M88928
- 2. The correct piston ring positions are shown above. The oil ring is installed with the expander (E) between the two oil control rings. The top and second compression rings are installed with "I.D." mark toward top of piston (F).
- 3. Install expander first. Spiral bottom oil control ring into top ring groove, then into second ring groove and into position below expander. Repeat procedure for top oil control ring.
- 4. Using ring expander, install center compression ring (taper face) (D) then, top compression ring (barrel face) (C) as shown above.



5. Apply oil to piston rings, piston skirt and compress rings with ring compressor tool (G). Place piston and ring compressor upside down on bench and push down until head of piston and edge of ring compressor are even. Tighten ring compressor until rings are fully compressed. Then loosen ring compressor very slightly so that compressor can be rotated on piston skirt while holding connecting rod.

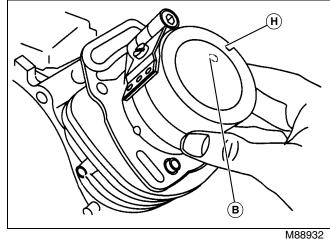


NOTE: The pistons have offset piston pin bores. When the Circle (B) on piston is facing toward the flywheel side (H) of engine, the words "OUT-1" on the side of the connecting rod for cylinder No. 1 and "OUT-2" on the side of the connecting rod for cylinder No. 2 (A) should face toward the PTO side (I) of the crankcase.

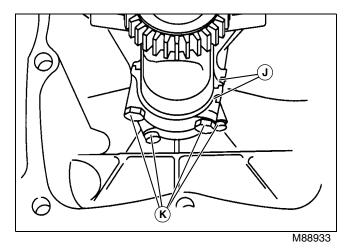


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6. Thoroughly clean and then oil cylinder bore. Rotate crankshaft until crankpin journal is at bottom of stroke. This permits complete entry of compressed rings, piston and rod assembly, when pushed into cylinder. If other piston and rod assembly was removed, repeat procedure for that cylinder.



- 7. Clean and oil crankshaft crankpin.
- 8. Pull connecting rod against crankpin.



9. Install rod cap with match marks (J) aligned.

NOTE: Failure to use a torque wrench can result in loose connecting rods causing breakage, or tight connecting rods causing scoring.

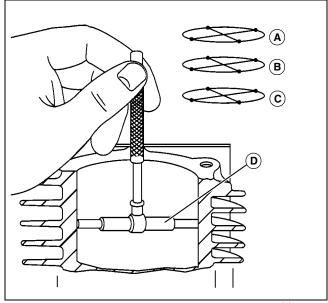
- 10.Install connecting rod screws (K) and tighten to specification.
- 11. Rotate crankshaft two (2) revolutions to check for binding. Rod should also be free to slide sideways on crankpin.

### Specification:

Connecting rod screws . . . . . . . . . . 13 N•m (115 lb-in.)

### **Cylinder Bore Inspection**

#### Procedure:



- 1. Always inspect cylinder after engine has been disassembled. Visual inspection will show if there are any cracks, stripped bolt holes, broken fins or if the cylinder walls are damaged. Use a telescoping gauge (D), and dial caliper, or an inside micrometer to determine the size of the cylinder bore. Measure at right angles and at six locations from the top (A), middle (B) and bottom (C).
- 2. If the cylinder bore is more than 0.03 mm (0.001 in.) oversize, or 0.04 mm (0.0015 in.) out of round, it must be resized, or replaced.
- 3. If cylinder bores are within specification and show no signs of scoring or other damage, new pistons rings may be installed providing the cylinder bores are reconditioned using a rigid hone with finishing stones. This will restore the proper cross hatch angle in the cylinder bores. The proper cylinder cross hatch ensures proper lubrication and piston ring rotation.

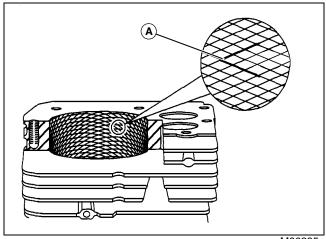
### **Specifications:**

Standard bore size . . . . . . . . . . . . . . . . . 68.0 mm (2.677 in.) Standard bore (maximum)) . . . . . 68.025 mm (2.684 in.)

### **Cylinder Bore Honing**

#### Procedure:

NOTE: To produce the proper cross hatch finish use a drill speed of approximately 200 rpm and 40 - 60 strokes per minute. Lubricate hone liberally to prevent build up on finishing stones.



- M86885
- 1. The cylinder finish, (Cross Hatch) should be applied after cylinder bore has been resized to within 0.038 mm (0.0015 in.) of the desired size or when reconditioning a cylinder bore. The finishing stones will produce the correct cross hatch necessary for proper lubrication and piston ring rotation. The correct hatch angle is approximately 45° (A).
- 2. It is recommended that the cylinder bores be reconditioned to restore the cross hatch when new piston rings are to be installed in a cylinder that is within specification. Be careful not to hone oversize or it will be necessary to resize the cylinder.

# **Cylinder Bore Cleaning**

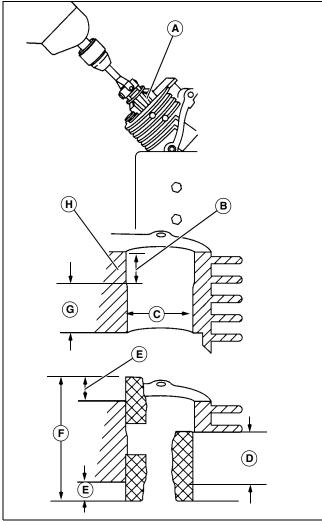
IMPORTANT: Avoid damage! Ensure that the entire cylinder and crankcase are thoroughly cleaned after honing. First wash the cylinder and crankcase carefully in a solvent such as kerosene or commercial solvent. Then thoroughly wash cylinder and crankcase using a stiff brush with soap and hot water, Rinse thoroughly with hot running water. Repeat washing and rinsing until all traces of honing grit are gone. Honing grit is highly abrasive and will cause rapid wear to all of the internal components of the engine unless it is completely removed.

#### Procedure:

1. When cylinder and crankcase have been thoroughly cleaned, use a clean white rag or napkin and wipe the cylinder bore. If honing grit is present it will appear as a gray residue on rag. If any honing grit is evident, re-wash and rinse entire cylinder and crankcase and check again. When there is no trace of honing grit on rag, the cylinder is properly cleaned. Then oil cylinder bore to prevent rusting.

### **Resizing Cylinder Bore**

### Procedure:



M88942

- 1. If the cylinder bore is not within specifications, it will have to be resized using a boring bar or hone. Always resize to exactly 0.51 mm (0.020 in.) over standard size.
- 2. If this is done accurately, the service oversize rings and pistons will fit perfectly and proper clearances will be maintained.

IMPORTANT: Avoid damage! If a boring bar is used, a hone must be used after the boring operation to produce the proper cylinder cross hatch. See "Cylinder Bore Honing".

- 3. If a hone is used to resize the cylinder bore, place hone (A) in middle of cylinder bore (C). Tighten adjusting knob with finger until stones fit snugly against cylinder wall. DO NOT FORCE.
- 4. Connect drive shaft to hone. Be sure that cylinder and hone are centered and aligned with drive shaft and drill spindle. Lubricate hone as recommended by hone manufacturer.
- 5. The recommended drill speed is 300 to 700 rpm maximum and 40 60 strokes per minute.
- 6. Because cylinder bores normally wear (H) only in the area of ring travel (B), the cylinder bore will be round above and below ring travel (G).
- 7. Start drill and, as hone spins, move it up and down at the bottom of the cylinder bore (D).
- 8. Gradually increase the length of the strokes until hone travels full length of cylinder bore (F). Do not travel more than 19.05 mm (0.750 in.) to 25.4 mm (1.0 in.) above cylinder bore (E).
- 9. Lubricate hone frequently to prevent build up on stones.
- 10.As cutting tension decreases, stop hone and tighten adjusting knob following hone manufacturer's recommendations.
- 11. Check cylinder bore size frequently.
- 12. Check cylinder bores at top and bottom for burrs. Remove burrs. Cylinder head and crankcase cover surfaces must be free of burrs and gasket material.
- 13. After cylinder bore has been brought to proper resizing dimension, a cross hatch must be applied to bore.

#### **Specifications:**

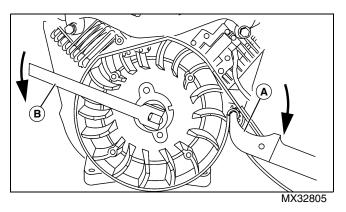
Standard bore size............ 68.0 mm (2.677 in.)

Oversize bore.................. 68.025 mm (2.684 in.)

### Flywheel Removal and Installation

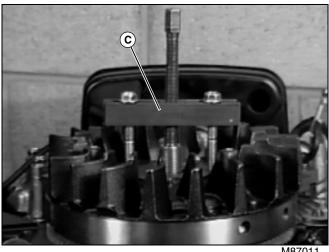
### Procedure:

- Remove rotating screen.
- 2. Remove blower housing.



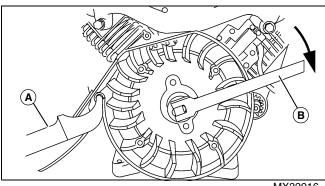
- 3. Prevent flywheel from turning with flywheel strap wrench (A) around the outer rim of flywheel.
- 4. Turn the flywheel nut counterclockwise with a 1/2" breaker bar (B) and a 30 mm socket to remove.

**IMPORTANT: Avoid damage! Protect crankshaft** threads during flywheel removal.



M87011

- 5. Install Flywheel puller (C) turning puller screws into flywheel puller holes evenly. Tighten puller screws equally until flywheel loosens.
- 6. Remove flywheel.
- 7. Flywheel should be inspected for cracks, broken flywheel fins, burrs on taper or keyway and distortion of keyway. Also check taper of crankshaft for burrs, rust or other damage. Replace crankshaft, if damaged.
- 8. Before installing flywheel, clean taper and crankshaft taper removing all oil, dirt or grease.
- 9. Install flywheel.
- 10.Install flywheel nut.



MX32916

11. Place flywheel holder (A) on fan retainer with lugs of flywheel holder engaging the slots of the fan retainer. While holding flywheel holder, tighten flywheel nut to specification.

### **Torque Specification:**

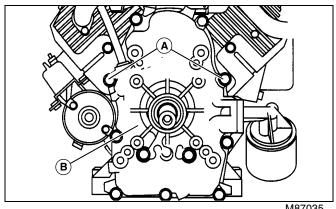
### **Crankshaft Removal and Installation**

#### Removal:

- 1. Remove governor lever and disconnect governor link and springs. Remove governor control bracket. Remove oil fill tube and dipstick assembly.
- 2. Remove exhaust manifold, intake manifold and cylinder heads.

**IMPORTANT: Avoid damage! DO NOT remove dowel** pins.

NOTE: Before crankcase cover is removed, it is recommended that any rust, paint or burrs be removed from power take off end of crankshaft. This will eliminate or reduce chances of damaging the crankcase cover bearing.

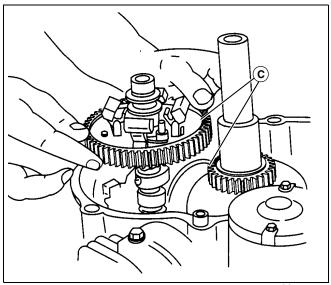


M87035

3. Remove crankcase cover (B). If crankcase cover sticks, tap lightly with soft hammer on alternate sides near dowel pins (A).

- 4. Tip engine over onto flywheel side of crankcase.
- 5. Support engine to prevent end of crankshaft from resting on workbench.

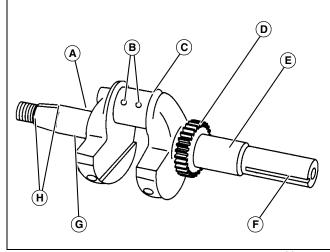
IMPORTANT: Avoid damage! If engine is rotated from this position, tappets will fall out. Tappets must not be mixed.



M88934

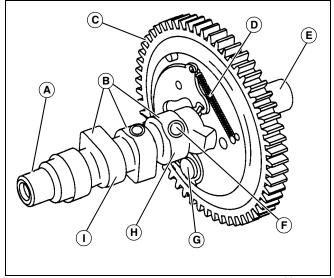
- 6. Rotate crankshaft until timing marks (C) are aligned. With cam gear in this position, the valve tappets will remain clear of cam lobes.
- 7. Lift out cam gear and governor assembly.
- 8. Mark the connecting rods and caps to prevent interchanging when reassembling.
- 9. Remove piston and connecting rod assemblies.
- 10.Remove crankshaft from crankcase.

IMPORTANT: Avoid damage! The various wear points on the crankshaft must be measured.



M88935

- A Mag. Journal
- **B** Oil Galleries
- C Crankpin
- **D** Timing Gear Teeth
- E P.T.O. Journal
- F Keyway
- **G** Oil Galleries
- H Threads and Keyway
- 11.Replace crankshaft if worn or if journals are scored. Keyways should be checked to be sure they are not worn or spread. Remove burrs from keyway edges to prevent damaging the bearing or oil seal. Check oil galleries for blockage or obstructions.



M88937

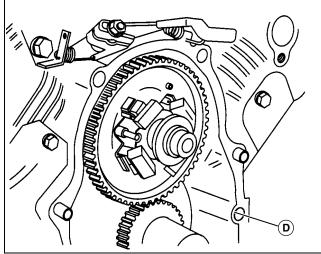
- A Mag. Journal
- **B** Cam Lobes
- C Gear Teeth
- D Spring

- E P.T.O. Journal
- F Compression Release Balls
- **G** Flywheel Pivot
- H Exhaust Lobe
- I Intake Lobe
- 12. Check timing gear teeth for chipped or cracked teeth. Replace if needed.
- 13. The compression release balls must be clean and free to move when the centrifugal weight is rotated counterclockwise. When the centrifugal weight is released, the balls should move up into the locked position.
- 14.Inspect cam gear teeth, lobes and journals for wear and nicks. Cam gear journal and lobe reject sizes are listed below.

#### Installation:

1. Governor slider must move freely on PTO journal of cam gear. Flywheel must pivot freely. Make sure flyweight spring is not stretched. Governor weights must move freely on hinge pins. Make sure hinge pins are not loose.

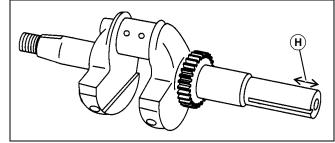
### NOTE: Be sure O-ring (D) is installed in crankcase.



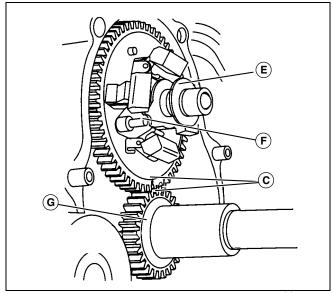
M88939

2. Place new crankcase cover gasket on crankcase.

IMPORTANT: Avoid damage! If a new crankshaft is installed, it must be cut 28.6 mm (1.125 in.) (H) from end of shaft. The cut must then be deburred and a small chamfer should be ground on the edge to ease installation of the hydraulic pump coupling.

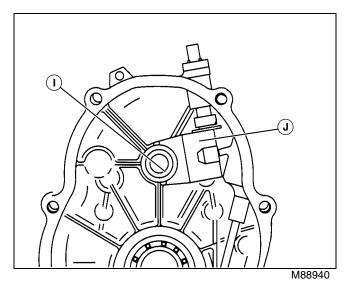


M88935



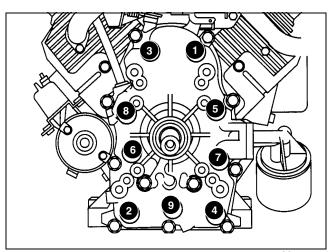
M88938

- 3. Assemble governor slider (E) onto PTO journal on cam gear making sure that slot on slider fits over locating pin (F) on cam gear. Be sure the weights are in the proper location so that they will be able to move freely without binding. Tip engine to position crankshaft horizontally.
- 4. Install crankshaft and camshaft, aligning timing marks (C) accordingly. Install thrust washer (G), if required.



5. Rotate governor shaft (J) against boss (I).

6. Take care to protect the oil seal while assembling crankcase cover. No force should be used.



M88941

- 7. Tighten cover bolts to specification in the above sequence.
- 8. Install cylinder heads.
- 9. Install flywheel.
- 10.Install intake manifold and carburetor assembly.
- 11.Install governor lever and governor springs.
- 12.Install oil fill tube and dipstick assembly. Perform static governor adjustment.
- 13.Install engine shrouding.
- 14.Install air filter assembly.

### **Specifications:**

### **Wear Limit Sizes:**

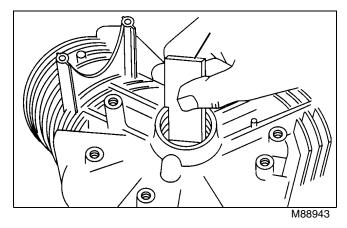
PTO journal	34.92 mm (1.375 in.)
MAG. journal	34.95 mm (1.376 in.)
Crankshaft crankpin	37.11 mm (1.461 ln.)
Cam Gear PTO journal	19.92 mm (0.784 in.)
Cam Gear MAG. journal	15.93 mm (0.627 in.)
Cam Lobes	30.25 mm (1.191 in.)

### **Torque Specification:**

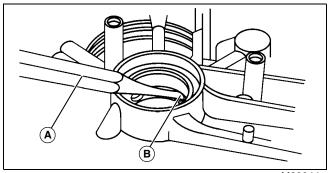
Cover Bolts . . . . . . . . . . . . . 17 Nem (150 lb-in.)

### **Magneto Bearing Inspection**

#### Procedure:

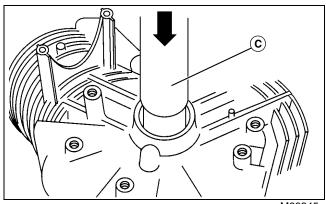


1. When checking the main magneto bearing, it should be replaced if scored or if not within tolerance.



M88944

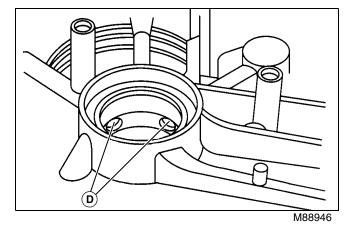
2. To remove the magneto bearing, first remove oil seal. The magneto bearing has a roll pin (B) installed in the oil gallery to prevent the bearing from turning. Use a 4.8 mm (0.1875 in.) punch (A) to drive roll pin into oil gallery.



M88945

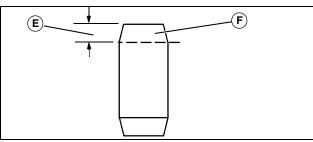
3. To remove magneto bearing, place cylinder on a suitable cylinder support. Press out old bushing with a suitable bushing driver tool (C).

NOTE: Be sure oil holes in bushing are aligned with oil gallery holes in bearing.

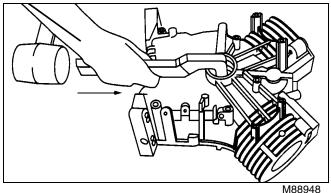


4. To install magneto bearing, place cylinder on a suitable cylinder support. Position new bushing against counterbore bearing in crankcase and carefully align oil holes (D) in bushing with oil gallery holes in bearing. Press in new bushing with a suitable bushing driver tool.

NOTE: Old roll pin was driven into oil gallery hole. Place new roll pin into second oil gallery, not into same gallery as old pin.



5. Before installing the new roll pin, grind off the taper (F), approximately 3 mm (0.125 in.) (E) from one end of new roll pin. Quench pin in water periodically to prevent loss of temper. Remove all burrs and clean thoroughly.



6. Place tapered end of new roll pin in oil hole in bearing.

Use roll pin driver, to install new roll pin. Drive in new roll pin until tool bottoms.

7. Install new oil seal using a suitable cylinder support. Press in new oil seal until it is flush with cylinder.

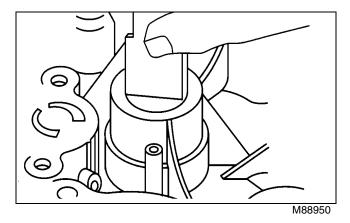
### **Specifications:**

Magneto bearing wear limit..... 30.08 mm (1.184 in.)

### **PTO and Cam Bearing Inspection**

### **Procedure:**

- 1. Remove oil pump.
- 2. Remove oil seal.



3. Inspect PTO bearing and cam bearing. The crankcase cover must be replaced if PTO bearing or cam bearing is scored or if dimensions exceed reject size.

NOTE: Always install new oil seal whenever engine is disassembled for major servicing or when repairing bearings. Always use the correct seal protector to prevent damaging oil seal.

4. Install new PTO oil seal using a cylinder support. Press in seal until it is flush with mounting surface.

### **Specifications:**

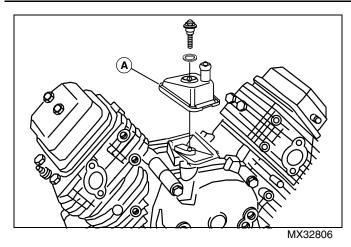
PTO end bearing wear limit..... 35.07 mm (1.381 in.) Cam Bearing wear limit . . . . . . . . 20.04 mm (0.789 in.)

### **Breather Valve Service**

The engine utilizes a breather valve to control and maintain a vacuum in the crankcase. The breather valve closes on the up stroke of the piston and opens on the down stroke of the piston to maintain a vacuum in the crankcase. This vacuum prevents oil leakage past piston rings, valve guides, oil seals, governor shaft and gaskets.

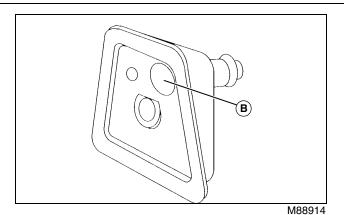
### Procedure:

NOTE: A leak at the seal between the tube and crankcase cover, or at the seal at the upper end of the dipstick, can result in a loss of crankcase vacuum and a discharge of oil or smoke through the muffler.

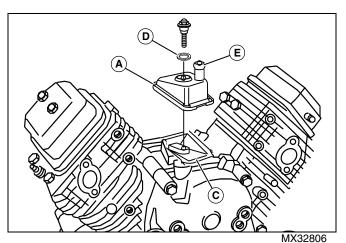


1. Before breather valve assembly (A) can be removed for inspection, the air cleaner assembly and support bracket must be removed.

# IMPORTANT: Avoid damage! Do not use force on reed valve.



2. The reed valve is spring loaded and must make a complete seal around the vent hole in breather body. Check to see that reed valve (B) is not deformed.

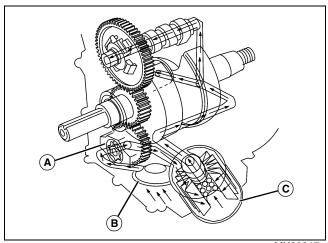


3. When installing breather (A), make sure breather gasket (C) is located properly.

- 4. Place breather on gasket (C). Slip large O-ring (D) onto mounting screw and install screw and tighten to specification.
- 5. The breather is vented through the air cleaner to prevent dirt from entering the crankcase. Check breather tube attached to fitting (E) on breather assembly for cracks, holes or hardening. Replace if damaged.

### Specification:

### **Oil Pump Removal**



MX32917

This engine is equipped with a full pressure lubrication system with an oil filter.

The gear driven oil pump supplies lubrication to all bearing journals.

The oil pump (A) draws oil through a screened pick up (B) in the engine base and pumps the oil through the oil filter (C). The filtered oil flows through oil galleries (passages) in the crankcase cover and cylinder where it is distributed to the main bearings and cam gear bearings.

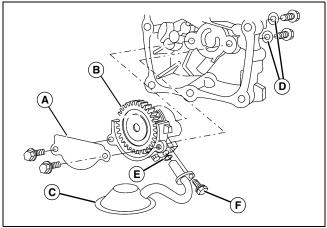
A pressure relief valve located in the oil pump housing limits the maximum oil pressure in the system.

An oil gallery in the crankshaft supplies oil from the magneto bearing to the crankpin, lubricating the connecting rods.

The oil pump is attached to the inside of the crankcase cover.

#### Procedure:

- 1. Remove oil fill dipstick assembly.
- 2. Remove crankcase cover.



MX32807

3. Remove gear baffle (A) and oil pump (B) with pickup (C) from crankcase cover. Discard all three O-rings (D) and (E).

### NOTE: Discard all three O-rings (D) and (E).

- 4. Remove screw (F) to remove oil pickup from oil pump.
- 5. Install new O-ring (E) to the pickup tube and screen assembly (C). Install the pickup tube assembly to the oil pump (B).
- 6. Install oil pump assembly and gear baffle (A) to crankcase. Use new O-rings (D) under screws. Tighten all screws to 7 N•m (65 lb-in.).

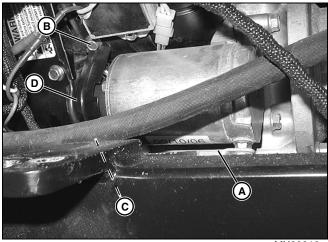
### **Specifications:**

NOTE: Engine oil pressure will vary with oil viscosity, ambient air temperature differences, operating temperatures and engine load.

### **Starting Motor Removal and Installation**

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Disconnect the negative (-) battery cable from the battery.



MX32919

- 3. Disconnect battery positive (+) cable (A) from starting motor.
- 4. Remove starting motor cover bolt (B) and screw (C) and starting motor cover (D).
- 5. Remove starting motor bolts and starter.

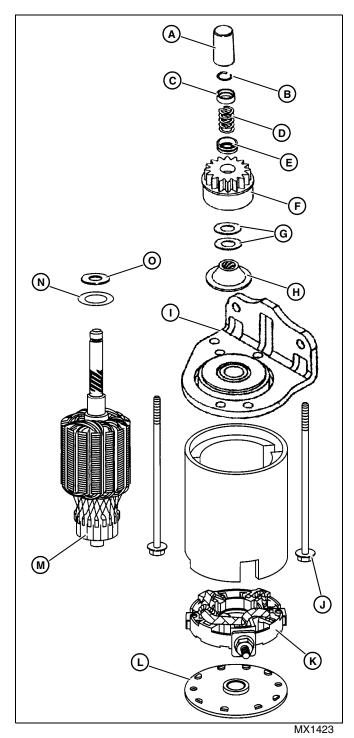
#### Installation:

- 1. Install starting motor bolts and tighten to specification.
- 2. Install starting motor cover.
- 3. Connect positive cable to the starter.
- 4. Connect the negative (-) battery cable to the battery.

### **Torque Specification:**

Starting Motor Bolts ...... 16 Nem (140 lb-in.)

### **Starting Motor Disassembly**



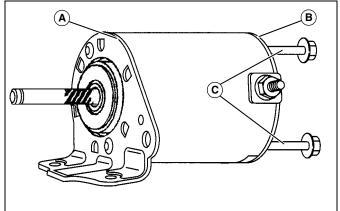
- A Cover
- **B** C-Ring
- C Retainer
- D Spring
- **E** Pinion Stopper
- F Pinion Gear
- G Washers (thin)

- H Bushing (splined)
- I Drive End Head
- J Through bolt
- K Brush Holder
- L End Cap
- M Armature
- N Wave Washer
- O Washer

IMPORTANT: Avoid damage! DO NOT clamp motor housing in a vise or strike with a steel hammer. Starting motors contain two powerful magnets that can be broken or cracked if the motor housing is deformed or dented.

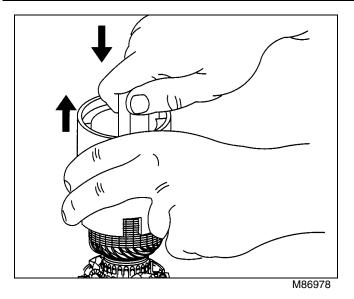
### Procedure:

1. Remove pinion gear assembly. See "Starting Motor Pinion Gear Replacement".

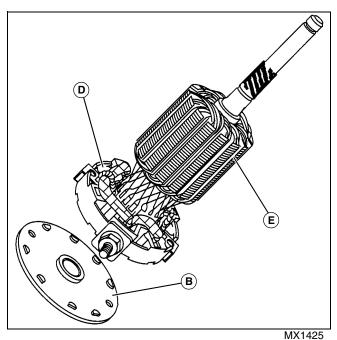


MX1424

- 2. Mark drive end head (A) and end cap (B) and housing using a marker. This will assure proper orientation of the drive end head and end cap when assembling starter.
- 3. Remove bolts (C) and inspect bushing for wear. If worn, replace drive head end assembly.

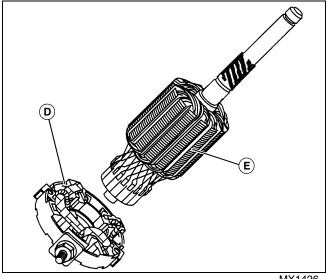


4. Hold the armature and bearing end cap against a work surface while sliding housing off the armature. (This allows the armature to remain in the bearing end cap and brush holder for inspection of brush contact to armature.)



5. While holding brush holder (D) and armature (E), remove bearing end cap (B) from armature.

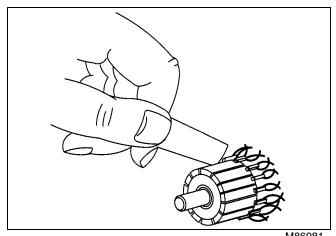
IMPORTANT: Avoid damage! DO NOT use emery cloth to clean the commutator. The particles from the cloth will become embedded in the commutator and cause rapid brush wear.



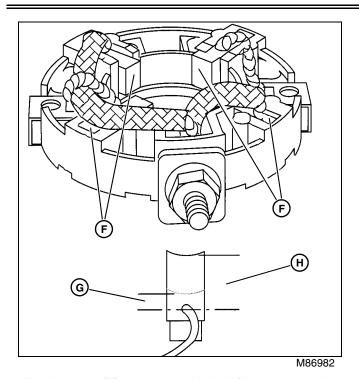
MX1426

6. Remove brush holder (D) from armature commutator (E).

NOTE: The bearing housing and armature should not be soaked in a cleaning solution. Fine sandpaper, such as crocus cloth, can be used to clean the armature. The commutator may also be machined with the use of a diamond cutting tool to no less than 31.24 mm (1.23 in.) outside diameter.

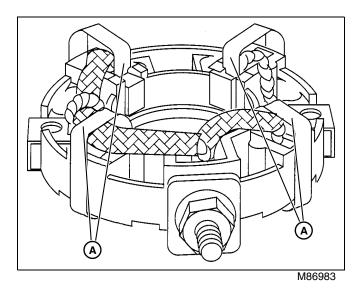


- 1000901
- 7. Slots between the commutator bars should be cleaned as shown using a broken piece of hacksaw blade
- 8. If it is suspected that the armature field coil, magnets or motor housing is defective, a new part should be tried in the motor. If proper testing equipment is available, check the suspected armature or field coil to determine if it is defective (opens or grounds).



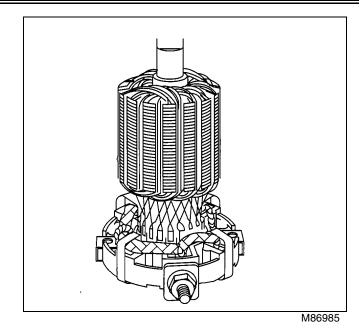
- 9. The brushes (F) should be checked for proper seating, weak brush springs, dirt, oil or corrosion.
- 10.Comparing to normal length when new (H), if brushes are worn to 3.2 mm (0.125 in.) (G), replace brushes. When all parts have been thoroughly cleaned, lightly lubricate the bearings with #20 oil.

### **Starting Motor Assembly**

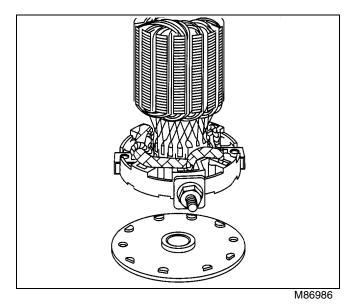


NOTE: Brush retainers (A) can be made from standard size paperclips. Straighten and cut to length (2 1/2 in.). Bend into a U-shape with sides of 1 in. and bottom 1/2 in. in length.

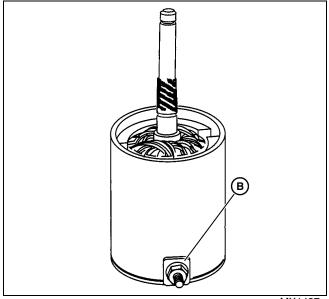
1. Place brushes in their slots and hold brushes with retainers.



2. Place armature commutator in brush holder and remove brush retainers.

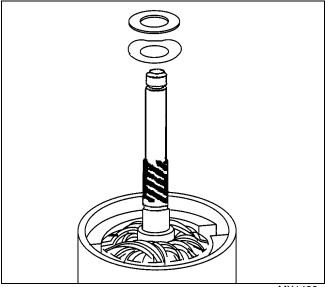


3. Install bearing end plate on armature commutator journal making sure plate indexes with brush holder.



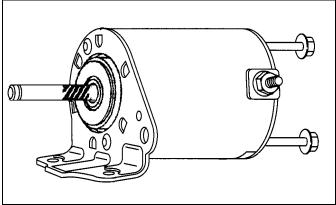
MX1427

4. Slide motor housing over armature with the notch (B) toward brush holder.



MX1428

- 5. Place wave washer on armature shaft with concave side up. Then place flat washer on armature.
- 6. Place drive end cap on starting motor housing making sure that marks on drive end head and end cap lines up with housing mark.



MX1424

- 7. Install bolts in starting motor, use starting motor clutch to check for binding of armature shaft and correct if it binds.
- 8. Install starting motor drive. (Perform steps 7-12 in "Starting Motor Pinion Gear Replacement").
- 9. Install starting motor and tighten bolts to specification.

### **Torque Specification:**

Starting Motor Bolts ...... 16 Nem (140 lb-in.)

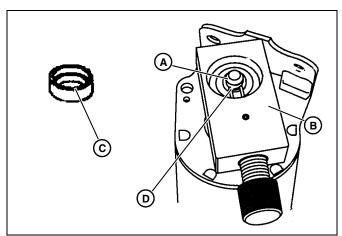
### **Starting Motor Pinion Gear Replacement**

### Required tools:

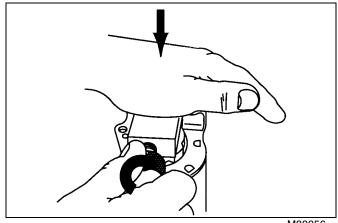
- JDG1087 C-Ring Remover
- JDG1086 C-Ring Installer

### Procedure:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Disconnect the negative (-) battery cable from the battery.
- 3. Remove starting motor. See "Starting Motor Removal and Installation" on page 60.



MX1429

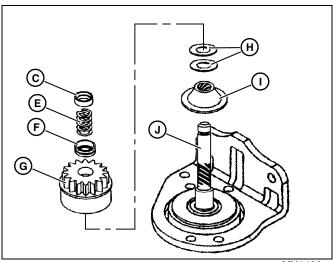


M88956

4. Position C-ring (A) using screw driver tip so C-ring removal tool (B) can be aligned properly.

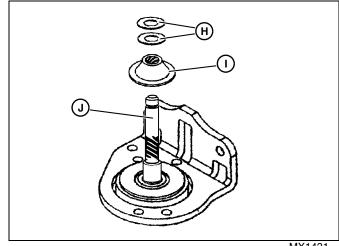
### NOTE: The C-Ring is not reusable once removed.

- 5. Install C-ring removal tool, JDG1087 over retainer (C) and compress spring.
- 6. Screw in handle until drive pins (D) on tool forces off the C-ring from starting motor shaft.



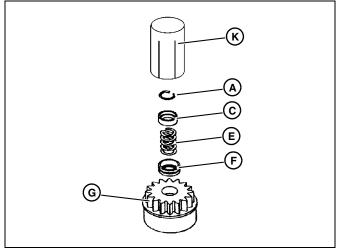
- 7. Remove retainer (C), spring (E), pinion stopper (F), pinion gear (G), flat washers (H), and splined bushing (I).
- 8. Before installing pinion gear, apply a lithium based lubricant sparingly around splines on armature shaft (J).

NOTE: Do not use mineral spirit based lubricants to lubricate splines.



MX1431

9. Place splined bushing (I) on starting motor shaft (J), rotate bushing until it drops into place. Insert two washers (H) on top of splined bushing.



MX1432

- 10.Install pinion gear (G) with teeth on top, then install pinion stopper (F) and return spring (E), making sure spring is in recess of pinion stopper.
- 11. Place retainer (C) and new C-ring (A) on starting motor shaft.
- 12. Align one of the slots on the C-ring installer (K) with open end of C-ring.
- 13. Use a hammer to drive snap ring down until it engages groove in starting motor shaft. Then make sure retainer is all the way up against the snap ring.
- 14.Install flywheel, upper blower housing and reconnect negative (-) battery cable.

ENGINE - GAS	REPAIR

# **ELECTRICAL TABLE OF CONTENTS**

# **Table of Contents**

General Information	69
Operation and Diagnostics	69
Diagnostic Information	
Wire Color Abbreviation Chart	69
Reading Electrical Schematics	70
Common Circuit Tests	
Conductors for 12 Volt Circuits	
Specifications	
General Specifications	
Test and Adjustment Specifications	
Repair Specifications	72
Special or Essential Tools	72
Schematics and Harnesses	
Main Schematic	
Main Wiring Harness	
Operation and Diagnostics	
Power Circuit Operation	
Power Circuit Schematic	
Power Circuit Diagnosis	76
Cranking Circuit Operation	
Cranking Circuit Schematic	
Cranking Circuit Diagnosis	
Tests and Adjustments	
Ground Circuit Tests	
Battery Voltage and Specific Gravity Tests	
Battery - Charge	
Battery - Load Test	
Starting Solenoid Test Starting Motor Amperage Draw - Loaded	
Starting Motor Amperage Draw - Loaded	
Flywheel Magnet Test	
Regulated Voltage Test	
Alternator Output Test	
Voltage Regulator/Rectifier Test	
Regulated Amperage Test	
Key Switch Test	
Circuit Breaker Test	87
Brake and Seat Switch Test	
Starting Motor Solenoid Test	
Spark Test	
Fuel Shutoff Solenoid Test	



## **ELECTRICAL SPECIFICATIONS**

## **Specifications**

## **General Specifications**

Ignition	Electronic CD
Type of Starter	Solenoid Shif
Charging System	Flywheel Alternato
Battery Type	12 Volt, 38 Amp Hou
Alternator	16 amp flywheel alternator

## **Test and Adjustment Specifications**

#### **Battery:**

Specific Gravity (Minimum)	1.225 with less than 50 point variation between cells
Voltage (Minimum)	12.4 volts
Cold Cranking Amps	

#### Starter:

Maximum Amperage (No-Load)	50 amps at 6000 rpm
Maximum Amperage (Load)	51 amps at 750 rpm

#### Stator:

Voltage Output (Unregulated at fast idle)	30 volts AC
Voltage Output (Regulated at fast idle)	12.2 - 14.7 volts DC
Amperage	3 - 16 amps
Amperage (Minimum - Regulated at fast idle)	3 amps

## **Repair Specifications**

## **Special or Essential Tools**

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

#### **Special or Required Tools**

Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Test battery performance.
Terminal Removal Tool	JDG777	Used to remove contacts from connector body.
Crimper	JDG776	Used to attach contacts and seals.
Universal Electrical Pliers	JDG145	Used to cut wires and strip insulation.

## **ELECTRICAL GENERAL INFORMATION**

#### **General Information**

## **Operation and Diagnostics**

The operation and diagnostics stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematic s are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

## **Diagnostic Information**

The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- · Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

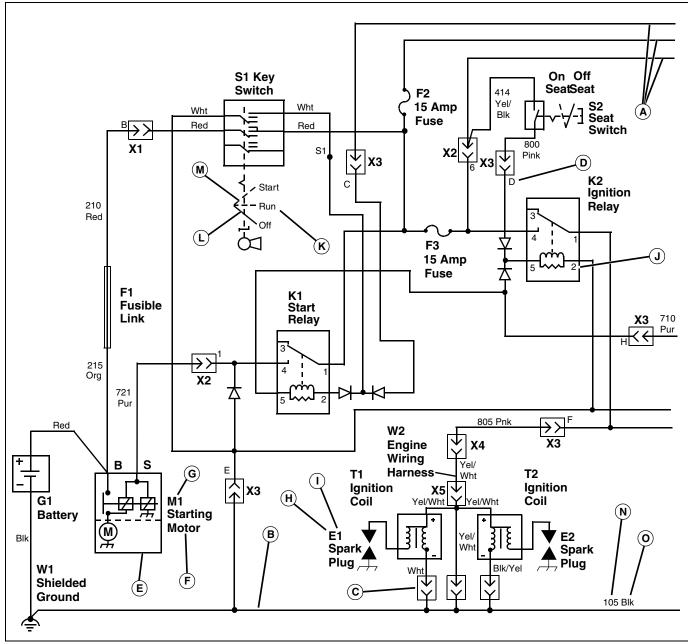
When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. performing the test or check. If the results of the test or check are not normal, perform the test, The diagram that accompanies each test procedure is drawn to resemble machine components. The key letter on the art matches the letter in the procedure and the leader line points to the exact point the test is to be made.

#### Wire Color Abbreviation Chart

BIK Black
Blu
Brn Brown
Grn Green
GryGray
Org Orange
PnkPink
PurPurple
Red Red
TanTan
WhtWhite
Yel Yellow
Lt Blue Light Blue
Lt Grn Light Green
Org/WhtOrange/White

## **ELECTRICAL GENERAL INFORMATION**

## **Reading Electrical Schematics**



The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

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

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly inside or outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly inside or outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

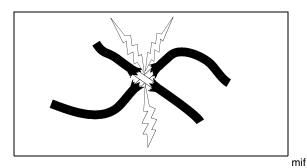
The circuit number (N) and wire color (O) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

## **ELECTRICAL GENERAL INFORMATION**

#### **Common Circuit Tests**

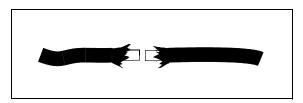
#### **Shorted Circuit:**



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

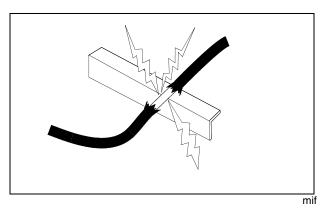
- 1. Turn component switch on.
- 2. Start at the controlling switch of the component that should not be operating.
- 3. Follow the circuit and disconnect wires at connectors until component stops operating.
- 4. Shorted or improper connections will be the last two wires disconnected.

#### **High Resistance or Open Circuit:**



- 1. High resistance or open circuits usually result in slow,
- dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:
- 2. Check all terminals and grounds of the circuit for corrosion.
- 3. If terminals are not corroded or loose, the problem is in the component or wiring.

#### **Grounded Circuit:**



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

#### **Conductors for 12 Volt Circuits**

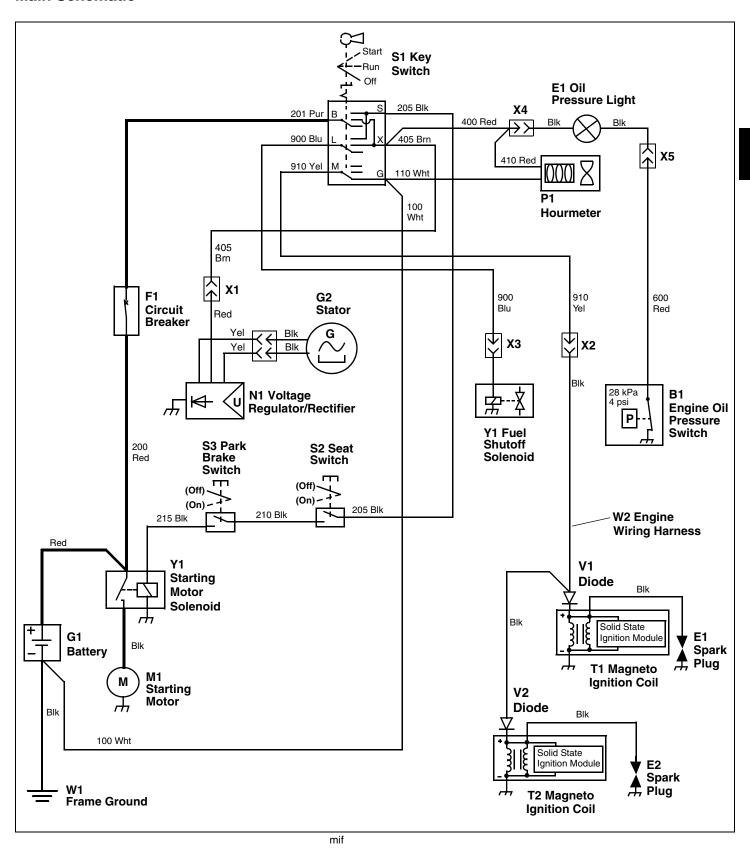
Standard Conductors For 12 Volt Circuits						
SAE Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
Minimum Conductor Area In Circular Mils	1072	1537	2336	3702	5833	9343

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## **ELECTRICAL SCHEMATICS AND HARNESSES**

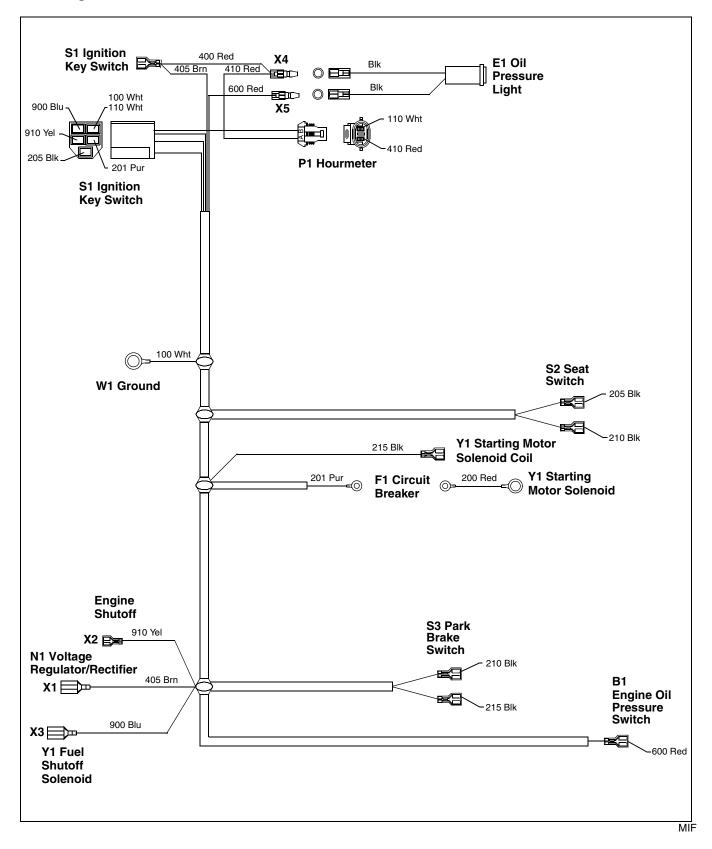
#### **Schematics and Harnesses**

#### **Main Schematic**



## **ELECTRICAL SCHEMATICS AND HARNESSES**

## **Main Wiring Harness**



## **Operation and Diagnostics**

## **Power Circuit Operation**

#### **Function:**

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

#### **Unswitched Power:**

Battery voltage is supplied to the key switch through the F1 circuit breaker. The circuit breaker is a thermal reset switch that opens when excess current is drawn through it.

A common connection is provided at the Y1 starting motor solenoid.

#### Switched Power:

When the key switch is placed in the RUN position power is connected from the "B" terminal to the "X" and "L" terminals.

The 900 Blu wire transmits power from the "L" terminal to the Y1 fuel shutoff solenoid. The fuel shutoff solenoid opens and allows fuel flow to the engine carburetor. The 400 Red wire transmits power from the "X" terminal to the X4 connector. The connector splits the power to the E1 oil pressure light and the P1 hourmeter. The oil pressure light has a ground circuit through the B1 engine oil pressure switch. The light will illuminate until the oil pressure is enough to open the oil pressure switch and the circuit. The P1 hourmeter has a direct connection to ground and will run any time the key switch is in the RUN position.

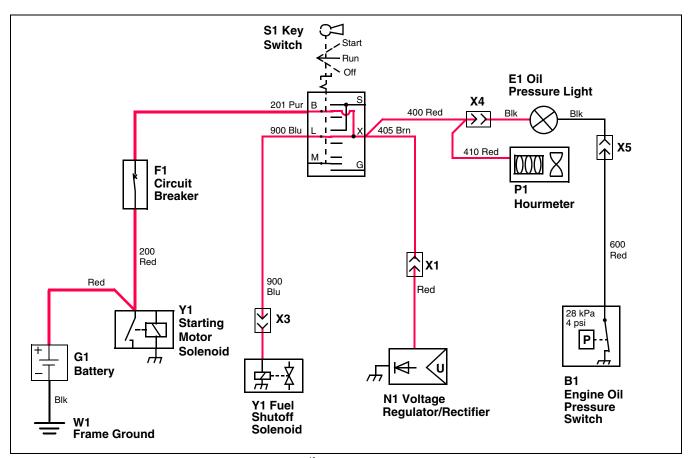
#### **Voltage Regulator/Rectifier Operation:**

The charging system is a permanent magnet and stator design. Charging output is controlled by the N1 voltage regulator/rectifier. With the engine running, current flows from the G2 stator to the N1 voltage regulator/rectifier to the battery positive (+) terminal to charge the battery.

A permanent magnet located in the flywheel induces AC current in the G2 stator windings. The AC current flows to the regulator/rectifier. The regulator/rectifier converts the AC current to DC current needed to charge the battery.

When voltage drops below 14.7 VDC, the voltage regulator/ rectifier allows DC current to flow to the battery to charge it. As the battery becomes fully charged, the regulator reduces current flow to the battery.

## **Power Circuit Schematic**



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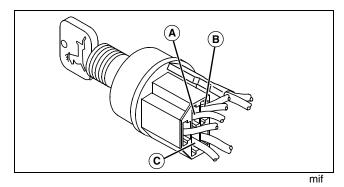
## **Power Circuit Diagnosis**

#### **Unswitched Power Test:**

#### **Test Conditions:**

- Machine parked safely
- Park brake on
- Key switch in the OFF position

#### **System: Power Circuit**



(1) Is there battery voltage at the key switch 201 Pur wire (A)?

Yes - Go to next step.

**No -** Check battery voltage. Check circuit breaker. See "Circuit Breaker Test" on page 87.

(2) Is there continuity to ground at the 100 Wht wire (B) and all ground connections?

**Yes -** Go to next step.

No - Check 100 Wht wire and connections.

(3) Is there continuity to ground at the 910 Yel wire (C)?

Yes - Go to next procedure.

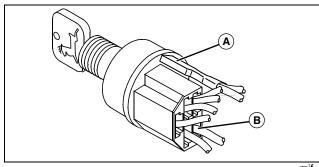
**No -** Test key switch. See "Key Switch Test" on page 86.

#### **Switched Power Tests:**

#### **Test Conditions:**

- Machine parked safely
- Park brake on
- · Key switch in the RUN position

## **System: Power Circuit**



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(1) Is there battery voltage at the key switch 400 Red and 405 Brn wires (A) at the separate spade terminal?

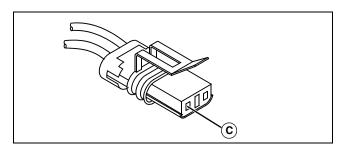
**Yes -** Go to next step.

**No -** Test key switch. See "Key Switch Test" on page 86.

(2) Is there battery voltage at the 900 Blu wire (B)?

Yes - Go to next step.

**No -** Test key switch. See "Key Switch Test" on page 86.



(3) Is there battery voltage at the hourmeter connector 410 Red wire (C)?

Yes - Go to next step.

**No -** Does the oil pressure light turn on? If yes: Check the 410 Red wire. If no: Check 400 and 410 Red wires and connections.

(4) Is there battery voltage at the 900 Blu wire to the Y1 fuel shutoff solenoid?

Yes - Tests complete.

No - Check 900 Blue wire and connections.

## **Cranking Circuit Operation**

#### **Function:**

Provides switched power to starting motor solenoid when the key switch is in the START position.

#### **Switched Power:**

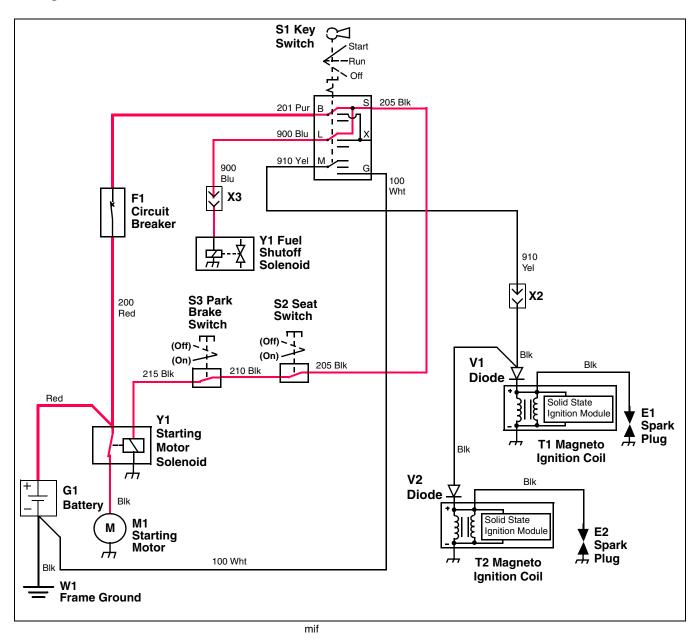
When the key switch is placed in the START position power is connected from the "B" terminal to the "S" and "L" terminals.

The 900 Blu wire transmits power from the "L" terminal to the Y1 fuel shutoff solenoid. The fuel shutoff solenoid opens and allows fuel flow to the engine carburetor. The 205 Red wire transmits power from the "S" terminal to the S2 seat switch. With the seat switch closed, power is transmitted to the S3 park brake switch. With the park brake set, power is transmitted to the Y1 starting motor solenoid.

When the starting motor solenoid is energized, the relay contacts close and current is provided to the starting motor from the battery and the engine cranks.

In the START and RUN positions the key switch "M" to "G" contacts open which prevents the engine ignition coils from being grounded and allows a spark to be produced by the spark plugs.

## **Cranking Circuit Schematic**



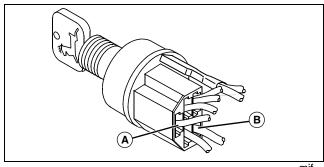
## **Cranking Circuit Diagnosis**

#### **Switched Power Tests:**

#### **Test Conditions:**

- Machine parked safely
- Park brake OFF
- Key switch in the START position

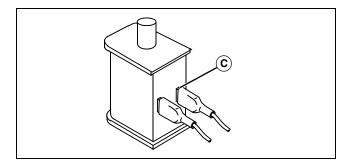
#### **System: Cranking Circuit**



### (1) Is there battery voltage at the key switch 205 Blk wire (A) and at the 900 Blu wire (B)?

Yes - Go to next step.

No - Test key switch. See "Key Switch Test" on page 86.



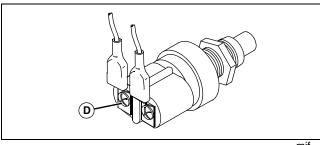
Picture Note: Seat switch shown removed from housing. The 205 and 215 Blk wires may be connected to either terminal of the seat switch.

#### (2) Is there battery voltage at the S2 seat switch 205 wire (C)?

Yes - Go to next step.

No - Check 205 Blk wire and connections.

#### **System: Cranking Circuit**



Picture Note: The 210 and 215 Blk wires may be connected to either terminal of the brake switch.

## (3) Is there battery voltage at the S3 park brake switch 210 Blk wire (D)?

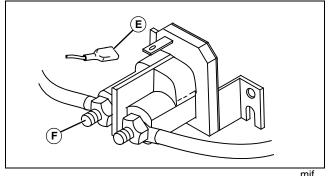
Yes - Go to next step.

No - Check other wire. Check that the seat switch is closed. Check 210 Blk wire and connections.

#### **Test Conditions:**

- Machine parked safely
- Disconnect 215 Blk wire from starting motor solenoid
- Park brake ON
- Seat switch CLOSED
- Key switch in the START position

## **System: Cranking Circuit**



#### (1) Is there battery voltage at the Y1 starting motor solenoid 215 Blk wire (E)?

Yes - Go to next step.

**No -** Check that the seat switch is closed and park brake is set. Check 215 Blk wire and connections.

### (2) Is there battery power at the Red battery cable (F)?

Yes - Go to next step.

## **System: Cranking Circuit**

**No -** Check battery cable for corrosion or loose connections. Test battery. See "Battery Voltage and Specific Gravity Tests" on page 80.

#### **Test Conditions:**

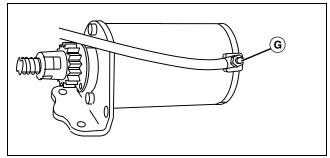
- Machine parked safely
- · Connect 215 Blk wire to starting motor solenoid
- Park brake ON
- Seat switch CLOSED
- Key switch in the START position

### System:

#### (1) Does the engine crank?

Yes - End of tests.

No - Go to next step.



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# (2) Is there battery voltage at the starting motor cable (G)?

**Yes -** Check connection for corrosion. Check starting motor housing to engine/frame ground. Remove and repair starting motor.

**No -** Check Red cable for corrosion. Test starting motor solenoid. See "Starting Solenoid Test" on page 82. Replace solenoid as necessary.

## **Tests and Adjustments**

#### **Ground Circuit Tests**

#### Reason:

To check for opens, loose terminal wire crimps, poor connections, or corrosion in the ground circuit. The voltmeter method checks ground connections under load.

#### **Equipment:**

Ohmmeter or Voltmeter

#### Ohmmeter Procedure:

- 1. Turn key switch to OFF position. Engage park brake.
- 2. Connect ohmmeter negative (BLACK) lead to negative (-) terminal of battery. Put meter positive (RED) lead on negative terminal of battery and record reading. Reading should be 0.1 ohm or less.
- 3. Put meter RED lead on ground terminal of circuit or component to be tested that is closest to the battery negative terminal. Resistance reading must be very close to or the same as the battery negative terminal reading. Work backwards from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohms. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohms. Check both sides of connectors closely as disconnecting and connecting may temporarily solve problem.

#### Voltmeter Procedure:

- 1. Move forward reverse pedals to neutral position. Engage park brake. Turn key switch to ON position. Raise rear body cowling.
- 2. Connect voltmeter negative (BLACK) lead to negative (-) terminal of battery.
- 3. Put meter positive (RED) lead on ground terminal of component to be tested. Be sure the component circuit is activated (key switch on, switches closed) so voltage will be present at the component. Record voltage. Voltage must be greater than 0 but less than 1 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

#### **Results:**

- If resistance is above 0.1 ohms, check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit
- If voltage is 0, the component is open

• If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

## **Battery Voltage and Specific Gravity Tests**

#### Reason:

To check voltage and determine condition of battery.

#### **Equipment:**

- Voltmeter or JT05685 Battery Tester
- · Hydrometer Procedure
- Clean battery terminals and top of battery

#### **Procedure:**



CAUTION: Avoid injury! Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes. Avoid the hazard by:

Filling batteries in a well-ventilated area

Wearing eye protection and rubber gloves

Avoiding breathing fumes when electrolyte is added

Avoid spilling or dripping electrolyte

Use proper jumpstart procedure

If you spill acid on yourself:

Flush your skin with water

Apply baking soda or lime to help neutralize the acid

Flush your eyes with water for 10 - 15 minutes. Get medical attention immediately

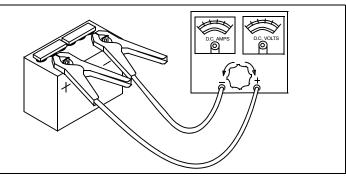
If acid is swallowed:

Drink large amounts of water or milk

Then drink milk of magnesia, beaten eggs, or vegetable oil

Get medical attention immediately

- Inspect battery terminals and case for breakage or cracks.
- 2. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water added, charge battery for 20 minutes at 10 amps.
- 3. Remove surface charge by placing a small load on the battery for 15 seconds.



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- Check battery voltage with voltmeter or JT05685 Battery Tester.
- 5. Check specific gravity of each cell with a hydrometer.

#### **Results:**

- Battery voltage less than 12.4 VDC, charge battery
- Battery voltage more than 12.4 VDC, test specific gravity
- All cells less than 1.175, charge battery at 10 amp rate
- All cells less than 1.225 with less than 50 point variation, charge battery at 10 amp rate
- All cells more than 1.225 with less than 50 point variation, load test battery
- More than 50 point variation: replace battery

#### **Specifications:**

#### **Battery - Charge**

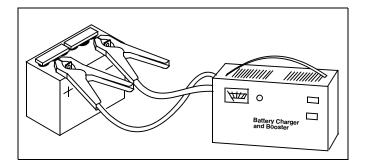
#### Reason:

To increase battery charge after battery has been discharged.

#### **Equipment:**

• Battery charger (variable rate)

#### **Procedure:**



1. Connect variable rate charger to battery.

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

- 2. Start charger at slow rate. Increase charge rate one setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10 amp charge rate. Use boost setting as necessary.
- 3. Check if battery is accepting a 10 amp charge after 10 minutes at boost setting.
  - Battery will not accept 10 amp charge after 10 minutes at boost setting: replace battery
  - Battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did not need water: go to steps 6 and 7
  - Battery is accepting 10 amp charge after 10 minutes at boost setting, but battery did need water or all cells were below 1.175: go to steps 4 and 5

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

- 4. Set charger at 15 25 amps.
- 5. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

NOTE: If battery was discharged at slow or unknown rate, charge at 10 - 15 amps for 6 - 12 hours (Maintenance-free battery: 12 - 24 hours). If battery was discharged at fast rate, charge at 20 - 25 amps for 2 - 4 hours (Maintenance-free battery: 4 - 8 hours).

- More than 50 point variation between cells: replace battery
- Less than 50 point variation between cells: go to steps 6 and 7
- 6. Continue charging battery until specific gravity is 1.230 1.265 points.
- 7. Load test battery. See "Battery Load Test" below.

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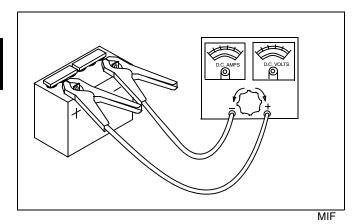
## **Battery - Load Test**

#### Reason:

To check condition of battery under load.

NOTE: See "Battery - Charge" before applying a load to battery.

#### **Equipment:**



JT05685 Battery Tester or equivalent

#### NOTE: Use the procedures given with the tester.

#### Procedure:

- 1. Turn load knob of tester clockwise until amperage reading is equal to:
  - Cold cranking amperage rating (use blue scale) OR

Three times ampere hour rating (use black scale)

- 2. Hold for 15 seconds and turn load knob of tester OFF.
- 3. Read battery voltage.

#### **Results:**

• If the battery does not indicate 9.6 volts or more, replace battery.

### **Starting Solenoid Test**

#### Reason:

To determine if starting solenoid is defective.

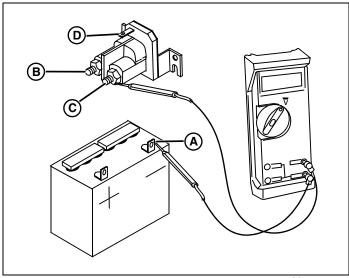
#### **Equipment:**

Volt Ohm Meter

#### **Procedure:**

- 1. Park machine on level surface.
- 2. Turn key switch to OFF position.
- 3. Move Forward/Reverse pedals to NEUTRAL position.

- 4. Engage park brake.
- 5. Lower front blade (if equipped).
- 6. Raise rear body cowling.
- 7. Disconnect and ground spark plug leads.



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- 8. Connect VOM to negative (-) battery terminal (A) and positive battery cable terminal (B) of solenoid. Check for battery voltage.
  - No battery voltage Check battery positive (+) terminal and starting motor solenoid terminal (B) for loose connections. Clean any corrosion
  - · Battery voltage go to next step.
- 9. Connect VOM to negative (-) battery terminal (A) and starting motor cable terminal (C) of solenoid.
- 10. Momentarily turn ignition key to START position and check for battery voltage.
  - Battery voltage starting motor solenoid is not defective.
  - No battery voltage go to next step.
- 11.Connect VOM to negative (-) battery terminal (A) and terminal (D) (Blk wire) of starting motor solenoid.
- 12. Momentarily turn ignition key to START position and check for battery voltage.
  - No battery voltage Check Blk wire and connections.
  - Battery voltage Check Blk wire and connections between starting motor solenoid and frame ground. If OK, starting motor solenoid is defective, replace solenoid.

## **Starting Motor Amperage Draw - Loaded**

#### Reason:

To determine amperage needed to crank the engine.

#### **Required Tools:**

- JT05791 Multimeter
- JT02153 Current Clamp

#### **Procedure:**

- 1. Ensure transmission is in neutral and park brake is set.
- 2. Remove spark plug lead and ground to engine.
- 3. Connect current clamp RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.
- 4. Clamp jaws of current clamp around the positive battery cable.
- 5. Set the current clamp to 2000A and the multimeter to 300mV.

NOTE: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

6. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

NOTE: If using a multimeter other than JT05791, use a meter that will read millivolts. Millivolts = current in amps; 1mV=1 amp.

7. Crank the engine and read the starting motor amperage draw.

#### Result:

- If amperage is above specification check starting motor for binding or damaged wires or windings.
- If starting motor is good, check internal engine, traction or PTO drive for binding or damage.

#### **Specifications:**

Maximum starting motor amp draw ...... 180 amps

#### Starting Motor Amperage Draw - No-Load

#### Reason:

To determine starting motor condition under no-load conditions.

#### **Required Tools:**

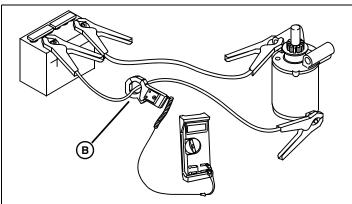
- JT05791 Multimeter
- JT02153 Current Clamp
- 12 Volt Battery
- Jumper Cables

#### **Procedure:**



CAUTION: Avoid injury! Do not clamp starting motor housing in vise or strike with a hammer. Clamp only on the mounting bracket. Starting motors contain two ceramic magnets that can be broken or cracked if the motor housing is hit, deformed or dented.

1. Clamp the starting motor mounting bracket in a vise.



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- 2. Connect current clamp (B) RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.
- 3. Connect the negative jumper cable to the battery negative post and the frame of the starting motor.
- 4. Connect the positive jumper cable to the positive post of the battery.
- 5. Connect current clamp RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.
- 6. Clamp jaws of current clamp around the positive jumper cable.
- 7. Set the current clamp to 2000A and the multimeter to 300mV.

NOTE: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

8. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

NOTE: If using a multimeter other than JT05791, use a meter that will read millivolts. Millivolts = current in amps; 1mV = 1 amp.

9. Momentarily touch the positive jumper cable lead to the starting motor positive post and read the starting motor amperage draw.

#### Result:

 If amperage is above specification, check starting motor for binding or damaged

#### **Specifications:**

Maximum starting motor amp draw ..... 50 amps

## Flywheel Magnet Test

#### Reason:

To make sure flywheel magnet(s) have enough force to induce current into ignition coil.

#### **Equipment:**

Screwdriver.

#### Procedure:

- 1. Park machine on level surface.
- 2. Turn key switch to OFF position.
- 3. Move Forward/Reverse pedals to NEUTRAL position.
- 4. Engage park brake.
- 5. Raise rear body cowling.
- 6. Remove flywheel blower housing from engine.
- 7. Loosely hold screwdriver blade about 25 mm (1.0 in.) away from magnet.

#### Results:

- Magnet should attract blade to it.
- If blade is NOT attracted to magnet, flywheel must be replaced.

## **Regulated Voltage Test**

#### Reason:

To determine regulated voltage output of the regulator/rectifier.

#### **Equipment:**

Multimeter

#### Procedure:

- 1. Park machine on level surface.
- 2. Turn key switch OFF.
- 3. Move Forward/Reverse pedals to NEUTRAL position.
- 4. Engage parking brake.
- 5. Raise rear body cowling.
- 6. Remove surface charge from battery by placing a small load on the battery for 15 seconds.
- 7. Set voltmeter to 50 DC volt scale.
- 8. Connect voltmeter positive (red) lead to battery positive (+) terminal.
- 9. Connect voltmeter negative (black) lead to battery negative (-) terminal.
- 10.Start and run engine at fast idle. Read voltmeter several times during 5 minutes of running time.
- 11. Voltage should remain between 12.2 14.7 volts DC.

#### Results:

- If the DC voltage remains below the minimum specification, test stator voltage output.
- If the DC voltage goes above the maximum specification, replace the regulator/rectifier.

## **Alternator Output Test**

#### Reason:

To measure AC voltage output of stator and verify correct resistance of stator.

#### **Equipment:**

Multimeter

#### **Procedure:**

- 1. Disconnect connector from stator.
- 2. Set multimeter for AC volts.
- 3. Attach RED test lead to either pin on stator side of stator connector.
- 4. Attach BLACK test lead to other pin.

- 5. Set parking brake, start engine and run at full throttle.
- 6. Check output.

#### **Results:**

- · Output will be approximately as listed below.
- · If no or low output is found, replace stator.

#### **Specifications:**

AC output at full throttle ...... 34 volts (minimum)

## **Voltage Regulator/Rectifier Test**

#### Reason:

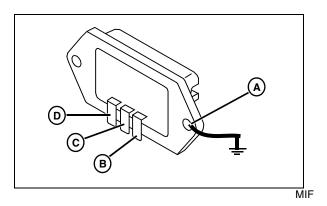
To verify proper operation capability of the voltage regulator/rectifier.

#### **Equipment:**

Multimeter

#### **Procedure:**

- 1. Disconnect stator connector from the voltage regulator/rectifier.
- 2. Set the multi-meter to the Ohms scale.



3. Measure resistance between each point as shown in the chart.

	Α	В	С	D
Α		8-9M	8-9M	31.2M
В	OL		0.2	OL
С	OL	0.2		OL
D	31.2 M	8-9M	8-9M	

4. If resistance is not within specification, replace voltage regulator/rectifier.

## **Regulated Amperage Test**

#### Reason:

To determine charging output of rectifier/regulator.

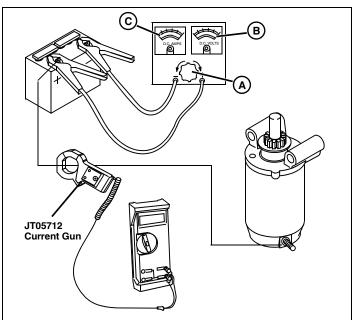
#### **Equipment:**

- Multimeter
- JT05712 Current Gun
- JT05685 Battery Tester

#### **Procedure:**

- 1. Park machine on level surface.
- 2. Turn key switch OFF.
- 3. Move Forward/Reverse pedals to NEUTRAL position.
- 4. Engage parking brake.
- 5. Raise rear body cowling.

NOTE: Battery must be in a good state of charge at 12 to 15 VDC.



MIF

- 6. Connect JT05712 Current Gun to voltmeter and put around positive (red) battery cable going to starting motor.
- 7. Set current gun for DC current.

NOTE: Turn load knob (A) fully counterclockwise (out) into OFF position BEFORE making any test connections.

8. Connect battery tester to battery.

NOTE: Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5 - 10 seconds.

- 9. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts for 5 seconds only to partially drain battery.
- 10.Quickly turn load knob completely counter-clockwise (out) to OFF position.
- 11. Start and run engine at fast idle. Battery voltage should read between 12.2 15.0 VDC.
- 12. Turn load knob clockwise (in) until voltage on tester voltage scale (B) reads 11 volts and look at current gun for a minimum reading of 13.5 amps.
- 13. Quickly turn load knob completely counter- clockwise (out) to OFF position.
- 14. After load test, voltage scale (B) should return to voltage level prior to test.

#### Results:

 If reading does not meet specifications, test stator voltage output.

If stator voltage output meets specifications and voltage and ground to the regulator/rectifier is verified, replace the regulator/rectifier.

#### **Specifications:**

#### **Key Switch Test**

#### Reason:

To verify key switch functions are operating properly.

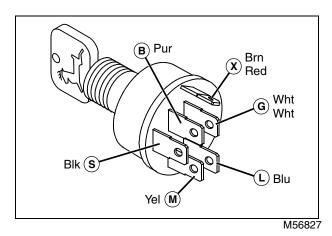
#### **Equipment:**

· Ohmmeter or Continuity Tester

#### Procedure:

- 1. Park machine safely on level surface and turn key switch OFF. See "Parking Safely" on page 5 in the Safety section.
- 2. Park brake ON.
- 3. Disconnect key switch connector.

NOTE: DO NOT refer to markings stamped on terminals. Identify terminals by art keys ONLY. Terminal combinations other than those listed in chart should NOT have continuity.



4. Use an ohmmeter to test switch continuity in OFF, RUN, and START positions.

#### Continuity

	Pin	X	L	В	S	G	M
Position							
Off						•	•
Run		•	•	•			
Start			•	•	•		

#### **Specifications:**

#### **Results:**

• If any continuity is NOT correct, replace switch.

#### **Circuit Breaker Test**

#### Reason:

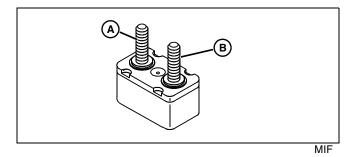
To check circuit breaker condition.

#### **Equipment:**

· Ohmmeter or continuity tester

#### **Procedure:**

- 1. Park machine safely.
- 2. Turn key switch OFF.
- 3. Disconnect one wire from the circuit breaker.



4. Check terminal continuity using an ohmmeter or continuity tester

• There should be continuity between terminals (A) and (B).

NOTE: This is a thermal circuit breaker. If continuity is not present allow circuit breaker to cool and reset.

· If continuity is NOT present, replace circuit breaker.

#### **Brake and Seat Switch Test**

#### Reason:

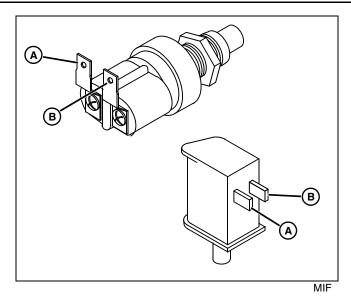
To check switch condition.

#### **Equipment:**

· Ohmmeter or continuity tester

#### **Procedure:**

- 1. Park machine safely.
- 2. Turn key switch OFF.
- 3. Disconnect one wire from the brake switch.



4. Check terminal continuity using an ohmmeter or continuity tester.

#### 5. Test switch:

- With the switch closed (pressed), there should be continuity between terminals (A) and (B).
- With the switch open (released), there should not be continuity between terminals (A) and (B).

#### Results:

If the switch does not have correct continuity, replace the switch.

### **Starting Motor Solenoid Test**

#### Reason:

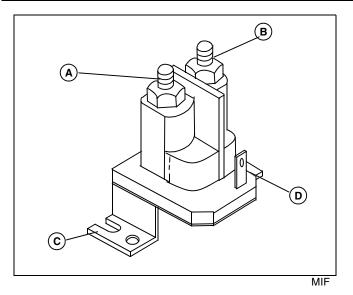
To check relay terminal continuity in the energized and deenergized condition.

#### **Equipment:**

· Ohmmeter or continuity tester

#### Procedure:

- 1. Park machine safely.
- 2. Turn key switch OFF.
- 3. Disconnect negative (-) battery cable.
- 4. Disconnect all wires to solenoid.



- 5. Check terminal continuity using an ohmmeter or continuity tester.
  - There should be continuity between terminal (C) and bracket (D).
  - There should NOT be continuity between terminals (A) and (B).
- 6. Connect a jumper wire from battery positive (+) terminal to relay terminal (D).
  - There should be continuity between terminals (A) and (B).
  - · If continuity is NOT correct, replace solenoid.

#### **Spark Test**

#### Reason:

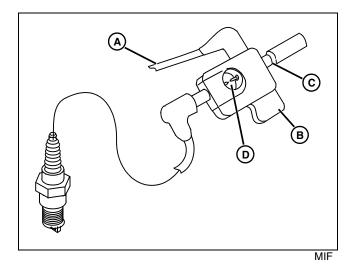
To determine condition of the ignition system.

#### **Equipment:**

D-05351st Spark Tester

#### Procedure:

- 1. Park machine on level surface.
- 2. Turn key switch to the OFF position.
- 3. Move Forward/Reverse pedals to NEUTRAL position.
- 4. Park brake ON.
- 5. Raise rear body cowling.



- 6. Remove high tension lead (A) from spark plug and connect to spark tester (B).
- 7. Connect spark tester lead to spark plug.
- 8. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).

NOTE: Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) as damage to ignition system components could occur.

9. Start engine and watch spark (D) at tester.

10.If there is no spark:

- Check for proper safety interlock setup.
- Check for shorted stop switch.
- · Check for closed engine diodes.
- · Check for armature failure.

#### **Results:**

- If engine will start, watch spark with engine running. There should be a strong, steady, blue spark.
- If spark is weak, or if no spark, install new spark plug and test again.
- If spark is still weak, or still no spark, check armature air gap, adjust as needed.
- If spark is still weak, or still no spark, Go To Test Procedure C, Ignition Circuit Diagnosis. Replace coils as needed.

#### **Fuel Shutoff Solenoid Test**

#### Reason:

To determine if the fuel shutoff plunger retracts when the solenoid is energized.

#### **Equipment:**

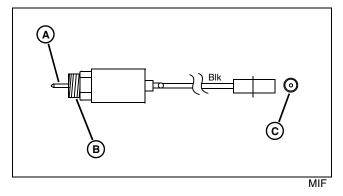
2 Jumper wires

#### Procedure:



CAUTION: Avoid injury! Keep gasoline away from sparks, flame, or hot engine parts or personal injury can result.

- 1. Disconnect fuel shutoff solenoid connector.
- 2. Remove fuel shutoff solenoid, washer and float bowl from carburetor.



3. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal (C).

# NOTE: It may be necessary to push plunger (A) inward slightly for plunger to retract.

- 4. Connect a jumper wire from the battery negative (-) terminal to solenoid threads (B). Plunger should now retract with the solenoid energized.
- 5. Remove jumper wire from the battery negative (-) terminal. Plunger should extend.

#### **Results:**

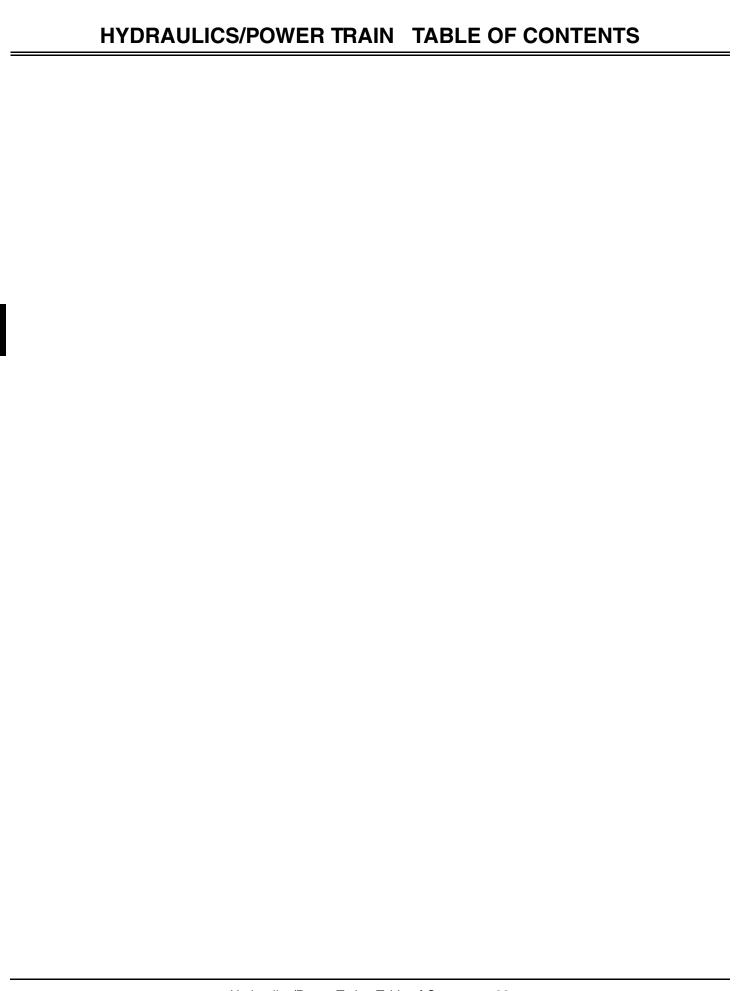
• If plunger does not move, replace solenoid.



## **HYDRAULICS/POWER TRAIN TABLE OF CONTENTS**

## **Table of Contents**

Specifications	93
General Specifications	93
Test Specifications	93
Repair Specifications	
Special or Essential Tools	93
Component Location	94
Hydraulic Drive Assembly	94
Hydraulic Lift Assembly	95
Hydraulic Schematic	96
Main Schematic	96
Operation and Diagnostics	97
Power Train Operation	97
Control Valve and Cylinder Operation	97
Relief Valve Operation	
Hydrostatic Power Train Diagnosis	98
Hydraulic Lift System Diagnosis	99
Tests and Adjustments	
Adjusting Forward and Reverse Speed	
Adjusting Wheel Creep	
Speed Control Linkage Adjustment	.101
Implement Charge Pressure Test	.101
Relief Pressure Test	.102
Repair	
Hydraulic Pump Removal and Installation.	.103
Hydraulic Pump Repair	.104
Rear Wheel Motor Removal and	
Installation	.105
Front Wheel Motor Removal and	
Installation	
Oil Cooler Removal and Installation	
Lower/Lift Levers Removal and Installation	
Forward and Reverse Pedals and Linkage	
Removal and Installation	.107



## **HYDRAULICS/POWER TRAIN SPECIFICATIONS**

## **Specifications**

## **General Specifications**

## **Test Specifications**

Relief Valve Pressure	172 kPa (25 psi)
Implement Charge Valve Pressure	6,205 kPa (900 psi)
Implement Relief Valve Pressure (Spool Control Valve)	10,342 kPa (1500 psi)

## **Repair Specifications**

#### **Hydraulic Pump:**

Hydraulic Pump Output	5.41 cc/rev (0.33 in <sup>3</sup> /rev)
Hydraulic Motor Output	0 - 14.96 cc/rev (0 - 0.913 in <sup>3</sup> /rev)
Reservoir Breather/Plug Torque	5 N•m (45 lb-in.)
Gear Pump Screw Torque	8 N•m (8 lb-in.)
Hydraulic Line Nut Torque	50 N•m (37 lb-ft)
Hex Plug Torque	59 N•m (44 lb-ft)
Lower Relief Valve Nut Torque	2 N•m (20 lb-in.)
Raise Relief Valve Nut Torque	2 N•m (20 lb-in.)
Thermal Relief Valve Torque	7 N•m (60 lb-in.)

## **Special or Essential Tools**

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

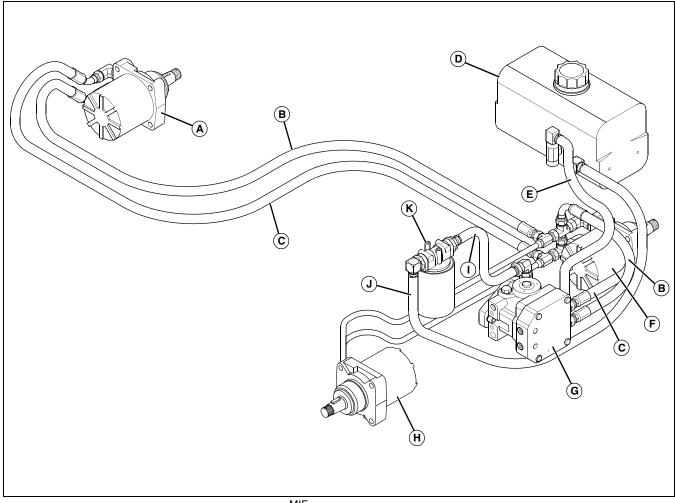
#### **Special or Required Tools**

Tool Name	Tool No.	Tool Use
JT05471	0 - 6900 kPa (0 - 1000 psi) Gauge	Used to check hydraulic relief valve pressures.

## **HYDRAULICS/POWER TRAIN COMPONENT LOCATION**

## **Component Location**

## **Hydraulic Drive Assembly**

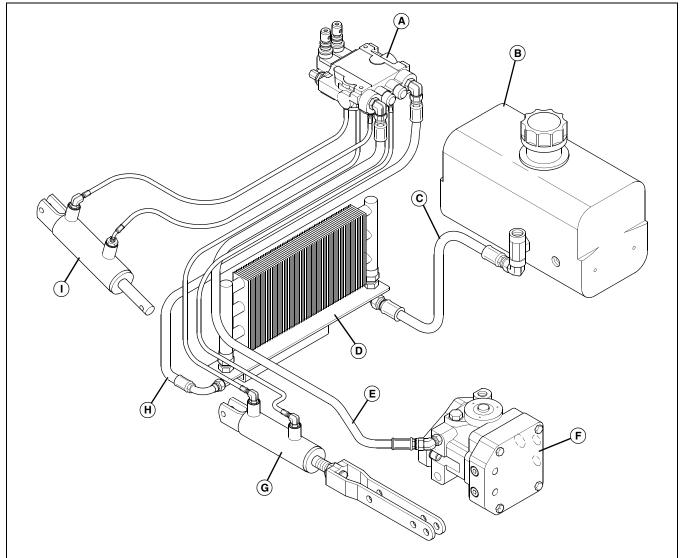


MIF

- A Front Drive Assembly
- **B** Hydraulic Forward Pressure Line
- C Hydraulic Reverse Pressure Line
- D Reservoir, Hydraulic Oil
- E Hydraulic Oil Return Line (Pump to Reservoir)
- F Drive Assembly, Right Rear
- **G** Hydraulic Pump
- H Drive Assembly, Left Rear
- I Suction Line (Oil Filter to Pump)
- J Suction Line (Reservoir to Filter)
- K Filter, Hydraulic Oil

## HYDRAULICS/POWER TRAIN COMPONENT LOCATION

## **Hydraulic Lift Assembly**



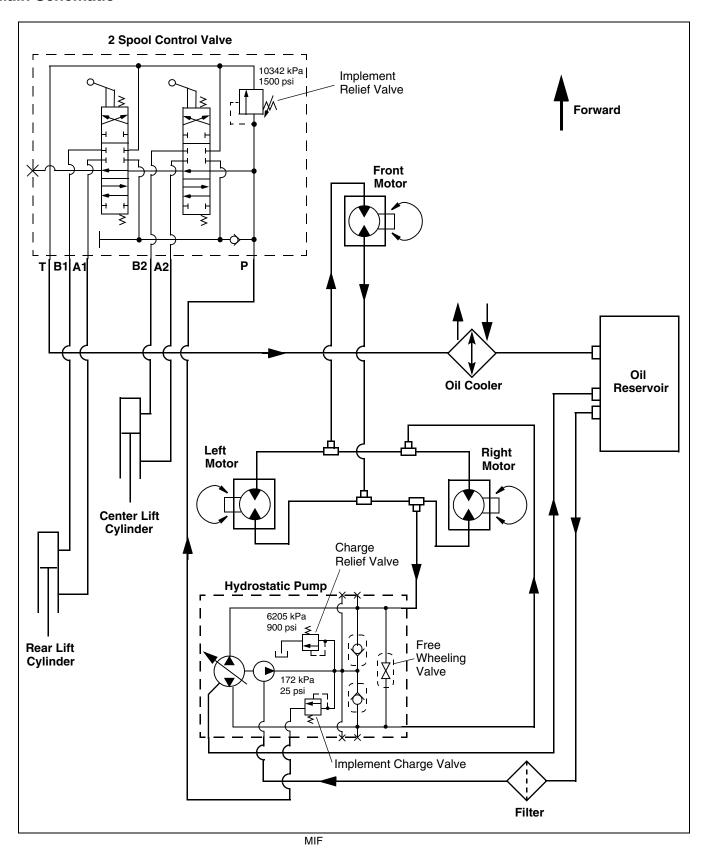
MIF

- A Control Valve
- **B** Reservoir, Hydraulic Oil
- C Hydraulic Oil Return Line (Cooler to Reservoir)
- D Oil Cooler
- **E** Hydraulic Implement Pressure Line
- F Hydraulic Pump
- **G** Lift Cylinder, Rear Mount
- H Hydraulic Oil Return Line (Control Valve to Cooler)
- I Lift Cylinder, Center Mount

## HYDRAULICS/POWER TRAIN HYDRAULIC SCHEMATIC

## **Hydraulic Schematic**

### **Main Schematic**



## HYDRAULICS/POWER TRAIN OPERATION AND DIAGNOSTICS

## **Operation and Diagnostics**

## **Power Train Operation**

#### **Function:**

To drive the machine using hydraulic wheel motors.

#### Theory of Operation:

The hydrostatic pump is driven by the engine and is connected by a splined coupler. The drive system is a closed-loop system, with charge oil added, through the check valves, when the pressure in the system drops below 6205 kPa (900 psi). The charge relief valve opens to maintain pressure oil to the drive system at that setting.

#### Neutral:

With the forward/reverse travel pedals in the neutral position, the spring in the cylinder block in the hydrostatic pump forces the swash plate to a position that is parallel to the pump body. With the swash plate parallel to the pump body, the pistons do not reciprocate in the cylinder block, they merely rotate, and no oil is being drawn in or discharged from the pump. The machine is in a zero displacement position and the machine remains stationary.

#### Forward:

As the forward travel pedal is depressed, the swash plate in the hydrostatic pump moves from the neutral position (parallel to the pump body) to a forward angle position. Springs inside the cylinder bores force the pistons against the swash plate.

As the cylinder block rotates, the pistons follow the contour of the swash plate, moving outward, drawing oil into their bores. As the cylinder block continues to rotate, the pistons are forced into their bores, discharging oil under pressure.

High-pressure oil form the hydrostatic pump is routed to the wheel motors, driving the machine forward.

If the pressure in the wheel motor loop is low, the relief pressure oil will provide makeup oil to the closed-loop system to maintain oil pressure/volume.

#### Reverse:

Reverse operation is accomplished by reversing the angle applied to the hydrostatic pump swash plate, reversing the flow of high-pressure oil to the wheel motors.

#### **Pump Bypass Mode**

When the machine must be moved with the engine off, the free wheeling valve on the pump can be opened to relieve pressure.

As the machine is moved, the wheel motors act as pumps, forcing hydraulic oil back to the pump. The pump blocks

cannot turn with the engine off, so oil pressure will build up. When the free wheeling valve is open, the oil is allowed to bypass the pump body and freely flow back to the hydraulic wheel motors.

## **Control Valve and Cylinder Operation**

#### **Function:**

The 2 spool control valve routes hydraulic oil to raise or lower the implements.

#### Theory of Operation:

#### Neutral:

The implement charge pressure valve opens at 172 kPa (25 psi) to provide high pressure oil to the 2 spool control valve.

When a lift lever is released, a spring centers the spool to the neutral position in the control valve housing.

Oil in the lift cylinder is trapped, maintaining the implement in its desired position. Some oil will leak past the internal seals in the cylinders and the raised implements will slowly settle to the ground. The settling is normal.

High pressure oil continues to be supplied to the control valve and passes through the spool directly to the oil cooler and hydraulic reservoir.

#### Raise:

When the lift lever is in the raise position the control valve spool routes oil to the "B" port of the control valve. The "B" port is connected to the rear of the hydraulic lift cylinder. The cylinder extends the piston and raises the connected implement.

Oil from the head of the cylinder flows back to the control valve and is routed to the oil cooler and hydraulic reservoir.

#### Lower:

When the lift lever is in the lower position, oil flow to the cylinders is reversed and pressure oil is supplied to the head of the cylinder. The pressure oil sent to the cylinder retracts the piston and lowers the connected implement.

The implement relief valve functions the same in the raise or lower operation.

#### Relief Valve Operation

If an implement hits an obstacle, oil pressure may spike at the outlet side of the gear pump or in the control valve.

The implement relief valve prevents the pressure from exceeding 10,342 kPa (1500 psi). At that pressure, the relief valve opens and excess oil passes through and returns to the hydraulic reservoir through the oil cooler.

## HYDRAULICS/POWER TRAIN OPERATION AND DIAGNOSTICS

## **Hydrostatic Power Train Diagnosis**

## Symptom: Hydraulic System

#### (1) System fails to build pressure?

- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- Yes Check to see if hydraulic oil filter is plugged.
- **Yes -** Check engine-to-hydrostatic pump coupler for damage.
- Yes Check hydrostatic pump for wear or damage.
- **Yes -** Check to see if there is sufficient charge pressure.
- **Yes -** Check to see if hydraulic free wheeling valve is in the OPEN position.
- No Go to next step.

#### (2) Machine will not drive straight?

- Yes Check wheel motor(s) for wear or damage.
- **Yes -** Check for restricted hydraulic hoses/lines.
- **Yes -** Check to see if parking brake is engaged or binding.
- **Yes -** Check to see if wheel motors are plumbed properly.
- No Go to next step.

#### (3) Machine will not reach maximum speed/ accelerates slowly?

- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- Yes Check to see if hydraulic oil filter is plugged.
- **Yes -** Check for air in the hydraulic system.
- **Yes -** Check to see if hydrostatic pump control linkage/cable is out of adjustment.
- **Yes -** Check that pedal is getting full stroke and is not binding.
- **Yes -** Check that rake speed adjustment arm is not engaged with implement up.
- **Yes -** Check to see if forward or reverse speed is overadjusted (adjusting forward speed higher will reduce reverse speed).
- **Yes -** Check hydrostatic pump for wear or damage.
- **Yes -** Check to see if there is sufficient charge pressure.
- **Yes -** Check wheel motor(s) for wear or damage.

#### Symptom: Hydraulic System

- Yes Check for restricted hydraulic hoses/lines.
- **Yes -** Check to see if parking brake is engaged or binding.
- No Go to next step.

# (4) Machine will not move when pedals are engaged?

- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- **Yes -** Check to see if hydraulic oil filter is plugged.
- Yes Check for air in the hydraulic system.
- **Yes -** Check to see if hydrostatic pump control linkage/cable is out of adjustment.
- **Yes -** Check to see if hydrostatic pump control cable is binding, broken, or damaged.
- Yes Check hydrostatic pump for wear or damage.
- **Yes -** Check to see if there is sufficient charge pressure.
- Yes Check wheel motor(s) for wear or damage.
- Yes Check for restricted hydraulic hoses/lines.
- **Yes -** Check to see if hydraulic pump free wheeling valve is in the OPEN position.
- **Yes -** Check to see if parking brake is engaged or binding.
- No Go to next step.

#### (5) Jerky or erratic operation?

- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- **Yes -** Check to see if hydraulic oil filter is plugged.
- Yes Check for air in the hydraulic system.
- Yes Check that pedal bushings are lubricated
- **Yes -** Check to see if hydrostatic control linkage return spring is properly tensioned or if it missing.
- **Yes -** Check hydrostatic pump for wear or damage.
- **Yes -** Check wheel motor(s) for wear or damage.
- Yes Check for restricted hydraulic hoses/lines.
- No Go to next step.

#### (6) Excessive noise?

- Yes Check to see if oil level is low.
- **Yes -** Check to see if using correct oil viscosity.

## HYDRAULICS/POWER TRAIN OPERATION AND DIAGNOSTICS

#### Symptom: Hydraulic System

- Yes Check to see if hydraulic oil filter is plugged.
- Yes Check for air in the hydraulic system.
- **Yes -** Check hydrostatic pump for wear or damage.
- Yes Check wheel motor(s) for wear or damage.
- **Yes -** Check for restricted hydraulic hoses/lines.
- **Yes -** Check to see if parking brake is engaged or binding.
- No Go to next step.

# (7) Machine moves when forward and reverse pedals are in neutral position, or machine does not return to neutral?

- **Yes -** Check to see if hydrostatic pump control linkage/cable is out of adjustment.
- **Yes -** Check to see if hydrostatic pump control cable is binding, broken, or damaged.
- **Yes -** Check that neutral creep is adjusted properly.
- **Yes -** Check hydrostatic pump control linkage for damage.
- **Yes -** Check to see if hydrostatic control linkage return spring is properly tensioned or if it is missing.
- **No -** Go to next step.

# (8) Machine does not slow down when rake is lowered?

- **Yes -** Check that speed control arm or bracket is not damaged, bent or loose.
- **Yes -** Check if control arm is contacted when forward pedal is pressed down with rake lowered.
- No Go to next step.

## **Hydraulic Lift System Diagnosis**

## Symptom: Hydraulic System

#### (1) Implement does not raise?

- **Yes -** Check to see if maximum load is being exceeded.
- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- Yes Check relief valve for damage.
- **Yes -** Check spool valve for binding or O-ring damage.
- Yes Check suction filter.
- **Yes -** Check gear pump for wear or damage.
- No Go to next step.

#### (2) Implement does not lower?

- Yes Check to see if oil level is low.
- Yes Check to see if using correct oil viscosity.
- **Yes -** Check spool valve for binding or O-ring damage.
- Yes Check suction filter.
- Yes Check gear pump for wear or damage.
- No Go to next step.

#### (3) Noisy operation?

- Yes Check to see if oil level is low.
- **Yes -** Check to see if using correct oil viscosity.
- **Yes -** Check spool valve for binding or O-ring damage.
- No Go to next step.

# (4) Implement lowers/leaks down during operation?

- Yes Check spool valve for O-ring damage.
- Yes Check control valve for oil bypass or wear.
- Yes Check cylinders for damage or wear.
- No Go to next step.

#### (5) Implement lowers/raises slowly?

Yes - Check to see if oil level is low.

## HYDRAULICS/POWER TRAIN TESTS AND ADJUSTMENTS

## **Tests and Adjustments**

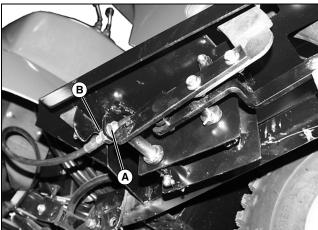
## **Adjusting Forward and Reverse Speed**

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



CAUTION: Avoid injury! The machine can fall or slip from an unsafe lifting device or supports.

- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.
- 2. Lift and safely support the machine so all wheels are off the ground and can turn freely.



MX32929

- 3. Loosen jam nut (A).
- 4. Turn adjusting nut (B) until the rear tires do not move; forward and reverse pedals will be in a neutral position.
- 5. Tighten nuts.
- 6. Lower machine.

## **Adjusting Wheel Creep**

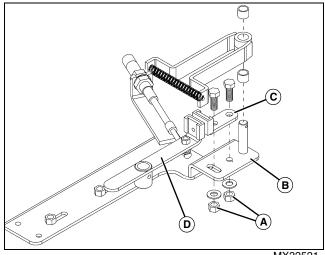
"Creep" is when engine is running and hydrostatic transmission is in neutral, but due to incorrect alignment, wheels still move. Do the following procedure to stop this motion.

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



CAUTION: Avoid injury! The machine can fall or slip from an unsafe lifting device or supports.

- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.
- 2. Lift and safely support the machine so all wheels are off the ground and can turn freely.



MX32521

- 3. Loosen the nuts (A) on the bottom of the hydrostatic transmission mounting plate (B), located at the rear of the machine.
- 4. Start engine.
- 5. Move stop (C) so it moves shift arm (D) to center and wheel creep stops.
- 6. Tighten all hardware and test by using foot pedal linkage to see that the "creep" is removed:
  - Press down on forward and reverse travel pedal slightly and release. Machine should remain motionless after pedals are released back to neutral position.
- 7. Stop engine and lower machine.

## HYDRAULICS/POWER TRAIN TESTS AND ADJUSTMENTS

## **Speed Control Linkage Adjustment**

#### Reason:

Allows the machine to operate at a proper speed while in forward.

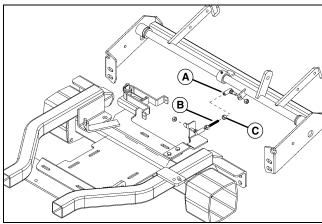


CAUTION: Avoid injury! When the rear rake attachment is lowered while the machine is in the forward position, the forward speed of the machine will slow drastically. Operator should be prepared for the rapid change in speed.

#### **Procedure:**

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.

NOTE: Speed has been factory set at an average speed of 5.0 - 6.5 kph (3 - 4 mph).



MX32922

2. Adjust speed by removing the ball joint (A) from the linkage rod (B).

NOTE: Speed control will limit speed only when rake is lowered. Forward speed of machine will slow abruptly when rear rake is lowered during transportation.

- 3. Loosen nut (C), and turn ball joint clockwise to make the the machine operate faster or turn counterclockwise to go slower.
- 4. Tighten jam nut, and connect ball joint to limiting arm.
- 5. Check to make sure nothing is binding and test drive to check desired speed.

## **Implement Charge Pressure Test**

#### Reason:

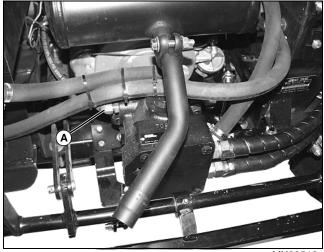
To test implement charge pressure.

#### **Test Equipment:**

- · Fittings as needed
- JT03092, 0 400 kPa (0 60 psi) Gauge

#### **Procedure:**

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32518

- 2. Install JT03092 pressure gauge to outlet (A) on pump.
- 3. Start engine and observe the pressure reading on the gauge.

#### Results:

- If the pressure reading is approximately to specification, the implement relief valve is good.
- If the pressure reading is too high, replace the implement relief valve.

#### Specification:

Implement Charge Pressure . . . . . . . . 172 kPa (25 psi)

## HYDRAULICS/POWER TRAIN TESTS AND ADJUSTMENTS

#### **Relief Pressure Test**

#### Reason:

To determine relief pressure operation and help determine condition of hydraulic charge pump. This also determines if there is sufficient pressure to operate forward and reverse wheel motors.

#### **Test Equipment:**

- · Fittings as needed
- JT03017 Hose
- JT03117, 0-13790 kPa (0 2000 psi) Pressure Gauge

#### **Pressure Test Procedure:**

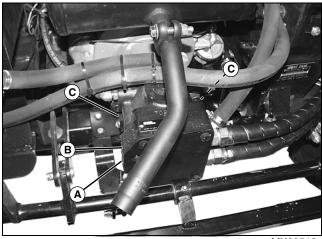
Warm hydraulic oil to operating temperature before performing this test. When done "cold" or at shop temperature, most machines (especially when new) will likely be close to **3450 kPa (500 psi)**.

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Safely support machine so that all wheels are clear of the ground.
- 3. Attach seat switch and set up machine so engine can be run.



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

• If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.



MX32518

- A Forward
- **B** Reverse
- 4. Install connector, hose and pressure gauge to forward hydraulic drive pressure port (A).
- 5. Start engine and run at high idle. Do not operate hydraulic control valves.
- 6. Observe gauge reading. This is charge relief pressure.
- 7. Press the forward pedal and observe pressure reading.
- 8. Stop the engine and install the pressure gauge in the reverse drive pressure port (B).
- 9. Repeat procedure and observe the reverse drive pressure reading.

#### Results:

- If the pressure readings are both approximately to specification, the hydraulic pump is good.
- If one of the pressure readings is good and the other is low, switch the two check valves (C) and repeat entire procedure. Replace the check valve if the low readings changes.
- If both of the readings are either low or high, replace the charge pressure relief valve.

#### Specification:

Charge Relief Pressure . . . . . . . . . 6205 kPa (900 psi)

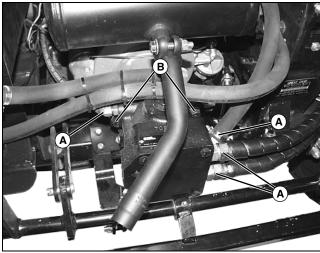
## **HYDRAULICS/POWER TRAIN REPAIR**

## Repair

## **Hydraulic Pump Removal and Installation**

#### Removal:

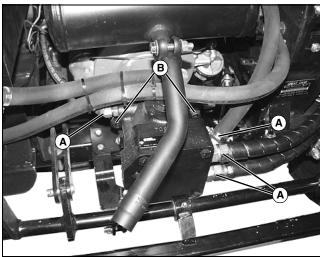
- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Lower all implements (if equipped).
- 3. Raise rear body cowling.



MX32518

- 4. Remove hydraulic hoses (A).
- 5. Remove socket head capscrews (B) and pump assembly.

#### Installation:



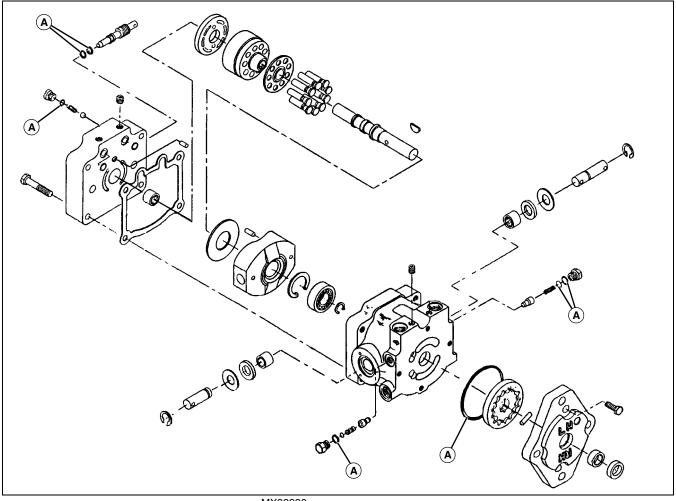
MX32518

- 1. Install pump assembly and install socket head capscrews (B).
- 2. Install hydraulic hoses (A).
- 3. Lower rear body cowling.

## **HYDRAULICS/POWER TRAIN REPAIR**

## **Hydraulic Pump Repair**

## Disassembly and Assembly:



MX32930

#### A - Seals

- Remove plugs, and inspect seals parts for wear or damage. Replace seals as necessary.
- If other parts are worn or damage, entire pump assembly must be replaced as a complete assembly.

### **Rear Wheel Motor Removal and Installation**

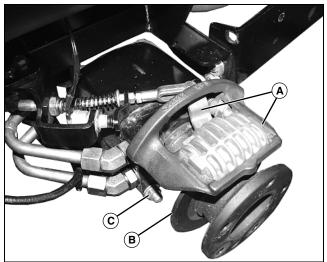


CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body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

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32679

- 2. Remove park brake assembly (A) and rotor (B). See "Parking Brake Caliper Removal and Installation" on page 122 in the Brakes section.
- 3. Disconnect hydraulic hoses.
- 4. Remove mounting cap screws and nuts (C).
- 5. Inspect parts for wear or damage. Replace seals as necessary.

#### Installation:

Installation is done in the reverse order of removal.

- Apply MPG-2 Multi-Purpose Grease to wheel motor shaft and key.
- Tighten the nut securing the rotor to the wheel to 407 N•m (300 lb-ft).
- Tighten hydraulic line nuts and to 50 N•m (37 lb-ft).
- · Check oil reservoir before operating machine.

#### Front Wheel Motor Removal and Installation

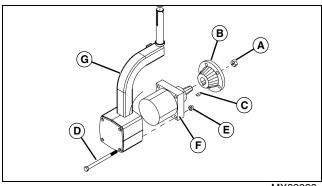


CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body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

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove front wheel.



MX3292

3. Remove nut (A) to remove front hub (B), being sure to retain key (C).

- 4. If necessary, remove bolts (D) and nuts (E) and remove front wheel motor (F) from front steering fork (G).
- 5. Inspect all parts for wear or damage. Replace seals as necessary.

#### Installation:

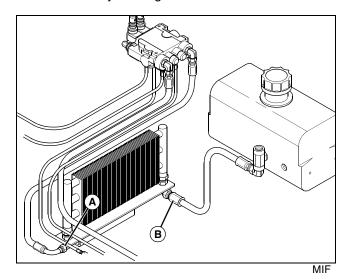
Installation is done in the reverse order of removal.

- Apply MPG-2 Multi-Purpose Grease to wheel motor shaft and key.
- Tighten the nut securing the front hub to the wheel to 407 Nem (300 lb-ft).
- Tighten hydraulic line nuts to 50 Nem (37 lb-ft).
- Check oil reservoir before operating machine.

#### Oil Cooler Removal and Installation

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Raise rear body cowling.



- 3. Remove lower left line (A) from oil cooler (line connected to control valve).
- 4. Remove lower right line (B) from oil cooler (connected to oil reservoir).
- 5. Remove hardware securing oil cooler to machine frame, and raise oil cooler from machine.

#### Installation:

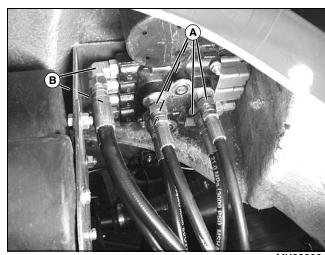
Installation is done in the reverse order of removal.

- Tighten line nuts (A) and (B) to 50 Nem (37 lb-ft).
- Check oil reservoir before operating machine.

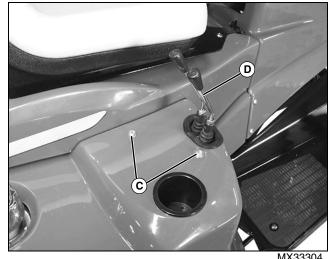
#### Lower/Lift Levers Removal and Installation

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



- 2. Disconnect four lines (A).
- 3. Disconnect two lines (B).



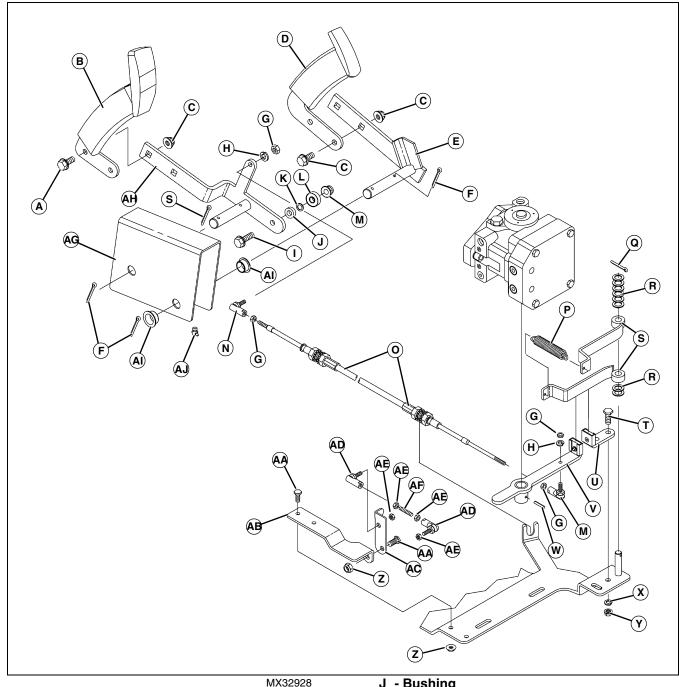
- MX33304
- 4. Remove two bolts (C) holding valve in position.
- 5. Lower valve assembly (D) from bottom of right fender.

#### Installation:

Installation is done in the reverse order of removal.

- Tighten all line connections to 50 N•m (37 lb-ft).
- Check oil reservoir before operating machine.

## Forward and Reverse Pedals and Linkage Removal and Installation



- A Screw (M8x25)
- **B** Pedal, Forward
- C Locknut (M8)
- D Pedal, Reverse
- E Shaft, Reverse
- F Cotter Pin (4 x 25 mm)
- G Nut, 1/4 in.
- H Lockwasher, 1/4 in.
- I Bolt

- J Bushing
  - K Washer
  - L Bearing
  - M Nut
  - N Tie Rod End
  - O Cable
  - P Spring
  - Q Cotter Pin (1/8 x 1 in.)
  - R Washer
  - S Arm, Centering

- T Capscrew (3/8 x 1 in.)
- U Stop
- V Control Arm
- W Spring Pin
- X Washer
- Y Nut
- Z Locknut
- **AA- Capscrew (5/16 x 1 in.)**
- **AB- Bracket**
- AC- Arm
- **AD- Tie Rod End**
- **AE-Nut**
- AF- Linkage
- AG- Pivot (part of floorboard assembly)
- AH- Shaft, Forward
- AI Bushing
- **AJ- Lubrication Fitting**
- Inspect all parts for wear or damage. Replace parts as necessary.
- Adjust linkage. See "Adjusting Forward and Reverse Speed" on page 100.

# STEERING TABLE OF CONTENTS

## **Table of Contents**

Specifications	.111
General Specifications	
Repair Specifications	.111
Other Materials	
Component Location	.112
Steering System	.112
Theory of Operation	
Steering System Operation	.114
Diagnostics	
System Diagnosis	.114
Tests and Adjustments	.114
Steering Chain Tension Adjustment	
Repair	.115
Steering Wheel Removal and Installation.	.115
Steering Shaft Removal and Installation	
Steering Fork Removal and Installation	



## STEERING SPECIFICATIONS

## **Specifications**

## **General Specifications**

Type	Mechanical, Roller-Chain and Sprocker
Ratio	8:1
Steering Wheel Diameter	355 mm (14 in.
Turns (Lock to Lock)	
Maximum Torque Required to Turn	14 N•m (10 lb-ft
Expected Operating Grade	
Repair Specifications	

Locking Collar Set Screw Torque	8 N•m (64 lb-in.)
Steering Disk Cap Screw Torque	33 N•m (24 lb-ft)
Steering Wheel-to-Shaft Nut Torque	33 Nem (24 lb-ft)

## **Other Materials**

### **Other Material**

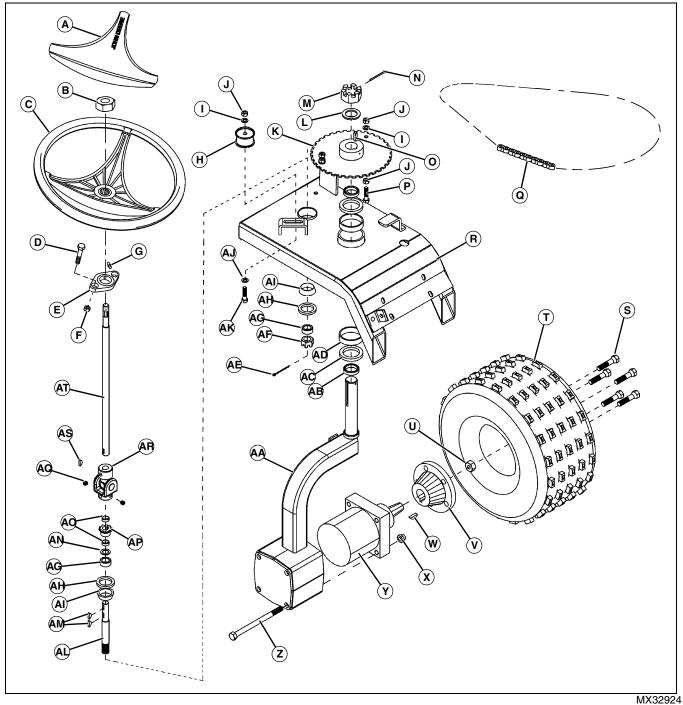
Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Polymer Grease	Apply to steering shaft and steering fork shaft.

®MPG-2 is a registered trademark of DuBois USA.

## STEERING COMPONENT LOCATION

## **Component Location**

## **Steering System**



- A Cover
- B Nut
- C Steering Wheel
- D Capscrew, 5/16 x 1-3/4 in.
- **E** Pillow Block
- F Nut

## STEERING COMPONENT LOCATION

- **G** Grease Fitting
- H Idler Pulley
- I Lock Washer, 3/8 in.
- J Nut, 3/8 in.
- K Chain Sprocket
- L Washer
- M Nut
- N Cotter Pin
- O Shaft Key, 1/4 x 1/4 x 1 in.
- P Bolt, 3/8 x 1-1/2 in.
- Q Chain
- R Main Frame
- S Bolt, Wheel
- T Tire and Wheel
- U Nut
- V Hub
- W Key, 5/16 x 1 in.
- X Nut, Flange, 1/2 in.
- Y Wheel Motor
- Z Bolt, 1/2 x 7 in.
- **AA- Front Fork**
- **AB-Spacer**
- **AC-Oil Seal**
- **AD- Ball Bearing**
- **AE- Cotter Pin**
- AF- Slotted Nut, 3/4 in.
- **AG-Spacer**
- **AH- Oil Seal**
- AI Ball Bearing
- AJ- Washer, 13/32 x 1-1/4 x 0.100 in.
- AK- Capscrew, 3/8 x 1-1/4 in.
- AL- Shaft, Lower Steering
- AM- Key, Shaft
- **AN-Washer**
- **AO-Spacer**
- **AP- Chain Sprocket**
- **AQ- Set Screw**
- **AR-Yoke**
- AS- Key, Shaft
- AT- Shaft, Upper Steering

## STEERING THEORY OF OPERATION

### Theory of Operation

## **Steering System Operation**

#### **Function:**

To direct movement of the machine in forward or reverse.

#### Theory of Operation:

When the steering wheel is turned, the steering shaft and sprocket rotate. The sprocket is connected to the steering disc by a chain. The steering disk is splined to the steering fork. As the sprocket turns, the chain causes the steering disk/steering fork to rotate, turning the front wheels.

Steering effort is quite low due to the 8 to 1 reduction between the steering shaft and the fork shaft. There are two mechanical stops between the fork and frame which limits the steering angle of the front wheel.

## **Diagnostics**

## System Diagnosis

### **Symptom: Steering System**

#### (1) Does steering wander?

Yes - Check to see if steering chain is loose or worn.

Yes - Check sprocket teeth for wear or damage.

Yes - Check wheel bearings for wear or damage.

Yes - Check for a bent rim.

**Yes -** Check to make sure tire is mounted correctly on rim.

No - Go to next step.

#### (2) Does steering feel loose or unresponsive?

**Yes -** Check to see if steering wheel is loose on column.

Yes - Check to see if steering chain is loose or worn.

Yes - Check sprocket teeth for wear or damage.

No - Go to next step.

#### (3) Is there vibration at steering wheel?

Yes - Check wheel bearings for wear or damage.

Yes - Check fork shaft bearings for wear or damage.

**Yes -** Check wheel motor components for wear or damage.

Yes - Check for a bent rim.

### **Symptom: Steering System**

**Yes -** Check to make sure tire is mounted correctly on rim.

#### (4) Does the steering wheel turn hard?

Yes - Check fork shaft bearings for wear or damage.

**Yes -** Check wheel motor components for wear or damage and that hoses are correctly installed.

### **Tests and Adjustments**

### **Steering Chain Tension Adjustment**

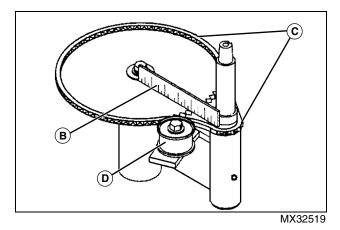
#### Procedure:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32570

2. Remove the four screws and access cover (A).



- 3. Check with a straight edge (B) that the steering sprockets (C) are level with each other.
  - a. Make any adjustments by sliding idler pulley (D) so that it is snug onto the chain.
  - b. Tighten all nuts and bolts in place.

## STEERING REPAIR

### Repair

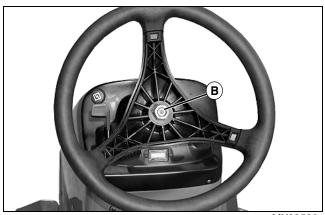
## Steering Wheel Removal and Installation

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



2. Remove cover from steering wheel by gently prying up on center cover at three points (A).



MX32536

- 3. Remove nut (B) securing steering wheel to shaft.
- 4. Note position of steering wheel by marking spline and wheel for proper positioning during assembly.

NOTE: If the steering wheel is hard to remove a knife edge bearing puller and a two leg bearing puller can be combined to remove it from the steering column.

5. Gently tap bottom of steering wheel up and off of shaft splines.

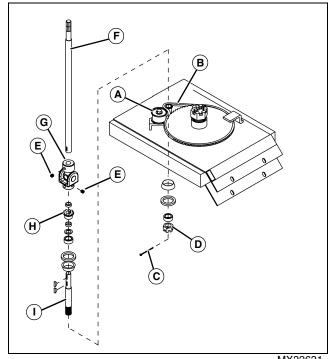
#### Installation:

- Installation is done in reverse of removal.
- Apply anti-seize compound to the steering column splines and taper.
- Tighten steering wheel nut to 33 Nem (24 lb-ft).

## Steering Shaft Removal and Installation

#### Removal:

- 1. Park machine safely.
- 2. Remove steering wheel.
- 3. Remove front cowling. See "Front Cowling Removal and Installation" on page 140 in the Miscellaneous section.



MX32631

- 4. Loosen idler pulley (A) and remove chain (B).
- 5. Remove cotter pin (C) and nut (D).
- 6. Loosen set screws (E).
- 7. Remove shaft (F) and universal joint (G).
- 8. Remove sprocket (H) and remaining components and lower shaft (I).
- 9. Inspect all parts for wear or damage. Replace parts as necessary.

#### Installation:

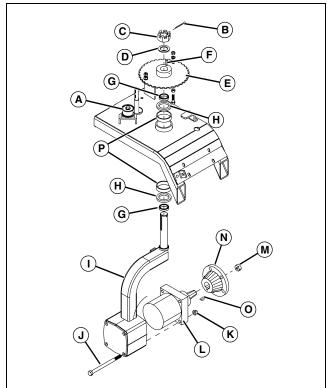
- Installation is done in reverse of removal.
- Apply MPG-2® Polymer Multipurpose Grease to lower half of steering shaft.
- Install bushings using a driver set.
- Perform "Steering Chain Tension Adjustment" above.

## STEERING REPAIR

## **Steering Fork Removal and Installation**

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove steering wheel.
- 3. Remove front cowling. See "Front Cowling Removal and Installation" on page 140 in the Miscellaneous section.
- 4. Remove front wheel. See "Front Wheel Removal and Installation" on page 142 in the Miscellaneous section.



MX32923

- 5. Loosen nut on idler pulley (A), and remove tension to remove chain.
- 6. Remove cotter pin (B), slotted nut (C), and bushing (D).
- 7. Remove steering sprocket (E) and key (F).
- 8. Remove spacer (G), and oil seal (H), and lower front fork assembly (I) from main frame.
- 9. If necessary, remove bolts (J) and nuts (K) and remove front wheel motor (L).
- 10.Remove nut (M) to remove front hub (N), being sure to retain key (O).
- 11.Inspect all parts for wear or damage. Replace parts as necessary.

NOTE: Bearings (P) are press-fit. Remove only if replacement is necessary.

12.Inspect bearings (P) for wear or damage. Replace if necessary.

#### Installation:

- Installation is done in reverse of removal.
- Apply MPG-2® Polymer Multipurpose Grease to steering fork shaft.
- Perform "Steering Chain Tension Adjustment" on page 114.

## **BRAKES TABLE OF CONTENTS**

## **Table of Contents**

Specifications	119
General Specifications	
Adjustment Specifications	
Repair Specifications	
Other Materials	
Component Location	120
Brake System Components	
Diagnostics	
System Diagnosis	121
Tests and Adjustments	
Parking Brake Switch Adjustment	
Parking Brake Lining Contact Adjustment	
Repair	
Parking Brake Caliper Removal and	
Installation	122

BRAKES	TABLE OF CONTENTS

## **BRAKES SPECIFICATIONS**

## **Specifications**

## **General Specifications**

Brake Location/Type .......Transaxle, Internal Parking Brake ......Brake Locking Lever

### **Adjustment Specifications**

### **Repair Specifications**

#### **Other Materials**

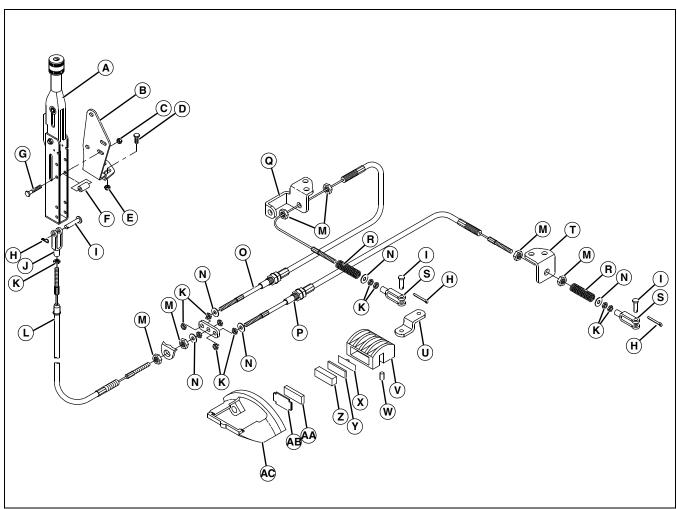
#### **Other Material**

Part No.	Part Name	Part Use
M79292	MPG-2® Polymer Multipurpose Grease	Prevents parts from seizing. Apply to transaxle axle shaft splines and brake actuator pin.
AR31790	Adhesive	Attaches brake lining to caliper housing.

## **BRAKES COMPONENT LOCATION**

## **Component Location**

## **Brake System Components**



- A Brake Handle
- B Bracket
- C Nut
- D Cap Screw
- E Nut
- F Spacer
- **G** Cap Screw
- H Spring Pin
- I Pin, Drilled
- J Clevis
- K Nut
- L Cable Assembly
- M Nut
- N Washer
- O Cable Assembly
- P Cable Assembly
- Q Bracket
- **R** Compression Spring

- S Clevis
- T Bracket
- U Lever
- V Brake Pad Housing
- W Pin
- X Cam Plate
- Y Wear Plate
- Z Brake Pad
- **AA- Brake Pad**
- **AB- Wear Plate**
- **AC- Assembly Frame**

## BRAKES DIAGNOSTICS

### **Diagnostics**

## **System Diagnosis**

### **Symptom: Brake Problems**

### (1) Steering pulls in one direction?

Yes - Brakes improperly adjusted.

Yes - Brakes worn or no longer serviceable.

**Yes -** Brake friction/stationary plates worn or damaged.

Yes - Brake linkage damaged/binding.

**No -** Go through diagnostic procedures and/or go back to previous steps.

#### (2) Brakes drag or slow to release?

Yes - Brakes improperly adjusted.

Yes - Brake return spring weak/damaged/missing.

Yes - Brake linkage damaged/binding.

**No -** Go through diagnostic procedures and/or go back to previous steps.

### (3) Brakes not effective?

Yes - Brakes improperly adjusted.

Yes - Brakes worn - no longer serviceable.

**Yes -** Brake friction/stationary plates worn or damaged.

Yes - Brake linkage damaged/binding.

Yes - Brake lever cam and/or actuator worn.

Yes - Actuator/housing worn or damaged.

**No -** Go through diagnostic procedures and/or go back to previous steps.

#### (4) Excessive brake lever travel?

Yes - Brakes improperly adjusted.

Yes - Brakes worn - no longer serviceable.

**Yes -** Brake friction/stationary plates worn or damaged.

Yes - Brake lever cam and/or actuator worn.

**Yes -** Actuator/housing worn or damaged.

**No -** Go through diagnostic procedures and/or go back to previous steps.

#### (5) Noise during braking?

**Yes -** Brakes worn - no longer serviceable.

### **Symptom: Brake Problems**

**Yes -** Brake friction/stationary plates worn or damaged.

Yes - Brake lever cam and/or actuator worn.

Yes - Actuator/housing worn or damaged.

**No -** Go through diagnostic procedures and/or go back to previous steps.

### **Tests and Adjustments**

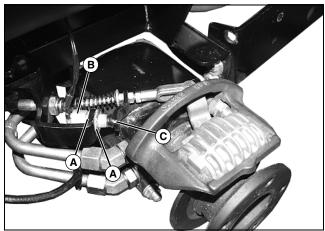
### **Parking Brake Switch Adjustment**

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



CAUTION: Avoid injury! The machine can fall or slip from an unsafe lifting device or supports.

- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.
- 2. Raise rear of vehicle with a safe lifting device. Place support stands under vehicle.
- 3. Remove left rear tire.
- 4. Release parking brake.



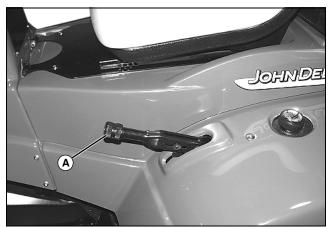
MX32679

- 5. Loosen jam nuts (A) and move switch (B) towards arm (C) on parking brake linkage.
- 6. Test parking brake switch by performing startup procedure.

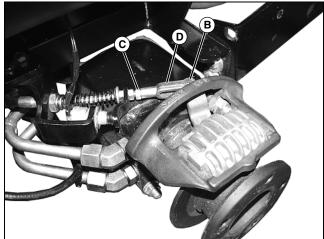
## BRAKES REPAIR

## Parking Brake Lining Contact Adjustment

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



- 2. Adjust knob (A) on parking brake lever to tighten or loosen the brake a small amount. (Clockwise to tighten, counterclockwise to loosen.)
- 3. If further adjustment is needed, raise rear of vehicle with a safe lifting device. Place support stands under vehicle.
- 4. Remove rear tire.
- 5. Release parking brake.



- 6. Remove cotter pin and pin (B), to disconnect linkage from parking brake assembly.
- 7. Loosen jam nut (C).
- 8. Rotate yoke (D) clockwise to increase brake pad tension, and counterclockwise to decrease tension to eliminate machine creep.
- 9. Replace pin (B) and cotter pin and check parking brake. Remove pin (B) and adjust yoke until creep is gone. Install pin (B) and cotter pin when creep has been eliminated.

10. Hold yoke (D) and tighten jam nut (C).

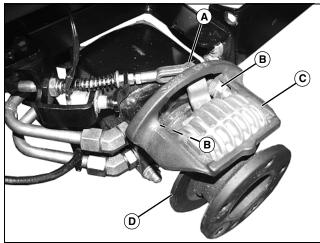
11. Repeat for opposite side, as necessary. Install rear tire and lower machine to ground.

### Repair

### Parking Brake Caliper Removal and Installation

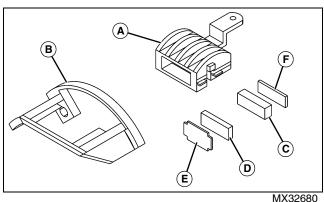
#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Raise rear of vehicle with a safe lifting device. Place support stands under vehicle.
- Remove rear tire.
- 4. Release parking brake.



- 5. Remove cotter pin and pin (A), to disconnect linkage from parking brake assembly.
- 6. Remove two nuts (B), and parking brake assembly (C) from rotor (D).

#### Disassembly:

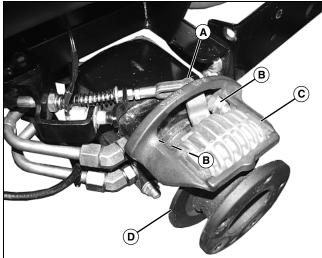


1. Remove brake pad housing (A) from parking brake assembly frame (B).

## **BRAKES REPAIR**

- 2. Remove inside (C) and outside (D) brake pads from parking brake pad housing (A).
- 3. Install new parking brake pads, being careful to keep slotted wear plate (E) and rectangular wear plate (F) in their respective positions.
- 4. Install brake pad housing back into parking brake assembly frame.

#### Installation:



MX32679

- 1. Install parking brake assembly (C) onto rotor (D), and secure with two nuts (B).
- 2. Connect linkage onto parking brake assembly, and secure with pin (A) and cotter pin.
- 3. Install rear tire.
- 4. Repeat procedure for opposite side, if necessary.

В	BRAKES	REPAIR	

# ATTACHMENTS TABLE OF CONTENTS

## **Table of Contents**

Specifications	127
Attachments and Kits	
Tests and Adjustments	128
Adjusting Rake Lift Cylinder	128
Adjusting the Front Blade	128
Adjusting Lift Assembly	129
Repair	130
Lift Assembly Removal and Installation	130
Rake Assembly Removal and Installation	130
Scarifier Removal and Installation	132
Front Blade Removal and Installation	134



## ATTACHMENTS SPECIFICATIONS

## **Specifications**

## **Attachments and Kits**

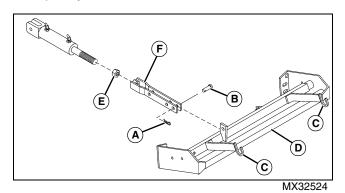
Front-Mount Attachments
Lift System
Front Blade (Optional)
Width
Height
Weight
Mid-Mount Attachments
Lift System
Lift Lever Location Right-Hand Side of Operator's Seat
Scarifier (Optional)
Width
Weight
Tines
Tines
Rear-Mount Attachments
Lift System
Lift Lever Location
Rake
Width
Weight
Blades

## ATTACHMENTS TESTS AND ADJUSTMENTS

### **Tests and Adjustments**

## **Adjusting Rake Lift Cylinder**

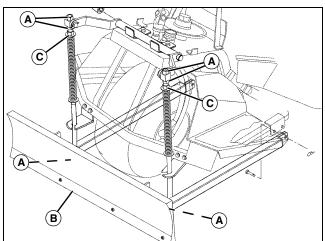
- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Completely lower rake lift.



- 3. Remove cotter pin (A) and clevis pin (B).
- 4. Place attachment lift arms (C) at 1/16-inch above cross member (D) on rake lift.
- 5. Loosen jam nut (E).
- 6. Twist cylinder extension (F) so clevis pin end of cylinder extension lines up with holes in attachment lift arm.
- 7. Replace clevis and cotter pins.
- 8. Tighten jam nuts.
- 9. Raise and lower rake lift to check for proper clearance.

## **Adjusting the Front Blade**

1. Park the machine safely. See "Parking Safely" on page 5 in the Safety section.

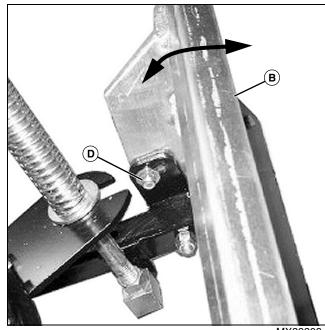


MX32573

2. With blade fully raised, adjust nuts (A) on lift rod, so blade (B) is approximately 15.2 cm (6 in.) above ground surface.

NOTE: Note the level and spring force of the front blade can only be slightly altered by turning the nuts (C) on the threaded spring rod.

3. Adjust the nuts (C) down or up to level the front blade (slightly left and right).

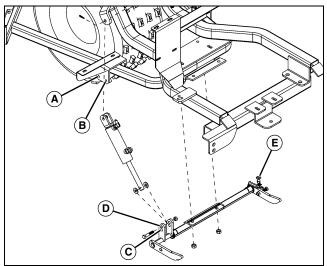


MX33308

4. Adjust pitch of blade by loosening bolt and nut (D) and move blade (B) forward or backward to correct pitch. Tighten bolt and nut (D).

## ATTACHMENTS TESTS AND ADJUSTMENTS

## **Adjusting Lift Assembly**



MX32522

Picture note: Front attachments are installed in front mounting holes (A), and all lift attachments are installed in rear holes (B).

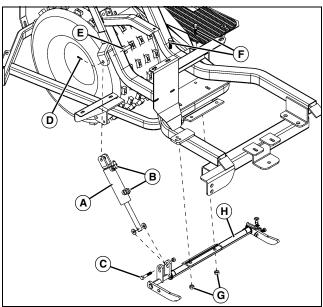
- To adjust attachment lift to dig deeper into the ground, relocate cylinder rod of hydraulic cylinder, which controls the lift distances, into the lower set of holes (C) in the attachment swing arm. This new position forces the attachment farther down. The upper holes (D) are the normal operating position.
- To align arms, loosen nut on bolt (E), and move arm. Tighten nut.

### Repair

## Lift Assembly Removal and Installation

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove attachments from machine.



MX32522

- 3. Disconnect hydraulic hoses from hydraulic cylinder (A) upper and lower fittings (B).
- 4. Remove bolt (C), washers, and nut from lower end of hydraulic cylinder.
- 5. Remove spring locking pin (D) and pin (E) securing top side of hydraulic cylinder and remove cylinder.
- 6. Remove bolts (F), nuts (G), and lift assembly (H).

#### Installation:

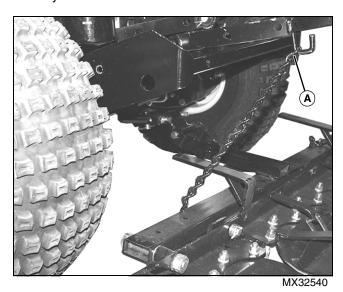
Installation is done in the reverse order of removal.

- Tighten nuts (G) to 8 Nem (71 lb-in.).
- Adjust lift assembly. See "Adjusting Lift Assembly" on page 129.

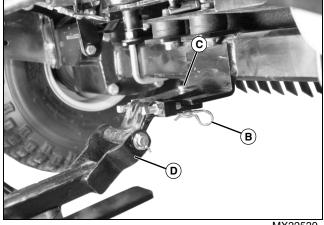
### **Rake Assembly Removal and Installation**

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



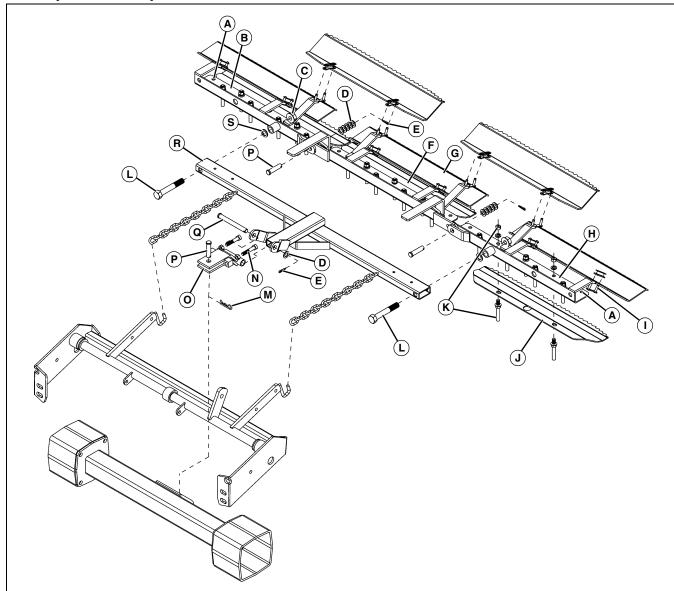
2. Remove chain (A) from lift hooks on each side of machine.



MX32539

3. Remove spring locking pin (B) and pin (C), and disconnect rake hitch (D) from rear axle bracket.

### Disassembly and Assembly:



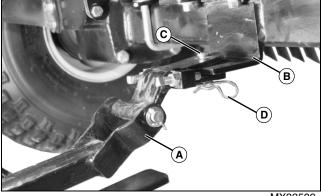
MX32727

- A Reference hole (left open on assembly)
- **B** Right Rake
- C Locknut, 5/8 in.
- D Bushing, 1/2 in.
- E Cotter Pin, 1/8 x 1 in.
- F Center Rake
- **G** Finishing Blade
- H Left Rake
- I Connector Link
- J Groomer Blade
- K Rake Teeth
- L Bolt, 5/8 x 4 in.
- M Spring Locking Pin, 1/8 in.
- N Set Screw, Square Head, 3/8 x 2 in.

- O Hitch
  - P Clevis Pin, 1/2 x 1-1/2 in.
  - Q Clevis Pin, 1/2 x 4-1/2 in.
  - R Drawbar
  - S Bushing, 5/8 in.
- Inspect all parts for wear or damage. Replace parts as necessary.

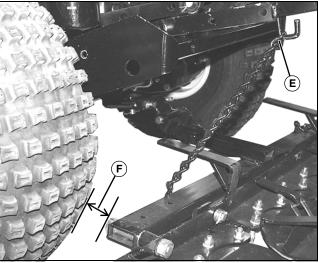
#### Installation:

1. Back the bunker rake to the rake.



MX32539

2. Install the rake hitch (A) to trap rake hitch (B) on the rear axle using a drilled pin (C) and quick pull pin (D).



- 3. Install the end links of the chain (E) on the drawbar to the hooks of the trap rake lift.
- 4. Check to be sure the rake is on the ground. Pull the rake to the left until left chain is tight.
- 5. Loosen jam nut and turn the left adjustment screw (F), until rake is 51 mm (2 in.) (G) from left tire. Tighten jam nut so adjustment will not change.
- 6. Repeat steps 4 and 5 on left side.

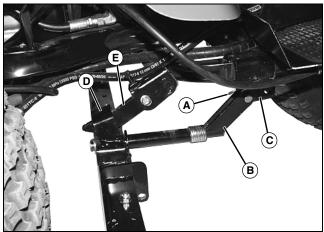
NOTE: Test rake in sand to assure tire tracks are covered by the rake when turning sharp corners in either direction. If there are tire tracks, readjust the adjusting screws on the hitch, so the rake comes closer to the tire.

7. Turn machine on and test for operation of rake assembly by raising and lowering the rake assembly. Also with rake down, turn sharp corners to check that the rake does not touch wheels.

### **Scarifier Removal and Installation**

#### Removal:

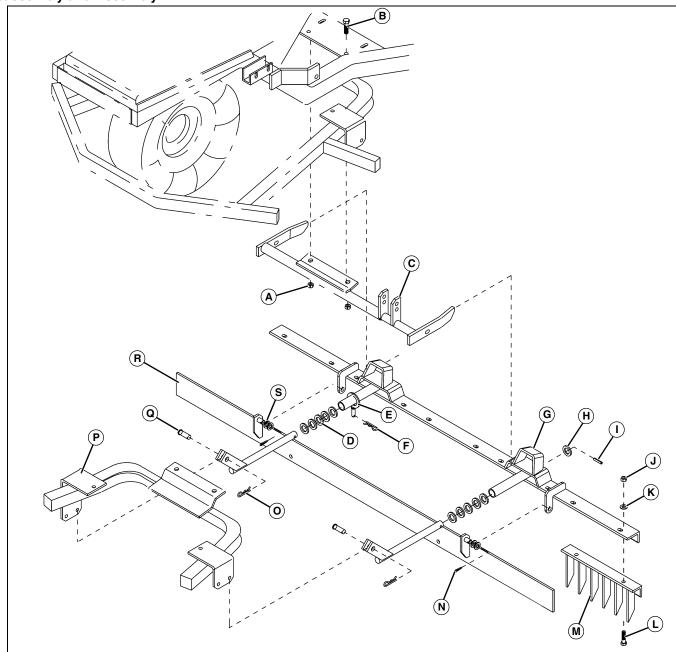
1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32543

- 2. Remove quick pull pin (A), and clevis pin. Remove pistols (B) from the tabs (C) of the trap rake frame undercarriage.
- 3. Lift and move frame hook bracket (D) from arms (E) of the attachment lift.

## Disassembly and Assembly:



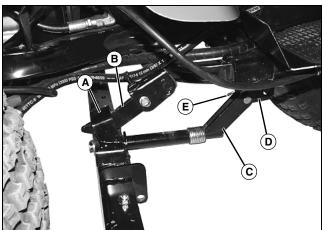
MX32699

- A Locknut
- B Bolt
- C Attachment Lift (Part of lift assembly)
- D Washer (5)
- E Hook
- F Spring Locking Pin
- G Frame
- H Bushing
- I Roll Pin
- J Nut
- K Lockwasher

- 2699 **L Bolt** 
  - M Tine Segment
  - N Cotter PIn
  - O Spring Locking Pin
  - P Trap Rake Frame
  - Q Clevis Pin
  - R Grader Blade
  - S Bushing
  - Inspect all parts for wear or damage. Replace parts as necessary.

#### Installation:

1. Slide scarifier attachment under machine.



MX32543

- 2. Lift frame and hook bracket (A) over arms (B) of the attachment lift.
- 3. Attach pistols (C) to the tabs (D) of the trap rake frame undercarriage in the rear holes using clevis pin, two washers and quick pull pin (E).
- 4. Repeat steps on other side of the machine.
- 5. Turn machine on and test for proper operation.

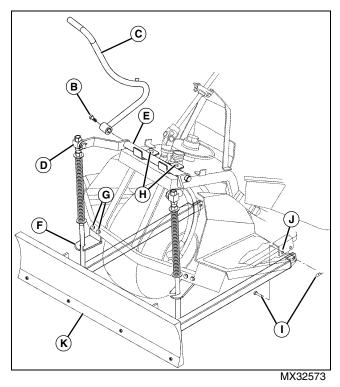
#### Front Blade Removal and Installation

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



2. Raise blade and secure in transport (lock) position with hold down strap (A), as shown. Place block under blade.



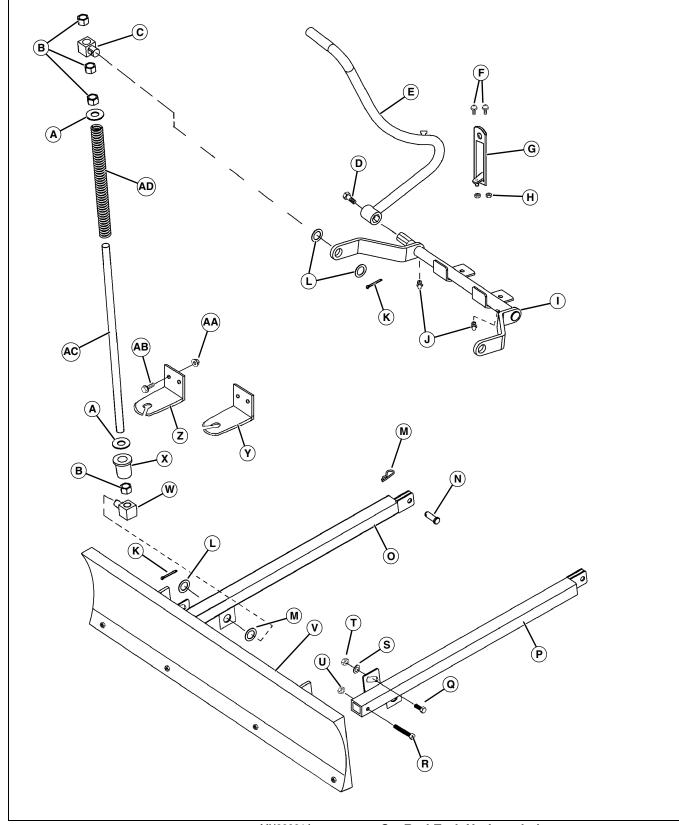
Picture Note: Front cowling shown removed for photo clarity only.

- 3. Remove hold down strap from handle, and remove bolt (B) and handle (C).
- 4. Remove spring locking pin and washer securing rod end (D) onto front tube bracket (E) arm.
- 5. Remove rod from bracket (F) on front bumper, and remove bolt and nut (G) and bracket (F). Repeat for opposite side.

NOTE: Only blade and rod assemblies need to be removed. Hardware (H) and front tube bracket (E) does not need to be removed from machine.

- 6. Remove spring locking pin and pin (I) securing blade to front hole (J) of machine frame.
- 7. Slide blade assembly (K) from under machine frame.

## Disassembly and Assembly:



A - Washer

B - Nut

MX32921A C - Rod End, Unthreaded

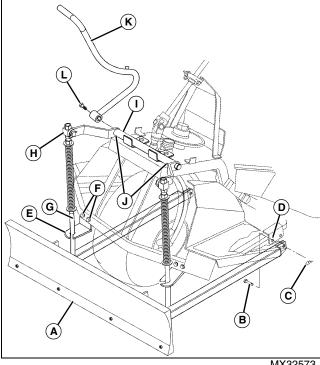
D - Screw

E - Lift Handle

- F Screw
- G Strap, Hold-Down
- H Nuts
- I Front Tube Bracket Assembly
- J Zerk
- K Cotter Pin
- L Washer
- M Spring Locking Pin
- N Pin
- O Lift Arm, Right
- P Lift Arm, Left
- Q Bolt
- R Bolt
- S Washer
- T Nut
- U Nut
- V Blade
- W Rod End, Threaded
- X Spacer
- Y Rod Guide, Left
- Z Rod Guide, Right
- AA- Nut
- **AB-Bolt**
- AC-Rod, LIft Assist
- **AD- Spring, Lift Assist**
- Inspect all parts for wear or damage. Replace parts as necessary.

#### Installation:

1. Park the machine safely. See "Parking Safely" on page 5 in the Safety section.

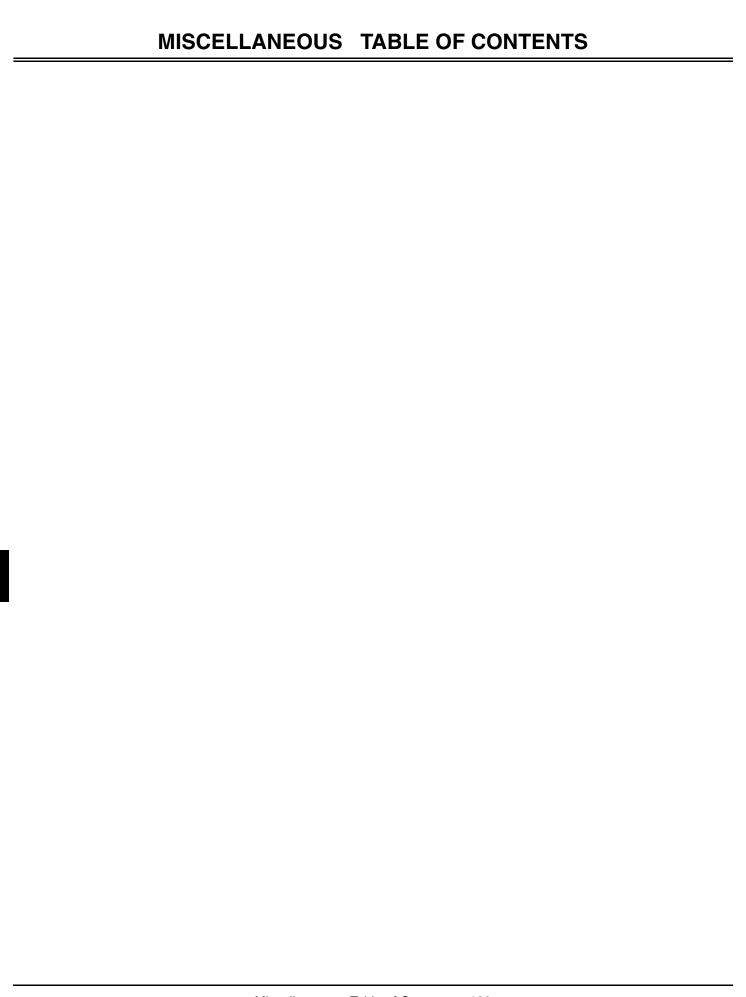


- MX32573
- 2. Slide front blade (A) under machine.
- 3. Secure front blade with pin (B) and spring locking pin (C) to the front hole of the machine bumper bracket (D).
- 4. Secure rod bracket (E) to front bumper with two bolts (F) and nuts. Repeat for opposite side.
- 5. Lift blade, and place a block under blade.
- 6. Install lift rod (G) onto rod bracket (E). Repeat for opposite side.
- 7. Install top unthreaded rod end (H) onto front tube bracket (I) arm, and secure with washer and spring locking pin.
- 8. Lubricate grease fittings (J) (on both ends of shaft) with one or two shots of grease.
- 9. Install handle (K) at a comfortable reach on the hex stud, and secure with bolt (L) to end of front tube bracket (I).
- 10. Check that the front blade is level after installation. See "Adjusting the Front Blade" on page 128.

# MISCELLANEOUS TABLE OF CONTENTS

## **Table of Contents**

Specifications	139
General Specifications	
Repair Specifications	139
Repair	140
Dash Panel Removal and Installation	
Front Cowling Removal and Installation.	140
Seat Removal and Installation	141
Hood Removal and Installation	141
Front Wheel Removal and Installation	142
Rear Wheel Removal and Installation	142



## MISCELLANEOUS SPECIFICATIONS

# 

## MISCELLANEOUS REPAIR

### Repair

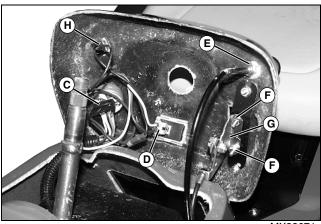
#### **Dash Panel Removal and Installation**

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Remove steering wheel. See "Steering Wheel Removal and Installation" on page 115 in the Steering section.



- 3. Remove four hex screws (A).
- 4. Carefully lift panel up just enough to clear panel from steering shaft (B).



MX32671

- 5. Disconnect key switch wiring connector (C).
- 6. Disconnect hourmeter wiring connector (D).
- 7. Disconnect choke cable hardware (E) from front side of dash panel and guide choke cable through hole.
- 8. Remove knob from throttle lever. Remove hardware (F) for throttle control and guide throttle cable assembly (G) through slotted area in dash panel.

9. Disconnect oil pressure indicator connector (H), and remove dash panel.

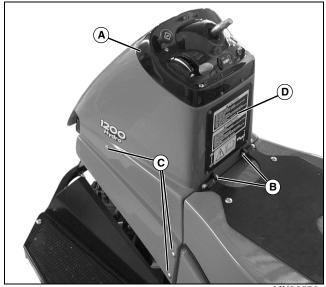
#### Installation:

- Installation is done in reverse of removal.
- Install steering wheel as marked during removal.
- Ensure that all electrical lights and components work correctly.

### Front Cowling Removal and Installation

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Lower front blade (if equipped).
- 3. Disconnect gas shocks.



MX32570

- 4. Remove dash panel (A) (See procedure above).
- 5. Remove two hex screws and locknuts (B).

### NOTE: Remove access panel (D) to reach nuts holding front two screws (C).

- 6. Remove six screws (C) and nuts (three on each side).
- 7. Move hood so cowling can be lifted and remove front cowling from around steering shaft.

#### Installation:

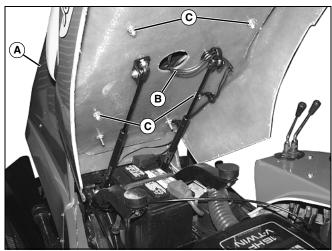
Installation is done in reverse of removal.

## MISCELLANEOUS REPAIR

#### Seat Removal and Installation

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.

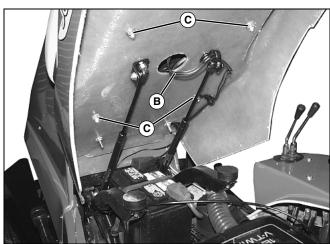


M72515

- 2. Raise rear body cowling (A).
- 3. Remove seat switch connector and lower wiring harness (B) from seat platform hole.
- 4. Remove the four locknuts (C) securing seat assembly to seat platform.
- 5. Raise seat assembly from platform.

#### Installation:

Remove the four locknuts on the seat rails.



M72515

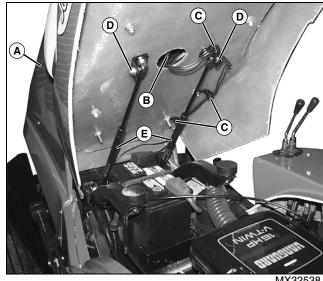
- 2. Lower seat in position above seat platform, and place wiring harness (B) connector through hole in seat platform and onto seat switch on bottom of seat.
- 3. Place the seat into the four holes in the seat platform, and secure with locknuts (C).

4. Adjust seat. The seat adjustment lever is in front and on the right side of the seat. Move seat lever to the left to move seat forward or rearward.

### **Hood Removal and Installation**

#### Removal:

1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.



MX32538

2. Raise rear body cowling (A).

# NOTE: Seat should be moved all the way forward to provide full access to seat switch connector.

- 3. Disconnect seat switch connector, and remove wiring (B) from hole in cowling and clips (C) attached to cowling.
- 4. Remove hardware (D) securing ends of cylinder rods (E) to cowling. Lower ends of cylinder rods.



MX32570

- 5. Remove hex screws and locknuts (F) from hinge assembly.
- 6. Remove rear body cowling.

## MISCELLANEOUS REPAIR

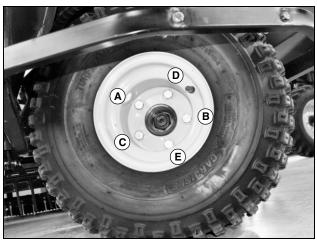
#### Installation:

· Installation is done in reverse of removal.

#### Front Wheel Removal and Installation

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Raise vehicle with a safe lifting device. Place support stands under vehicle.
- 3. Remove the five bolts.
- 4. Remove tire.

# NOTE: Overtightening of wheel bolts may result in bearing damage.



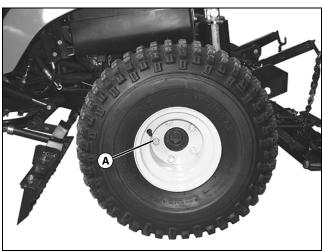
MX32520

- 5. Attach each wheel to axle hub with valve stem to outside using five wheel bolts. Tighten wheel bolts evenly in proper sequence (A), (B), (C), (D), and (E) until snug. Finish tightening to 94 N•m (69 lb-ft) using a torque wrench.
- 6. Remove support stands and lower vehicle.

#### **Rear Wheel Removal and Installation**

#### Removal:

- 1. Park machine safely. See "Parking Safely" on page 5 in the Safety section.
- 2. Raise vehicle with a safe lifting device. Place support stands under vehicle.



MX32676

3. Remove bolts (A) and rear wheels.

#### Installation:

- Installation is done in reverse of removal.
- Tighten bolts to 94 N•m (69 lb-ft).

A	Cranking Circuit Diagnosis	
Adjusting Front Blade	Cranking Circuit Operation	
Adjusting Lift Assembly	Diagnostic Information	
Adjusting Rake Lift Cylinder 128	Flywheel Magnet Test	
Air Cleaner Removal and Installation 34	Fuel Shutoff Solenoid Test	
Alternative lubricants	General Information	
Avoid Harmful Asbestos Dust 4	Ground Circuit Tests	
Avoid Injury	Key Switch Test	
Rotating Blades, Augers and PTO Shafts 5	Power Circuit Diagnosis	
	Power Circuit Operation	
В	Reading Electrical Schematics	
Battery	Regulated Amperage Test	
Charge 81	Regulated Voltage Test	
Load Test 82	Relay Test	
Voltage and Specific Gravity Tests 80	Seat Switch Test	
Blade, Front	Spark Test	
Adjusting 128	Starter Solenoid Test	82
Removal and Installation	Starting Motor	00
C	Amperage Draw - Loaded	
	Amperage Draw - No-Load	
California Proposition 65 Warning 4	Assembly	
Carburetor	Disassembly	
Adjustment	Pinion Gear Replacement	
Assembly	Removal and Installation	
Disassembly	Theory of Operation Information	
Inspection	Voltage Regulator/Rectifier Test	
Removal and Installation	Wire Color Abbreviation Chart	/ 0
Choke Cable Adjustment	Engine Air Cleaner Removal and Installation	24
Common Circuit Tests	Air Cleaner Removal and Installation	
Component Location	Armature Air Gap Adjustment	
Brakes	Blower Housing Removal and Installation Breather Valve Service	
Hydraulics/Power Train	Carburetor	30
Steering	Adjustment	20
D	Assembly	
Dash Panel Removal and Installation 140	Disassembly	
Diagnosis	Inspection	
Hydraulic Lift System	Removal and Installation	
Hydrostatic Power Train System	Choke Cable Adjustment	
Diagnostics	Compression Test	
Brakes	Connecting Rod & Camshaft Specifications	
Engine	Connecting Rod Inspection	
Steering	Crankshaft Removal and Installation	
Dispose of Waste Properly 5	Cylinder Air Guides Removal and Installation	
	Cylinder Bore	40
E	Cleaning	52
Electrical	Honing	
Alternator Output Test	Inspection	
Battery	Resizing	
Charge	Cylinder Bore & Piston Specifications	
Load Test 82	Cylinder Head	
Voltage and Specific Gravity Tests 80	Inspection and Repair	46
Brake Switch Test	Removal and Installation	
Circuit Breaker Test	Diagnostics	
Common Circuit Tests	Flywheel Removal and Installation	
Conductors for 12 Volt Circuits 72	Fuel Shutoff Solenoid Test	
	. doi ondion oblibila root i i i i i i i i i i i i i i i i i i	· · · <u>-</u> /

Governor Adjustment29Intake Manifold Removal and Installation43Magneto Bearing Inspection57Oil Pressure Test32Oil Pump Removal59PTO and Cam Bearing Inspection58Piston Inspection49	Handle Chemical Products Safely
Piston Rod Assembly50Piston, Rings, & Rod Removal and Installation48Removal and Installation41Repair Specifications21Starting Motor63Assembly63Disassembly61Pinion Gear Replacement64Removal and Installation60	Implement Charge Pressure Test
Test and Adjustment Specifications	Key Switch Test
Installation 48 Removal 46 Specifications 21 Valve Guide Ream 47 Engine oil specifications 4-cycle, gasoline 16	Live With Safety
Face seal fittings torque With inch stud ends	Machine serial number locations
Adjusting	O-Ring Boss Fittings
Gasoline specifications 4-cycle engines	Hydraulics

Piston Inspection49Prevent Acid Burns2Prevent Battery Explosions2	Regulated Amperage Test
_	Seat Switch Test87
R	Spark Test88
Rake Assembly Removal and Installation 130	Starter Amperage Draw
Reading Electrical Schematics	Loaded83
Rear Wheel Motor Removal and Installation 105	No-Load
Rear Wheel Removal and Installation	Starter Solenoid Test82
Recognize Safety Information	Voltage Regulator/Rectifier Test85
Relief Pressure Test	Key Switch Test86
Remove Paint Before Welding or Heating	Theory of Operation
Replace Safety Signs	Steering
S	Throttle Cable Adjustment
Scarifier Removal and Installation	Torque values
Seat Removal and Installation	Face seal fittings  With inch stud ends12
Service Machines Safely	With metric stud ends
Service Tires Safely 4	Inch Fastener11
Service recommendations	Metric fastener, grade 7
O-ring Boss Fittings	Metric fasteners, standard
O-ring face seal fittings 14	Straight fitting or special nut
Specifications	Transmission and Hydraulic Oil, Hydrostatic
Attachments 127	•
Brakes	U
Electrical	Understand Signal Words
Engine	Use Proper Lifting Equipment
Hydraulics	Use Proper Tools
Miscellaneous	Using High Pressure Washers3
Steering	V
Speed Control Linkage Adjustment	•
Starting Motor Assembly	Valves Guide Ream47
Disassembly	Inspection and Repair
Pinion Gear Replacement	Installation
Removal and Installation	Removal
Steering	
Chain Tension Adjustment	W
Fork Removal and Installation	Wear Protective Clothing
Shaft Removal and Installation	Wheel Creep, Adjusting100
Steering Wheel Removal and Installation 115	Wire Color Abbreviation Chart70
Support Machine Properly	Work In Clean Area
Synthetic lubricants	Work In Ventilated Area4
T	
Tests and Adjustments	
Electrical	
Alternator Output Test	
Battery Charge	
Battery Voltage and Specific Crevity 80	
Battery Voltage and Specific Gravity 80	
Brake Switch Test	
Circuit Breaker Test	
Flywheel Magnet Test	
Fuel Shutoff Solenoid Test	
Ground Circuit 80	