200-AMP DIESEL WELDER

DJB SERIES

FORM NUMBER
967-1033

ISSUE DATE
10-78
(SPEC R-T)
Replaces 8RT76

TABLE OF CONTENTS

KEEP THIS MANUAL HANDY SO YOU CAN EASILY REFER TO IT WHEN ORDERING PARTS, MAKING ADJUSTMENTS, ETC.

SAFETY PRECAUTIONS

ALWAYS USE PRECAUTIONARY MEASURES DURING ARC WELDING OPERATIONS TO ENSURE MAXIMUM PERSONAL SAFETY AND THE SAFETY OF NEARBY PERSONNEL.

WARNING **Onan uses this symbol throughout this manual to warn of possible serious personal injury.**

CAUTION **This symbol refers to possible equipment damage.**

- **Operate and Maintain The Machine And Its Equipment Properly.**

  Do not overload the cables. Do not use worn or poorly connecting cables. Do not allow the welding cables to contact hot metal, water, oil or grease. Prevent cables from becoming a stumbling hazard by keeping them in order and out of the way.

  Use electrode holders that are completely insulated. Do not use holders with defective jaws.

  Do not use the welder without grounding the frame or the case. Do not ground to pipelines carrying gases of flammable liquids. Be sure the conductors can safely carry the grounding current.

  Keep all connections clean and tight.

  Do not use an electric welder on an engine unless both the engine's battery cables and alternator wires are disconnected.

- **Take Precautions Against Electric Shock.**

  NEVER work in a damp area without suitable insulation against shock.

  NEVER stand in water or on a wet floor or use wet gloves when welding.

  ALWAYS dry out the work pieces or bench if there is any evidence of moisture.

  OPEN power circuits before inspecting machines.

  ALWAYS turn off the machine when leaving the work.

- **Do Not Weld Near Flammable Materials.**

  NEVER weld in or near EXPLOSIVE ATMOSPHERES.

  Clean any container that has held combustible or flammable materials by approved or prescribed methods. A very small amount of residual gas or liquid can cause a serious explosion. When the contacts of the container is unknown, use an explosimeter.

  Use carbon dioxide or nitrogen to ventilate a container. NEVER USE OXYGEN.

  When the container has held a gas or liquid that readily dissolves in water, perform the following:

  1. Flush the container several times with water and a wetting agent (e.g., a low powered detergent). Then, fill with as much water as the work permits.
  2. Provide a vent or opening in the container to allow the release of air pressure.

  When the container has held a gas or liquid that does not readily dissolve in water, proceed as follows:

  1. Clean the container with steam or a cleaning agent and purge all air with a gas such as carbon dioxide or nitrogen.
  2. Use steam to clean out light material.
  3. To clean out heavy grease or oil, use a strong caustic soda solution.
  4. Before welding on the container, PURGE ALL AIR with a gas such as carbon dioxide or nitrogen.

  Wear goggles and gloves when cleaning with steam or caustic soda.

  Always clean the container in a well ventilated area, away from any open flame.

  When scraping or hammering heavy sludge or scale, use a WET, spark resistant tool.

  Always keep head and arms as far away from the work as possible.

- **Never Weld On Hollow (Cored) Castings That Have Not Been Properly Vented.**
- **Never Pick Up Hot Metal With Bare Hands.**
- **Do Not Weld In Confined Areas Without Adequate Ventilation.**
- **Never Wear Frayed, Flammable Or Otherwise Inadequate Clothing When Welding. Keep Clothing Dry.**

Avoid wearing light colored or open shirts that allow arc rays to penetrate and expose parts of the body to ultra-violet rays. Do not wear flammable cotton fabrics when arc welding. Wear heavy shoes, tightly laced.

To prevent severe burns from splatter and molten metal, wear leather or asbestos gloves at all times protecting the hand and wrists. When welding in vertical and overhead positions, wear ear shields under helmet and leather sleevelets, apron, and leggings.

- **Use Eye Protection At All Times.**

ALWAYS wear safety goggles under the welding helmet. Keep the helmet, hand shields, and face shield in good condition. Replace defective equipment.

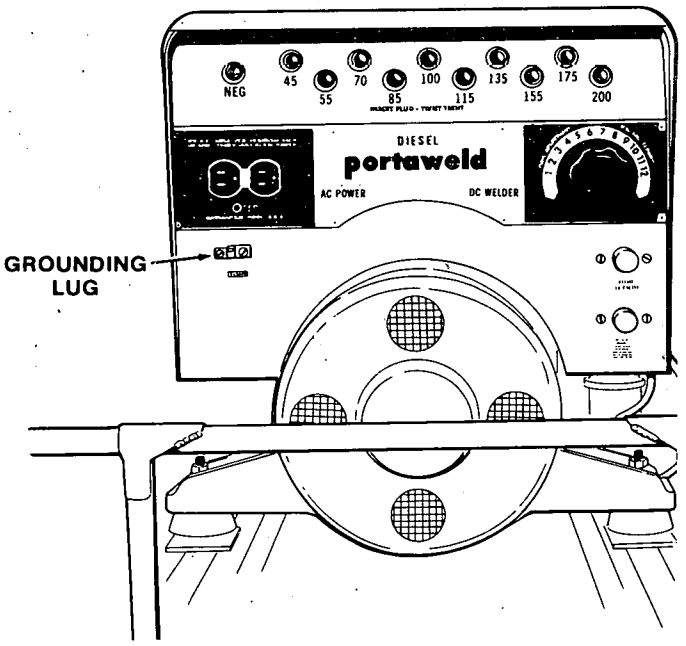
All arc welding produces intense ultra-violet and infra-red radiation. When welding in open areas, provide portable nonreflecting screens to protect nearby personnel from arc rays.

- **Do Not Work On This Equipment When Mentally Or Physically Fatigued.**
- **If the unit is mounted with wheels and is portable, chock the wheels before use to prevent movement from vibration.**

GROUNDING

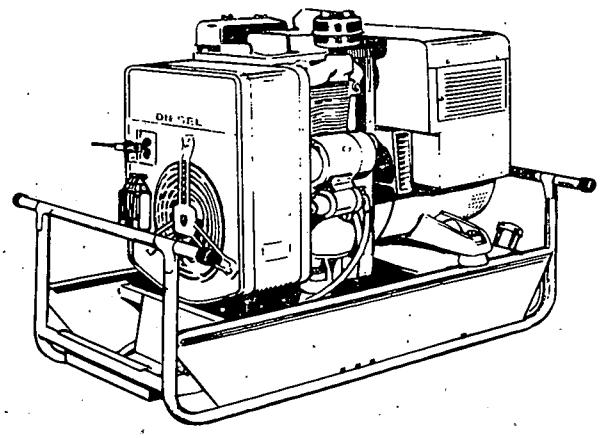
WARNING **The National Electrical Code (NEC) requires that all separately derived AC systems be grounded per Article 250-26. Manufacturer has added a bonding jumper per article 250-26 (a.) from the noncurrent carrying metal parts to the conductor to be grounded. Manufacturer does not supply the required grounding conductor or grounding electrode because it would be impossible to cover every exception and all local code requirements. See your local codes and the NEC manual for the proper grounding for your application.**

As a general rule, do not use electrical equipment in wet or damp areas. Additional rules apply to portable alternators when used on construction sites, from NEC, OSHA and state codes. It is the responsibility of the consumer to meet these requirements.



GENERAL INFORMATION

The DJB welder is a complete engine-driven, direct-current arc welding machine. It consists of a diesel engine directly connected to an electric generator and mounted to a sturdy carrying frame.

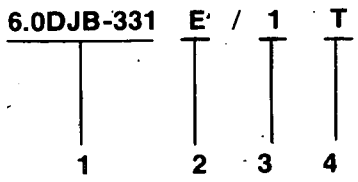


The welder is rated 200 amperes, 28 volts direct current at 50% duty cycle. Auxiliary alternating current is available at 100% duty cycle for 120 or 240 volts and is rated 3500 watts at 60 hertz, or 2500 watts at 50 hertz, single-phase. AC output is available at any time the welding current is not being used through a simple lever control. This AC output is convenient for emergency lighting, running power tools, etc. when working at locations away from commercial AC power sources. Models are available in either voltage.

All 1/16-inch through 5/32-inch electrodes may be used. Positive and negative 3/16-inch electrodes which do not exceed the welder capacity may also be used.

When instructions in this manual refer to a specific model of welder, identify the model by referring to the complete model number, specification letter and serial number as shown on the unit nameplate.

How to interpret MODEL and SPEC NO.



1. Factory code for general identification.
2. Specific type:
   E - Electric starting (at welder).
3. Factory code for optional equipment.
4. Specification (Spec) letter advances with production modification.

Throughout the text, engine end is considered front of the welder. Left and right apply when facing the engine.

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

SPECIFICATIONS

All values in inches unless otherwise specified.

Dimensions	
Height	32-1/2 (825.5 mm)
Width	29 (736.6 mm)
Length	46 (1168.4 mm)
Weight	600 lb. (272 kg)
Number of Cylinders	2
Displacement	60 cu in. (983 cm^3)
Bore	3-1/4 (82.55 mm)
Stroke	3-5/8 (92.08 mm)
Power at 2400 rpm (nominal)	14.6 bhp (10.9 kW)
Operating RPM	
Weld	2400
AC Power	1800
Compression Ratio	19:1
Compression Pressure (sea level)	350-400 psi (2415-2760 kPa)
Main Bearings are Leaded Bronze, Precision Type for Replacement (Qty.)	2
Connecting Rod Bearings Tri-Metal Replaceable	Yes
Piston Rings (chrome plated)	
Oil Control (Qty.)	1
Compression (Qty.)	3
Hardened Chrome-Cobalt Alloy Faced Valves	Yes
Hardened Chrome-Cobalt Alloy Replaceable Valve Seats	Yes
Valve Rotator	Yes
Governor (internal flyball—externally adjustable)	Yes
Governor Regulation	±5%
Nominal Battery Voltage	12
Battery Size	
SAE Group 24C (number used)	One
Capacity, SAE 20 hr. Minimum	74 Amp. Hr. (266 kC)
Solenoid Shift Starter	Yes
Combustion Air Required	42 cfm (1.2 m^3/min)
Cooling Air Required	850 cfm (24.1 m^3/min)
Glow Plugs and Air Heater to Aid Starting	Yes
Injection Pump (American Bosch)	PSU
Nozzle Opening Pressure (approx.)	1800 psi (12409 kPa)
Primary and Secondary Fuel Filters	Yes
Oil Pump (Gear Type)	Yes
Oil Filter (full flow)	Yes
Oil Capacity*	3-1/2 qt (3.31 lit)
Mounted Fuel Tank Capacity	7-1/3 gal (27.79 lit)
Generator Welder—Maximum Amperes (50% duty cycle)	200
Generator AC Auxiliary Output (120 or 240 volts, single-phase, 100% duty cycle)	
Watts at 60-hertz operation	3500
Watts at 50-hertz operation	2500

* - Includes 1/2 quart (.47 lit) for oil filter.

DIMENSIONS AND CLEARANCES

All values in inches unless otherwise specified

	Minimum	Maximum
CAMSHAFT		
Bearing Journal Diameter, Front	2.500 (63.500 mm)	2.505 (63.627 mm)
Bearing Journal Diameter, Rear	1.1875 (30.1625 mm)	1.1880 (30.1752 mm)
Camshaft Bearing Diameter 1	2.251 (57.175 mm)	2.253 (57.226 mm)
Camshaft Bearing Diameter 2	1.189 (30.201 mm)	1.191 (30.251 mm)
Bearing Clearance Limit	.0012 (.0305 mm)	.0037 (.0940 mm)
End Play, Camshaft	.007 (.178 mm)	.039 (.991 mm)
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871 (55.5523 mm)	2.1876 (55.5650 mm)
Small Bushing Bore Diameter	1.044 (26.5176 mm)	1.045 (26.5430 mm)
Distance Center Large Bearing Bore to Small Bushing Bore	5.998 (152.349 mm)	6.002 (152.451 mm)
Clearance, Large Bearing to Crankshaft	.0010 (.0254 mm)	.0030 (.0762 mm)
Clearance, Side	.002 (.0508 mm)	.016 (.4064 mm)
CRANKSHAFT		
Main Bearing Journal Diameter	2.2437 (56.9900 mm)	2.2445 (57.0103 mm)
Main Bearing Diameter	2.2459 (57.0459 mm)	2.2489 (57.1221 mm)
Crankshaft Main Bearing Clearance	.0020 (.0508 mm)	.0033 (.0838 mm)
Connecting Rod Journal Diameter	2.0597 (52.3164 mm)	2.0605 (52.3367 mm)
End Play, Crankshaft	.010 (.254 mm)	.015 (.381 mm)
CYLINDER		
Cylinder Bore	3-1/4 (82.55 mm)	
Cylinder Diameter Limits	3.2495 (82.5373 mm)	3.2505 (82.5627 mm)
Out-of-Round Limit (not more than)	.001 (.0254 mm)	
PISTON		
Piston Clearance to Cylinder Wall	.0055 (.1397 mm)	.0075 (.1905 mm)
Piston Diameter	3.2430 (82.3722 mm)	3.2440 (82.3976 mm)
Piston Pin Hole Diameter	.99005 (25.14727 mm)	.99025 (25.15235 mm)
Ring Groove Width, Top	.0970 (2.4638 mm)	.0980 (2.4892 mm)
Ring Groove Width, 2nd	.0965 (2.4511 mm)	.0975 (2.4765 mm)
Ring Groove Width, 3rd	.0965 (2.4511 mm)	.0975 (2.4765 mm)
Ring Groove Width, 4th	.1880 (4.7752 mm)	.1895 (4.8133 mm)
Ring Gap in Cylinder	.010 (.254 mm)	
Ring Side Clearance	.002 (.0508 mm)	.006 (.1524 mm)
PISTON PIN		
Piston Pin Fit in Rod	.0002 (.0051 mm)	
Length	2.738 (69.5452 mm)	2.753 (69.9262 mm)
Diameter	.9899 (25.1435 mm)	.9901 (25.1486 mm)
Connecting Rod Bushing Clearance	.0002 (.0051 mm)	.0007 (.0178 mm)
PISTON RINGS		
Ring Type		
Top	Compression	
2nd	Compression	
3rd	Compression	
4th	Oil Control	
Ring Width		
Top	.0925 (2.3495 mm)	.0935 (2.3749 mm)
2nd	.0925 (2.3495 mm)	.0935 (2.3749 mm)
3rd	.0925 (2.3495 mm)	.0935 (2.3749 mm)

STARTING MOTOR		
Rotation	Counterclockwise	
Pinion to Pinion Stop (Solenoid Plunger Bottomed)	.070 (1.778 mm)	.120 (3.048 mm)
Pinion Rest Position - Distance from Pinion Housing Mounting Face to Outer Edge of Pinion	1-9/32 (32.544 mm)	1-15/32 (37.306 mm)
Armature End Play	.005 (0.127 mm)	.030 (0.762 mm)
Test Specifications		
No Load	10 volt	80 amps
	5000 rpm min.	
Stall Torque	4 volt	420 amps
	7.8 ft. lbs. (10.6 N•m) min.	
Brush Spring Tension	32 - 40 oz. (907-1134 g) with new brushes	
VALVE, INTAKE (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.6487 mm)	.3410 (8.6614 mm)
Clearance in Guide	.0015 (0.0381 mm)	.0030 (0.0762 mm)
Face Angle	42°	
Valve Clearance (cold)	.009 Intake (0.2286 mm)	
VALVE, EXHAUST (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.6487 mm)	.3415 (8.6741 mm)
Clearance in Guide	.0030 (0.0762 mm)	.0050 (0.1270 mm)
Face Angle	45°	
Valve Clearance (cold)	.007 Exhaust (0.179 mm)	
VALVE GUIDE		
Length	1-25/32 (45.2438 mm)	
Outside Diameter	.4690 (11.9126 mm)	.4695 (11.9253 mm)
Cylinder Head Bore Diameter	.467 (11.8618 mm)	.468 (11.8872 mm)
Inside Diameter (after reaming)		
Exhaust	.3445 (8.7503 mm)	.3455 (8.7757 mm)
Intake	.3425 (8.6995 mm)	.3435 (8.7249 mm)
VALVE SEATS (Stellite)		
Valve Seat Bore		
Diameter	1.361 (34.569 mm)	1.362 (34.595 mm)
Depth (from Cylinder Head Face)	.433 (10.998 mm)	.439 (11.151 mm)
Seat Outside Diameter	1.364 (34.646 mm)	1.365 (34.671 mm)
Seat Width	3/64 (1.191 mm)	1/16 (1.588 mm)
Seat Angle	45°	
VALVE SPRINGS		
Free Length	1-7/8 (47.625 mm)	
Length, Valve Closed	1.528 (38.8112 mm)	
Load, Valve Closed	45-49 lbs. (20.43-22.25 kg)	
Length, Valve Open	1.182 (30.0228 mm)	
Load, Valve Open	87-97 lbs. (39.50-44.04 kg)	
VALVE LIFTERS		
Lifter Diameter	.8725 (22.1615 mm)	.8730 (22.1742 mm)
Lifter Bore	.8755 (22.2377 mm)	.8765 (22.2631 mm)
GOVERNOR		
Cup Free Travel Distance	7/32 (5.5563 mm)	
OIL PUMP BYPASS VALVE		
Plunger Diameter	.3365 (8.5471 mm)	.3380 (8.5852 mm)
Spring Free Length	2-1/4 (57.15 mm)	2-3/8 (60.33 mm)
Spring Tension (at 1-3/16 inch compressed)	2.225 lb. + .11 lb. (1.0102 kg + 0.05 kg)	
GENERATOR	.002 (0.0508 mm)	
AC Brush Spring Tension	16-20 oz. (454-567 g)	
DC Brush Spring Tension	30-34 oz. (851-964 g)	

ASSEMBLY TORQUES AND SPECIAL TOOLS

The assembly torques given here will assure proper tightness without danger of stripping threads. If a torque wrench is not available, estimate the degree of tightness necessary for the stud, nut or screw. Be careful not to strip threads. Use only reasonable force and a wrench of normal length.

Specially designed place bolts (Figure 1) do not require a lockwasher or gasket. Do not attempt to use a lockwasher with these bolts. Check all studs, nuts and screws often and tighten as needed to keep them from working loose.

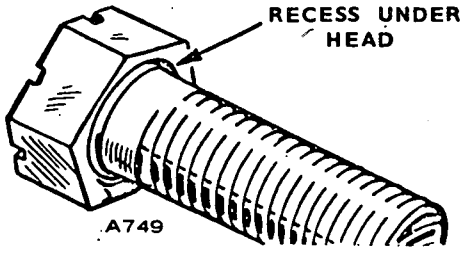


FIGURE 1. SPECIAL PLACE BOLT

TORQUE SPECIFICATIONS	Lb-Ft	(N•m)
Connecting Rod Bolt	27-29	(37-39)
Cover-Rocker Box	8-10	(11-14)
Cylinder Head Bolt	44-46	(60-62)
Exhaust Manifold Nuts	*13-15	(18-20)
Flywheel Hub Nut	17-21	(23-28)
Flywheel Mounting Screw	65-70	(88-95)
Fuel Pump Mounting Screws	15-20	(20-27)
Gear Case Cover	18-20	(24-27)
Governor Arm Locking Screw	2.7-3	(3.6-4)
Glow Plug	10-15	(14-20)
Injection Nozzle Mounting Screws	20-21	(27-28)
Injection Pump Mounting Screws	15-16	(20-22)
Intake Manifold	13-15	(18-20)
Oil Base Mounting Screws	45-50	(61-68)
Oil Filter	Hand Tight + 1/4 to 1/2 Turn	
Oil Pump Mounting Screws	15-20	(20-27)
Rear Bearing Plate	40-45	(54-61)
Rocker Arm Nut	★ 4-10	(5-14)
Rocker Arm Stud	35-40	(47-54)
Armature Through Stud Nut	30-40	(41-54)
Brush Rig Fastener Screw	6-7	(8-9)
Generator Through Stud Nut	20-22	(27-30)
Mounting Base Screw	35-37	(47-50)
Generator to Engine Adapter Screw	35-37	(47-50)

* - *Caution:* Tighten nuts evenly to avoid manifold damage.

★ - This torque is from friction between the threads only and locks the nuts in place. The rocker arm nuts are for adjusting valve lash.

SPECIAL TOOLS AND EQUIPMENT

These tools are available to aid service and repair.

Crankshaft Gear Pulling Ring	420-0275
Diesel Nozzle Tester	420-0184
Diesel Pintle Nozzle Cleaning Tool Set (Includes Injection Nozzle Centering Tool)	420-0208
Nozzle Centering Sleeve	420-0321
Delivery Valve Test Fixture	420-0322†
Combination Main and Cam Bearing Driver	420-0326
Driver, Valve Seat	420-0270
Oil Seal Guide and Driver Bearing Plate	420-0250
Gear Cover	420-0281
Ridge Reamer	420-0260
Replacement Cutter Blade for 420-0260	420-0261
Diesel Compression Tester	420-0283
Valve Seat Remover	420-0311
Replacement Blades for 420-0311	420-0274
Valve Guide Driver	420-0300

† - Used with diesel nozzle tester.

DIESEL ENGINE TROUBLESHOOTING GUIDE LIQUID OR AIR COOLED

TROUBLE / CAUSE	COMPRESSION POOR	CONNECTING ROD, BUSHINGS, BEARINGS WORN	COOLANT TEMPERATURE TOO HIGH (FRESH WATER SYSTEM)	COOLANT TEMPERATURE TOO LOW (FRESH WATER SYSTEM)	COOLANT LOSS (FRESH WATER SYSTEM)	ENGINE MISFIRE	ENGINE POWER LOW	ENGINE OVERHEAT	ENGINE SPEED TOO LOW	ENGINE SPEED TOO HIGH	FUEL CONSUMPTION EXCESSIVE - BLACK SMOKEY EXHAUST	FUEL CONSUMPTION EXCESSIVE	FUEL KNOCKS	GOVERNOR CONTROL LOSS	HUNTING	INJECTION PUMP TIMING INCORRECT	MECHANICAL KNOCKS	OIL CONSUMPTION EXCESSIVE - LIGHT BLUE SMOKEY EXHAUST	OIL CONSUMPTION EXCESSIVE - NO SMOKE INCREASE	OIL DILUTED	OIL PRESSURE HIGH	OIL PRESSURE LOW	PISTON, CYLINDER AND RING WEAR	STARTER SPEED SLOW	STARTER MOTOR DOES NOT TURN	STARTING HARD, OR FAILURE TO START	SENSITIVITY POOR	VALVE BREAKAGE	VALVE BURNING	VALVE STICKING
STARTING SYSTEM																														
Discharged or Defective Battery																								•	•					
Defective Glow Plug or Lead						•					•		•												•					
Load Connected When Starting																									•					
Defective Solenoid																							•	•	•					
Defective Starter																							•	•	•					
Defective Control Circuit																								•	•					
FUEL SYSTEM																														
Defective Fuel System						•	•				•	•			•										•					
Air in Fuel System						•	•						•		•										•					
Incorrect Timing						•	•				•	•	•			•									•					
Restricted Air Intake - Dirty Air Filter						•	•				•	•											•		•					•
Poor Quality Fuel						•	•				•	•	•												•					
Dirty Fuel Filters						•	•					•													•					
Out of Fuel or Shut Off Closed																									•					
Worn or Damaged Transfer Pump, Leaking Diaphragm												•						•							•					
Faulty Injection Pump, Nozzles or Gaskets						•	•				•	•	•			•									•					
Fuel Line Leaks						•	•					•			•	•									•					
Wrong Timing Button in Injection Pump							•									•														
Wrong Thickness Pump Mounting Gaskets							•									•														
Run For Long Periods of Time at NO LOAD	•						•										•													
LUBRICATION SYSTEM																														
Low Oil Supply		•	•													•				•	•									
Defective Oil Gauge																				•										
Excess Oil in Crankcase																	•				•									
Oil Leaks From Engine Base or Connections																		•												
Light or Diluted Crankcase Oil		•														•	•			•	•									
Leaky Oil Seals																		•												
Improper Lubrication		•	•														•			•	•									•
Faulty Oil By-Pass																		•		•										
Worn Oil Pump		•																		•										
Heavy Oil or Clogged Passages		•																		•										
Dirty Oil Filter		•																												•
GOVERNOR SYSTEM																														
Loose or Disconnected Linkage							•		•	•					•	•										•				
Binding Linkage							•		•	•					•	•										•				
Excessive Wear in Linkage									•	•					•	•										•				
Incorrect Governor Adjustment									•	•					•	•										•				
High Spring Sensitivity															•	•														
Incorrectly Installed Governor Yoke or Cup										•					•															
Overloaded Generator			•						•	•																				
COOLING SYSTEM																														
Insufficient Coolant			•				•																							
Faulty Thermostat			•	•		•	•																							
Worn Water Pump or Defective Seals			•		•		•																							
Water Passages Restricted			•				•																							
Blown Head Gasket	•		•	•	•	•												•												
Overheating																	•	•			•	•						•	•	
Restricted or Too Long Water Lines							•																							
Defective Expansion Tank Pressure Cap			•	•																										
Dirt on Cooling Fins (Air Cooled)							•																							
Inadequate Air Circulation (Air Cooled)							•																							
INTERNAL ENGINE																														
Poor Compression						•				•	•					•									•					
Loose Piston																•					•									
Loose Connecting Rod or Crankshaft Bearing																•				•										
Incorrect Valve Clearance	•					•	•				•					•									•			•	•	•
Broken or Weak Valve Spring	•					•	•									•												•	•	•
High Exhaust Back Pressure							•																					•	•	
Valves Not Seating Properly	•					•	•		•	•	•														•					
Worn Bearings																•				•		•								
Worn Cylinder Walls, Pistons, Rings	•					•	•				•						•	•		•										
Sticking Valves	•					•	•				•						•	•												
Worn or Dirty Valve Guides																	•											•	•	•

OPERATION

WARNING

ENGINE EXHAUST GAS (CARBON MONOXIDE) IS DEADLY!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- **Dizziness**
- **Intense Headache**
- **Weakness and Sleepiness**
- **Vomiting**
- **Muscular Twitching**
- **Throbbing in Temples**

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

GENERAL

Operating conditions vary for different localities and certain procedures must be followed during operation to assure best performance.

Welders generate considerable heat during operation. To avoid a possible fire make sure the air inlets and outlets of the generator are unobstructed and clean.

WARNING **Never operate the welder inside a building or confined area without piping exhaust gases outside the enclosure. EXHAUST GASES CAN CAUSE SERIOUS PERSONAL INJURY OR DEATH.**

If the welder is mobile mounted, extra vehicle floor support may be necessary to prevent welder mounting bolts from tearing loose due to rough roads, turning sharp corners, etc. Use pipe clamps or U-bolts to secure the welder frame to the floor. For service convenience, especially when draining oil, elevate the welder above the vehicle floor.

CRANKCASE OIL

Use an oil with the API designation CD/SD or CD/SE. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following.

Above 32° F (0° C)	SAE 30
0° F to 32° F (-18° C to 0° C)	SAE 10W or 5W-30
Below 0° F (-18° C)	SAE 5W-30

Multigrade oils are recommended for temperatures of 32° F (0° C) and below, but they are not recommended for temperatures above 32° F (0° C). When adding oil between oil changes, it is preferable to use the same brand as in the crankcase. Various brands of oil may not be compatible when mixed together.

WARNING **Never check oil with the engine running. Hot oil discharged from the engine could cause personal injury.**

RECOMMENDED FUEL

Although number 2 diesel fuel gives the best economy for most operating conditions, number 1 diesel fuel can be used:

1. When ambient temperatures are below 32° F (0° C);
2. During long periods of light engine load; or,
3. If preferred by user.

Use low sulfur content fuel having a pour point (ability to filter) of at least 10°F (6°C) below the lowest expected temperature. Keep the fuel clean and protected from adverse weather. Leave some room for expansion when filling the welder's fuel tank.

CAUTION **Due to the precise tolerances of diesel injection systems, it's extremely important the fuel be kept clean. Dirt in the system can cause severe damage to both the injection pump and the injection nozzles.**

BATTERY CONNECTIONS

Connect battery cable marked POS. to the battery positive (+) terminal (Figure 2). Connect unmarked cable to the battery negative (-) terminal. Always keep cable connections tight and clean.

If the battery is accidently connected in reverse, a fuse will blow protecting rectifiers in the battery charger. Correct the battery connections and install a new fuse.

INITIAL START

Check the engine to make sure it has been filled with oil and fuel. Cylinder air housing door should be closed. Heavy exhaust smoke when the engine is first started is normal and is caused by the inhibitor oil. Bleed air from fuel system as follows: Disconnect the fuel return line. See Figure 3. Operate the hand priming lever on diaphragm type fuel transfer pump until there are no air bubbles in fuel flowing from the fuel return line fitting. Then connect the fuel return line.

If the camshafts pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

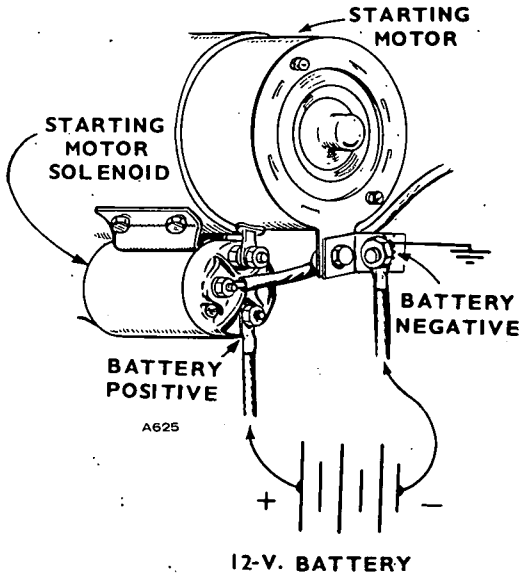


FIGURE 2. BATTERY CONNECTIONS

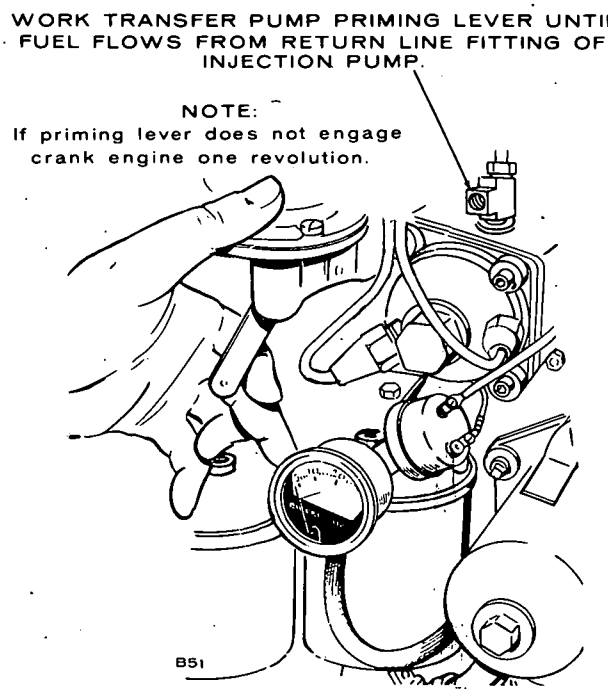


FIGURE 3. BLEEDING FUEL SYSTEM

STARTING

1. When starting a cold engine in ambients below 50°F (10°C), preheat for 20 seconds.
2. Continue to hold preheat switch and press the *start* switch.
3. Release start and preheat switches after engine starts and reaches speed.
4. Oil pressure should read at least 20 pounds (138 kPa). The pressure relief valve is not adjustable.

When starting at temperatures below 50°F (10°C) or under high humidity conditions, refer to suggested starting aids in *Low Temperatures*.

When the engine is to be restarted after short periods of shutdown, preheat is usually not necessary.

BREAK-IN PROCEDURE

The welders can be loaded to full nameplate rated output as soon as they are put into operation. It's recommended the welder be loaded to 80% rated capacity during the first few hours of operation. Heavy loading during initial operation helps seat piston rings and brings oil consumption to normal in the shortest time. See *Duty Cycle* for normal operation.

Drain the initial oil after 50 hours of operation while the engine is still hot.

DUTY CYCLE

When interpreting the duty cycle chart (Figure 4), note at 200 amperes rated load, the no-welding time must be at least one-half (50%) of each 10-minute

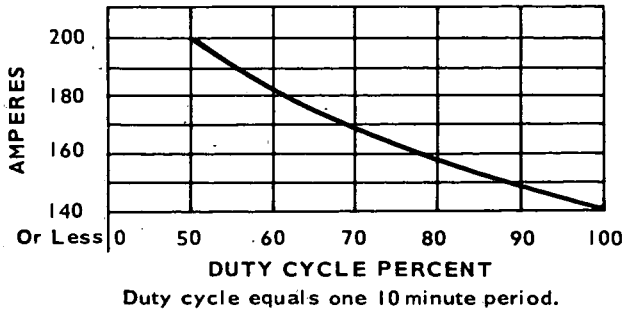


FIGURE 4. DUTY CYCLE CHART

operating period. As the welding load is reduced, longer welding time is permissible because less no-welding load time is required for the welder to cool. Any extreme ambient temperatures must also be taken into consideration. Continuous welding is permissible at 140 amperes or less.

WELDING CABLE CONNECTIONS

Insert welding cables into the main current amperage jack receptacles (Figure 5) according to the welding requirements. Some welding jobs may require frequent polarity changing to permit using various types of welding rod.

Straight Polarity Welding: Connect the electrode cable to the negative (NEG.) jack receptacle. Connect the ground cable to the desired amperage jack receptacle.

Reverse Polarity Welding: Connect the ground cable to the negative (NEG.) jack receptacle. Connect the electrode cable to the desired amperage jack receptacle.

ELECTRODES

All 1/16-inch through 5/32-inch electrodes can be used. Positive and negative 3/16-inch electrodes which do not exceed the welder capacity can also be used.

WELDING CURRENT ADJUSTMENT

Welders have an engine speed control lever and a fine current adjustment control (Figure 6). The engine speed control lever, when at WELD (2400 rpm) position, cuts off AC output and only welding current is available. When the speed control lever is at POWER, welding current is bypassed and only AC power is available.

The jack receptacle type main current control connects various resistance units into the welding circuit, limiting the amount of current at each jack receptacle. The fine current control provides for further adjustment between the jack receptacles of the main control.

CAUTION **NEVER WELD WITH ENGINE AND CONTROL COVER REMOVED! Considerable heat is generated by the resistance units inside the welder control box. Always keep the engine and control cover installed on the unit to properly direct cooling air to the control box.**

1. Plug cables into proper jack receptacles to obtain the amperage recommended for the electrode used.
2. Set fine current control at its approximate center position (midway between minimum and maximum). Try the welding characteristics, making fine current adjustments as necessary.

   Fine current control range is greater than the current spread of the main current control jack receptacles. If perfect arc conditions are not obtained by normal procedure, try the next higher or lower jack receptacle connections and re-adjust the fine current control to compensate.

3. When operating welders in parallel (see WELDERS IN PARALLEL), always have both ends of the connecting cables plugged into

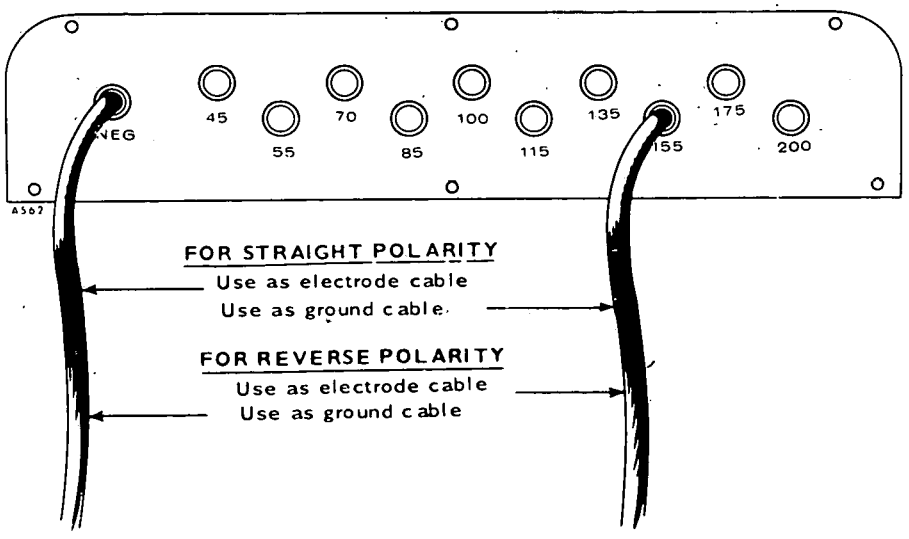


FIGURE 5. MAIN CURRENT WELDING JACK RECEPTACLES

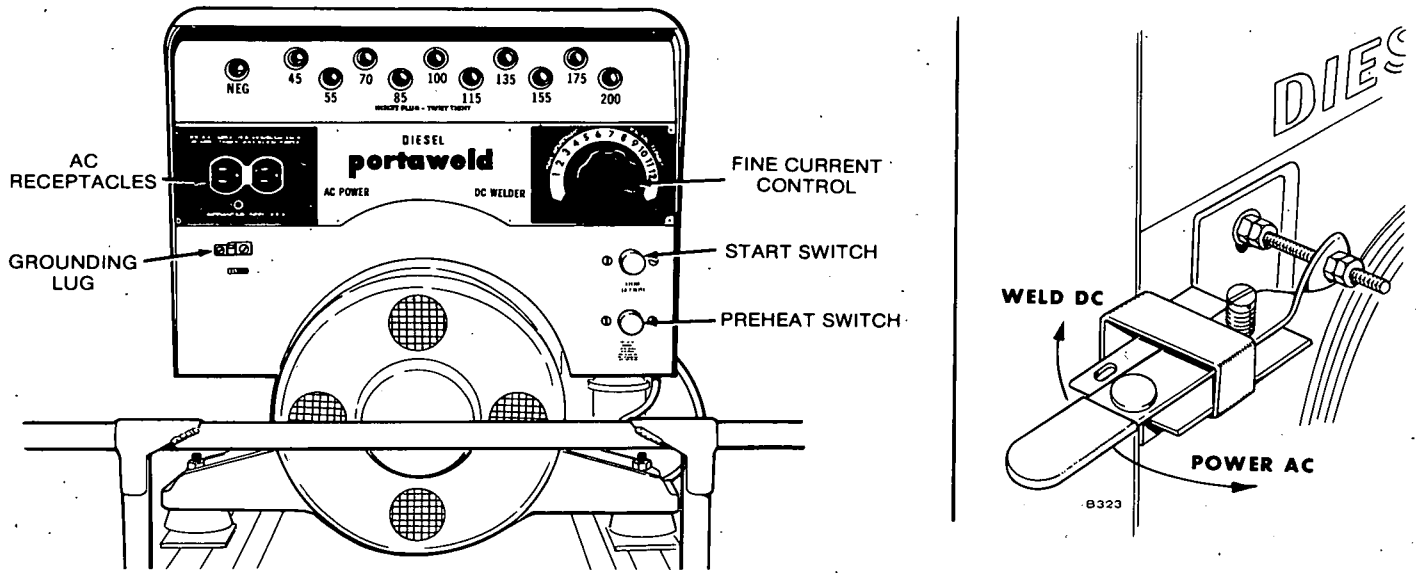


FIGURE 6. WELDER CONTROL

identical jack receptacles on each welder. If an amperage connection change is made on one welder, immediately change the other end of the connecting cable to the like jack receptacle of the second welder.

If welding current cannot be adjusted satisfactorily, check for poor electrical contact of cable connections at welder, ground clamp and electrode clamp.

WELDERS IN PARALLEL

Two welders can be connected in parallel if the welding amperage requirements are greater than those provided by one welder.

WARNING **Use larger welding cables because of higher amperage. Smaller cables can become hot creating a fire hazard.**

1. Determine welding amperage requirements. Select identical amperage jack receptacles on each welder which total the amperage requirements.

   EXAMPLE: If 300 amperes are required, select the 155-ampere jack receptacle on each welder. It may be necessary to select amperages which total slightly higher than the welding requirements to obtain proper welding characteristics. This is due to voltage and current differences which occur when welders are connected in parallel. Proper current can then be obtained using the fine current control adjustment.

2. Connect a cable between the preselected identical amperage jack receptacles of the welders. This cable (Figure 7) must have some means of attaching a second cable by splicing, clamping, etc. which will insure a tight connection.

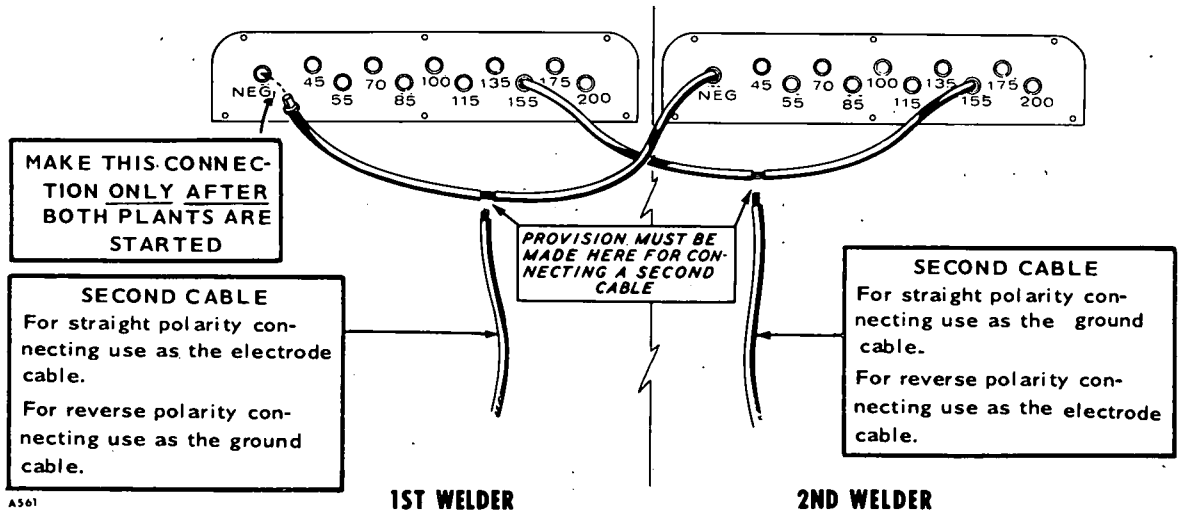


FIGURE 7. CONNECTIONS FOR WELDING IN PARALLEL

3. Connect another cable of equal size and length to the negative (NEG.) jack receptacle of only one welder. Do not complete connection to negative (NEG.) jack receptacle of second welder until both welders are running. Provisions for connecting a second cable must also be made as described in step 2.

CAUTION **Do not attempt to parallel the welder's AC output. Serious control and welder damage will result.**

AC OUTPUT

Move speed control lever to POWER position. This cuts the welding current control off and supplies 120- or 240-volt current to the output receptacles. Limit AC loads to not more than 3500 watts (60 hertz) or 2500 watts (50 hertz).

Canadian models have two 15-ampere fuses on the control panel that should be checked if AC power is lost. The fuses are located directly below the duplex receptacle.

STOPPING

Disconnect as much load as practical from the engine before shutdown. Hold the injection pump stop lever in up position to stop (Figure 8).

CAUTION **Carbon in the exhaust system will occur in diesel engines operated consistently at light loads. Operate the welder at full load occasionally (or about 5 minutes just before stopping) to clean out the exhaust system.**

MICROSWITCH OPERATION

The engine speed control lever operates a microswitch which selects the AC circuit or DC welding circuit. If the microswitch becomes stuck or inoperative, welder operation is affected. Refer to wiring diagram.

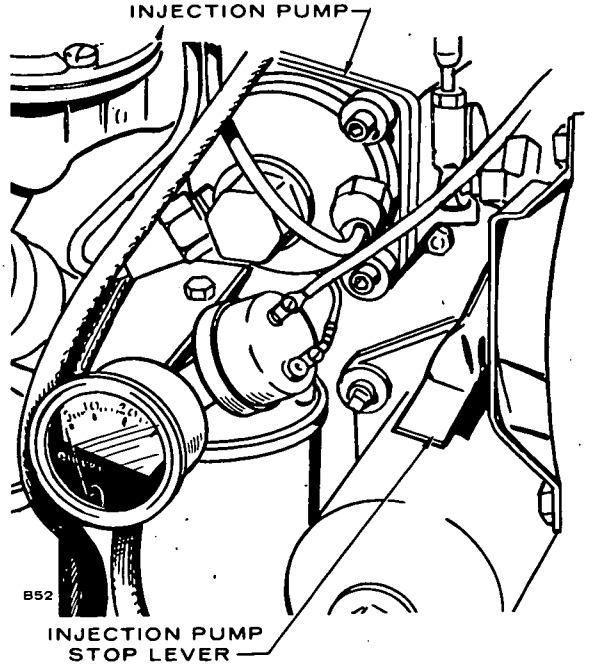


FIGURE 8. WELDER STOP LEVER

1. If microswitch DC contacts remain closed when speed control lever is at WELD position, welder voltage at no load increases from approximately a normal 60 volts to 80 volts. At heavy welding load, speed will drop excessively and welder will appear to lack power.
2. If microswitch DC contacts remain open when speed control lever is at POWER position, AC voltage will be low with similarily low power performance.
3. If microswitch AC contacts fail to close with speed lever at POWER position, there will be no available AC output.
4. If microswitch AC contacts remain closed with speed control lever at WELD position, AC output voltage will be excessively high, and any AC load left connected will be damaged.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the welder.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE oil for temperature conditions. Change oil only when engine is warm. If an unexpected temperature drop causes an emergency, move the welder to a warm location or apply heated air (do not use open flame) externally until oil flows freely.
2. Preheat for 1 minute if the temperature is 32 to 50°F (0 to 10°C). If engine fails to start after cranking for 1 minute, preheat for 1 minute more and reattempt the start.
3. Protect fuel against condensation.
4. Keep battery in a well charged condition.

HIGH ALTITUDE

Maximum power will be reduced approximately 4% for each 1000 feet (310 m) above sea level after the first 1000 feet (310 m).

EXERCISE

Infrequent use results in hard starting. Operate welder for at least a half hour each week. Run longer if battery needs charging.

OUT-OF-SERVICE PROTECTION

Protect a welder that will be out-of-service for more than 30 days as follows:

1. Run until thoroughly warm and then shut down.
2. Disconnect battery and follow standard battery storage procedure.
3. Drain oil from oil base while still warm. Refill and attach a tag stating oil viscosity used.
4. Remove glow plugs. Inject two squirts of rust inhibitor (or SAE 10 oil) into each cylinder. Crank engine over several times. Reinstall glow plugs.

5. Service air cleaner. See *PERIODIC MAINTENANCE* section.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Remove access panels and clean all cooling surfaces.
9. Wipe generator brushes, slip rings, etc. Do not apply lubricant or preservative.
10. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
11. Provide a suitable cover for the entire unit.

RETURN UNIT TO SERVICE

1. Remove cover from unit and all protective wrapping.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperatures.
3. Clean and check battery. Measure specific gravity (1.260 at 77° F [25° C]) and verify level to be at split ring. If specific gravity is low, charge until correct valve is obtained. If the level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

WARNING **Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of the gases can cause severe personal injury.**

4. Check that fuel filter and fuel lines are secure, with no leaks.
5. Check carburetor, adjust if necessary.
6. Connect battery. Connect ground lead last.
7. Be sure no load is connected to the generator.
8. Start engine.

PERIODIC MAINTENANCE

Regularly scheduled maintenance lowers operating costs and lengthens service life. Use this schedule as a servicing guide, but consider actual operating conditions when establishing a more definite schedule.

The operator should periodically make a complete visual inspection with the set running at rated load. Some of the things to check for are:

1. Check all fuel and oil lines for possible leakage.
2. Inspect exhaust lines and mufflers for possible leakage and cracks.
3. Periodically or daily, drain moisture from condensation traps.
4. Inspect air shrouds for leaks and security. Be sure cooling fins are clean and free from cracks or breaks.
5. Inspect electrical wires and connections for security and fray damage.

WARNING **Before beginning any maintenance work on the engine, generator or control panel, disconnect the battery. Failure to do so could result in damage to the equipment or serious personal injury in the event of inadvertant starting.**

CARE OF BATTERIES

To increase battery life, the operator can perform a number of routine checks and some preventive maintenance.

1. Keep the battery case clean and dry.
2. Make sure the battery cable connections are clean and tight. Use a terminal puller when removing cables for any reason.
3. Coat the battery terminals with a mineral grease or petroleum jelly to reduce corrosion and oxidation.
4. Identify each battery cable to be positive or negative before making connection. Always connect the ground (negative) cable last.
5. Maintain the electrolyte level by adding water (drinking quality or better) as needed for filling to split ring level marker. (The water ingredient of the electrolyte evaporates, but the sulphuric acid ingredient remains. Therefore, add water, not electrolyte.
6. Avoid overcharging when recharging. Stop the boost charge when the specific gravity is 1.260 and the electrolyte is 80° F (27° C).

PERIODIC MAINTENANCE

HOURS OF OPERATION	MAINTENANCE TASK
8	• Check exhaust system for leaks • Inspect welder • Check fuel supply • Check oil level
50	• Check air cleaner. See Note 1 • Clean governor linkage. See Note 1.
100	• Change crankcase oil. See Note 1.
200	• Clean crankcase breather • Check battery • Replace oil filter. See Note 1. • Check slip rings. See Note 1. • Check brushes. See Note 2. • Drain fuel system condensation traps. See Note 3.
500	• Check valve clearance
600	• Replace primary fuel filter See Note 1.
1000	• Clean generator and engine
2000	• Remove and clean oil base • Grind valves (if required) • Clean rocker box oil line holes • Check nozzle opening pressure spray pattern. See Note 4.
3000	• Replace secondary fuel filter See Note 1.
5000	• General overhaul (if required)

Note 1: Perform more often in extremely dusty conditions.

Note 2: Replace brushes when worn to 5/8 inch (16 mm).

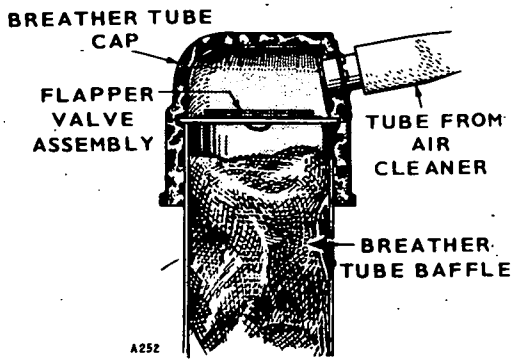
Note 3: Water or foreign material in the fuel can ruin the injection system. If daily inspection shows water or dirt in the primary filter bowl, check fuel handling and storage facilities and correct the situation. Replace filter elements following corrections of fuel contamination problems.

Note 4: This service must be performed by trained diesel injection equipment personnel with suitable test facilities.

CRANKCASE BREATHER

Engines prior to Spec S have a crankcase breather with a breather tube baffle and engines begin Spec S have a ball check valve and baffle. Every 200 hours, clean in a petroleum-base solvent as described and shown in Figure 9.

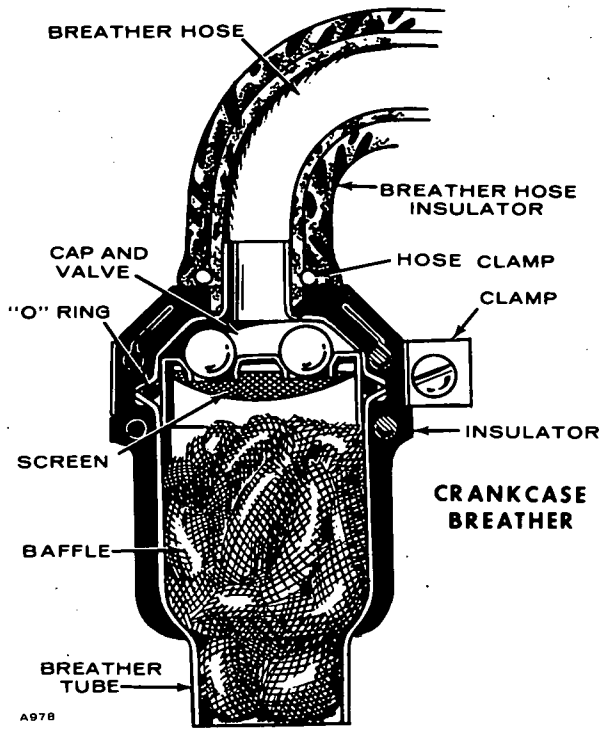
PRIOR TO SPEC S



CRANKCASE BREATHER

Remove breather cap. Remove valve from cap and wash. Dry and install with perforated disc toward engine. If faulty, install new valve.

BEGIN SPEC S



Remove hose clamp, breather hose, breather cap clamp and insulator halves to release breather cap and valve assembly. Wash cap and valve assembly and the baffle. Then reinstall.

FIGURE 9. CRANKCASE BREATHER

WARNING **Use extreme care when cleaning with a petroleum-base cleaner due to fire hazard.**

CRANKCASE OIL

Whenever checking the oil level of the welder, fill with oil (if necessary) to the FULL mark on the oil level indicator. See the *OPERATION* section or *OIL SYSTEM* section for the recommended oils to use.

Never operate the welder with the oil level below the LOW level of the indicator. Replace the indicator cap tightly or oil leakage may occur. Although oil changes are recommended every 100 hours, change the oil every 50 hours if operating in extremely dusty or dirty conditions.

WARNING **Do not remove the oil dipstick while the engine is running or oil could blow out of the oil fill tube causing injury.**

The oil filter should be changed every 200 hours, but it may also have to be changed more often if severe conditions exist. Coat the filter gasket before installing. Turn on the filter finger tight plus 1/2 turn.

AIR CLEANER

Allowing the filter element to become plugged with dirt restricts the intake of air and results in reduced engine life. Clean the element and retainer in a petroleum-base solvent, dry and oil as shown in Figure 10.

WARNING **Use extreme care when cleaning with a petroleum-base cleaner due to fire hazard.**

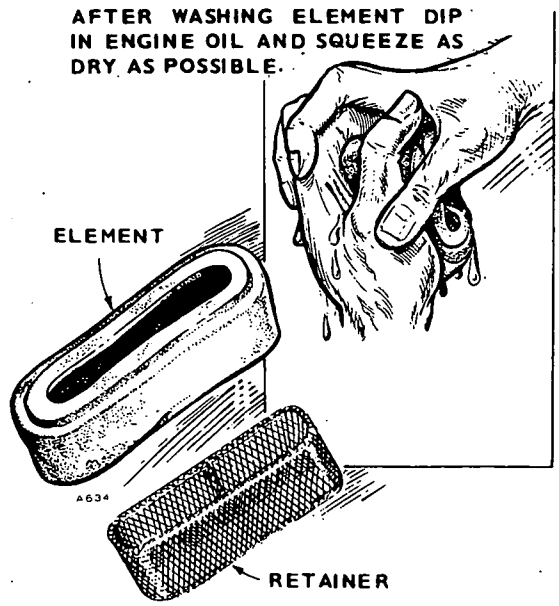


FIGURE 10. SERVICING AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Clean the plastic joints (do not lubricate) with a clean cloth (Figure 11). At the same time, check for binding, excessive slack and wear of the linkage.

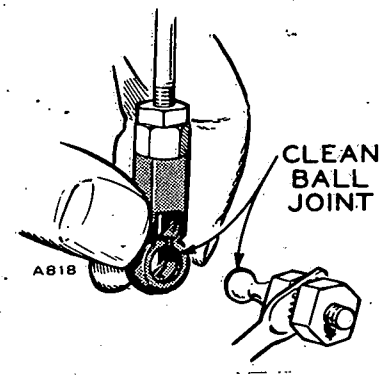


FIGURE 11. CLEANING BALL JOINT OF GOVERNOR LINKAGE

FUEL SYSTEM

Every 200 hours, remove and empty the fuel sediment bowl of dirt and condensation. Drain water from the fuel filters by loosening the drains on the bottom of each filter (Figure 12). Drain more often if needed.

Install a new primary fuel filter every 600 hours and a new secondary fuel filter every 3000 hours. Replace the fuel filters more often for extremely dusty conditions.

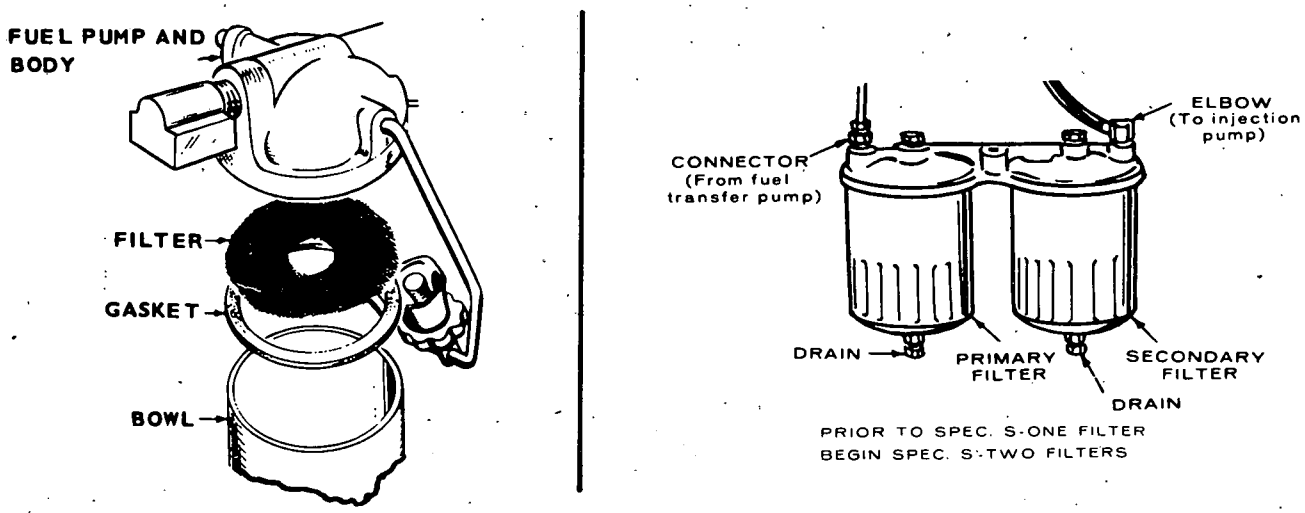


FIGURE 12. FUEL SYSTEM SEDIMENT BOWL AND FILTER MAINTENANCE

COOLING SYSTEM

To remove the heat produced during operation, engines use a pressure air cooling system. Blades on the flywheel draw air in the front of the engine housing, force the air past all the cylinders and out the right side of the engine.

MAINTENANCE

Maintenance should consist of cleaning the generator cooling and engine cooling area (fins on cylinder heads) at regular intervals, normally every 1,000 hours but more often under dirty operating conditions.

ENGINE OVERHEATING

Overheating is usually difficult to discover in any air-cooled engine, but the first sign is usually engine loosing speed momentarily or low engine power. This happens before the engine siezes and results in scored pistons.

The most probable causes of overheating are dirty cooling surfaces, operating without the engine air housing, poor air circulation, improper lubrication, wrong injection timing and overloaded engine.

CAUTION **Overheating can permanently damage the engine. The air housing including the door must be on when operating the engine.**

GENERATOR

The generator pulls in cooling air at the rear air inlet, then pushes it through the generator as it picks up generator heat. Openings on the front of the generator by the engine expel the heated air. Make sure the generator cooling inlets and outlet are never covered or restricted.

FUEL SYSTEM

The diesel system provides a means of filtering, transporting and delivering fuel in a fine spray to the engine cylinder at the correct time for ignition. The system consists of a primary fuel filter, fuel transfer pump, secondary fuel filter, injection pump and an injection nozzle. Figure 13 shows the fuel system.

The diaphragm fuel transfer pump which operates directly off the engine camshaft, draws fuel from a supply tank and delivers it through two filters to the injection pump. The injection pump meters fuel and delivers it at high pressure to the injection nozzle at the correct time.

The injection nozzle opens at a set pressure, delivering fuel in a fine spray to the precombustion chamber for ignition.

Excess fuel is returned to the tank after each injection cycle by a fuel return line from the nozzle. An adapter combines the leak-off fuel with the flow-through fuel from the injection pump. A return line connected at this point returns the combined fuel back to the fuel supply tank.

CAUTION **A diesel engine cannot tolerate dirt in the fuel system. It is one of the major causes of diesel engine failure. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly and install while still wet.**

MAINTENANCE

In addition to the regular service periods, change the secondary fuel filter cartridge whenever the engine shows signs of starving from lack of fuel. Remove the secondary filter by removing the large cap screws in the center of the filter cover. Use care when replacing the filter cartridge to avoid getting dirt into the injection pump passages.

When replacing or cleaning the filters, bleed the fuel system. Operate the hand priming lever on the transfer pump until no air bubbles flow from the return line fitting of the injection pump. Return the priming lever to its original position. See Figure 14.

CAUTION **If the transfer pump cam is on the high side, the priming lever will not operate the pump. Turn the engine one revolution before operating the prime lever.**

Starting with Spec S, the fuel filtration system accommodates both primary and secondary fuel filters on a common mounting casting which is bolted to a newly-designed oil fill tube. The engine cannot be run with either filter loose or missing, thus ensuring proper filtration at all times.

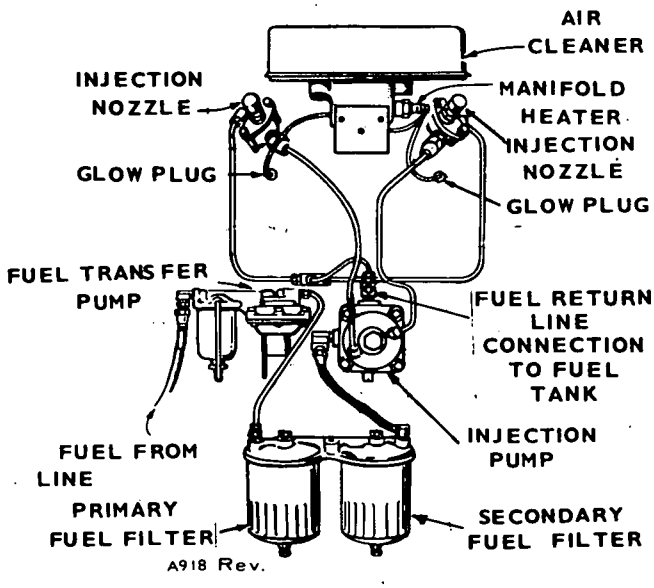


FIGURE 13. FUEL SYSTEM

Drain water periodically as required from both filters. Replace primary filter every 600 hours and secondary filter every 3000 hours. When replacing filter, tighten screw until gasket touches base, then tighten screw 1 to 1-1/2 turns.

FUEL TRANSFER PUMP

The transfer pump is located on the left side of the engine near the rear. If fuel does not reach the secondary filter, make the following checks before removing the pump.

1. Check the fuel tank and see that the shutoff valve is open.
2. Remove the fuel line from the transfer pump outlet and work the priming lever on the pump. Fuel should spurt out of the pump. If not, remove the pump for repair or replacement.

Testing: If the transfer pump delivers fuel, test it with a pressure gauge or manometer. Perform these tests before removing the pump from the engine. Remove the pump outlet and install the pressure gauge (Figure15).

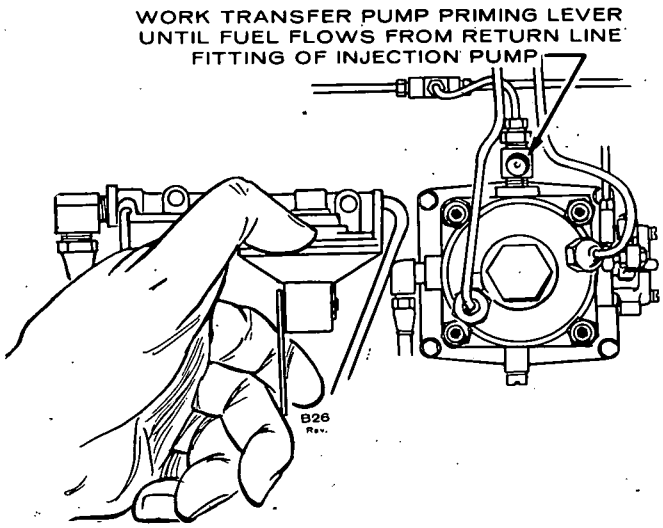


FIGURE 14. BLEEDING FUEL SYSTEM

Test the valves and diaphragm by operating the primer lever a few times and watching the pressure. It should not drop off rapidly after priming has stopped.

Next, run the engine at governed speed on fuel provided by gravity feed and measure the fuel pump pressure developed. Pressure should be between 12 and 14 psi (83 and 97 kPa) with the gauge 16 inches above the fuel pump.

A low pressure reading indicates extreme wear in one part or some wear in all parts, and the pump should be overhauled or replaced. If the reading is above maximum, the diaphragm is probably too tight or the diaphragm spring too strong. This can also be caused by fuel seeping under the diaphragm retainer nut and

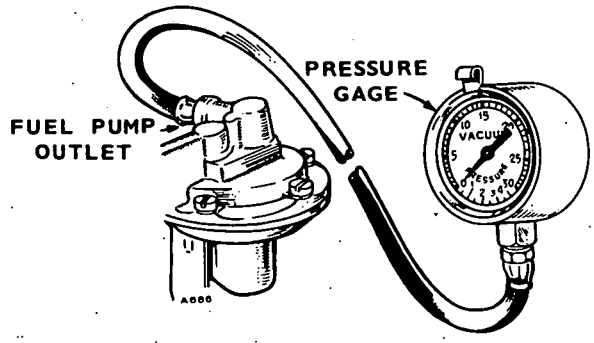


FIGURE 15. FUEL PRESSURE GAUGE

between the diaphragm layers, causing a bulge in the diaphragm. Overhaul the pump and replace the defective parts.

Low pressure with little or no pressure leak after pump stops indicates a weak or broken spring or worn linkage, and in most cases, the pump should be replaced. Figure 16 shows the fuel transfer pump.

Fuel Pump Disassembly:

1. Remove the pump inlet and outlet lines. Remove the two cap screws holding the pump to the engine and lift it off.
2. Notch the pump cover and body with a file so they can be reassembled in the same relative positions and remove the six screws holding them together.
3. Tap the body with a screwdriver to separate the two parts.

CAUTION **Do not pry them apart because the diaphragm will be damaged.**

4. Remove the screws holding the valve plate to the cover and lift out the valve and cage assemblies.

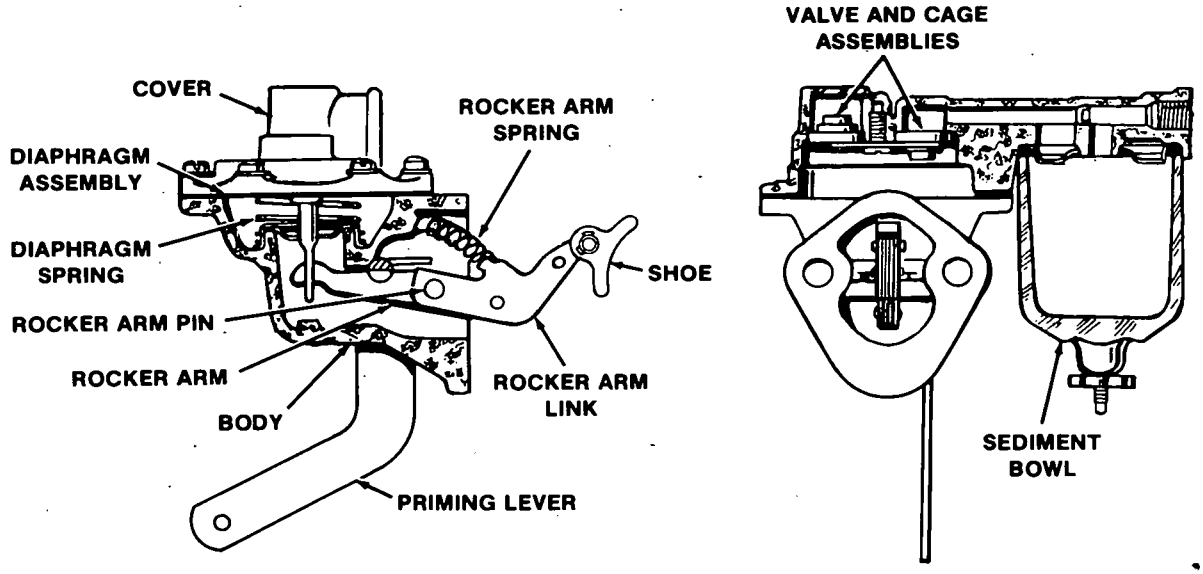


FIGURE 16. FUEL TRANSFER PUMP

5. Drive out the rocker arm hinge pin.
6. Remove the rocker arm, spring and link.
7. Lift out the diaphragm assembly and diaphragm spring.

Repair: Transfer pump failure is usually due to a leaking diaphragm, valve and valve gasket. A kit is available for replacement of these parts. Because the extent of wear cannot be detected by the eye, replace all parts in the kit. If the diaphragm is broken or leaks, check for diluted crankcase oil and replace.

Assembly:

1. When installing a new diaphragm, insert the diaphragm spring and diaphragm into the pump body.
2. Insert the link and rocker arm into the body and hook it over the diaphragm pull rod. Align the rocker arm with the rocker arm pin hole and drive in the pin. The priming lever must be in the position shown in Figure 14 when installing the rocker arm.
3. Compress the rocker spring and install between the body and rocker arm.
4. Insert the valve cages, gaskets and valve cover plate. Position the inlet valve with spring showing and the outlet valve with spring in the cover recess.
5. Assemble the cover to the body with notch marks lined up. Install the screws, but do not tighten.
6. Push the rocker arm in full stroke and hold in this position to flex the diaphragm.

CAUTION **The diaphragm must be flexed or it will deliver too much fuel pressure.**

7. Tighten the cover screws alternately and securely, then release the rocker arm.
8. Install the pump on the engine and repeat the pressure test.

INJECTION PUMP

The American Bosch PSU injection pump is located near the center of the left side of the engine crankcase. A cam and gear on the camshaft drive the pump. The gear drives the pump face gear, providing fuel distribution to each cylinder in the proper order. The cam operates the pump plunger, producing pressure to deliver the fuel and open the nozzles. A control sleeve meters the fuel by controlling the length of time the plunger port is closed, maintaining pressure and the amount of fuel delivered in each stroke. Timing the pump to the engine determines the point of port closing. The correct port closing point is 19° BTC. The position of the metering sleeve on the plunger controls the port opening and this depends on the throttle setting.

Adjustments: One adjustment screw, located on the injection pump control assembly, sets the maximum and minimum injection points. Set the maximum stop screw while gradually increasing the load to stop the throttle at the smoke point. Set the minimum stop screw to just fully close the throttle (no fuel injection).

Repair: Since most fuel system troubles are not due to a faulty injection pump, test the rest of the fuel system before condemning the injection pump.

CAUTION **It's generally recommended not to make field repairs of the injection pump because of the exceptionally close tolerances between parts and the specialized equipment necessary for repair. The injection pump is an expensive part of the unit and even a particle of dirt as fine as talcum powder could score its working surfaces. If the rest of the fuel system is in working order and fuel delivery abnormal, remove the pump for replacement or repair. American Bosch maintains a world-wide repair service for these pumps.**

Removal: If the pump is removed from the engine, be sure the steel shims between the pump and the crankcase mounting are the same on reassembly to maintain proper gear backlash. The number stamped on the crankcase indicates the proper shim thickness. This thickness does not change when a new pump is installed. It only changes when a new crankcase is installed, and then the thickness of the proper shims is stamped on the new crankcase.

CAUTION **Do not change the pump mounting shims total thickness or the proper pump gear to camshaft gear mesh will be affected. The shims thickness is stamped on the cylinder block above the pump mounting boss. Shim thickness is established at the factory during engine assembly and does not change unless a new cylinder block is installed.**

Remove the pump inlet, outlet and return lines. Remove the four cap screws holding the pump to the crankcase and lift it off. Be careful to retain the shims between the crankcase and pump.

Injection Pump Timing: Time the injection pump to the engine by using the proper thickness timing button between the pump plunger and tappet. It is timed to the engine at the factory so the port closing for injection occurs at 19° BTC (PC mark in Figure 17).

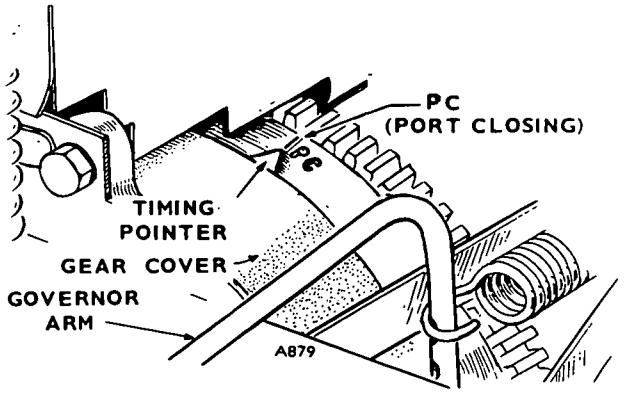


FIGURE 17. PORT CLOSING

Use **Method 1** when replacing an old pump if the port closing dimensions and button number of the old pump were recorded. Use **Method 2** if the dimensions are unknown and old pump is being retimed, or when replacing either the camshaft or crankshaft.

CAUTION **Pump timing is critical for correct engine power and performance.**

Method 1: This is a means for calculating the correct button thickness before the pump is installed. It requires the port closing dimensions and button thickness from the pump being replaced.

The formula for determining the proper port closing (PC) timing button for a new or replacement pump is as follows:

1. Remove old pump.
2. Determine total pump flange and button thickness for old pump (see Table 1 and Figure 18).
   a. Write down dimension given on old pump flange. See Example.

Example Formula:

Port closing dimension of old pump	1.109 (28.169 mm)
Button thickness of old pump	+ .107 (2.718 mm)
	1.216 (30.886 mm)
Port closing dimension of new pump.....	−1.103 (28.016 mm)
Button thickness of new pump	.113 (2.870 mm)

   b. Remove old pump timing button.

CAUTION **Be sure to hold the pump drive securely to the pump body when removing the tappet, Figure 18. If not, the pump will come apart and be difficult to reassemble. Also, the metering sleeve may drop off the plunger into the sump when the plunger is removed. If the mechanic is not aware of it, he could put the pump back together, but it will not operate. If the plunger port is not enclosed by the sleeve, there will be no fuel delivery. Use a pair of channel lock pliers or a screwdriver to remove the tappet from the O-ring in the drive gear.**

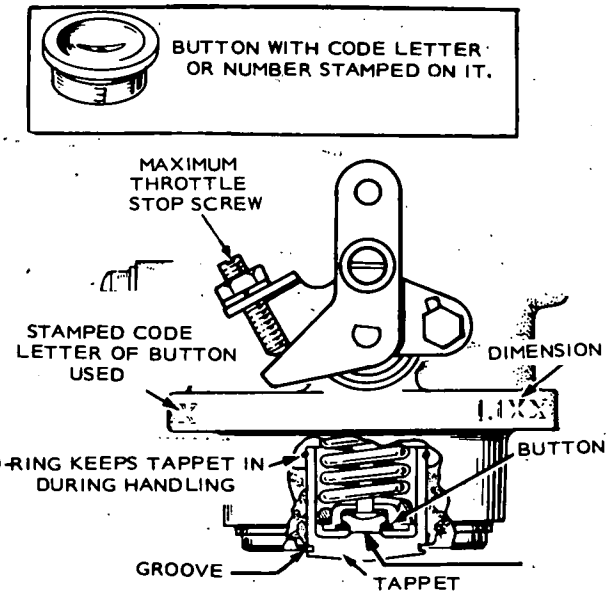


FIGURE 18. INJECTION PUMP BUTTON INSTALLATION

   c. Obtain dimension of old timing button from Table 1 corresponding with number or letter code on timing button.
   d. Add dimension on old pump flange to timing button dimension from Table 1.
   e. Write down total PC dimension for old pump.
   f. Write PC dimension from new pump flange and subtract it from total PC dimension for old pump.
   g. Use calculated dimension for new timing button.

TABLE 1. TIMING BUTTONS

GROUP 1				GROUP 2			
CODE	PART NO.	SIZE		CODE	PART NO.	SIZE	
		Inch	mm			Inch	mm
16 or S	147-0186	.134	3.404	1 or A	147-0147	.119	3.023
15 or R	147-0187	.131	3.357	2 or B	147-0148	.116	2.946
14 or P	147-0188	.128	3.251	3 or C	147-0149	.113	2.870
13 or N	147-0189	.125	3.175	4 or D	147-0150	.110	2.794
12 or M	147-0190	.122	3.099	5 or E	147-0151	.107	2.718
				11 or Std	147-0161	.104	2.642

Group 1. Used in all late model pumps
Group 2. Used in early models of all pumps

Pump Kits prior to Spec R— 147-0218

Pump Kits beginning Spec R— 147-0219

TABLE 2. TIMING BUTTONS

TIMING EARLY	USE BUTTON	TIMING LATE	USE BUTTON
.1"	6 or F	.1"	5 or E
.2"	7 or H	.2"	4 or D
.3"	8 or J	.3"	3 or C
.4"	9 or K	.4"	2 or B
.5"	10 or L	.5"	1 or A
		.6"	12 or M
		.7"	13 or N
		.8"	14 or P
		.9"	15 or R
		1.0"	16 or S

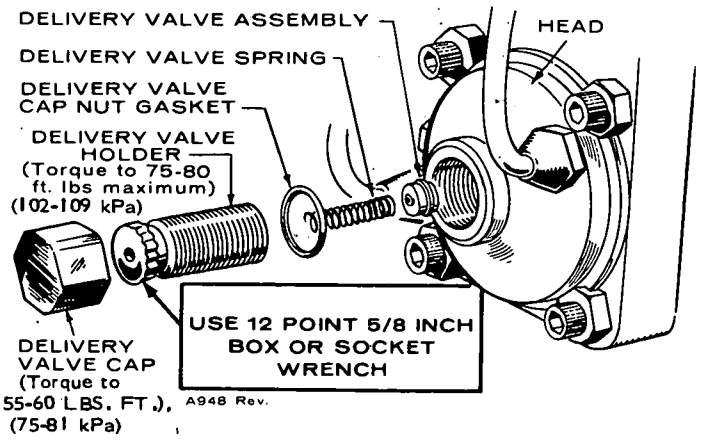


FIGURE 19. DELIVERY VALVE ASSEMBLY

Method 2, Flowing the Pump: Flow timing the injection pump can be done using fuel to determine whether or not the proper timing button has been installed for best operating conditions. In case the pump is removed without recording the PC dimension and the timing button thickness, it is necessary to flow time the pump to establish the exact PC position.

1. Install No. 12 timing button in pump as previously discussed and install the pump per instructions under *Injection Pump Installation.*

   Button 12 or M is the mid-range of the button sizes used the most. The button dimension is determined by the number or letter stamped on its side.

2. Remove the delivery valve cap nut (also delivery valve holder on later models, Figure 19), and lift out the delivery valve spring. Install the delivery valve cap nut and holder.
3. Rotate the flywheel (counterclockwise) to a point about 15 degrees before the port closing mark (compression stroke number 1 cylinder).
4. Position the fuel control in the full fuel position. Disconnect number 1 injection line from the nozzle and position line so full fuel is visible. Pump the priming lever while turning the flywheel clockwise until fuel stops coming out of the injection line. This is the port closing point or the point where injection begins.
5. Check the position of the port closing mark in reference to the timing pointer. If the button thickness is correct, the pointer will coincide with the port closing mark. See Figure 17. If the timing pointer is before port closing (early timing) a thinner button is needed. If the timing pointer is between port closing and top center (late timing) a thicker button is needed. To determine the correct button, measure the distance between the port closing mark and the timing pointer. For each .1 inch difference, one button either larger or smaller, depending on whether timing is early or late, is required. A distance of .1 inch (2.5 mm) on the flywheel represents .003 inch (.076 mm) button thickness.
6. Replace the delivery valve spring (Figure 19). Be sure all components of the delivery valve are installed and properly torqued. The delivery valve holder must be retorqued prior to installation of cap nut.

   CAUTION **The PSU pump housing must never be clamped in a vise to torque the delivery valve holder and cap nut. Clamping the pump in a vise can distort the aluminum body, unseat the lower body seal and cause the face gear to bind in the housing. Any signs of damage from a vise or similar device is reason for refusing a warranty claim. Fuel injection pumps are precision equipment that must not be tampered with by inexperienced personnel or handled carelessly. Returning any pump for warranty claims or for rebuilding and reuse must be properly protected from dirt, moisture and shipping damages.**

7. Finish injection pump installation procedure.

Injection Pump Installation:

1. Put number 1 cylinder on compression.
2. Turn the flywheel to the port closing mark (PC) on the front cylinder compression stroke (Figure 17).
3. Remove the timing hole screw located on the pump mounting flange. Insert a 1/8 inch (3 mm) diameter brass wire into the hole (Figure 20).
4. Rotate the pump face gear until the wire slips into place, locking the gear in position.
5. Mount the pump on the crankcase (be sure the shims are in place) and secure with screws. If the "O" ring between pump and crankcase is worn, cracked or otherwise defective, replace it.

   The flat area just above the pump has a number marked on it which refers to the shim thickness required between the pump and its mounting pad for assuring proper backlash in the gearing. Don't forget the shims.

6. Remove the brass wire.
7. Rotate the crankshaft manually to see if the gears mesh. If gears mesh properly, secure the pump on the mounting studs using a flat washer, a lock washer, and a nut on each stud. Torque these nuts evenly to 15-16 ft. lb. (20-22 N•m).

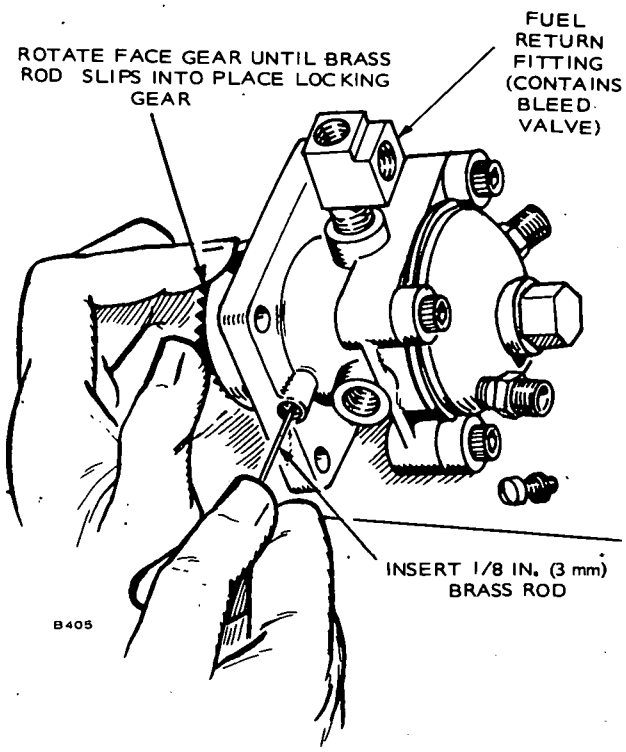


FIGURE 20. INJECTION PUMP

8. If the pump was not timed by **Method 1,** do it now, using **Method 2.**
9. Connect the flexible fuel inlet line to the pump inlet. Connect the fuel return line.
10. Connect each fuel outlet line to the proper pump outlet.
11. Connect the throttle linkage to the governor (see *GOVERNOR SYSTEM* section).
12. Run the engine and adjust the throttle maximum and minimum stops.

A constant bleed-check valve is furnished with all PSU pumps. The bleed valve automatically bleeds off a restricted amount of fuel, fuel vapors, and small quantities of air to prevent air accumulation in the fuel sump area of the pumps. This valve should open at pressures between 0.9 and 3.0 psi (6.2 and 20.7 kPa). See Figure 20 for location.

NOZZLES

The injection nozzles are the conventional inward-opening pintle type with adjustable opening pressure (Figure 21). They are factory adjusted to open at 1900 to 1950 psi (13110 - 13455 kPa). Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do this work.

Inspection: To inspect the nozzle spray pattern, remove the nozzle from the cylinder head. Crank the engine, let the nozzle spray into the air and watch the pattern. The spray should be cone shaped with a solid appearing center surrounded by cloudlike fog in which the spray is evenly atomized. See Figure 22. An apparent chattering of the nozzle is normal.

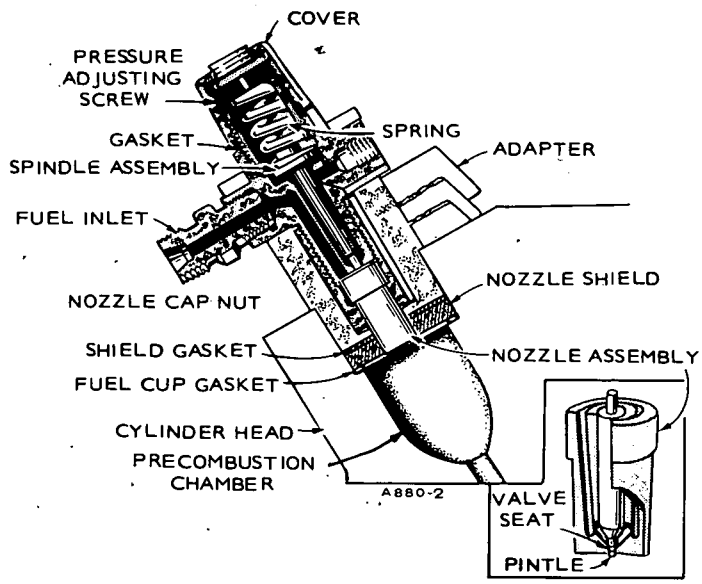


FIGURE 21. NOZZLE ASSEMBLY

If streamers are visible, the pattern is badly distorted or the nozzle drips before it reaches opening pressure, it is defective and must be cleaned or replaced.

WARNING **Do not let the nozzle spray against your skin. The fuel can penetrate flesh and cause a serious infection.**

Adjustment: To adjust the opening pressure, remove each nozzle from the engine and remove the cap nut over the adjusting screw of each. Install the nozzle to be tested on a static fuel nozzle testing fixture. Following the instructions on the tester, adjust the opening pressure to 1750 psi (12075 kPa) by turning the adjusting screw. Clockwise increases the pressure and counterclockwise decreases it. Do not try to adjust the pressure without a testing fixture.

Disassembly: When removing and disassembling nozzles, separate and label all components of each nozzle. Never interchange components between nozzles.

1. Remove each nozzle assembly from the engine and remove the fuel inlet and return lines.
2. Clamp the nozzle holder body in a vise and

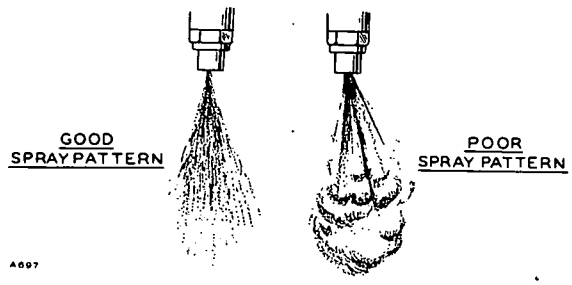


FIGURE 22. NOZZLE SPRAY PATTERN

remove the nozzle cap nut and nozzle.

3. Install the nozzle cap nut loosely to protect the lapped surface for the holder body.
4. If necessary to further disassemble the nozzle, reverse the pressure adjusting screw and lift out the spring and spindle assembly.

Work only in a clean room, on a clean work bench. Keep a pan of clean diesel fuel handy and have a supply of clean, lint-free wiping rags. Never use hard or sharp tools, emery paper, grinding powder or abrasives of any kind.

Soak each nozzle in fuel to loosen dirt. Then clean the inside with a small strip of wood soaked in oil and the spray hole with a wood splinter. If necessary, clean the outer surfaces of the nozzle body with a brass brush but do not attempt to scrape carbon from the nozzle surfaces. This can severely damage the spray hole. Use a soft, oil soaked rag or mutton tallow and felt to clean the nozzle valve.

Repair: If cleaning will not eliminate a nozzle defect, replace the nozzle or take it to an authorized American Bosch service station. Do not attempt to replace parts of the nozzle except for nozzle and pintle assembly.

Assembly: Rinse both valve and nozzle thoroughly before assembly and coat with oil. The valve must be free in the nozzle. Lift it about 1/3 out of the body. It should slide back to its seat without aid when the assembly is held at a 45° angle. If necessary, work the valve into its body with clean mutton tallow.

1. Remove all pressure on the nozzle spring by adjusting the pressure adjusting screw.
2. Clamp the nozzle holder body in a vise.
3. Set the valve in the body and set the nozzle over it.
4. Install the nozzle cap nut loosely.
5. Place the centering sleeve over the nozzle (Figure 23) for initial tightening. Then remove the centering sleeve to prevent it from binding between nozzle and cap nut and tighten the nozzle cap nut to specified torque.

Installation: Before installing the injection nozzles in the engine, thoroughly clean each mounting recess.

A dirty mounting surface could permit blow-by, causing nozzle failure and resulting power loss.

1. Install a new heat shield to head gasket in the cylinder head recess.

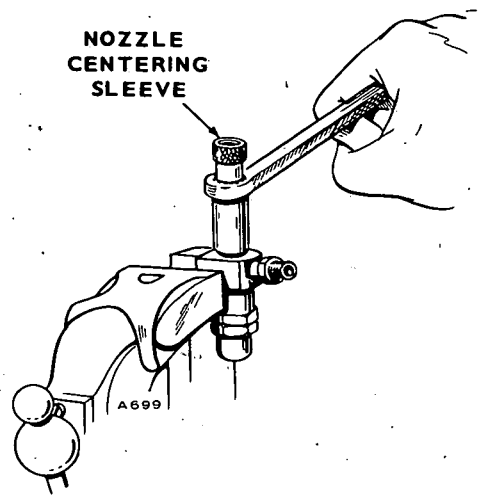


FIGURE 23. TIGHTENING NOZZLE CAP

2. Install the heat shield, a new nozzle gasket and the nozzle adapter.
3. Insert the nozzle assembly into the recess. Do not strike the tip against any hard surface.
4. Install the nozzle flange and cap screws. Tighten the cap screws alternately to avoid cocking the nozzle assembly. Tighten each to 20 to 21 ft. lbs. (27 to 28 N•m).

PREHEATING CIRCUIT

This circuit consists of two manifold heaters to heat the engine intake air in the intake manifold and glow plugs in each cylinder to heat the precombustion chamber. Used for engine starting, the manifold heater and glow plugs are wired in parallel and controlled by a preheat switch.

Check each heater by removing its lead, operating the preheat switch and touching the lead to its terminal. If it sparks, there is continuity and the heater is working. If any components of this circuit fail, replace them. Do not attempt repairs on individual components. If there is still a question, check the components for heating.

GOVERNOR SYSTEM

The purpose of the engine governor is to maintain a constant engine speed during changes in power demands.

The speed sensing device is a ball and cup mechanism on the camshaft gear. A yoke, resting on the cup, is connected to the governor arm which, in turn, is connected to the throttle lever (Figure 24). Any change in engine speed is transmitted from the cup to the yoke and on to the throttle.

The manual governor control lever has two positions, WELD and POWER. Engine speed is 1800 rpm for POWER operation, 2400 rpm for WELD operation (approximately 1850 and 2450 rpm respectively for no-load operation). For adjustments of the speed control or governor control linkage, refer to "Early Spec R Models" or "Begin Late Spec R Models," whichever is applicable (see Figures 25 and 26).

For removal of governor cup, governor balls, cam gear, etc., see *ENGINE DISASSEMBLY* section.

BEGIN LATE SPEC R MODELS

1. Move the manual governor control lever to POWER. There should be some slack between the lever and the nuts on the governor adjusting stud. Otherwise, the adjustment for step 2 won't be properly made.
2. Engine speed should be approximately 1850 rpm for AC power at no load. If not, loosen the nuts on the end of the governor switch plate, turn clockwise (CW) to increase engine speed and counterclockwise (CCW) to decrease speed.
3. After the desired rpm is reached, tighten the two nuts together again.
4. Move the manual governor control lever to WELD.
5. Engine speed should be approximately 2450 rpm at no load. If not, loosen the two nuts on the end of the governor adjusting stud (or nuts holding end of the manual governor control lever). Turning the nuts CW increases speed, CCW decreases engine speed.
6. Check engine speed while welding at maximum current load. Speed should be approximately 100 rpm lower (2350 rpm) than no load.
7. For sensitivity adjustment, take a screwdriver and adjust as shown in Figure 25.

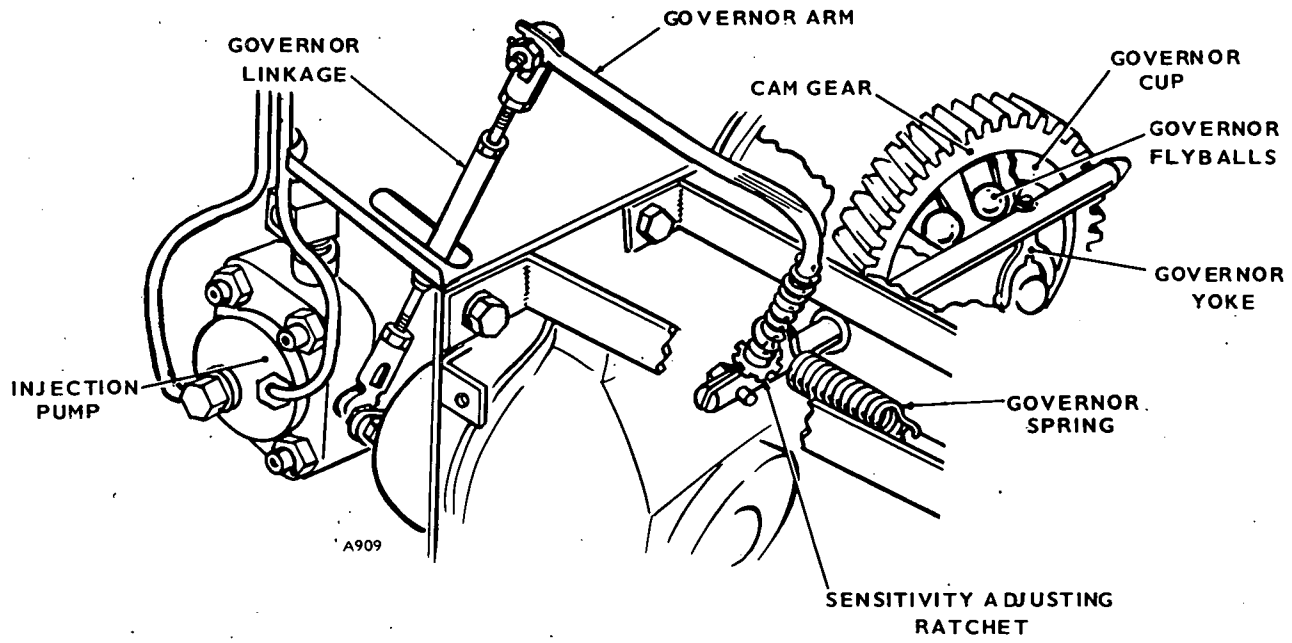


FIGURE 24. GOVERNOR SYSTEM

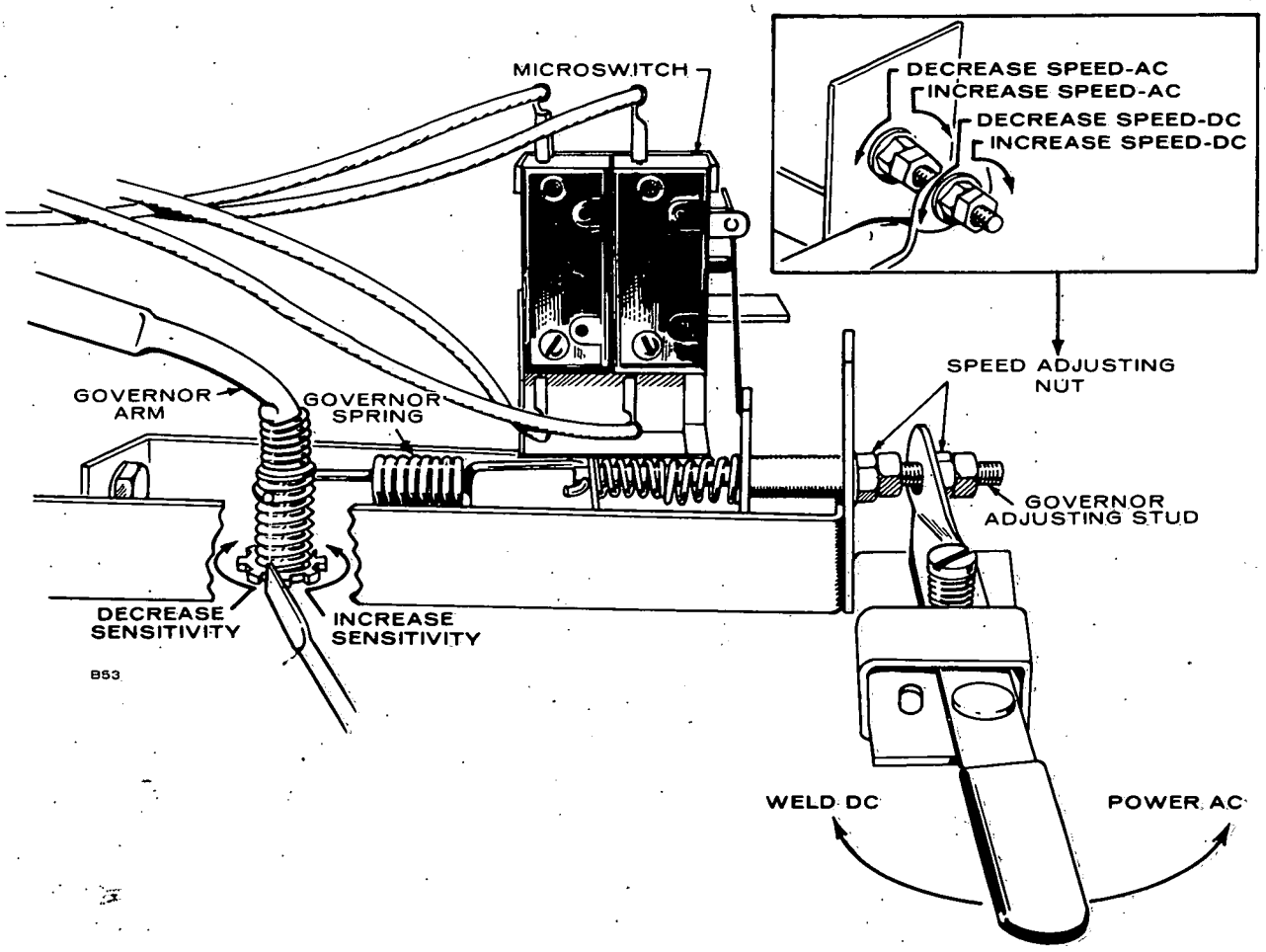


FIGURE 25. GOVERNOR ADJUSTMENTS (BEGIN LATE SPEC R MODELS)

EARLY SPEC R MODELS

1. Move the manual governor control lever to POWER.
2. Adjust the spring tension as shown in Figure 26 to produce engine speed of approximately 1850 rpm at no load.
3. Move lever to WELD position. Engine speed should be approximately 2450 rpm at no load.
4. Check engine speed while welding at maximum current load. Engine speed should be approximately 100 rpm lower (2350 rpm) than no-load speed.
5. For sensitivity adjustment, use a screwdriver and adjust as shown.

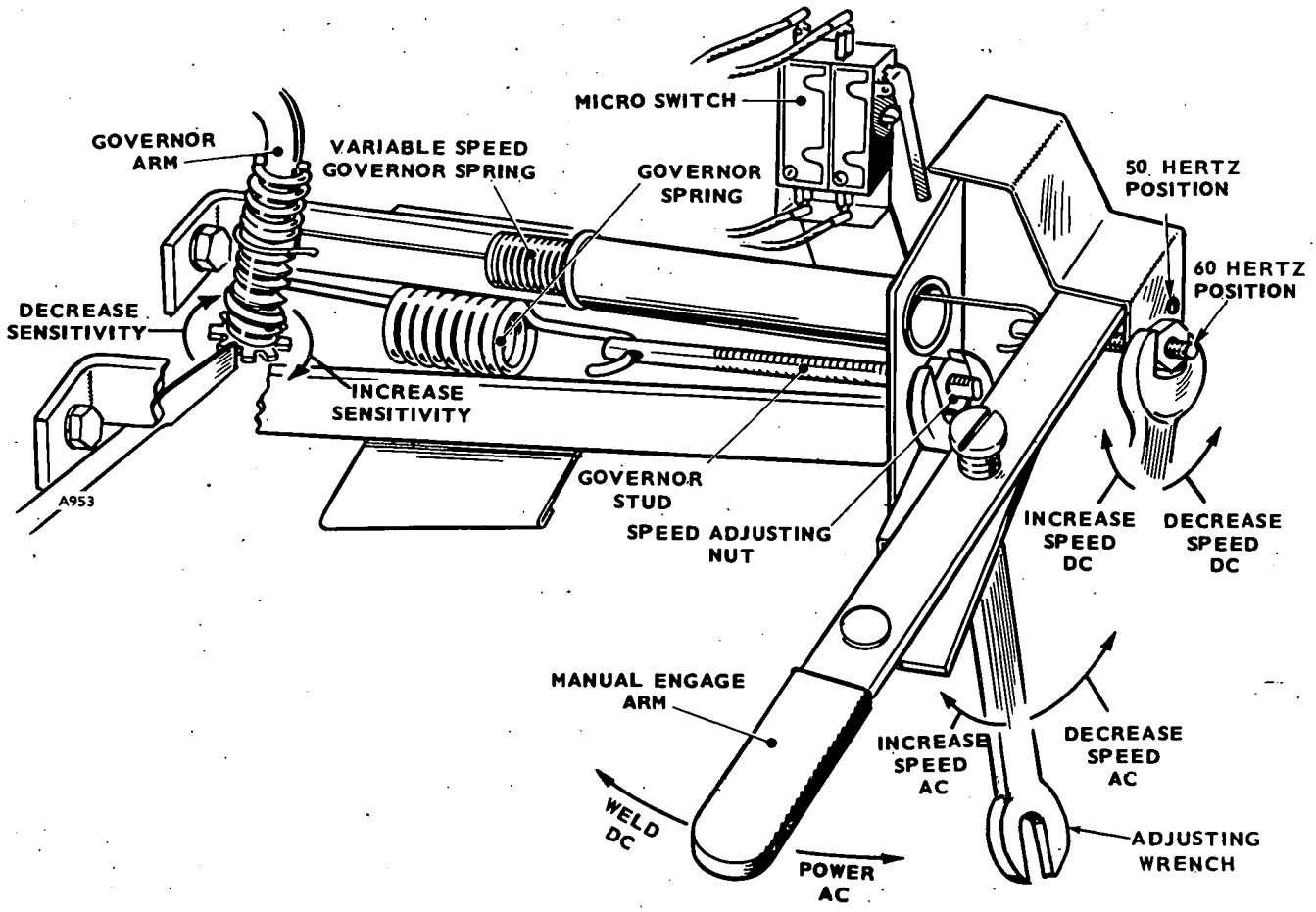


FIGURE 26. GOVERNOR ADJUSTMENTS (EARLY SPEC R MODELS)

OIL SYSTEM

DJB engines have pressure lubrication to all working engine parts. The oil system includes:

- Oil intake cup
- Gear type oil pump
- Bypass valve
- Oil pressure gauge
- Full-flow oil filter
- Oil passages to deliver oil throughout the engine

The pump draws oil from the crankcase and delivers it through the oil filter to the rocker housing, crankcase drillings to the crankshaft bearings, camshaft passages to connecting rod bearings and connecting rod passages to piston pin bushings. Because it aids oil consumption control, the crankcase breather is included in the oil system.

Normal oil pressure should be 25 psi (173 kPa) or higher when the engine is at operating temperature. If pressure drops below 20 psi (138 kPa) at governed speed, inspect the oil system for faulty components.

MAINTENANCE

Maintenance of the oil system includes changing crankcase oil, cleaning the crankcase breather and rocker box oil lines, and replacing the oil filter. See *PERIODIC MAINTENANCE* for recommended service.

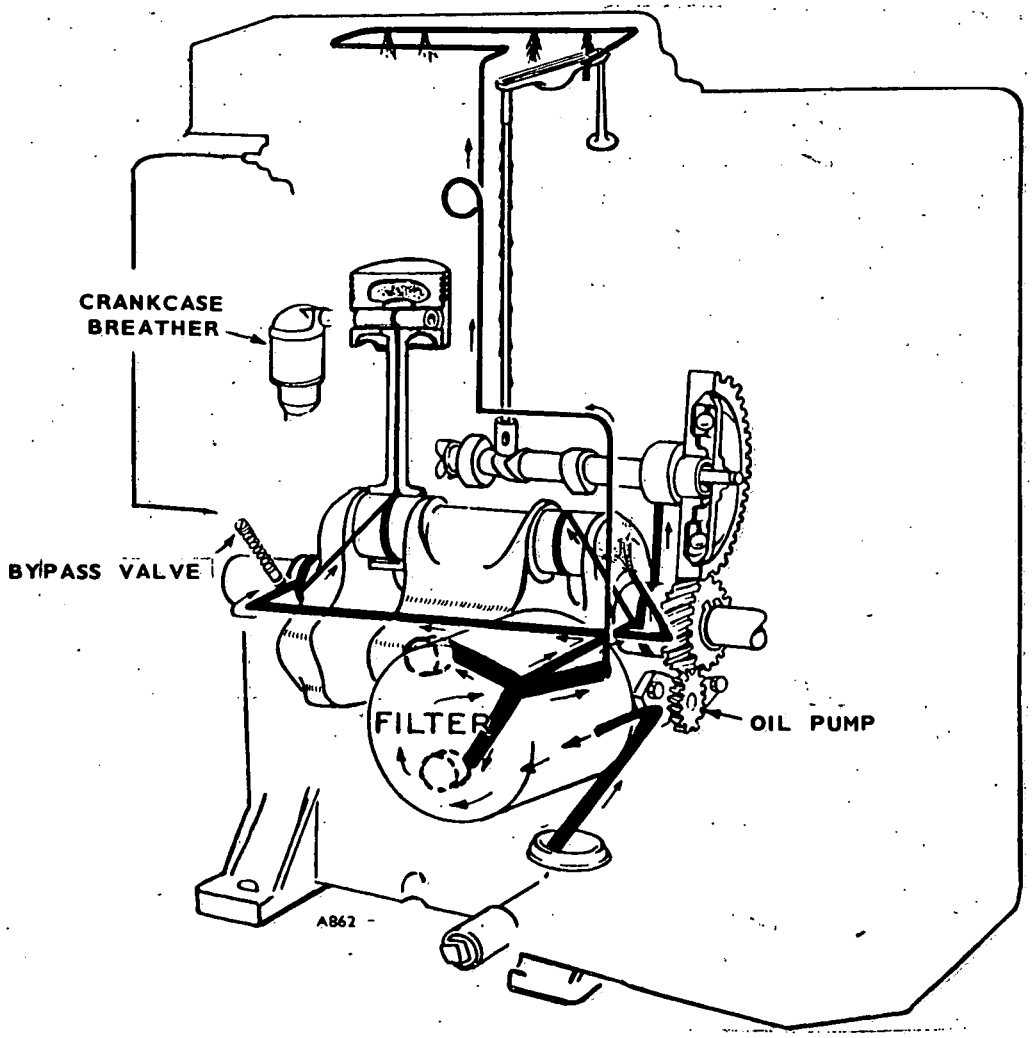


FIGURE 27. OIL SYSTEM

Use an oil with the API designation CD/SE or CD/SD. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following.

TEMPERATURE	GRADE
Above 32° F (0° C)	SAE 30
0° F to 32° F (-18° C to 0° C)	SAE 10W or 5W-30
Below 0° F (-18° C)	SAE 5W-30

Multigrade oils are recommended for temperatures of 32° F (0° C) and below, but they are not recommended for temperatures above 32° F (0° C). When adding oil between oil changes, it is preferable to use the same brand as in the crankcase. Various brands of oil may not be compatible when mixed together.

OIL PUMP

The pump is driven by the crankshaft gear and is mounted in front of the crankcase behind the gear cover.

Oil Pump Removal

1. Remove the gear cover and oil base.
2. Unscrew the intake cup from the pump.
3. Remove the crankshaft lock ring and gear retaining washer.
4. Loosen two cap screws holding the pump and lift out.

Repair parts for the pump are not individually available except for gaskets. If the pump is excessively worn, replace it. Disassemble the pump by removing two cap screws holding the pump cover to the body. To improve pump performance, adjust the gear end clearance by changing gasket thickness between the pump body and cover. Use the thinnest gasket permitting free movement of the pump shaft. Oil all parts when assembling the pump.

Installation includes filling the pump intake and outlet with oil to be sure it is primed before installing.

Mount pump on the engine and adjust for .005 inch (.127 mm) lash between the pump gear and crankshaft gear. Mount pump intake cup parallel with the bottom of the crankcase.

BYPASS VALVE

The bypass valve (located on the outside of the rear bearing plate) controls oil pressure by returning excess oil back to the crankcase. Normally, the valve opens at 25 psi (173 kPa).

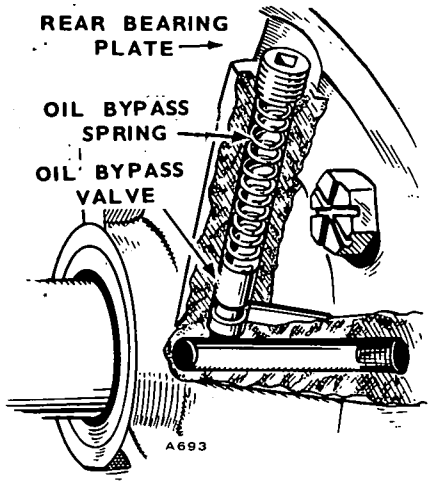


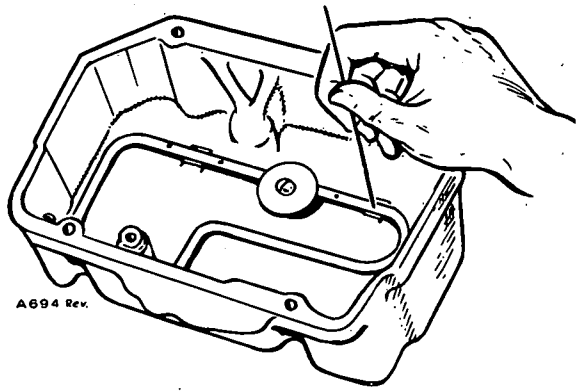
FIGURE 28. OIL BYPASS VALVE

High oil pressure may be caused by the plunger sticking closed, and low oil pressure by the plunger sticking open.

To inspect the valve, unscrew the recessed plug in the rear bearing plate. Then lift out the spring and plunger assembly. Determine valve operation by comparing spring and plunger to specification in *DIMENSIONS AND CLEARANCES* section.

OIL LINES

The oil lines in the rocker box should be flushed with an approved solvent and the small holes opened with fine wire. Blow out all other oil lines and drillings with compressed air whenever the engine is disassembled. Reach the oil gauge passage by removing the oil filter mounting plate.



FLUSH ROCKER BOX OIL LINE WITH FUEL AND CLEAN HOLES WITH FINE WIRE.

FIGURE 29. ROCKER BOX OIL LINE

All external oil lines, rocker box oil line and the internal oil line to the rear bearing are replaceable.

OIL PRESSURE GAUGE

The gauge is located on the lower front cylinder block corner. Before replacing, check for clogged oil passage behind the gauge. Remove it with a wrench and replace with a new gauge if faulty.

FULL FLOW OIL FILTER

The oil filter mounts on the filter plate at the left front crankcase corner. It requires replacement every 200 hours of normal operation. Remove filter by turning counterclockwise using a filter wrench. Install new filter fingertight plus 1/4 to 1/2 turn. See Figure 30.

If oil becomes so dirty that markings on the dip stick cannot be seen, change the oil filter and shorten filter service period.

OIL PRESSURE SWITCH

An oil pressure switch is used to open the battery charger regulator circuit when the engine stops, and prevents battery discharge. Switch operation is explained in the Battery Charging System section of this manual.

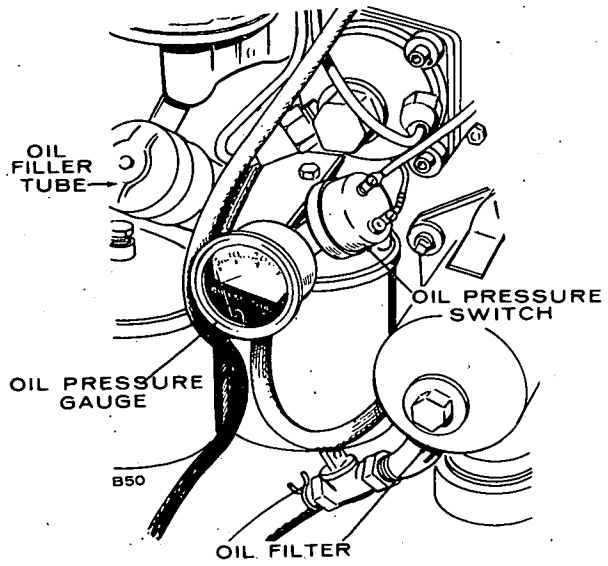


FIGURE 30. OIL FILTER LOCATION

STARTING SYSTEM

This engine has a separate Prestolite starting motor on the right side of the engine to drive the flywheel. It is a standard automotive type with solenoid shift and over-running clutch controlled by a start solenoid. When the solenoid energizes, the motor solenoid operates, shifting the starter pinion to engage the flywheel ring gear and closing the starting motor circuit. The over-running clutch protects the starter armature from overspeeds.

Because parts for the Prestolite starter are not stocked, see a Prestolite dealer.

MAINTENANCE

Periodically inspect the starting system to assure that it is in peak condition.

Inspect motors every 500 hours for loose or dirty connections. Inspect the starter commutator and clean with number 240 sandpaper if dirty. Check the brushes for excessive wear and reduced armature seating.

Test for poor cranking performance caused by a faulty starting motor, defective battery or high resistance in the starting circuit.

Battery charge condition should be tested with a hydrometer every 100 hours. Specific gravity should read from 1.225 to 1.260. If not, charge the battery. If the battery won't charge, replace it.

Wiring should be checked with the starting motor operating. Check the voltage drops:

1. From the battery ground terminal post (not the cable clamp) to the cylinder block.
2. From the cylinder block to the starting motor frame.
3. From the battery positive post to the battery terminal stud on the solenoid.

Normally, each of these should be less than 0.2 volts. If extra-long cables are used, voltage drops may be higher. Clean all circuit connection showing excessively high voltage drops.

Starting motor tests should include testing of free running voltage, speed and current, and tests of stall torque, voltage and current. Always remove motor for these tests.

To test the free running characteristics, connect the starting motor in series with a battery and ammeter and install a tachometer on the motor. Read the free running current and speed.

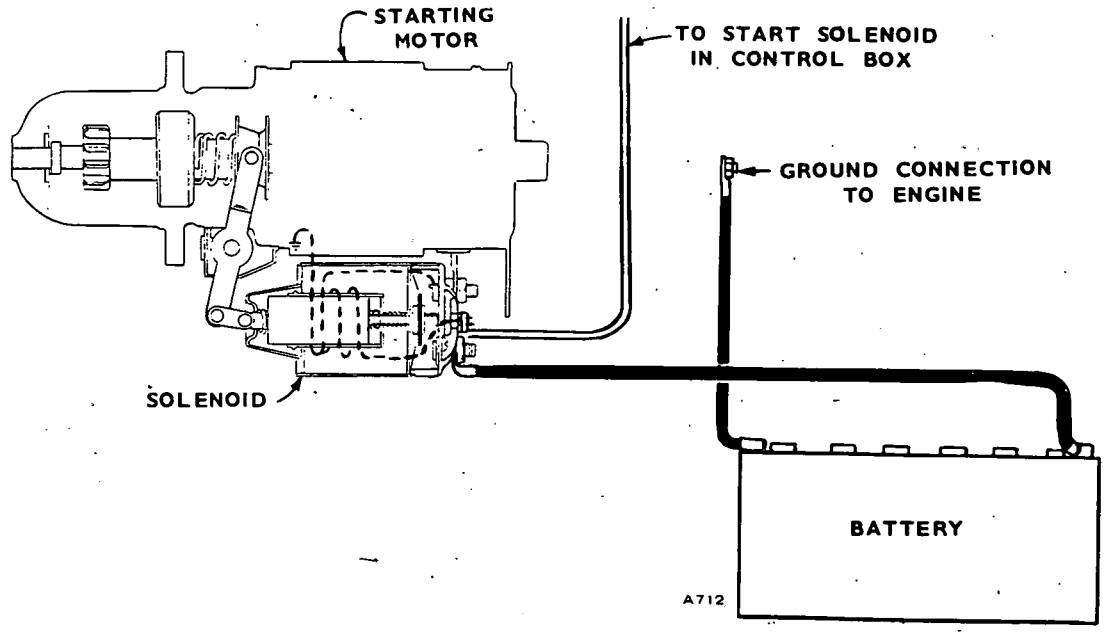


FIGURE 31. STARTING SYSTEM

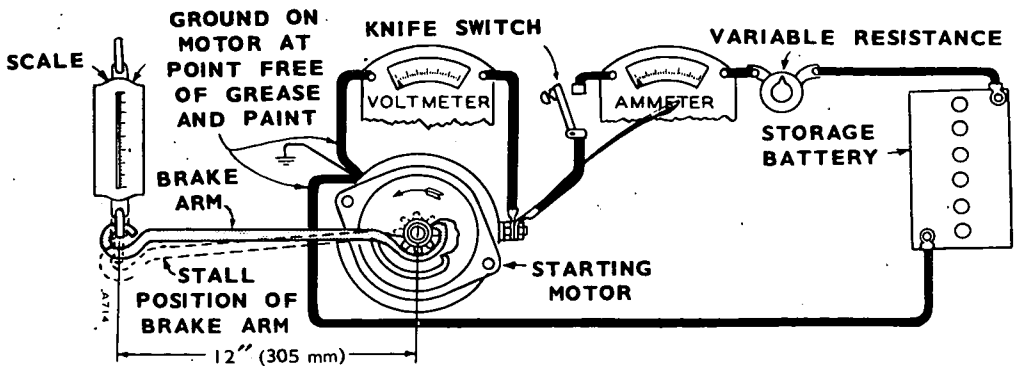


FIGURE 32. STARTING MOTOR STALL TORQUE TEST

The torque test (Figure 32) requires a spring scale and torque arm, voltmeter, ammeter and variable resistance to apply the voltage specified by the test characteristics.

The voltage drop across the solenoid on the starting motor should be less than 1.50 volts. If not, remove and repair.

The battery charging system maintains the battery at or near full charge at all times. If it doesn't maintain charge, adjust the charge rate if battery is in good condition.

If battery discharge (or failure to charge) can't be traced to the charging system, test the battery. Replace if necessary.

STARTING MOTOR REMOVAL AND DISASSEMBLY

1. Remove electrical connections to control box and battery at the starter shift solenoid.
2. Remove the muffler heat shield.
3. Remove rear starting mounting bracket nut.
4. Remove two cap screws holding starting motor to the starter mounting flange. Then pull starting motor off the engine.
5. Remove link pin holding shift lever to solenoid plunger and remove the shift lever pivot pin.
6. Extract through bolts from commutator end of motor. Remove end cover and lift brushes off their seats.
7. Pull the cast housing from the front end of the motor and lift the armature and clutch out of the motor frame.
8. Remove over-running clutch by driving the retainer away from lock-ring near the front end of the shaft. Remove lock-ring and pull off assembly. Don't disassemble the clutch.
9. To service the solenoid, remove four cap screws and electrical connection holding it to the motor frame. Remove two screws at solenoid rear to reach the switch contacts.

STARTING MOTOR REPAIR

Armature: Inspect armature for mechanical defects before testing for grounds or shorted coils.

CONDITION	CHECK FOR
Low Free Speed, High Current	Tight, dirty or worn bearings, bent armature shaft or loose field power screws which would allow the armature to drag, a shorted armature or a grounded armature or field.
Won't Operate, High Current	Direct ground in switch terminal, field, or frozen shaft bearings.
Won't Operate, No Current	Open field circuit, open armature coils, broken or weakened brush springs, worn brushes, high mica on commutator.
Low Free Speed, Low Torque, Low Current	Open field winding, or high internal resistance due to poor connections, defective leads, or dirty commutator.
High Free Speed, Low Torque, High Current	Shorted field windings. Since there is no easy way to detect shorted field coils because of their low resistance, replace them and check for improved performance.

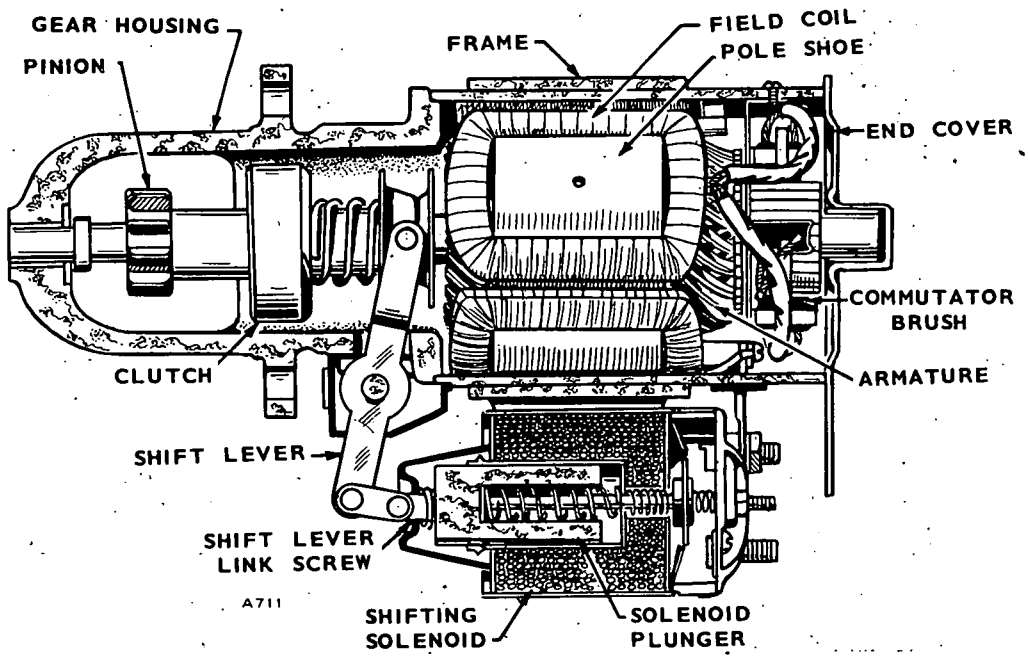


FIGURE 33. STARTING MOTOR

Test for grounds with a 120-volt test lamp. Check between each commutator segment and the shaft. If commutator is grounded, the ohmmeter will show continuity. See Figure 34.

CAUTION **Don't touch probes to commutator brush surfaces; it will burn them.**

Use a growler to test for shorted coils. Place armature in growler and run a steel strip over the armature surface. If a coil is shorting, the steel strip becomes magnetized and vibrates. Rotate armature slightly and repeat test for one complete revolution of the armature. If armature is defective, replace it. See Figure 35.

Clean commutator with number 240 sandpaper. Blow the sand out of motor after cleaning. If heavily scored or worn, turn it down in a lathe.

Field Coils: Field coils are checked with an ohmmeter and probes. Check for motor frame grounds or open circuit. All connections should be clinched and

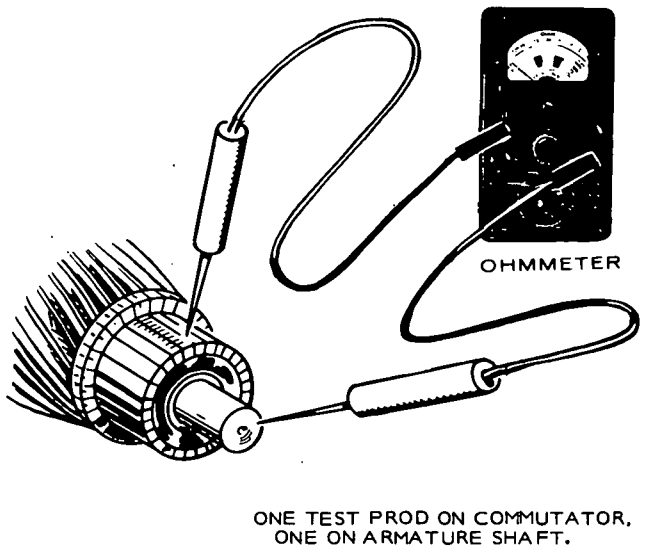


FIGURE 34. TESTING FOR GROUNDS

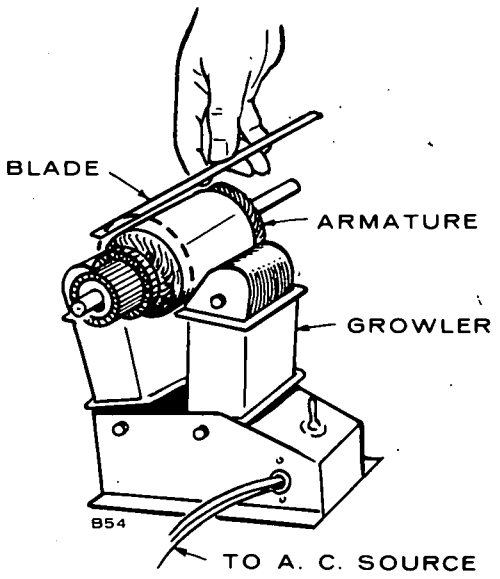


FIGURE 35. TESTING ARMATURE FOR SHORTS

soldered. Inspect the insulation for evidence of damage. The only way to check for field coil shorts is to use the starting motor test.

Bearings: Starter motor bearings should be replaced if they show excessive wear. Drive out old bearings using an arbor press. Press new bearings into place.

Brushes: Brushes should slide freely in their holders. Inspect for wear or improper seating. Check brush spring tension with a spring scale. Change spring tension by twisting spring at the holder with needle-nosed pliers. Replace excessively worn brushes.

Some brushes are soldered to the field coil load. To remove brushes, unsolder the lead and open the loop in the field coil lead. Insert the new brush pigtail into the loop and clinch before soldering. A good soldering job is necessary to ensure good contact and low voltage drop across the connection.

Over-running Clutch: Over-running clutch should be thoroughly cleaned (do not dip in solvent). It can't be repacked with grease. It should slide easily on the armature shaft without binding. Turn the pinion; it should rotate smoothly but not freely. The clutch should instantly lock and unlock when reversing rotation direction. If the clutch is defective (pinion worn or damaged), replace it.

Shifting Solenoid: Shift solenoid plunger should move freely in the coil. Test pull-in continuity (between solenoid control terminal and solenoid connection to the motor) and hold-in coil continuity (between solenoid control terminal and engine ground).

ASSEMBLY, STARTING MOTOR

Starter motor assembly includes soaking the bronze bearings in oil. These bearings are designed to absorb 25% of their own weight in oil. Be sure the felt oil pad is in the outer end of the commutator end bearing.

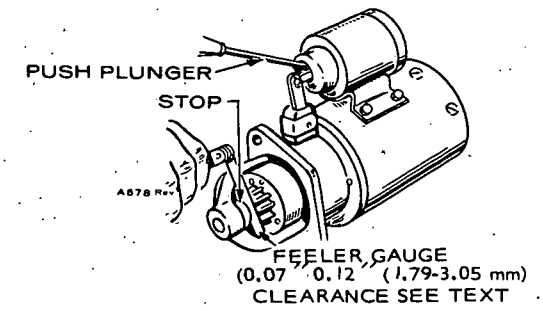


FIGURE 36. STARTER PINION CLEARANCE

After assembly, check the armature end play. See *DIMENSIONS AND CLEARANCES* section. Adjust end play by adding or removing washers at the commutator end.

Check pinion clearance (Figure 36) to ensure engagement. Press solenoid core to shift pinion into full mesh. Measure clearance between pinion and pinion stop (see *DIMENSIONS AND CLEARANCES* section). Adjust solenoid plunger link screw for proper clearance.

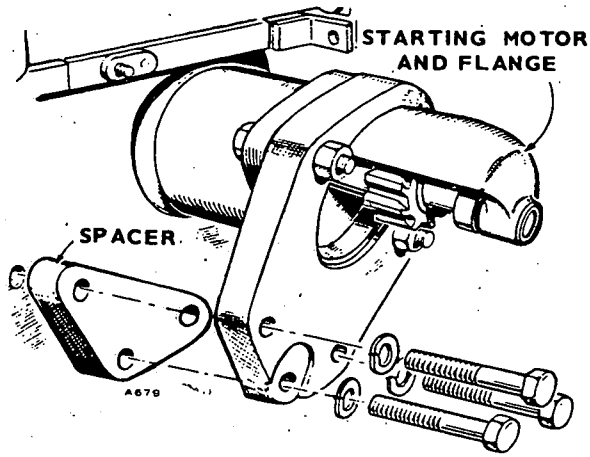


FIGURE 37. STARTER INSTALLATION

BATTERY CHARGING SYSTEM

Two descriptions and troubleshooting techniques for battery charging are given for welders: welders Prior to Spec T and welders begin Spec T.

Both types of battery charging systems have a permanent magnet (rotor) which is held to the flywheel by screws. The stator windings have an epoxy resin coating for moisture protection. Cooling the stator is done by special fins of the rotor. A fuse protects the battery charging system from damage if the battery is connected accidently in reverse polarity.

A cut-off switch, operated by oil pressure, opens when the welder stops and disconnects the battery from the regulator-rectifier of the battery charging circuit. The switch has two wire leads and is located next to the fuel filters and injection pump. Before making all of the flywheel alternator tests following, be sure to check operation of the cut-off switch. The switch is designed to close with increasing pressure at 14 ± 2 PSI (96 ± 14 kPa).

FLYWHEEL ALTERNATOR (Begin Spec T)

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output (Figure 38).

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. The fuse is located behind the air housing door (above injection pump). Check the fuse before performing any tests.

A weak or discharged battery indicates trouble in the charging system, but always check the battery for serviceability first.

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure the output control plug (connector) is inserted properly. The plug must bottom in receptacle—eliminates any resistance due to a poor connection. Keep clean and tight.
2. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
3. Never reverse the battery leads.

Regulator-Rectifier Tests:

The following tests for the regulator-rectifier require a fully-charged battery.

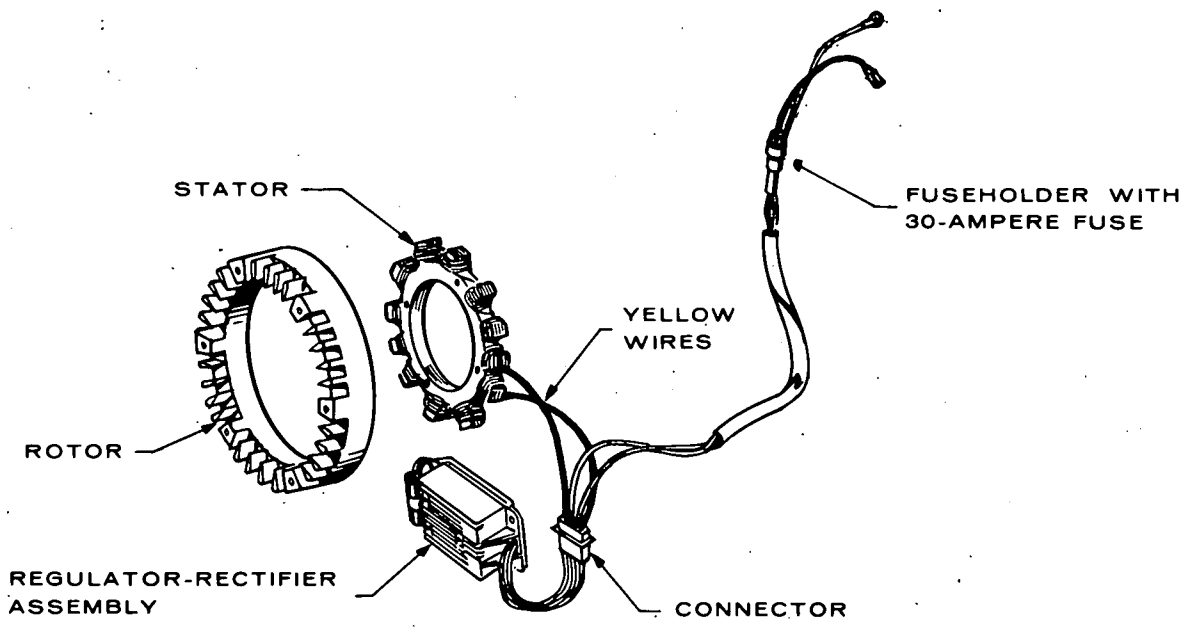


FIGURE 38. FLYWHEEL ALTERNATOR (BEGIN SPEC T)

1. Connect a voltmeter across the battery. Start the engine and operate at 2400 rpm or with manual governor control lever in WELD.
2. Voltmeter should read 13.4 to 14.5 volts. If it does, no further testing of the charging system is necessary. If not, install a new regulator-rectifier and retest. Be sure it has a good ground connection and the connector is properly seated.

Stator Tests

For testing, use a Simpson 260 VOM or equivalent. Be sure test meter and battery, if battery powered, are in good condition. Check with engine NOT running.

1. Set voltage selector switch to DC+ and zero meter on RX1 scale.

   Zero the meter before each reading and each time scales are changed.

2. Unplug the connector and connect the meter leads to the two terminals of the female plug with the yellow wires. Meter should read less than 0.8 ohms if stator has continuity. If meter shows no reading, winding is open and stator should be replaced.
3. Touch red meter lead to yellow wire plug terminal and other meter lead to metal core of stator. If meter doesn't read infinity, the stator winding is grounded. Replace the stator.

Flywheel Magnet Group or Rotor

To test the magnet group or rotor, lay a piece of ferrous (iron) material up against the magnets to be sure they are charged. If not, replace the rotor.

FLYWHEEL ALTERNATOR (Prior to Spec T)

There are neither brushes nor bearings in this sytem, so maintenance is limited to keeping the components in good condition. When the flywheel is off, clean the rotor and stator and check the wires. In general, see that all connections are secure and all components clean. If the alternator is operating satisfactorily, do not tamper with it.

A 20-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. It's located on the left side of the blower housing. Check this fuse before performing following tests.

1. Connect an ammeter between the red terminal on the rectifier and the ignition switch.
2. With the engine running at 1800 rpm, the ammeter should indicate about 8 amperes into a fully discharged battery and progressively less as the battery becomes charged. The regulator switches from high to low charge at about 14-1/2 volts and from low to high at about 13 volts.

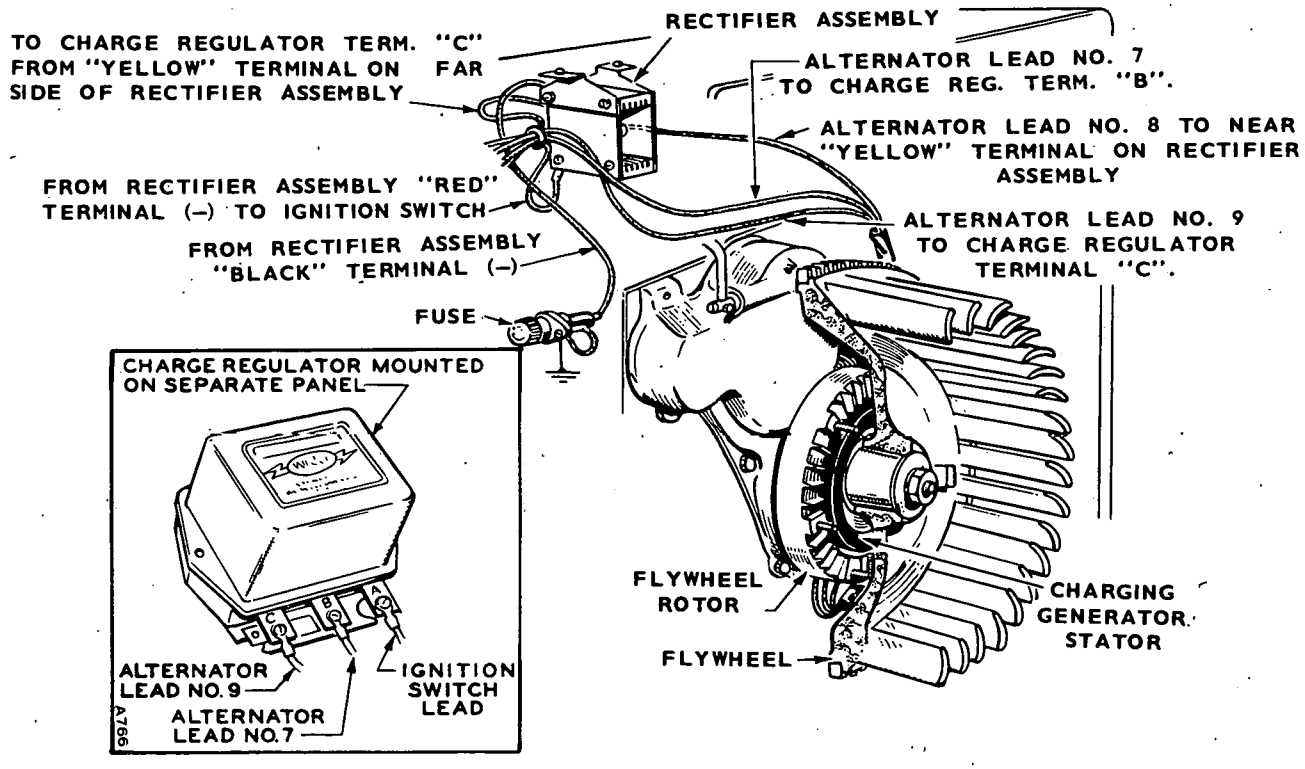


FIGURE 39. FLYWHEEL ALTERNATOR (PRIOR TO SPEC T)

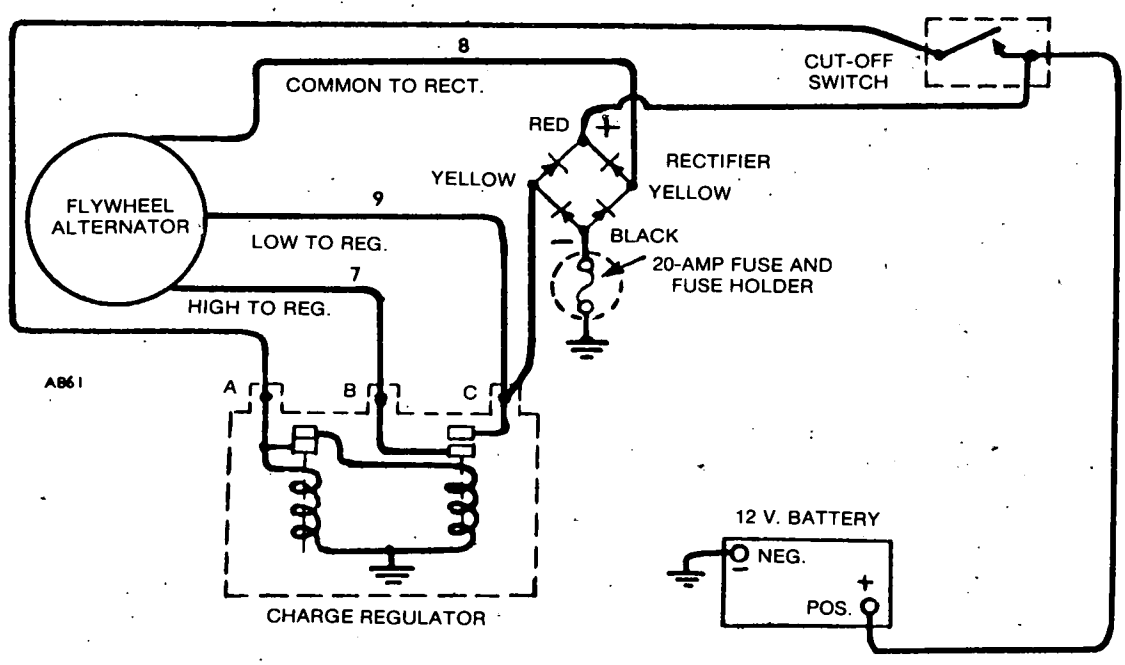


FIGURE 40. WIRING SCHEMATIC (PRIOR TO SPEC T)

Stator

1. Disconnect the stator leads and test each one with a 12-volt test lamp for grounding. Touch one probe to the lead and the other probe to a good ground on the engine. None of the leads should show a ground, which will be indicated if the lamp lights. If a ground is indicated, replace the stator.
2. To test for shorted coils or opened circuits, use an ohmmeter set to read the proper range of resistances. The resistance values are as follows:

Lead 7 to 8 — .25 ohms
Lead 8 to 9 — .95 ohms
Lead 9 to 7 — 1.10 ohms.

If the resistance varies over 25% from the above values, install a new stator and check for improved performance.

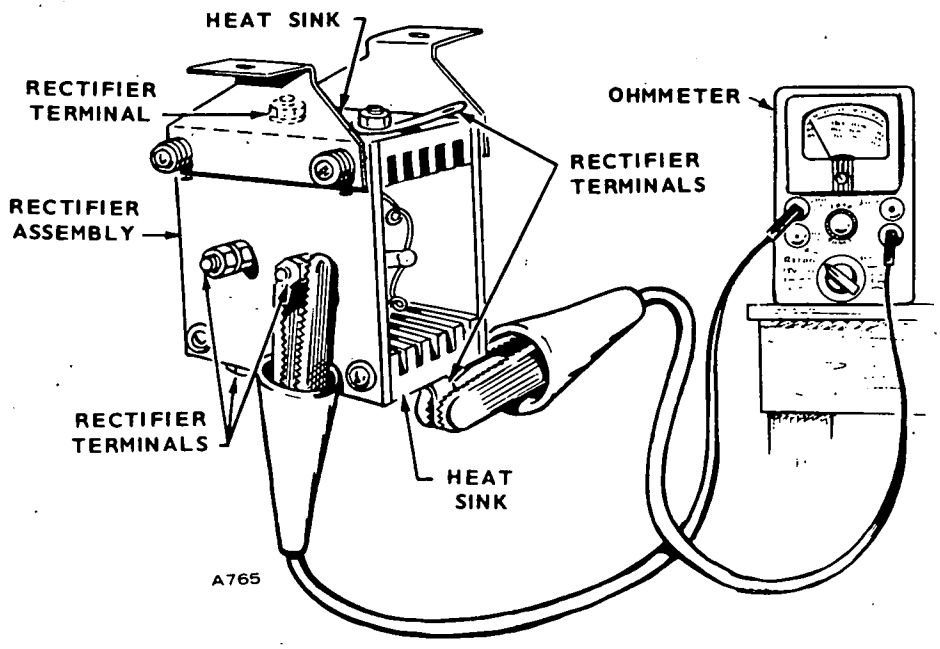


FIGURE 41. CHECKING RECTIFIERS (PRIOR TO SPEC T)

3. Current at low charge should be about 2 amperes. If output is unsatisfactory, perform the following tests.

Rotor: To test for magnetism in the rotor, merely hold a piece of steel close to the magnet. If the steel is strongly attracted, the rotor is satisfactory. Strength of the magnet is a basic quality that will not change much over a period of time.

Rectifier

1. Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter or test lamp.
2. With an ohmmeter, connect one test lead to the rectifier lead and the other test lead to the rectifier base. Take the reading and then reverse the test probes. If the rectifier is good, one reading will be much higher than the other.

   If using a test lamp, touch the test probes together and observe the brightness of the bulb. Then touch the probes across the rectifier. If the rectifier is good, the bulb will light dimly. If the bulb lights brightly or not at all, the rectifier is defective and must be replaced.

Voltage Regulator

1. If the low charge rate is satisfactory, but high rate is not, connect a jumper between terminals B and C.
2. Run the engine and check the charge rate at the battery — should be 8 amperes. If it is, either the regulator or its power circuit is defective.
3. With a 12-volt test lamp, check input to the voltage sensitive coil at terminal A. If the lamp lights, input is okay and the regulator is defective.
4. If the charge rate with B and C jumpered is low, look to the alternator or its wiring for the cause.

ENGINE DISASSEMBLY

If engine disassembly is necessary, observe the following order (i.e. flywheel, gear cover . . .). As disassembly progresses, the order may be changed somewhat as will be self-evident. The engine assembly procedure is the reverse of disassembly. Any special assembly instructions for a particular group are included in the applicable section. When reassembling, check each section for these special assembly instructions or procedures.

FLYWHEEL

Remove the blower housing. The flywheel is a tapered fit on the crankshaft. Improvise a puller using at least a 7/16 inch (11.113 mm) bar and drilling two 7/16 inch (11.113 mm) holes 2-7/8 inches (22.225 mm) between centers. Loosen the flywheel mounting screw a few turns. Place bar against the flywheel screw, attach bar using two 3/8 inch thread screws in the holes provided in flywheel. Alternately tighten the screws until flywheel is free.

Replacement flywheels are supplied without the timing markings because each flywheel must be fitted to its engine. The only accurate method of determining the top dead center (TDC) and port closing points is to measure the piston travel. This is a critical measurement and should be attempted only with accurate, dependable equipment.

With the flywheel mounted, remove the head and install a depth gauge over the front piston. Rotate the flywheel to find the TDC position on the compression stroke and mark this point on the flywheel. Next, turn the flywheel counterclockwise until the piston drops exactly .126 inch (3.200 mm) from TDC. This is the port closing point, 19° BTC.

Ring Gear: To remove the ring gear, if damaged, saw part way through, then break it using a cold chisel and heavy hammer.

To install a new ring gear, place it in an oven heated to 380 to 400° F (193° C to 204° C) for 30 to 40 minutes.

CAUTION **Do not heat with a torch. When heated properly, the ring will fall into place on the flywheel. If it does not go on all the way by itself drive it with a hammer. Do it fast and do not damage the gear teeth. The ring will contract rapidly and may shrink to the flywheel before it is in place. If this occurs, a new ring gear may be required.**

GEAR COVER

To remove the gear cover, detach the upper governor ball joint. Remove the governor speed adjustment nut and governor spring bracket.

Remove the screws holding the gear cover to the crankcase. To loosen the gear cover, tap it with a soft hammer.

Governor Shaft: The governor shaft is supported by two sets of needle bearings. To remove the shaft, remove the yoke and pull the shaft from the gear cover. If the shaft is binding, clean the bearings, if loose, replace the bearings. To remove the larger bearing, drive both bearing and oil seal out from the outside of the gear cover. Remove the smaller bearing

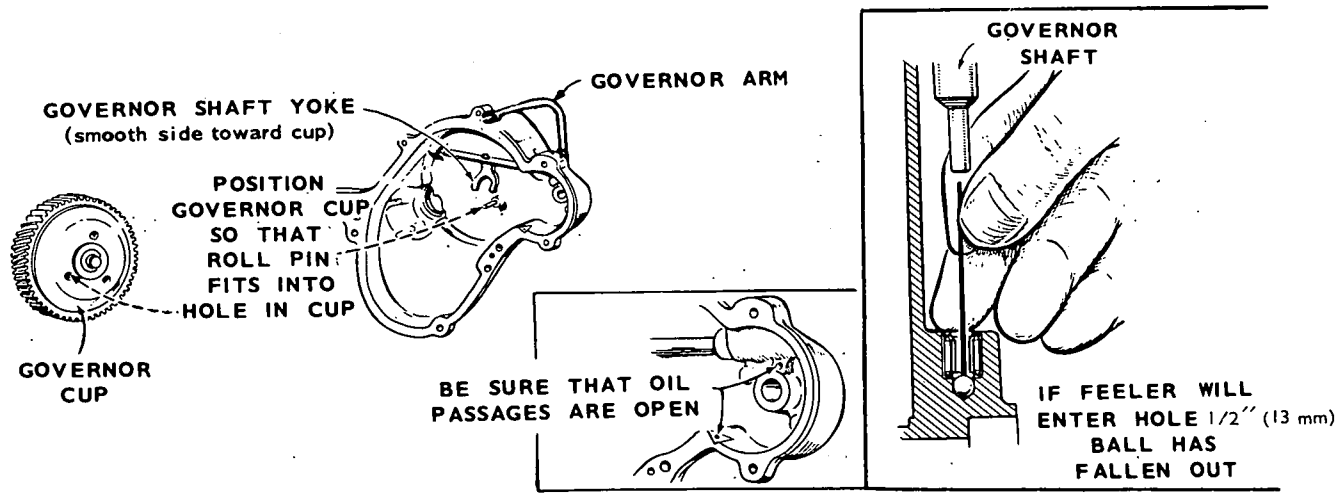


FIGURE 42. GEAR COVER

with an "Easy-Out" or similar tool. Press new bearings and oil seal into place.

Gear Cover Oil Seal: Replace the oil seal if damaged or worn. Drive the old seal out from inside the gear cover. Lay the cover on a board so the seal boss is supported. Using an oil seal driver, insert the new seal from the inside with rubber lip toward outside of gear cover (open side of seal inward) and drive it flush with the outside surface. During gear cover installation, use the driver to protect the oil seal. See Figure 43.

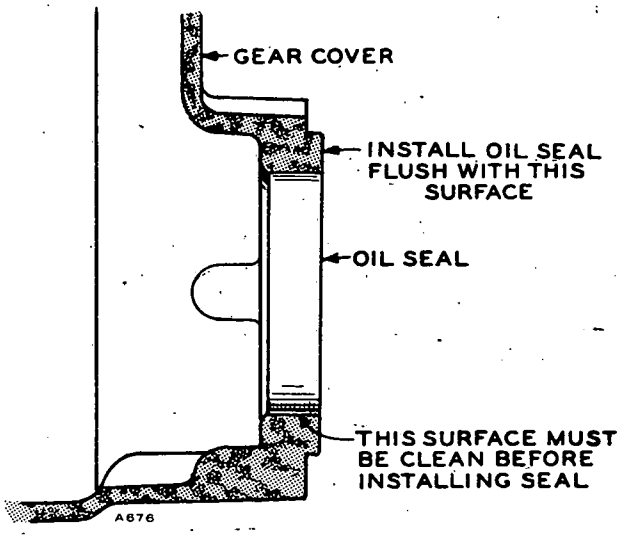


FIGURE 43. GEAR COVER OIL SEAL

Assembly, Gear Cover:

1. Work the governor shaft to check for binding and see that the governor-shaft-end-thrust ball is in place (Figure 42). Later models have a larger ball which will not fall out.
2. Turn governor yoke so the smooth side is toward governor cup.
3. Turn the governor cup so the stop pin in the gear cover fits into one of the holes in the cup surface. Measure the distance from the end of the stop pin to the mounting face of the cover. It should be 25/32 inch (19.84 mm). If it is not, replace the pin. Pin should be positioned with open end facing crankshaft seal.
4. Coat the oil seal lip with oil or grease. Set a piece of shim stock over the crankshaft keyway to protect the seal and install the gear cover. Tighten the mounting screws to specified torque. Before tightening screws, be sure the stop pin is in the governor hole.

GOVERNOR CUP

To remove the governor cup, remove the snap ring from the camshaft center pin and slide the cup off. Be sure to catch the flyballs that will fall out when the cup is removed.

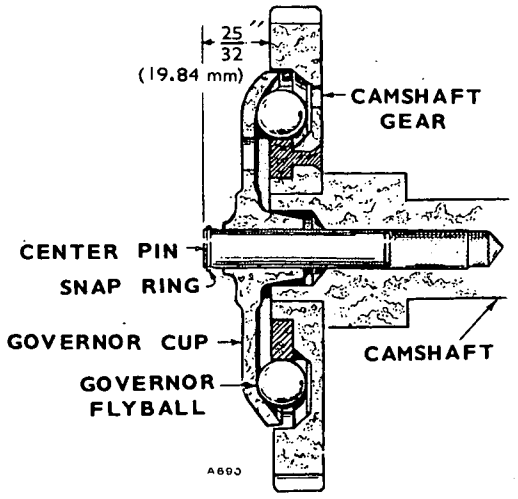


FIGURE 44. GOVERNOR CUP

Repair: Replace any flyballs that have flat spots or grooves. Replace the cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but should be replaced if excessively loose or wobbly.

Check the distance the center pin extends from the camshaft gear, this distance must be 25/32 inch (19.84 mm) to give the proper travel distance for the cup (Figure 44). If it is less, the engine may race; if more, the cup will not hold the balls properly. If the distance is too great, drive or press the center pin in. If it is too small, replace the pin; it cannot be removed without damaging the surface. In some cases, if the distance is too small, the head of the governor cup can be ground to give the necessary 7/32 inch (19.84 mm) travel distance.

Installation: To install the governor assembly, tip the front of the unit upward. Set the flyballs in their recesses and position the governor cup on its shaft. Finally, brush with heavy grease and install the snap ring on the center pin.

CYLINDER HEADS, VALVES

The cast iron cylinder head assembly has alloy hardened faced valves, release type rotators, alloy hardened inserts, guides, rocker arms, injection nozzles and glow plugs. The push rods run through shields.

Disassembly:

1. Remove the rocker box cover, fuel nozzles and oil lines to the cylinder heads.
2. Remove the intake and exhaust manifold.
3. Remove the cap screws holding each cylinder head to the cylinder block.
4. Remove each head. If it sticks, rap it sharply with a soft hammer. Do not use a pry.

5. Remove the rocker arms and push rods.
6. Using a valve spring compressor, disassemble the valve assemblies.

Identify valve parts for identical reassembly.

Thoroughly clean all components of the cylinder head assemblies. Remove all the carbon deposits from the intake and exhaust ports and clean all gasket surfaces.

Valves: Remove all carbon and check each valve for burning, pitting or warped stem. Valves that are slightly pitted or burned, refinish on an accurate valve grinder. Refinish intake valves to a 42° angle and exhaust valves to a 45° angle. But, if they are badly pitted or will have a thin edge when refacing, replace them.

Check refinished valve for a tight seat to the valve seat with an air pressure type testing tool or by applying Prussian Blue on the valve face and rotating it against the seat.

Valve Guides: Check valve guide to valve clearance, see *DIMENSIONS AND CLEARANCES* section. If the proper clearances cannot be obtained by replacing the valves, replace the valve guides (available in .001 inch oversize).

Removing Old Guides:

1. Before pressing guide out, use a wire brush and electric drill to remove carbon and all other foreign matter from top surface of guide.

CAUTION **Damage could occur to the guide wall in the cylinder head if this procedure is not followed.**

2. Place removal tool in guide and position in arbor press using care in pressing old guide out.

CAUTION **Do not use hammer to remove old guides (or to install the new ones).**

3. Run fine crocus cloth on a small polishing rod through cylinder head valve guide hole to clean out carbon and other foreign materials. Be careful not to enlarge guide hole.

Installing New Guides:

1. Coat outer edge of new guide with oil (or other lubricant). Position guide notch up in cylinder head and press in until the guide protrudes 11/32 inch (8.71 mm) from the rocker box side of the head.
2. Place valve guide reamer in drill press (if not available, use an electric drill). Two size reamers are used:
   a. intake guide — reamer size .342 inch to .343 inch (8.687 to 8.712 mm).
   b. exhaust guide — reamer size .344 inch to .345 inch (8.738 to 8.763 mm)
3. Use polishing rod and crocus cloth to obtain a good smooth honed finish after reaming.
4. Thoroughly wash cylinder head in solvent after reaming and honing is completed.

Valve Seats: If the valve seats are pitted, refinish them. Using conventional seat grinding equipment, reface each seat to a 45° angle and seat width of 3/64 to 1/16 inch (1.19 to 1.59 mm). You should be able to reface each seat several times before it becomes necessary to replace it.

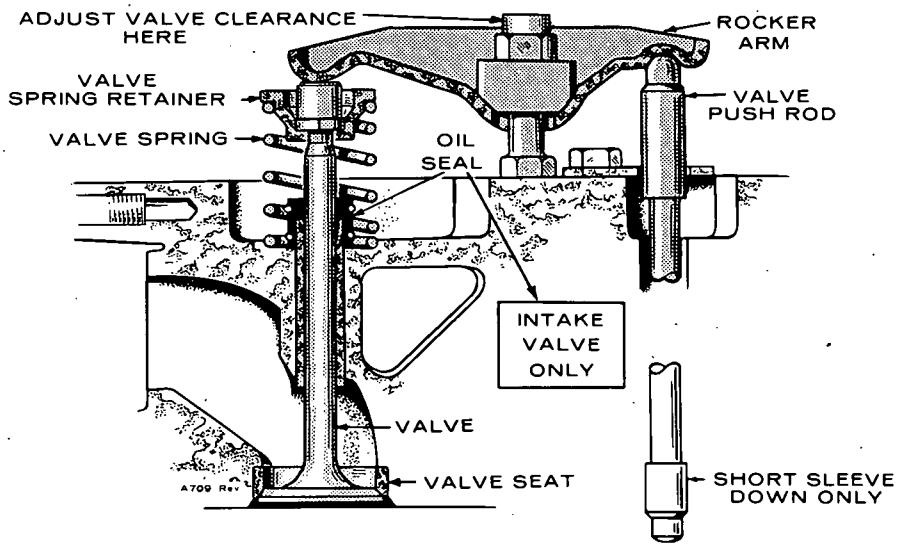


FIGURE 45. VALVE TRAIN

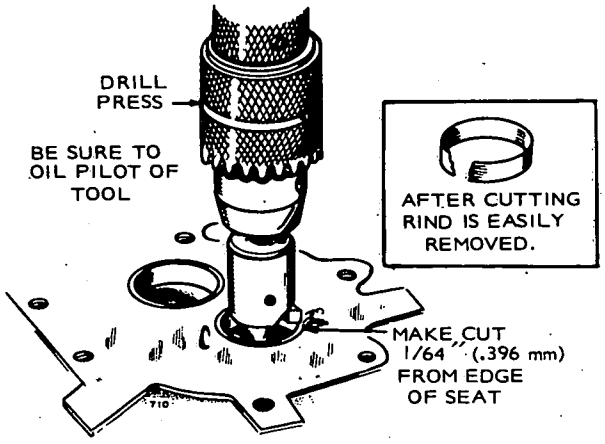


FIGURE 46. REMOVING VALVE SEAT

If, however, the valve seats are loose or cannot be refaced, replace them.

Use the valve seat remover tool in a drill press (Figure 46) to remove each valve seat. Adjust the tool to cut 1/64 inch (.396 mm) from the edge of the seat. Oil the pilot to prevent it from seizing in the valve guide. Cut each seat down to a narrow rind on edges and bottom and break it out with a sharp tool.

CAUTION **Don't cut into the counterbore bottom.**

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be remachined for an oversize seat. Oversize seats are available in .002, .005, .010 and .025 inch. Otherwise, install new standard size seat inserts.

Drive the new valve seat inserts into place. Be certain that each seat rests solidly on the bottom of the counterbore at all points. To make installation easier, heat the cylinder head in an oven at 325° F (160° C) for about 1/2 hour and cool the valve seats in dry ice.

Face each new seat to a 45° angle and width of approximately 3/64 inch (1.19 mm). The finished seat face should contact approximately center of the valve face. Use Prussion Blue on each valve face to check this. Make any corrections on the seat, not the valve face.

When the new seats are installed and faced, insert the valve into each and check the clearance from valve head to the face of the cylinder head. This must be at least .030 inch (.762 mm). If it is not, regrind the seat.

Valve Springs: Check the valve springs on an accurate compression scale. Valve spring data is given in the *DIMENSIONS AND CLEARANCES* section. Replace any spring that is weak, cracked or pitted or has ends out of square.

Installation of Cylinder Head and Valves:

1. Push a valve stem oil seal onto each intake valve guide and clamp in place. Then oil the inside surface of each seal.
2. Oil the stem of each valve lightly and insert each in its own guide.
3. Check each valve for a tight seat with an air pressure type tester. If a tester is not available, make pencil marks at intervals on the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn in the seat. If the seat is not tight, regrind the valves.
4. Using a valve spring compressor, compress each valve spring and insert the valve spring retainer and retainer locks.

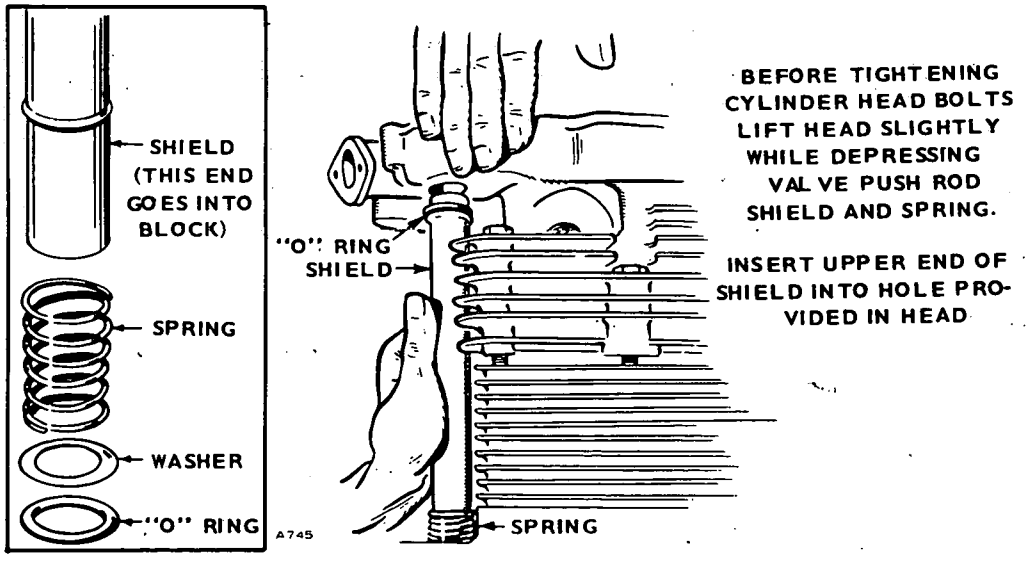


FIGURE 47. INSTALLING PUSH ROD SHIELD

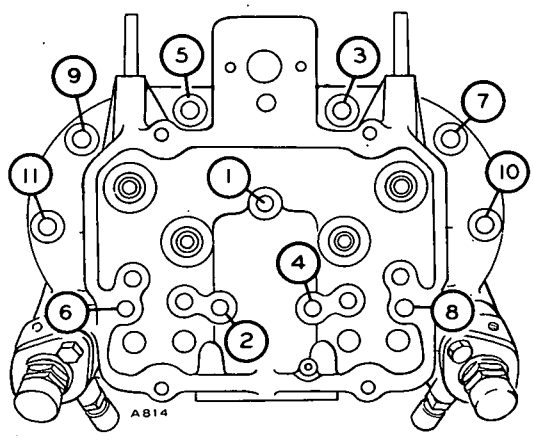


FIGURE 48. HEAD TIGHTENING SEQUENCE

5. Install the head assembly and gasket to the cylinder block.
6. Before tightening the cylinder head, install the push rod shield as shown in Figure 47.
7. Tighten the head bolts to half torque value (*ASSEMBLY TORQUES AND SPECIAL TOOLS* section) following sequence in Figure 48.
8. Torque head bolts to torque value following same sequence.
9. Install the exhaust manifold, nozzles, glow plugs and oil lines.
10. Install the valve stem caps.
11. Install the push rods, rocker arms and rocker arm nuts.
12. Set the valve clearance (see *DIMENSIONS AND CLEARANCES* section).

After the first 50 hours of operation on a new or overhauled engine, retighten the cylinder head bolts and check valve clearance.

Valve Clearances: Check the valve clearances at regular intervals (see service chart in *PERIODIC MAINTENANCE* section). In addition, clean valve seats at regular intervals.

After engine has reached a stable temperature condition, the valve clearances may be adjusted. It is recommended that the valve clearance is set with engine at room temperature (approximately 75° F [24° C]). Allow at least two hours cooling time after engine operation.

To adjust valve clearance on the two-cylinder engine, proceed as follows:

1. Turn the flywheel until the cylinder which is to have its valve adjusted is on its compression stroke, which follows closing of intake valve.
2. Turn the flywheel until the TC (top center) mark on the flywheel lines up with the timing pointer on the gear cover. Then turn the flywheel in a clockwise direction for an additional 10 to 45 degrees. There is no timing mark for this position so it must be estimated. With the piston located in this position, the cylinder will be in its power stroke with both valves completely closed.
3. Check the cylinder head-bolt torque for 44 to 46 ft. lb. (60 - 62 N•m).
4. Using a feeler gauge, check the clearance between the rocker arm and the valve (see Figure 49). Increase or reduce the clearance until the proper gap is established adjusting with the lock nut which secures the rocker arm to the cylinder head. Correct valve clearance is in *DIMENSIONS AND CLEARANCES* section.
5. To adjust the valve clearance for the other cylinder, turn the flywheel in a clockwise direction 360° (1 revolution) from the position used in step 2. Then follow steps 3 and 4.

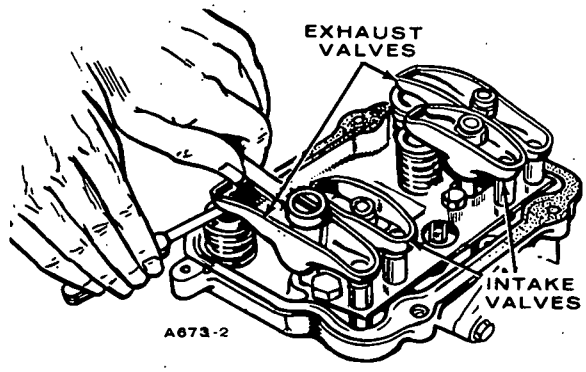


FIGURE 49. VALVE CLEARANCES

PISTONS, RINGS, CONNECTING RODS

These engines use cam ground aluminum pistons. Each piston is tapered and fitted with three compression rings and an oil control ring. Full floating piston pins connect the piston to its connecting rod. The pins are held in place with a snap ring at each end. The lower end of each connecting rod contains half shell, precision bearings and the upper end, semi-finished bushings.

Some engines are fitted with .005 inch oversize pistons at the factory. These engines are marked with an E following the engine serial number. Use 0.005 oversize rings for these pistons.

Pistons: The connecting rod and cap are stamped for proper installation in the proper cylinder. When removing piston assemblies, check the marking so each can be installed in the proper cylinder.

1. Drain the crankcase oil and remove the oil base.
2. Remove the cylinder heads. Remove carbon from bore.
3. Remove the ridge from the top of both cylinders with a ridge reamer before removing the piston (Figure 50).

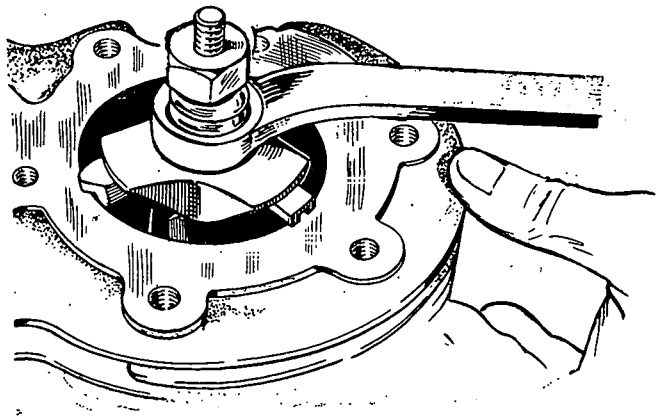


FIGURE 50. REMOVING RIDGE FROM THE CYLINDER

CAUTION **Pushing and forcing the piston from the cylinder before the ridge is removed can crack the piston rings or damage the piston lands.**

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Avoid scratching the crankpin and cylinder wall when removing the piston and rod.

   Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps and bearings with their respective rods.

5. Remove the piston rings from the piston with a piston ring spreader.
6. Remove the piston pin retainers and push the piston pin out.
7. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 51). Care must be taken not to remove metal from the groove sides.

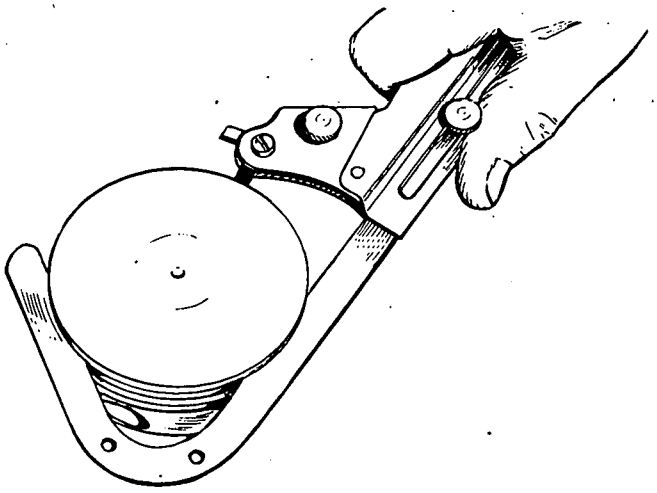


FIGURE 51. PISTON GROOVE CLEANING

Do not use a caustic cleaning solvent or wire brush for cleaning pistons.

8. Check for wear or breaks at the ring lands using a new ring and feeler gauge as shown in Figure 52. Replace the piston when the side clearance exceeds that shown in *DIMENSIONS AND CLEARANCES* section. If any piston is badly scored or burred, loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, replace it.
9. Check the clearance 90° from the axis of the piston pin and below the oil control ring. Clearance should be .0055 to .0075 inch (.1397 to .1095 mm). If not, replace the piston and check the cylinder for possible reconditioning.

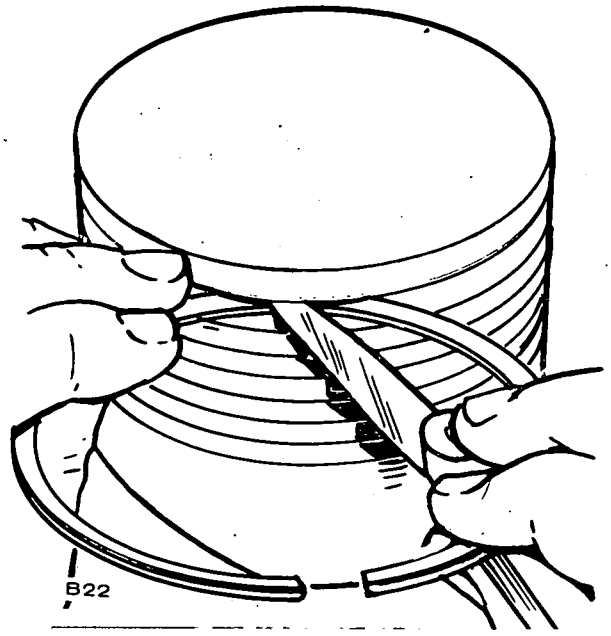


FIGURE 52. CHECKING RING SIDE CLEARANCE

Piston Pins: Each piston pin should be a thumb push fit into its piston at room temperatures. If the pin is excessively loose, install a new one (available as standard or .002 inch oversize).

Rings: Inspect each ring carefully for fit in the piston grooves and seating on the cylinder wall. Fit each ring to the cylinder wall at the bottom of its travel, using a piston to square the ring in the bore. Check the gap with a feeler gauge. It should be .010 inch (.254 mm). If the gap is too small, file the butt ends of the rings. Do not use rings that need a lot of filing, they will not seat properly on the cylinder walls. If oversize pistons are used, use the correct oversize rings.

Connecting Rods: Clean the connecting rods and check each for defects. Check the connecting rod bushings for proper clearance with the piston pin.

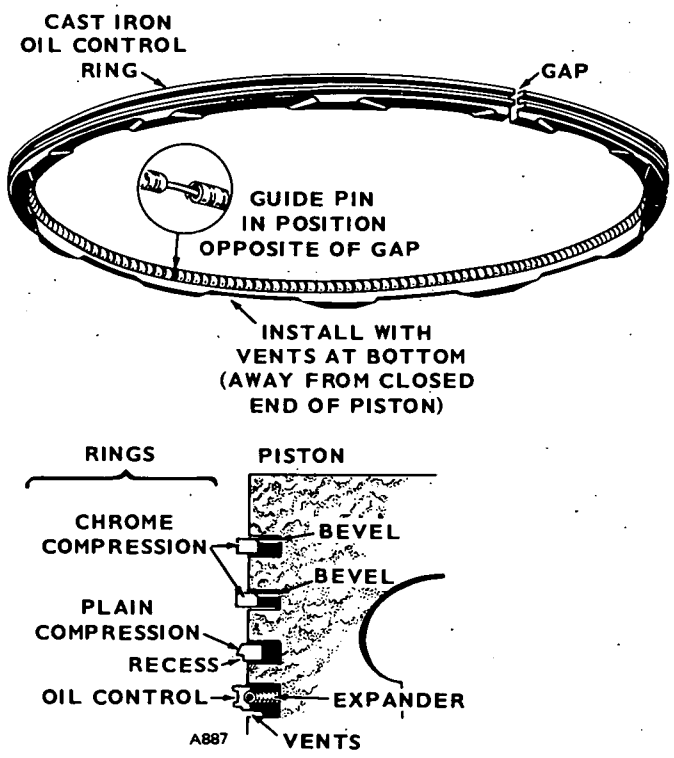


FIGURE 53. PISTON RINGS

Clearance should be .0002 to .0007 inch (.0051 to .0178 mm).

Checking Bearing Clearance With Plastigauge:

1. Make certain that all parts are marked or identified so that they are reinstalled in their original positions.
2. Place a piece of correct size Plastigauge in the bearing cap the full width of the bearing insert about 1/4 inch (6 mm) off center (Figure 54).
3. Rotate the crank about 30° from bottom dead center and reinstall the bearing cap. Tighten the bolts to the torque specified in *ASSEMBLY TORQUES AND SPECIAL TOOLS* section. Do not turn the crankshaft.
4. Remove the bearing cap. Leave the flattened Plastigauge (adhered to crankshaft) and compare the widest point with the graduations on the Plastigauge envelope to determine clearance.

Installation of Piston Assemblies:

1. Turn the crankshaft to position one rod bearing journal at the bottom of its stroke.
2. Lubricate the corresponding piston assembly and inside of the cylinder.
3. Install the bearing insert in the rod.
4. Compress the rings with a ring compressor and position the piston and rod assembly in the cylinder block.

The connecting rod numbers or witness marks should always face the camshaft (top) side of engine.

5. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal.
6. Install the bearing cap on the rod with the witness marks and stamped reference numbers matching the marks on the rod.
7. Install and tighten the bolts to the specified torques. The bearing cap must be tapped several times to properly align it with the rest of the connecting rod. Clearance varies on the journal if this is not done.
8. Install the remaining pistons and rods in the same manner. Crank the engine over by hand to see that all bearings are free.

CYLINDERS

The cylinder walls should be free of scratches, pitting and scuffing. Check each with an inside reading micrometer for out-of-round and wear. The bore should measure between 3.2495 and 3.2505 inches (82.5373 and 82.5627 mm) and be less than .001 inch (.025 mm) out-of-round. Check each cylinder for taper, out-of-round and wear with a cylinder bore gauge, telescope gauge or inside micrometer (Figure 55).

If necessary, rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in .005, .010, .020, .030 and .040 inch

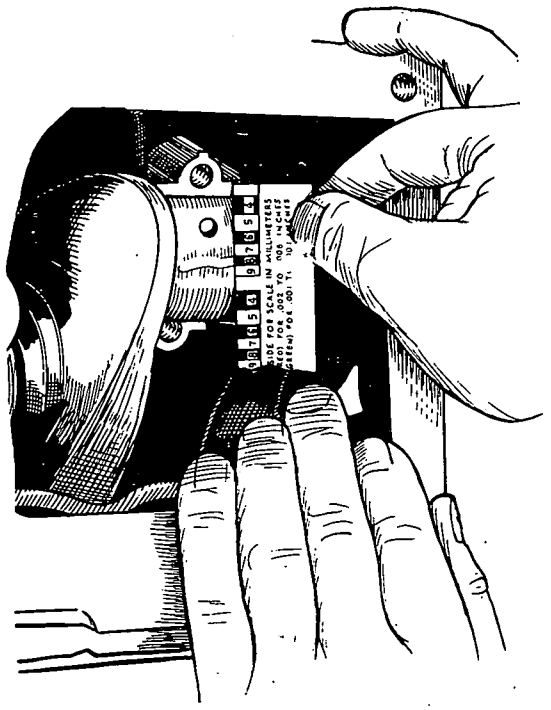


FIGURE 54. MEASURING BEARING CLEARANCE WITH PLASTIGAUGE

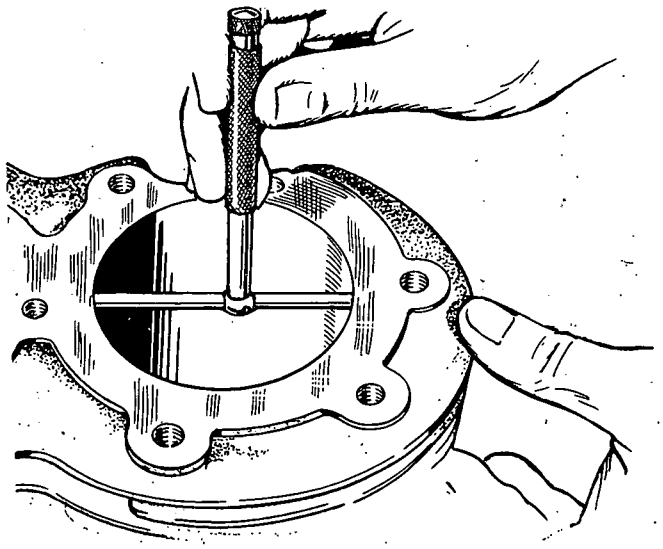


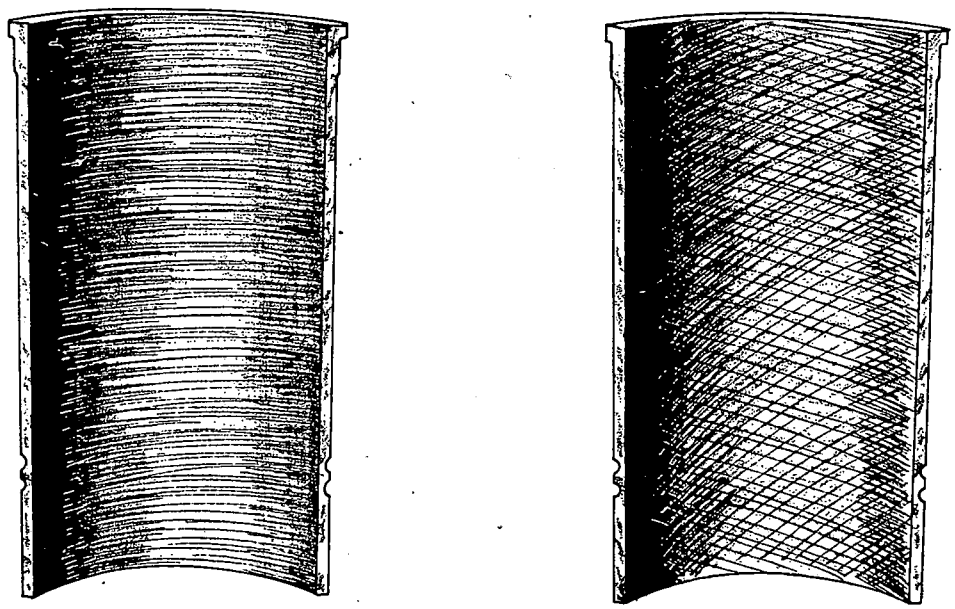
FIGURE 55. MEASURING CYLINDER

oversize. If the cylinders do not need refinishing, remove any existing ridges from the top of the wall.

A reboring machine is used when going to oversize pistons. The following repair data cover honing to oversize by use of a hone.

Repair

1. A hone can be used to rebore a cylinder. Remove stock to 0.002 inch (.051 mm) undersize of finish bore with coarse hone (100 grit), then complete honing with finish hones (300 grit).
2. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.
3. Lower the hone into the cylinder until it protrudes 1/2 to 3/4 inch past the end of the cylinder. Rotate the adjusting nut until the stones come in contact with the cylinder wall at the narrowest point.
4. Turn the hone by hand. Loosen the adjusting nut until the hone can be turned.
5. Connect drill to hone and start drill. Move the hone up and down in the cylinder approximately 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. Then when the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.
6. Check the diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90° angles.
7. When the cylinder is approximately 0.002 inch (.0508 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but as shown in Figure 56.
8. Clean the cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete. Do not use a solvent or gasoline since



AVOID THIS FINISH

PRODUCE CROSS HATCH SCRATCHES FOR FAST RING SEATING

FIGURE 56. CORRECT HONE FINISH

they wash the oil from the walls but leave the metal particles.

9. Dry the crankcase and coat it with oil.

Coat cylinder walls as soon as possible. After washing with soap and water, oxidation takes place and forms a fine layer of rust within minutes.

CAMSHAFT BEARINGS

The camshaft bearings should be replaced if the clearance to the camshaft is greater than specified, the bearings show cracks, breaks, burrs, excessive wear, or other defects. The camshaft to bearing clearance should be .0012 to .0037 inch (.0305 to .0940 mm). To check the rear bearing, remove the expansion plug at the rear of the crankcase.

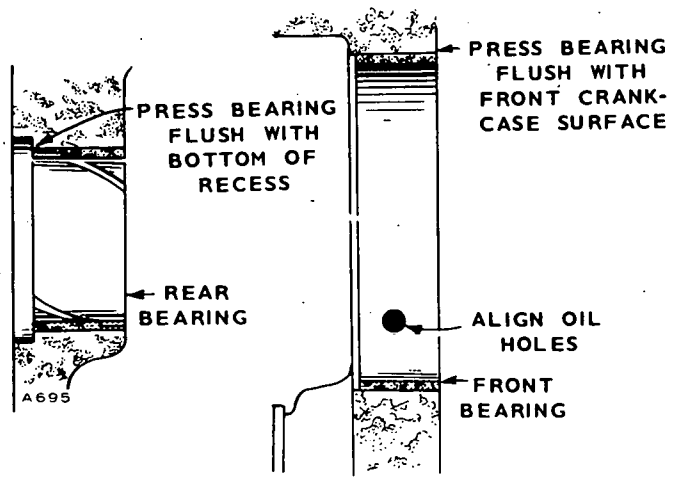


FIGURE 57. CAMSHAFT BEARINGS

Press new bearings into place (Figure 57). Press the rear bearing flush with the bottom of the expansion plug recess. Press the front bearing in flush with the crankcase front surface so the oil passages are aligned. Do not attempt to ream the bearings, they are a precision type. After the rear bearing is installed, insert a new expansion plug in the recess using sealing compound, and expand it into place with sharp blows at its center.

Installation, Camshaft Assembly:

1. Install the key and press the camshaft gear on its shaft.
2. Install the governor components.
3. Slide the thrust washer onto the shaft.
4. Lay the engine on side or end and insert the push rod tappets.
5. Install the camshaft assembly in the engine. Align the timing marks on the camshaft gear and crankshaft gear (Figure 59).
6. Replace the push rods and fuel transfer pump.
7. When the engine is reassembled, install the injection pump following the steps in *FUEL SYSTEM* section. This step is critical.

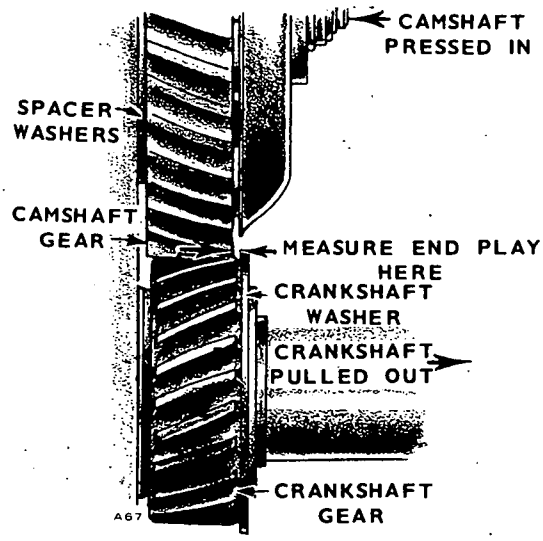


FIGURE 58. CAMSHAFT END PLAY

CRANKSHAFT, MAIN BEARINGS AND OIL SEALS

The DJB welder series of engines use a counter-balanced, ductile iron crankshaft. To increase the shaft's fatigue durability, all crankpin fillets are shot-peened during manufacturing. The 2-cylinder crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase and the rear one in the bearing plate.

Removal:

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off the crankshaft gear. It has two, 1/4-20 UNC tapped holes for attaching a gear pulling ring. Use care not to damage teeth if the gear is to be reused.
3. Remove the oil pan, piston, and connecting rod.

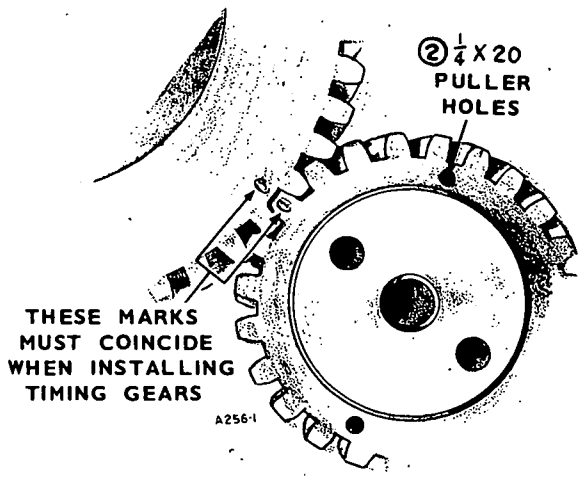


FIGURE 59. TIMING MARKS

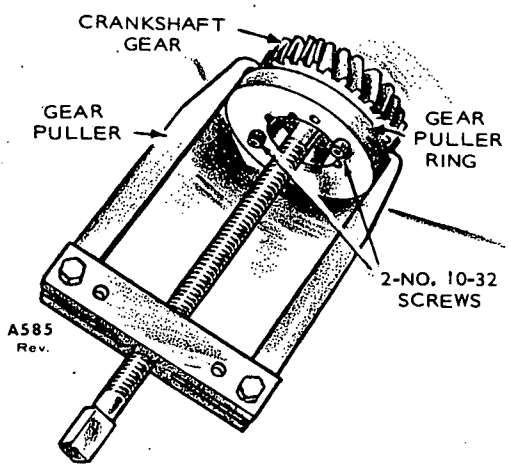


FIGURE 60. REMOVING CRANKSHAFT GEAR

4. Remove the rear bearing plate from the crankcase.
5. Remove the crankshaft from crankcase.

Inspection: Clean the crankshaft and blow out all oil passages. Check journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of the oil hole areas. Unusual conditions here often point to previous neglect of oil changes.

If journal dimensions are not within limits or the journals are scored, regrind the crankshaft.

Crankshaft Regrinding: Crankshaft grinding requires a trained, experienced operator with precision equipment.

Special procedures must be observed when reworking diesel crankshafts. In addition to machining, the crankshaft must be shot-peened and super-finished.

CAUTION **Failure to shot-peen crankshaft and crankpin fillets is likely to cause early failure.**

When the shaft is machined, follow this data and Figure 61 to shot-peen each crankpin fillet.

1. Almen gauge reading, .012-A.
2. Peen with .019 inch diameter cast steel shot.
3. Peen for 15 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

Undersize bearings and connecting rods are available to rework the shaft to .010, .020, and .030 inch undersize.

Main Bearings: Replace main bearings if clearances are greater than limits, bearings worn, grooved or broken (see *Installation of Crankshaft and Bearings*). Precision replacement bearing inserts and thrust washers are available for all main bearings. Do not ream the bearings.

Align the oil holes and press the new bearings into the front and rear housings.

Rear Oil Seal: The rear oil seal is in the rear bearing plate. If damaged, drive it out from the inside of the plate. Using the oil seal guide and driver tool, install a new seal with the rubber lip facing outward (open side of seal inward), Figure 57. Drive the new seal flush with the rear surface of the bearing plate. Leave the seal installer on during bearing plate installation to protect the oil seal.

Installation of Crankshaft and Bearings: After each installation step, check the crankshaft to be sure it is not frozen into place.

1. Press the front and rear main bearings into place, aligning the bearing and bearing housing oil holes. Do not attempt to drive a bearing into a cold block or rear bearing plate.

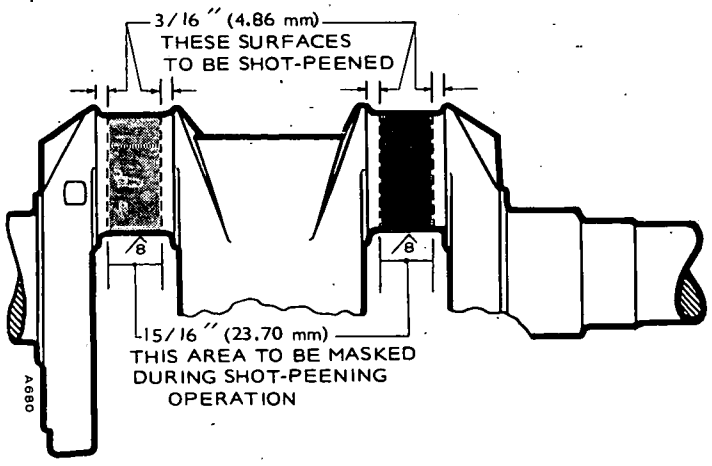


FIGURE 61. SHOT-PEENING CRANKSHAFT

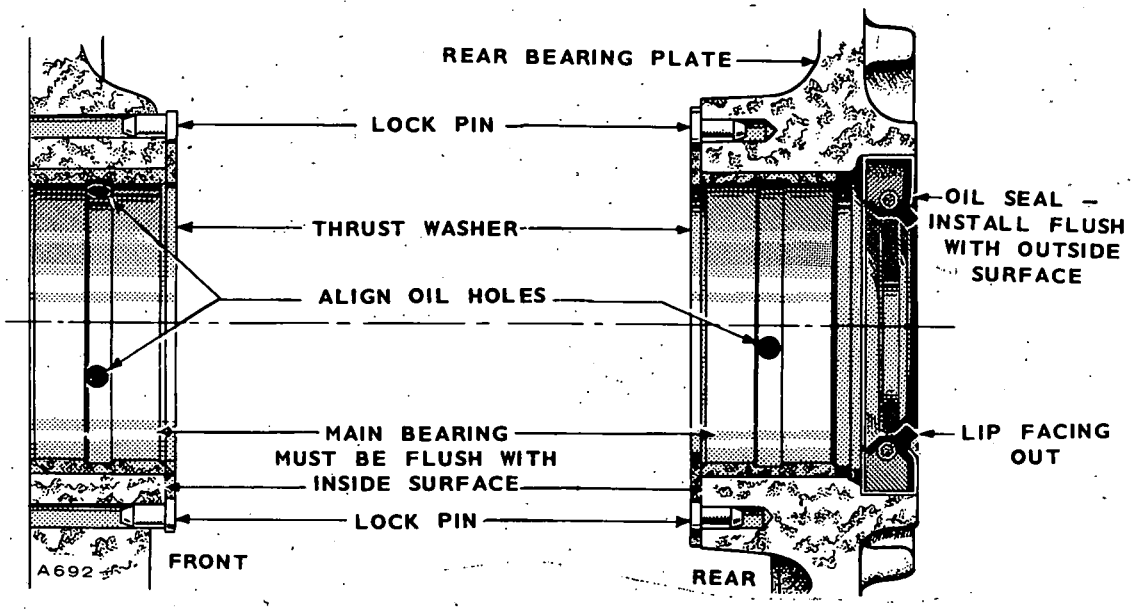


FIGURE 62. MAIN BEARING HOUSING

2. Install the thrust washers and locking pins.
3. Oil the bearing surfaces and install the crankshaft from the rear of the crankcase, through the rear bearing plate hole.
4. Mount and secure the rear bearing plate.
5. Heat the timing gear on an electric burner or oven to about 350° F (177° C). Install the key on the crankshaft, then drive the gear into place. Install the retaining washer and lock ring.
6. Check the crankshaft end play. Use enough rear bearing plate gaskets or shim and gaskets to provide .010 to .015 inch (.254 to .381 mm) end play. If gaskets of more than .015 inch (.381 mm) total thickness are required, then use a steel shim of proper thickness and a thin gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque.

See *Installation of Piston Assemblies* for installing pistons.

OIL PUMP

Mount the oil pump with the intake cup parallel with the bottom of the crankcase. Then install the oil base with a new gasket.

CRANKCASE

If the crankcase requires replacement, a new set of injection pump shims will be furnished with the new crankcase. These must be used, and in addition, the injection pump must be retimed to the engine.

GENERATOR

If a major generator repair should become necessary, have the equipment checked and repaired by a competent electrician who is thoroughly familiar with electric generating equipment. Continuity tests can be performed without disassembling the generator.

MAINTENANCE

The generator normally requires little care besides cleaning. However, give a periodic inspection (1000 hours) of the brushes, commutator and collector rings. If they require service, refer to the appropriate section following.

GENERATOR DISASSEMBLY

Disassembly procedure for the generator (Figure 63) is largely self evident and follows a natural sequence. Remove the cover band and the end bell cover. Remove all brush springs by pressing down on the spring holder and out as shown in Figure 64. Lift all the brushes from their guides.

Remove nuts from generator frame through studs. Tap end bell back until it is free of the armature bearing, then lift it off.

Provide blocking under the rear of the engine for support. Slots in engine-to-generator adapter provide for prying the generator frame loose. Pull the generator frame straight back over the armature using care not to let it catch or drag on the armature.

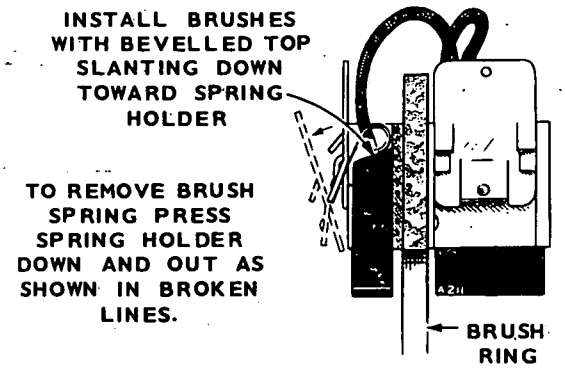
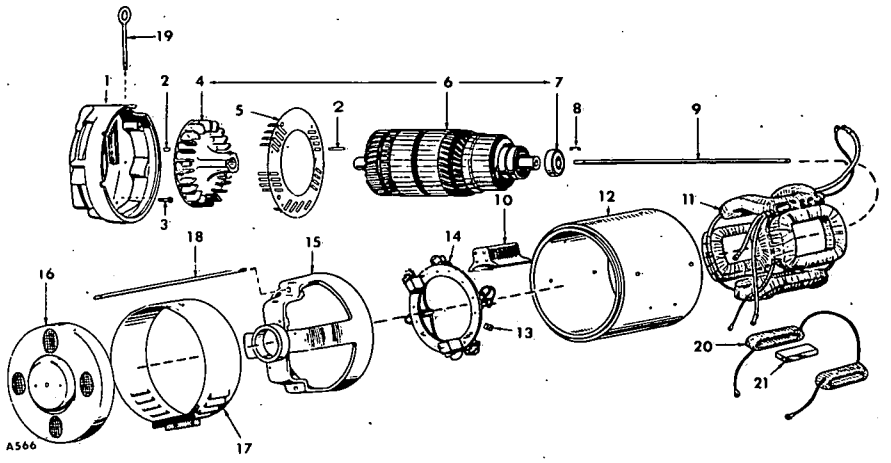


FIGURE 64. BRUSH, HOLDER & SPRING

Turn the armature nut out to the end of the armature through stud. While pulling outward with one hand under the armature, strike a sharp endwise blow on the nut to loosen the armature. Remove the armature and blower as an assembly. The blower is keyed and pressed onto the armature and is keyed with a tapered fit onto the engine crankshaft.

If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature half turn before



1- ADAPTER
2- KEY
3- SCREW
4- BLOWER
5- PLATE
6- ARMATURE ASSEMBLY
7- BEARING
8- CLIP
9- STUD
10- SHOE
11- COIL ASSEMBLY, FIELD
12- FRAME
13- CLIP
14- RIG ASSEMBLY
15- BELL
16- COVER
17- BAND
18- STUD
19- EYE
20- COIL SET, INTERPOLE
21- INTERPOLE

FIGURE 63. GENERATOR ASSEMBLY

repeating. Do not strike the commutator, collector rings or bearing.

BRUSHES AND SPRINGS

Inspect brushes periodically. Brushes worn to 5/8 inch (16 mm) should be replaced. Use replacement brushes specified in the parts list for this welder. Other brushes may look identical but have entirely different electrical characteristics. Replace springs if damaged or if proper tension is questionable. To remove the brush, press down on the spring holder and out (Figure 64). Then lift the brush from the guide. Spring tension for the DC brushes is 30 to 34 ounces (851 to 964 g) and for the AC brushes is 16 to 20 ounces (464 to 567 g). Always replace a brush spring if it's twisted, bent or broken.

CAUTION **Never bend the constant-pressure spring over the edge of its support.**

Rapid brush wear may be caused from high mica between commutator bars, rough commutator or collector rings or from a deviation from "neutral" position in the adjustment of the brush rig.

BRUSH RIG POSITION

Check the reference mark on the edge of the brush rig and if necessary align it with the boss in the end bell (Figure 65). If the brush rig is adjusted so that there is arcing of the brushes, brush wear will be rapid, voltage and current will not hold steady and the generator may overheat.

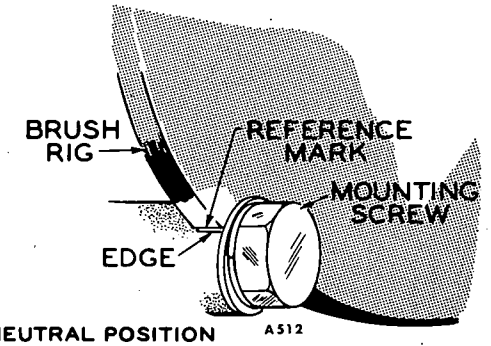
Whenever a new brush rig or armature is installed, the brush rig must be adjusted to the point where the brushes do not arc, regardless of where the witness mark falls. This is commonly known as the neutral brush position.

For determining neutral position, perform the following steps:

1. Attach a voltmeter (0 to 75) across the welding output terminals of the welder and start the welder. With no load, loosen the brush rig mounting screws and adjust the position of the brush rig until the higher voltage is obtained as indicated on the voltmeter. Tighten one brush rig screw and mark the brush rig with a pencil at a mounting screw boss.
2. Weld and note if sparking occurs at the brushes during welding. To correct, move the brush rig slightly in either direction (preferably with armature rotation) until sparking is no longer noticeable while welding.
3. After final setting is reached, make a permanent mark on the brush rig (Figure 65).

   The final adjustment will be a compromise between welding characteristics and sparking at the brushes.

4. Stop the welder and remove the voltmeter. Be sure all brush rig mounting screws have been tightened after final adjustment.



FOR PROPER NEUTRAL POSITION ALIGN YELLOW PAINT OR CHISEL REFERENCE MARK ON BRUSH RIG TO TOUCH EDGE OF END BELL NEAR BRUSH RIG MOUNTING SCREW.

FIGURE 65. BRUSH RIG NEUTRAL POSITION

Whenever a welding arc is struck, some sparking will occur at the brushes and is normal.

COLLECTOR RINGS

If collector rings become grooved or out-of-round, or the brush contact surface becomes pitted or rough so that good brush seating cannot be maintained, remove the armature and refinish the collector rings in a lathe. If the commutator appears to be rough or scored, refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

COMMUTATOR

The commutator gradually wears with use. If the proper brushes have been used, and they have been replaced at the proper intervals, this wear will be slow and even. Under dusty conditions or if improper brushes have been used, the wear may be accelerated. Improper or excessive cleaning with sandpaper may cause the commutator to become grooved or out-of-round. Refinish in a lathe.

TURNING COLLECTOR RINGS OR COMMUTATOR (Using a Lathe)

When a collector ring or commutator becomes grooved, worn out-of-round or pitted, it should be turned true on a lathe. This operation is easily performed by any qualified lathe operator. Remove the armature and center accurately on the lathe. Turn the commutator or collector ring enough to provide a pertectly true surface. Tool marks can be removed by using number 240 sandpaper.

After turning the slip rings, cut a slight chamfer on them to remove burrs and sharp edges. This reduces the possibility of a "flash over" between the rings. After turning the commutator, the mica insulation between the commutator bars must be undercut as described in the paragraph *Undercutting The Mica Insulation.*

Always install new brushes after servicing slip rings and commutator.

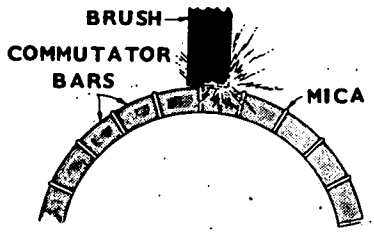


FIGURE 66. HIGH MICA CONDITION OF COMMUTATOR

UNDERCUTTING THE MICA INSULATION

When the commutator wears down so that the mica insulation between any bars comes in contact with the brushes, it will cause the brushes to "jump", spark, be noisy in operation and wear rapidly. Sparking brushes lower the efficiency of the generator and burn the commutator (Figure 66). When a "high mica" condition exists or after commutator has been turned on a lathe, mica insulation requires undercutting. A typical tool for this is shown in Figure 67.

To undercut the mica, center the cutting tool over the mica and with a firm, steady pull draw the tool the length of the commutator.

CAUTION **Be careful not to draw the undercutting tool into the slip rings.**

Repeat the cutting operation until the mica has been cut down to approximately 1/32 inch (.80 mm) below the surface of the commutator. As each section of mica is cut to the proper depth, proceed to the next one until all are equally undercut. If any burrs are present along the edges of the bars after the mica is undercut, carefully remove them. This is done by holding a piece of number 240 sandpaper against the commutator with a perfectly flat piece of wood while the commutator is turning rapidly. Before putting the armature back into service, be sure to blow or brush all mica dust, metallic particles, etc. from the commutator grooves and surface. The edges of the bars on the larger commutators should be beveled to assure a good edge.

TESTING WINDINGS

An ohmmeter and an armature growler are required for the various tests. Before making any tests, lift all brushes in their holders and disconnect the load circuit wires from the welder. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as required.

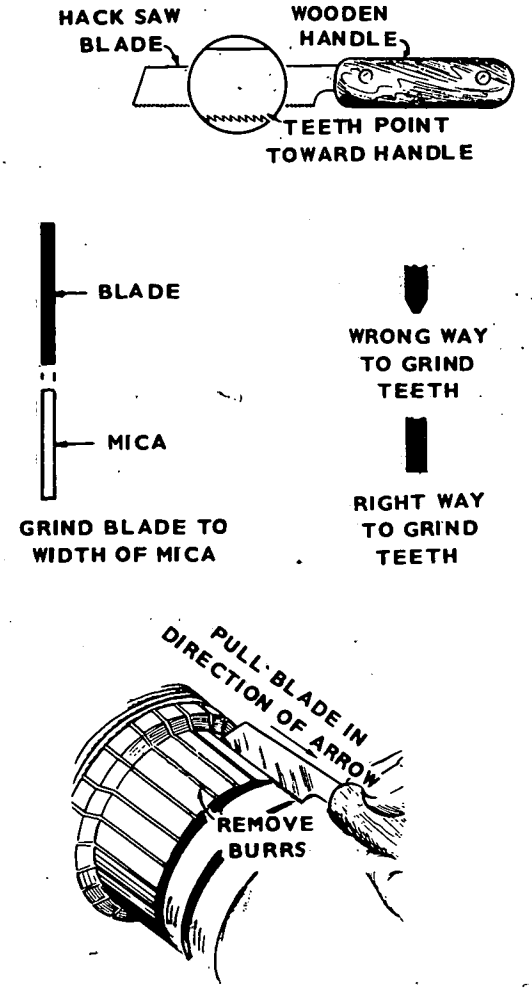


FIGURE 67. UNDERCUTTING COMMUTATOR MICA

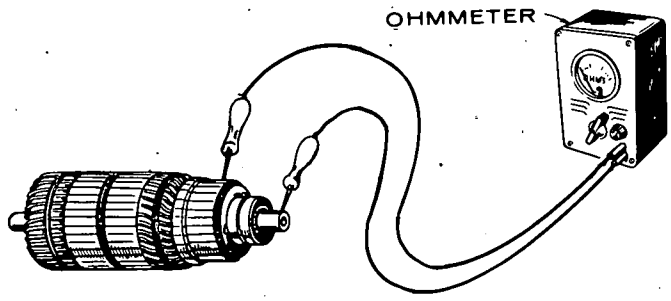
ARMATURE GROUND TEST

To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Using the ohmmeter, place one test prod on the commutator and the other test prod on a bare, clean part of the armature shaft (Figure 68). The test prods must make good electrical contact. If the ohmmeter shows continuity, the DC winding or commutator is grounded, replace the armature.

To test the AC winding, place one prod on one of the collector rings and the other prod on the armature shaft (Figure 69). If the ohmmeter indicates continuity, the AC winding or a collector ring is grounded. Replace armature.

ARMATURE OPEN CIRCUIT TEST

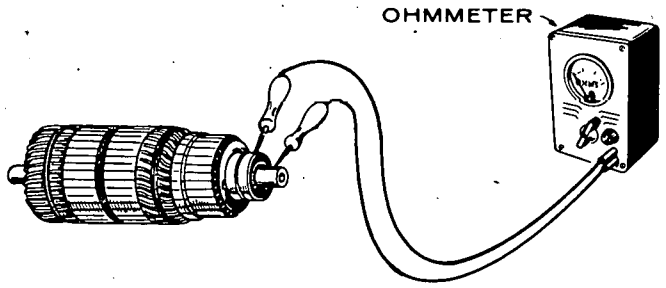
Armature AC windings may be tested for an open circuit without armature removal. Testing DC windings requires armature removal and the use of an armature growler.



ONE PROD ON COMMUTATOR, ONE PROD ON ARMATURE SHAFT.

FIGURE 68. ARMATURE DC GROUND TEST

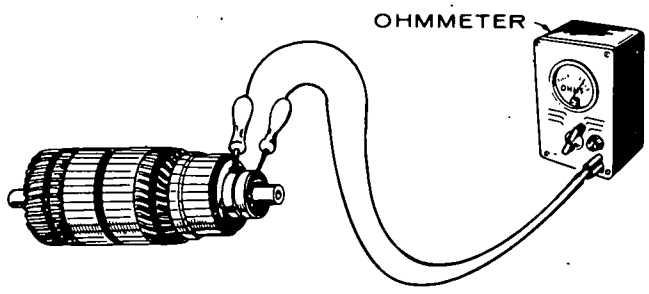
To test the AC winding, be sure all brushes are lifted or removed. Place one prod on each of the collector rings (Figure 70). If the ohmmeter indicates continuity, the AC winding is okay. If it doesn't, the AC winding is open and the armature should be replaced.



ONE PROD ON SLIP RING, ONE PROD ON ARMATURE SHAFT.

FIGURE 69. ARMATURE AC GROUND TEST

To test the DC winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments (Figure 71). Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. Replace an open circuited armature with a new one.



ONE PROD ON EACH SLIP RING.

FIGURE 70. ARMATURE AC OPEN TEST

A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph.

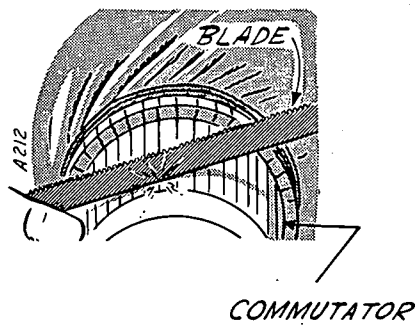


FIGURE 71. ARMATURE DC OPEN TEST

ARMATURE SHORT CIRCUIT TEST

To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2 inch (13 mm) above the armature laminations (Figure 72). Pass the strip back and forth

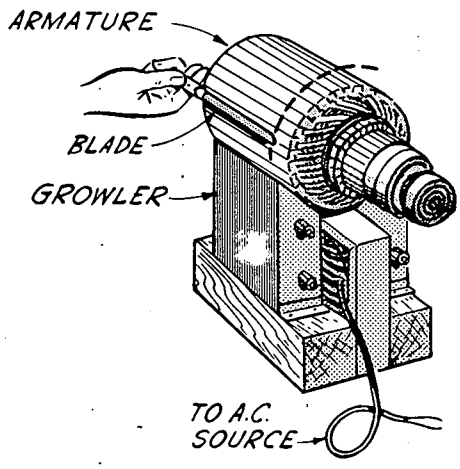


FIGURE 72. ARMATURE SHORT CIRCUIT TEST

over the laminations. Cover as much of the laminated area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

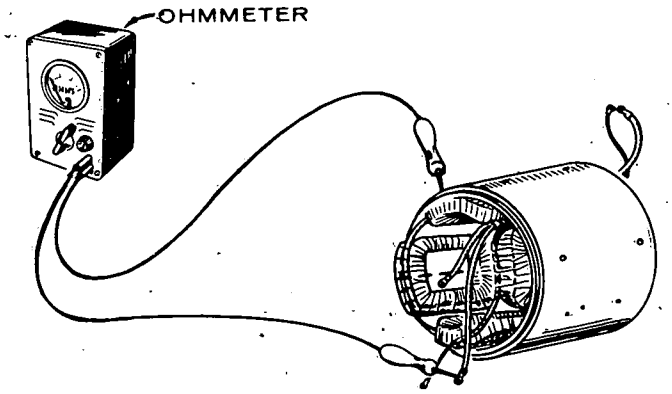


FIGURE 73. GROUND TEST FOR FIELD WINDINGS

TESTING FIELD WINDINGS FOR GROUNDS

To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. Continuity indicates the coil assembly is grounded (Figure 73). The ground may be in a coil, coil connection or coil lead. Repair or replace as required. Repeat procedure for each coil assembly.

TESTING FIELD WINDINGS FOR OPEN CIRCUIT

To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the terminal of one coil winding lead and the other test prod to each of the other leads of the coil winding in turn (Figure 74). If the ohmmeter indicates infinity, the field coil circuit is open. If the open circuit is caused by a connection between coils or in a coil lead, the trouble can be repaired. If it is inside the coil itself, the entire coil assembly must be replaced. Repeat the procedure for each coil assembly.

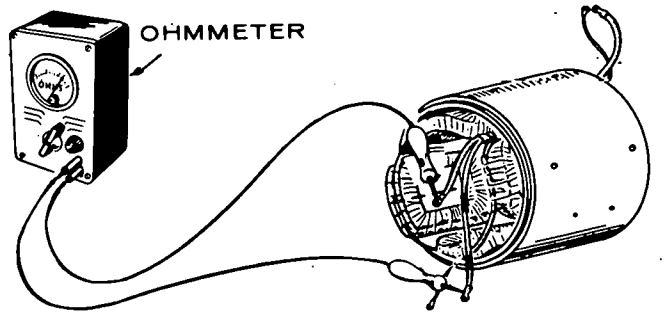


FIGURE 74. OPEN TEST FOR FIELD WINDINGS

BALL BEARING

If armature ball bearing replacement becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder of the shaft.

The bearing is prelubricated, double sealed and normally requires no service. However, when rebuilding the engine or generator, or if the bearing ever becomes noisy, replace it.

GENERATOR ASSEMBLY

1. Clean and inspect all mating surfaces. Surfaces should be free of nicks and dirt.
2. Coat mating area between the generator shaft and the engine crankshaft with a thin film of lubricating oil, Molykote or equal.
3. Assemble the armature through stud to the engine crankshaft with required torque.
4. Check to see that the key is in the crankshaft.
5. Slide armature over the through stud and onto the crankshaft being careful not to let the weight of the armature rest on the through stud.
6. Install baffle ring, when used.
7. Assemble generator through studs to the adapter with required torque.

   CAUTION **Do not tighten the armature or rotor through stud before mounting the frame and bearing support. If this procedure is not followed, misalignment may occur shortening the life of the rear main and outboard bearings. Also, cranking torque requirements could be doubled, resulting in damage to the commutator and DC brushes of the starter.**

8. Install the bearing support. Tighten frame to required torque.
9. Now torque down the armature through-stud nut. Because the frame and bearing support were tightened before tightening the armature, the armature and frame are aligned.
10. Tap the bearing support in the horizontal and vertical plane with a lead hammer to relieve stresses on the components and then recheck the torque.
11. Reconnect the wire leads to the engine.
12. Reinstall the battery cables.
13. Align the brush rig.

CONTROL

If any control equipment fails to function properly, replace the defective parts with a new part rather than try to repair the old part. Check all electrical connections and contacts whenever servicing control equipment.

When disassembling controls, tag each lead that is to be removed, and mark the lead connection point on the tag to assure correct connections when assembling.

WARNING **Always disconnect the battery (electric start units) whenever servicing controls to avoid accidentally starting the unit and causing personal injury.**

GENERATOR TROUBLESHOOTING

LOW OR NO AC OUTPUT

NATURE OF TROUBLE	CAUSE/REMEDY
Microswitch DC contacts stuck open	Replace microswitch
Poor brush contact	Brushes incorrectly installed (bevel must be toward spring holder).
	Brushes not well seated (operate under light load until seated).
	Brushes worn shorter than 5/8 inch (16 mm). Replace.
	Incorrect brush spring tension (see "BRUSHES AND SPRINGS").
	Incorrect brushes. Replace.
Brush shunt broken	Check brush shunts with an ohmmeter. Replace if necessary.
Loose connections at slip ring brush terminals	Check and tighten connections.
Slip rings shorting	Dirt, dust, grease or oil shorting out rings. Clean with suitable solvent.
Open circuit, short circuit or ground in generator	Make generator tests per text.
Faulty AC load and/or connections	Open or short load circuit. Check load and connections.
Blown control panel fuse (Canadian models)	Check fuses and replace as needed.

AC OUTPUT WHEN WELDING

NATURE OF TROUBLE	CAUSE/REMEDY
Microswitch AC contacts stuck closed	Replace.

GENERATOR OVERHEATING

NATURE OF TROUBLE	CAUSE/REMEDY
Welding operation too long without correct periods of no-weld operation	Follow duty cycles recommended in *OPERATION* section.
Poor generator ventilation	Obstructed generator inlet or outlet. Clean.
	Generator dirty. Clean with low pressure, 35 psi (242 kPa) or less, compressed air.
Arcing brushes during normal operation	See troubleshooting "Excessive arcing of brushes."

LOW OR NO DC WELDING OUTPUT

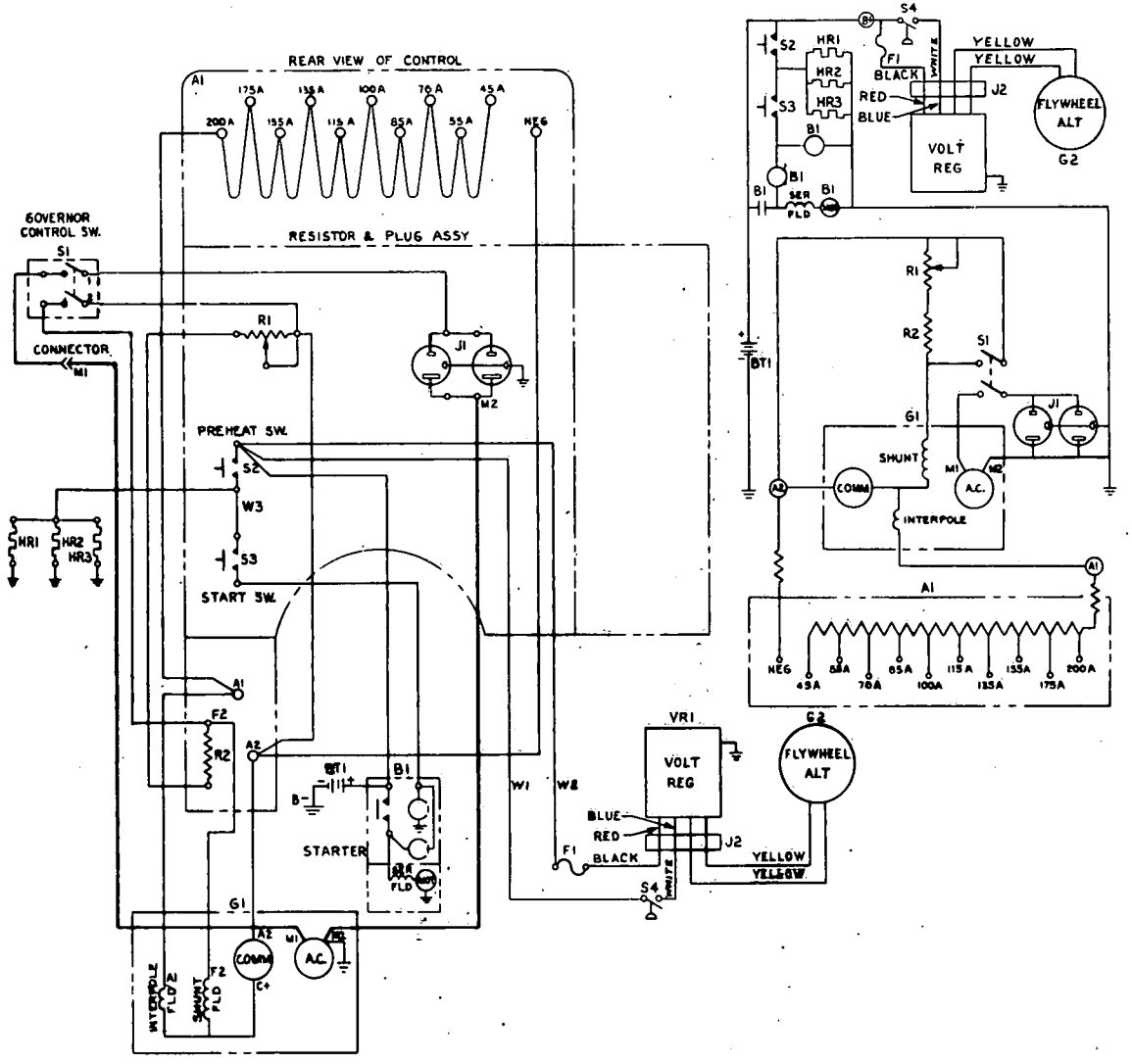
NATURE OF TROUBLE	CAUSE/REMEDY
Poor brush contact	Brushes incorrectly installed (bevel must be toward spring holder).
	Brushes not well seated (operate under light load until seated).
	Brushes worn shorter than 5/8 inch (16 mm). Replace.
	Incorrect brush spring tension (see "BRUSHES AND SPRINGS").
	Incorrect brushes. Replace.
Broken brush leads	Check brush shunts with an ohmmeter and replace defective brushes and leads.
Loose connections at brush terminals	Check and tighten connections.
Insulating film or commutator	Clean with sandpaper, commutator stone and blow out dust. Do not use emery cloth.
Brush rig not in neutral position	Reposition as described in "BRUSH RIG POSITION."
Open circuit in rheostat	Check rheostat with ohmmeter and repair or replace.
DC open, short or ground in generator	Make DC generator tests per text.

NOISY BRUSHES

NATURE OF TROUBLE	CAUSE/REMEDY
Brushes incorrectly installed	Brushes reversed in holder (bevel must be toward spring holder).
Incorrect brush spring tension	See "BRUSHES AND SPRINGS."
DC brushes arcing from high mica	Undercut mica. Follow procedures under "UNDERCUTTING MICA INSULATION."

EXCESSIVE ARCING OF BRUSHES

NATURE OF TROUBLE	CAUSE/REMEDY
Brushes not seated properly	Operate welder at reduced load until seated
Dirty commutator or slip rings	Clean with low pressure (35 psi (242 kPa) or less). filtered, compressed air or with lint-free cloth.
Brush rig out of neutral position	See "BRUSH RIG POSITION."
Rough commutator or slip rings	Turn down with a lathe. Refer to "TURNING COLLECTOR RINGS OR COMMUTATOR."
Open circuit in armature	Make test per text. Replace if open.

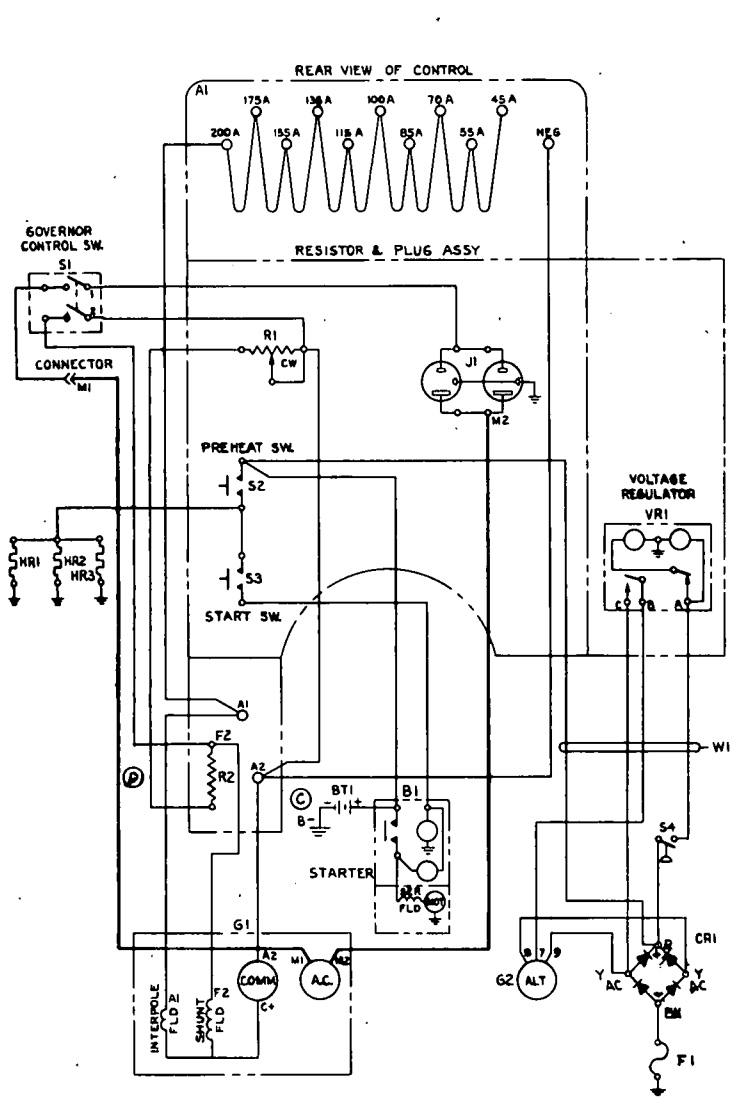


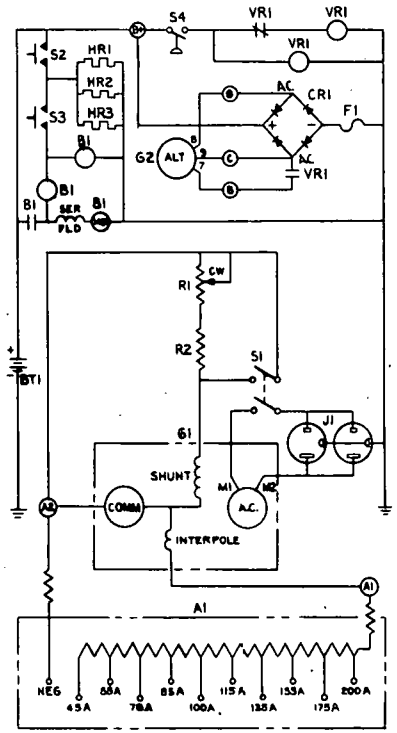
PARTS LIST	
REF. DES.	DESCRIPTION
A1	Resistor & Plug Assy
B1	Starter & Solenoid
BT1	Battery, 12-V.
F1	Fuse, 30 A.
G1	Generator
G2	Alternator-Flywheel
HR1,3	Plug - Glow
HR2	Heater Manifold
*J1	Receptacle - Duplex
J2	Connector
R1	Rheostat, 3.5 Ohm, 100 W
R2	Resistor Corrib, 5.5 Ohm, 160 W
S1	Switch, Gov. Control
S2	Switch, Preheat
S3	Switch, Start
S4	Switch, Low Oil Press
VR1	Voltage Regulator
W1	Lead Assy
W2	Lead Assy

* - *120-Volt Receptacle Shown*

TYPICAL 120/240 VOLT MODELS
SPEC T

6.0DJB-331E
6.0DJB-5331E
6.0DJB-332E
6.0DJB-5332E



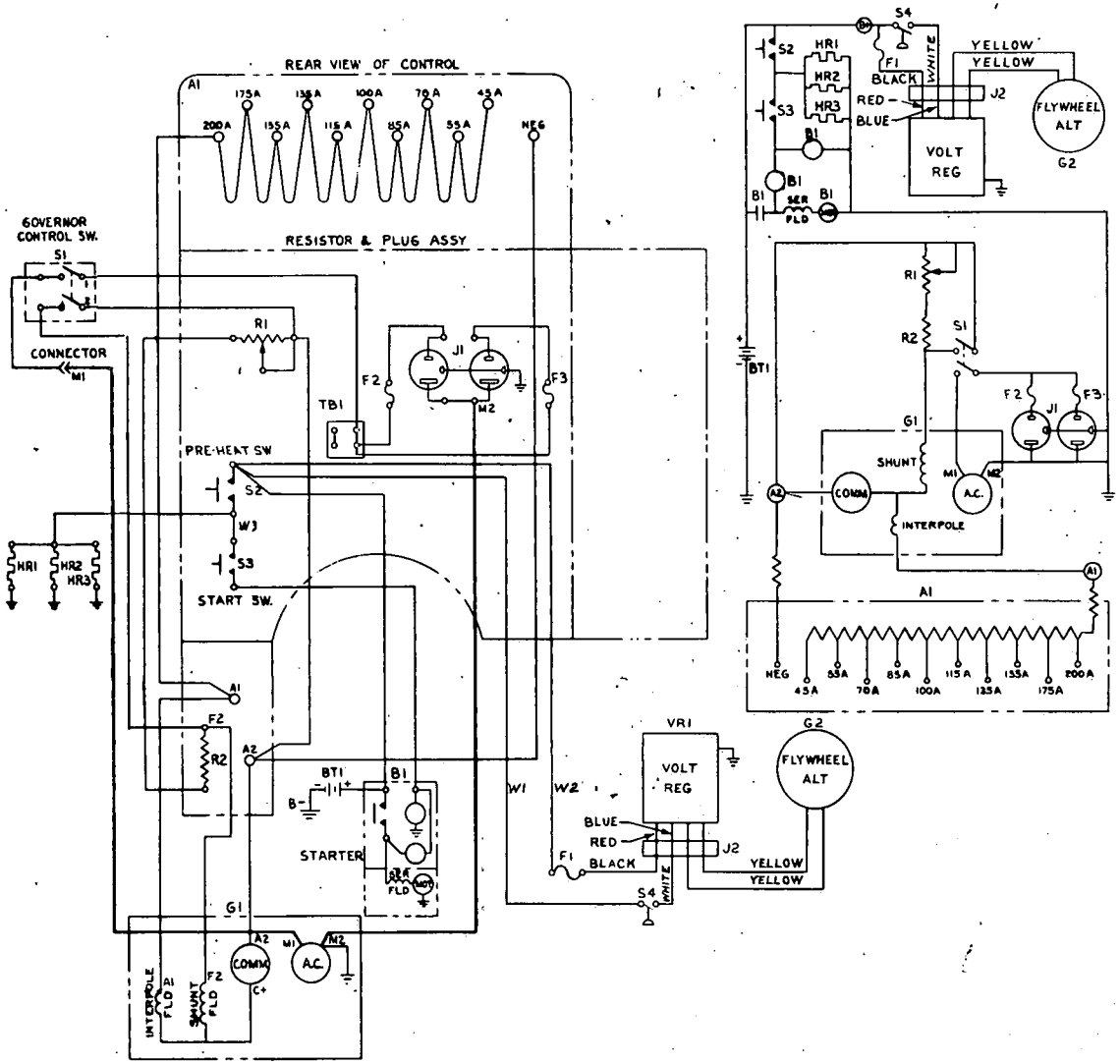


PARTS LIST	
REF. DES.	**DESCRIPTION**
A1	Resistor & Plug Assy
B1	Starter & Solenoid
BT1	Battery, 12 V.
CR1	Rectifier - Bridge
F1	Fuse, 20 A.
G1	Generator
G2	Alternator - Flywheel
HR1,3	Plug - Glow
HR2	Heater - Manifold
*J1	Receptacle - Duplex
R1	Rheostat, 3.5 Ohm, 100 W.
R2	Resistor Corrib, 5.5 Ohm, 160 W.
S1	Switch, Gov. Control
S2	Switch, Preheat
S3	Switch, Start
S4	Switch, Low Oil Press
VR1	Voltage Regulator
W1	Harness - Voltage Regulator

* - 120-Volt Receptacle Shown

TYPICAL 120/240 VOLT MODELS
PRIOR TO SPEC T

6.0DJB-331E
6.0DJB-5331E
6.0DJB-332E
6.0DJB-5332E



PARTS LIST	
REF. DES.	**DESCRIPTION**
A1	Resistor & Plug Assy
B1	Starter & Solenoid
BT1	Battery, 12 V
F1	Fuse, 30 A.
F2, 3	Fuse, 15 A.
G1	Generator
G2	Alternator - Flywheel
HR1,3	Plug - Glow
HR2	Heater - Manifold
*J1	Receptacle - Duplex
J2	Connector
R1	Rheostat - Lead Assy
R2	Resistor Assy
S1	Switch - Gov. Control
S2	Switch Pre-Heat
S3	Switch - Start
S4	Switch, Low Oil Press
TB1	Terminal Block
VR1	Volt Regulator
W1	Lead Assy
W2	Lead Assy
W3	Jumper - Solenoid S2 - S3

* - 120-Volt Receptacle Shown

6.0DJB-331E38
6.0DJB-5331E38
6.0DJB-332E38
6.0DJB-5332E38

TYPICAL 120/240 VOLT CANADIAN MODELS

PARTS CATALOG
INDEX

INTRODUCTION

This catalog applies to the standard 200 ampere DJB Welder. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number in the parts list for that group. Parts illustrations are typical. Using the *Model* and *Spec No.* from the nameplate, select parts from this catalog that apply to your welder. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left sides are determined by facing the engine end (front) of the welder.

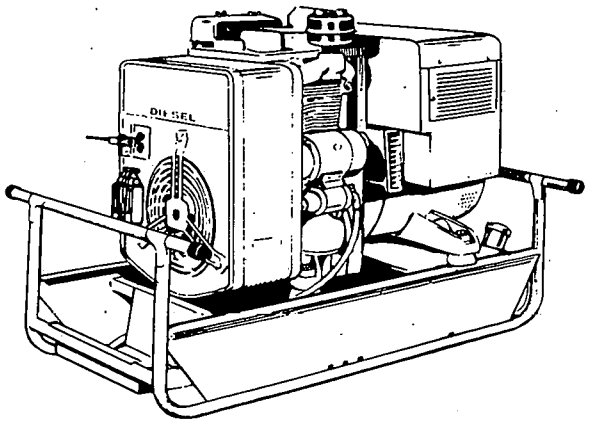
WELDER DATA TABLE

MODEL & SPEC £	ELECTRICAL DATA					
	DC OUTPUT			AC OUTPUT		
	AMPS	VOLTS	DUTY CYCLE	WATTS	VOLTS	HERTZ
6.0DJB-331E/*	200	28	50%	3500	120	60
6.0DJB-332E/*	200	28	50%	3500	240	60
6.0DJB-5331E/*	200	28	50%	2500	120	50
6.0DJB-5332E/*	200	28	50%	2500	240	50

* - The Specification Letter advances (R to S, S to T, etc.) with manufacturing changes.

£ - New model designations shown, began during 1969. Previous designations did not use a decimal in the kW rating. EXAMPLE: 6.0DJB was formerly 6DJB.

NOTE: Hertz is a unit of frequency equal to one cycle per second.

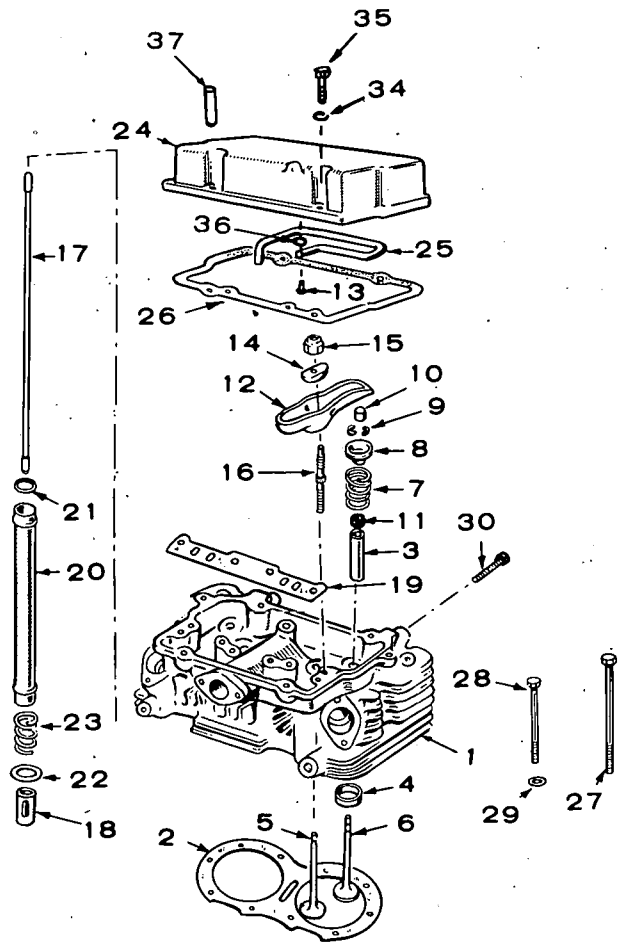


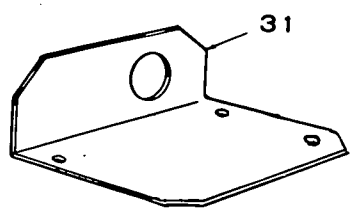
NOTICE!

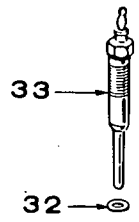
ITEMS REFERENCED AS **OPTIONAL** INDICATE PART IS FACTORY INSTALLED AND MAY NOT BE APPLICABLE TO ALL MODELS. FOR FIELD CONVERSIONS ADDITIONAL PARTS ARE USUALLY REQUIRED.

CYLINDER HEAD, VALVE AND ROCKER

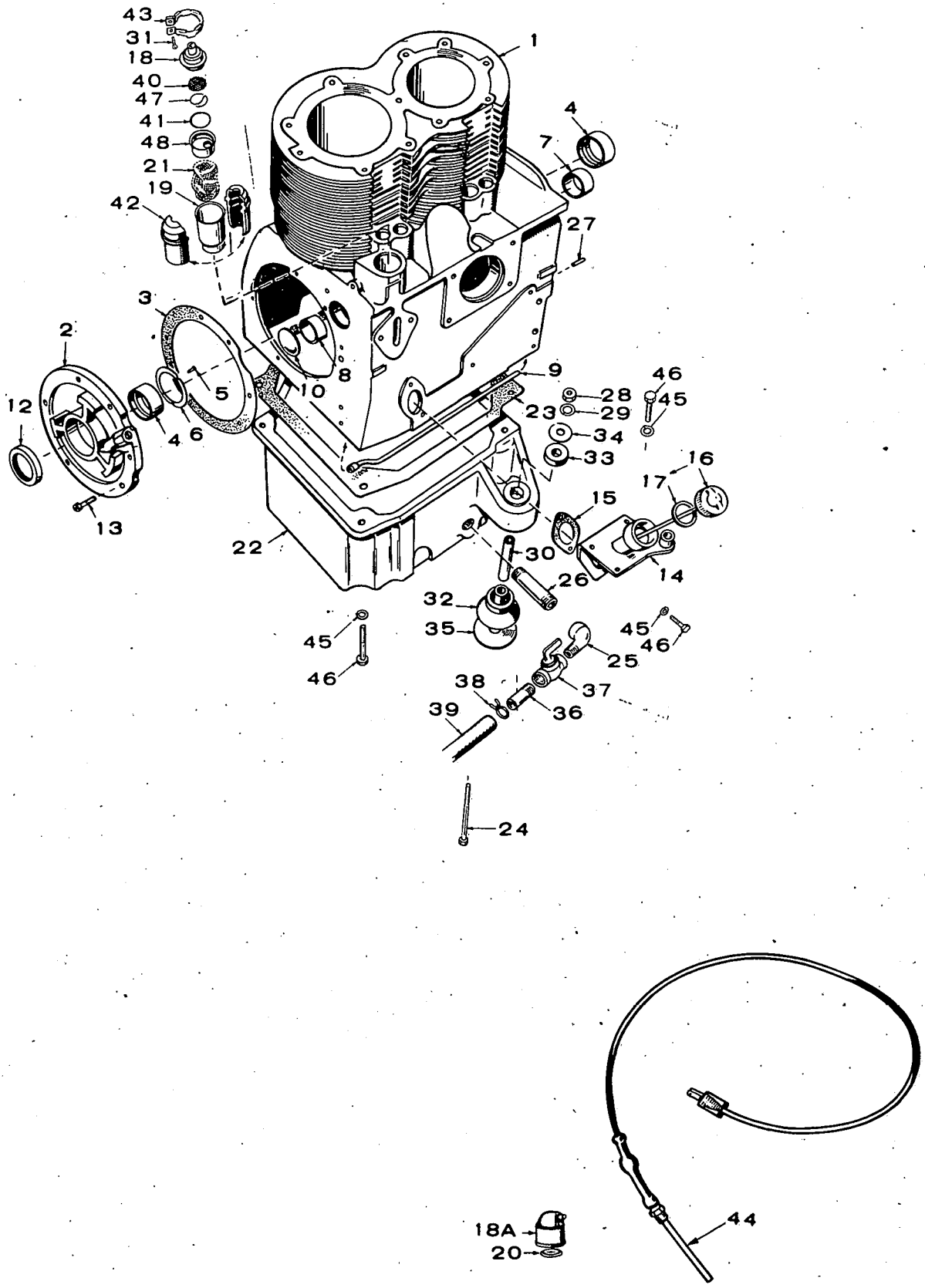
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	110-1546	1	Head, Cylinder
2	110-1223	1	Gasket, Head
3	GUIDE, VALVE		
	110-1501	4	Standard
	110-1501-01	4	.001" Oversize
4	INSERT, VALVE SEAT (Intake & Exhaust)		
	110-1268	4	Standard
	110-1268-02	4	.002" Oversize
	110-1268-05	4	.005" Oversize
	110-1268-10	4	.010" Oversize
	110-1268-25	4	.025" Oversize
5	110-1320	2	Valve, Intake
6	110-1278	2	Valve, Exhaust, Stellite
7	110-1221	4	Spring, Valve
8	110-1220	4	Retainer, Valve Spring
9	110-0858	8	Lock, Valve Spring Retainer
10	110-0859	4	Cap, Valve Stem
11	509-0090	2	Seal, Oil, Intake Valve - Includes Retaining Rings
12	ARM, ROCKER		
	115-0128	2	Exhaust
	115-0129	2	Intake
13	809-0042	1	Screw, Oil Line, Rocker Cover
14	115-0127	4	Ball, Rocker Arm
15	115-0150	4	Nut, Lock - Rocker Arm
16	115-0152	4	Stud, Rocker Arm
17	115-0149	4	Rod, Valve Push (Steel)
18	115-0195	4	Tappet, Valve
19	115-0196	1	Guide, Push Rod
20	115-0151	4	Shield, Push Rod
21	509-0084	8	Seal, Push Rod Shield
22	115-0155	8	Washer, Spring Retaining
23	115-0146	4	Spring, Shield Retainer
24	115-0197	1	Cover, Rocker
25	120-0628	1	Line, Oil, Rocker Cover
26	115-0130	1	Gasket, Rocker Cover
27	110-1264	5	Screw (3/8-16 x 4-1/4") Cylinder Head Mounting
28	800-0503	6	Screw (3/8-16 x 1-3/4") Cylinder Head Mounting
29	526-0174	5	Washer, Cylinder Head
30	114-0022	4	Screw, Exhaust Manifold
31	403-0707	1	Bracket, Lifting (Includes Hardware)
32	110-0546	2	Gasket, Glow Plug
33	333-0106	2	Plug, Glow (12 Volt) - Includes Gasket
34	WASHER, LOCK		
34	850-0045	4	5/16" Rocker Cover and Lifting Bracket Mounting
	850-0060	1	1/2" - Lifting Bracket Mounting
35	SCREW, ROCKER COVER AND LIFTING BRACKET MOUNTING		
	800-0038	2	5/16-18 x 3-1/4"
	800-0030	2	5/16-18 x 1-1/4"
	800-0091	1	1/2-13 x 1-1/4"
36	526-0130	1	Washer, Flat
37	403-0826	2	Spacer, Lifting Bracket







CRANKCASE AND OIL BASE

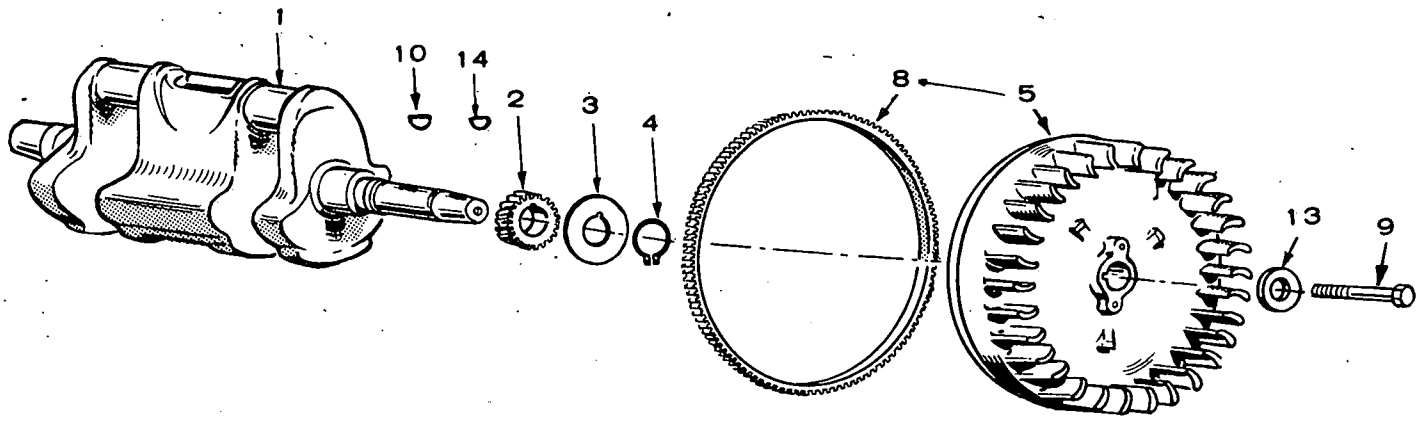


CRANKCASE AND OIL BASE

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	110-1330	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	101-0337	1	*Plate, Bearing (Less Bearing & Pins)
3	101-0386	1	*Gasket Kit, Bearing Plate (Includes Steel Shims)
4	BEARING, PRECISION MAIN		
	101-0359	2	*Standard
	101-0359-02	2	.002" Undersize
	101-0359-10	2	.010" Undersize
	101-0359-20	2	.020" Undersize
	101-0359-30	2	.030" Undersize
5	516-0072	4	*Pin, Thrust Washer
6	104-0420	2	*Washer, Crankshaft Thrust
7	101-0363	1	*Bearing, Precision Camshaft Front, Standard Only
8	101-0365	1	*Bearing, Precision Camshaft Rear, Standard Only
9	120-0553	1	*Tube, Crankcase Oil
10	517-0053	1	*Plug, Camshaft Opening
12	509-0086	1	*Seal, Crankshaft Rear
13	805-0019	6	*Bolt, Place, Plate (3/8-16 x 1-1/4)
14	TUBE, OIL FILL		
	123-0681	1	Spec R Only
	123-1085	1	Begin Spec S
15	123-0667	1	Gasket, Oil Fill Tube
16	CAP AND INDICATOR		
	123-0651	1	Spec R Only
	123-1058	1	Begin Spec S
17	123-0191	1	Gasket, Cap
18	123-0954	1	Cap & Valve Assembly, Breather - Begin Spec S
18A	123-0787	1	Cap, Breather - Spec R Only
19	TUBE, BREATHER		
	123-0645	1	Spec R Only
	123-0952	1	Begin Spec S
20	123-0315	1	Valve, Breather - Spec R Only
21	123-0865	1	Baffle, Breather
22	102-0540	1	Base, Oil
23	102-0451	1	Gasket, Base
24	800-0082	2	+Screw (7/16-14 x 3-3/4")-Cushion Mounting - Engine End
25	505-0050	1	Elbow, Street (1/2" x 90°)
26	505-0078	1	Nipple (1/2" x 2-1/2")
27	516-0141	2	*Pin, Dowel, Gear Cover Locating
28	862-0004	4	+Nut (7/16 x 14)
29	850-0055	4	+Washer, Lock (7/16)
30	402-0290	4	+Bushing, Spacer, Vibration Mount
31	809-0035	1	Screw, Breather Clamp - Begin Spec S
32	CUSHION, VIBRATION, CONE-SHAPED		
	402-0284	2	Engine End
	402-0285	2	Generator End
33	402-0282	4	+Snubber, Shock Mounting
34	526-0014	4	+Washer (29/64" I.D. x 1-1/2" O.D. x 1/8")
35	526-0199	As Req.	+Washer (29/64" I.D. x 3-1/4" O.D. x 1/8")
36	505-0100	1	Nipple, Oil Drain
37	504-0011	1	Valve, Oil Drain
38	503-0197	1	Clamp, Oil Drain
39	503-0564	1	Hose, Oil Drain
40	123-1202	1	Screen, Breather Tube - Begin Spec S
41	509-0117	1	Seal, "O" Ring, Breather Tube - Begin Spec S
42	123-0998	2	Insulator Halves, Breather Tube - Begin Spec S
43	518-0268	1	Clamp, Breather Tube Insulator Halves - Begin Spec S
44	102-0558	1	Heater, Oil Base (Optional)
45	WASHER, LOCK		
	850-0055	4	Oil Base Mounting (7/16")
	850-0045	2	Oil Fill Tube Mounting (5/16")
	850-0045	3	Fuel Filter Adapter Mounting (5/16")
46	SCREW		
	800-0072	4	Oil Base Mounting (7/16-14 x 1-1/4")
	800-0026	2	Oil Fill Mounting (5/16-18 x 3/4")
	821-0016	3	Fuel Filter Adapter to Oil Fill Tube (5/16-18 x 3/4")
	402-0355	1	Hardware Package, Mounting (Includes Parts Marked +)
47	123-1201	1	Retainer, Breather Screen - Begin Spec S
48	123-1153	1	Baffle Cup, Breather - Begin Spec S

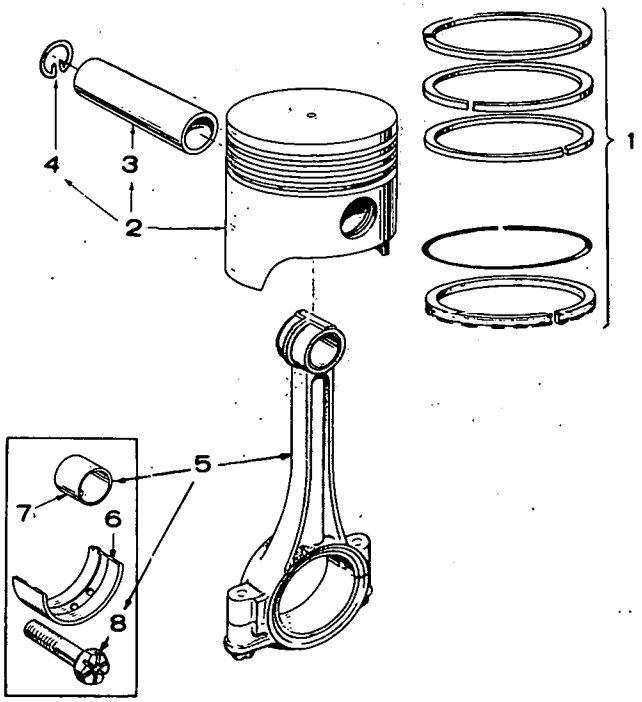
* - Included in Cylinder Block Assembly.
+ - Included in Mounting Hardware Package.

CRANKSHAFT AND FLYWHEEL



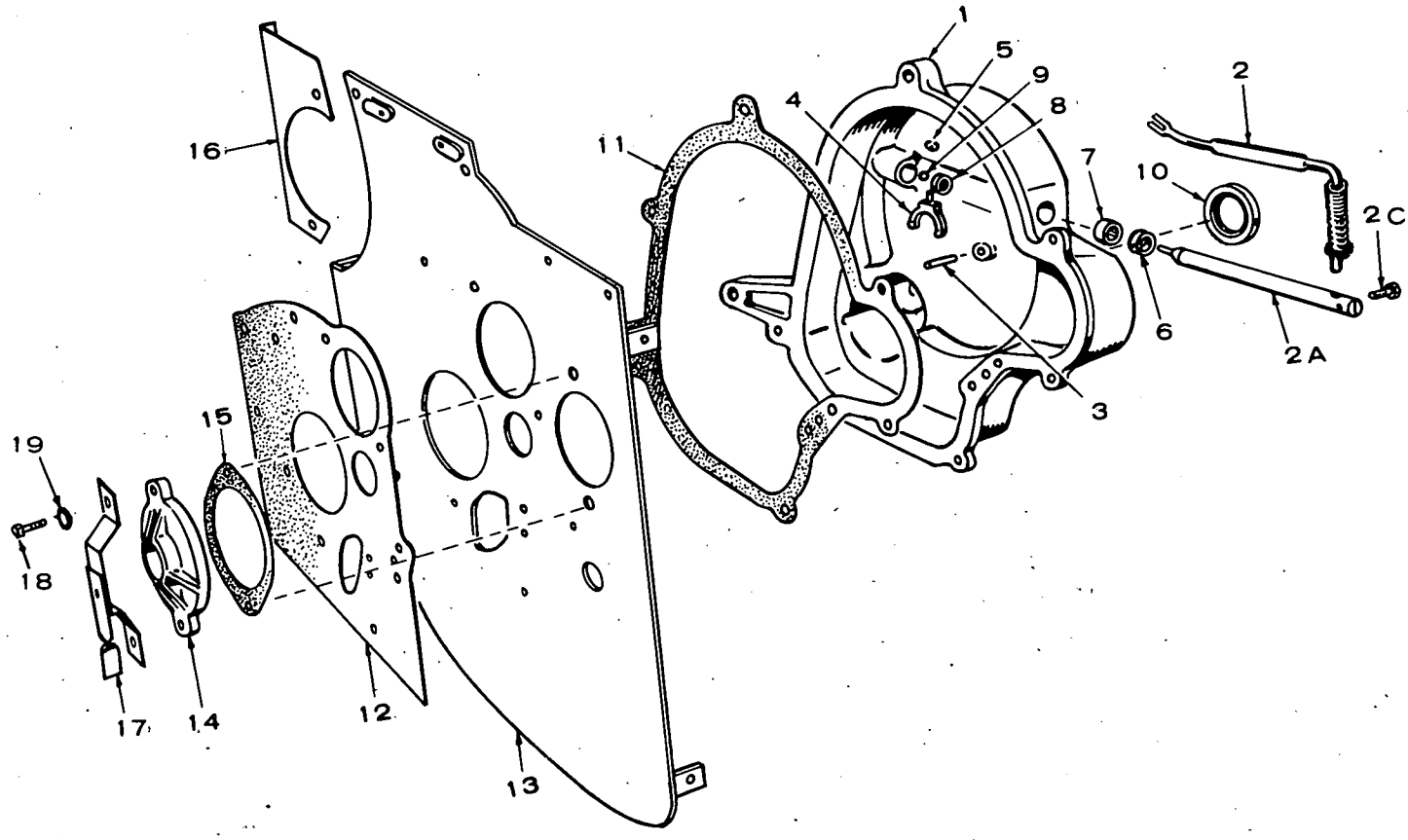
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	104-0451	1	Crankshaft
2	104-0418	1	Gear
3	104-0416	1	Washer, Retainer
4	518-0188	1	Ring, Lock
5	191-0408	1	Flywheel (Includes Ring Gear)
8	104-0423	1	Gear, Ring
9	800-0500	1	Screw (7/16-14 x 5-1/2")-Flywheel
10	515-0001	1	Key, Gear
13	526-0185	1	Washer, Flywheel
14	515-0153	1	Key, Flywheel to Crankshaft

PISTON AND ROD



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	RING SET, PISTON		
	113-0130	2	Standard
	113-0130-05	2	.005" Oversize
	113-0130-10	2	.010" Oversize
	113-0130-20	2	.020" Oversize
	113-0130-30	2	.030" Oversize
	113-0130-40	2	.040" Oversize
2	PISTON & PIN (Includes Pin Retaining Rings)		
	112-0109	2	Standard
	112-0109-05	2	.005" Oversize
	112-0109-10	2	.010" Oversize
	112-0109-20	2	.020" Oversize
	112-0109-30	2	.030" Oversize
	112-0109-40	2	.040" Oversize
3	PIN, PISTON		
	112-0093	2	Standard
	112-0093-02	2	.002" Oversize
4	112-0085	4	Ring, Retaining, Pin
5	114-0168	2	Rod Assembly, Connecting
6	BEARING HALF, CONNECTING ROD		
	114-0164	4	Standard
	114-0164-02	4	.002" Undersize
	114-0164-10	4	.010" Undersize
	114-0164-20	4	.020" Undersize
	114-0164-30	4	.030" Undersize
7	114-0170	4	Bushing, Piston Pin, Connecting Rod, Semi-Finished
8	805-0012	4	Bolt (5/16-24 x 1-13/16")

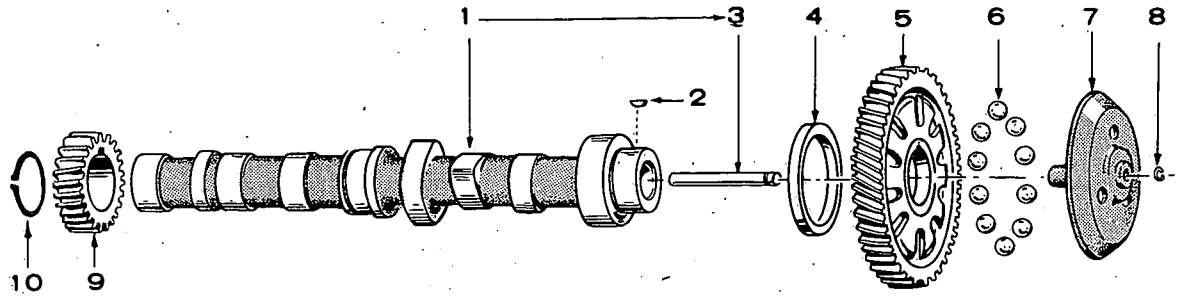
GEARCASE



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	COVER ASSEMBLY, GEAR (Includes Parts Marked *)		
	103-0277	1	Prior to Spec T
	103-0366	1	Begin Spec T
2	150-1095	1	Arm, Governor
2A	150-0838	1	*Shaft, Governor
2C	815-0176	1	*Screw (8-32 x 1/2")
3	516-0111	1	*Pin, Roll, Governor Cup Stop
4	150-0777	1	*Yoke, Governor
5	518-0129	1	*Ring, Yoke
6	509-0088	1	*Seal, Oil
7	510-0048	1	*Bearing (1/2") - Governor Shaft
8	510-0082	1	*Bearing (1/4") - Governor Shaft
9	510-0043	1	*Ball, Bearing, Governor Shaft Thrust
10	509-0087	1	*Seal, Oil
11	103-0251	1	Gasket, Gear Cover
12	103-0218	1	Gasket, Backplate
13	103-0271	1	Backplate
14	103-0221	1	Cover, Backplate Opening
15	160-0721	1	Gasket, Backplate Opening Cover
16	134-1532	1	Baffle, Backplate
17	147-0236	1	Arm and Bracket Assembly, Manual Stop
18	800-0051	2	Screw, Hex Head - 3/8-16 x 1-1/4"
19	850-0050	2	Lockwasher (3/8)

* - Parts Included in Gear Cover Assembly.

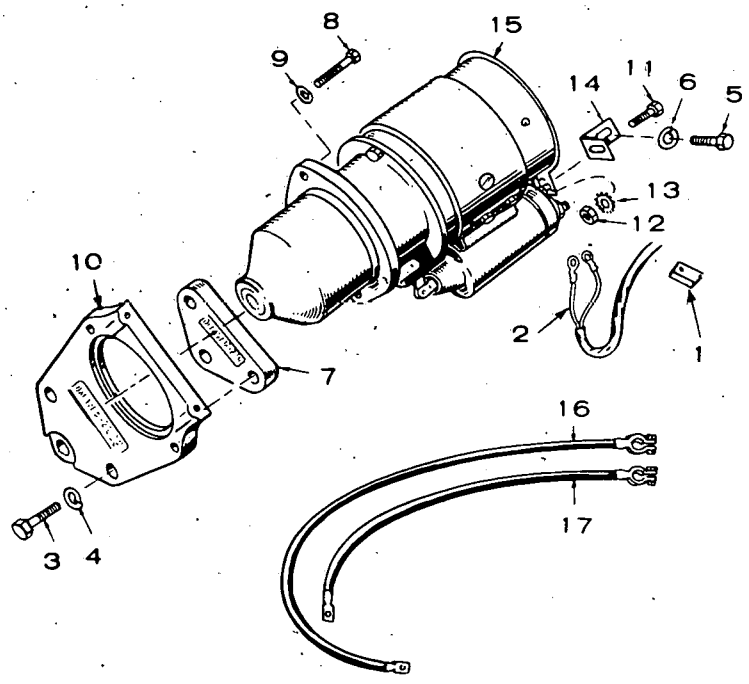
CAMSHAFT



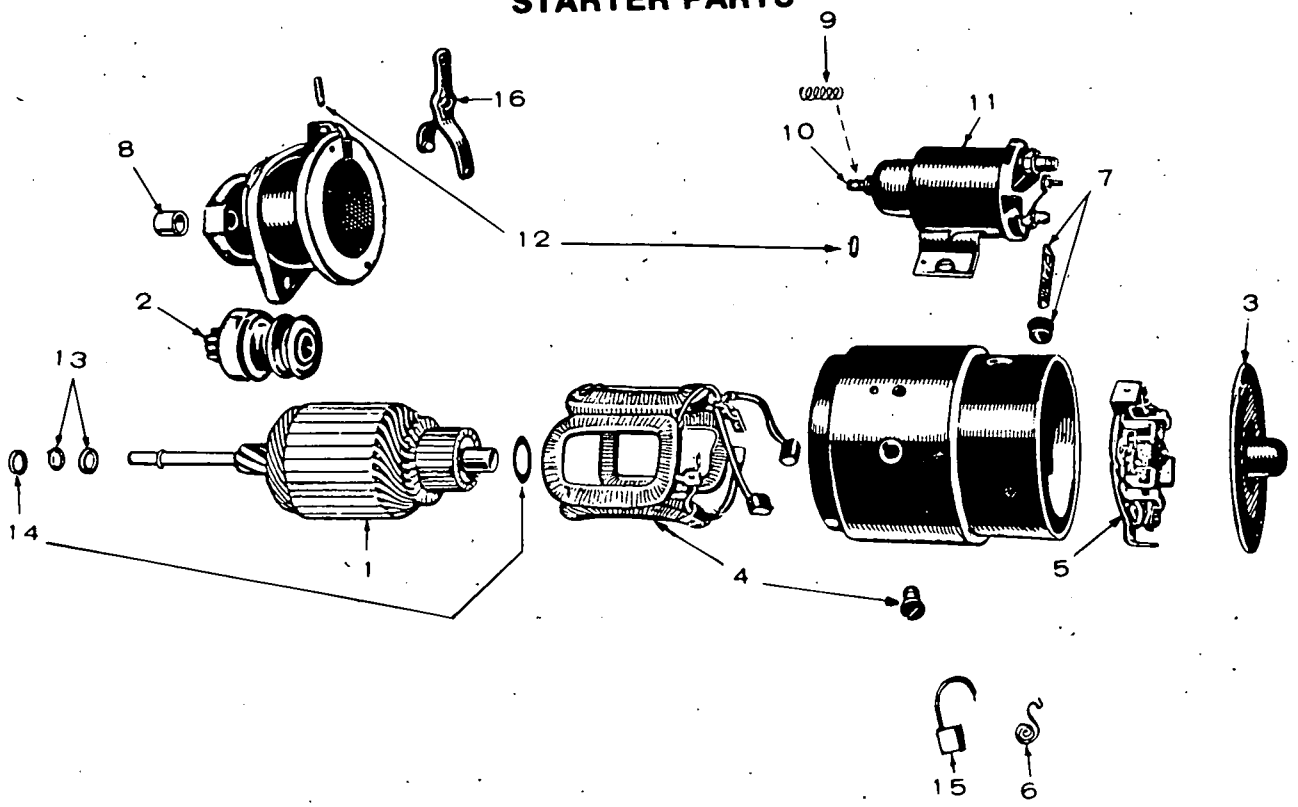
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	105-0271	1	Camshaft (Includes Center Pin)
2	515-0001	2	Key, Camshaft Gear or Distributor Gear
3	150-0075	1	Pin, Center
4	105-0205	1	Washer, Thrust
5	105-0218	1	Gear (Includes Flyball Spacer & Plate)
6	BALL, FLY-GOVERNOR		
	510-0046	5	Spec R Only
	510-0046	10	Begin Spec S
7	150-0775	1	Cup, Governor
8	150-0078	1	Ring, Snap, Center Pin
9	147-0142	1	Gear, Injection Pump Drive
10	518-0195	1	Ring, Snap, Injection Pump Drive Gear

STARTER

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	416-0096	1	Clamp, Cable
2	338-0279	1	Harness, Wiring
3	800-0054	3	Screw, Hex Head (3/8-16 x 2")
4	850-0050	3	Washer, Lock - Spring (3/8)
5	800-0052	1	Screw, Hex Head (3/8-16 x 1-1/2")
6	850-0050	1	Washer, Lock - Spring (3/8)
7	191-0311	1	Spacer, Starter
8	800-0051	2	Screw, Hex Head (3/8-16 x 1-1/4")
9	850-0050	2	Washer, Lock - Spring (3/8)
10	191-0512	1	Flange, Starter
11	800-0046	1	Screw, Hex Head (3/8-16 x 1/2")
12	864-0003	1	Nut, Hex (3/8-16)
13	856-0010	1	Washer, Lock - External/Internal Tooth, (3/8)
14	191-0365	1	Bracket, Starter
15	STARTER (See Separate Group For Components)		
	191-0324	1	12 Volt
	191-0443	1	24 Volt (Optional)
16	416-0580	1	Cable, Battery - Positive (32-1/2")
17	416-0581	1	Cable, Battery - Ground (47")

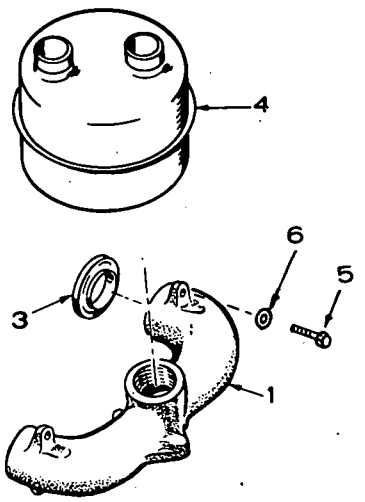


STARTER PARTS



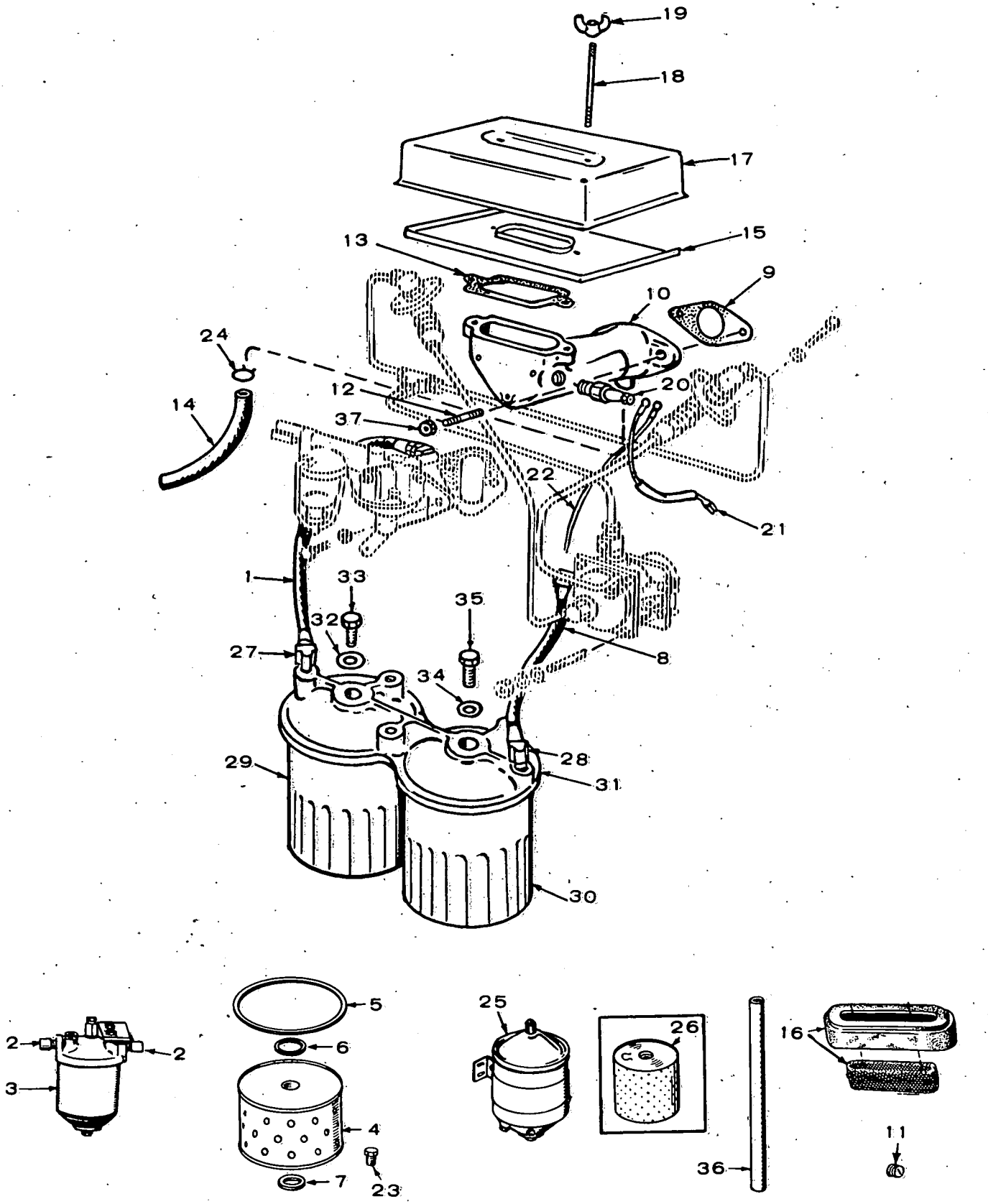
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	STARTER		
	191-0324	1	12 Volt
	191-0443	1	24 Volt
1	ARMATURE		
	191-0712	1	12 Volt
	191-0713	1	24 Volt
2	191-0432	1	Clutch
3	191-1023	1	Head Assembly, Commutator End
4	COIL PACKAGE, FIELD		
	191-1024	1	12 Volt
	191-1043	1	24 Volt
5	PLATE ASSEMBLY, BRUSH		
	191-1025	1	12 Volt
	191-1042	1	24 Volt
6	191-1020	1	Spring Set, Brush (Set of 4)
7	191-1026	1	Connector Package
8	191-0497	1	Bearing (Bronze), Drive End
9	191-1027	1	Spring, Plunger
10	191-1028	1	Core Assembly, Moving
11	SWITCH, SOLENOID		
	191-0433	1	12 Volt
	191-0715	1	24 Volt
12	191-1029	1	Yoke Parts Package
13	191-1030	1	Stop and Lock Ring Package, Pinion
14	191-1031	1	Thrust Washer Package, Armature (Use as Required)
15	BRUSH SET, SERVICE		
	191-0434	1	12 Volt
	191-0714	1	24 Volt
16	191-1032	1	Yoke

EXHAUST SYSTEM



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	154-0633	1	Manifold, Exhaust, Vertical Outlet
3	154-0463	2	Gasket, Exhaust Manifold
4	155-0976	1	Muffler, Exhaust
5	114-0022	4	Screw, Hex Head (5/16-18 x 1-3/4")
6	526-0045	4	Washer, Flat (5/16)

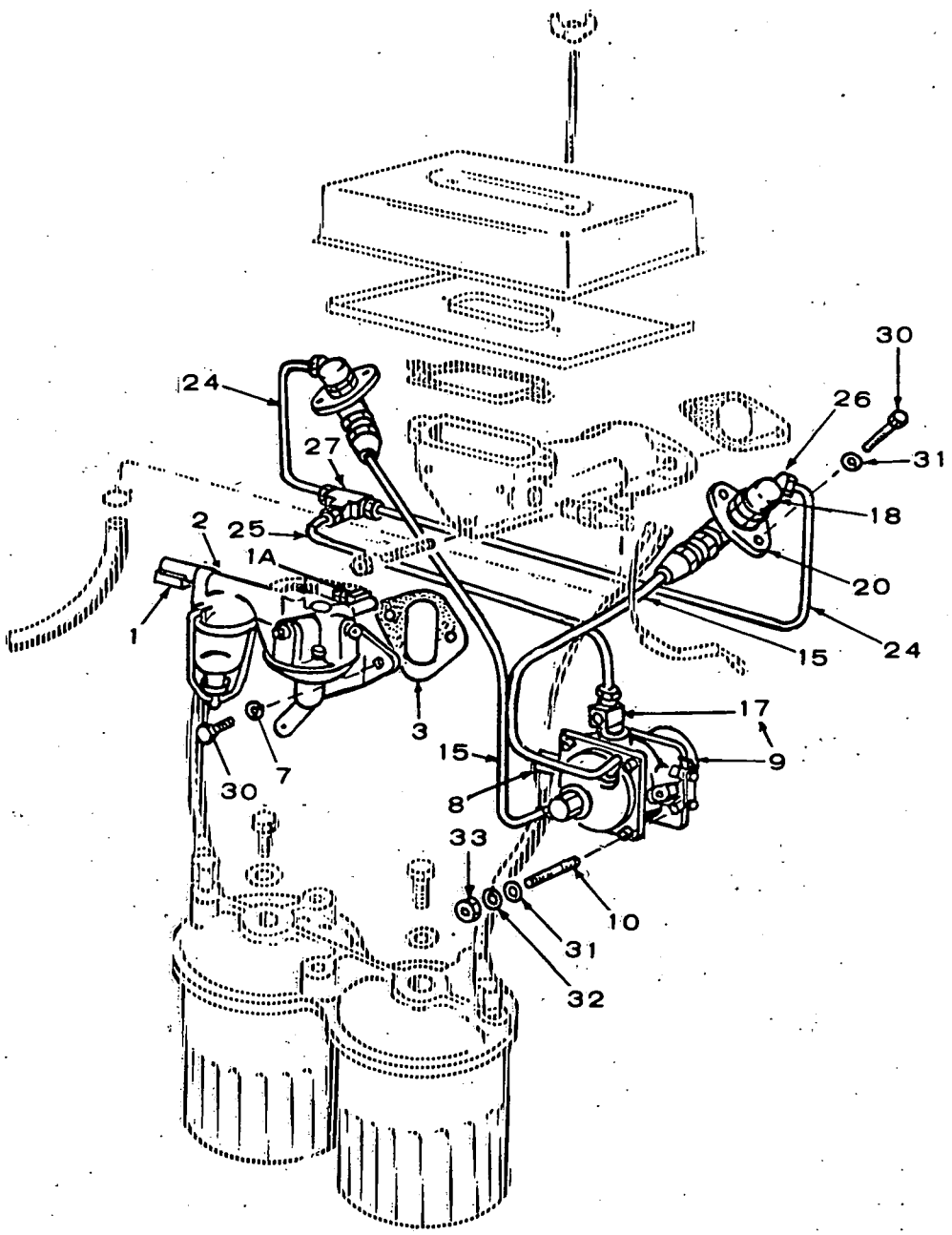
AIR CLEANER AND FUEL FILTER

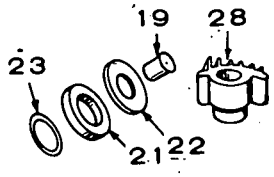


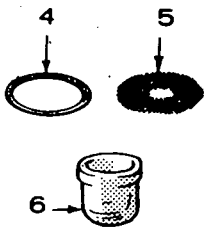
AIR CLEANER AND FUEL FILTER

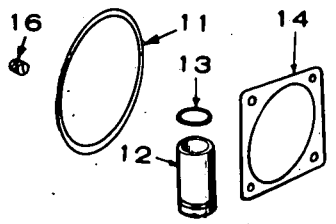
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	LINE, FUEL - PUMP TO SECONDARY FILTER		
	501-0032	1	Spec R Only
	501-0003	1	Begin Spec S
2	502-0041	2	Elbow, Inverted Male, Secondary Filter Inlet & Outlet - Spec R Only
3	149-0408	1	Filter, Secondary Fuel - Includes Cartridge (Bleed Plug 149-0769 is available separately) - Spec R Only
4	149-0428	1	Cartridge, Secondary Fuel Filter - Spec R Only
5	149-0456	1	Gasket, Secondary Filter, Bowl to Cover - Spec R Only
6	149-0455	1	Gasket, Secondary Filter Cartridge to Head - Spec R Only
7	149-0493	1	Gasket, Secondary Filter Cartridge to Retainer - Spec R Only
8	LINE, FUEL - SECONDARY FILTER TO INJECTION PUMP		
	501-0091	1	Spec R Only
	501-0129	1	Begin Spec S
9	141-0281	1	Gasket, Air Cleaner Adapter to Cylinder Head
10	140-0576	1	Adapter, Air Cleaner
11	505-0180	1	Plug, Pipe (1/4") Air Cleaner Adapter & Intake Manifold - Used on some early models
12	520-0011	2	Stud, Air Cleaner Adapter Mounting
13	140-0584	1	Gasket, Air Cleaner
14	HOSE, BREATHER		
	503-0462	1	Spec R Only
	503-0557	1	Begin Spec S
15	140-0595	1	Pan, Air Cleaner
16	140-0636	1	Element and Retainer, Air Cleaner
17	140-0594	1	Cover, Air Cleaner
18	520-0621	2	Stud, Air Cleaner
19	865-0020	2	Nut, Air Cleaner - Self Locking
20	154-0712	1	Heater, Manifold - Includes Gasket (12 Volt)
21	LEAD, GLOW PLUG TO AIR HEATER		
	336-1504	1	#1-Cylinder (12-1/4") Blade Type Terminal
	336-1505	1	#2-Cylinder (5-1/4") Blade Type Terminal
22	336-1418	1	Lead, Air Heater to Solenoid in Control
23	149-0769	1	Plug, Air Bleed, Secondary Filter
24	503-0170	2	Clamp, Breather Hose
25	149-1078	1	Filter, Fuel - Mounted Between Fuel Tank and Transfer Pump
26	149-0846	1	Cartridge, For 149-1078 Filter
27	502-0002	1	Elbow, Primary Fuel Filter Inlet - Begin Spec S
28	502-0099	1	Elbow, Reducer - Secondary Fuel Filter Outlet - Begin Spec S
29	122-0325	1	Filter, Fuel - Primary - Begin Spec S
30	122-0326	1	Filter, Fuel - Secondary - Begin Spec S
31	149-1185	1	Adapter, Fuel Filters - Begin Spec S
32	526-0068	1	Washer, Primary Fuel Filter Mounting - Begin Spec S
33	801-0074	1	Screw, Hex Head - Primary Fuel Filter Mounting - Begin Spec S
34	526-0066	1	Washer, Secondary Fuel Filter Mounting - Begin Spec S
35	801-0053	1	Screw, Hex Head - Secondary Fuel Filter Mounting - Begin Spec S
36	503-0559	1	Insulator, Breather Hose - Begin Spec S
37	870-0137	2	Nut, Air Cleaner Adapter Mounting (5/16-24)

FUEL TRANSFER AND INJECTION SYSTEM





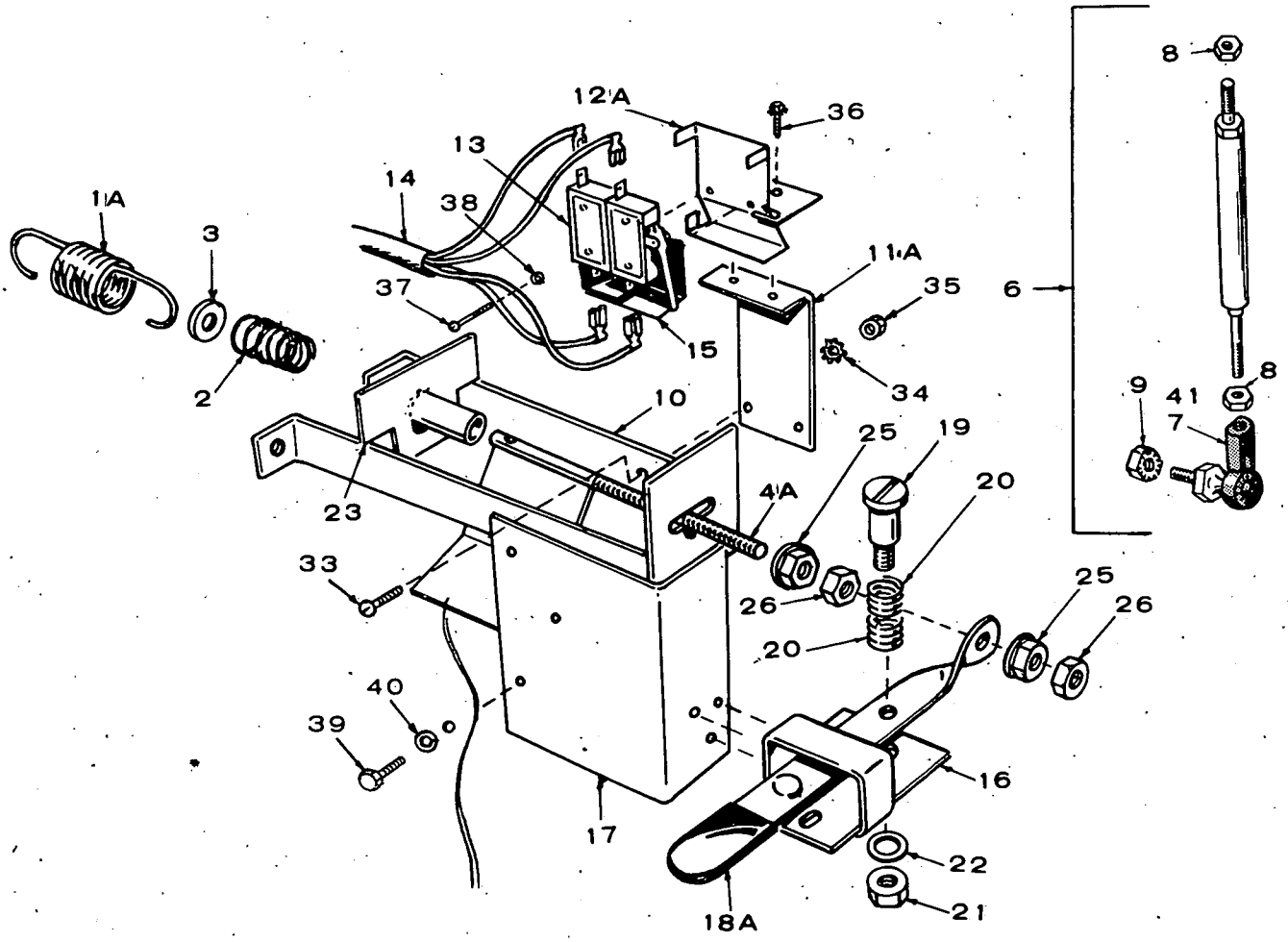




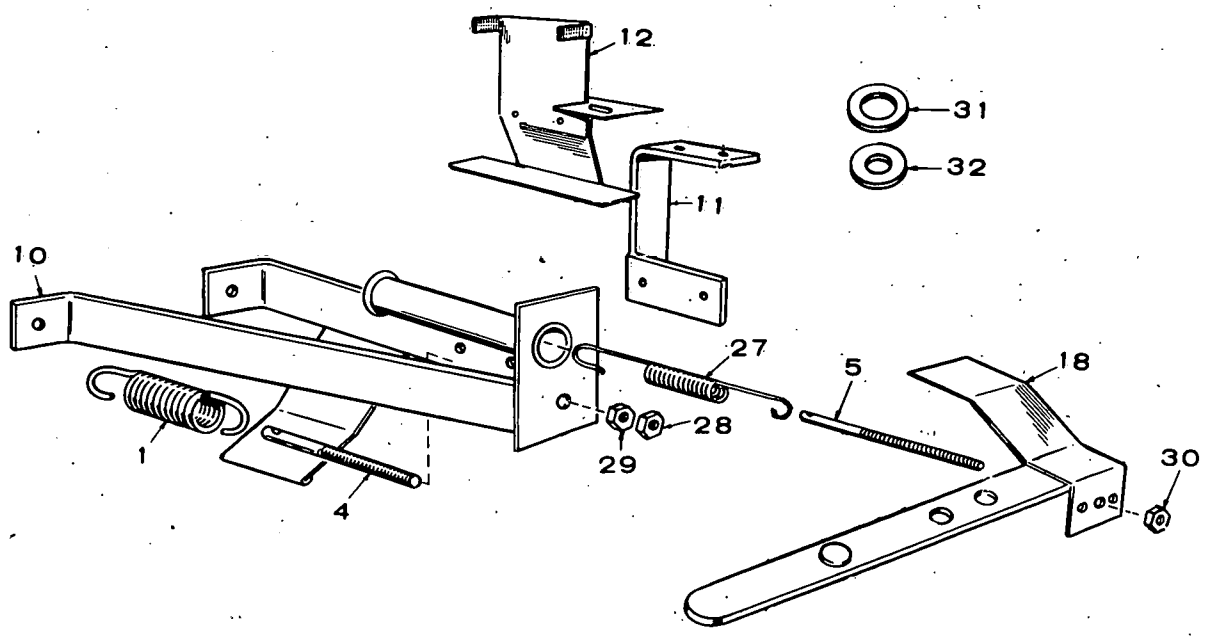
FUEL TRANSFER AND INJECTION SYSTEM

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1046	1	Repair Kit, Fuel Pump (Includes Diaphragm & Gaskets)
1	502-0002	1	Elbow, Inverted Male, Fuel Pump Inlet
1A	ELBOW, INVERTED MALE, FUEL PUMP OUTLET		
	502-0002	1	Spec R Only
	502-0020	1	Begin Spec S
2	149-0979	1	Pump, Fuel Transfer
3	149-0792	1	Gasket, Fuel Transfer Pump Mounting
4	149-0517	1	Gasket, Fuel Pump Bowl
5	149-0463	1	Screen, Fuel Pump Filter
6	149-0116	1	Bowl, Fuel Pump (Glass)
7	526-0065	2	Washer, Copper, Fuel Pump Mounting
8	ELBOW, INJECTION PUMP INLET		
	502-0054	1	Spec R Only
	502-0039	1	Begin Spec S
9	147-0219	1	Pump, Fuel Injection (Includes Buttons 2, 4, 12)
10	520-0129	4	Stud, Injection Pump Mounting
11	509-0094	1	Seal, "O" Ring, Injection Pump to Crankcase
12	147-0182	1	Tappet, Injection Pump
13	147-0196	1	Gasket, "O" Ring, Injection Pump Tappet
14	147-0145	1	Shim Kit, Injection Pump Mounting
15	LINE, INJECTION PUMP TO NOZZLE		
	149-1101	1	No. 1 Cylinder
	149-1102	1	No. 2 Cylinder
16	BUTTON, INJECTION PUMP PLUNGER		
	147-0147	1	.119 - Marked 1 or A
	147-0148	1	.116 - Marked 2 or B
	147-0149	1	.113 - Marked 3 or C
	147-0150	1	.110 - Marked 4 or D
	147-0151	1	.107 - Marked 5 or E
	147-0161	1	.104 - Std., 11 or No Mark
	147-0152	1	.101 - Marked 6 or F
	147-0153	1	.098 - Marked 7 or H
	147-0154	1	.095 - Marked 8 or J
	147-0155	1	.092 - Marked 9 or K
	147-0156	1	.089 - Marked 10 or L
	147-0190	1	.122 - Marked 12 or M
	147-0189	1	.125 - Marked 13 or N
	147-0188	1	.128 - Marked 14 or P
	147-0187	1	.131 - Marked 15 or R
	147-0186	1	.134 - Marked 16 or S
17	147-0183	1	Valve, Bleeder, Injection Pump
18	147-0136	2	Nozzle & Holder Assembly
19	147-0134	2	Nozzle Only, Component of Nozzle & Holder Assembly
20	147-0141	2	Flange, Injection Nozzle Hold-down
21	147-0044	2	Shield, Nozzle Heat, Steel
22	147-0043	2	Gasket, Nozzle Heat Shield (Asbestos)
23	110-0419	2	Gasket, Shield to Head (Copper)
24	LINE, NOZZLE FUEL RETURN		
	149-1056	1	No. 1 Cylinder
	149-1057	1	No. 2 Cylinder
25	149-1058	1	Line, Injection Pump to Fuel Return Lines Tee
26	502-0065	2	Elbow, Inverted (45°) - Nozzle (Fuel Return Line)
27	502-0102	1	Tee, Return Lines
28	ADAPTER, INJECTION NOZZLE		
	147-0133	1	No. 1 Cylinder
	147-0132	1	No. 2 Cylinder
29	147-0243	2	Gasket, Nozzle
30	SCREW, HEX HEAD		
	800-0508	4	Nozzle & Holder Mounting (5/16-18 x 2-3/4")
	800-0027	2	Transfer Pump Mounting (5/16-18 x 7/8")
31	WASHER, FLAT		
	526-0122	4	Nozzle & Holder Mounting
	526-0022	4	Injection Pump Mounting
32	850-0045	4	Lockwashers, Injection Pump Mounting (5/16")
33	862-0015	4	Nut, Injection Pump Mounting (5/16-18)

GOVERNOR



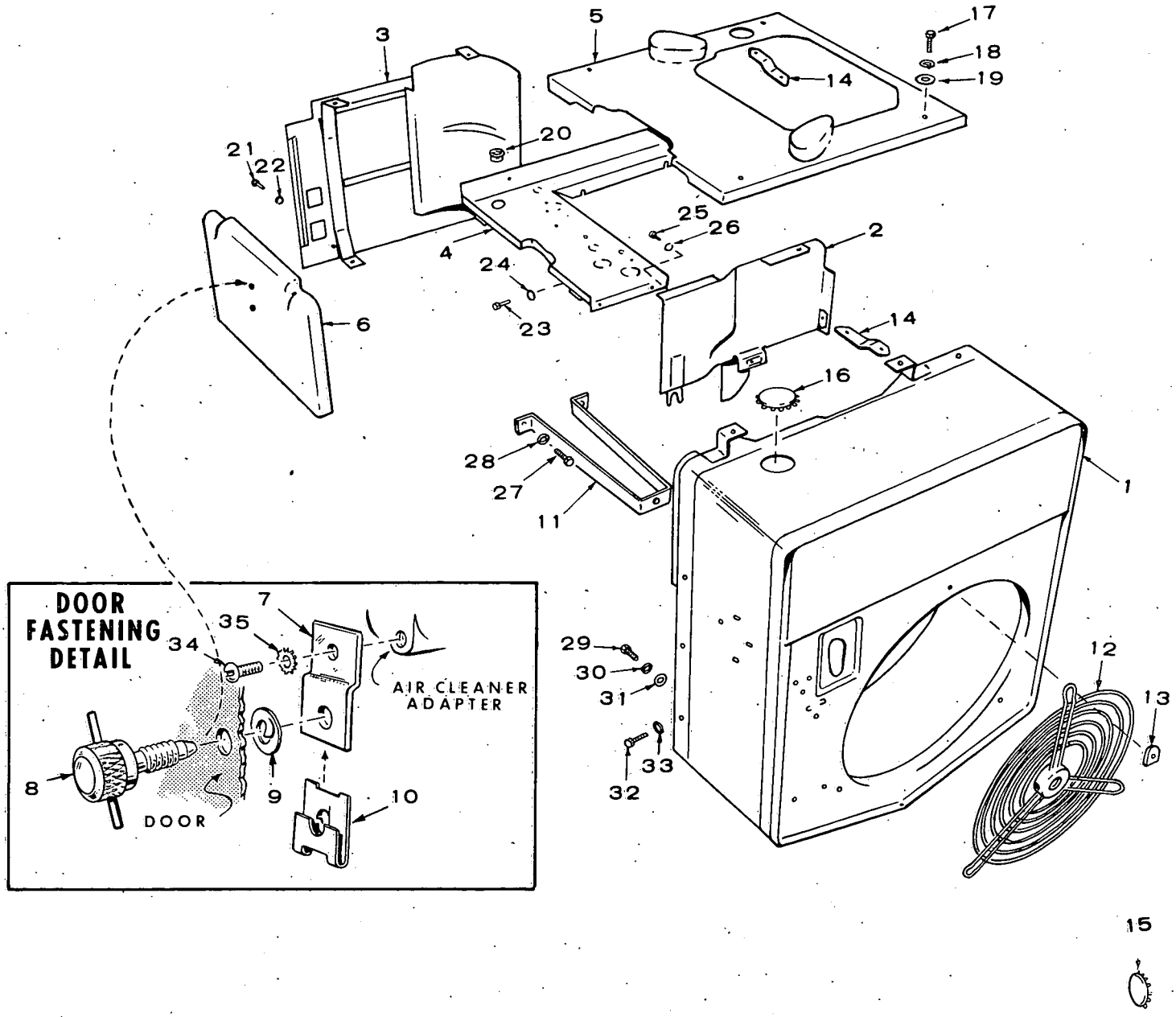
NOTE: These parts used on early Spec R Models Only.



GOVERNOR

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	SPRING, GOVERNOR		
1	150-1233	1	Early Spec R Models
1A	150-1085	1	Use Begin During Spec R
2	306-0166	1	Spring, Activator - Use Began During Spec R
3	526-0201	1	Washer, Governor Rod
	STUD, GOVERNOR ADJUSTING		
4	150-1083	1	Early Spec R Models
4A	150-1246	1	Use Began During Spec R
5	150-0096	1	Stud, Adjusting - Variable Speed - Early Spec R Models
6	150-1132	1	Linkage Assembly, Governor
7	150-1358	1	Joint, Ball
8	871-0053	2	Nut, Keps - Linkage
9	870-0131	1	Nuts, Keps - Ball Joint
10	150-1144	1	Bracket and Plate Assembly (Replaces early style w/tube)
	BRACKET, MICRO SWITCH MOUNTING		
11	150-1150	1	Early Spec R Models
11A	150-1248	1	Use Began During Spec R
	BRACKET, MICRO SWITCH		
12	152-0112	1	Early Spec R Models
12A	152-0174	1	Use Began During Spec R
13	308-0151	1	Switch, Micro
14	338-0461	1	Harness, Micro Switch
15	152-0119	1	Insulator, Terminal - Switch
16	150-1147	1	Bracket, Lever
17	150-0917	1	Bracket, Stiffener
	LEVER, MANUAL GOVERNOR		
18	150-1148	1	Early Spec R Models
18A	150-1261	1	Use Began During Spec R
19	150-1146	1	Screw, Adjustment
20	150-0907	2	Spring, Adjustment Screw
21	115-0025	1	Nut, Tappet (1/4-28)
22	850-0040	1	Washer, Lock (1/4)
23	150-1247	1	Plate, Governor Switch
25	870-0084	2	Nut (with shoulder) 1/4-20
26	862-0001	2	Nut, Lock (1/4-20)
27	150-1162	1	Spring, Governor, Variable Speed - Early Spec R Models
28	870-0130	1	Nut, Lock, Adjusting Stud - Early Spec R Models
29	862-0003	1	Nut, Adjusting Stud - Early Spec R Models
30	870-0129	1	Nut (Nylon) - Governor Stud - Early Spec R Models
31	526-0143	2	Washer (1/4" I.D. x 3/8" O.D.) - Adjustment Screw - Early Spec R Models
32	526-1015	1	Washer, Flat (1/4") - Adjustment Screw, Early Spec R Models
33	813-0100	2	Screw, Round Head (10-32 x 1/2")
34	853-0008	2	Lockwasher (#10)
35	861-0008	2	Nut, Hex (10-32)
36	815-0181	2	Screw, Hex Head, Thread Cutting with Lockwasher (10-32 x 1/2")
37	812-0066	2	Screw, Round Head (6-32 x 3/4")
38	850-0020	2	Lockwasher (#6)
39	800-0004	6	Screw, Hex Head (1/4-20 x 5/8")
40	850-0040	6	Lockwasher (1/4)
41	150-0939	1	Joint, Ball

AIR HOUSING


DOOR FASTENING DETAIL
AIR CLEANER ADAPTER
DOOR
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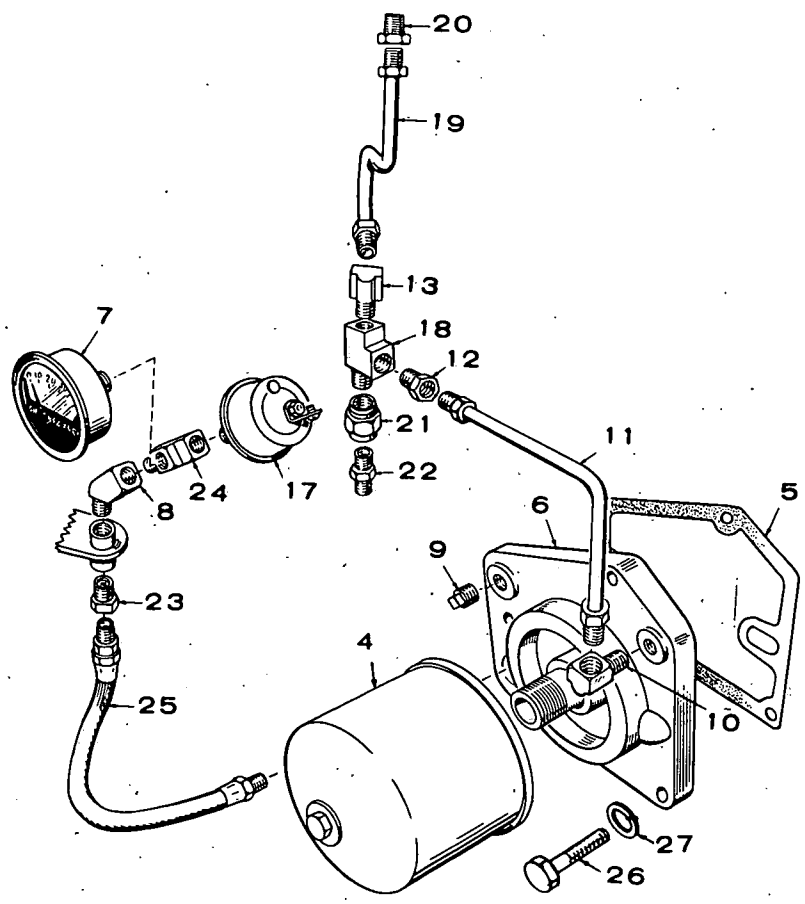
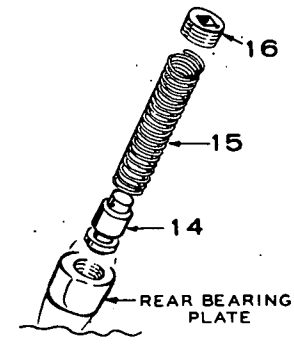
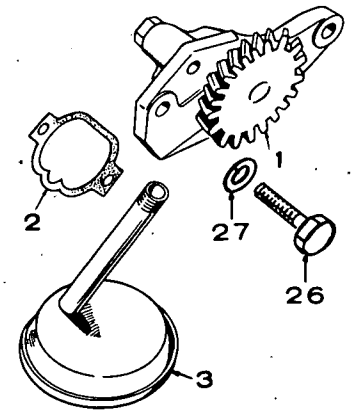
AIR HOUSING

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	HOUSING, BLOWER		
	134-1851	1	Early Spec R Models
	134-1371	1	Use Begin During Spec R and Used through Spec S
	134-2203	1	Begin Spec T
2	134-1048	1	Housing, Cylinder Air - Front
3	134-1849	1	Housing, Cylinder Air - Rear
4	PANEL, CYLINDER AIR HOUSING - BOTTOM		
	134-1915	1	Prior to Spec T
	134-1419	1	Begin Spec T
5	134-1125	1	Cover, Cylinder Air Housing
6	134-1039	1	Panel, Air Housing Door
7	134-1554	1	Bracket, Air Housing Door Panel
8	134-1373	1	Screw, Captive - Door
9	134-1180	1	Washer, Captive Screw - Door
10	870-0194	5	Nut, U-Clip - Door and Cover
11	134-1088	1	Support, Blower Housing and Grille
12	134-1178	1	Grille
13	134-1092	3	Retainer, Grille
14	BRACKET, BLOWER HOUSING & CYLINDER SHROUD		
	134-1703	1	Front
	134-1704	1	Rear
15	PLUG, DOT BUTTON - PRIOR TO SPEC T		
	517-0044	4	For 1/4" Hole
	517-0012	1	For 5/8" Hole
	517-0021	1	For 7/8" Hole
16	517-0009	1	Plug, Dot Button (For 2" Hole) - Begin Spec T
17	815-0235	4	Screw, Hex Head (1/4-20 x 5/8")
18	526-0021	4	Washer, Flat (1/4)
19	850-0040	4	Lockwasher (1/4)
20	331-0103	1	Bushing, Nylon
21	813-0097	1	Screw, Round Head (10-32 x 5/16")
22	854-0010	1	Lockwasher (#10)
23	815-0235	1	Screw, Hex Head (1/4-20 x 5/8")
24	853-0013	1	Lockwasher (1/4)
25	815-0235	1	Screw, Hex Head (1/4-20 x 5/8")
26	853-0013	1	Lockwasher (1/4)
27	800-0024	2	Screw, Hex Head (5/16-18 x 1/2")
28	850-0045	2	Lockwasher (5/16)
29	800-0007	3	Screw, Hex Head (1/4-20 x 1")
30	850-0040	3	Lockwasher (1/4)
31	521-0115	3	Washer, Flat (1/4)
32	815-0235	6	Screw, Hex Head (1/4-20 x 5/8")
33	854-0014	6	Lockwasher (1/4)
34	813-0098	2	Screw, Round Head (10-32 x 5/16")
35	853-0008	2	Lockwasher (#10)

OIL SYSTEM



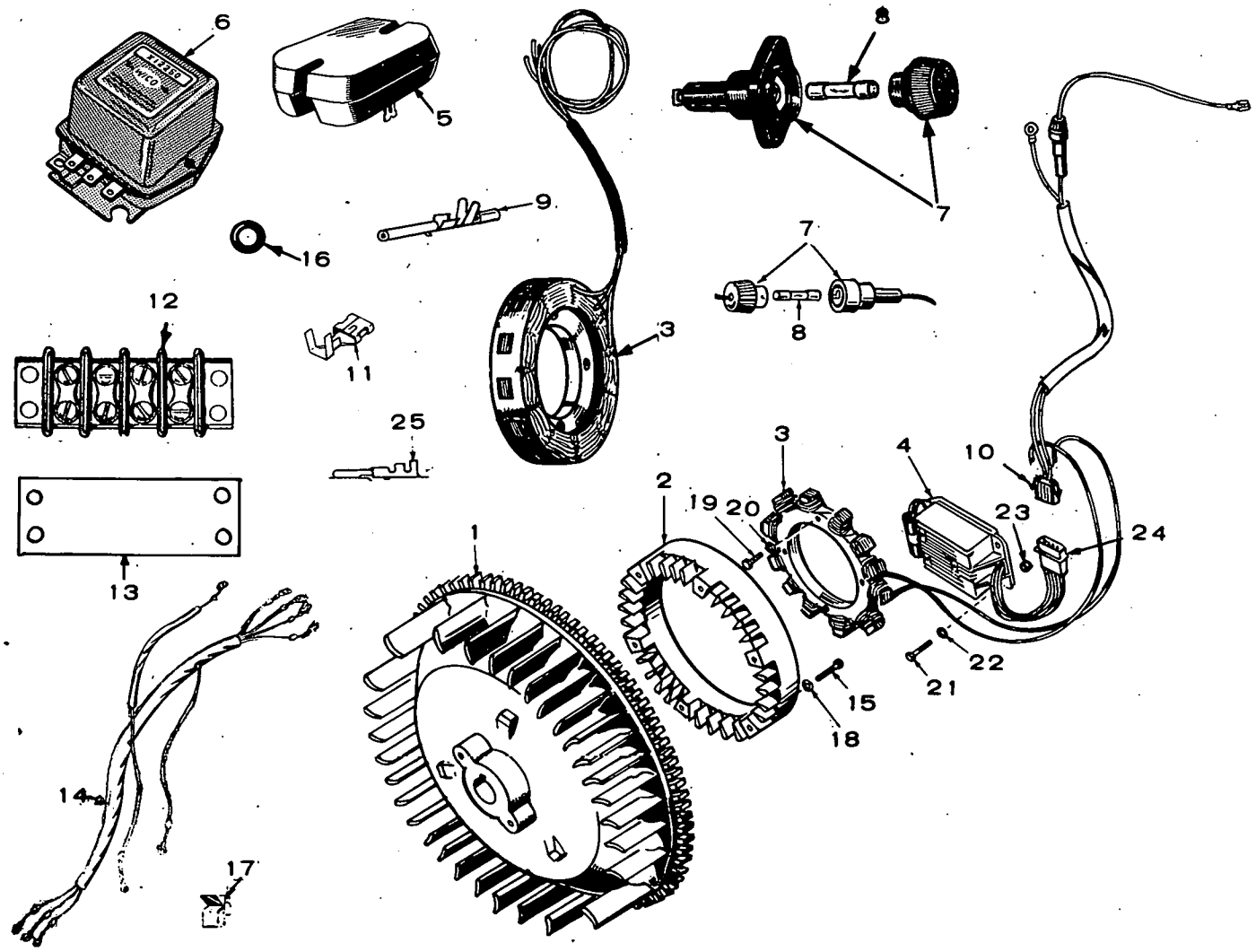




REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120-0547	1	Pump Assembly, Oil
2	120-0580	1	Gasket Kit, Pump
3	120-0551	1	Cup, Oil Intake
4	122-0185	1	Filter, 3-1/2" Long - Standard
4	122-0193	1	Filter, 5-1/2" Long - Optional
5	122-0188	1	Gasket, Adapter
6	122-0182	1	Adapter, Oil Filter
7	193-0006	1	Gauge, Oil Pressure
8	502-0053	1	Elbow, 45°, Oil Pressure Switch, Also (1) Oil Gauge Mounting - Prior to Spec S
9	505-0057	1	Plug, 1/8", Adapter
10	502-0037	1	Elbow, Inverted Male, Oil Line to Filter Adapter
11	120-0614	1	Line, Adapter to Injection Pump Tee
12	502-0274	1	Connector, Inverted Male, Injection Pump Lubrication Tee
13	502-0037	1	Elbow, Injection Pump - Lubrication Tee
14	120-0539	1	Valve, Oil By-Pass
15	120-0555	1	Spring, By-Pass Valve

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
16	505-0274	1	Plug, 1/8" Oil By-Pass
17	309-0177	1	Switch, Oil Pressure
18	502-0242	1	Tee, Restricted - Injection Pump Lubrication
19	120-0633	1	Line, Oil, Injection Pump Tee to Cylinder Head
20	502-0281	1	Connector, Restricted, Oil Line to Cylinder Head
21	502-0051	1	Coupling, Tee to Injection Pump
22	502-0082	1	Nipple, Tee to Injection Pump
23	502-0003	1	Connector, Oil Fill Bracket to Oil Line - Begin Spec S
24	502-0058	1	Tee, Oil Fill Bracket to Gauge & Switch - Begin Spec S
25	501-0003	1	Line, Oil - Begin Spec S
26	SCREW, HEX CAP		
	800-0030	2	Oil Pump Mounting (5/16-18 x 1-1/4")
	800-0028	3	Oil Filter Adapter Mounting (5/16-18 x 1")
27	WASHER, LOCK		
	850-0045	2	Oil Pump Mounting (5/16")
	850-0045	3	Oil Filter Adapter Mounting (5/16")

CHARGING ALTERNATOR - 12 VOLT

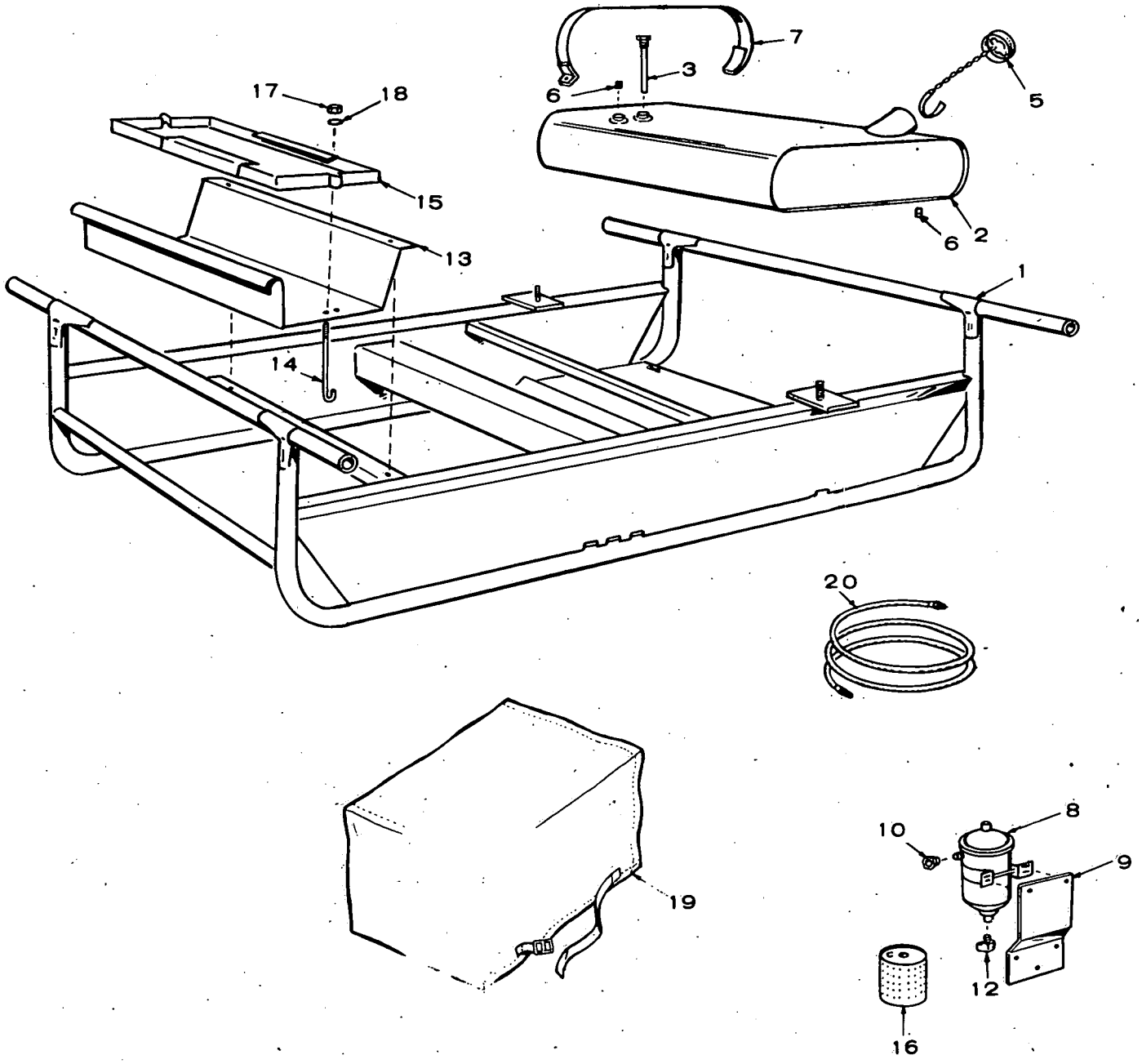


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	191-0408	1	Flywheel (Includes Ring Gear) - Also Listed in Crankshaft & Flywheel Group
2	191-0400	1	Rotor
3	STATOR		
	191-0711	1	Prior to Spec T
	191-0724	1	*Begin Spec T
4	305-0478	1	Regulator, Voltage (Includes Rectifier) - Begin Spec T
5	305-0343	1	Rectifier - Prior to Spec T
6	305-0261	1	Regulator, Voltage (2-Step) - Prior to Spec T
7	HOLDER, FUSE		
	321-0103	1	Prior to Spec T
	321-0165	1	*Begin Spec T
8	FUSE		
	321-0128	1	20 Amp. - Prior to Spec T
	321-0162	1	*30 Amp. - Begin Spec T
9	323-0488	4	*Socket, Connector - Begin Spec T
10	323-0759	1	*Connector, Socket Housing - Begin Spec T
11	332-0529	As Req.	*Terminal, Crimp
12	332-0537	1	Block, Terminal (4-Place) - Used on some early models
13	332-0872	1	Strip, Marker - Used on some early models

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
14	338-0463	1	Harness, Wiring, Voltage Regulator - Prior to Spec T
15	812-0133	6	Screw (12-24 x 1-1/2") - Rotor Mounting
16	508-0071	1	Grommet, Rubber, Blower Housing - Prior to Spec T
17	518-0178	2	Clip, Cable, Alternator - Begin Spec T
18	850-0035	6	Washer, Lock (#12)
19	SCREW, STATOR MOUNTING		
	815-0110	4	10-32 x 7/8" - Prior to Spec T
	813-0107	4	10-32 x 1-1/4" - Begin Spec T
20	850-0030	4	Washer, Lock (#10)
21	800-0005	3	Screw (1/4-20 x 3/4") - Voltage Regulator Mounting - Begin Spec T
22	850-0040	3	Washer, Lock (1/4) - Begin Spec T
23	862-0001	3	Nut (1/4-20) - Regulator Mounting - Begin Spec T
24	323-0763	1	Connector, Pin Housing - Begin Spec T
25	323-0438	4	Pin, Connector

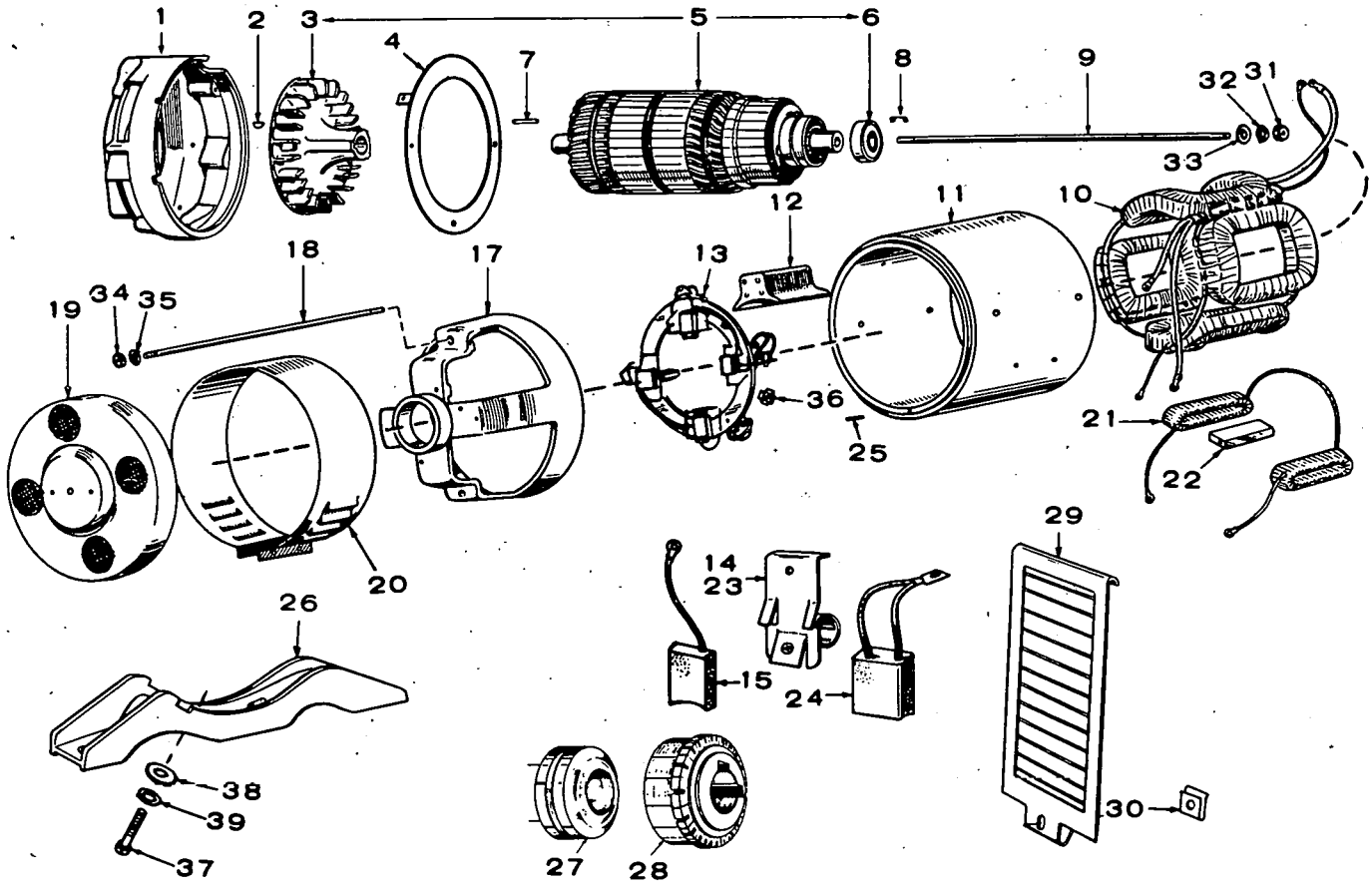
* - Included in Stator Assembly 191-0833.

CARRYING FRAME AND MOUNTED FUEL TANK



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	403-0822	1	Frame, Carrying
2	159-0929	1	Tank, Fuel (7.35 Gallon)
3	159-0695	1	Tube, Fuel Pick-Up
5	159-0020	1	Cap, Fuel
6	505-0008	2	Plug, Pipe - Fuel Tank
7	159-0692	2	Band, Fuel Tank
8	149-1078	1	Filter, Fuel - Mounted on Carrying Frame - Spec R Only
9	149-1124	1	Bracket, Fuel Filter Mounting - Spec R Only
10	502-0029	2	Bushing, Fuel Filter to Lines - Spec R Only
12	502-0054	1	Elbow, Filter Outlet - Spec R Only
13	416-0577	1	Rack, Battery
14	416-0578	2	Stud, Battery Hold-down
15	416-0576	1	Frame, Battery Hold-down
16	149-0846	1	Cartridge, Filter - Spec R Only
17	862-0015	2	Nut (5/16-18)
18	526-0213	2	Washer (5/16)
19	412-0032	1	Cover, Canvas - Welder Set (Optional)
20	LINE, FUEL		
	501-0015	1	Tank to Filter
	501-0131	1	Fuel Tank Return

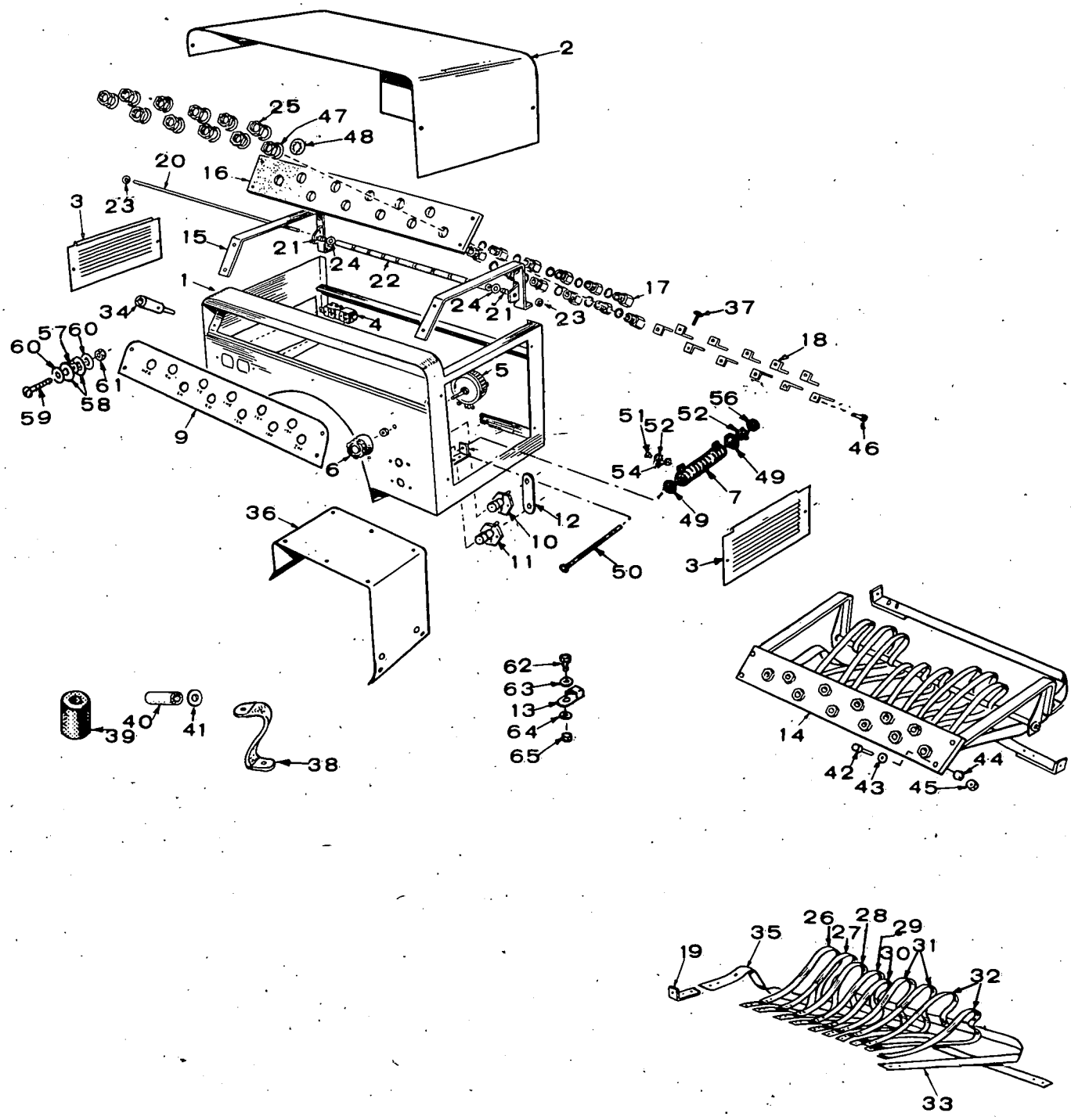
GENERATOR



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	231-0120	1	Adapter, Generator to Engine
2	515-0006	1	Key, Blower to Crankshaft
3	205-0065	1	Blower, Generator
4	232-1815	1	Plate, Baffle
5	ARMATURE ASSEMBLY (Includes Blower & Bearing - DC)		
	201-1492	1	6.0DJB-331E Sets
	201-1516	1	6.0DJB-332E Sets
	201-1515	1	6.0DJB-5331E Sets
	201-1514	1	6.0DJB-5332E Sets
6	510-0047	1	Bearing, Armature (Double Sealed - Pre-Lubricated)
7	515-0122	1	Key, Drive - Blower to Armature
8	232-0596	1	Clip, Bearing Stop
9	520-0534	1	Stud, Armature Through
10	222-1695	1	Coil Assembly, Field - Set of 4 Coils, Connected - DC
11	210-0260	1	Frame, Generator - Machined - Less Coils & Poleshoes - DC
12	221-0118	4	Shoe, Pole - DC
13	212-0276	1	Rig Assembly, Brush - DC
14	212-1105	4	Spring, AC Brush
15	214-0050	4	Brush, AC
17	211-0097	1	Bell, End
18	520-0161	2	Stud, Generator Through
19	211-0114	1	Cover, End Bell
20	234-0002	1	Band, End Bell
21	222-1458	1	Coil Set, Interpole - DC

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
22	221-0116	2	Interpole - DC
23	212-1106	4	Spring, DC Brush
24	214-0067	4	Brush, DC
25	516-0103	2	Pin, Roll - Generator Frame
26	232-1977	1	Base, Mounting
27	204-0009	1	Collector Ring (AC)
28	203-0125	1	Commutator (DC)
29	234-0286	1	Cover, Air Outlet
30	870-0177	1	Clip, Air Outlet Cover Fastener
31	862-0004	1	Nut, Hex (7/16-14) - Armature Stud
32	850-0055	1	Washer, Lock (7/16)
33	526-0032	1	Washer, Flat
34	862-0015	2	Nut, Hex (5/16-18) - Generator
35	850-0045	2	Washer, Lock (5/16)
36	212-1214	4	Clamp, Brush Rig
37	800-0050	2	Screw (3/8-16 x 1") - Mounting Base
38	526-0030	2	Washer, Flat
39	850-0050	2	Washer, Lock

CONTROL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CONTROL

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	BOX, CONTROL		
	301-2902	1	Specs R through S
	301-3326	1	Begin Spec T
2	301-2901	1	Cover, Control Box
3	301-2900	2	Plate, Control Box Vent
4	RECEPTACLE, DUPLEX		
	323-0184	1	Models with 120 Volt AC Output
	323-0213	1	Models with 240 Volt AC Output
5	303-0112	1	Rheostat
6	304-0061	1	Knob, Rheostat
7	304-0183	1	Resistor, Field (5.5 Ohm - 160 Watt)
8	304-0117	1	Bracket, Field Resistor Mounting
9	301-1785	1	Panel, Control Box
10	313-0032	1	Switch, Start
11	313-0032	1	Switch, Pre-heat
12	332-0602	1	Jumper
13	332-0142	1	Lug, Solderless
14	304-0661	1	Resistor Assembly, Jacks and Elements (Includes Parts Marked £)
15	301-4843	2	£Bracket, Resistor Element Mounting
16	301-4819	1	£Block, Terminal - Resistor Element Fastening
17	316-0044	11	£Jack Plug - Welder Cable Connecting
18	308-0149	10	£Angle, Connector - Resistor Element to Plug Jack (1-23/32" lg)
19	308-0128	3	£Angle, Connector - Resistor Element to Plug Jack (3-1/8" lg)
20	304-0469	1	£Rod, Insulator Tubes Mtg.
21	115-0056	1	£Spring, Insulator Tubes
22	304-0379	8	£Tube, Insulator
23	870-0173	2	£Nut, Push - Insulator Rod Mounting (3/8-24)
24	526-0101	1	£Washer, Flat - Insulator Rod Mounting (19/64" ID x 5/8" OD x 1/16" Thk)
25	868-0011	11	£Nut, Hex (3/4-16) - Jack Mtg.
26	304-0551	1	£Element, Resistor
27	304-0467	1	£Element, Resistor
28	304-0466	1	£Element, Resistor
29	304-0552	1	£Element, Resistor
30	304-0553	1	£Element, Resistor
31	304-0465	2	£Element, Resistor
32	304-0468	2	£Element, Resistor
33	304-0554	1	£Element, Resistor
34	316-0045	2	Plug, Welding Cable
35	304-0660	1	£Element, Resistor
36	301-2899	1	Bracket, Control Box Mtg.
37	815-0026	26	£Screw, Cap - Truss Head (10-32 x 5/8" lg)
38	337-0044	1	Strap, Ground
39	402-0078	6	Dampener, Vibration
40	304-0379	2	Tube, Insulator
41	304-0151	1	Washer, Insulator (5/16" ID x 1" OD x 1/8" Thk)
42	800-0007	4	Screw, Cap - Hex Head (1/4-20 x 1" lg)
43	526-0015	4	Washer, Flat (9/32" ID x 9/16" OD x 1/16" Thk)
44	850-0040	4	Washer, Lock - Spring (1/4")
45	860-0013	4	Nut, Hex (1/4-20)
46	815-0223	11	Screw, Cap - Hex Head (1/4-20 x 5/8" lg)
47	526-0120	11	Washer, Flat - Jack Mtg. (25/32" ID x 1-1/4" OD x 1/16" Thk)
48	854-0031	11	Washer, Lock - Internal - Jack Mounting (3/4")
49	304-0015	2	Washer, Resistor Centering
50	813-0116	1	Screw, Machine - Round Head (#10-32 x 6-1/2" lg)
51	815-0238	2	Screw, Machine - Round Head (#8-32 x 7/16" lg)
52	853-0005	3	Washer, Lock - External (#8)
53	526-0048	1	Washer, Flat (.172" ID x 3/8" OD x 1/32" Thk)
54	871-0007	3	Nut, Hex (#8-32)
55	853-0008	1	Washer, Lock - External (#10)
56	870-0053	1	Nut, Hex (#10-32)
57	508-0006	2	Washer, Fiber
58	508-0018	4	Washer, Fiber
59	812-0155	2	Screw, Machine - Round Head (1/4-20 x 1-1/4" lg)
60	526-0052	4	Washer, Flat (Brass) - 17/64" ID x 9/16" OD x 1/32" Thk
61	871-0016	4	Nut, Hex (Brass) - 1/4-20
62	813-0100	1	Screw, Machine - Round Head (#10-32 x 1/2" lg)
63	853-0008	1	Washer, Lock - External (#10)
64	856-0003	2	Washer, Lock - Internal (#10)
65	870-0053	1	Nut, Hex (#10-32)

SERVICE KITS AND MISCELLANEOUS

NOTE: For other kits, refer to the group for the part in question.

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	98-2028	1	Decal Kit, Set
	168-0086	1	Gasket Kit, Engine
	OVERHAUL KIT, ENGINE		
	522-0201	1	Prior to Spec S
	522-0247	1	Begin Spec S

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200-AMP DIESEL WELDER

DJB

SERIES

FORM NUMBER
967-1033

ISSUE DATE
~~8-76~~ 10-78
(SPEC R-T)
Replaces 3RT75

TABLE OF CONTENTS

KEEP THIS MANUAL HANDY SO YOU CAN EASILY REFER TO IT WHEN ORDERING PARTS, MAKING ADJUSTMENTS, ETC.

SAFETY PRECAUTIONS

ALWAYS USE PRECAUTIONARY MEASURES DURING ARC WELDING OPERATIONS TO ENSURE MAXIMUM PERSONAL SAFETY AND THE SAFETY OF NEARBY PERSONNEL.

WARNING **Onan uses this symbol throughout this manual to warn of possible serious personal injury.**

CAUTION **This symbol refers to possible equipment damage.**

- **Operate and Maintain The Machine And Its Equipment Properly.**

  Do not overload the cables. Do not use worn or poorly connecting cables. Do not allow the welding cables to contact hot metal, water, oil or grease. Prevent cables from becoming a stumbling hazard by keeping them in order and out of the way.

  Use electrode holders that are completely insulated. Do not use holders with defective jaws.

  Do not use the welder without grounding the frame or the case. Do not ground to pipelines carrying gases of flammable liquids. Be sure the conductors can safely carry the grounding current.

  Keep all connections clean and tight.

  Do not use an electric welder on an engine unless both the engine's battery cables and alternator wires are disconnected.

- **Take Precautions Against Electric Shock.**

  NEVER work in a damp area without suitable insulation against shock.

  NEVER stand in water or on a wet floor or use wet gloves when welding.

  ALWAYS dry out the work pieces or bench if there is any evidence of moisture.

  OPEN power circuits before inspecting machines.

  ALWAYS turn off the machine when leaving the work.

- **Do Not Weld Near Flammable Materials.**

  NEVER weld in or near EXPLOSIVE ATMOSPHERES.

  Clean any container that has held combustible or flammable materials by approved or prescribed methods. A very small amount of residual gas or liquid can cause a serious explosion. When the contacts of the container is unknown, use an explosimeter.

  Use carbon dioxide or nitrogen to ventilate a container. NEVER USE OXYGEN.

  When the container has held a gas or liquid that readily dissolves in water, perform the following:

  1. Flush the container several times with water and a wetting agent (e.g., a low powered detergent). Then, fill with as much water as the work permits.
  2. Provide a vent or opening in the container to allow the release of air pressure.

  When the container has held a gas or liquid that does not readily dissolve in water, proceed as follows:

  1. Clean the container with steam or a cleaning agent and purge all air with a gas such as carbon dioxide or nitrogen.
  2. Use steam to clean out light material.
  3. To clean out heavy grease or oil, use a strong caustic soda solution.
  4. Before welding on the container, PURGE ALL AIR with a gas such as carbon dioxide or nitrogen.

  Wear goggles and gloves when cleaning with steam or caustic soda.

  Always clean the container in a well ventilated area, away from any open flame.

  When scraping or hammering heavy sludge or scale, use a WET, spark resistant tool.

  Always keep head and arms as far away from the work as possible.

- **Never Weld On Hollow (Cored) Castings That Have Not Been Properly Vented.**

- **Never Pick Up Hot Metal With Bare Hands.**

- **Do Not Weld In Confined Areas Without Adequate Ventilation.**

- **Never Wear Frayed, Flammable Or Otherwise Inadequate Clothing When Welding. Keep Clothing Dry.**

  Avoid wearing light colored or open shirts that allow arc rays to penetrate and expose parts of the body to ultra-violet rays. Do not wear flammable cotton fabrics when arc welding. Wear heavy shoes, tightly laced.

  To prevent severe burns from splatter and molten metal, wear leather or asbestos gloves at all times protecting the hand and wrists. When welding in vertical and overhead positions, wear ear shields under helmet and leather sleevelets, apron, and leggings.

- **Use Eye Protection At All Times.**

  ALWAYS wear safety goggles under the welding helmet. Keep the helmet, hand shields, and face shield in good condition. Replace defective equipment.

  All arc welding produces intense ultra-violet and infra-red radiation. When welding in open areas, provide portable nonreflecting screens to protect nearby personnel from arc rays.

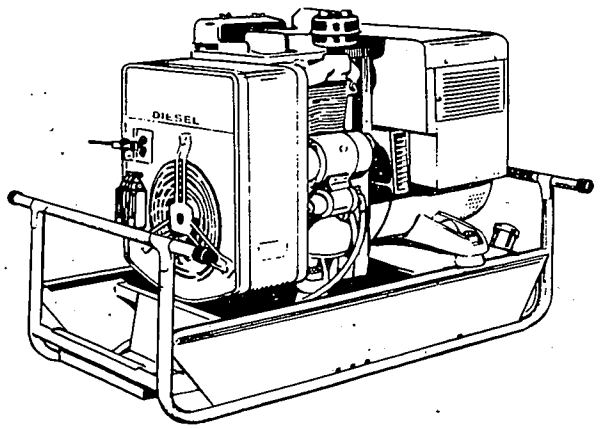
- **Do Not Work On This Equipment When Mentally Or Physically Fatigued.**

GROUNDING STATEMENT

PK OF UNIT SHOWING GROUNDING LUG

GENERAL INFORMATION

The DJB welder is a complete engine-driven, direct-current arc welding machine. It consists of a diesel engine directly connected to an electric generator and mounted to a sturdy carrying frame.



The welder is rated 200 amperes, 28 volts direct current at 50% duty cycle. Auxiliary alternating current is available at 100% duty cycle for 120 or 240 volts and is rated 3500 watts at 60 hertz, or 2500 watts at 50 hertz, single-phase. AC output is available at any time the welding current is not being used through a simple lever control. This AC output is convenient for emergency lighting, running power tools, etc. when working at locations away from commercial AC power sources. Models are available in either voltage.

All 1/16-inch through 5/32-inch electrodes may be used. Positive and negative 3/16-inch electrodes which do not exceed the welder capacity may also be used.

When instructions in this manual refer to a specific model of welder, identify the model by referring to the complete model number, specification letter and serial number as shown on the unit nameplate.

How to interpret MODEL and SPEC NO.

6.0DJB-331 E / 1 T

1 2 3 4

1. Factory code for general identification.
2. Specific type:
   E - Electric starting (at welder).
3. Factory code for optional equipment.
4. Specification (Spec) letter advances with production modification.

Throughout the text, engine end is considered front of the welder. Left and right apply when facing the engine.

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

SPECIFICATIONS

All values in inches unless otherwise specified.

Dimensions	
Height	32-1/2 (825.5 mm)
Width	29 (736.6 mm)
Length	46 (1168.4 mm)
Weight	600 lb. (272 kg)
Number of Cylinders	2
Displacement	60 cu in. (983 cm^3)
Bore	3-1/4 (82.55 mm)
Stroke	3-5/8 (92.08 mm)
Power at 2400 rpm (nominal)	14.6 bhp (10.9 kW)
Operating RPM	
Weld	2400
AC Power	1800
Compression Ratio	19:1
Compression Pressure (sea level)	350-400 psi (2415-2760 kPa)
Main Bearings are Leaded Bronze, Precision Type for Replacement (Qty.)	2
Connecting Rod Bearings Tri-Metal Replaceable	Yes
Piston Rings (chrome plated)	
Oil Control (Qty.)	1
Compression (Qty.)	3
Hardened Chrome-Cobalt Alloy Faced Valves	Yes
Hardened Chrome-Cobalt Alloy Replaceable Valve Seats	Yes
Valve Rotator	Yes
Governor (internal flyball—externally adjustable)	Yes
Governor Regulation	±5%
Nominal Battery Voltage	12
Battery Size	
SAE Group 24C (number used)	One
Capacity, SAE 20 hr. Minimum	74 Amp. Hr. (266 kC)
Solenoid Shift Starter	Yes
Combustion Air Required	42 cfm (1.2 m^3/min)
Cooling Air Required	850 cfm (24.1 m^3/min)
Glow Plugs and Air Heater to Aid Starting	Yes
Injection Pump (American Bosch)	PSU
Nozzle Opening Pressure (approx.)	1800 psi (12409 kPa)
Primary and Secondary Fuel Filters	Yes
Oil Pump (Gear Type)	Yes
Oil Filter (full flow)	Yes
Oil Capacity*	3-1/2 qt (3.31 lit)
Mounted Fuel Tank Capacity	7-1/3 gal (27.79 lit)
Generator Welder—Maximum Amperes (50% duty cycle)	200
Generator AC Auxiliary Output (120 or 240 volts, single-phase, 100% duty cycle)	
Watts at 60-hertz operation	3500
Watts at 50-hertz operation	2500

* - Includes 1/2 quart (.47 lit) for oil filter.

DIMENSIONS AND CLEARANCES

All values in inches unless otherwise specified

	Minimum	Maximum
CAMSHAFT		
Bearing Journal Diameter, Front	2.500 (63.500 mm)	2.505 (63.627 mm)
Bearing Journal Diameter, Rear	1.1875 (30.1625 mm)	1.1880 (30.1752 mm)
Camshaft Bearing Diameter 1	2.251 (57.175 mm)	2.253 (57.226 mm)
Camshaft Bearing Diameter 2	1.189 (30.201 mm)	1.191 (30.251 mm)
Bearing Clearance Limit	.0012 (.0305 mm)	.0037 (.0940 mm)
End Play, Camshaft	.007 (.178 mm)	.039 (.991 mm)
CONNECTING RODS		
Large Bearing Bore Diameter	2.1871 (55.5523 mm)	2.1876 (55.5650 mm)
Small Bushing Bore Diameter	1.044 (26.5176 mm)	1.045 (26.5430 mm)
Distance Center Large Bearing Bore to Small Bushing Bore	5.998 (152.349 mm)	6.002 (152.451 mm)
Clearance, Large Bearing to Crankshaft	.0010 (.0254 mm)	.0030 (.0762 mm)
Clearance, Side	.002 (.0508 mm)	.016 (.4064 mm)
CRANKSHAFT		
Main Bearing Journal Diameter	2.2437 (56.9900 mm)	2.2445 (57.0103 mm)
Main Bearing Diameter	2.2459 (57.0459 mm)	2.2489 (57.1221 mm)
Crankshaft Main Bearing Clearance	.0020 (.0508 mm)	.0033 (.0838 mm)
Connecting Rod Journal Diameter	2.0597 (52.3164 mm)	2.0605 (52.3367 mm)
End Play, Crankshaft	.010 (.254 mm)	.015 (.381 mm)
CYLINDER		
Cylinder Bore	3-1/4 (82.55 mm)	
Cylinder Diameter Limits	3.2495 (82.5373 mm)	3.2505 (82.5627 mm)
Out-of-Round Limit (not more than)	.001 (.0254 mm)	
PISTON		
Piston Clearance to Cylinder Wall	.0055 (.1397 mm)	.0075 (.1905 mm)
Piston Diameter	3.2430 (82.3722 mm)	3.2440 (82.3976 mm)
Piston Pin Hole Diameter	.99005 (25.14727 mm)	.99025 (25.15235 mm)
Ring Groove Width, Top	.0970 (2.4638 mm)	.0980 (2.4892 mm)
Ring Groove Width, 2nd	.0965 (2.4511 mm)	.0975 (2.4765 mm)
Ring Groove Width, 3rd	.0965 (2.4511 mm)	.0975 (2.4765 mm)
Ring Groove Width, 4th	.1880 (4.7752 mm)	.1895 (4.8133 mm)
Ring Gap in Cylinder	.010 (.254 mm)	
Ring Side Clearance	.002 (.0508 mm)	.006 (.1524 mm)
PISTON PIN		
Piston Pin Fit in Rod	.0002 (.0051 mm)	
Length	2.738 (69.5452 mm)	2.753 (69.9262 mm)
Diameter	.9899 (25.1435 mm)	.9901 (25.1486 mm)
Connecting Rod Bushing Clearance	.0002 (.0051 mm)	.0007 (.0178 mm)
PISTON RINGS		
Ring Type		
Top	Compression	
2nd	Compression	
3rd	Compression	
4th	Oil Control	
Ring Width		
Top	.0925 (2.3495 mm)	.0935 (2.3749 mm)
2nd	.0925 (2.3495 mm)	.0935 (2.3749 mm)
3rd	.0925 (2.3495 mm)	.0935 (2.3749 mm)

STARTING MOTOR		
Rotation	Counterclockwise	
Pinion to Pinion Stop (Solenoid Plunger Bottomed)	.070 (1.778 mm)	.120 (3.048 mm)
Pinion Rest Position - Distance from Pinion Housing Mounting Face to Outer Edge of Pinion	1-9/32 (32.544 mm)	1-15/32 (37.306 mm)
Armature End Play	.005 (0.127 mm)	.030 (0.762 mm)
Test Specifications		
No Load	10 volt	80 amps
	5000 rpm min.	
Stall Torque	4 volt	420 amps
	7.8 ft. lbs. (10.6 N•m) min.	
Brush Spring Tension	32 - 40 oz. (907-1134 g)	
	with new brushes	
VALVE, INTAKE (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.6487 mm)	.3410 (8.6614 mm)
Clearance in Guide	.0015 (0.0381 mm)	.0030 (0.0762 mm)
Face Angle	42°	
Valve Clearance (cold)	.009 Intake (0.2286 mm)	
VALVE, EXHAUST (Cobalt-Chrome Alloy)		
Stem Diameter	.3405 (8.6487 mm)	.3415 (8.6741 mm)
Clearance in Guide	.0030 (0.0762 mm)	.0050 (0.1270 mm)
Face Angle	45°	
Valve Clearance (cold)	.007 Exhaust (0.179 mm)	
VALVE GUIDE		
Length	1-25/32 (45.2438 mm)	
Outside Diameter	.4690 (11.9126 mm)	.4695 (11.9253 mm)
Cylinder Head Bore Diameter	.467 (11.8618 mm)	.468 (11.8872 mm)
Inside Diameter (after reaming)		
Exhaust	.3445 (8.7503 mm)	.3455 (8.7757 mm)
Intake	.3425 (8.6995 mm)	.3435 (8.7249 mm)
VALVE SEATS (Stellite)		
Valve Seat Bore		
Diameter	1.361 (34.569 mm)	1.362 (34.595 mm)
Depth (from Cylinder Head Face)	.433 (10.998 mm)	.439 (11.151 mm)
Seat Outside Diameter	1.364 (34.646 mm)	1.365 (34.671 mm)
Seat Width	3/64 (1.191 mm)	1/16 (1.588 mm)
Seat Angle	45°	
VALVE SPRINGS		
Free Length	1-7/8 (47.625 mm)	
Length, Valve Closed	1.528 (38.8112 mm)	
Load, Valve Closed	45-49 lbs. (20.43-22.25 kg)	
Length, Valve Open	1.182 (30.0228 mm)	
Load, Valve Open	87-97 lbs. (39.50-44.04 kg)	
VALVE LIFTERS		
Lifter Diameter	.8725 (22.1615 mm)	.8730 (22.1742 mm)
Lifter Bore	.8755 (22.2377 mm)	.8765 (22.2631 mm)
GOVERNOR		
Cup Free Travel Distance	7/32 (5.5563 mm)	
OIL PUMP BYPASS VALVE		
Plunger Diameter	.3365 (8.5471 mm)	.3380 (8.5852 mm)
Spring Free Length	2-1/4 (57.15 mm)	2-3/8 (60.33 mm)
Spring Tension (at 1-3/16 inch compressed)	2.225 lb. + .11 lb. (1.0102 kg + 0.05 kg)	
GENERATOR	.002 (0.0508 mm)	
AC Brush Spring Tension	16-20 oz. (454-567 g)	
DC Brush Spring Tension	30-34 oz. (851-964 g)	

ASSEMBLY TORQUES AND SPECIAL TOOLS

The assembly torques given here will assure proper tightness without danger of stripping threads. If a torque wrench is not available, estimate the degree of tightness necessary for the stud, nut or screw. Be careful not to strip threads. Use only reasonable force and a wrench of normal length.

Specially designed place bolts (Figure 1) do not require a lockwasher or gasket. Do not attempt to use a lockwasher with these bolts. Check all studs, nuts and screws often and tighten as needed to keep them from working loose.

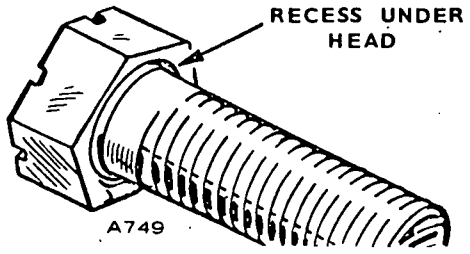


FIGURE 1. SPECIAL PLACE BOLT

TORQUE SPECIFICATIONS	Lb-Ft	(N•m)
Connecting Rod Bolt	27-29	(37-39)
Cover-Rocker Box	8-10	(11-14)
Cylinder Head Bolt	44-46	(60-62)
Exhaust Manifold Nuts	*13-15	(18-20)
Flywheel Hub Nut	17-21	(23-28)
Flywheel Mounting Screw	65-70	(88-95)
Fuel Pump Mounting Screws	15-20	(20-27)
Gear Case Cover	18-20	(24-27)
Governor Arm Locking Screw	2.7-3	(3.6-4)
Glow Plug	10-15	(14-20)
Injection Nozzle Mounting Screws	20-21	(27-28)
Injection Pump Mounting Screws	15-16	(20-22)
Intake Manifold	13-15	(18-20)
Oil Base Mounting Screws	45-50	(61-68)
Oil Filter	Hand Tight + 1/4 to 1/2 Turn	
Oil Pump Mounting Screws	15-20	(20-27)
Rear Bearing Plate	40-45	(54-61)
Rocker Arm Nut	★ 4-10	(5-14)
Rocker Arm Stud	35-40	(47-54)
Armature Through Stud Nut	30-40	(41-54)
Brush Rig Fastener Screw	6-7	(8-9)
Generator Through Stud Nut	20-22	(27-30)
Mounting Base Screw	35-37	(47-50)
Generator to Engine Adapter Screw	35-37	(47-50)

* - *Caution:* Tighten nuts evenly to avoid manifold damage.

★ - This torque is from friction between the threads only and locks the nuts in place. The rocker arm nuts are for adjusting valve lash.

SPECIAL TOOLS AND EQUIPMENT

These tools are available to aid service and repair.

Crankshaft Gear Pulling Ring	420-0275
Diesel Nozzle Tester	420-0184
Diesel Pintle Nozzle Cleaning Tool Set (Includes Injection Nozzle Centering Tool)	420-0208
Nozzle Centering Sleeve	420-0321
Delivery Valve Test Fixture	420-0322†
Combination Main and Cam Bearing Driver	420-0326
Driver, Valve Seat	420-0270
Oil Seal Guide and Driver	
Bearing Plate	420-0250
Gear Cover	420-0281
Ridge Reamer	420-0260
Replacement Cutter Blade for 420-0260	420-0261
Diesel Compression Tester	420-0283
Valve Seat Remover	420-0311
Replacement Blades for 420-0311	420-0274
Valve Guide Driver	420-0300

† - Used with diesel nozzle tester.

DIESEL ENGINE TROUBLESHOOTING GUIDE LIQUID OR AIR COOLED

OPERATION

WARNING

ENGINE EXHAUST GAS (CARBON MONOXIDE) IS DEADLY!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- **Dizziness**
- **Intense Headache**
- **Weakness and Sleepiness**
- **Vomiting**
- **Muscular Twitching**
- **Throbbing in Temples**

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

GENERAL

Operating conditions vary for different localities and certain procedures must be followed during operation to assure best performance.

Welders generate considerable heat during operation. To avoid a possible fire make sure the air inlets and outlets of the generator are unobstructed and clean.

WARNING **Never operate the welder inside a building or confined area without piping exhaust gases outside the enclosure. EXHAUST GASES CAN CAUSE SERIOUS PERSONAL INJURY OR DEATH.**

If the welder is mobile mounted, extra vehicle floor support may be necessary to prevent welder mounting bolts from tearing loose due to rough roads, turning sharp corners, etc. Use pipe clamps or U-bolts to secure the welder frame to the floor. For service convenience, especially when draining oil, elevate the welder above the vehicle floor.

CRANKCASE OIL

Use an oil with the API designation CD/SD or CD/SE. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following.

Above 32° F (0° C)	SAE 30
0° F to 32° F (-18° C to 0° C)	SAE 10W or 5W-30
Below 0° F (-18° C)	SAE 5W-30

Multigrade oils are recommended for temperatures of 32° F (0° C) and below, but they are not recommended for temperatures above 32° F (0° C). When adding oil between oil changes, it is preferable to use the same brand as in the crankcase. Various brands of oil may not be compatible when mixed together.

WARNING **Never check oil with the engine running. Hot oil discharged from the engine could cause personal injury.**

RECOMMENDED FUEL

Although number 2 diesel fuel gives the best economy for most operating conditions, number 1 diesel fuel can be used:

1. When ambient temperatures are below 32° F (0° C);
2. During long periods of light engine load; or,
3. If preferred by user.

Use low sulfur content fuel having a pour point (ability to filter) of at least 10°F (6°C) below the lowest expected temperature. Keep the fuel clean and protected from adverse weather. Leave some room for expansion when filling the welder's fuel tank.

CAUTION **Due to the precise tolerances of diesel injection systems, it's extremely important the fuel be kept clean. Dirt in the system can cause severe damage to both the injection pump and the injection nozzles.**

BATTERY CONNECTIONS

Connect battery cable marked POS. to the battery positive (+) terminal (Figure 2). Connect unmarked cable to the battery negative (-) terminal. Always keep cable connections tight and clean.

If the battery is accidently connected in reverse, a fuse will blow protecting rectifiers in the battery charger. Correct the battery connections and install a new fuse.

INITIAL START

Check the engine to make sure it has been filled with oil and fuel. Cylinder air housing door should be closed. Heavy exhaust smoke when the engine is first started is normal and is caused by the inhibitor oil. Bleed air from fuel system as follows: Disconnect the fuel return line. See Figure 3. Operate the hand priming lever on diaphragm type fuel transfer pump until there are no air bubbles in fuel flowing from the fuel return line fitting. Then connect the fuel return line.

If the camshafts pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

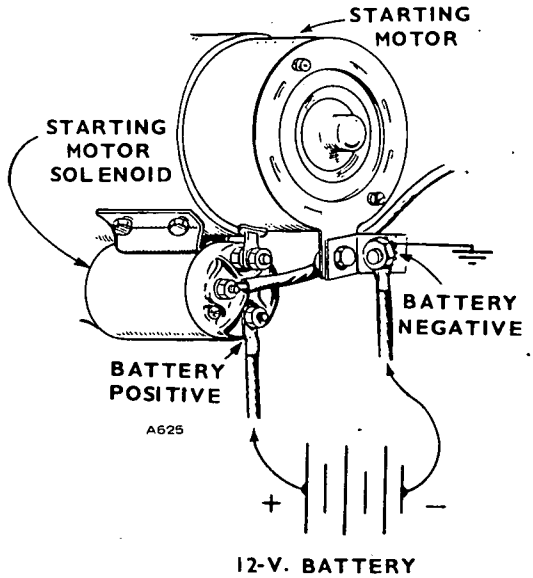


FIGURE 2. BATTERY CONNECTIONS

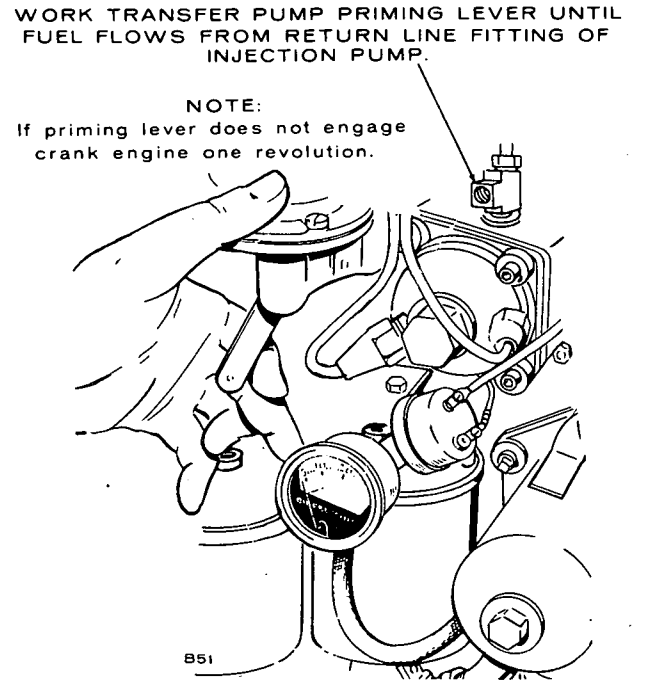


FIGURE 3. BLEEDING FUEL SYSTEM

STARTING

1. When starting a cold engine in ambients below 50°F (10°C), preheat for 20 seconds.
2. Continue to hold preheat switch and press the *start* switch.
3. Release start and preheat switches after engine starts and reaches speed.
4. Oil pressure should read at least 20 pounds (138 kPa). The pressure relief valve is not adjustable.

When starting at temperatures below 50°F (10°C) or under high humidity conditions, refer to suggested starting aids in *Low Temperatures.*

When the engine is to be restarted after short periods of shutdown, preheat is usually not necessary.

BREAK-IN PROCEDURE

The welders can be loaded to full nameplate rated output as soon as they are put into operation. It's recommended the welder be loaded to 80% rated capacity during the first few hours of operation. Heavy loading during initial operation helps seat piston rings and brings oil consumption to normal in the shortest time. See *Duty Cycle* for normal operation.

Drain the initial oil after 50 hours of operation while the engine is still hot.

DUTY CYCLE

When interpreting the duty cycle chart (Figure 4), note at 200 amperes rated load, the no-welding time must be at least one-half (50%) of each 10-minute

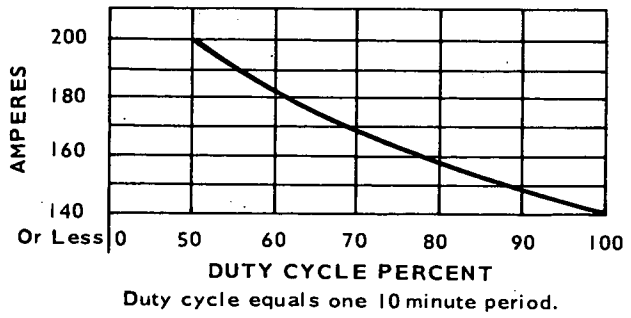


FIGURE 4. DUTY CYCLE CHART

operating period. As the welding load is reduced, longer welding time is permissible because less no-welding load time is required for the welder to cool. Any extreme ambient temperatures must also be taken into consideration. Continuous welding is permissible at 140 amperes or less.

WELDING CABLE CONNECTIONS

Insert welding cables into the main current amperage jack receptacles (Figure 5) according to the welding requirements. Some welding jobs may require frequent polarity changing to permit using various types of welding rod.

Straight Polarity Welding: Connect the electrode cable to the negative (NEG.) jack receptacle. Connect the ground cable to the desired amperage jack receptacle.

Reverse Polarity Welding: Connect the ground cable to the negative (NEG.) jack receptacle. Connect the electrode cable to the desired amperage jack receptacle.

ELECTRODES

All 1/16-inch through 5/32-inch electrodes can be used. Positive and negative 3/16-inch electrodes which do not exceed the welder capacity can also be used.

WELDING CURRENT ADJUSTMENT

Welders have an engine speed control lever and a fine current adjustment control (Figure 6). The engine speed control lever, when at WELD (2400 rpm) position, cuts off AC output and only welding current is available. When the speed control lever is at POWER, welding current is bypassed and only AC power is available.

The jack receptacle type main current control connects various resistance units into the welding circuit, limiting the amount of current at each jack receptacle. The fine current control provides for further adjustment between the jack receptacles of the main control.

CAUTION **NEVER WELD WITH ENGINE AND CONTROL COVER REMOVED! Considerable heat is generated by the resistance units inside the welder control box. Always keep the engine and control cover installed on the unit to properly direct cooling air to the control box.**

1. Plug cables into proper jack receptacles to obtain the amperage recommended for the electrode used.
2. Set fine current control at its approximate center position (midway between minimum and maximum). Try the welding characteristics, making fine current adjustments as necessary.

   Fine current control range is greater than the current spread of the main current control jack receptacles. If perfect arc conditions are not obtained by normal procedure, try the next higher or lower jack receptacle connections and re-adjust the fine current control to compensate.

3. When operating welders in parallel (see WELDERS IN PARALLEL), always have both ends of the connecting cables plugged into

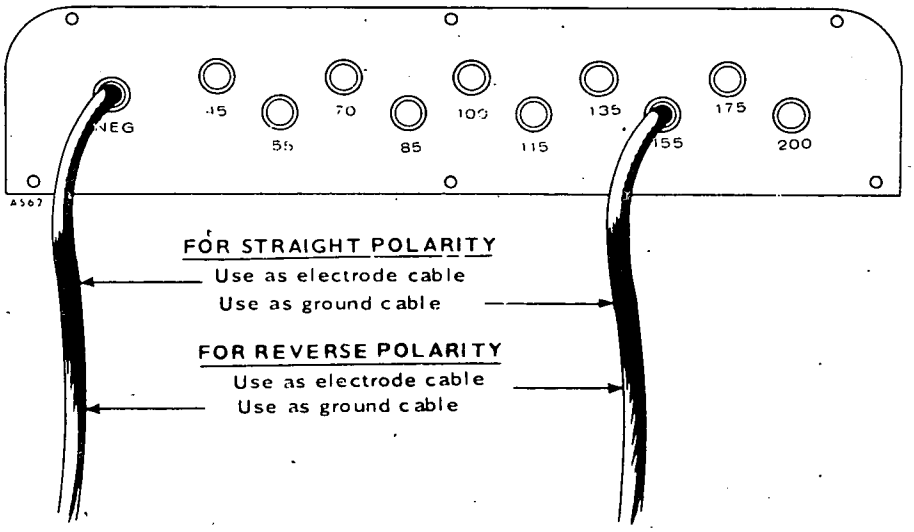


FIGURE 5. MAIN CURRENT WELDING JACK RECEPTACLES

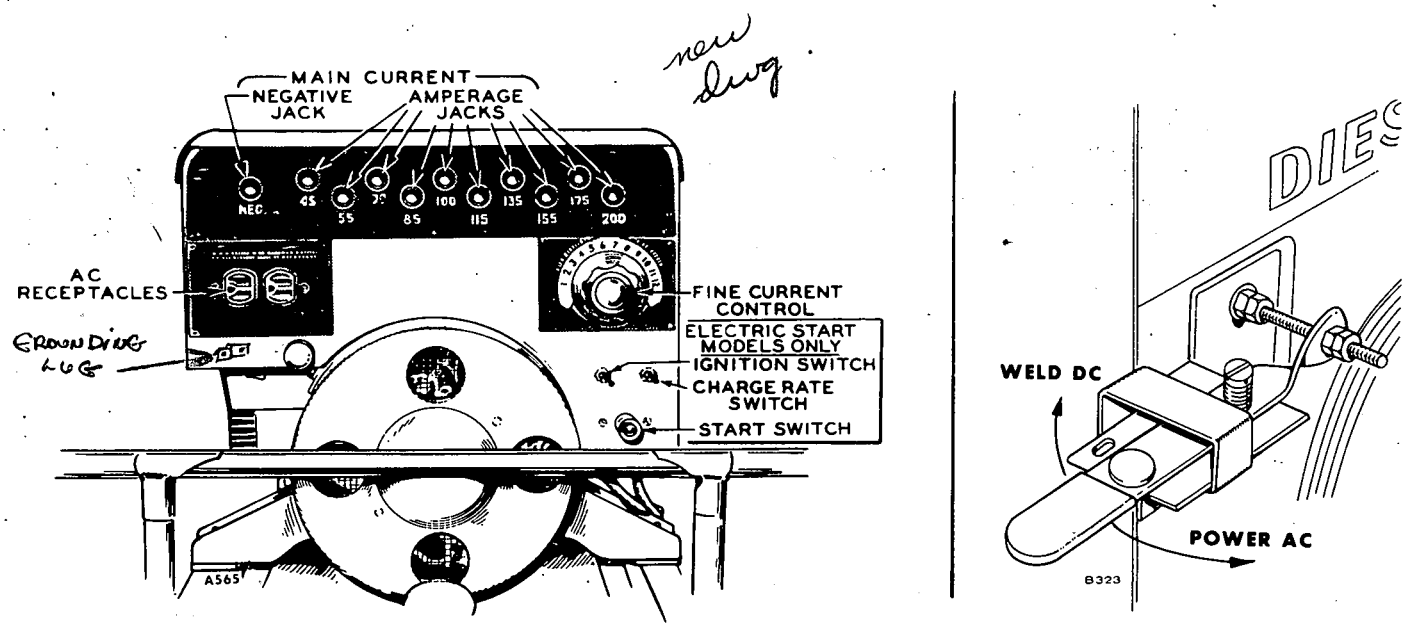


FIGURE 6. WELDER CONTROL

identical jack receptacles on each welder. If an amperage connection change is made on one welder, immediately change the other end of the connecting cable to the like jack receptacle of the second welder.

If welding current cannot be adjusted satisfactorily, check for poor electrical contact of cable connections at welder, ground clamp and electrode clamp.

WELDERS IN PARALLEL

Two welders can be connected in parallel if the welding amperage requirements are greater than those provided by one welder.

WARNING **Use larger welding cables because of higher amperage. Smaller cables can become hot creating a fire hazard.**

1. Determine welding amperage requirements. Select identical amperage jack receptacles on each welder which total the amperage requirements.

   EXAMPLE: If 300 amperes are required, select the 155-ampere jack receptacle on each welder. It may be necessary to select amperages which total slightly higher than the welding requirements to obtain proper welding characteristics. This is due to voltage and current differences which occur when welders are connected in parallel. Proper current can then be obtained using the fine current control adjustment.

2. Connect a cable between the preselected identical amperage jack receptacles of the welders. This cable (Figure 7) must have some means of attaching a second cable by splicing, clamping, etc. which will insure a tight connection.

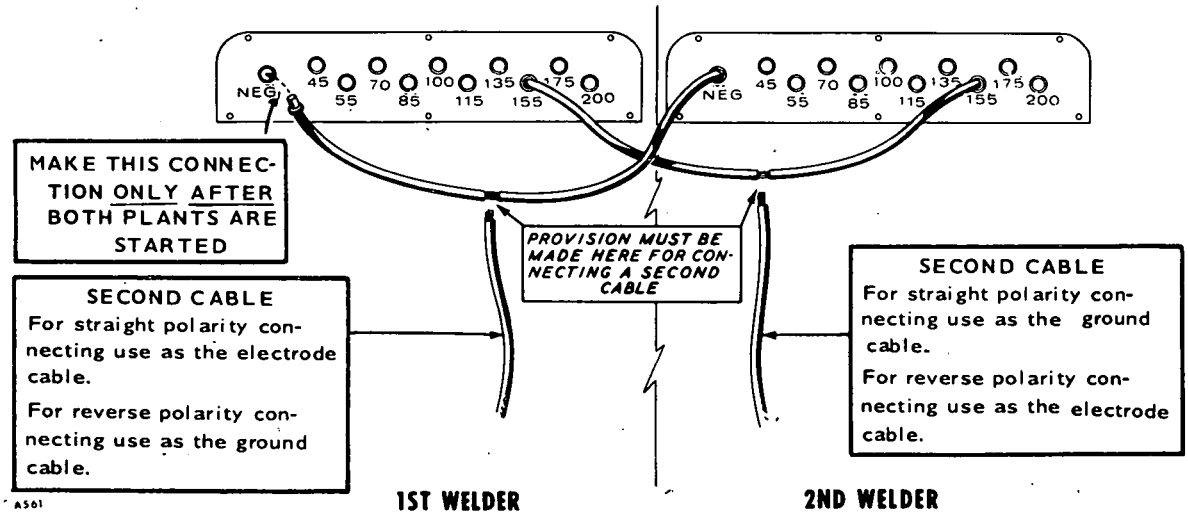


FIGURE 7. CONNECTIONS FOR WELDING IN PARALLEL

3. Connect another cable of equal size and length to the negative (NEG.) jack receptacle of only one welder. Do not complete connection to negative (NEG.) jack receptacle of second welder until both welders are running. Provisions for connecting a second cable must also be made as described in step 2.

CAUTION **Do not attempt to parallel the welder's AC output. Serious control and welder damage will result.**

AC OUTPUT

Move speed control lever to POWER position. This cuts the welding current control off and supplies 120- or 240-volt current to the output receptacles. Limit AC loads to not more than 3500 watts (60 hertz) or 2500 watts (50 hertz).

Canadian models have two 15-ampere fuses on the control panel that should be checked if AC power is lost. The fuses are located directly below the duplex receptacle.

CAUTION **Carbon in the exhaust system will occur in diesel engines operated consistently at light loads. Operate the welder at full load occasionally (or about 5 minutes just before stopping) to clean out the exhaust system.**

MICROSWITCH OPERATION

The engine speed control lever operates a microswitch which selects the AC circuit or DC welding circuit. If the microswitch becomes stuck or inoperative, welder operation is affected. Refer to wiring diagram.

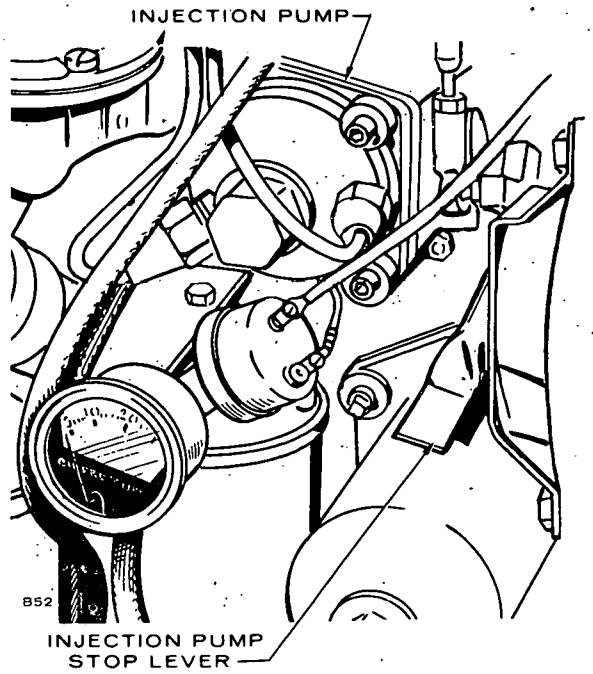


FIGURE 8. WELDER STOP LEVER

1. If microswitch DC contacts remain closed when speed control lever is at WELD position, welder voltage at no load increases from approximately a normal 60 volts to 80 volts. At heavy welding load, speed will drop excessively and welder will appear to lack power.
2. If microswitch DC contacts remain open when speed control lever is at POWER position, AC voltage will be low with similarily low power performance.
3. If microswitch AC contacts fail to close with speed lever at POWER position, there will be no available AC output.
4. If microswitch AC contacts remain closed with speed control lever at WELD position, AC output voltage will be excessively high, and any AC load left connected will be damaged.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the welder.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE oil for temperature conditions. Change oil only when engine is warm. If an unexpected temperature drop causes an emergency, move the welder to a warm location or apply heated air (do not use open flame) externally until oil flows freely.
2. Preheat for 1 minute if the temperature is 32 to 50°F (0 to 10°C). If engine fails to start after cranking for 1 minute, preheat for 1 minute more and reattempt the start.
3. Protect fuel against condensation.
4. Keep battery in a well charged condition.

HIGH ALTITUDE

Maximum power will be reduced approximately 4% for each 1000 feet (310 m) above sea level after the first 1000 feet (310 m).

EXERCISE

Infrequent use results in hard starting. Operate welder for at least a half hour each week. Run longer if battery needs charging.

OUT-OF-SERVICE PROTECTION

Protect a welder that will be out-of-service for more than 30 days as follows:

1. Run until thoroughly warm and then shut down.
2. Disconnect battery and follow standard battery storage procedure.
3. Drain oil from oil base while still warm. Refill and attach a tag stating oil viscosity used.
4. Remove glow plugs. Inject two squirts of rust inhibitor (or SAE 10 oil) into each cylinder. Crank engine over several times. Reinstall glow plugs.

5. Service air cleaner. See *PERIODIC MAINTENANCE* section.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Remove access panels and clean all cooling surfaces.
9. Wipe generator brushes, slip rings, etc. Do not apply lubricant or preservative.
10. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
11. Provide a suitable cover for the entire unit.

RETURN UNIT TO SERVICE

1. Remove cover from unit and all protective wrapping.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperatures.
3. Clean and check battery. Measure specific gravity (1.260 at 77° F [25° C]) and verify level to be at split ring. If specific gravity is low, charge until correct valve is obtained. If the level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

WARNING **Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of the gases can cause severe personal injury.**

4. Check that fuel filter and fuel lines are secure, with no leaks.
5. Check carburetor, adjust if necessary.
6. Connect battery. Connect ground lead last.
7. Be sure no load is connected to the generator.
8. Start engine.

PERIODIC MAINTENANCE

Regularly scheduled maintenance lowers operating costs and lengthens service life. Use this schedule as a servicing guide, but consider actual operating conditions when establishing a more definite schedule.

The operator should periodically make a complete visual inspection with the set running at rated load. Some of the things to check for are:

1. Check all fuel and oil lines for possible leakage.
2. Inspect exhaust lines and mufflers for possible leakage and cracks.
3. Periodically or daily, drain moisture from condensation traps.
4. Inspect air shrouds for leaks and security. Be sure cooling fins are clean and free from cracks or breaks.
5. Inspect electrical wires and connections for security and fray damage.

WARNING **Before beginning any maintenance work on the engine, generator or control panel, disconnect the battery. Failure to do so could result in damage to the equipment or serious personal injury in the event of inadvertant starting.**

CARE OF BATTERIES

To increase battery life, the operator can perform a number of routine checks and some preventive maintenance.

1. Keep the battery case clean and dry.
2. Make sure the battery cable connections are clean and tight. Use a terminal puller when removing cables for any reason.
3. Coat the battery terminals with a mineral grease or petroleum jelly to reduce corrosion and oxidation.
4. Identify each battery cable to be positive or negative before making connection. Always connect the ground (negative) cable last.
5. Maintain the electrolyte level by adding water (drinking quality or better) as needed for filling to split ring level marker. (The water ingredient of the electrolyte evaporates, but the sulphuric acid ingredient remains. Therefore, add water, not electrolyte.
6. Avoid overcharging when recharging. Stop the boost charge when the specific gravity is 1.260 and the electrolyte is 80°F (27°C).

PERIODIC MAINTENANCE

HOURS OF OPERATION	MAINTENANCE TASK
8	• Check exhaust system for leaks • Inspect welder • Check fuel supply • Check oil level
50	• Check air cleaner. See Note 1 • Clean governor linkage. See Note 1.
100	• Change crankcase oil. See Note 1.
200	• Clean crankcase breather • Check battery • Replace oil filter. See Note 1. • Check slip rings. See Note 1. • Check brushes. See Note 2. • Drain fuel system condensation traps. See Note 3.
500	• Check valve clearance
600	• Replace primary fuel filter See Note 1.
1000	• Clean generator and engine
2000	• Remove and clean oil base • Grind valves (if required) • Clean rocker box oil line holes • Check nozzle opening pressure spray pattern. See Note 4.
3000	• Replace secondary fuel filter See Note 1.
5000	• General overhaul (if required)

Note 1: Perform more often in extremely dusty conditions.

Note 2: Replace brushes when worn to 5/8 inch (16 mm).

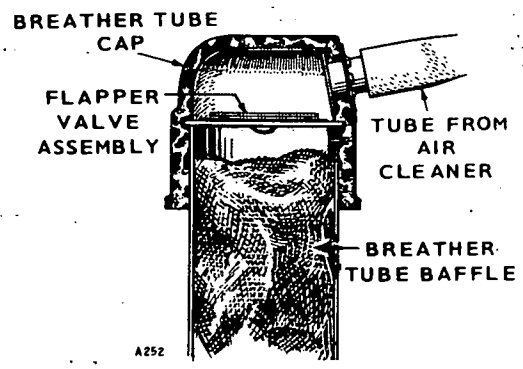
Note 3: Water or foreign material in the fuel can ruin the injection system. If daily inspection shows water or dirt in the primary filter bowl, check fuel handling and storage facilities and correct the situation. Replace filter elements following corrections of fuel contamination problems.

Note 4: This service must be performed by trained diesel injection equipment personnel with suitable test facilities.

CRANKCASE BREATHER

Engines prior to Spec S have a crankcase breather with a breather tube baffle and engines begin Spec S have a ball check valve and baffle. Every 200 hours, clean in a petroleum-base solvent as described and shown in Figure 9.

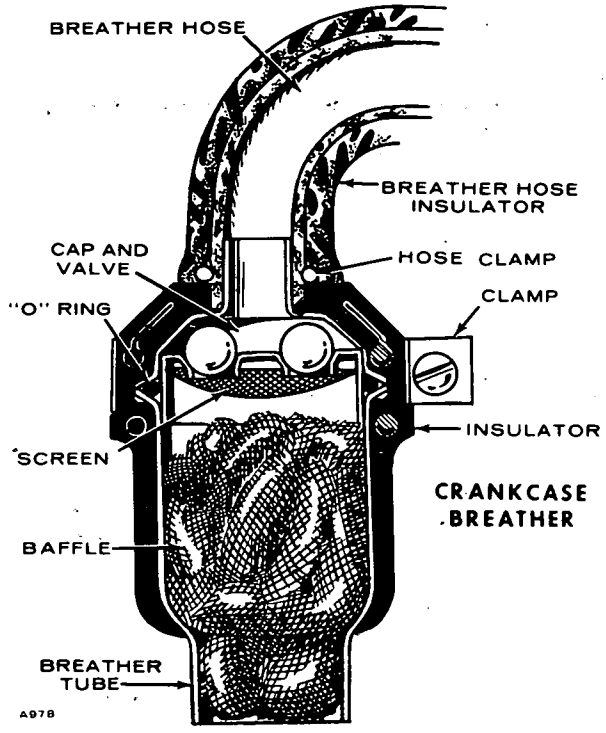
PRIOR TO SPEC S



CRANKCASE BREATHER

Remove breather cap. Remove valve from cap and wash. Dry and install with perforated disc toward engine. If faulty, install new valve.

BEGIN SPEC S



Remove hose clamp, breather hose, breather cap clamp and insulator halves to release breather cap and valve assembly. Wash cap and valve assembly and the baffle. Then reinstall.

FIGURE 9. CRANKCASE BREATHER

WARNING **Use extreme care when cleaning with a petroleum-base cleaner due to fire hazard.**

CRANKCASE OIL

Whenever checking the oil level of the welder, fill with oil (if necessary) to the FULL mark on the oil level indicator. See the *OPERATION* section or *OIL SYSTEM* section for the recommended oils to use.

Never operate the welder with the oil level below the LOW level of the indicator. Replace the indicator cap tightly or oil leakage may occur. Although oil changes are recommended every 100 hours, change the oil every 50 hours if operating in extremely dusty or dirty conditions.

WARNING **Do not remove the oil dipstick while the engine is running or oil could blow out of the oil fill tube causing injury.**

The oil filter should be changed every 200 hours, but it may also have to be changed more often if severe conditions exist. Coat the filter gasket before installing. Turn on the filter finger tight plus 1/2 turn.

AIR CLEANER

Allowing the filter element to become plugged with dirt restricts the intake of air and results in reduced engine life. Clean the element and retainer in a petroleum-base solvent, dry and oil as shown in Figure 10.

WARNING **Use extreme care when cleaning with a petroleum-base cleaner due to fire hazard.**

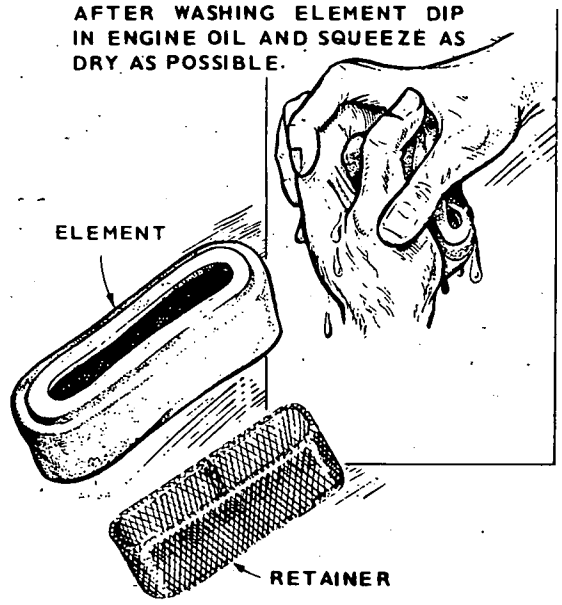


FIGURE 10. SERVICING AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Clean the plastic joints (do not lubricate) with a clean cloth (Figure 11). At the same time, check for binding, excessive slack and wear of the linkage.

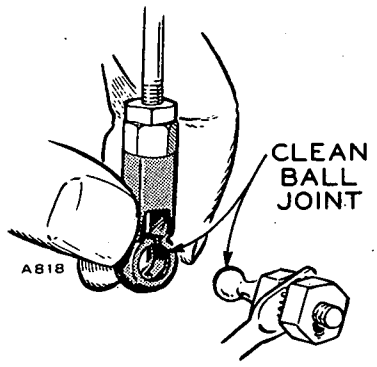


FIGURE 11. CLEANING BALL JOINT OF GOVERNOR LINKAGE

FUEL SYSTEM

Every 200 hours, remove and empty the fuel sediment bowl of dirt and condensation. Drain water from the fuel filters by loosening the drains on the bottom of each filter (Figure 12). Drain more often if needed.

Install a new primary fuel filter every 600 hours and a new secondary fuel filter every 3000 hours. Replace the fuel filters more often for extremely dusty conditions.

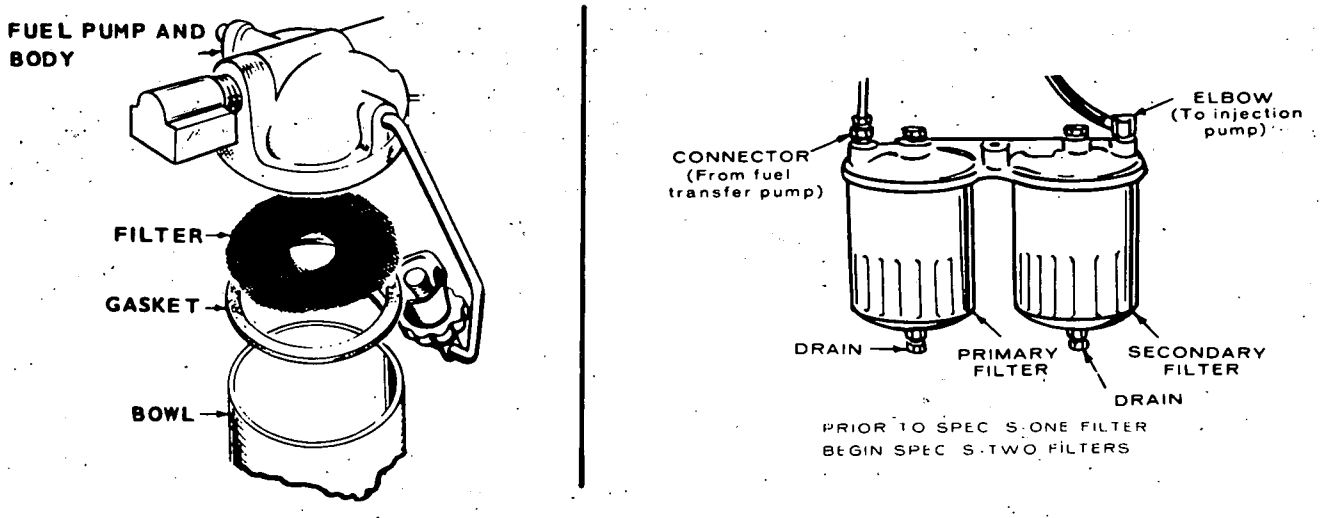


FIGURE 12. FUEL SYSTEM SEDIMENT BOWL AND FILTER MAINTENANCE

COOLING SYSTEM

To remove the heat produced during operation, engines use a pressure air cooling system. Blades on the flywheel draw air in the front of the engine housing, force the air past all the cylinders and out the right side of the engine.

MAINTENANCE

Maintenance should consist of cleaning the generator cooling and engine cooling area (fins on cylinder heads) at regular intervals, normally every 1,000 hours but more often under dirty operating conditions.

ENGINE OVERHEATING

Overheating is usually difficult to discover in any air-cooled engine, but the first sign is usually engine loosing speed momentarily or low engine power. This happens before the engine siezes and results in scored pistons.

The most probable causes of overheating are dirty cooling surfaces, operating without the engine air housing, poor air circulation, improper lubrication, wrong injection timing and overloaded engine.

CAUTION **Overheating can permanently damage the engine. The air housing including the door must be on when operating the engine.**

GENERATOR

The generator pulls in cooling air at the rear air inlet, then pushes it through the generator as it picks up generator heat. Openings on the front of the generator by the engine expel the heated air. Make sure the generator cooling inlets and outlet are never covered or restricted.

FUEL SYSTEM

The diesel system provides a means of filtering, transporting and delivering fuel in a fine spray to the engine cylinder at the correct time for ignition. The system consists of a primary fuel filter, fuel transfer pump, secondary fuel filter, injection pump and an injection nozzle. Figure 13 shows the fuel system.

The diaphragm fuel transfer pump which operates directly off the engine camshaft, draws fuel from a supply tank and delivers it through two filters to the injection pump. The injection pump meters fuel and delivers it at high pressure to the injection nozzle at the correct time.

The injection nozzle opens at a set pressure, delivering fuel in a fine spray to the precombustion chamber for ignition.

Excess fuel is returned to the tank after each injection cycle by a fuel return line from the nozzle. An adapter combines the leak-off fuel with the flow-through fuel from the injection pump. A return line connected at this point returns the combined fuel back to the fuel supply tank.

CAUTION **A diesel engine cannot tolerate dirt in the fuel system. It is one of the major causes of diesel engine failure. When opening any part of the fuel system beyond the secondary fuel filter, place all parts in a pan of clean diesel fuel as they are removed. Before installing new or used parts, flush them thoroughly and install while still wet.**

MAINTENANCE

In addition to the regular service periods, change the secondary fuel filter cartridge whenever the engine shows signs of starving from lack of fuel. Remove the secondary filter by removing the large cap screws in the center of the filter cover. Use care when replacing the filter cartridge to avoid getting dirt into the injection pump passages.

When replacing or cleaning the filters, bleed the fuel system. Operate the hand priming lever on the transfer pump until no air bubbles flow from the return line fitting of the injection pump. Return the priming lever to its original position. See Figure 14.

CAUTION **If the transfer pump cam is on the high side, the priming lever will not operate the pump. Turn the engine one revolution before operating the prime lever.**

Starting with Spec S, the fuel filtration system accommodates both primary and secondary fuel filters on a common mounting casting which is bolted to a newly-designed oil fill tube. The engine cannot be run with either filter loose or missing, thus ensuring proper filtration at all times.

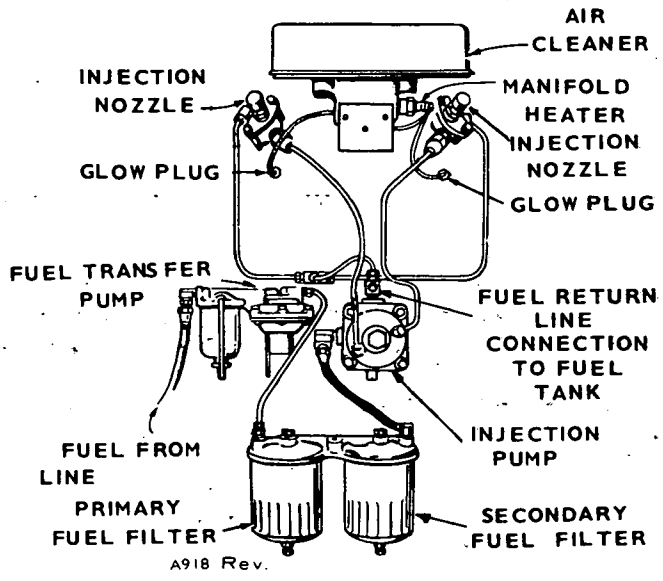


FIGURE 13. FUEL SYSTEM

Drain water periodically as required from both filters. Replace primary filter every 600 hours and secondary filter every 3000 hours. When replacing filter, tighten screw until gasket touches base, then tighten screw 1 to 1-1/2 turns.

FUEL TRANSFER PUMP

The transfer pump is located on the left side of the engine near the rear. If fuel does not reach the secondary filter, make the following checks before removing the pump.

1. Check the fuel tank and see that the shutoff valve is open.
2. Remove the fuel line from the transfer pump outlet and work the priming lever on the pump. Fuel should spurt out of the pump. If not, remove the pump for repair or replacement.

Testing: If the transfer pump delivers fuel, test it with a pressure gauge or manometer. Perform these tests before removing the pump from the engine. Remove the pump outlet and install the pressure gauge (Figure15).

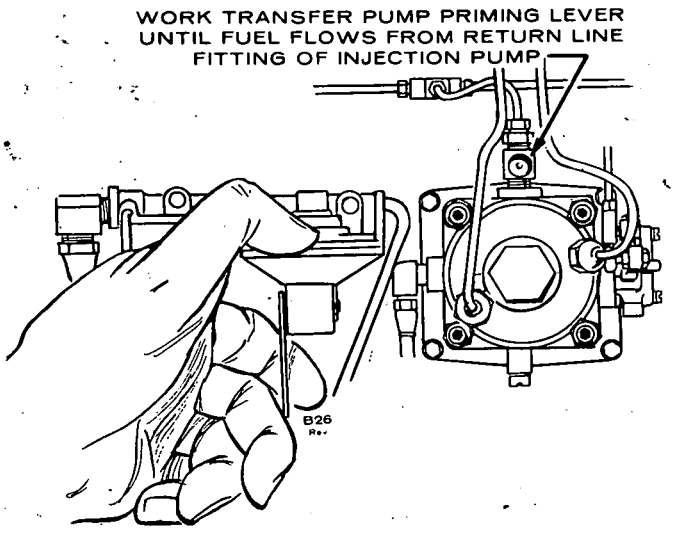


FIGURE 14. BLEEDING FUEL SYSTEM

Test the valves and diaphragm by operating the primer lever a few times and watching the pressure. It should not drop off rapidly after priming has stopped.

Next, run the engine at governed speed on fuel provided by gravity feed and measure the fuel pump pressure developed. Pressure should be between 12 and 14 psi (83 and 97 kPa) with the gauge 16 inches above the fuel pump.

A low pressure reading indicates extreme wear in one part or some wear in all parts, and the pump should be overhauled or replaced. If the reading is above maximum, the diaphragm is probably too tight or the diaphragm spring too strong. This can also be caused by fuel seeping under the diaphragm retainer nut and

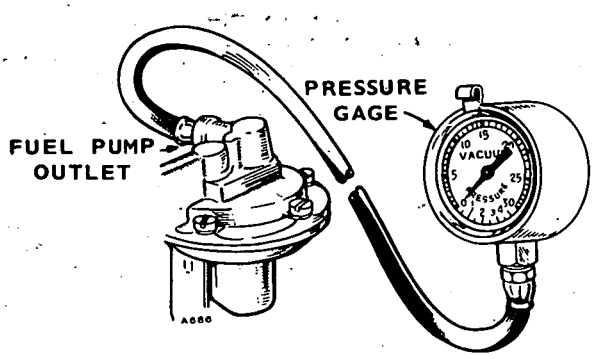


FIGURE 15. FUEL PRESSURE GAUGE

between the diaphragm layers, causing a bulge in the diaphragm. Overhaul the pump and replace the defective parts.

Low pressure with little or no pressure leak after pump stops indicates a weak or broken spring or worn linkage, and in most cases, the pump should be replaced. Figure 16 shows the fuel transfer pump.

Fuel Pump Disassembly:

1. Remove the pump inlet and outlet lines. Remove the two cap screws holding the pump to the engine and lift it off.
2. Notch the pump cover and body with a file so they can be reassembled in the same relative positions and remove the six screws holding them together.
3. Tap the body with a screwdriver to separate the two parts.

CAUTION **Do not pry them apart because the diaphragm will be damaged.**

4. Remove the screws holding the valve plate to the cover and lift out the valve and cage assemblies.

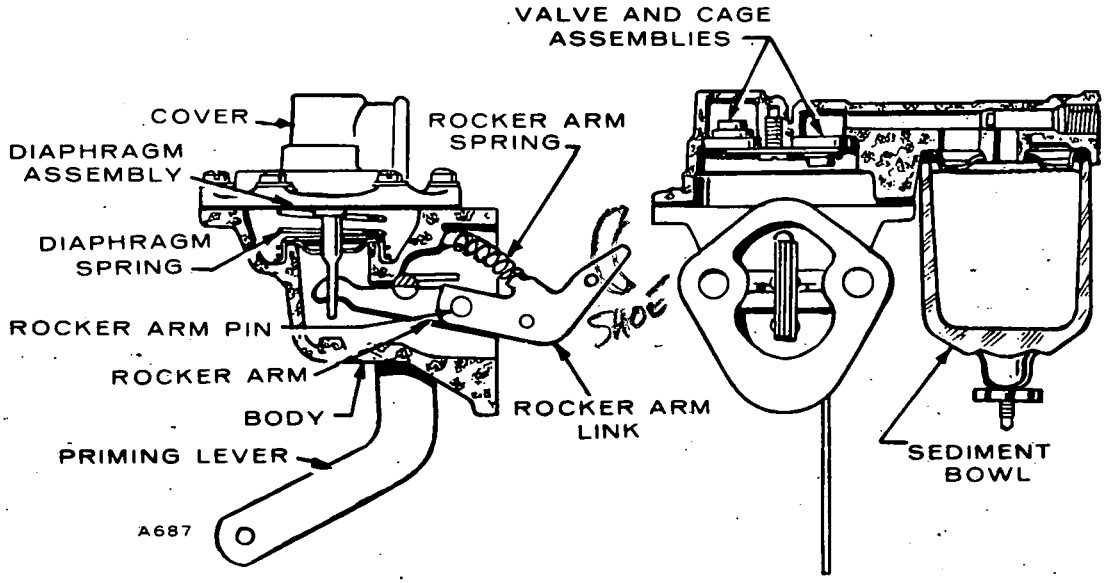


FIGURE 16. FUEL TRANSFER PUMP

5. Drive out the rocker arm hinge pin.
6. Remove the rocker arm, spring and link.
7. Lift out the diaphragm assembly and diaphragm spring.

Repair: Transfer pump failure is usually due to a leaking diaphragm, valve and valve gasket. A kit is available for replacement of these parts. Because the extent of wear cannot be detected by the eye, replace all parts in the kit. If the diaphragm is broken or leaks, check for diluted crankcase oil and replace.

Assembly:

1. When installing a new diaphragm, insert the diaphragm spring and diaphragm into the pump body.
2. Insert the link and rocker arm into the body and hook it over the diaphragm pull rod. Align the rocker arm with the rocker arm pin hole and drive in the pin. The priming lever must be in the position shown in Figure 14 when installing the rocker arm.
3. Compress the rocker spring and install between the body and rocker arm.
4. Insert the valve cages, gaskets and valve cover plate. Position the inlet valve with spring showing and the outlet valve with spring in the cover recess.
5. Assemble the cover to the body with notch marks lined up. Install the screws, but do not tighten.
6. Push the rocker arm in full stroke and hold in this position to flex the diaphragm.

CAUTION **The diaphragm must be flexed or it will deliver too much fuel pressure.**

7. Tighten the cover screws alternately and securely, then release the rocker arm.
8. Install the pump on the engine and repeat the pressure test.

INJECTION PUMP

The American Bosch PSU injection pump is located near the center of the left side of the engine crankcase. A cam and gear on the camshaft drive the pump. The gear drives the pump face gear, providing fuel distribution to each cylinder in the proper order. The cam operates the pump plunger, producing pressure to deliver the fuel and open the nozzles. A control sleeve meters the fuel by controlling the length of time the plunger port is closed, maintaining pressure and the amount of fuel delivered in each stroke. Timing the pump to the engine determines the point of port closing. The correct port closing point is 19° BTC. The position of the metering sleeve on the plunger controls the port opening and this depends on the throttle setting.

Adjustments: One adjustment screw, located on the injection pump control assembly, sets the maximum and minimum injection points. Set the maximum stop screw while gradually increasing the load to stop the throttle at the smoke point. Set the minimum stop screw to just fully close the throttle (no fuel injection).

Repair: Since most fuel system troubles are not due to a faulty injection pump, test the rest of the fuel system before condemning the injection pump.

CAUTION **It's generally recommended not to make field repairs of the injection pump because of the exceptionally close tolerances between parts and the specialized equipment necessary for repair. The injection pump is an expensive part of the unit and even a particle of dirt as fine as talcum powder could score its working surfaces. If the rest of the fuel system is in working order and fuel delivery abnormal, remove the pump for replacement or repair. American Bosch maintains a world-wide repair service for these pumps.**

Removal: If the pump is removed from the engine, be sure the steel shims between the pump and the crankcase mounting are the same on reassembly to maintain proper gear backlash. The number stamped on the crankcase indicates the proper shim thickness. This thickness does not change when a new pump is installed. It only changes when a new crankcase is installed, and then the thickness of the proper shims is stamped on the new crankcase.

CAUTION **Do not change the pump mounting shims total thickness or the proper pump gear to camshaft gear mesh will be affected. The shims thickness is stamped on the cylinder block above the pump mounting boss. Shim thickness is established at the factory during engine assembly and does not change unless a new cylinder block is installed.**

Remove the pump inlet, outlet and return lines. Remove the four cap screws holding the pump to the crankcase and lift it off. Be careful to retain the shims between the crankcase and pump.

Injection Pump Timing: Time the injection pump to the engine by using the proper thickness timing button between the pump plunger and tappet. It is timed to the engine at the factory so the port closing for injection occurs at 19° BTC (PC mark in Figure 17).

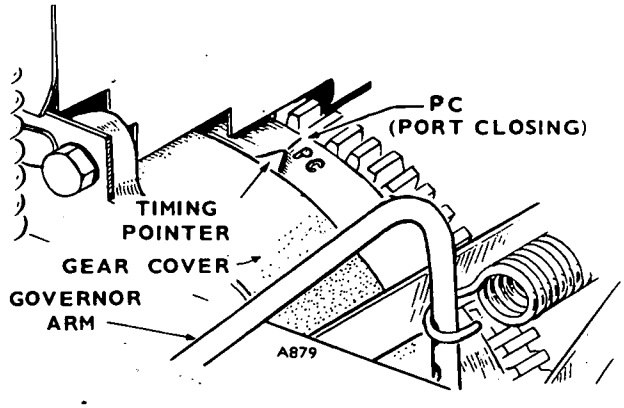


FIGURE 17. PORT CLOSING

Use **Method 1** when replacing an old pump if the port closing dimensions and button number of the old pump were recorded. Use **Method 2** if the dimensions are unknown and old pump is being retimed, or when replacing either the camshaft or crankshaft.

CAUTION **Pump timing is critical for correct engine power and performance.**

Method 1: This is a means for calculating the correct button thickness before the pump is installed. It requires the port closing dimensions and button thickness from the pump being replaced.

The formula for determining the proper port closing (PC) timing button for a new or replacement pump is as follows:

1. Remove old pump.
2. Determine total pump flange and button thickness for old pump (see Table 1 and Figure 18).
   a. Write down dimension given on old pump flange. See Example.

Example Formula:

Port closing dimension of old pump	1.109 (28.169 mm)
Button thickness of old pump	+ .107 (2.718 mm)
	1.216 (30.886 mm)
Port closing dimension of new pump.....	-1.103 (28.016 mm)
Button thickness of new pump	.113 (2.870 mm)

b. Remove old pump timing button.

CAUTION **Be sure to hold the pump drive securely to the pump body when removing the tappet, Figure 18. If not, the pump will come apart and be difficult to reassemble. Also, the metering sleeve may drop off the plunger into the sump when the plunger is removed. If the mechanic is not aware of it, he could put the pump back together, but it will not operate. If the plunger port is not enclosed by the sleeve, there will be no fuel delivery. Use a pair of channel lock pliers or a screwdriver to remove the tappet from the O-ring in the drive gear.**

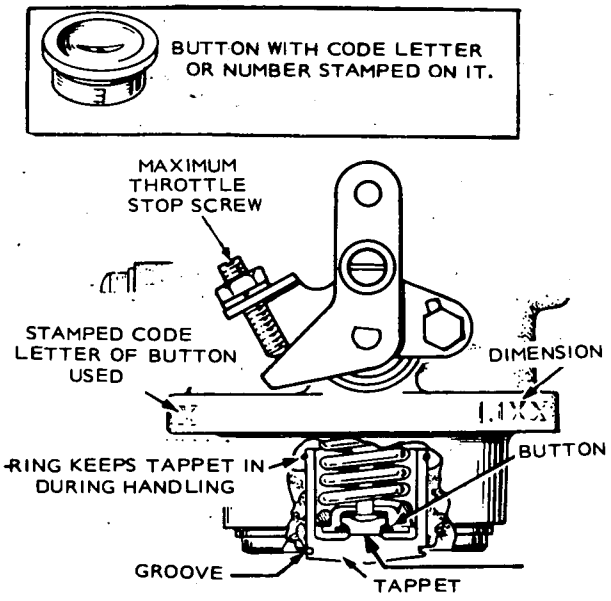


FIGURE 18. INJECTION PUMP BUTTON INSTALLATION

c. Obtain dimension of old timing button from Table 1 corresponding with number or letter code on timing button.
d. Add dimension on old pump flange to timing button dimension from Table 1.
e. Write down total PC dimension for old pump.
f. Write PC dimension from new pump flange and subtract it from total PC dimension for old pump.
g. Use calculated dimension for new timing button.

TABLE 1. TIMING BUTTONS

GROUP 1				GROUP 2			
CODE	PART NO.	SIZE		CODE	PART NO.	SIZE	
		Inch	mm			Inch	mm
16 or S	147-0186	.134	3.404	1 or A	147-0147	.119	3.023
15 or R	147-0187	.131	3.357	2 or B	147-0148	.116	2.946
14 or P	147-0188	.128	3.251	3 or C	147-0149	.113	2.870
13 or N	147-0189	.125	3.175	4 or D	147-0150	.110	2.794
12 or M	147-0190	.122	3.099	5 or E	147-0151	.107	2.718
				11 or Std	147-0161	.104	2.642

Group 1. Used in all late model pumps
Group 2. Used in early models of all pumps

Pump Kits prior to Spec R—147-0218

Pump Kits beginning Spec R—147-0219

TABLE 2. TIMING BUTTONS

TIMING EARLY	USE BUTTON	TIMING LATE	USE BUTTON
.1"	6 or F	.1"	5 or E
.2"	7 or H	.2"	4 or D
.3"	8 or J	.3"	3 or C
.4"	9 or K	.4"	2 or B
.5"	10 or L	.5"	1 or A
		.6"	12 or M
		.7"	13 or N
		.8"	14 or P
		.9"	15 or R
		1.0"	16 or S

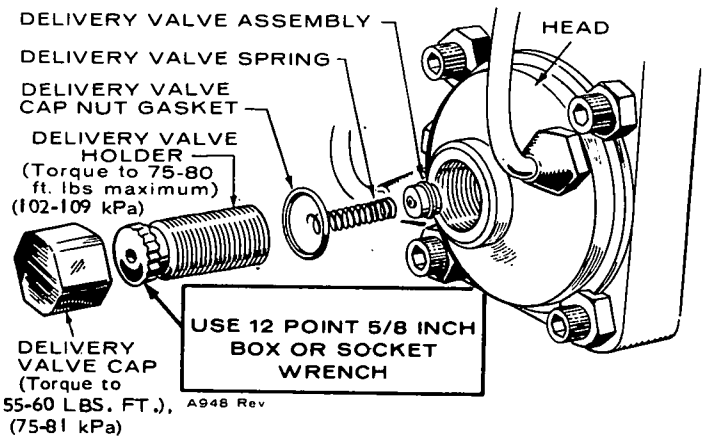


FIGURE 19. DELIVERY VALVE ASSEMBLY

Method 2, Flowing the Pump: Flow timing the injection pump can be done using fuel to determine whether or not the proper timing button has been installed for best operating conditions. In case the pump is removed without recording the PC dimension and the timing button thickness, it is necessary to flow time the pump to establish the exact PC position.

1. Install No. 12 timing button in pump as previously discussed and install the pump per instructions under *Injection Pump Installation.*

   Button 12 or M is the mid-range of the button sizes used the most. The button dimension is determined by the number or letter stamped on its side.

2. Remove the delivery valve cap nut (also delivery valve holder on later models, Figure 19), and lift out the delivery valve spring. Install the delivery valve cap nut and holder.
3. Rotate the flywheel (counterclockwise) to a point about 15 degrees before the port closing mark (compression stroke number 1 cylinder).
4. Position the fuel control in the full fuel position. Disconnect number 1 injection line from the nozzle and position line so full fuel is visible. Pump the priming lever while turning the flywheel clockwise until fuel stops coming out of the injection line. This is the port closing point or the point where injection begins.
5. Check the position of the port closing mark in reference to the timing pointer. If the button thickness is correct, the pointer will coincide with the port closing mark. See Figure 17. If the timing pointer is before port closing (early timing) a thinner button is needed. If the timing pointer is between port closing and top center (late timing) a thicker button is needed. To determine the correct button, measure the distance between the port closing mark and the timing pointer. For each .1 inch difference, one button either larger or smaller, depending on whether timing is early or late, is required. A distance of .1 inch (2.5 mm) on the flywheel represents .003 inch (.076 mm) button thickness.
6. Replace the delivery valve spring (Figure 19). Be sure all components of the delivery valve are installed and properly torqued. The delivery valve holder must be retorqued prior to installation of cap nut.

   CAUTION **The PSU pump housing must never be clamped in a vise to torque the delivery valve holder and cap nut. Clamping the pump in a vise can distort the aluminum body, unseat the lower body seal and cause the face gear to bind in the housing. Any signs of damage from a vise or similar device is reason for refusing a warranty claim. Fuel injection pumps are precision equipment that must not be tampered with by inexperienced personnel or handled carelessly. Returning any pump for warranty claims or for rebuilding and reuse must be properly protected from dirt, moisture and shipping damages.**

7. Finish injection pump installation procedure.

Injection Pump Installation:

1. Put number 1 cylinder on compression.
2. Turn the flywheel to the port closing mark (PC) on the front cylinder compression stroke (Figure 17).
3. Remove the timing hole screw located on the pump mounting flange. Insert a 1/8 inch (3 mm) diameter brass wire into the hole (Figure 20).
4. Rotate the pump face gear until the wire slips into place, locking the gear in position.
5. Mount the pump on the crankcase (be sure the shims are in place) and secure with screws. If the "O" ring between pump and crankcase is worn, cracked or otherwise defective, replace it.

   The flat area just above the pump has a number marked on it which refers to the shim thickness required between the pump and its mounting pad for assuring proper backlash in the gearing. Don't forget the shims.

6. Remove the brass wire.
7. Rotate the crankshaft manually to see if the gears mesh. If gears mesh properly, secure the pump on the mounting studs using a flat washer, a lock washer, and a nut on each stud. Torque these nuts evenly to 15-16 ft. lb. (20-22 N•m).

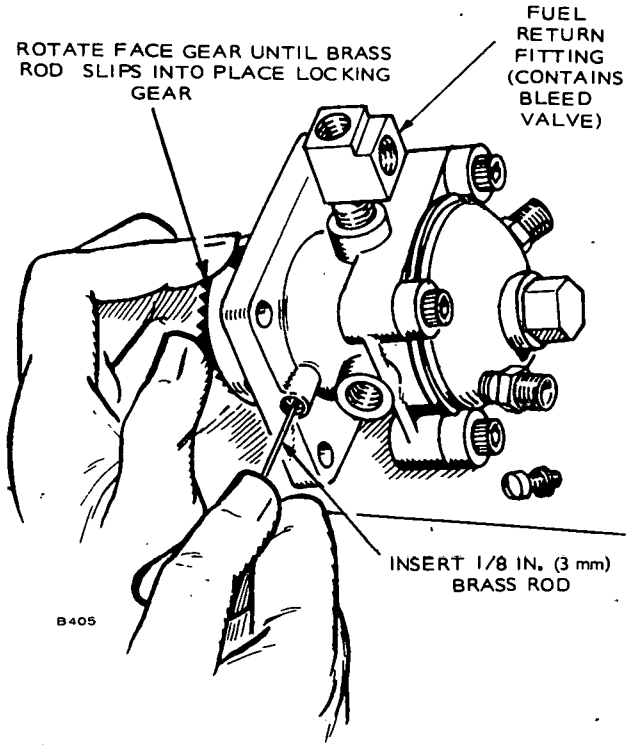


FIGURE 20. INJECTION PUMP

8. If the pump was not timed by **Method 1,** do it now, using **Method 2.**
9. Connect the flexible fuel inlet line to the pump inlet. Connect the fuel return line.
10. Connect each fuel outlet line to the proper pump outlet.
11. Connect the throttle linkage to the governor (see *GOVERNOR SYSTEM* section).
12. Run the engine and adjust the throttle maximum and minimum stops.

A constant bleed-check valve is furnished with all PSU pumps. The bleed valve automatically bleeds off a restricted amount of fuel, fuel vapors, and small quantities of air to prevent air accumulation in the fuel sump area of the pumps. This valve should open at pressures between 0.9 and 3.0 psi (6.2 and 20.7 kPa). See Figure 20 for location.

NOZZLES

The injection nozzles are the conventional inward-opening pintle type with adjustable opening pressure (Figure 21). They are factory adjusted to open at 1900 to 1950 psi (13110 - 13455 kPa). Do not attempt to disassemble the nozzles or adjust nozzle pressure without the proper test equipment. A nozzle pressure tester is essential to do this work.

Inspection: To inspect the nozzle spray pattern, remove the nozzle from the cylinder head. Crank the engine, let the nozzle spray into the air and watch the pattern. The spray should be cone shaped with a solid appearing center surrounded by cloudlike fog in which the spray is evenly atomized. See Figure 22. An apparent chattering of the nozzle is normal.

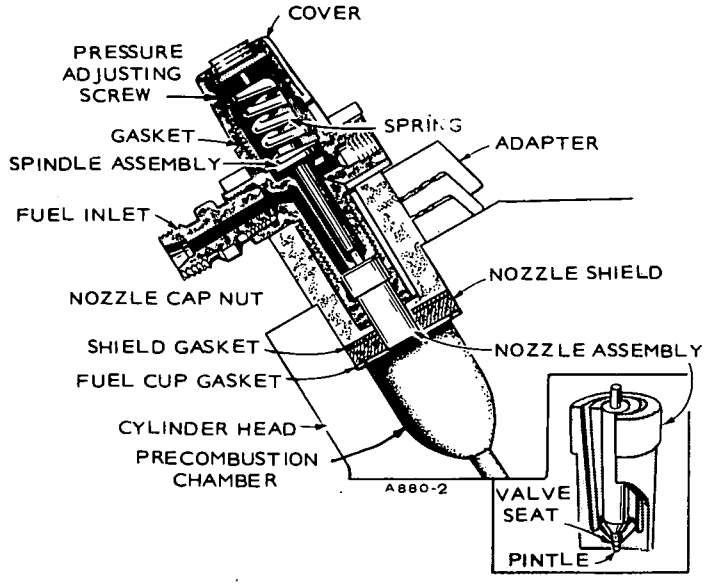


FIGURE 21. NOZZLE ASSEMBLY

If streamers are visible, the pattern is badly distorted or the nozzle drips before it reaches opening pressure, it is defective and must be cleaned or replaced.

WARNING **Do not let the nozzle spray against your skin. The fuel can penetrate flesh and cause a serious infection.**

Adjustment: To adjust the opening pressure, remove each nozzle from the engine and remove the cap nut over the adjusting screw of each. Install the nozzle to be tested on a static fuel nozzle testing fixture. Following the instructions on the tester, adjust the opening pressure to 1750 psi (12075 kPa) by turning the adjusting screw. Clockwise increases the pressure and counterclockwise decreases it. Do not try to adjust the pressure without a testing fixture.

Disassembly: When removing and disassembling nozzles, separate and label all components of each nozzle. Never interchange components between nozzles.

1. Remove each nozzle assembly from the engine and remove the fuel inlet and return lines.
2. Clamp the nozzle holder body in a vise and

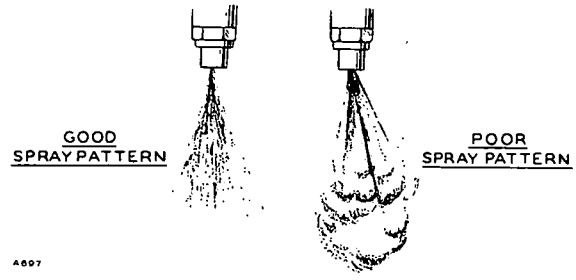


FIGURE 22. NOZZLE SPRAY PATTERN

remove the nozzle cap nut and nozzle.

3. Install the nozzle cap nut loosely to protect the lapped surface for the holder body.
4. If necessary to further disassemble the nozzle, reverse the pressure adjusting screw and lift out the spring and spindle assembly.

Work only in a clean room, on a clean work bench. Keep a pan of clean diesel fuel handy and have a supply of clean, lint-free wiping rags. Never use hard or sharp tools, emery paper, grinding powder or abrasives of any kind.

Soak each nozzle in fuel to loosen dirt. Then clean the inside with a small strip of wood soaked in oil and the spray hole with a wood splinter. If necessary, clean the outer surfaces of the nozzle body with a brass brush but do not attempt to scrape carbon from the nozzle surfaces. This can severely damage the spray hole. Use a soft, oil soaked rag or mutton tallow and felt to clean the nozzle valve.

Repair: If cleaning will not eliminate a nozzle defect, replace the nozzle or take it to an authorized American Bosch service station. Do not attempt to replace parts of the nozzle except for nozzle and pintle assembly.

Assembly: Rinse both valve and nozzle thoroughly before assembly and coat with oil. The valve must be free in the nozzle. Lift it about 1/3 out of the body. It should slide back to its seat without aid when the assembly is held at a 45° angle. If necessary, work the valve into its body with clean mutton tallow.

1. Remove all pressure on the nozzle spring by adjusting the pressure adjusting screw.
2. Clamp the nozzle holder body in a vise.
3. Set the valve in the body and set the nozzle over it.
4. Install the nozzle cap nut loosely.
5. Place the centering sleeve over the nozzle (Figure 23) for initial tightening. Then remove the centering sleeve to prevent it from binding between nozzle and cap nut and tighten the nozzle cap nut to specified torque.

Installation: Before installing the injection nozzles in the engine, thoroughly clean each mounting recess.

A dirty mounting surface could permit blow-by, causing nozzle failure and resulting power loss.

1. Install a new heat shield to head gasket in the cylinder head recess.

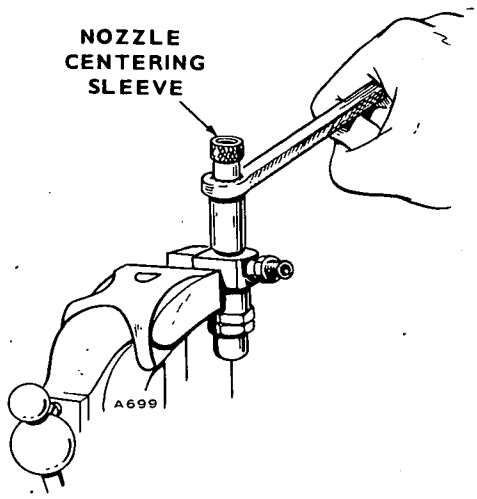


FIGURE 23. TIGHTENING NOZZLE CAP

2. Install the heat shield, a new nozzle gasket and the nozzle adapter.
3. Insert the nozzle assembly into the recess. Do not strike the tip against any hard surface.
4. Install the nozzle flange and cap screws. Tighten the cap screws alternately to avoid cocking the nozzle assembly. Tighten each to 20 to 21 ft. lbs. (27 to 28 N•m).

PREHEATING CIRCUIT

This circuit consists of two manifold heaters to heat the engine intake air in the intake manifold and glow plugs in each cylinder to heat the precombustion chamber. Used for engine starting, the manifold heater and glow plugs are wired in parallel and controlled by a preheat switch.

Check each heater by removing its lead, operating the preheat switch and touching the lead to its terminal. If it sparks, there is continuity and the heater is working. If any components of this circuit fail, replace them. Do not attempt repairs on individual components. If there is still a question, check the components for heating.

GOVERNOR SYSTEM

The purpose of the engine governor is to maintain a constant engine speed during changes in power demands.

The speed sensing device is a ball and cup mechanism on the camshaft gear. A yoke, resting on the cup, is connected to the governor arm which, in turn, is connected to the throttle lever (Figure 24). Any change in engine speed is transmitted from the cup to the yoke and on to the throttle.

The manual governor control lever has two positions, WELD and POWER. Engine speed is 1800 rpm for POWER operation, 2400 rpm for WELD operation (approximately 1850 and 2450 rpm respectively for no-load operation). For adjustments of the speed control or governor control linkage, refer to "Early Spec R Models" or "Begin Late Spec R Models," whichever is applicable (see Figures 25 and 26).

For removal of governor cup, governor balls, cam gear, etc., see *ENGINE DISASSEMBLY* section.

BEGIN LATE SPEC R MODELS

1. Move the manual governor control lever to POWER. There should be some slack between the lever and the nuts on the governor adjusting stud. Otherwise, the adjustment for step 2 won't be properly made.
2. Engine speed should be approximately 1850 rpm for AC power at no load. If not, loosen the nuts on the end of the governor switch plate, turn clockwise (CW) to increase engine speed and counterclockwise (CCW) to decrease speed.
3. After the desired rpm is reached, tighten the two nuts together again.
4. Move the manual governor control lever to WELD.
5. Engine speed should be approximately 2450 rpm at no load. If not, loosen the two nuts on the end of the governor adjusting stud (or nuts holding end of the manual governor control lever). Turning the nuts CW increases speed, CCW decreases engine speed.
6. Check engine speed while welding at maximum current load. Speed should be approximately 100 rpm lower (2350 rpm) than no load.
7. For sensitivity adjustment, take a screwdriver and adjust as shown in Figure 25.

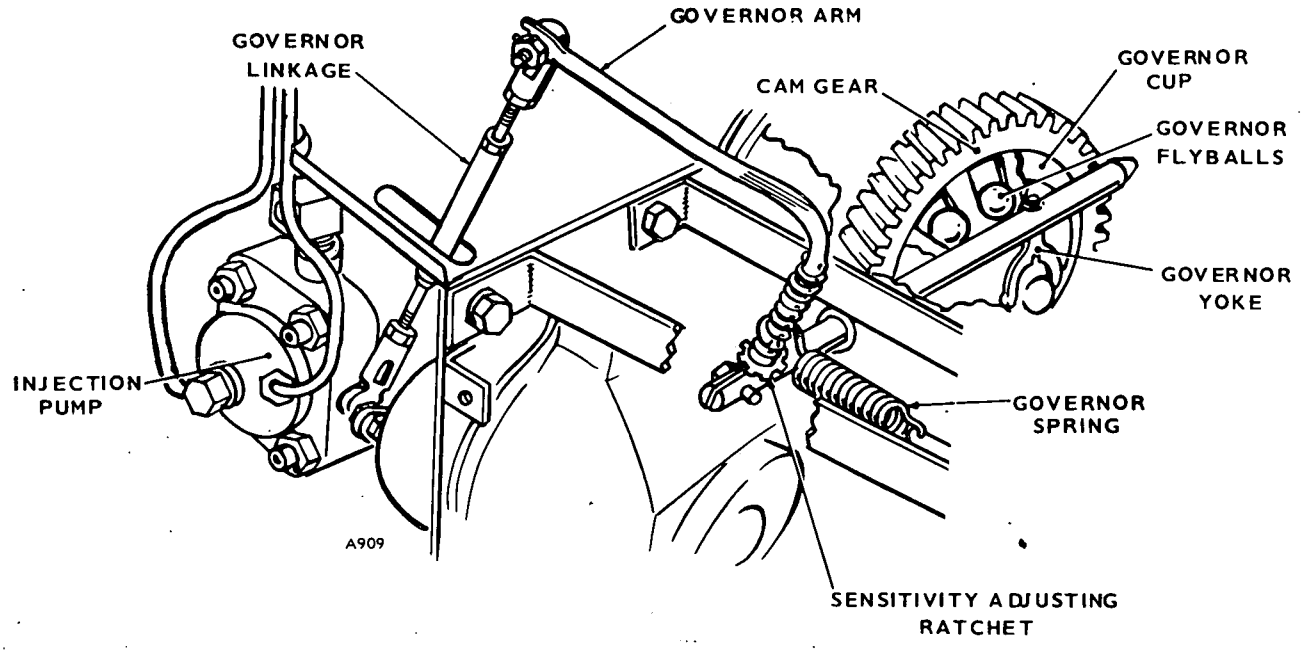


FIGURE 24. GOVERNOR SYSTEM

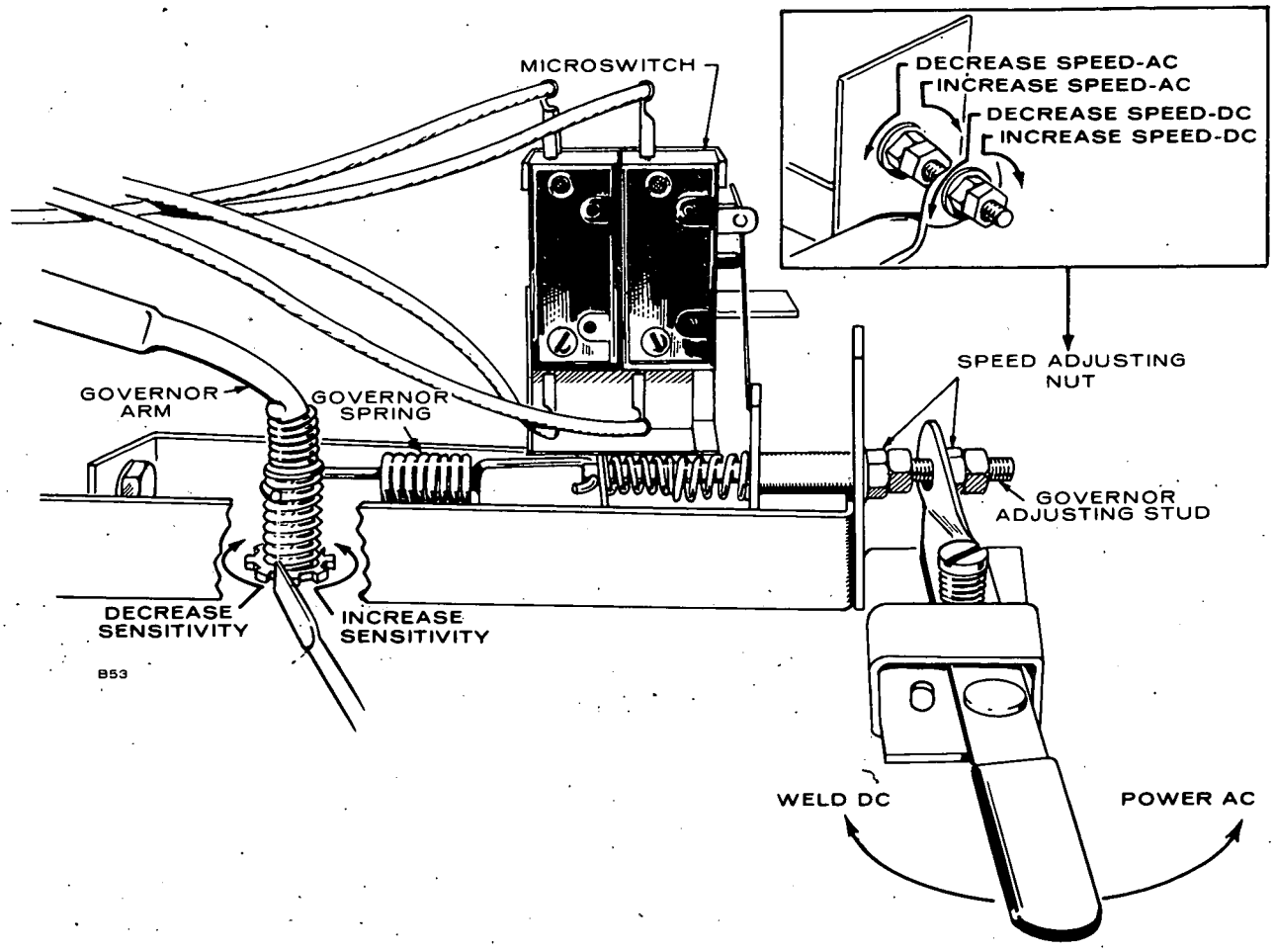


FIGURE 25. GOVERNOR ADJUSTMENTS (BEGIN LATE SPEC R MODELS)

EARLY SPEC R MODELS

1. Move the manual governor control lever to POWER.
2. Adjust the spring tension as shown in Figure 26 to produce engine speed of approximately 1850 rpm at no load.
3. Move lever to WELD position. Engine speed should be approximately 2450 rpm at no load.
4. Check engine speed while welding at maximum current load. Engine speed should be approximately 100 rpm lower (2350 rpm) than no-load speed.
5. For sensitivity adjustment, use a screwdriver and adjust as shown.

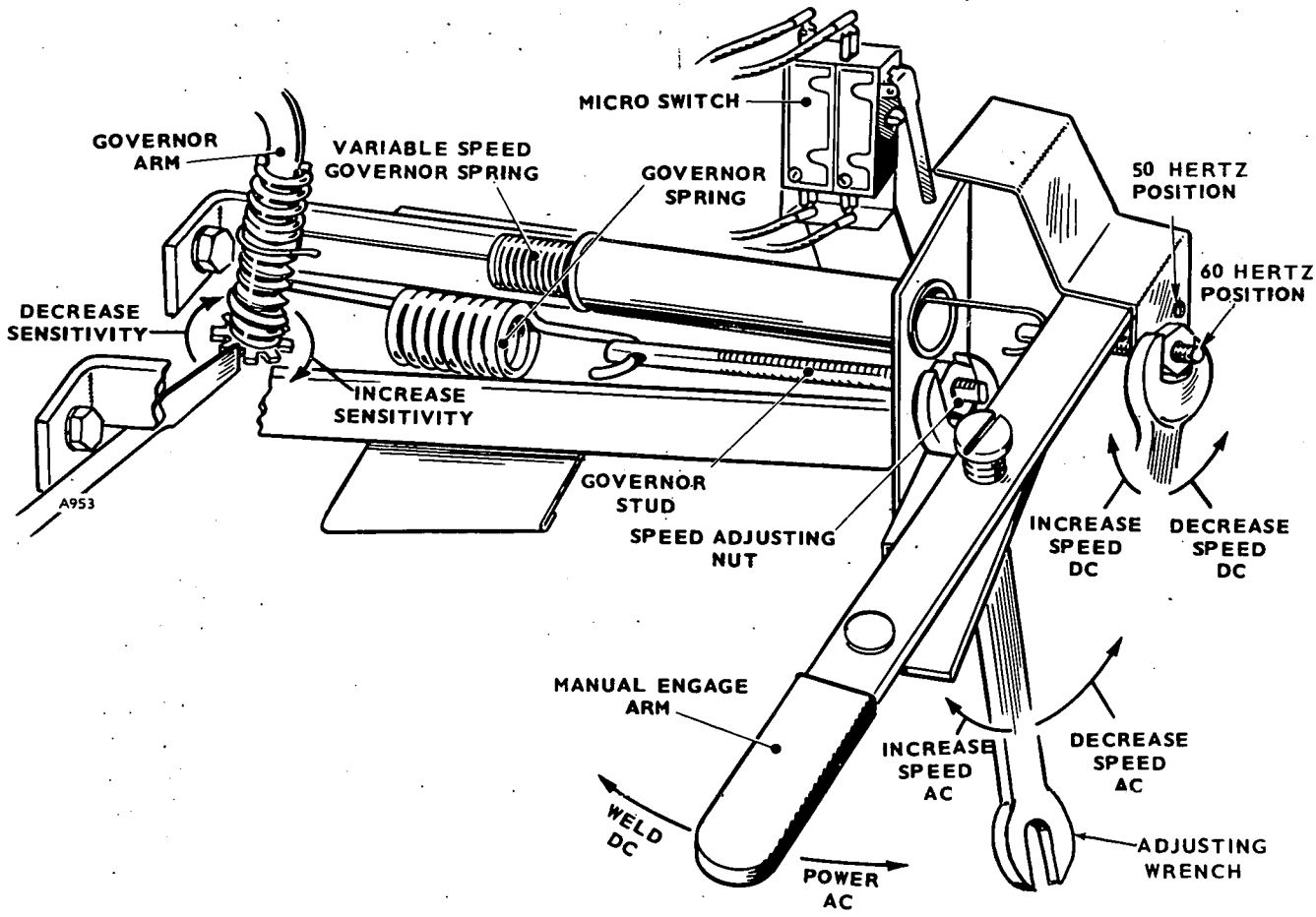


FIGURE 26. GOVERNOR ADJUSTMENTS (EARLY SPEC R MODELS)

OIL SYSTEM

DJB engines have pressure lubrication to all working engine parts. The oil system includes:

- Oil intake cup
- Gear type oil pump
- Bypass valve
- Oil pressure gauge
- Full-flow oil filter
- Oil passages to deliver oil throughout the engine

The pump draws oil from the crankcase and delivers it through the oil filter to the rocker housing, crankcase drillings to the crankshaft bearings, camshaft passages to connecting rod bearings and connecting rod passages to piston pin bushings. Because it aids oil consumption control, the crankcase breather is included in the oil system.

Normal oil pressure should be 25 psi (173 kPa) or higher when the engine is at operating temperature. If pressure drops below 20 psi (138 kPa) at governed speed, inspect the oil system for faulty components.

MAINTENANCE

Maintenance of the oil system includes changing crankcase oil, cleaning the crankcase breather and rocker box oil lines, and replacing the oil filter. See *PERIODIC MAINTENANCE* for recommended service.

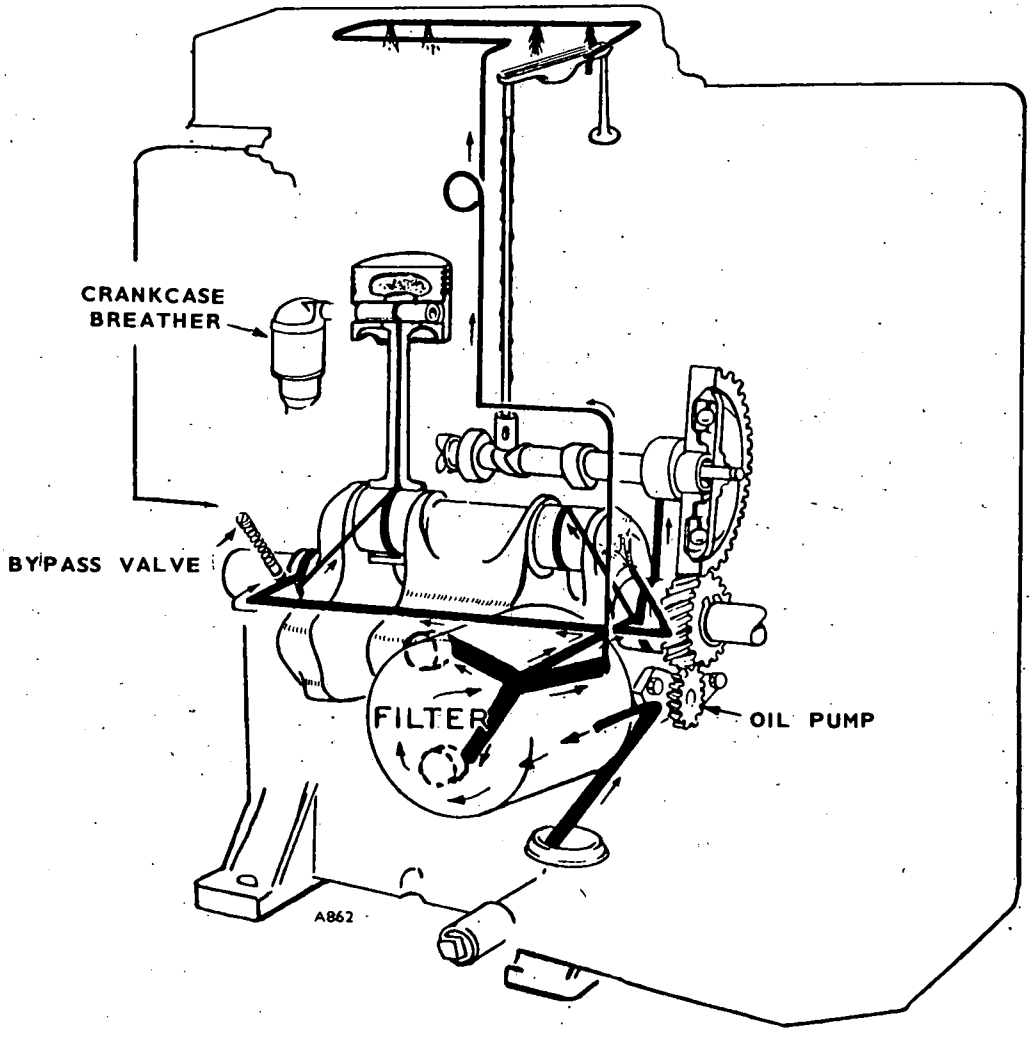


FIGURE 27. OIL SYSTEM

Use an oil with the API designation CD/SE or CD/SD. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following.

TEMPERATURE	GRADE
Above 32° F (0° C)	SAE 30
0° F to 32° F (-18° C to 0° C)	SAE 10W or 5W-30
Below 0° F (-18° C)	SAE 5W-30

Multigrade oils are recommended for temperatures of 32° F (0° C) and below, but they are not recommended for temperatures above 32° F (0° C). When adding oil between oil changes, it is preferable to use the same brand as in the crankcase. Various brands of oil may not be compatible when mixed together.

OIL PUMP

The pump is driven by the crankshaft gear and is mounted in front of the crankcase behind the gear cover.

Oil Pump Removal

1. Remove the gear cover and oil base.
2. Unscrew the intake cup from the pump.
3. Remove the crankshaft lock ring and gear retaining washer.
4. Loosen two cap screws holding the pump and lift out.

Repair parts for the pump are not individually available except for gaskets. If the pump is excessively worn, replace it. Disassemble the pump by removing two cap screws holding the pump cover to the body. To improve pump performance, adjust the gear end clearance by changing gasket thickness between the pump body and cover. Use the thinnest gasket permitting free movement of the pump shaft. Oil all parts when assembling the pump.

Installation includes filling the pump intake and outlet with oil to be sure it is primed before installing.

Mount pump on the engine and adjust for .005 inch (.127 mm) lash between the pump gear and crankshaft gear. Mount pump intake cup parallel with the bottom of the crankcase.

BYPASS VALVE

The bypass valve (located on the outside of the rear bearing plate) controls oil pressure by returning excess oil back to the crankcase. Normally, the valve opens at 25 psi (173 kPa).

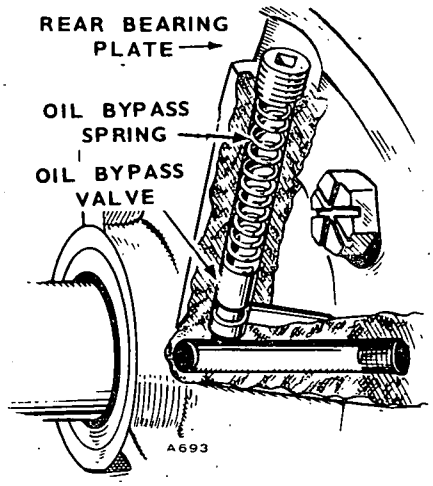


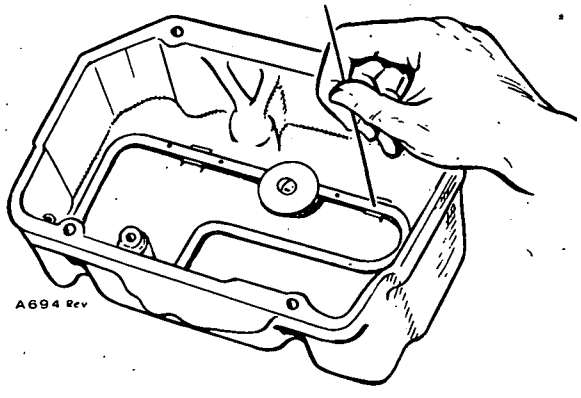
FIGURE 28. OIL BYPASS VALVE

High oil pressure may be caused by the plunger sticking closed, and low oil pressure by the plunger sticking open.

To inspect the valve, unscrew the recessed plug in the rear bearing plate. Then lift out the spring and plunger assembly. Determine valve operation by comparing spring and plunger to specification in *DIMENSIONS AND CLEARANCES* section.

OIL LINES

The oil lines in the rocker box should be flushed with an approved solvent and the small holes opened with fine wire. Blow out all other oil lines and drillings with compressed air whenever the engine is disassembled. Reach the oil gauge passage by removing the oil filter mounting plate.



FLUSH ROCKER BOX OIL LINE WITH FUEL AND CLEAN HOLES WITH FINE WIRE.

FIGURE 29. ROCKER BOX OIL LINE

All external oil lines, rocker box oil line and the internal oil line to the rear bearing are replaceable.

OIL PRESSURE GAUGE

The gauge is located on the lower front cylinder block corner. Before replacing, check for clogged oil passage behind the gauge. Remove it with a wrench and replace with a new gauge if faulty.

FULL FLOW OIL FILTER

The oil filter mounts on the filter plate at the left front crankcase corner. It requires replacement every 200 hours of normal operation. Remove filter by turning counterclockwise using a filter wrench. Install new filter fingertight plus 1/4 to 1/2 turn. See Figure 30.

If oil becomes so dirty that markings on the dip stick cannot be seen, change the oil filter and shorten filter service period.

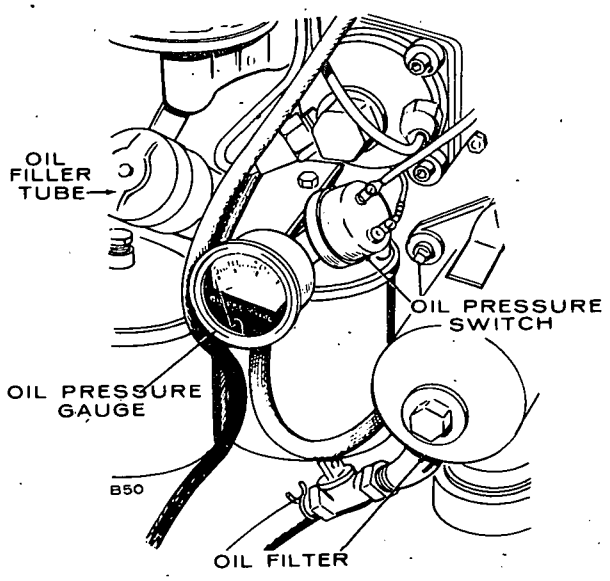


FIGURE 30. OIL FILTER LOCATION

STARTING SYSTEM

This engine has a separate Prestolite starting motor on the right side of the engine to drive the flywheel. It is a standard automotive type with solenoid shift and over-running clutch controlled by a start solenoid. When the solenoid energizes, the motor solenoid operates, shifting the starter pinion to engage the flywheel ring gear and closing the starting motor circuit. The over-running clutch protects the starter armature from overspeeds.

Because parts for the Prestolite starter are not stocked, see a Prestolite dealer.

MAINTENANCE

Periodically inspect the starting system to assure that it is in peak condition.

Inspect motors every 500 hours for loose or dirty connections. Inspect the starter commutator and clean with number 240 sandpaper if dirty. Check the brushes for excessive wear and reduced armature seating.

Test for poor cranking performance caused by a faulty starting motor, defective battery or high resistance in the starting circuit.

Battery charge condition should be tested with a hydrometer every 100 hours. Specific gravity should read from 1.225 to 1.260. If not, charge the battery. If the battery won't charge, replace it.

Wiring should be checked with the starting motor operating. Check the voltage drops:

1. From the battery ground terminal post (not the cable clamp) to the cylinder block.
2. From the cylinder block to the starting motor frame.
3. From the battery positive post to the battery terminal stud on the solenoid.

Normally, each of these should be less than 0.2 volts. If extra-long cables are used, voltage drops may be higher. Clean all circuit connection showing excessively high voltage drops.

Starting motor tests should include testing of free running voltage, speed and current, and tests of stall torque, voltage and current. Always remove motor for these tests.

To test the free running characteristics, connect the starting motor in series with a battery and ammeter and install a tachometer on the motor. Read the free running current and speed.

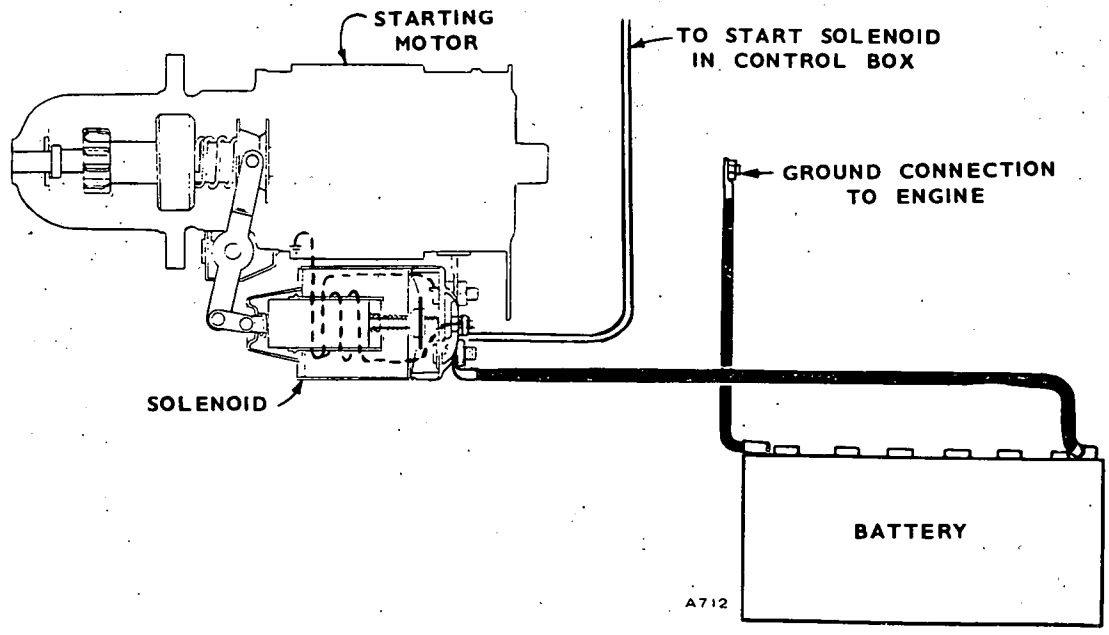


FIGURE 31. STARTING SYSTEM

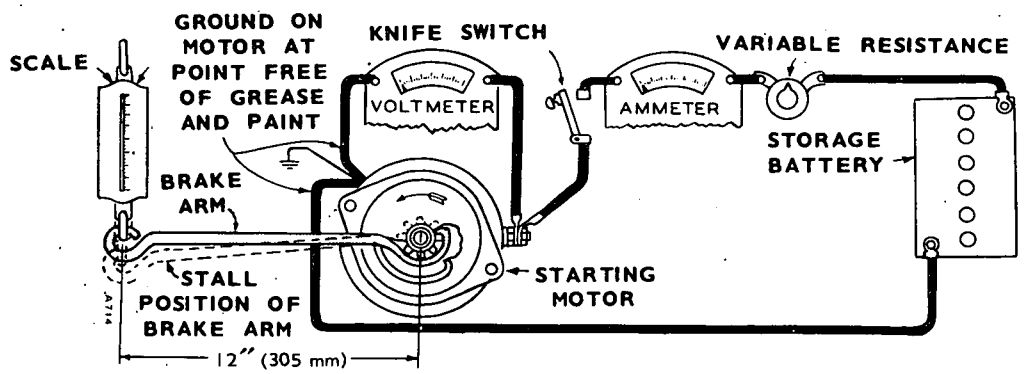


FIGURE 32. STARTING MOTOR STALL TORQUE TEST

The torque test (Figure 32) requires a spring scale and torque arm, voltmeter, ammeter and variable resistance to apply the voltage specified by the test characteristics.

The voltage drop across the solenoid on the starting motor should be less than 1.50 volts. If not, remove and repair.

The battery charging system maintains the battery at or near full charge at all times. If it doesn't maintain charge, adjust the charge rate if battery is in good condition.

If battery discharge (or failure to charge) can't be traced to the charging system, test the battery. Replace if necessary.

STARTING MOTOR REMOVAL AND DISASSEMBLY

1. Remove electrical connections to control box and battery at the starter shift solenoid.
2. Remove the muffler heat shield.
3. Remove rear starting mounting bracket nut.
4. Remove two cap screws holding starting motor to the starter mounting flange. Then pull starting motor off the engine.
5. Remove link pin holding shift lever to solenoid plunger and remove the shift lever pivot pin.
6. Extract through bolts from commutator end of motor. Remove end cover and lift brushes off their seats.
7. Pull the cast housing from the front end of the motor and lift the armature and clutch out of the motor frame.
8. Remove over-running clutch by driving the retainer away from lock-ring near the front end of the shaft. Remove lock-ring and pull off assembly. Don't disassemble the clutch.
9. To service the solenoid, remove four cap screws and electrical connection holding it to the motor frame. Remove two screws at solenoid rear to reach the switch contacts.

STARTING MOTOR REPAIR

Armature: Inspect armature for mechanical defects before testing for grounds or shorted coils.

CONDITION	CHECK FOR
Low Free Speed, High Current	Tight, dirty or worn bearings, bent armature shaft or loose field power screws which would allow the armature to drag, a shorted armature or a grounded armature or field.
Won't Operate, High Current	Direct ground in switch terminal, field, or frozen shaft bearings.
Won't Operate, No Current	Open field circuit, open armature coils, broken or weakened brush springs, worn brushes, high mica on commutator.
Low Free Speed, Low Torque, Low Current	Open field winding, or high internal resistance due to poor connections, defective leads, or dirty commutator.
High Free Speed, Low Torque, High Current	Shorted field windings. Since there is no easy way to detect shorted field coils because of their low resistance, replace them and check for improved performance.

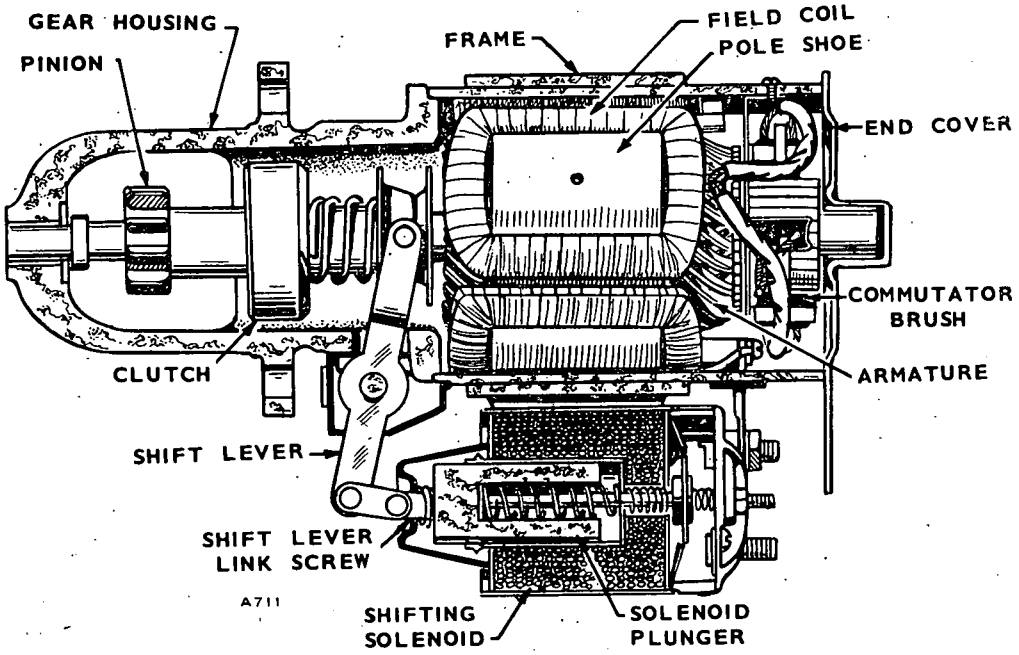


FIGURE 33. STARTING MOTOR

Test for grounds with a 120-volt test lamp. Check between each commutator segment and the shaft. If commutator is grounded, the ohmmeter will show continuity. See Figure 34.

CAUTION **Don't touch probes to commutator brush surfaces; it will burn them.**

Use a growler to test for shorted coils. Place armature in growler and run a steel strip over the armature surface. If a coil is shorting, the steel strip becomes magnetized and vibrates. Rotate armature slightly and repeat test for one complete revolution of the armature. If armature is defective, replace it. See Figure 35.

Clean commutator with number 240 sandpaper. Blow the sand out of motor after cleaning. If heavily scored or worn, turn it down in a lathe.

Field Coils: Field coils are checked with an ohmmeter and probes. Check for motor frame grounds or open circuit. All connections should be clinched and

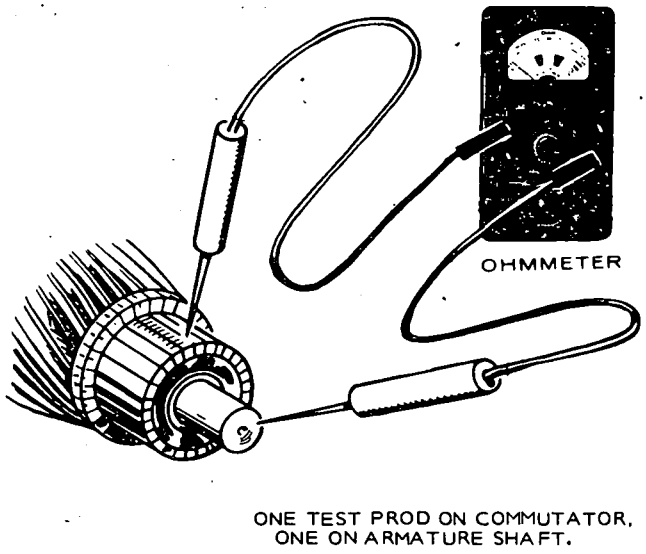


FIGURE 34. TESTING FOR GROUNDS

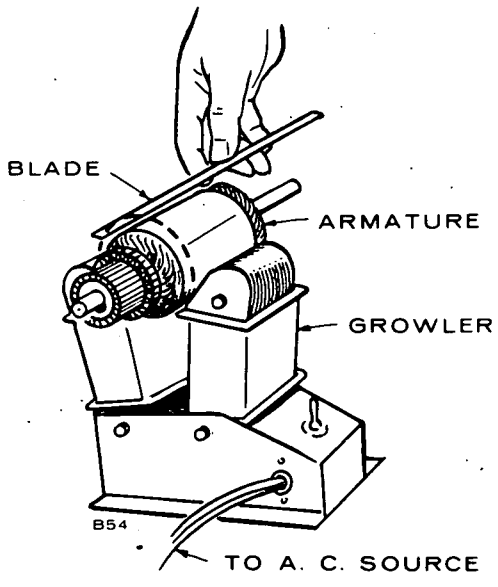


FIGURE 35. TESTING ARMATURE FOR SHORTS

soldered. Inspect the insulation for evidence of damage. The only way to check for field coil shorts is to use the starting motor test.

Bearings: Starter motor bearings should be replaced if they show excessive wear. Drive out old bearings using an arbor press. Press new bearings into place.

Brushes: Brushes should slide freely in their holders. Inspect for wear or improper seating. Check brush spring tension with a spring scale. Change spring tension by twisting spring at the holder with needle-nosed pliers. Replace excessively worn brushes.

Some brushes are soldered to the field coil load. To remove brushes, unsolder the lead and open the loop in the field coil lead. Insert the new brush pigtail into the loop and clinch before soldering. A good soldering job is necessary to ensure good contact and low voltage drop across the connection.

Over-running Clutch: Over-running clutch should be thoroughly cleaned (do not dip in solvent). It can't be repacked with grease. It should slide easily on the armature shaft without binding. Turn the pinion; it should rotate smoothly but not freely. The clutch should instantly lock and unlock when reversing rotation direction. If the clutch is defective (pinion worn or damaged), replace it.

Shifting Solenoid: Shift solenoid plunger should move freely in the coil. Test pull-in continuity (between solenoid control terminal and solenoid connection to the motor) and hold-in coil continuity (between solenoid control terminal and engine ground).

ASSEMBLY, STARTING MOTOR

Starter motor assembly includes soaking the bronze bearings in oil. These bearings are designed to absorb 25% of their own weight in oil. Be sure the felt oil pad is in the outer end of the commutator end bearing.

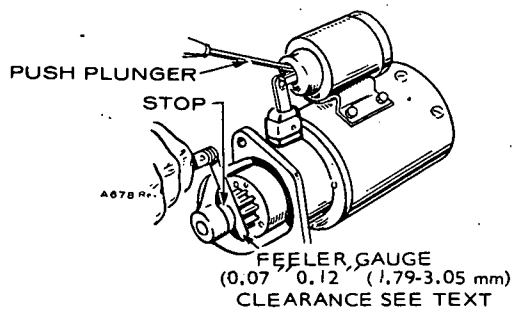


FIGURE 36. STARTER PINION CLEARANCE

After assembly, check the armature end play. See *DIMENSIONS AND CLEARANCES* section. Adjust end play by adding or removing washers at the commutator end.

Check pinion clearance (Figure 36) to ensure engagement. Press solenoid core to shift pinion into full mesh. Measure clearance between pinion and pinion stop (see *DIMENSIONS AND CLEARANCES* section). Adjust solenoid plunger link screw for proper clearance.

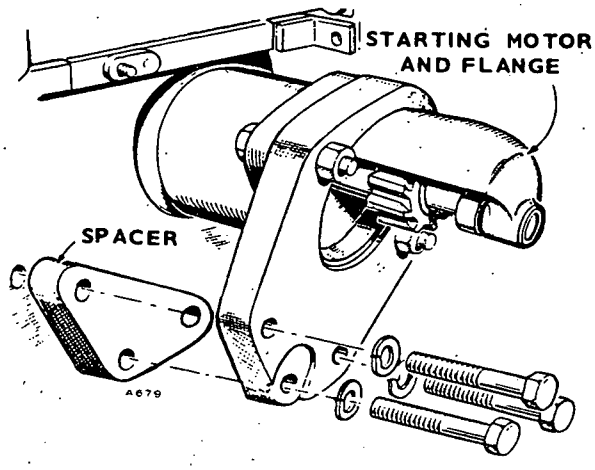


FIGURE 37. STARTER INSTALLATION

BATTERY CHARGING SYSTEM

Two descriptions and troubleshooting techniques for battery charging are given for welders: welders Prior to Spec T and welders begin Spec T.

Both types of battery charging systems have a permanent magnet (rotor) which is held to the flywheel by screws. The stator windings have an epoxy resin coating for moisture protection. Cooling the stator is done by special fins of the rotor. A fuse protects the battery charging system from damage if the battery is connected accidently in reverse polarity.

A cut-off switch, operated by oil pressure, opens when the welder stops and disconnects the battery from the regulator-rectifier of the battery charging circuit. The switch has two wire leads and is located next to the fuel filters and injection pump. Before making all of the flywheel alternator tests following, be sure to check operation of the cut-off switch.

FLYWHEEL ALTERNATOR (Begin Spec T)

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output (Figure 38).

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. The fuse is located behind the air housing door (above injection pump). Check the fuse before performing any tests.

Weak ignition spark or a discharged battery indicates trouble in the charging system, but always check the battery for serviceability first.

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure the output control plug (connector) is inserted properly. The plug must bottom in receptacle—eliminates any resistance due to a poor connection. Keep clean and tight.
2. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
3. Never reverse the battery leads.

Regulator-Rectifier Tests:

The following tests for the regulator-rectifier require a fully-charged battery.

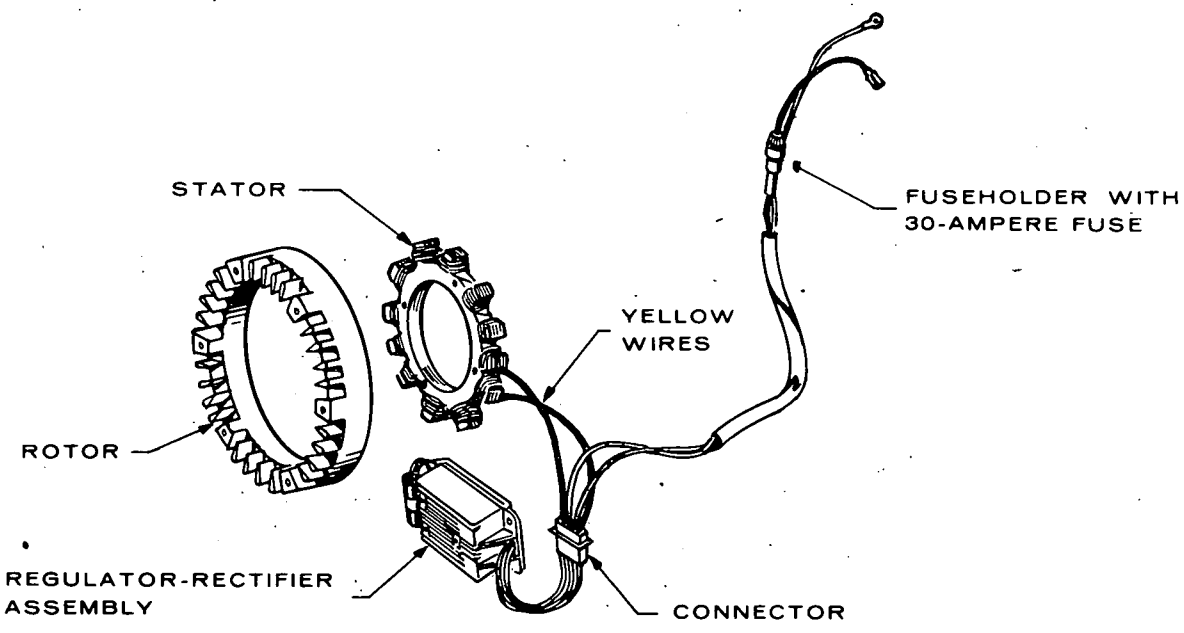


FIGURE 38. FLYWHEEL ALTERNATOR (BEGIN SPEC T)

1. Connect a voltmeter across the battery. Start the engine and operate at 2400 rpm or with manual governor control lever in WELD.
2. Voltmeter should read 13.4 to 14.5 volts. If it does, no further testing of the charging system is necessary. If not, install a new regulator-rectifier and retest. Be sure it has a good ground connection and the connector is properly seated.

Stator Tests

For testing, use a Simpson 260 VOM or equivalent. Be sure test meter and battery, if battery powered, are in good condition. Check with engine NOT running.

1. Set voltage selector switch to DC+ and zero meter on RX1 scale.

   Zero the meter before each reading and each time scales are changed.

2. Unplug the connector and connect the meter leads to the two terminals of the female plug with the yellow wires. Meter should read less than 0.8 ohms if stator has continuity. If meter shows no reading, winding is open and stator should be replaced.
3. Touch red meter lead to yellow wire plug terminal and other meter lead to metal core of stator. If meter doesn't read infinity, the stator winding is grounded. Replace the stator.

Flywheel Magnet Group or Rotor

To test the magnet group or rotor, lay a piece of ferrous (iron) material up against the magnets to be sure they are charged. If not, replace the rotor.

FLYWHEEL ALTERNATOR (Prior to Spec T)

There are neither brushes nor bearings in this sytem, so maintenance is limited to keeping the components in good condition. When the flywheel is off, clean the rotor and stator and check the wires. In general, see that all connections are secure and all components clean. If the alternator is operating satisfactorily, do not tamper with it.

A 20-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. It's located on the left side of the blower housing. Check this fuse before performing following tests.

1. Connect an ammeter between the red terminal on the rectifier and the ignition switch.
2. With the engine running at 1800 rpm, the ammeter should indicate about 8 amperes into a fully discharged battery and progressively less as the battery becomes charged. The regulator switches from high to low charge at about 14-1/2 volts and from low to high at about 13 volts.

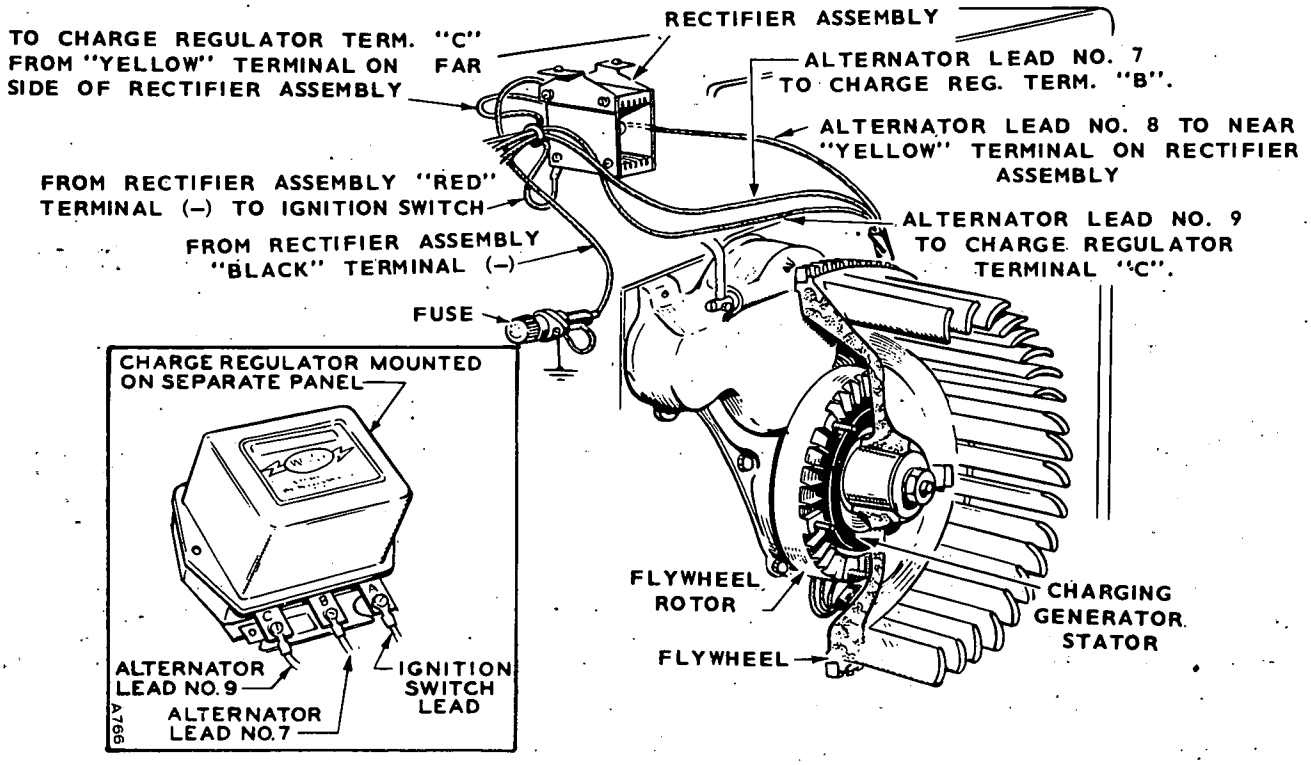


FIGURE 39. FLYWHEEL ALTERNATOR (PRIOR TO SPEC T)

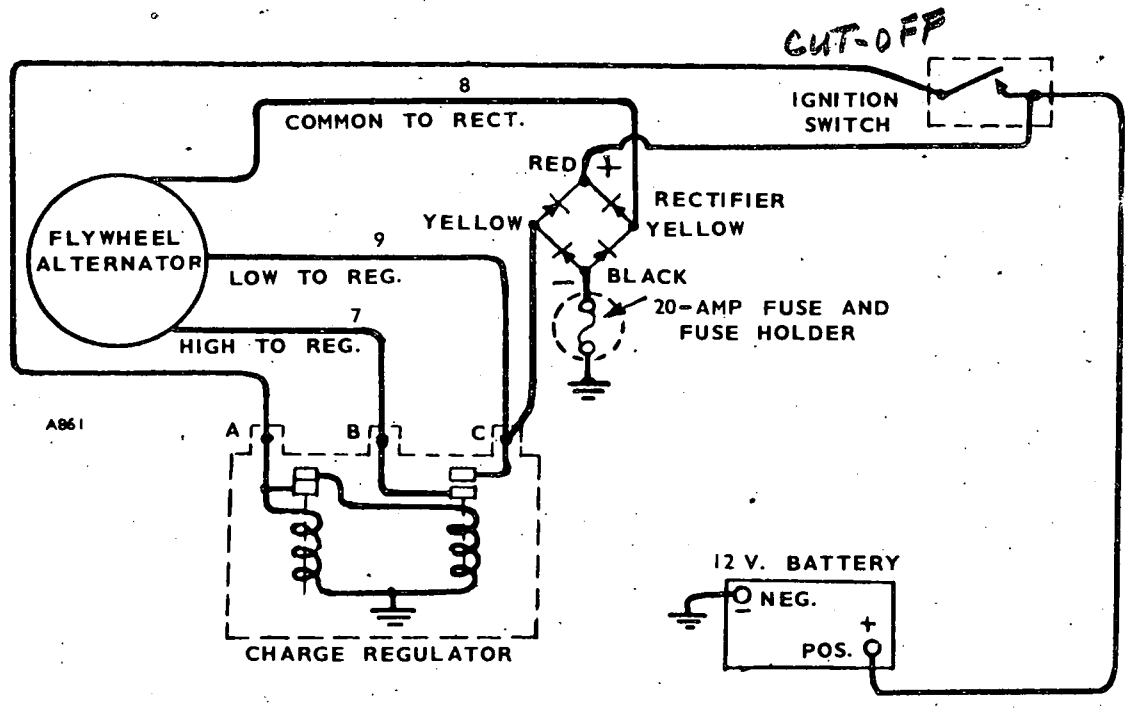


FIGURE 40. WIRING SCHEMATIC (PRIOR TO SPEC T)

Stator

1. Disconnect the stator leads and test each one with a 12-volt test lamp for grounding. Touch one probe to the lead and the other probe to a good ground on the engine. None of the leads should show a ground, which will be indicated if the lamp lights. If a ground is indicated, replace the stator.
2. To test for shorted coils or opened circuits, use an ohmmeter set to read the proper range of resistances. The resistance values are as follows:

on next page

3. Current at low charge should be about 2 amperes. If output is unsatisfactory, perform the following tests.

Rotor: To test for magnetism in the rotor, merely hold a piece of steel close to the magnet. If the steel is strongly attracted, the rotor is satisfactory. Strength of the magnet is a basic quality that will not change much over a period of time.

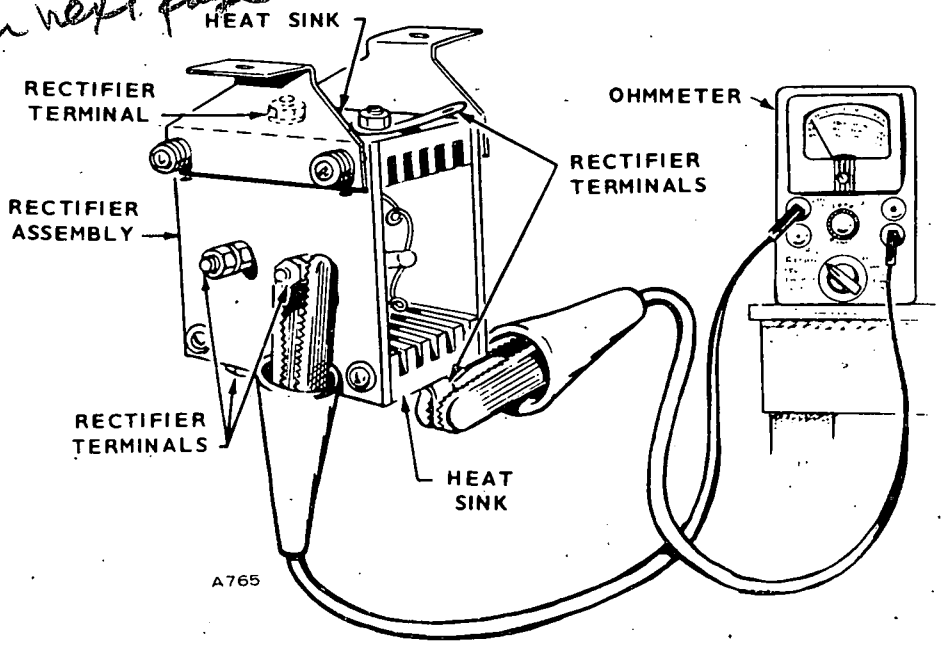


FIGURE 41. CHECKING RECTIFIERS (PRIOR TO SPEC T)

step 2 page 39

Lead 7 to 8 — .25 ohms
Lead 8 to 9 — .95 ohms
Lead 9 to 7 — 1.10 ohms

If the resistance varies over 25% from the above values, install a new stator and check for improved performance.

Rectifier

1. Completely isolate the rectifier assembly from the charging circuit by disconnecting all four wires. Test each rectifier separately with an ohmmeter or test lamp.
2. With an ohmmeter, connect one test lead to the rectifier lead and the other test lead to the rectifier base. Take the reading and then reverse the test probes. If the rectifier is good, one reading will be much higher than the other.

   If using a test lamp, touch the test probes together and observe the brightness of the bulb. Then touch the probes across the rectifier. If the rectifier is good, the bulb will light dimly. If the bulb lights brightly or not at all, the rectifier is defective and must be replaced.

Voltage Regulator

1. If the low charge rate is satisfactory, but high rate is not, connect a jumper between terminals B and C.
2. Run the engine and check the charge rate at the battery — should be 8 amperes. If it is, either the regulator or its power circuit is defective.
3. With a 12-volt test lamp, check input to the voltage sensitive coil at terminal A. If the lamp lights, input is okay and the regulator is defective.
4. If the charge rate with B and C jumpered is low, look to the alternator or its wiring for the cause.

ENGINE DISASSEMBLY

If engine disassembly is necessary, observe the following order (i.e. flywheel, gear cover . . .). As disassembly progresses, the order may be changed somewhat as will be self-evident. The engine assembly procedure is the reverse of disassembly. Any special assembly instructions for a particular group are included in the applicable section. When reassembling, check each section for these special assembly instructions or procedures.

FLYWHEEL

Remove the blower housing. The flywheel is a tapered fit on the crankshaft. Improvise a puller using at least a 7/16 inch (11.113 mm) bar and drilling two 7/16 inch (11.113 mm) holes 2-7/8 inches (22.225 mm) between centers. Loosen the flywheel mounting screw a few turns. Place bar against the flywheel screw, attach bar using two 3/8 inch thread screws in the holes provided in flywheel. Alternately tighten the screws until flywheel is free.

Replacement flywheels are supplied without the timing markings because each flywheel must be fitted to its engine. The only accurate method of determining the top dead center (TDC) and port closing points is to measure the piston travel. This is a critical measurement and should be attempted only with accurate, dependable equipment.

With the flywheel mounted, remove the head and install a depth gauge over the front piston. Rotate the flywheel to find the TDC position on the compression stroke and mark this point on the flywheel. Next, turn the flywheel counterclockwise until the piston drops exactly .126 inch (3.200 mm) from TDC. This is the port closing point, 19° BTC.

Ring Gear: To remove the ring gear, if damaged, saw part way through, then break it using a cold chisel and heavy hammer.

To install a new ring gear, place it in an oven heated to 380 to 400° F (193° C to 204° C) for 30 to 40 minutes.

CAUTION **Do not heat with a torch. When heated properly, the ring will fall into place on the flywheel. If it does not go on all the way by itself drive it with a hammer. Do it fast and do not damage the gear teeth. The ring will contract rapidly and may shrink to the flywheel before it is in place. If this occurs, a new ring gear may be required.**

GEAR COVER

To remove the gear cover, detach the upper governor ball joint. Remove the governor speed adjustment nut and governor spring bracket.

Remove the screws holding the gear cover to the crankcase. To loosen the gear cover, tap it with a soft hammer.

Governor Shaft: The governor shaft is supported by two sets of needle bearings. To remove the shaft, remove the yoke and pull the shaft from the gear cover. If the shaft is binding, clean the bearings, if loose, replace the bearings. To remove the larger bearing, drive both bearing and oil seal out from the outside of the gear cover. Remove the smaller bearing

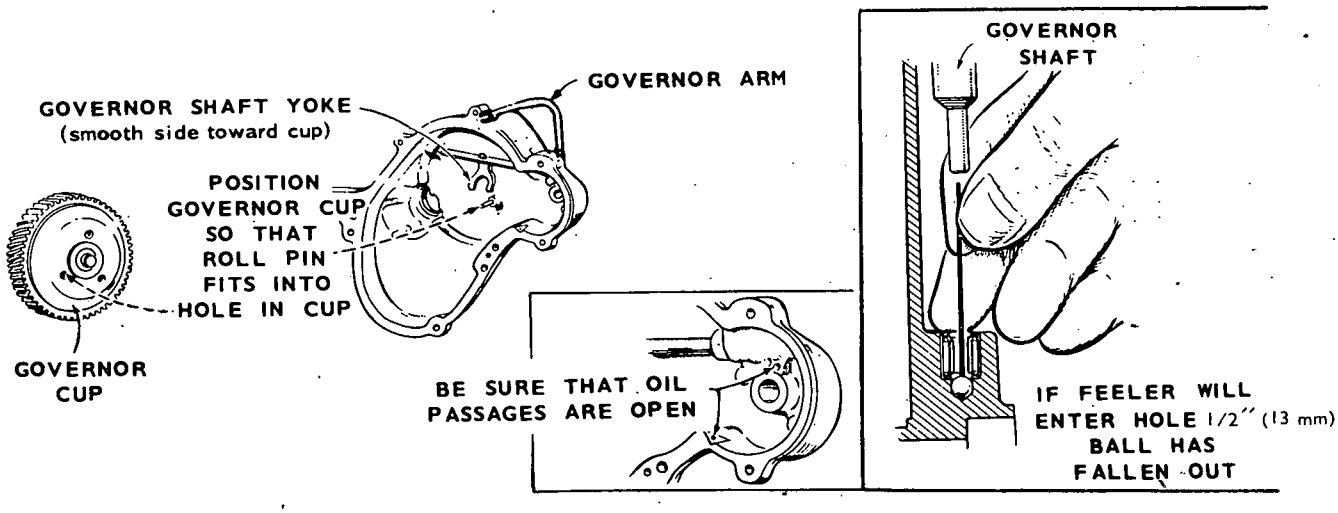


FIGURE 42. GEAR COVER

with an "Easy-Out" or similar tool. Press new bearings and oil seal into place.

Gear Cover Oil Seal: Replace the oil seal if damaged or worn. Drive the old seal out from inside the gear cover. Lay the cover on a board so the seal boss is supported. Using an oil seal driver, insert the new seal from the inside with rubber lip toward outside of gear cover (open side of seal inward) and drive it flush with the outside surface. During gear cover installation, use the driver to protect the oil seal. See Figure 43.

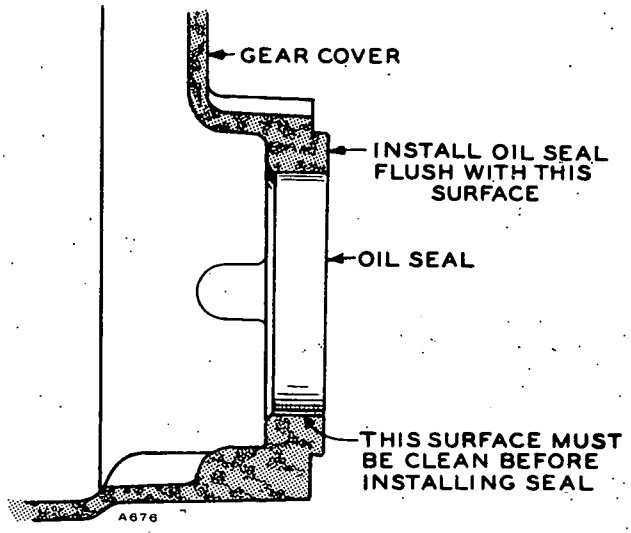


FIGURE 43. GEAR COVER OIL SEAL

Assembly, Gear Cover:

1. Work the governor shaft to check for binding and see that the governor-shaft-end-thrust ball is in place (Figure 42). Later models have a larger ball which will not fall out.
2. Turn governor yoke so the smooth side is toward governor cup.
3. Turn the governor cup so the stop pin in the gear cover fits into one of the holes in the cup surface. Measure the distance from the end of the stop pin to the mounting face of the cover. It should be 25/32 inch (19.84 mm). If it is not, replace the pin. Pin should be positioned with open end facing crankshaft seal.
4. Coat the oil seal lip with oil or grease. Set a piece of shim stock over the crankshaft keyway to protect the seal and install the gear cover. Tighten the mounting screws to specified torque. Before tightening screws, be sure the stop pin is in the governor hole.

GOVERNOR CUP

To remove the governor cup, remove the snap ring from the camshaft center pin and slide the cup off. Be sure to catch the flyballs that will fall out when the cup is removed.

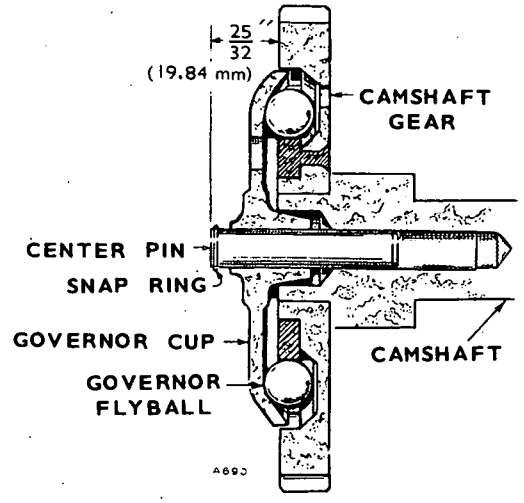


FIGURE 44. GOVERNOR CUP

Repair: Replace any flyballs that have flat spots or grooves. Replace the cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but should be replaced if excessively loose or wobbly.

Check the distance the center pin extends from the camshaft gear, this distance must be 25/32 inch (19.84 mm) to give the proper travel distance for the cup (Figure 44). If it is less, the engine may race; if more, the cup will not hold the balls properly. If the distance is too great, drive or press the center pin in. If it is too small, replace the pin; it cannot be removed without damaging the surface. In some cases, if the distance is too small, the head of the governor cup can be ground to give the necessary 7/32 inch (19.84 mm) travel distance.

Installation: To install the governor assembly, tip the front of the unit upward. Set the flyballs in their recesses and position the governor cup on its shaft. Finally, brush with heavy grease and install the snap ring on the center pin.

CYLINDER HEADS, VALVES

The cast iron cylinder head assembly has alloy hardened faced valves, release type rotators, alloy hardened inserts, guides, rocker arms, injection nozzles and glow plugs. The push rods run through shields.

Disassembly:

1. Remove the rocker box cover, fuel nozzles and oil lines to the cylinder heads.
2. Remove the intake and exhaust manifold.
3. Remove the cap screws holding each cylinder head to the cylinder block.
4. Remove each head. If it sticks, rap it sharply with a soft hammer. Do not use a pry.

5. Remove the rocker arms and push rods.
6. Using a valve spring compressor, disassemble the valve assemblies.

Identify valve parts for identical reassembly.

Thoroughly clean all components of the cylinder head assemblies. Remove all the carbon deposits from the intake and exhaust ports and clean all gasket surfaces.

Valves: Remove all carbon and check each valve for burning, pitting or warped stem. Valves that are slightly pitted or burned, refinish on an accurate valve grinder. Refinish intake valves to a 42° angle and exhaust valves to a 45° angle. But, if they are badly pitted or will have a thin edge when refacing, replace them.

Check refinished valve for a tight seat to the valve seat with an air pressure type testing tool or by applying Prussian Blue on the valve face and rotating it against the seat.

Valve Guides: Check valve guide to valve clearance, see *DIMENSIONS AND CLEARANCES* section. If the proper clearances cannot be obtained by replacing the valves, replace the valve guides (available in .001 inch oversize).

Removing Old Guides:

1. Before pressing guide out, use a wire brush and electric drill to remove carbon and all other foreign matter from top surface of guide.

CAUTION **Damage could occur to the guide wall in the cylinder head if this procedure is not followed.**

2. Place removal tool in guide and position in arbor press using care in pressing old guide out.

CAUTION **Do not use hammer to remove old guides (or to install the new ones).**

3. Run fine crocus cloth on a small polishing rod through cylinder head valve guide hole to clean out carbon and other foreign materials. Be careful not to enlarge guide hole.

Installing New Guides:

1. Coat outer edge of new guide with oil (or other lubricant). Position guide notch up in cylinder head and press in until the guide protrudes 11/32 inch (8.71 mm) from the rocker box side of the head.
2. Place valve guide reamer in drill press (if not available, use an electric drill). Two size reamers are used:
   a. intake guide — reamer size .342 inch to .343 inch (8.687 to 8.712 mm)
   b. exhaust guide — reamer size .344 inch to .345 inch (8.738 to 8.763 mm)
3. Use polishing rod and crocus cloth to obtain a good smooth honed finish after reaming.
4. Thoroughly wash cylinder head in solvent after reaming and honing is completed.

Valve Seats: If the valve seats are pitted, refinish them. Using conventional seat grinding equipment, reface each seat to a 45° angle and seat width of 3/64 to 1/16 inch (1.19 to 1.59 mm). You should be able to reface each seat several times before it becomes necessary to replace it.

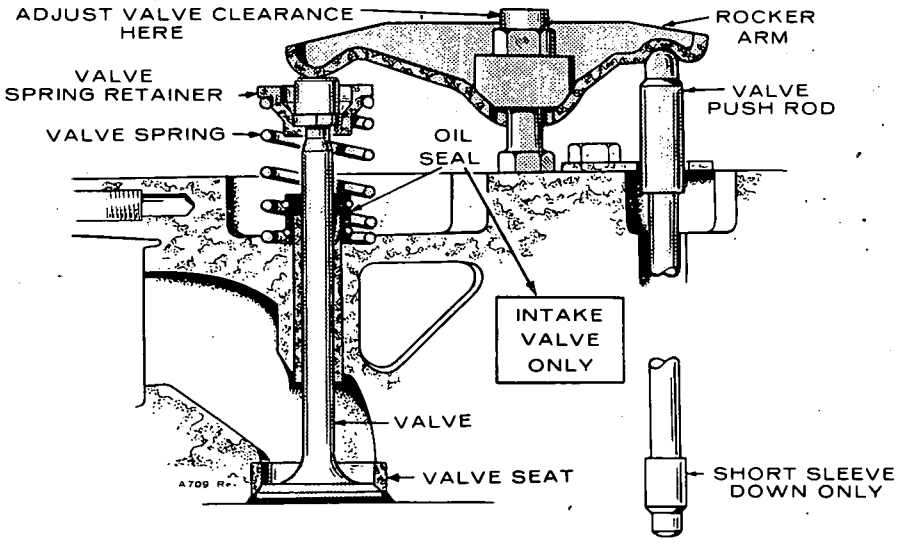


FIGURE 45. VALVE TRAIN

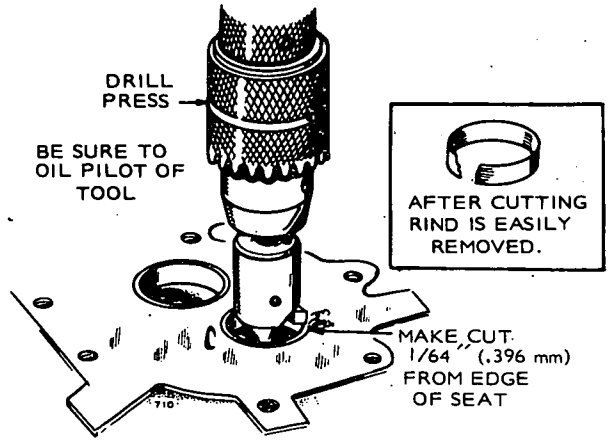


FIGURE 46. REMOVING VALVE SEAT

If, however, the valve seats are loose or cannot be refaced, replace them.

Use the valve seat remover tool in a drill press (Figure 46) to remove each valve seat. Adjust the tool to cut 1/64 inch (.396 mm) from the edge of the seat. Oil the pilot to prevent it from seizing in the valve guide. Cut each seat down to a narrow rind on edges and bottom and break it out with a sharp tool.

CAUTION **Don't cut into the counterbore bottom.**

Thoroughly clean the valve seat counterbore and remove any burrs from the edges. If the counterbore is damaged, it will have to be remachined for an oversize seat. Oversize seats are available in .002, .005, .010 and .025 inch. Otherwise, install new standard size seat inserts.

Drive the new valve seat inserts into place. Be certain that each seat rests solidly on the bottom of the counterbore at all points. To make installation easier, heat the cylinder head in an oven at 325° F (160° C) for about 1/2 hour and cool the valve seats in dry ice.

Face each new seat to a 45° angle and width of approximately 3/64 inch (1.19 mm). The finished seat face should contact approximately center of the valve face. Use Prussion Blue on each valve face to check this. Make any corrections on the seat, not the valve face.

When the new seats are installed and faced, insert the valve into each and check the clearance from valve head to the face of the cylinder head. This must be at least .030 inch (.762 mm). If it is not, regrind the seat.

Valve Springs: Check the valve springs on an accurate compression scale. Valve spring data is given in the *DIMENSIONS AND CLEARANCES* section. Replace any spring that is weak, cracked or pitted or has ends out of square.

Installation of Cylinder Head and Valves:

1. Push a valve stem oil seal onto each intake valve guide and clamp in place. Then oil the inside surface of each seal.
2. Oil the stem of each valve lightly and insert each in its own guide.
3. Check each valve for a tight seat with an air pressure type tester. If a tester is not available, make pencil marks at intervals on the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn in the seat. If the seat is not tight, regrind the valves.
4. Using a valve spring compressor, compress each valve spring and insert the valve spring retainer and retainer locks.

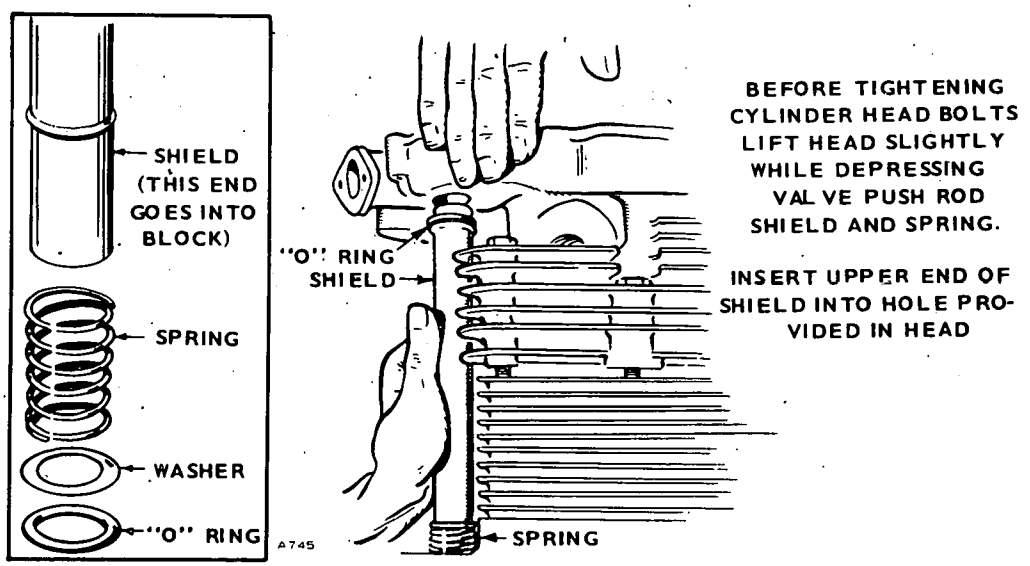


FIGURE 47. INSTALLING PUSH ROD SHIELD

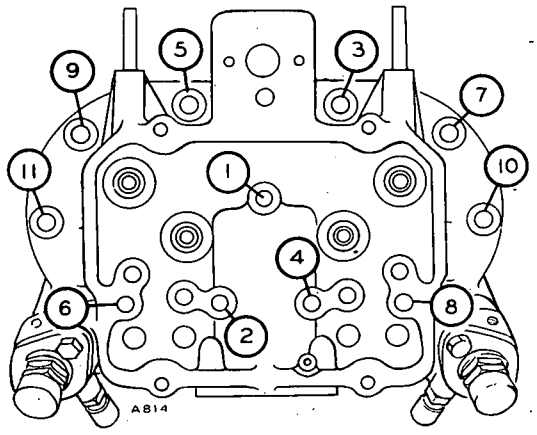


FIGURE 48. HEAD TIGHTENING SEQUENCE

5. Install the head assembly and gasket to the cylinder block.
6. Before tightening the cylinder head, install the push rod shield as shown in Figure 47.
7. Tighten the head bolts to half torque value (*ASSEMBLY TORQUES AND SPECIAL TOOLS* section) following sequence in Figure 48.
8. Torque head bolts to torque value following same sequence.
9. Install the exhaust manifold, nozzles, glow plugs and oil lines.
10. Install the valve stem caps.
11. Install the push rods, rocker arms and rocker arm nuts.
12. Set the valve clearance (see *DIMENSIONS AND CLEARANCES* section).

After the first 50 hours of operation on a new or overhauled engine, retighten the cylinder head bolts and check valve clearance.

Valve Clearances: Check the valve clearances at regular intervals (see service chart in *PERIODIC MAINTENANCE* section). In addition, clean valve seats at regular intervals.

After engine has reached a stable temperature condition, the valve clearances may be adjusted. It is recommended that the valve clearance is set with engine at room temperature (approximately 75° F [24° C]). Allow at least two hours cooling time after engine operation.

To adjust valve clearance on the two-cylinder engine, proceed as follows:

1. Turn the flywheel until the cylinder which is to have its valve adjusted is on its compression stroke, which follows closing of intake valve.
2. Turn the flywheel until the TC (top center) mark on the flywheel lines up with the timing pointer on the gear cover. Then turn the flywheel in a clockwise direction for an additional 10 to 45 degrees. There is no timing mark for this position so it must be estimated. With the piston located in this position, the cylinder will be in its power stroke with both valves completely closed.
3. Check the cylinder head-bolt torque for 44 to 46 ft. lb. (60 - 62 N•m).
4. Using a feeler gauge, check the clearance between the rocker arm and the valve (see Figure 49). Increase or reduce the clearance until the proper gap is established adjusting with the lock nut which secures the rocker arm to the cylinder head. Correct valve clearance is in *DIMENSIONS AND CLEARANCES* section.
5. To adjust the valve clearance for the other cylinder, turn the flywheel in a clockwise direction 360° (1 revolution) from the position used in step 2. Then follow steps 3 and 4.

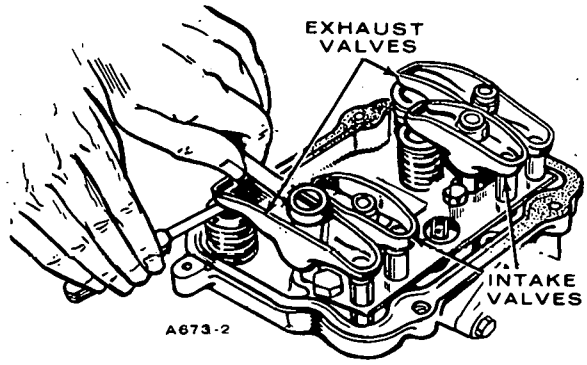


FIGURE 49. VALVE CLEARANCES

PISTONS, RINGS, CONNECTING RODS

These engines use cam ground aluminum pistons. Each piston is tapered and fitted with three compression rings and an oil control ring. Full floating piston pins connect the piston to its connecting rod. The pins are held in place with a snap ring at each end. The lower end of each connecting rod contains half shell, precision bearings and the upper end, semi-finished bushings.

Some engines are fitted with .005 inch oversize pistons at the factory. These engines are marked with an E following the engine serial number. Use 0.005 oversize rings for these pistons.

Pistons: The connecting rod and cap are stamped for proper installation in the proper cylinder. When removing piston assemblies, check the marking so each can be installed in the proper cylinder.

1. Drain the crankcase oil and remove the oil base.
2. Remove the cylinder heads. Remove carbon from bore.
3. Remove the ridge from the top of both cylinders with a ridge reamer before removing the piston (Figure 50).

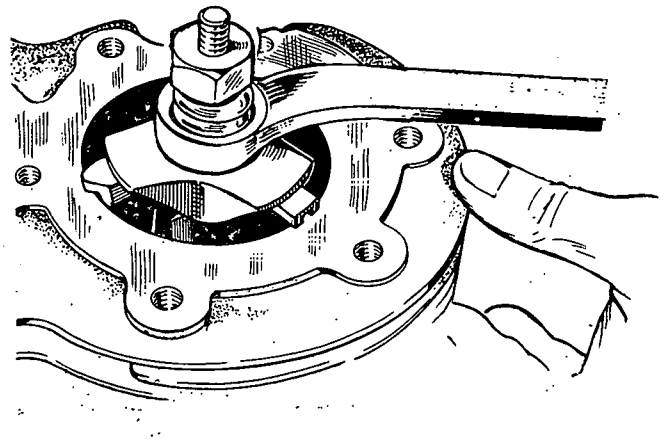


FIGURE 50. REMOVING RIDGE FROM THE CYLINDER

CAUTION **Pushing and forcing the piston from the cylinder before the ridge is removed can crack the piston rings or damage the piston lands.**

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Avoid scratching the crankpin and cylinder wall when removing the piston and rod.

Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps and bearings with their respective rods.

5. Remove the piston rings from the piston with a piston ring spreader.
6. Remove the piston pin retainers and push the piston pin out.
7. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 51). Care must be taken not to remove metal from the groove sides.

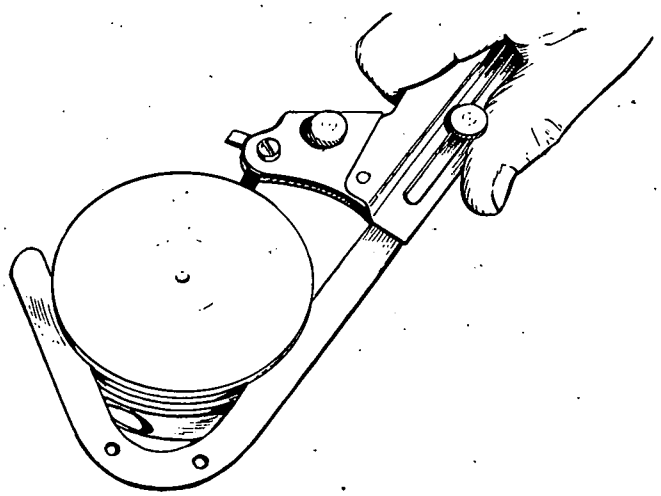


FIGURE 51. PISTON GROOVE CLEANING

Do not use a caustic cleaning solvent or wire brush for cleaning pistons.

8. Check for wear or breaks at the ring lands using a new ring and feeler gauge as shown in Figure 52. Replace the piston when the side clearance exceeds that shown in *DIMENSIONS AND CLEARANCES* section. If any piston is badly scored or burred, loose in the cylinder, has badly worn ring grooves or otherwise is not in good condition, replace it.
9. Check the clearance 90° from the axis of the piston pin and below the oil control ring. Clearance should be .0055 to .0075 inch (.1397 to .1095 mm). If not, replace the piston and check the cylinder for possible reconditioning.

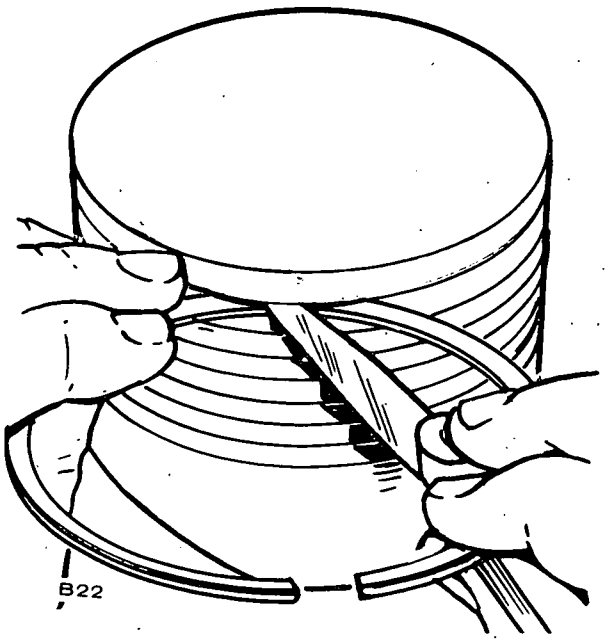


FIGURE 52. CHECKING RING SIDE CLEARANCE

Piston Pins: Each piston pin should be a thumb push fit into its piston at room temperatures. If the pin is excessively loose, install a new one (available as standard or .002 inch oversize).

Rings: Inspect each ring carefully for fit in the piston grooves and seating on the cylinder wall. Fit each ring to the cylinder wall at the bottom of its travel, using a piston to square the ring in the bore. Check the gap with a feeler gauge. It should be .010 inch (.254 mm). If the gap is too small, file the butt ends of the rings. Do not use rings that need a lot of filing, they will not seat properly on the cylinder walls. If oversize pistons are used, use the correct oversize rings.

Connecting Rods: Clean the connecting rods and check each for defects. Check the connecting rod bushings for proper clearance with the piston pin.

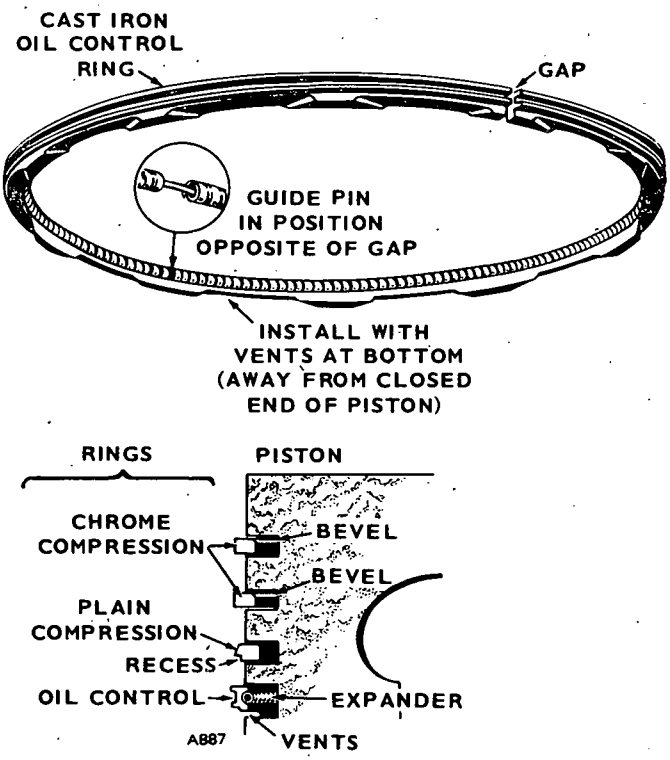


FIGURE 53. PISTON RINGS

Clearance should be .0002 to .0007 inch (.0051 to .0178 mm).

Checking Bearing Clearance With Plastigauge:

1. Make certain that all parts are marked or identified so that they are reinstalled in their original positions.
2. Place a piece of correct size Plastigauge in the bearing cap the full width of the bearing insert about 1/4 inch (6 mm) off center (Figure 54).
3. Rotate the crank about 30° from bottom dead center and reinstall the bearing cap. Tighten the bolts to the torque specified in *ASSEMBLY TORQUES AND SPECIAL TOOLS* section. Do not turn the crankshaft.
4. Remove the bearing cap. Leave the flattened Plastigauge (adhered to crankshaft) and compare the widest point with the graduations on the Plastigauge envelope to determine clearance.

Installation of Piston Assemblies:

1. Turn the crankshaft to position one rod bearing journal at the bottom of its stroke.
2. Lubricate the corresponding piston assembly and inside of the cylinder.
3. Install the bearing insert in the rod.
4. Compress the rings with a ring compressor and position the piston and rod assembly in the cylinder block.

The connecting rod numbers or witness marks should always face the camshaft (top) side of engine.

5. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal.
6. Install the bearing cap on the rod with the witness marks and stamped reference numbers matching the marks on the rod.
7. Install and tighten the bolts to the specified torques. The bearing cap must be tapped several times to properly align it with the rest of the connecting rod. Clearance varies on the journal if this is not done.
8. Install the remaining pistons and rods in the same manner. Crank the engine over by hand to see that all bearings are free.

CYLINDERS

The cylinder walls should be free of scratches, pitting and scuffing. Check each with an inside reading micrometer for out-of-round and wear. The bore should measure between 3.2495 and 3.2505 inches (82.5373 and 82.5627 mm) and be less than .001 inch (.025 mm) out-of-round. Check each cylinder for taper, out-of-round and wear with a cylinder bore gauge, telescope gauge or inside micrometer (Figure 55).

If necessary, rebore the cylinder to fit the next available oversize piston. Pistons and rings are available in .005, .010, .020, .030 and .040 inch

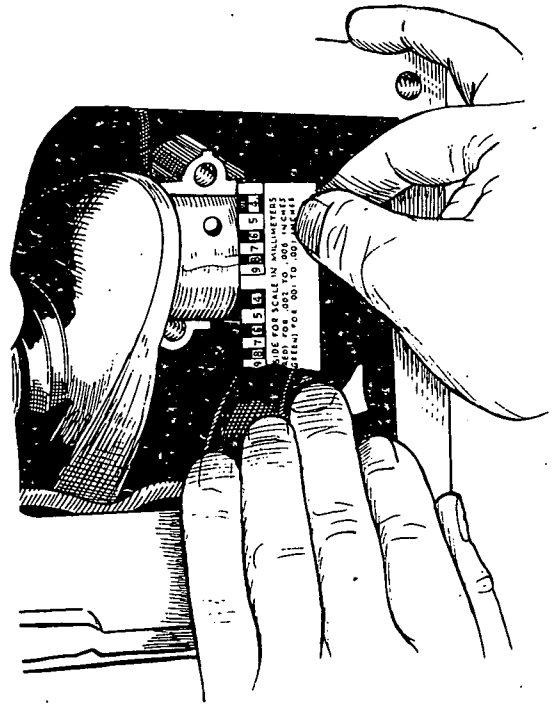


FIGURE 54. MEASURING BEARING CLEARANCE WITH PLASTIGAUGE

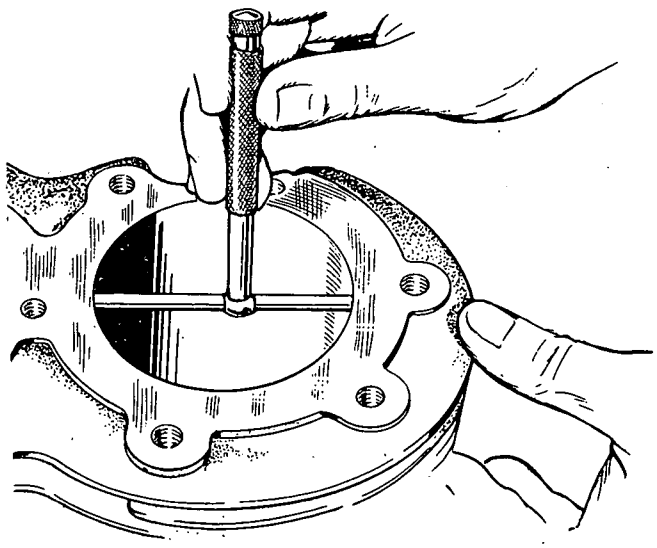


FIGURE 55. MEASURING CYLINDER

oversize. If the cylinders do not need refinishing, remove any existing ridges from the top of the wall.

A reboring machine is used when going to oversize pistons. The following repair data cover honing to oversize by use of a hone.

Repair

1. A hone can be used to rebore a cylinder. Remove stock to 0.002 inch (.051 mm) undersize of finish bore with coarse hone (100 grit), then complete honing with finish hones (300 grit).
2. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.
3. Lower the hone into the cylinder until it protrudes 1/2 to 3/4 inch past the end of the cylinder. Rotate the adjusting nut until the stones come in contact with the cylinder wall at the narrowest point.
4. Turn the hone by hand. Loosen the adjusting nut until the hone can be turned.
5. Connect drill to hone and start drill. Move the hone up and down in the cylinder approximately 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. Then when the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.
6. Check the diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90° angles.
7. When the cylinder is approximately 0.002 inch (.0508 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but as shown in Figure 56.
8. Clean the cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete. Do not use a solvent or gasoline since

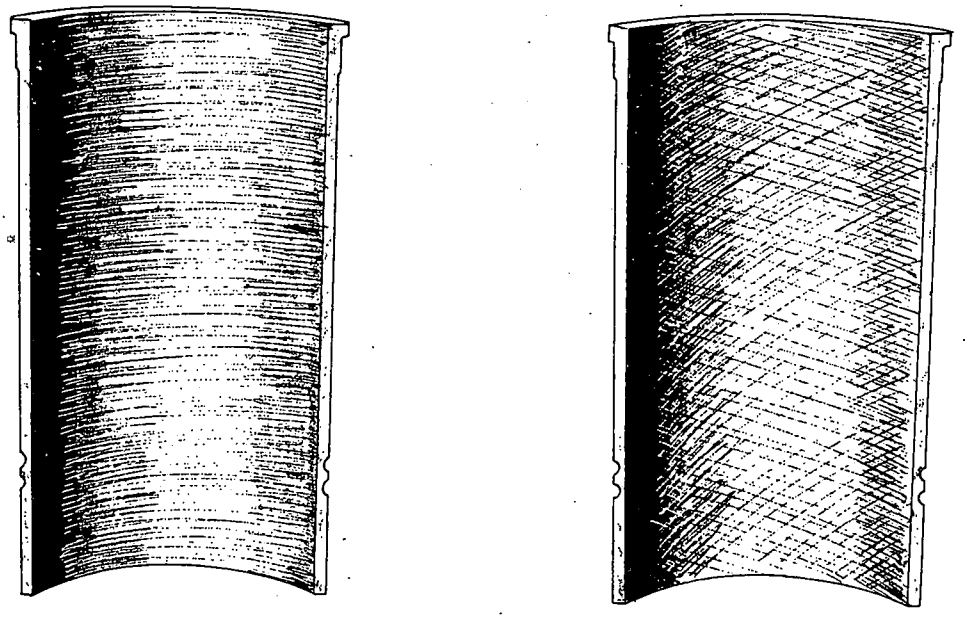


FIGURE 56. CORRECT HONE FINISH

they wash the oil from the walls but leave the metal particles.

9. Dry the crankcase and coat it with oil.

Coat cylinder walls as soon as possible. After washing with soap and water, oxidation takes place and forms a fine layer of rust within minutes.

CAMSHAFT BEARINGS

The camshaft bearings should be replaced if the clearance to the camshaft is greater than specified, the bearings show cracks, breaks, burrs, excessive wear, or other defects. The camshaft to bearing clearance should be .0012 to .0037 inch (.0305 to .0940 mm). To check the rear bearing, remove the expansion plug at the rear of the crankcase.

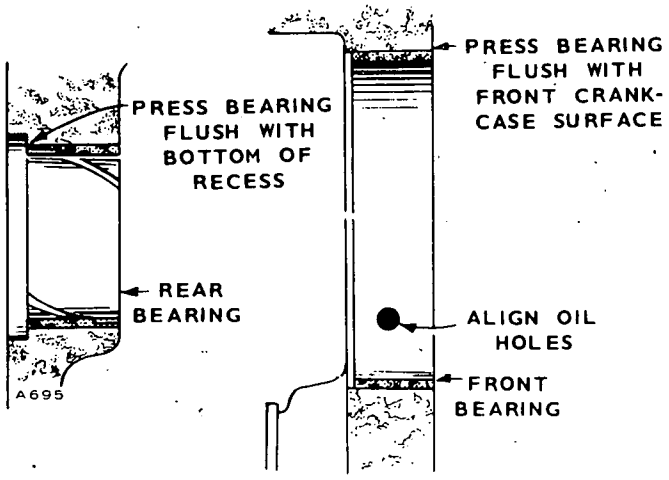


FIGURE 57. CAMSHAFT BEARINGS

Press new bearings into place (Figure 57). Press the rear bearing flush with the bottom of the expansion plug recess. Press the front bearing in flush with the crankcase front surface so the oil passages are aligned. Do not attempt to ream the bearings, they are a precision type. After the rear bearing is installed, insert a new expansion plug in the recess using sealing compound, and expand it into place with sharp blows at its center.

Installation, Camshaft Assembly:

1. Install the key and press the camshaft gear on its shaft.
2. Install the governor components.
3. Slide the thrust washer onto the shaft.
4. Lay the engine on side or end and insert the push rod tappets.
5. Install the camshaft assembly in the engine. Align the timing marks on the camshaft gear and crankshaft gear (Figure 59).
6. Replace the push rods and fuel transfer pump.
7. When the engine is reassembled, install the injection pump following the steps in *FUEL SYSTEM* section. This step is critical.

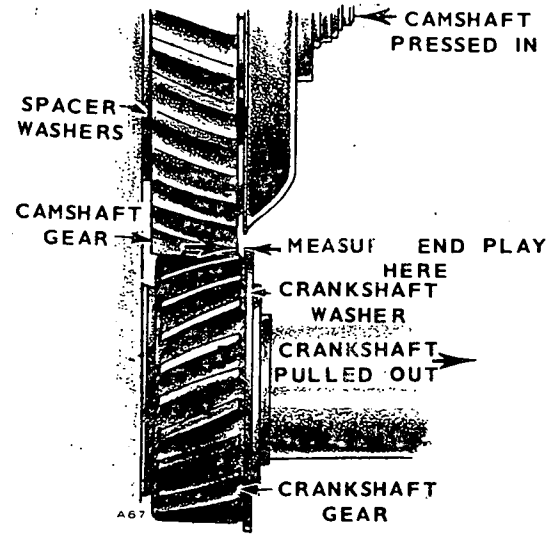


FIGURE 58. CAMSHAFT END PLAY

CRANKSHAFT, MAIN BEARINGS AND OIL SEALS

The DJB welder series of engines use a counter-balanced, ductile iron crankshaft. To increase the shaft's fatigue durability, all crankpin fillets are shot-peened during manufacturing. The 2-cylinder crankshafts ride on two lead-bronze bearings, the front one housed in the crankcase and the rear one in the bearing plate.

Removal:

1. Remove the lock ring and retaining washer in front of the crankshaft gear.
2. Pull off the crankshaft gear. It has two, 1/4-20 UNC tapped holes for attaching a gear pulling ring. Use care not to damage teeth if the gear is to be reused.
3. Remove the oil pan, piston, and connecting rod.

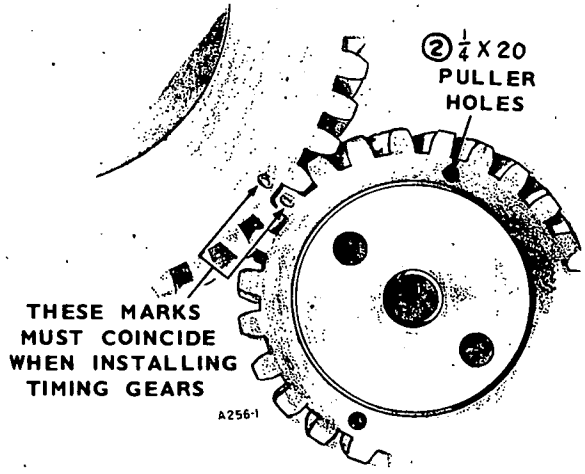


FIGURE 59. TIMING MARKS

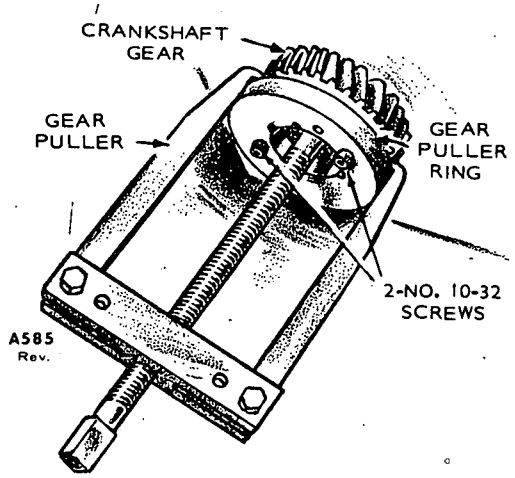


FIGURE 60. REMOVING CRANKSHAFT GEAR

4. Remove the rear bearing plate from the crankcase.
5. Remove the crankshaft from crankcase.

Inspection: Clean the crankshaft and blow out all oil passages. Check journals for out-of-round, taper, grooving or ridges. Pay particular attention to ridges or grooves on either side of the oil hole areas. Unusual conditions here often point to previous neglect of oil changes.

If journal dimensions are not within limits or the journals are scored, regrind the crankshaft.

Crankshaft Regrinding: Crankshaft grinding requires a trained, experienced operator with precision equipment.

Special procedures must be observed when reworking diesel crankshafts. In addition to machining, the crankshaft must be shot-peened and super-finished.

CAUTION **Failure to shot-peen crankshaft and crankpin fillets is likely to cause early failure.**

When the shaft is machined, follow this data and Figure 61 to shot-peen each crankpin fillet.

1. Almen gauge reading, .012-A.
2. Peen with .019 inch diameter cast steel shot.
3. Peen for 15 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

Undersize bearings and connecting rods are available to rework the shaft to .010, .020, and .030 inch undersize.

Main Bearings: Replace main bearings if clearances are greater than limits, bearings worn, grooved or broken (see *Installation of Crankshaft and Bearings*). Precision replacement bearing inserts and thrust washers are available for all main bearings. Do not ream the bearings.

Align the oil holes and press the new bearings into the front and rear housings.

Rear Oil Seal: The rear oil seal is in the rear bearing plate. If damaged, drive it out from the inside of the plate. Using the oil seal guide and driver tool, install a new seal with the rubber lip facing outward (open side of seal inward), Figure 57. Drive the new seal flush with the rear surface of the bearing plate. Leave the seal installer on during bearing plate installation to protect the oil seal.

Installation of Crankshaft and Bearings: After each installation step, check the crankshaft to be sure it is not frozen into place.

1. Press the front and rear main bearings into place, aligning the bearing and bearing housing oil holes. Do not attempt to drive a bearing into a cold block or rear bearing plate.

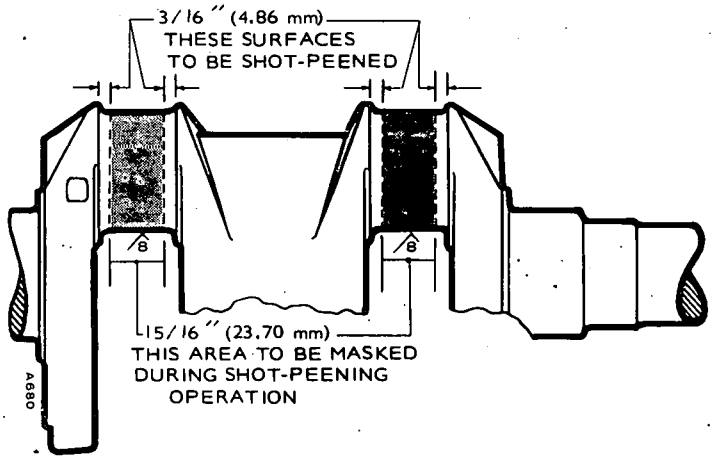


FIGURE 61. SHOT-PEENING CRANKSHAFT

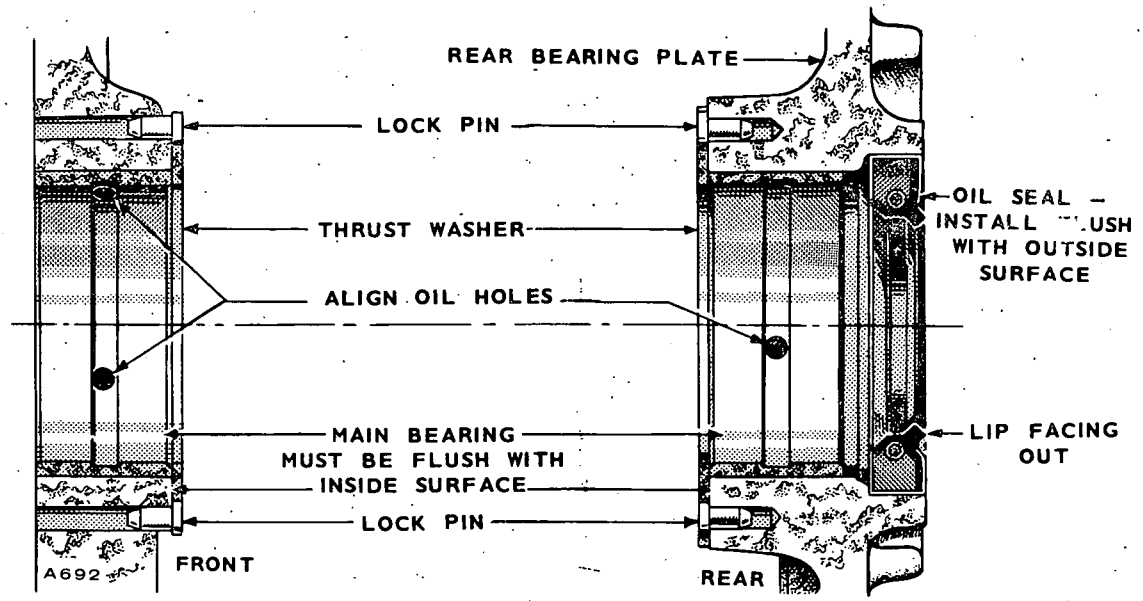


FIGURE 62. MAIN BEARING HOUSING

2. Install the thrust washers and locking pins.
3. Oil the bearing surfaces and install the crankshaft from the rear of the crankcase, through the rear bearing plate hole.
4. Mount and secure the rear bearing plate.
5. Heat the timing gear on an electric burner or oven to about 350° F (177° C). Install the key on the crankshaft, then drive the gear into place. Install the retaining washer and lock ring.
6. Check the crankshaft end play. Use enough rear bearing plate gaskets or shim and gaskets to provide .010 to .015 inch (.254 to .381 mm) end play. If gaskets of more than .015 inch (.381 mm) total thickness are required, then use a steel shim of proper thickness and a thin gasket on each side of shim. This avoids excessive gasket compression and maintains bolt torque.

See *Installation of Piston Assemblies* **for installing pistons.**

OIL PUMP

Mount the oil pump with the intake cup parallel with the bottom of the crankcase. Then install the oil base with a new gasket.

CRANKCASE

If the crankcase requires replacement, a new set of injection pump shims will be furnished with the new crankcase. These must be used, and in addition, the injection pump must be retimed to the engine.

GENERATOR

If a major generator repair should become necessary, have the equipment checked and repaired by a competent electrician who is thoroughly familiar with electric generating equipment. Continuity tests can be performed without disassembling the generator.

MAINTENANCE

The generator normally requires little care besides cleaning. However, give a periodic inspection (1000 hours) of the brushes, commutator and collector rings. If they require service, refer to the appropriate section following:

GENERATOR DISASSEMBLY

Disassembly procedure for the generator (Figure 63) is largely self evident and follows a natural sequence. Remove the cover band and the end bell cover. Remove all brush springs by pressing down on the spring holder and out as shown in Figure 64. Lift all the brushes from their guides.

Remove nuts from generator frame through studs. Tap end bell back until it is free of the armature bearing, then lift it off.

Provide blocking under the rear of the engine for support. Slots in engine-to-generator adapter provide for prying the generator frame loose. Pull the generator frame straight back over the armature using care not to let it catch or drag on the armature.

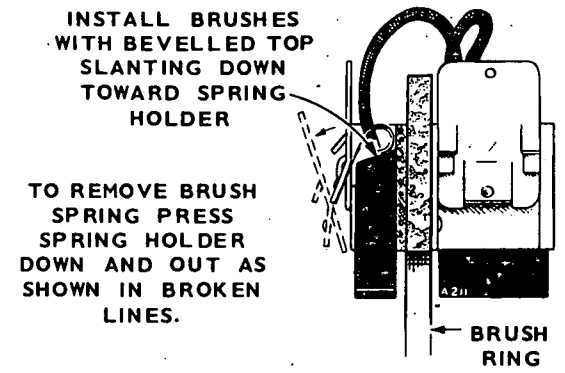
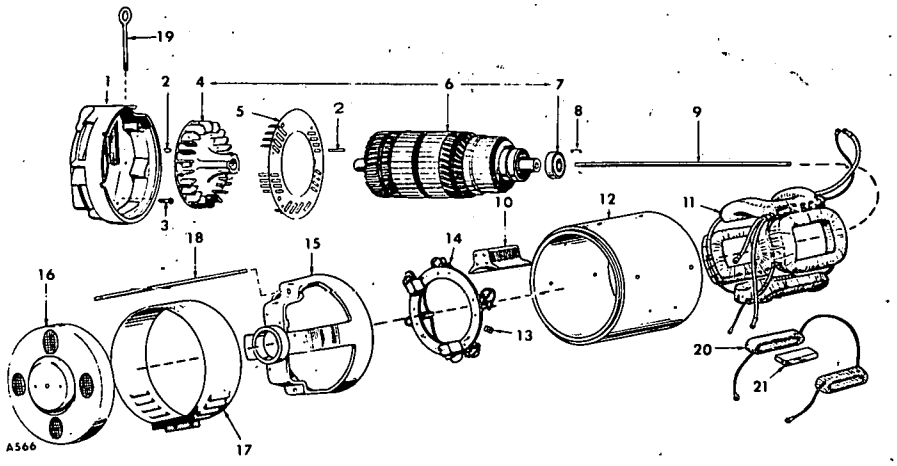


FIGURE 64. BRUSH, HOLDER & SPRING

Turn the armature nut out to the end of the armature through stud. While pulling outward with one hand under the armature, strike a sharp endwise blow on the nut to loosen the armature. Remove the armature and blower as an assembly. The blower is keyed and pressed onto the armature and is keyed with a tapered fit onto the engine crankshaft.

If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature half turn before



1- ADAPTER
2- KEY
3- SCREW
4- BLOWER
5- PLATE
6- ARMATURE ASSEMBLY
7- BEARING
8- CLIP
9- STUD
10- SHOE
11- COIL ASSEMBLY, FIELD
12- FRAME
13- CLIP
14- RIG ASSEMBLY
15- BELL
16- COVER
17- BAND
18- STUD
19- EYE
20- COIL SET, INTERPOLE
21- INTERPOLE

FIGURE 63. GENERATOR ASSEMBLY

repeating. Do not strike the commutator, collector rings or bearing.

BRUSHES AND SPRINGS

Inspect brushes periodically. Brushes worn to 5/8 inch (16 mm) should be replaced. Use replacement brushes specified in the parts list for this welder. Other brushes may look identical but have entirely different electrical characteristics. Replace springs if damaged or if proper tension is questionable. To remove the brush, press down on the spring holder and out (Figure 64). Then lift the brush from the guide. Spring tension for the DC brushes is 30 to 34 ounces (851 to 964 g) and for the AC brushes is 16 to 20 ounces (464 to 567 g). Always replace a brush spring if it's twisted, bent or broken.

CAUTION **Never bend the constant-pressure spring over the edge of its support.**

Rapid brush wear may be caused from high mica between commutator bars, rough commutator or collector rings or from a deviation from "neutral" position in the adjustment of the brush rig.

BRUSH RIG POSITION

Check the reference mark on the edge of the brush rig and if necessary align it with the boss in the end bell (Figure 65). If the brush rig is adjusted so that there is arcing of the brushes, brush wear will be rapid, voltage and current will not hold steady and the generator may overheat.

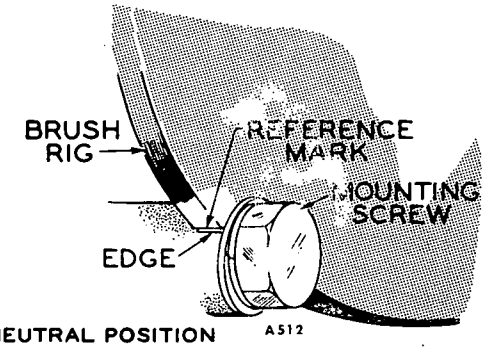
Whenever a new brush rig or armature is installed, the brush rig must be adjusted to the point where the brushes do not arc, regardless of where the witness mark falls. This is commonly known as the neutral brush position.

For determining neutral position, perform the following steps:

1. Attach a voltmeter (0 to 75) across the welding output terminals of the welder and start the welder. With no load, loosen the brush rig mounting screws and adjust the position of the brush rig until the higher voltage is obtained as indicated on the voltmeter. Tighten one brush rig screw and mark the brush rig with a pencil at a mounting screw boss.
2. Weld and note if sparking occurs at the brushes during welding. To correct, move the brush rig slightly in either direction (preferably with armature rotation) until sparking is no longer noticeable while welding.
3. After final setting is reached, make a permanent mark on the brush rig (Figure 65).

   The final adjustment will be a compromise between welding characteristics and sparking at the brushes.

4. Stop the welder and remove the voltmeter. Be sure all brush rig mounting screws have been tightened after final adjustment.



FOR PROPER NEUTRAL POSITION ALIGN YELLOW PAINT OR CHISEL REFERENCE MARK ON BRUSH RIG TO TOUCH EDGE OF END BELL NEAR BRUSH RIG MOUNTING SCREW.

FIGURE 65. BRUSH RIG NEUTRAL POSITION

Whenever a welding arc is struck, some sparking will occur at the brushes and is normal.

COLLECTOR RINGS

If collector rings become grooved or out-of-round, or the brush contact surface becomes pitted or rough so that good brush seating cannot be maintained, remove the armature and refinish the collector rings in a lathe. If the commutator appears to be rough or scored, refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

COMMUTATOR

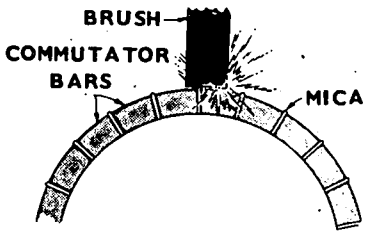
The commutator gradually wears with use. If the proper brushes have been used, and they have been replaced at the proper intervals, this wear will be slow and even. Under dusty conditions or if improper brushes have been used, the wear may be accelerated. Improper or excessive cleaning with sandpaper may cause the commutator to become grooved or out-of-round. Refinish in a lathe.

TURNING COLLECTOR RINGS OR COMMUTATOR (Using a Lathe)

When a collector ring or commutator becomes grooved, worn out-of-round or pitted, it should be turned true on a lathe. This operation is easily performed by any qualified lathe operator. Remove the armature and center accurately on the lathe. Turn the commutator or collector ring enough to provide a perfectly true surface. Tool marks can be removed by using number 240 sandpaper.

After turning the slip rings, cut a slight chamfer on them to remove burrs and sharp edges. This reduces the possibility of a "flash over" between the rings. After turning the commutator, the mica insulation between the commutator bars must be undercut as described in the paragraph *Undercutting The Mica Insulation.*

Always install new brushes after servicing slip rings and commutator.



COMMUTATOR BARS WORN BELOW LEVEL OF MICA SEPARATORS CAUSE SPARKING JUMPING, NOISY BRUSHES

FIGURE 66. HIGH MICA CONDITION OF COMMUTATOR

UNDERCUTTING THE MICA INSULATION

When the commutator wears down so that the mica insulation between any bars comes in contact with the brushes, it will cause the brushes to "jump", spark, be noisy in operation and wear rapidly. Sparking brushes lower the efficiency of the generator and burn the commutator (Figure 66). When a "high mica" condition exists or after commutator has been turned on a lathe, mica insulation requires undercutting. A typical tool for this is shown in Figure 67.

To undercut the mica, center the cutting tool over the mica and with a firm, steady pull draw the tool the length of the commutator.

CAUTION **Be careful not to draw the undercutting tool into the slip rings.**

Repeat the cutting operation until the mica has been cut down to approximately 1/32 inch (.80 mm) below the surface of the commutator. As each section of mica is cut to the proper depth, proceed to the next one until all are equally undercut. If any burrs are present along the edges of the bars after the mica is undercut, carefully remove them. This is done by holding a piece of number 240 sandpaper against the commutator with a perfectly flat piece of wood while the commutator is turning rapidly. Before putting the armature back into service, be sure to blow or brush all mica dust, metallic particles, etc. from the commutator grooves and surface. The edges of the bars on the larger commutators should be beveled to assure a good edge.

TESTING WINDINGS

An ohmmeter and an armature growler are required for the various tests. Before making any tests, lift all brushes in their holders and disconnect the load circuit wires from the welder. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as required.

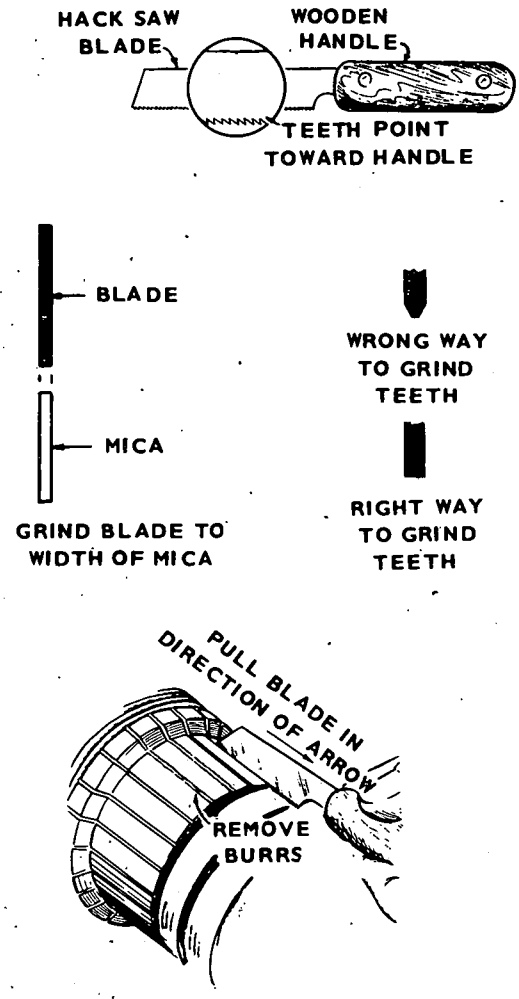


FIGURE 67. UNDERCUTTING COMMUTATOR MICA

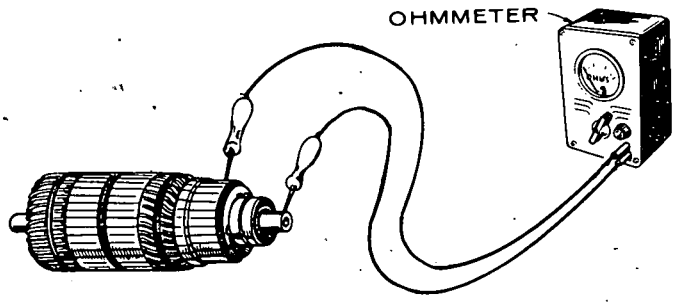
ARMATURE GROUND TEST

To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Using the ohmmeter, place one test prod on the commutator and the other test prod on a bare, clean part of the armature shaft (Figure 68). The test prods must make good electrical contact. If the ohmmeter shows continuity, the DC winding or commutator is grounded, replace the armature.

To test the AC winding, place one prod on one of the collector rings and the other prod on the armature shaft (Figure 69). If the ohmmeter indicates continuity, the AC winding or a collector ring is grounded. Replace armature.

ARMATURE OPEN CIRCUIT TEST

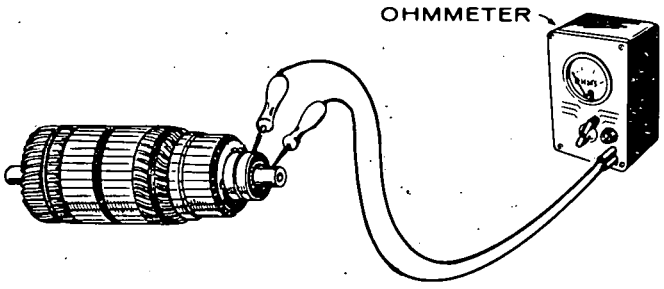
Armature AC windings may be tested for an open circuit without armature removal. Testing DC windings requires armature removal and the use of an armature growler.



ONE PROD ON COMMUTATOR, ONE PROD ON ARMATURE SHAFT.

FIGURE 68. ARMATURE DC GROUND TEST

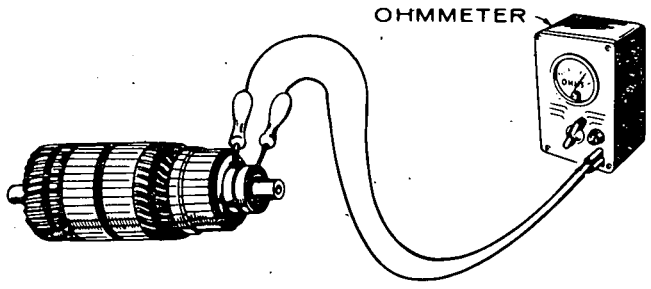
To test the AC winding, be sure all brushes are lifted or removed. Place one prod on each of the collector rings (Figure 70). If the ohmmeter indicates continuity, the AC winding is okay. If it doesn't, the AC winding is open and the armature should be replaced.



ONE PROD ON SLIP RING, ONE PROD ON ARMATURE SHAFT.

FIGURE 69. ARMATURE AC GROUND TEST

To test the DC winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments (Figure 71). Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. Replace an open circuited armature with a new one.



ONE PROD ON EACH SLIP RING.

FIGURE 70. ARMATURE AC OPEN TEST

A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph.

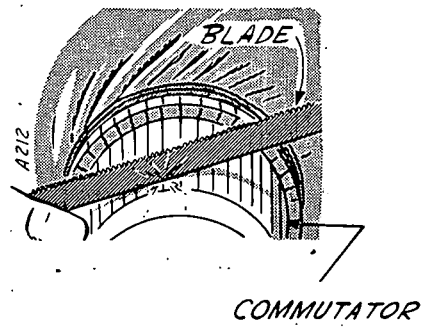


FIGURE 71. ARMATURE DC OPEN TEST

ARMATURE SHORT CIRCUIT TEST

To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2 inch (13 mm) above the armature laminations (Figure 72). Pass the strip back and forth

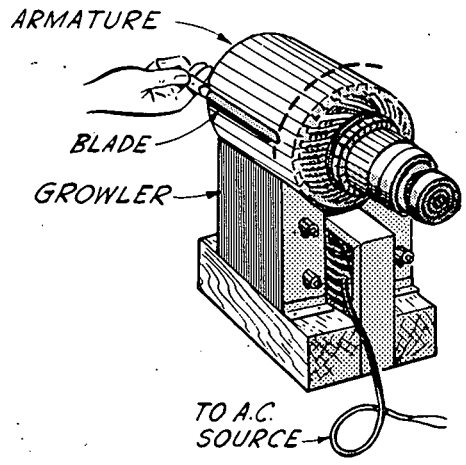


FIGURE 72. ARMATURE SHORT CIRCUIT TEST

over the laminations. Cover as much of the laminated area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

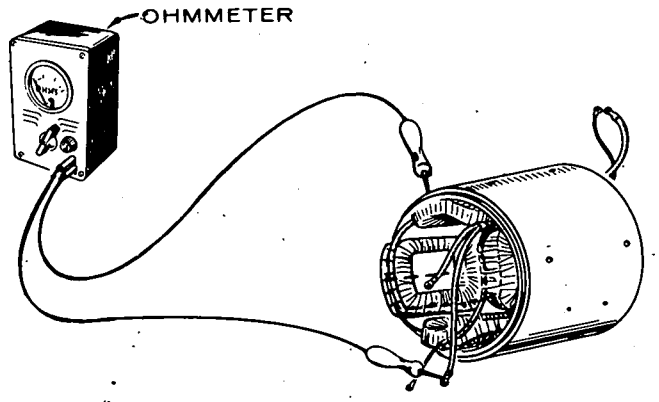


FIGURE 73. GROUND TEST FOR FIELD WINDINGS

TESTING FIELD WINDINGS FOR GROUNDS

To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. Continuity indicates the coil assembly is grounded (Figure 73). The ground may be in a coil, coil connection or coil lead. Repair or replace as required. Repeat procedure for each coil assembly.

TESTING FIELD WINDINGS FOR OPEN CIRCUIT

To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the terminal of one coil winding lead and the other test prod to each of the other leads of the coil winding in turn (Figure 74). If the ohmmeter indicates infinity, the field coil circuit is open. If the open circuit is caused by a connection between coils or in a coil lead, the trouble can be repaired. If it is inside the coil itself, the entire coil assembly must be replaced. Repeat the procedure for each coil assembly.

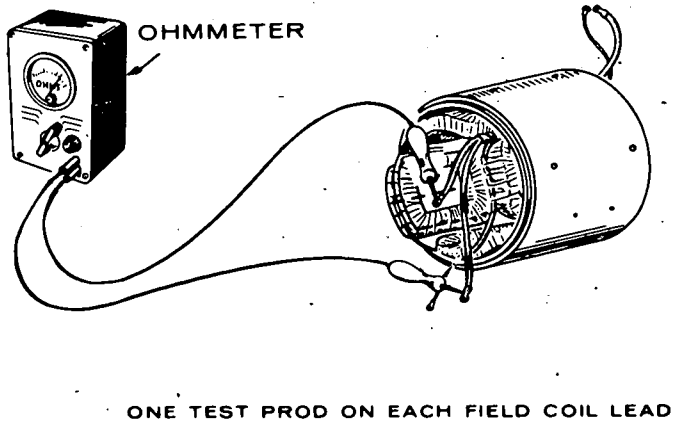


FIGURE 74. OPEN TEST FOR FIELD WINDINGS

BALL BEARING

If armature ball bearing replacement becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder of the shaft.

The bearing is prelubricated, double sealed and normally requires no service. However, when rebuilding the engine or generator, or if the bearing ever becomes noisy, replace it.

GENERATOR ASSEMBLY

1. Clean and inspect all mating surfaces. Surfaces should be free of nicks and dirt.
2. Coat mating area between the generator shaft and the engine crankshaft with a thin film of lubricating oil, Molykote or equal.
3. Assemble the armature through stud to the engine crankshaft with required torque.
4. Check to see that the key is in the crankshaft.
5. Slide armature over the through stud and onto the crankshaft being careful not to let the weight of the armature rest on the through stud.
6. Install baffle ring, when used.
7. Assemble generator through studs to the adapter with required torque.

CAUTION **Do not tighten the armature or rotor through stud before mounting the frame and bearing support. If this procedure is not followed, misalignment may occur shortening the life of the rear main and outboard bearings. Also, cranking torque requirements could be doubled, resulting in damage to the commutator and DC brushes of the starter.**

8. Install the bearing support. Tighten frame to required torque.
9. Now torque down the armature through-stud nut. Because the frame and bearing support were tightened before tightening the armature, the armature and frame are aligned.
10. Tap the bearing support in the horizontal and vertical plane with a lead hammer to relieve stresses on the components and then recheck the torque.
11. Reconnect the wire leads to the engine.
12. Reinstall the battery cables.
13. Align the brush rig.

CONTROL

If any control equipment fails to function properly, replace the defective parts with a new part rather than try to repair the old part. Check all electrical connections and contacts whenever servicing control equipment.

When disassembling controls, tag each lead that is to be removed, and mark the lead connection point on the tag to assure correct connections when assembling.

WARNING **Always disconnect the battery (electric start units) whenever servicing controls to avoid accidentally starting the unit and causing personal injury.**

GENERATOR TROUBLESHOOTING

LOW OR NO AC OUTPUT

NATURE OF TROUBLE	CAUSE/REMEDY
Microswitch DC contacts stuck open	Replace microswitch
Poor brush contact	Brushes incorrectly installed (bevel must be toward spring holder).
	Brushes not well seated (operate under light load until seated).
	Brushes worn shorter than 5/8 inch (16 mm). Replace.
	Incorrect brush spring tension (see "BRUSHES AND SPRINGS").
	Incorrect brushes. Replace.
Brush shunt broken	Check brush shunts with an ohmmeter. Replace if necessary.
Loose connections at slip ring brush terminals	Check and tighten connections.
Slip rings shorting	Dirt, dust, grease or oil shorting out rings. Clean with suitable solvent.
Open circuit, short circuit or ground in generator	Make generator tests per text.
Faulty AC load and/or connections	Open or short load circuit. Check load and connections.
Blown control panel fuse (Canadian models)	Check fuses and replace as needed.

AC OUTPUT WHEN WELDING

NATURE OF TROUBLE	CAUSE/REMEDY
Microswitch AC contacts stuck closed	Replace.

GENERATOR OVERHEATING

NATURE OF TROUBLE	CAUSE/REMEDY
Welding operation too long without correct periods of no-weld operation	Follow duty cycles recommended in *OPERATION* section.
Poor generator ventilation	Obstructed generator inlet or outlet. Clean.
	Generator dirty. Clean with low pressure, 35 psi (242 kPa) or less, compressed air.
Arcing brushes during normal operation	See troubleshooting "Excessive arcing of brushes."

LOW OR NO DC WELDING OUTPUT

NATURE OF TROUBLE	CAUSE/REMEDY
Poor brush contact	Brushes incorrectly installed (bevel must be toward spring holder).
	Brushes not well seated (operate under light load until seated).
	Brushes worn shorter than 5/8 inch (16 mm). Replace.
	Incorrect brush spring tension (see "BRUSHES AND SPRINGS").
	Incorrect brushes. Replace.
Broken brush leads	Check brush shunts with an ohmmeter and replace defective brushes and leads.
Loose connections at brush terminals	Check and tighten connections.
Insulating film or commutator	Clean with sandpaper, commutator stone and blow out dust. Do not use emery cloth.
Brush rig not in neutral position	Reposition as described in "BRUSH RIG POSITION."
Open circuit in rheostat	Check rheostat with ohmmeter and repair or replace.
DC open, short or ground in generator	Make DC generator tests per text.

NOISY BRUSHES

NATURE OF TROUBLE	CAUSE/REMEDY
Brushes incorrectly installed	Brushes reversed in holder (bevel must be toward spring holder).
Incorrect brush spring tension	See "BRUSHES AND SPRINGS."
DC brushes arcing from high mica	Undercut mica. Follow procedures under "UNDERCUTTING MICA INSULATION."

EXCESSIVE ARCING OF BRUSHES

NATURE OF TROUBLE	CAUSE/REMEDY
Brushes not seated properly	Operate welder at reduced load until seated
Dirty commutator or slip rings	Clean with low pressure (35 psi (242 kPa) or less). filtered, compressed air or with lint-free cloth.
Brush rig out of neutral position	See "BRUSH RIG POSITION."
Rough commutator or slip rings	Turn down with a lathe. Refer to "TURNING COLLECTOR RINGS OR COMMUTATOR."
Open circuit in armature	Make test per text. Replace if open.

PARTS CATALOG

This catalog applies to the standard 200 ampere DJB Welder. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number in the parts list for that group. Parts illustrations are typical. Using the *Model* and *Spec No.* from the nameplate, select parts from this catalog that apply to your welder. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left sides are determined by facing the engine end (front) of the welder.

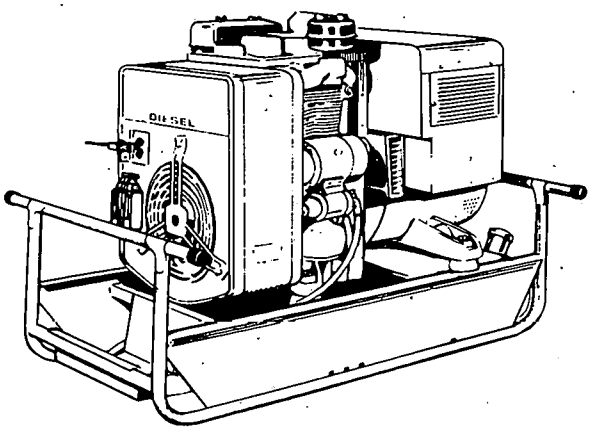
WELDER DATA TABLE

MODEL & SPEC £	ELECTRICAL DATA					
	DC OUTPUT			AC OUTPUT		
	AMPS	VOLTS	DUTY CYCLE	WATTS	VOLTS	HERTZ
6.0DJB-331E/*	200	28	50%	3500	120	60
6.0DJB-332E/*	200	28	50%	3500	240	60
6.0DJB-5331E/*	200	28	50%	2500	120	50
6.0DJB-5332E/*	200	28	50%	2500	240	50

* - The Specification Letter advances (R to S, S to T, etc.) with manufacturing changes.

£ - New model designations shown, began during 1969. Previous designations did not use a decimal in the kW rating. EXAMPLE: 6.0DJB was formerly 6DJB.

NOTE: Hertz is a unit of frequency equal to one cycle per second.

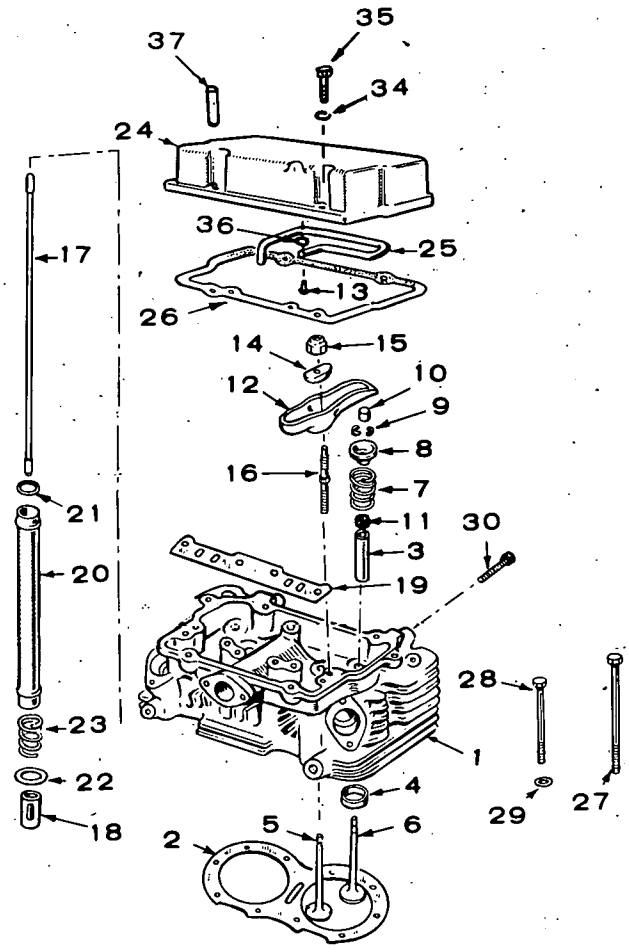


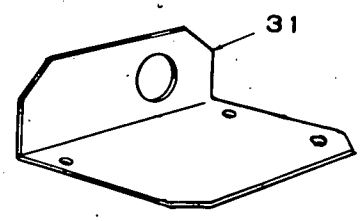
NOTICE!

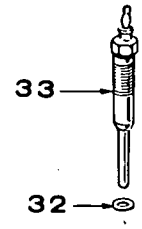
ITEMS REFERENCED AS **OPTIONAL** INDICATE PART IS FACTORY INSTALLED AND MAY NOT BE APPLICABLE TO ALL MODELS. FOR FIELD CONVERSIONS ADDITIONAL PARTS ARE USUALLY REQUIRED.

CYLINDER HEAD, VALVE AND ROCKER GROUP

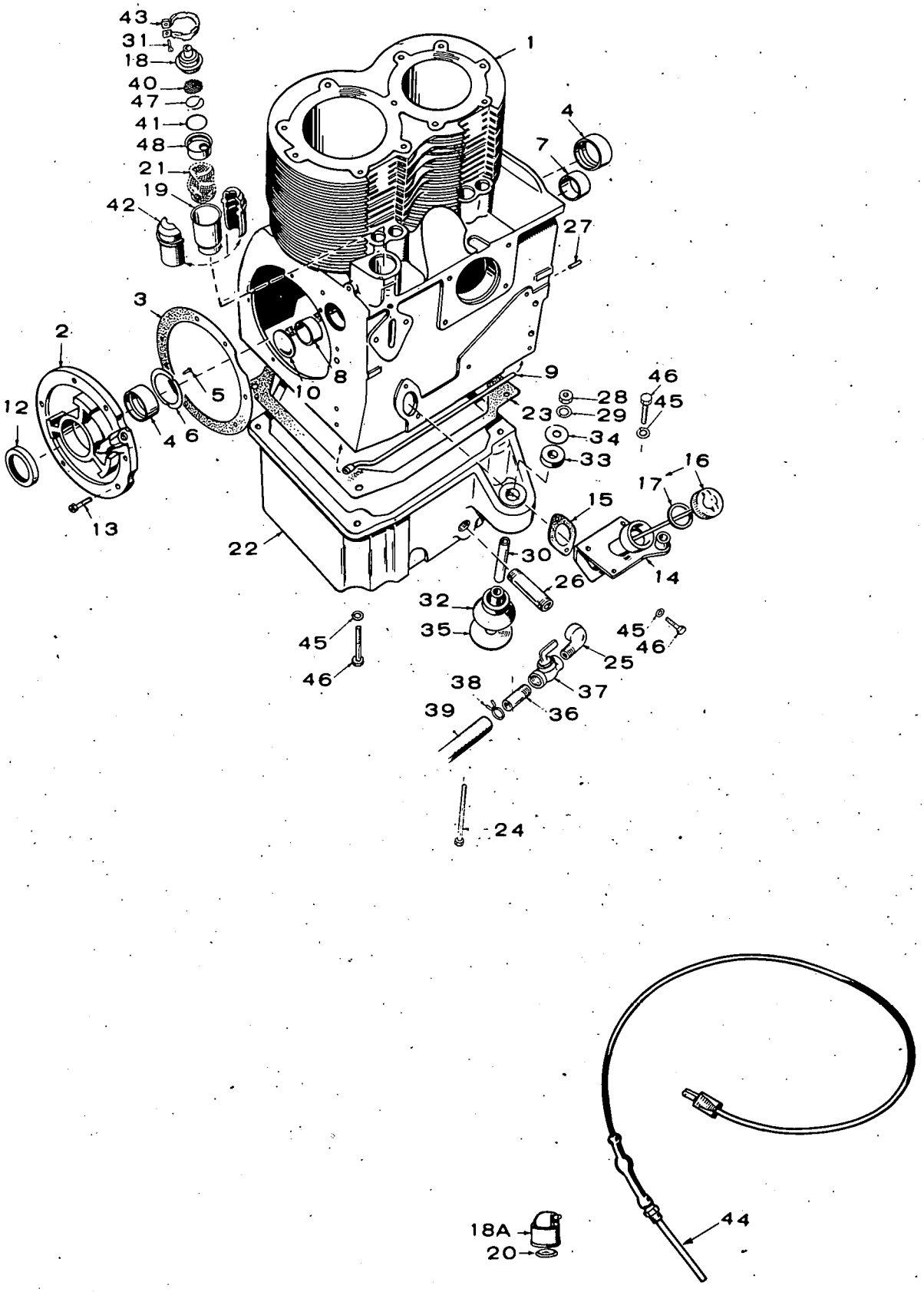
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	110-1546	1	Head, Cylinder
2	110-1223	1	Gasket, Head
3	GUIDE, VALVE		
	110-1501	4	Standard
	110-1501-01	4	.001" Oversize
4	INSERT, VALVE SEAT (Intake & Exhaust)		
	110-1268	4	Standard
	110-1268-02	4	.002" Oversize
	110-1268-05	4	.005" Oversize
	110-1268-10	4	.010" Oversize
	110-1268-25	4	.025" Oversize
5	110-1320	2	Valve, Intake
6	110-1278	2	Valve, Exhaust, Stellite
7	110-1221	4	Spring, Valve
8	110-1220	4	Retainer, Valve Spring
9	110-0858	8	Lock, Valve Spring Retainer
10	110-0859	4	Cap, Valve Stem
11	509-0090	2	Seal, Oil, Intake Valve - Includes Retaining Rings
12	ARM, ROCKER		
	115-0128	2	Exhaust
	115-0129	2	Intake
13	809-0042	1	Screw, Oil Line, Rocker Cover
14	115-0127	4	Ball, Rocker Arm
15	115-0150	4	Nut, Lock - Rocker Arm
16	115-0152	4	Stud, Rocker Arm
17	115-0149	4	Rod, Valve Push (Steel)
18	115-0195	4	Tappet, Valve
19	115-0196	1	Guide, Push Rod
20	115-0151	4	Shield, Push Rod
21	509-0084	8	Seal, Push Rod Shield
22	115-0155	8	Washer, Spring Retaining
23	115-0146	4	Spring, Shield Retainer
24	115-0197	1	Cover, Rocker
25	120-0628	1	Line, Oil, Rocker Cover
26	115-0130	1	Gasket, Rocker Cover
27	110-1264	5	Screw (3/8-16 x 4-1/4") Cylinder Head Mounting
28	800-0503	6	Screw (3/8-16 x 1-3/4") Cylinder Head Mounting
29	526-0174	5	Washer, Cylinder Head
30	114-0022	4	Screw, Exhaust Manifold
31	403-0825	1	Bracket, Lifting, Includes Hardware
32	110-0546	2	Gasket, Glow Plug
33	333-0106	2	Plug, Glow (12 Volt) - Includes Gasket
34	WASHER, LOCK		
34	850-0045	4	5/16" Rocker Cover and Lifting Bracket Mounting
	850-0060	1	1/2" - Lifting Bracket Mounting
35	SCREW, ROCKER COVER AND LIFTING BRACKET MOUNTING		
	800-0038	2	5/16-18 x 3-1/4"
	800-0030	2	5/16-18 x 1-1/4"
	800-0091	1	1/2-13 x 1-1/4"
36	526-0130	1	Washer, Flat
37	403-0826	2	Spacer, Lifting Bracket





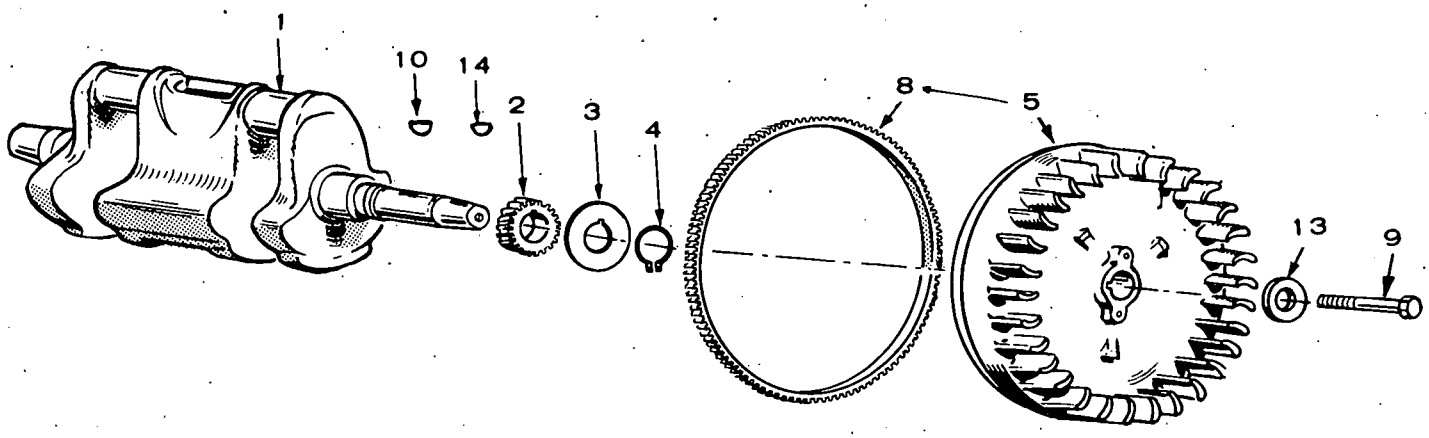


CRANKCASE AND OIL BASE GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	110-1330	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	101-0337	1	*Plate, Bearing (Less Bearing & Pins)
3	101-0386	1	*Gasket Kit, Bearing Plate (Includes Steel Shims)
4	BEARING, PRECISION MAIN		
	101-0359	2	*Standard
	101-0359-02	2	.002" Undersize
	101-0359-10	2	.010" Undersize
	101-0359-20	2	.020" Undersize
	101-0359-30	2	.030" Undersize
5	516-0072	4	*Pin, Thrust Washer
6	104-0420	2	*Washer, Crankshaft Thrust
7	101-0363	1	*Bearing, Precision Camshaft Front, Standard Only
8	101-0365	1	*Bearing, Precision Camshaft Rear, Standard Only
9	120-0553	1	*Tube, Crankcase Oil
10	517-0053	1	*Plug, Camshaft Opening
12	509-0086	1	*Seal, Crankshaft Rear
13	805-0019	6	*Bolt, Place, Plate (3/8-16 x 1-1/4)
14	TUBE, OIL FILL		
	123-0681	1	Spec R Only
	123-1085	1	Begin Spec S
15	123-0667	1	Gasket, Oil Fill Tube
16	CAP AND INDICATOR		
	123-0651	1	Spec R Only
	123-1058	1	Begin Spec S
17	123-0191	1	Gasket, Cap
18	123-0954	1	Cap & Valve Assembly, Breather - Begin Spec S
18A	123-0787	1	Cap, Breather - Spec R Only
19	TUBE, BREATHER		
	123-0645	1	Spec R Only
	123-0952	1	Begin Spec S
20	123-0315	1	Valve, Breather - Spec R Only
21	123-0865	1	Baffle, Breather
22	102-0540	1	Base, Oil
23	102-0451	1	Gasket, Base
24	800-0082	2	+Screw (7/16-14 x 3-3/4")-Cushion Mounting - Engine End
25	505-0050	1	Elbow, Street (1/2" x 90°)
26	505-0078	1	Nipple (1/2" x 2-1/2")
27	516-0141	2	*Pin, Dowel, Gear Cover Locating
28	862-0004	4	+Nut (7/16 x 14)
29	850-0055	4	+Washer, Lock (7/16)
30	402-0290	4	+Bushing, Spacer, Vibration Mount
31	809-0035	1	Screw, Breather Clamp - Begin Spec S
32	CUSHION, VIBRATION, CONE-SHAPED		
	402-0284	2	Engine End
	402-0285	2	Generator End
33	402-0282	4	+Snubber, Shock Mounting
34	526-0014	4	+Washer (29/64" I.D. x 1-1/2" O.D. x 1/8")
35	526-0199	As Req.	+Washer (29/64" I.D. x 3-1/4" O.D. x 1/8")
36	505-0100	1	Nipple, Oil Drain
37	504-0011	1	Valve, Oil Drain
38	503-0197	1	Clamp, Oil Drain
39	503-0564	1	Hose, Oil Drain
40	123-1202	1	Screen, Breather Tube - Begin Spec S
41	509-0117	1	Seal, "O" Ring, Breather Tube - Begin Spec S
42	123-0998	2	Insulator Halves, Breather Tube - Begin Spec S
43	518-0268	1	Clamp, Breather Tube Insulator Halves - Begin Spec S
44	102-0558	1	Heater, Oil Base (Optional)
45	WASHER, LOCK		
	850-0055	4	Oil Base Mounting (7/16")
	850-0045	2	Oil Fill Tube Mounting (5/16")
	850-0045	3	Fuel Filter Adapter Mounting (5/16")
46	SCREW		
	800-0072	4	Oil Base Mounting (7/16-14 x 1-1/4")
	800-0026	2	Oil Fill Mounting (5/16-18 x 3/4")
	821-0016	3	Fuel Filter Adapter to Oil Fill Tube (5/16-18 x 3/4")
	402-0355	1	Hardware Package, Mounting (Includes Parts Marked +)
47	123-1201	1	Retainer, Breather Screen - Begin Spec S
48	123-1153	1	Baffle Cup, Breather - Begin Spec S

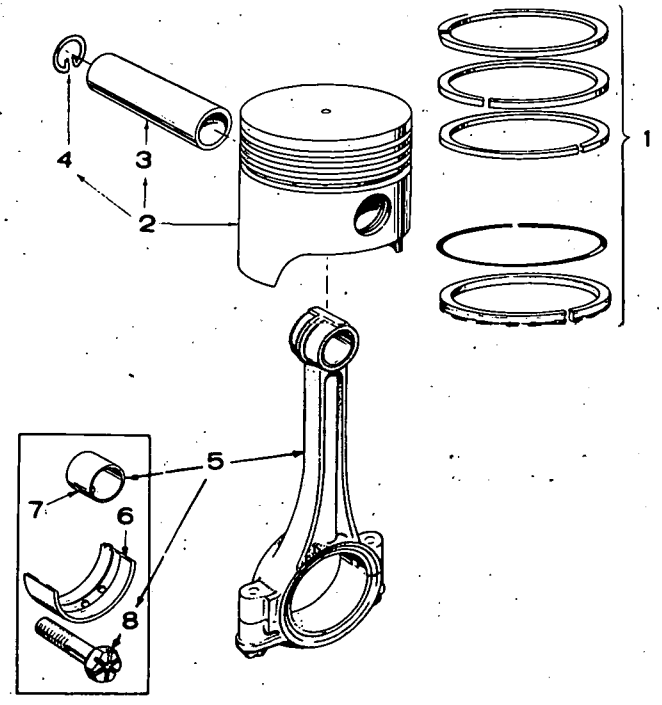
* - Included in Cylinder Block Assembly.
+ - Included in Mounting Hardware Package.



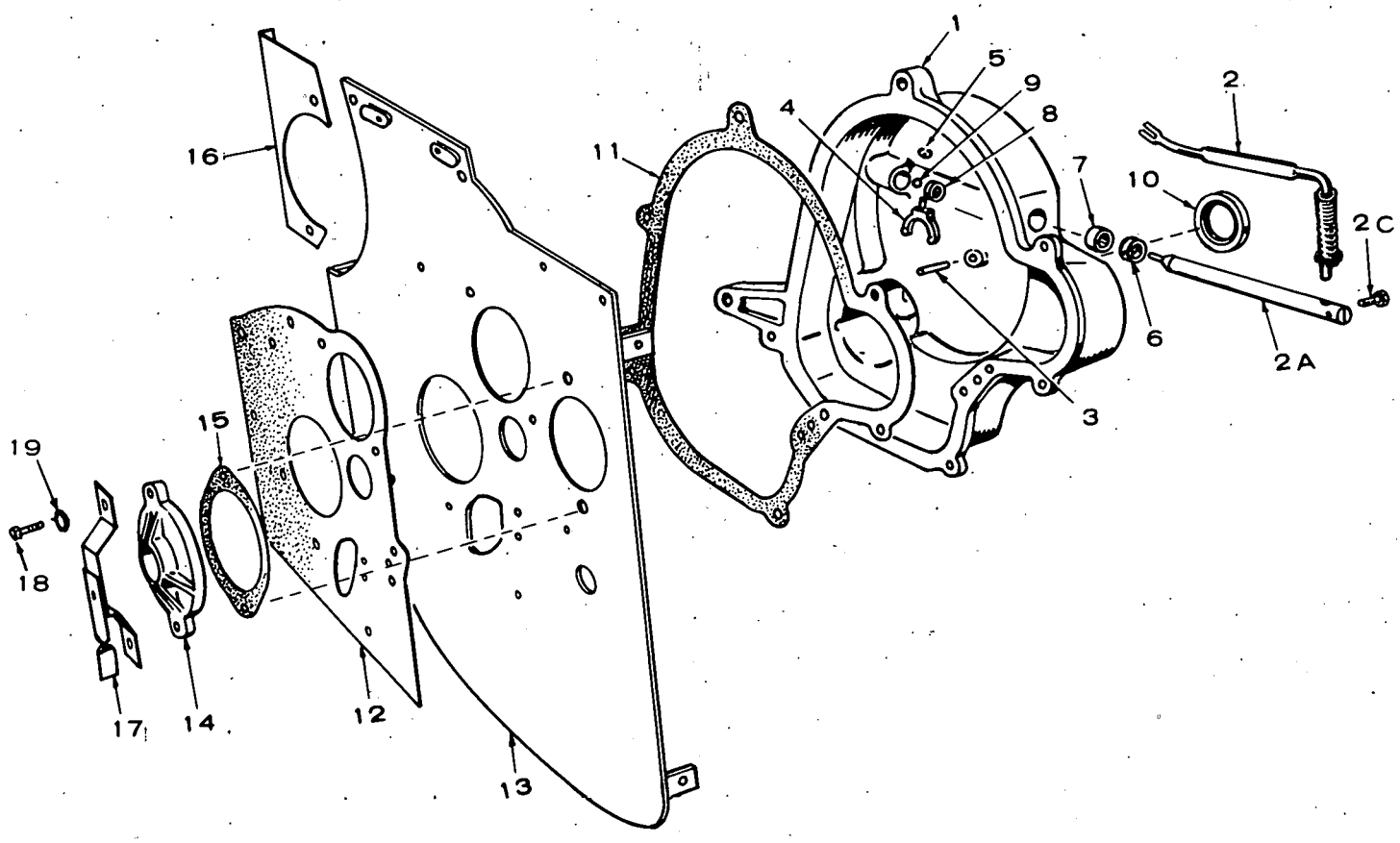
CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	104-0451	1	Crankshaft
2	104-0418	1	Gear
3	104-0416	1	Washer, Retainer
4	518-0188	1	Ring, Lock
5	191-0408	1	Flywheel (Includes Ring Gear)
8	104-0423	1	Gear, Ring
9	800-0500	1	Screw (7/16-14 x 5-1/2")-Flywheel
10	515-0001	1	Key, Gear
13	526-0185	1	Washer, Flywheel
14	515-0153	1	Key, Flywheel to Crankshaft

PISTON AND CONNECTING ROD GROUP



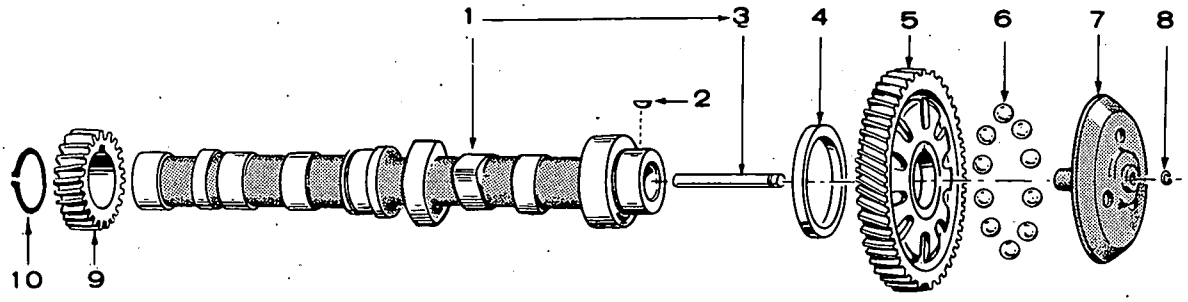
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	RING SET, PISTON		
	113-0130	2	Standard
	113-0130-05	2	.005" Oversize
	113-0130-10	2	.010" Oversize
	113-0130-20	2	.020" Oversize
	113-0130-30	2	.030" Oversize
	113-0130-40	2	.040" Oversize
2	PISTON & PIN (Includes Pin Retaining Rings)		
	112-0109	2	Standard
	112-0109-05	2	.005" Oversize
	112-0109-10	2	.010" Oversize
	112-0109-20	2	.020" Oversize
	112-0109-30	2	.030" Oversize
	112-0109-40	2	.040" Oversize
3	PIN, PISTON		
	112-0093	2	Standard
	112-0093-02	2	.002" Oversize
4	112-0085	4	Ring, Retaining, Pin
5	114-0168	2	Rod Assembly, Connecting
6	BEARING HALF, CONNECTING ROD		
	114-0164	4	Standard
	114-0164-02	4	.002" Undersize
	114-0164-10	4	.010" Undersize
	114-0164-20	4	.020" Undersize
	114-0164-30	4	.030" Undersize
7	114-0170	4	Bushing, Piston Pin, Connecting Rod, Semi-Finished
8	805-0012	4	Bolt (5/16-24 x 1-13/16")



GEAR COVER GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	COVER ASSEMBLY, GEAR (Includes Parts Marked *)		
	103-0277	1	Prior to Spec T
	103-0366	1	Begin Spec T
2	150-1095	1	Arm, Governor
2A	150-0838	1	*Shaft, Governor
2C	815-0176	1	*Screw (8-32 x 1/2")
3	516-0111	1	*Pin, Roll, Governor Cup Stop
4	150-0777	1	*Yoke, Governor
5	518-0129	1	*Ring, Yoke
6	509-0088	1	*Seal, Oil
7	510-0048	1	*Bearing (1/2") - Governor Shaft
8	510-0082	1	*Bearing (1/4") - Governor Shaft
9	510-0043	1	*Ball, Bearing, Governor Shaft Thrust
10	509-0087	1	*Seal, Oil
11	103-0251	1	Gasket, Gear Cover
12	103-0218	1	Gasket, Backplate
13	103-0271	1	Backplate
14	103-0221	1	Cover, Backplate Opening
15	160-0721	1	Gasket, Backplate Opening Cover
16	134-1532	1	Baffle, Backplate
17	147-0236	1	Arm and Bracket Assembly, Manual Stop
18	800-0051	2	Screw, Hex Head - 3/8-16 x 1-1/4"
19	850-0050	2	Lockwasher (3/8)

* - Parts Included in Gear Cover Assembly.

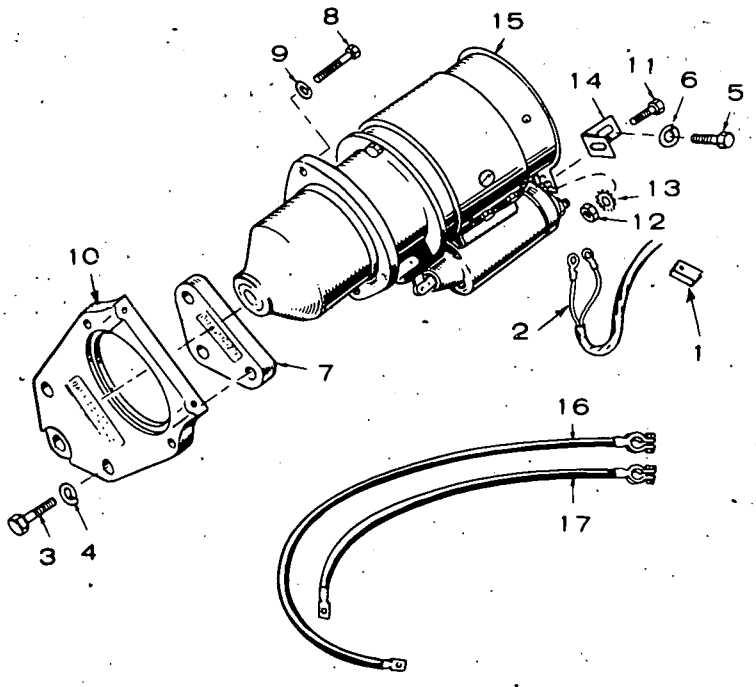


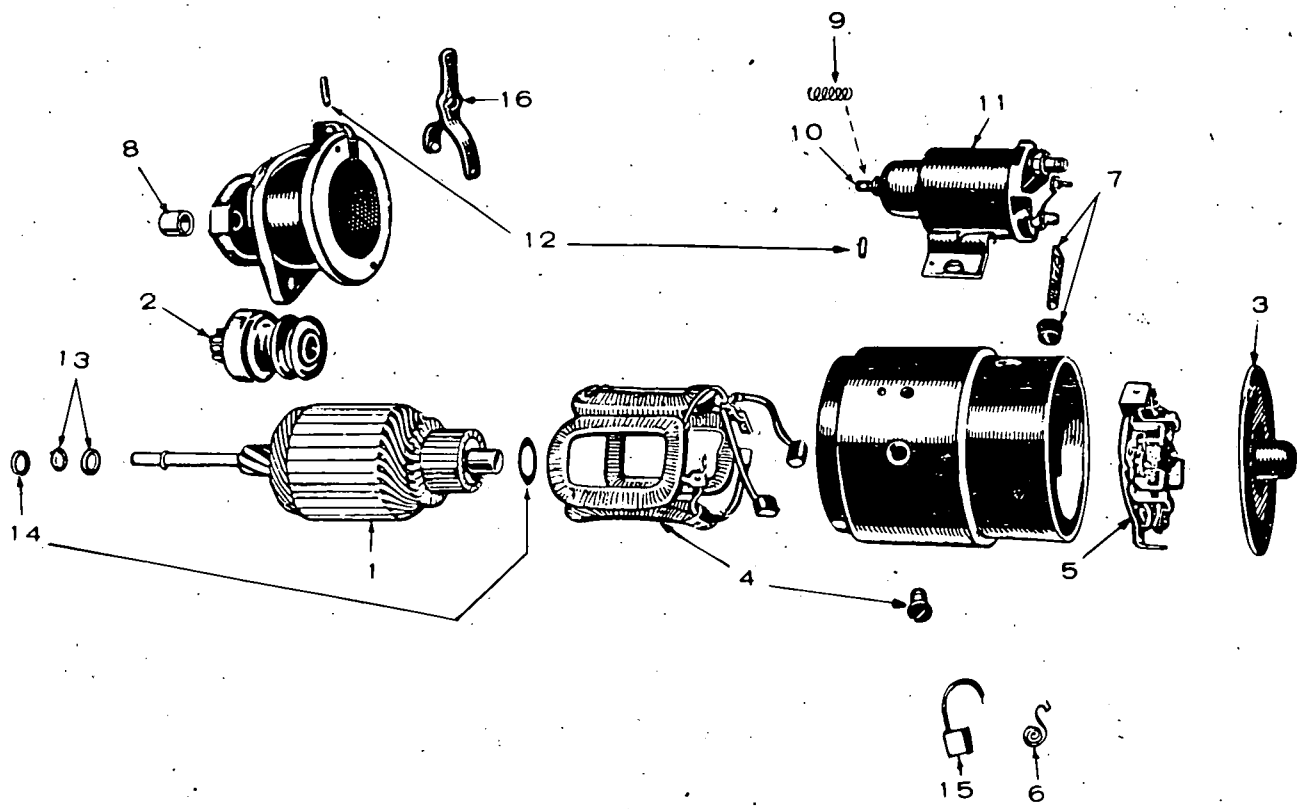
CAMSHAFT GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	105-0271	1	Camshaft (Includes Center Pin)
2	515-0001	2	Key, Camshaft Gear or Distributor Gear
3	150-0075	1	Pin, Center
4	105-0205	1	Washer, Thrust
5	105-0218	1	Gear (Includes Flyball Spacer & Plate)
6	BALL, FLY - GOVERNOR		
	510-0046	5	Spec R Only
	510-0046	10	Begin Spec S
7	150-0775	1	Cup, Governor
8	150-0078	1	Ring, Snap, Center Pin
9	147-0142	1	Gear, Injection Pump Drive
10	518-0195	1	Ring, Snap, Injection Pump Drive Gear

STARTER GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	416-0096	1	Clamp, Cable
2	338-0279	1	Harness, Wiring
3	800-0054	3	Screw, Hex Head (3/8-16 x 2")
4	850-0050	3	Washer, Lock - Spring (3/8)
5	800-0052	1	Screw, Hex Head (3/8-16 x 1-1/2")
6	850-0050	1	Washer, Lock - Spring (3/8)
7	191-0311	1	Spacer, Starter
8	800-0051	2	Screw, Hex Head (3/8-16 x 1-1/4")
9	850-0050	2	Washer, Lock - Spring (3/8)
10	191-0512	1	Flange, Starter
11	800-0046	1	Screw, Hex Head (3/8-16 x 1/2")
12	864-0003	1	Nut, Hex (3/8-16)
13	856-0010	1	Washer, Lock - External/Internal Tooth (3/8)
14	191-0365	1	Bracket, Starter
15	STARTER (See Separate Group For Components)		
	191-0324	1	12 Volt
	191-0443	1	24 Volt (Optional)
16	416-0580	1	Cable, Battery - Positive (32-1/2")
17	416-0581	1	Cable, Battery - Ground (47")



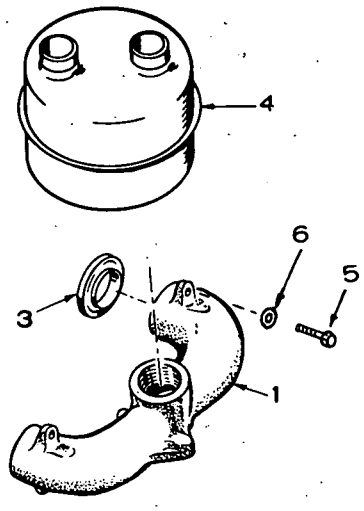


STARTER PARTS GROUP

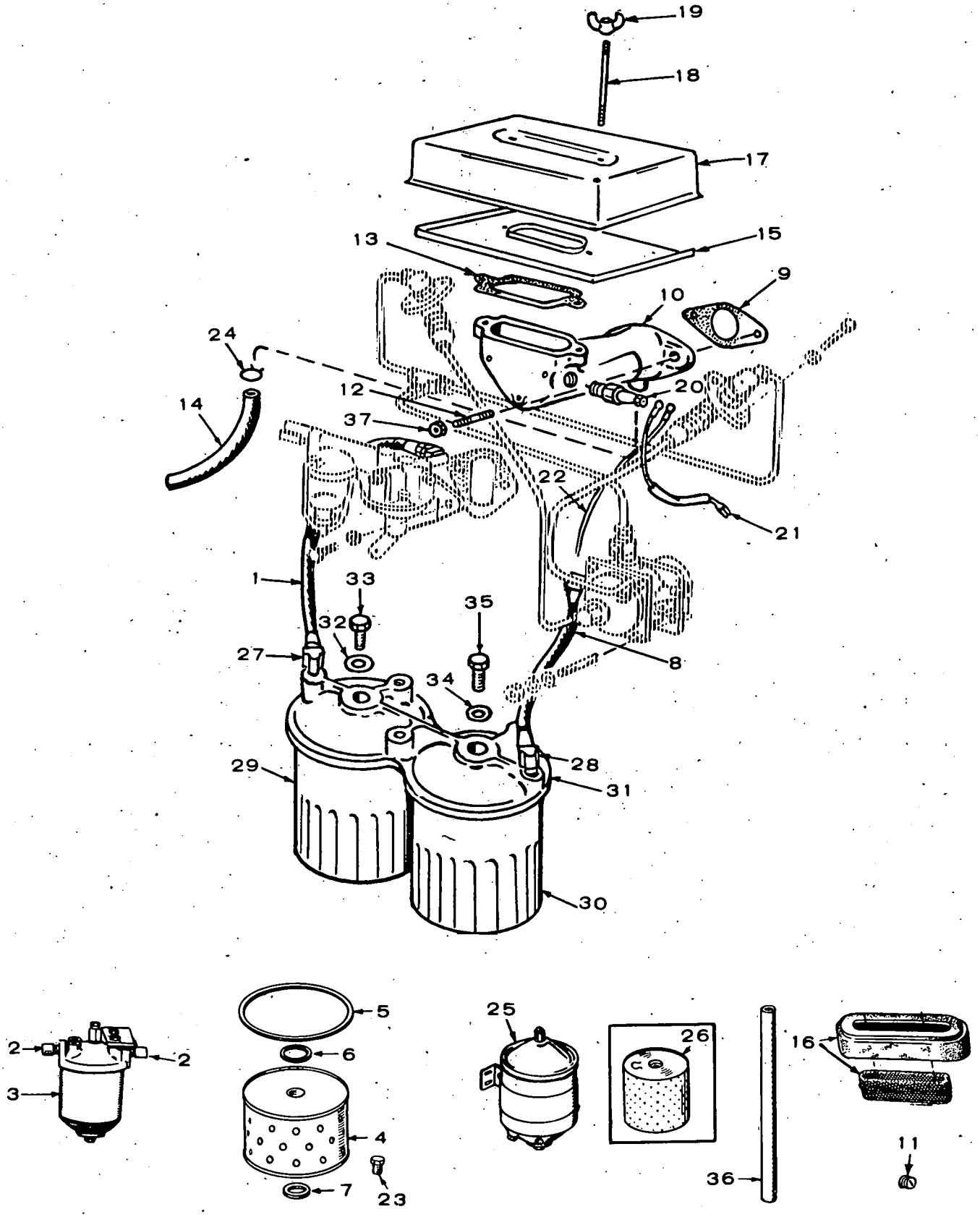
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	STARTER		
	191-0324	1	12 Volt
	191-0443	1	24 Volt
1	ARMATURE		
	191-0712	1	12 Volt
	191-0713	1	24 Volt
2	191-0432	1	Clutch
3	191-1023	1	Head Assembly, Commutator End
4	COIL PACKAGE, FIELD		
	191-1024	1	12 Volt
	191-1043	1	24 Volt
5	PLATE ASSEMBLY, BRUSH		
	191-1025	1	12 Volt
	191-1042	1	24 Volt
6	191-1020	1	Spring Set, Brush (Set of 4)
7	191-1026	1	Connector Package
8	191-0497	1	Bearing (Bronze), Drive End
9	191-1027	1	Spring, Plunger
10	191-1028	1	Core Assembly, Moving
11	SWITCH, SOLENOID		
	191-0433	1	12 Volt
	191-0715	1	24 Volt
12	191-1029	1	Yoke Parts Package
13	191-1030	1	Stop and Lock Ring Package, Pinion
14	191-1031	1	Thrust Washer Package, Armature (Use as Required)
15	BRUSH SET, SERVICE		
	191-0434	1	12 Volt
	191-0714	1	24 Volt
16	191-1032	1	Yoke

MANIFOLD AND EXHAUST GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	154-0633	1	Manifold, Exhaust, Vertical Outlet
3	154-0463	2	Gasket, Exhaust Manifold
4	155-0976	1	Muffler, Exhaust
5	114-0022	4	Screw, Hex Head (5/16-18 x 1-3/4")
6	526-0045	4	Washer, Flat (5/16)

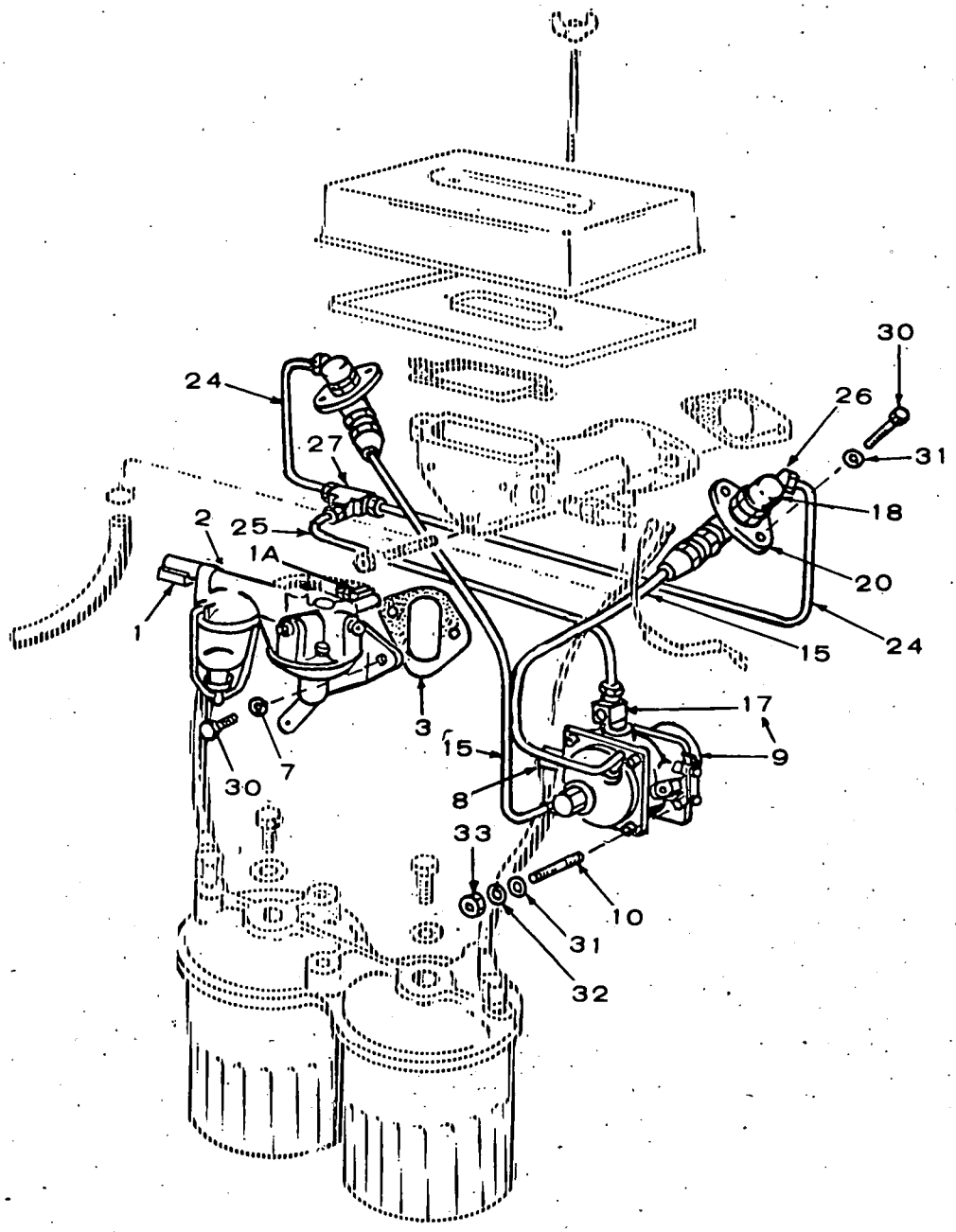


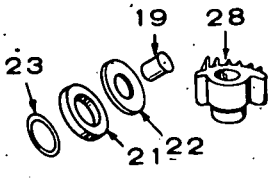
AIR CLEANER AND FUEL FILTERS GROUP

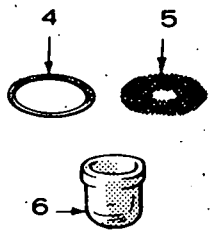


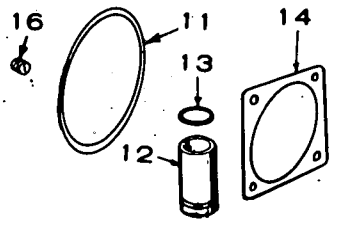
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	LINE, FUEL - PUMP TO SECONDARY FILTER		
	501-0032	1	Spec R Only
	501-0003	1	Begin Spec S
2	502-0041	2	Elbow, Inverted Male, Secondary Filter Inlet & Outlet - Spec R Only
3	149-0408	1	Filter, Secondary Fuel - Includes Cartridge (Bleed Plug 149-0769 is available separately) - Spec R Only
4	149-0428	1	Cartridge, Secondary Fuel Filter - Spec R Only
5	149-0456	1	Gasket, Secondary Filter, Bowl to Cover - Spec R Only
6	149-0455	1	Gasket, Secondary Filter Cartridge to Head - Spec R Only
7	149-0493	1	Gasket, Secondary Filter Cartridge to Retainer - Spec R Only
8	LINE, FUEL - SECONDARY FILTER TO INJECTION PUMP		
	501-0091	1	Spec R Only
	501-0129	1	Begin Spec S
9	141-0281	1	Gasket, Air Cleaner Adapter to Cylinder Head
10	140-0576	1	Adapter, Air Cleaner
11	505-0180	1	Plug, Pipe (1/4") Air Cleaner Adapter & Intake Manifold - Used on some early models
12	520-0011	2	Stud, Air Cleaner Adapter Mounting
13	140-0584	1	Gasket, Air Cleaner
14	HOSE, BREATHER		
	503-0462	1	Spec R Only
	503-0557	1	Begin Spec S
15	140-0595	1	Pan, Air Cleaner
16	140-0636	1	Element and Retainer, Air Cleaner
17	140-0594	1	Cover, Air Cleaner
18	520-0621	2	Stud, Air Cleaner
19	865-0020	2	Nut, Air Cleaner - Self Locking
20	154-0712	1	Heater, Manifold - Includes Gasket (12 Volt)
21	LEAD, GLOW PLUG TO AIR HEATER		
	336-1504	1	#1-Cylinder (12-1/4") Blade Type Terminal
	336-1505	1	#2-Cylinder (5-1/4") Blade Type Terminal
22	336-1418	1	Lead, Air Heater to Solenoid in Control
23	149-0769	1	Plug, Air Bleed, Secondary Filter
24	503-0170	2	Clamp, Breather Hose
25	149-1078	1	Filter, Fuel - Mounted Between Fuel Tank and Transfer Pump
26	149-0846	1	Cartridge, For 149-1078 Filter
27	502-0002	1	Elbow, Primary Fuel Filter Inlet - Begin Spec S
28	502-0099	1	Elbow, Reducer - Secondary Fuel Filter Outlet - Begin Spec S
29	122-0325	1	Filter, Fuel - Primary - Begin Spec S
30	122-0326	1	Filter, Fuel - Secondary - Begin Spec S
31	149-1185	1	Adapter, Fuel Filters - Begin Spec S
32	526-0068	1	Washer, Primary Fuel Filter Mounting - Begin Spec S
33	801-0074	1	Screw, Hex Head - Primary Fuel Filter Mounting - Begin Spec S
34	526-0066	1	Washer, Secondary Fuel Filter Mounting - Begin Spec S
35	801-0053	1	Screw, Hex Head - Secondary Fuel Filter Mounting - Begin Spec S
36	503-0559	1	Insulator, Breather Hose - Begin Spec S
37	870-0137	2	Nut, Air Cleaner Adapter Mounting (5/16-24)

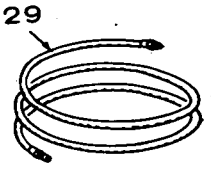
FUEL TRANSFER PUMP AND INJECTION SYSTEM GROUP







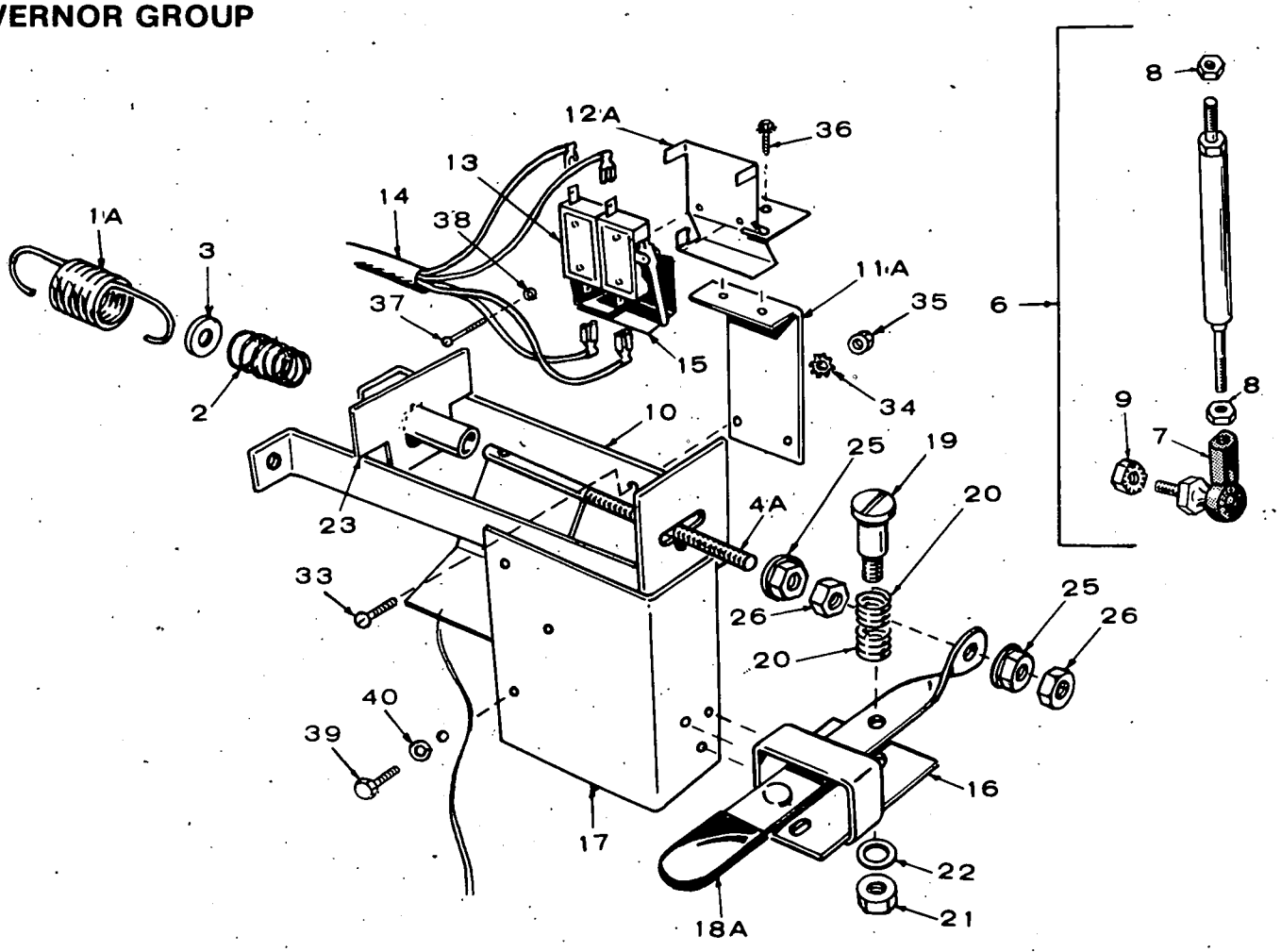




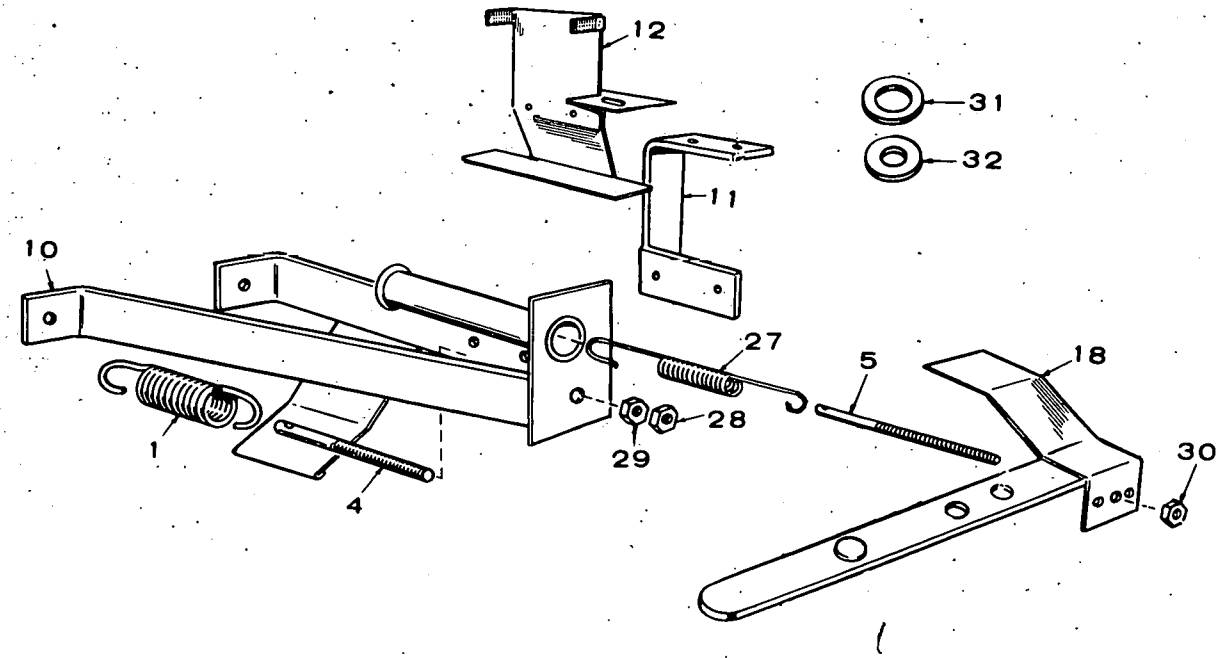
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1046	1	Repair Kit, Fuel Pump (Includes Diaphragm & Gaskets)
1	502-0002	1	Elbow, Inverted Male, Fuel Pump Inlet
1A	ELBOW, INVERTED MALE; FUEL PUMP OUTLET		
	502-0002	1	Spec R Only
	502-0020	1	Begin Spec S
2	149-0979	1	Pump, Fuel Transfer
3	149-0792	1	Gasket, Fuel Transfer Pump Mounting
4	149-0517	1	Gasket, Fuel Pump Bowl
5	149-0463	1	Screen, Fuel Pump Filter
6	149-0116	1	Bowl, Fuel Pump (Glass)
7	526-0065	2	Washer, Copper, Fuel Pump Mounting
8	ELBOW, INJECTION PUMP INLET		
	502-0054	1	Spec R Only
	502-0039	1	Begin Spec S
9	147-0219	1	Pump, Fuel Injection (Includes Buttons 2, 4, 12)
10	520-0129	4	Stud, Injection Pump Mounting
11	509-0094	1	Seal; "O" Ring, Injection Pump to Crankcase
12	147-0182	1	Tappet, Injection Pump
13	147-0196	1	Gasket, "O" Ring, Injection Pump Tappet
14	147-0145	1	Shim Kit, Injection Pump Mounting
15	LINE, INJECTION PUMP TO NOZZLE		
	149-1101	1	No. 1 Cylinder
	149-1102	1	No. 2 Cylinder
16	BUTTON, INJECTION PUMP PLUNGER		
	147-0147	1	.119 - Marked 1 or A
	147-0148	1	.116 - Marked 2 or B
	147-0149	1	.113 - Marked 3 or C
	147-0150	1	.110 - Marked 4 or D
	147-0151	1	.107 - Marked 5 or E
	147-0161	1	.104 - Std., 11 or No Mark
	147-0152	1	.101 - Marked 6 or F
	147-0153	1	.098 - Marked 7 or H
	147-0154	1	.095 - Marked 8 or J
	147-0155	1	.092 - Marked 9 or K
	147-0156	1	.089 - Marked 10 or L
	147-0190	1	.122 - Marked 12 or M
	147-0189	1	.125 - Marked 13 or N
	147-0188	1	.128 - Marked 14 or P
	147-0187	1	.131 - Marked 15 or R
	147-0186	1	.134 - Marked 16 or S

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
17	147-0183	1	Valve, Bleeder; Injection Pump
18	147-0136	2	Nozzle & Holder Assembly
19	147-0134	2	Nozzle Only, Component of Nozzle & Holder Assembly
20	147-0141	2	Flange, Injection Nozzle Hold-down
21	147-0044	2	Shield, Nozzle Heat, Steel
22	147-0043	2	Gasket, Nozzle Heat Shield (Asbestos)
23	110-0419	2	Gasket, Shield to Head (Copper)
24	LINE, NOZZLE FUEL RETURN		
	149-1056	1	No. 1 Cylinder
	149-1057	1	No. 2 Cylinder
25	149-1058	1	Line, Injection Pump to Fuel Return Lines Tee
26	502-0065	2	Elbow, Inverted (45°) - Nozzle (Fuel Return Line)
27	502-0102	1	Tee, Return Lines
28	ADAPTER, INJECTION NOZZLE		
	147-0133	1	No. 1 Cylinder
	147-0132	1	No. 2 Cylinder
29	LINE, FUEL		
	501-0015	1	Tank to Filter
	501-0131	1	Fuel Tank Return
30	SCREW, HEX HEAD		
	800-0508	4	Nozzle & Holder Mounting (5/16-18 x 2-3/4")
	800-0027	2	Transfer Pump Mounting (5/16-18 x 7/8")
31	WASHER, FLAT		
	526-0122	4	Nozzle & Holder Mounting
	526-0022	4	Injection Pump Mounting
32	850-0045	4	Lockwashers, Injection Pump Mounting (5/16")
33	862-0015	4	Nut, Injection Pump Mounting (5/16-18)

GOVERNOR GROUP

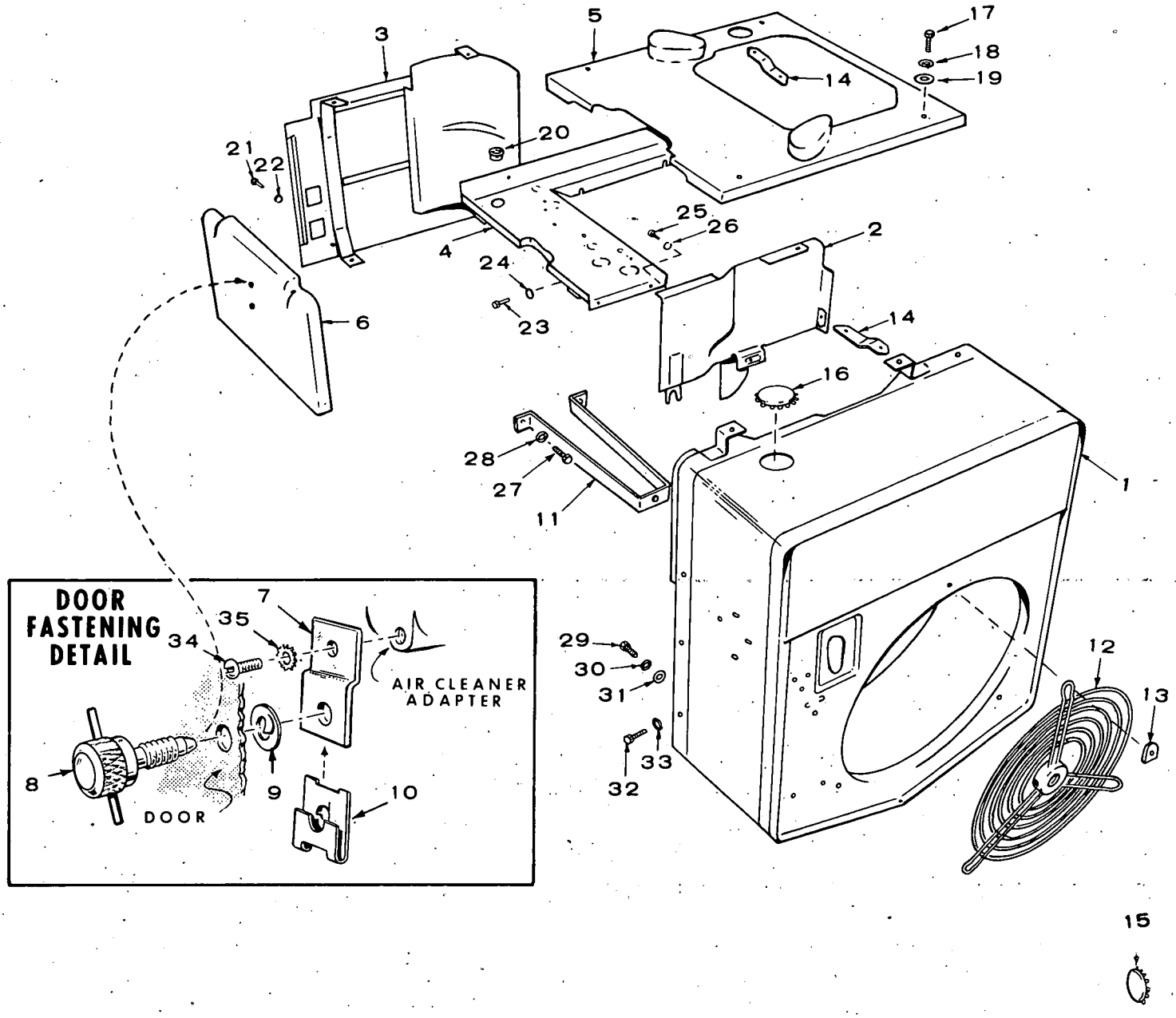


NOTE: These parts used on early Spec R Models Only.

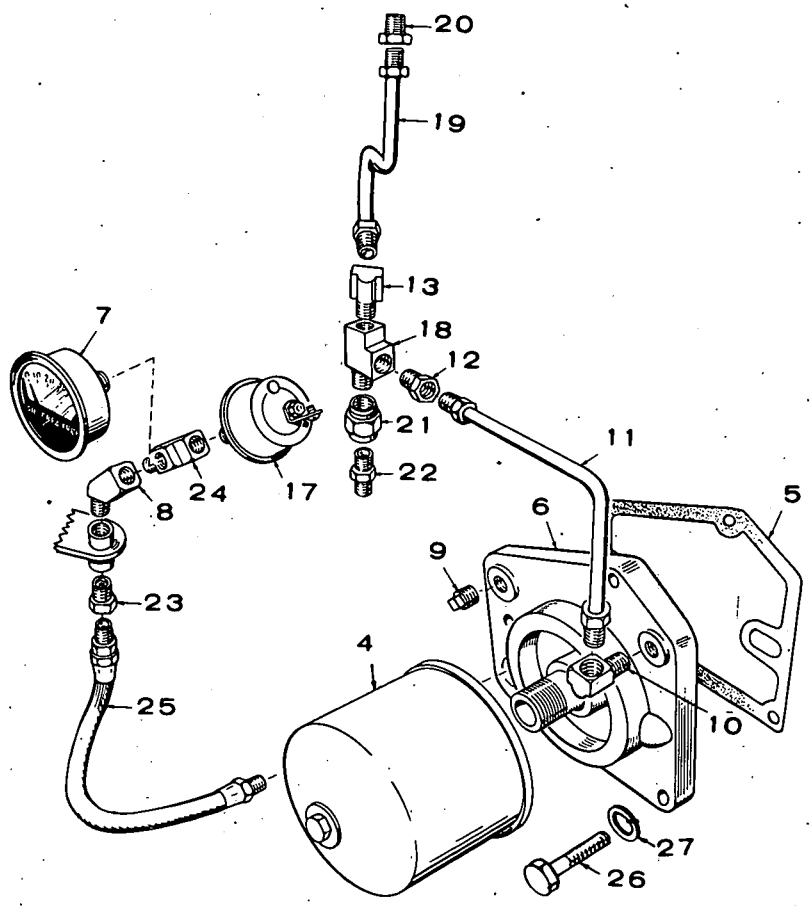


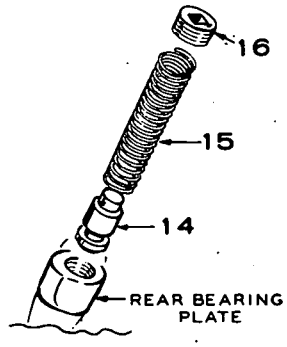
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	SPRING, GOVERNOR		
1	150-1233	1	Early Spec R Models
1A	150-1085	1	Use Begin During Spec R
2	306-0166	1	Spring, Activator - Use Began During Spec R
3	526-0201	1	Washer, Governor Rod
	STUD, GOVERNOR ADJUSTING		
4	150-1083	1	Early Spec R Models
4A	150-1246	1	Use Began During Spec R
5	150-0096	1	Stud, Adjusting - Variable Speed - Early Spec R Models
6	150-1132	1	Linkage Assembly, Governor
7	150-1358	1	Joint, Ball
8	871-0053	2	Nut, Keps - Linkage
9	870-0131	1	Nuts, Keps - Ball Joint
10	150-1144	1	Bracket and Plate Assembly (Replaces early style w/tube)
	BRACKET, MICRO SWITCH MOUNTING		
11	150-1150	1	Early Spec R Models
11A	150-1248	1	Use Began During Spec R
	BRACKET, MICRO SWITCH		
12	152-0112	1	Early Spec R Models
12A	152-0174	1	Use Began During Spec R
13	308-0151	1	Switch, Micro
14	338-0461	1	Harness, Micro Switch
15	152-0119	1	Insulator, Terminal - Switch
16	150-1147	1	Bracket, Lever
17	150-0917	1	Bracket, Stiffener
	LEVER, MANUAL GOVERNOR		
18	150-1148	1	Early Spec R Models
18A	150-1261	1	Use Began During Spec R
19	150-1146	1	Screw, Adjustment
20	150-0907	2	Spring, Adjustment Screw
21	115-0025	1	Nut, Tappet (1/4-28)
22	850-0040	1	Washer, Lock (1/4)
23	150-1247	1	Plate, Governor Switch
25	870-0084	2	Nut (with shoulder) 1/4-20
26	862-0001	2	Nut, Lock (1/4-20)
27	150-1162	1	Spring, Governor, Variable Speed - Early Spec R Models
28	870-0130	1	Nut, Lock, Adjusting Stud - Early Spec R Models
29	862-0003	1	Nut, Adjusting Stud - Early Spec R Models
30	870-0129	1	Nut (Nylon) - Governor Stud - Early Spec R Models
31	526-0143	2	Washer (1/4" I.D. x 3/8" O.D.) - Adjustment Screw - Early Spec R Models
32	526-1015	1	Washer, Flat (1/4") - Adjustment Screw, Early Spec R Models
33	813-0100	2	Screw, Round Head (10-32 x 1/2")
34	853-0008	2	Lockwasher (#10)
35	861-0008	2	Nut, Hex (10-32)
36	815-0181	2	Screw, Hex Head, Thread Cutting with Lockwasher (10-32 x 1/2")
37	812-0066	2	Screw, Round Head (6-32 x 3/4")
38	850-0020	2	Lockwasher (#6)
39	800-0004	6	Screw, Hex Head (1/4-20 x 5/8")
40	850-0040	6	Lockwasher (1/4)

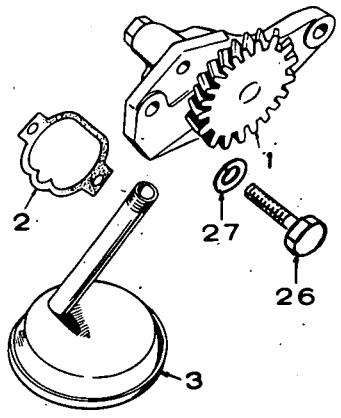
AIR HOUSING GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	HOUSING, BLOWER		
	134-1851	1	Early Spec R Models
	134-1371	1	Use Begin During Spec R and Used through Spec S
	134-2203	1	Begin Spec T
2	134-1048	1	Housing, Cylinder Air - Front
3	134-1849	1	Housing, Cylinder Air - Rear
4	PANEL, CYLINDER AIR HOUSING - BOTTOM		
	134-1915	1	Prior to Spec T
	134-1419	1	Begin Spec T
5	134-1125	1	Cover, Cylinder Air Housing
6	134-1039	1	Panel, Air Housing Door
7	134-1554	1	Bracket, Air Housing Door Panel
8	134-1373	1	Screw, Captive - Door
9	134-1180	1	Washer, Captive Screw - Door
10	870-0194	5	Nut, U-Clip - Door and Cover
11	134-1088	1	Support, Blower Housing and Grille
12	134-1178	1	Grille
13	134-1092	3	Retainer, Grille
14	BRACKET, BLOWER HOUSING & CYLINDER SHROUD		
	134-1703	1	Front
	134-1704	1	Rear
15	PLUG, DOT BUTTON - PRIOR TO SPEC T		
	517-0044	4	For 1/4" Hole
	517-0012	1	For 5/8" Hole
	517-0021	1	For 7/8" Hole
16	517-0009	1	Plug, Dot Button (For 2" Hole) - Begin Spec T
17	815-0235	4	Screw, Hex Head (1/4-20 x 5/8")
18	526-0021	4	Washer, Flat (1/4)
19	850-0040	4	Lockwasher (1/4)
20	331-0103	1	Bushing, Nylon
21	813-0097	1	Screw, Round Head (10-32 x 5/16")
22	854-0010	1	Lockwasher (#10)
23	815-0235	1	Screw, Hex Head (1/4-20 x 5/8")
24	853-0013	1	Lockwasher (1/4)
25	815-0235	1	Screw, Hex Head (1/4-20 x 5/8")
26	853-0013	1	Lockwasher (1/4)
27	800-0024	2	Screw, Hex Head (5/16-18 x 1/2")
28	850-0045	2	Lockwasher (5/16)
29	800-0007	3	Screw, Hex Head (1/4-20 x 1")
30	850-0040	3	Lockwasher (1/4)
31	521-0115	3	Washer, Flat (1/4)
32	815-0235	6	Screw, Hex Head (1/4-20 x 5/8")
33	854-0014	6	Lockwasher (1/4)
34	813-0098	2	Screw, Round Head (10-32 x 5/16")
35	853-0008	2	Lockwasher (#10)

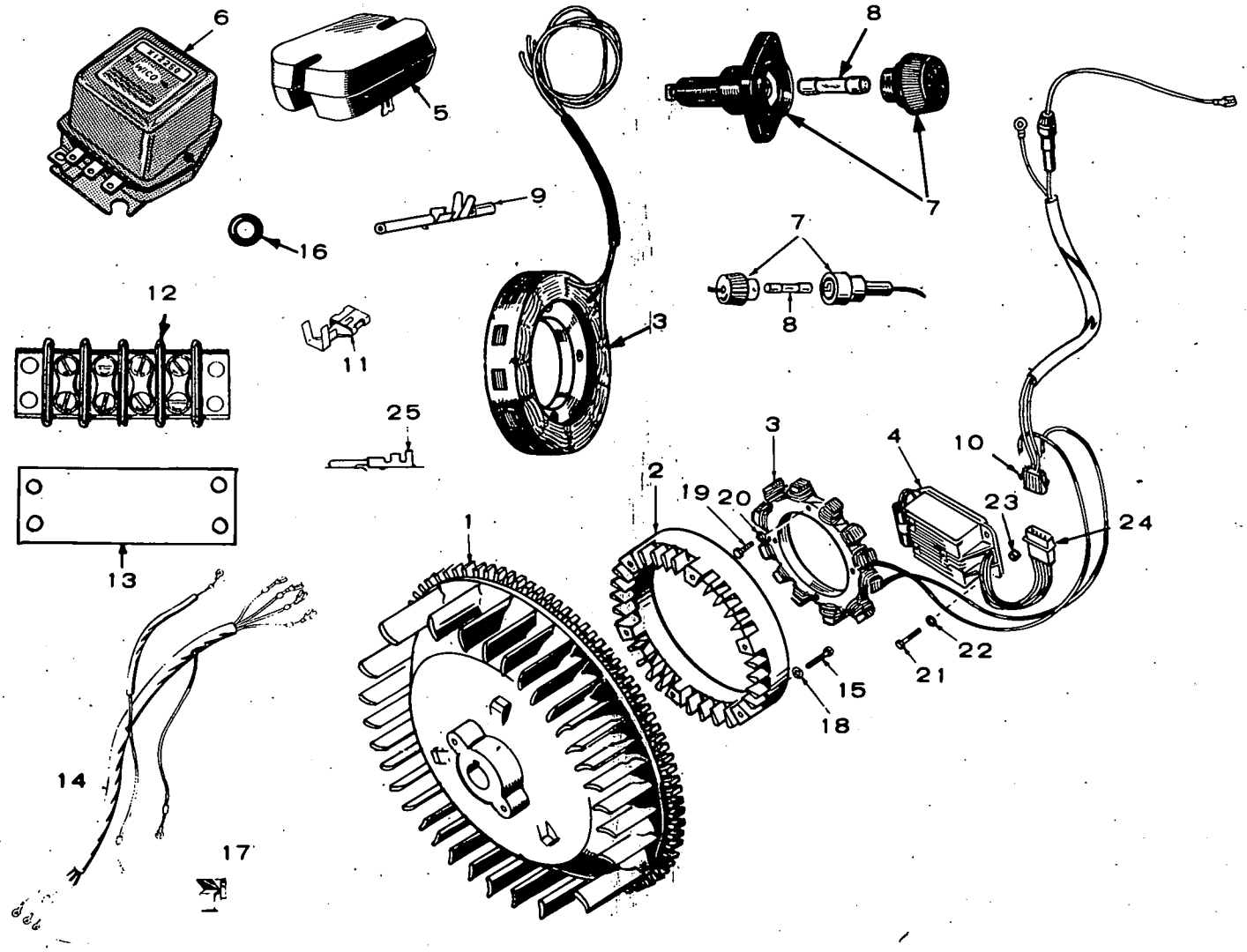






OIL SYSTEM GROUP

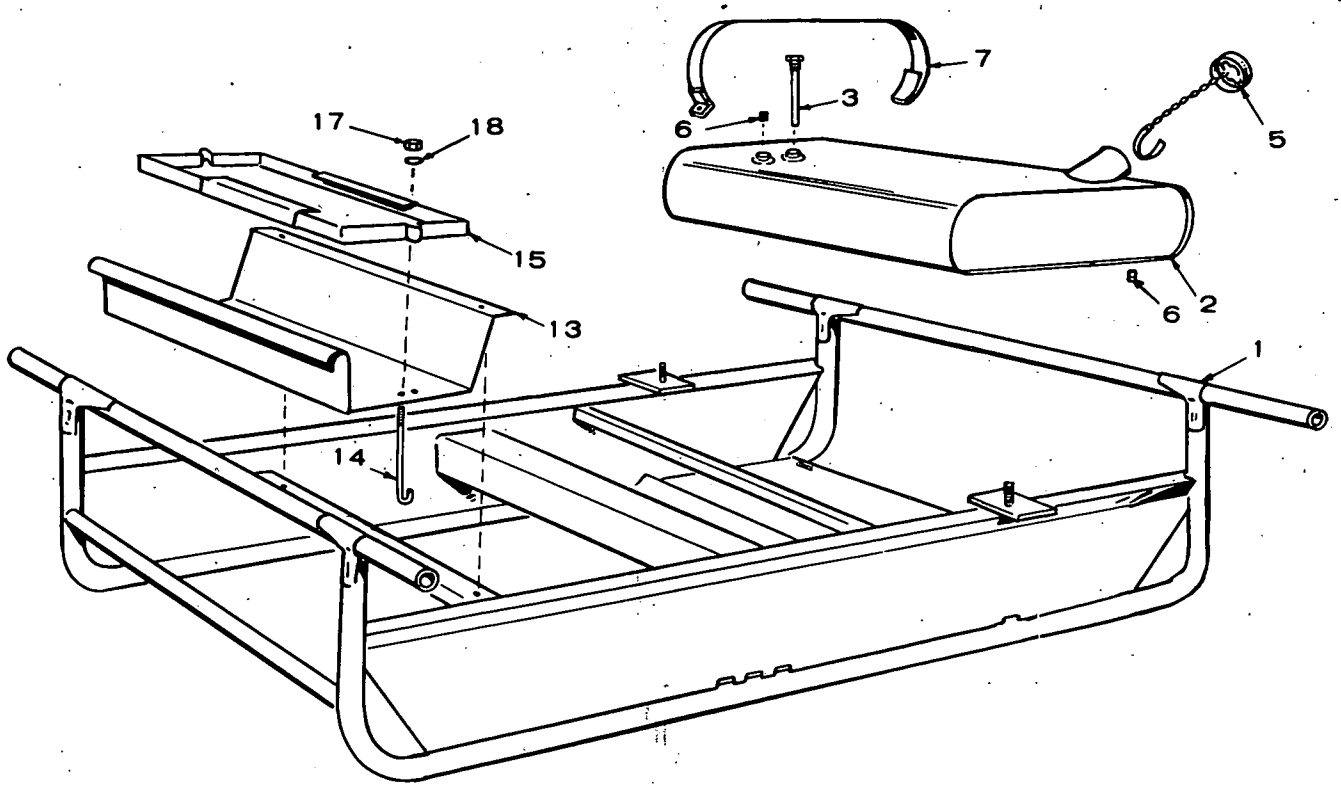
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120-0547	1	Pump Assembly, Oil
2	120-0580	1	Gasket Kit, Pump
3	120-0551	1	Cup, Oil Intake
4	122-0185	1	Filter, 3-1/2" Long - Standard
4	122-0193	1	Filter, 5-1/2" Long - Optional
5	122-0188	1	Gasket, Adapter
6	122-0182	1	Adapter, Oil Filter
7	193-0006	1	Gauge, Oil Pressure
8	502-0053	1	Elbow, 45°, Oil Pressure Switch, Also (1) Oil Gauge Mounting - Prior to Spec S
9	505-0057	1	Plug, 1/8", Adapter
10	502-0037	1	Elbow, Inverted Male, Oil Line to Filter Adapter
11	120-0614	1	Line, Adapter to Injection Pump Tee
12	502-0274	1	Connector, Inverted Male, Injection Pump Lubrication Tee
13	502-0037	1	Elbow, Injection Pump - Lubrication Tee
14	120-0539	1	Valve, Oil By-Pass
15	120-0555	1	Spring, By-Pass Valve
16	505-0274	1	Plug, 1/8" Oil By-Pass
17	309-0177	1	Switch, Oil Pressure
18	502-0242	1	Tee, Restricted - Injection Pump Lubrication
19	120-0633	1	Line, Oil; Injection Pump Tee to Cylinder Head
20	502-0281	1	Connector, Restricted, Oil Line to Cylinder Head
21	502-0051	1	Coupling, Tee to Injection Pump
22	502-0082	1	Nipple, Tee to Injection Pump
23	502-0003	1	Connector, Oil Fill Bracket to Oil Line - Begin Spec S
24	502-0058	1	Tee, Oil Fill Bracket to Gauge & Switch - Begin Spec S
25	501-0003	1	Line, Oil - Begin Spec S
26	SCREW, HEX CAP		
	800-0030	2	Oil Pump Mounting (5/16-18 x 1-1/4")
	800-0028	3	Oil Filter Adapter Mounting (5/16-18 x 1")
27	WASHER, LOCK		
	850-0045	2	Oil Pump Mounting (5/16")
	850-0045	3	Oil Filter Adapter Mounting (5/16")

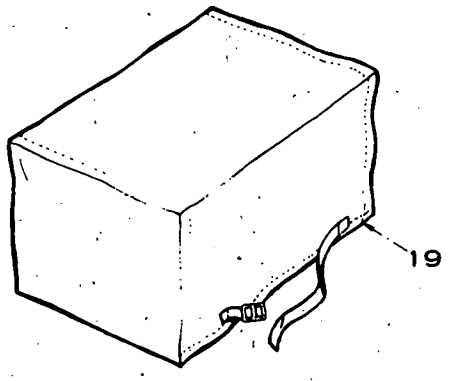


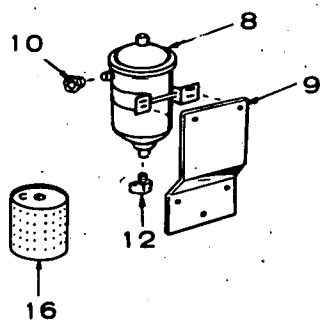
CHARGING ALTERNATOR GROUP - 12 VOLT

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	191-0408	1	Flywheel (Includes Ring Gear) - Also Listed in Crankshaft & Flywheel Group
2	191-0400	1	Rotor
3	STATOR		
	191-0711	1	Prior to Spec T
	191-0724	1	*Begin Spec T
4	305-0478	1	Regulator, Voltage (Includes Rectifier) - Begin Spec T
5	305-0343	1	Rectifier - Prior to Spec T
6	305-0261	1	Regulator, Voltage (2-Step) - Prior to Spec T
7	HOLDER, FUSE		
	321-0103	1	Prior to Spec T
	321-0165	1	*Begin Spec T
8	FUSE		
	321-0128	1	20 Amp. - Prior to Spec T
	321-0162	1	*30 Amp. - Begin Spec T
9	323-0488	4	*Socket, Connector - Begin Spec T
10	323-0759	1	*Connector, Socket Housing - Begin Spec T
11	332-0529	As Req.	*Terminal, Crimp
12	332-0537	1	Block, Terminal (4-Place) - Used on some early models
13	332-0872	1	Strip, Marker - Used on some early models
14	338-0463	1	Harness, Wiring, Voltage Regulator - Prior to Spec T
15	812-0133	6	Screw (12-24 x 1-1/2") - Rotor Mounting
16	508-0071	1	Grommet, Rubber, Blower Housing - Prior to Spec T
17	518-0178	2	Clip, Cable, Alternator - Begin Spec T
18	850-0035	6	Washer, Lock (#12)
19	SCREW, STATOR MOUNTING		
	815-0110	4	10-32 x 7/8" - Prior to Spec T
	813-0107	4	10-32 x 1-1/4" - Begin Spec T
20	850-0030	4	Washer, Lock (#10)
21	800-0005	3	Screw (1/4-20 x 3/4") - Voltage Regulator Mounting - Begin Spec T
22	850-0040	3	Washer, Lock (1/4) - Begin Spec T
23	862-0001	3	Nut (1/4-20) - Regulator Mounting - Begin Spec T
24	323-0763	1	Connector, Pin Housing - Begin Spec T
25	323-0438	4	Pin, Connector

* - Included in Stator Assembly 191-0833.

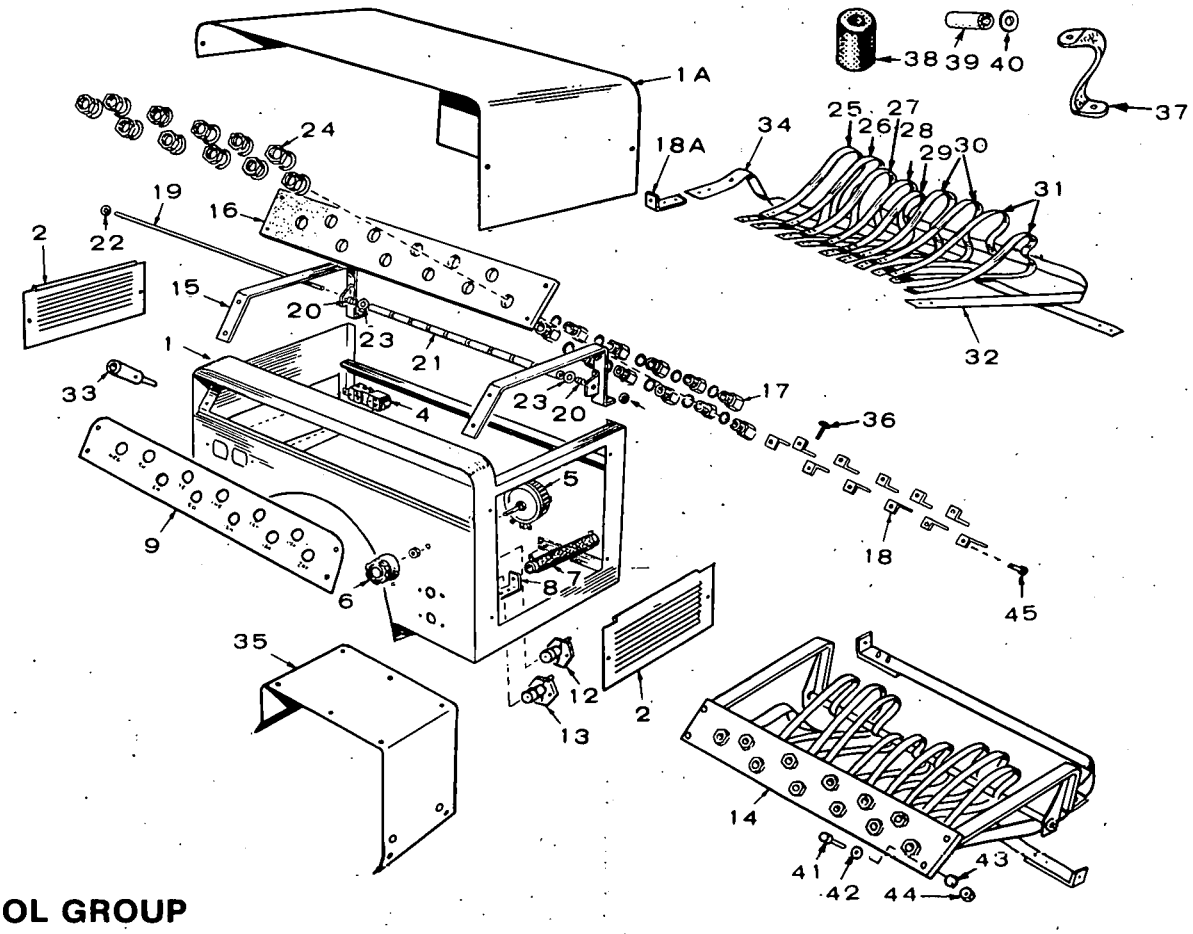






CARRYING FRAME AND MOUNTED FUEL TANK GROUP

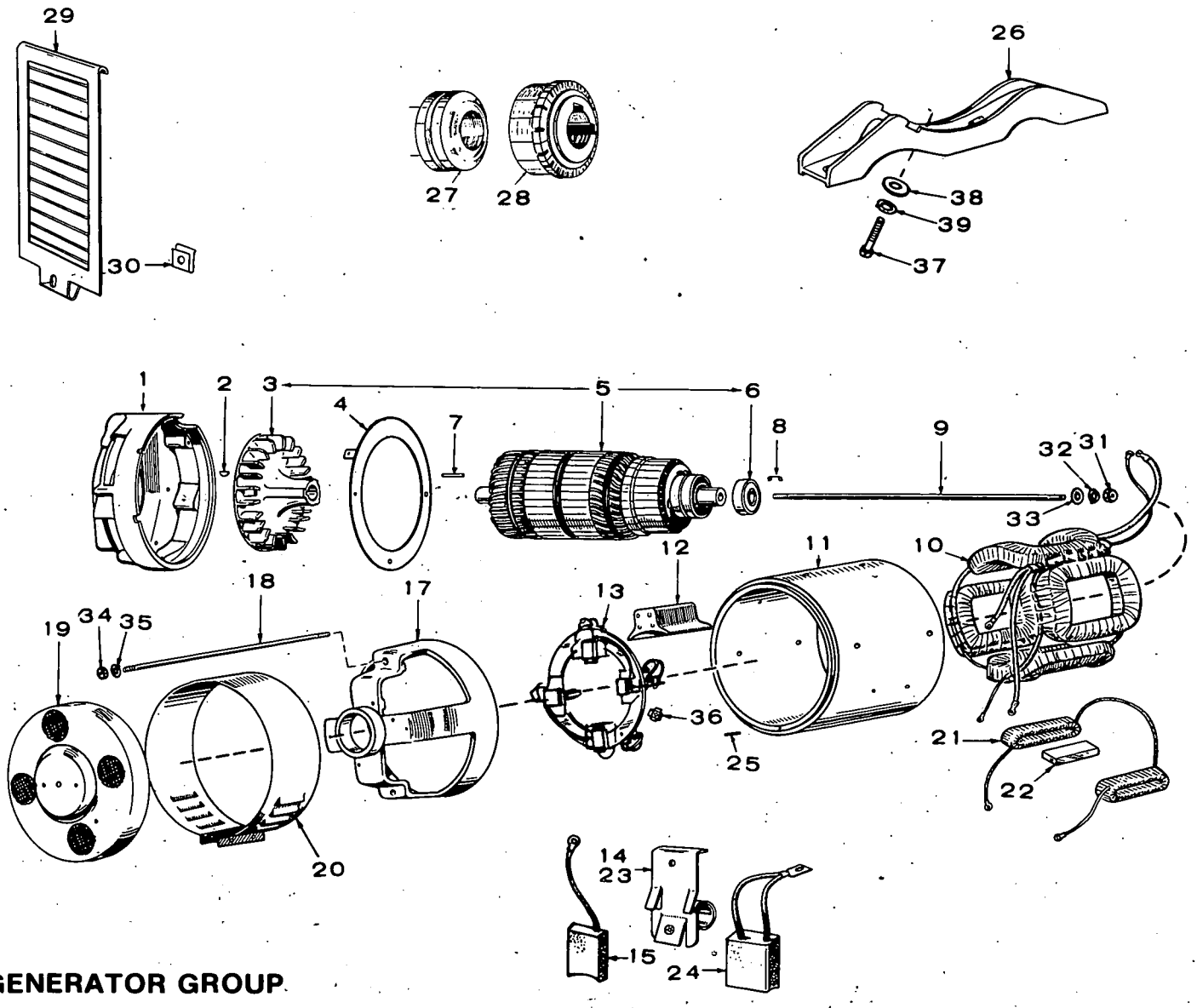
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	403-0822	1	Frame, Carrying
2	159-0929	1	Tank, Fuel (7.35 Gallon)
3	159-0695	1	Tube, Fuel Pick-Up
5	159-0020	1	Cap, Fuel
6	505-0008	2	Plug, Pipe - Fuel Tank
7	159-0692	2	Band, Fuel Tank
8	149-1078	1	Filter, Fuel - Mounted on Carrying Frame - Spec R Only
9	149-1124	1	Bracket, Fuel Filter Mounting - Spec R Only
10	502-0029	2	Bushing, Fuel Filter to Lines - Spec R Only
12	502-0054	1	Elbow, Filter Outlet - Spec R Only
13	416-0577	1	Rack, Battery
14	416-0578	2	Stud, Battery Hold-down
15	416-0576	1	Frame, Battery Hold-down
16	149-0846	1	Cartridge, Filter - Spec R Only
17	862-0015	2	Nut (5/16-18)
18	526-0213	2	Washer (5/16)
19	412-0032	1	Cover, Canvas - Welder Set (Optional)



CONTROL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	BOX, CONTROL		
	301-2902	1	Prior to Spec T
	301-3326	1	Begin Spec T
1A	301-2901	1	Cover, Control Box
2	301-2900	2	Plate, Control Box Vent
4	RECEPTACLE, DUPLEX		
	323-0184	1	Models with 120 Volt AC Output
	323-0213	1	Models with 240 Volt AC Output
5	303-0112	1	Rheostat
6	304-0061	1	Knob, Rheostat
7	304-0183	1	Resistor, Field (5.5-Ohm, 160 Watt)
8	304-0117	1	Bracket, Field Resistor Mounting
9	301-1785	1	Panel, Control Box
12	313-0032	1	Switch, Start
13	313-0032	1	Switch, Preheat
14	304-0661	1	Resistor, Elements & Jack Assembly, (Includes Parts Marked £ Plus Hardware)
15	301-1778	2	£Bracket, Resistor Elements Mounting
16	301-1777	1	£Block, Terminal - Resistor Element Fastening
17	316-0044	11	£Jack, Plug - Welder Cable Connecting
18	308-0149	10	£Angle, Connector - Resistor Elements to Plug Jack (1-23/32" Long)
18A	308-0128	3	£Angle, Connector - Resistor Elements to Plug Jack (3-1/8" Long)
19	304-0469	1	£Rod, Insulator Tubes Mounting
20	115-0056	1	£Spring, Insulator Tube
21	304-0379	8	£Tube, Insulator
22	870-0173	2	£Nut, Push - Insulator Rod Mounting
23	526-0101	1	£Washer, Flat - Insulator Rod Mounting
24	868-0011	11	£Nut, Hex Jam - Jack Mounting
25	304-0551	1	£Element, Resistor
26	304-0467	1	£Element, Resistor
27	304-0466	1	£Element, Resistor
28	304-0552	1	£Element, Resistor
29	304-0553	1	£Element, Resistor
30	304-0465	2	£Element, Resistor
31	304-0468	2	£Element, Resistor
32	304-0554	1	£Element, Resistor
33	316-0045	2	Plug, Welding Cables
34	304-0660	1	£Element, Resistor
35	301-2899	1	Bracket, Control Box Mounting
36	815-0026	26	£Screw, Truss Head (10-32 x 5/8")
37	337-0044	1	Strap, Ground
38	402-0078	6	Dampener, Vibration
39	304-0379	2	Tube, Insulator
40	304-0151	1	Washer, Insulator (1" O.D. x 5/16" I.D. x 1/8")
41	800-0007	4	Screw, Hex Head (1/4-20 x 1")
42	526-0015	4	Washer, Flat (1/4)
43	850-0040	4	Lockwasher (1/4)
44	860-0013	4	Nut, Hex (1/4-20)
45	815-0223	11	Screw, Hex Head, with Lockwasher (1/4-20 x 5/8")

£ - These parts contained in 304-0661 Resistor Elements and Jack Assembly.



GENERATOR GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	231-0120	1	Adapter, Generator to Engine
2	515-0006	1	Key, Blower to Crankshaft
3	205-0065	1	Blower, Generator
4	232-1815	1	Plate, Baffle
5		1	Armature Assembly - Includes Blower & Bearing - DC
6	510-0047	1	Bearing, Armature (Double Sealed - Pre-Lubricated)
7	515-0122	1	Key, Drive - Blower to Armature
8	232-0596	1	Clip, Bearing Stop
9	520-0534	1	Stud, Armature Through
10	222-1695	1	Coil Assembly, Field - Set of 4 Coils, Connected - DC
11	210-0260	1	Frame, Generator - Machined - Less Coils & Poleshoes - DC
12	221-0118	4	Shoe, Pole - DC
13	212-0276	1	Rig Assembly, Brush - DC
14	212-1105	4	Spring, AC Brush
15	214-0050	4	Brush, AC
17	211-0097	1	Bell, End
18	520-0161	2	Stud, Generator Through
19	211-0114	1	Cover, End Bell
20	234-0002	1	Band, End Bell
21	222-1458	1	Coil Set, Interpole - DC
22	221-0116	2	Interpole - DC
23	212-1106	4	Spring, DC Brush
24	214-0067	4	Brush, DC
25	516-0103	2	Pin, Roll - Generator Frame
26	232-1977	1	Base, Mounting
27	204-0009	1	Collector Ring (AC)
28	203-0125	1	Commutator (DC)
29	234-0286	1	Cover, Air Outlet
30	870-0177	1	Clip, Air Outlet Cover Fastener
31	862-0004	1	Nut, Hex (7/16-14) - Armature Stud
32	850-0055	1	Washer, Lock (7/16)
33	526-0032	1	Washer, Flat
34	862-0015	2	Nut, Hex (5/16-18) - Generator
35	850-0045	2	Washer, Lock (5/16)
36	212-1214	4	Clamp, Brush Rig
37	800-0050	2	Screw (3/8-16 x 1") - Mounting Base
38	526-0030	2	Washer, Flat
39	850-0050	2	Washer, Lock

* - Order by Description, giving complete Model, Spec and Serial Number.

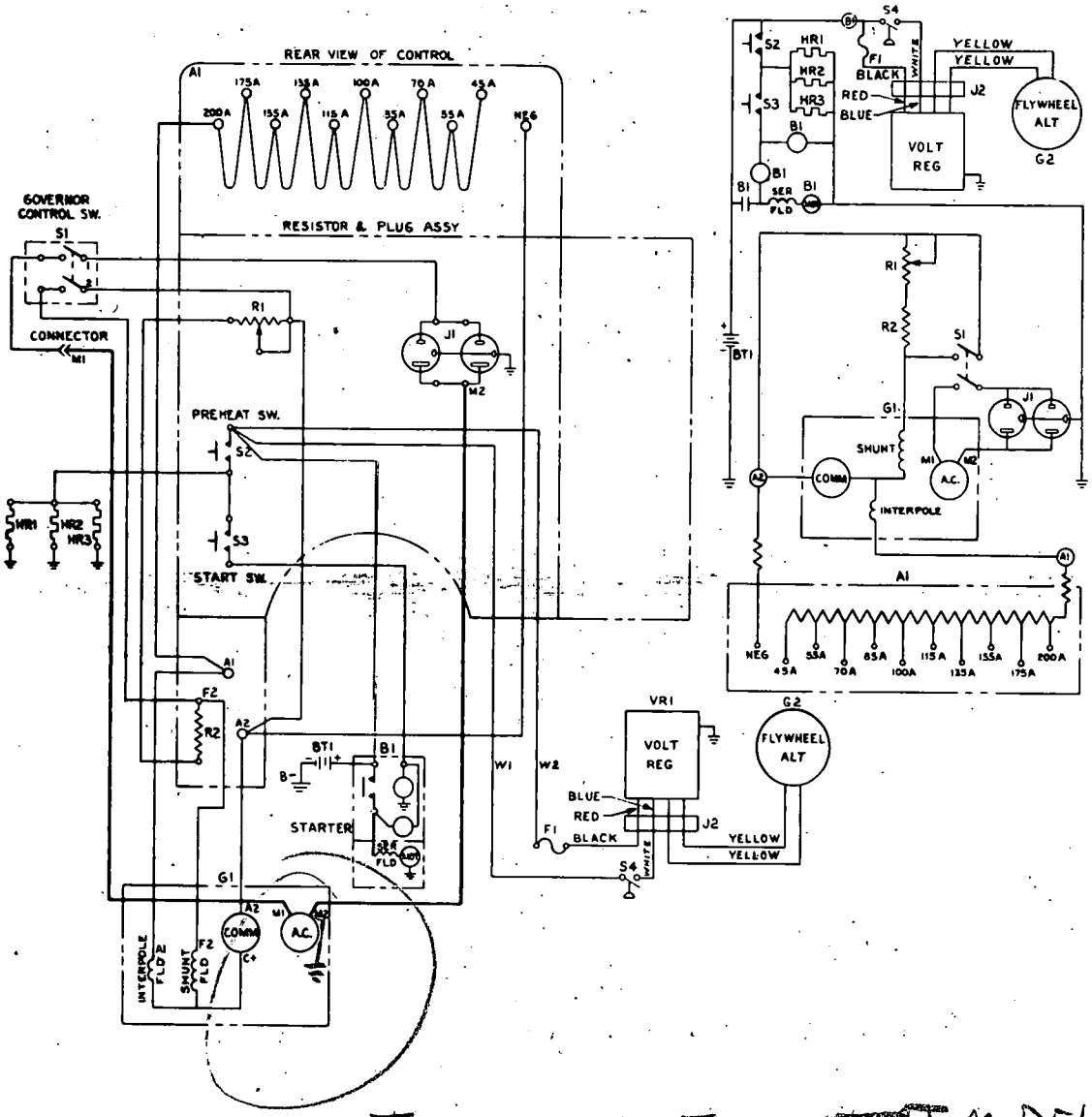
SERVICE KITS & MISCELLANEOUS

NOTE: For other kits, refer to the group for the part in question.

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	98-2028	1	Decal Kit, Set
	168-0086	1	Gasket Kit, Engine
	OVERHAUL KIT, ENGINE		
	522-0201	1	Prior to Spec S
	522-0247	1	Begin Spec S

L. K. wants Photostat for master sound

WIRING DIAGRAMS



PARTS LIST	
REF.DES.	DESCRIPTION
A1	RESISTOR & PLUG ASSY
B1	STARTER & SOLENOID
BT1	BATTERY, 12 V.
F1	1 USI .30 A.
G1	GENERATOR
G2	ALTERNATOR-FLYWHEEL
HR1,3	PLUG-GLOW
HR2	HEATER MANIFOLD
* J1	RECEPTACLE-DUPLEX
J2	CONNECTOR
R1	RHEOSTAT, 3.5 OHM, 100 W.
	KNOB
R2	RESISTER-CORRIB, 5.5 OHM, 160 W.
S1	SWITCH, GOV. CONTROL
S2	SWITCH, PREHEAT
S3	SWITCH, START
S4	SWITCH, LOW OIL PRESS
VR1	VOLTAGE REGULATOR
W1	LEAD ASSY
W2	LEAD ASSY
	CONTROL BOX
	COVER - CONTROL BOX
	PLATE - CONTROL BOX
	BRACKET - CONTROL BOX MTG.
	PANEL - CONTROL
	BRACKET - RESISTER MTG.
	SHOCK MOUNT
	GROUND STRAP
	WASHER
	TUBE
*	120 VOLT
**	240 VOLT

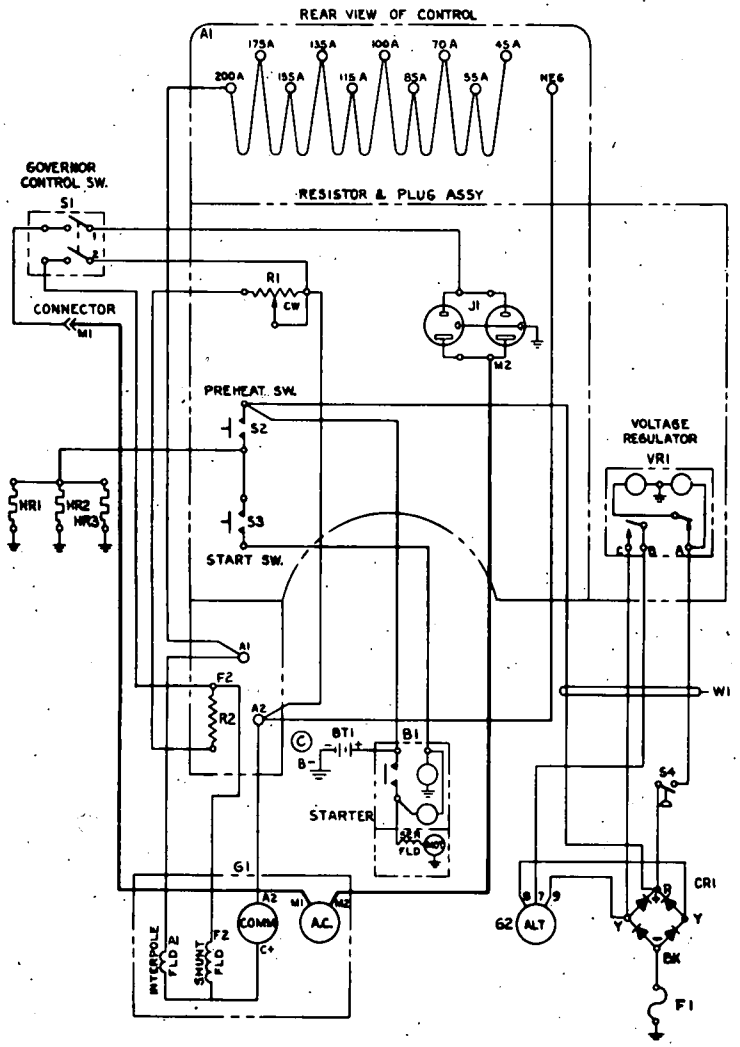
* 120 VOLT RECEPTACLE SHOWN

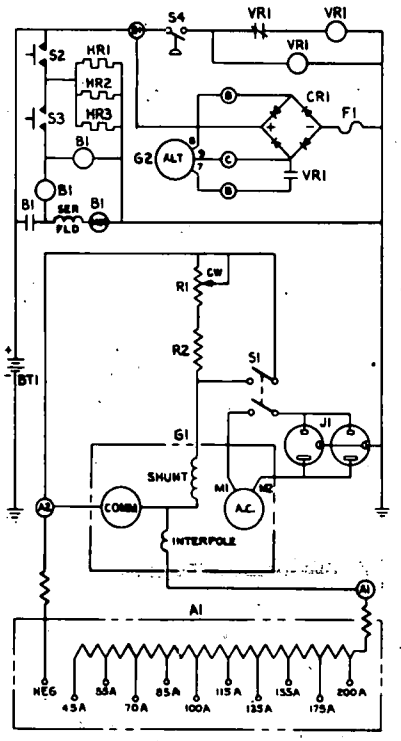
6.0DJB-331E
6.0DJB-5331E
6.0DJB-332E
6.0DJB-5332E

~~SPEC~~

TYPICAL ~~ELECTRIC START~~ MODEL - 120/240V ← (12M)

~~(SPEC 115)~~ SPEC T





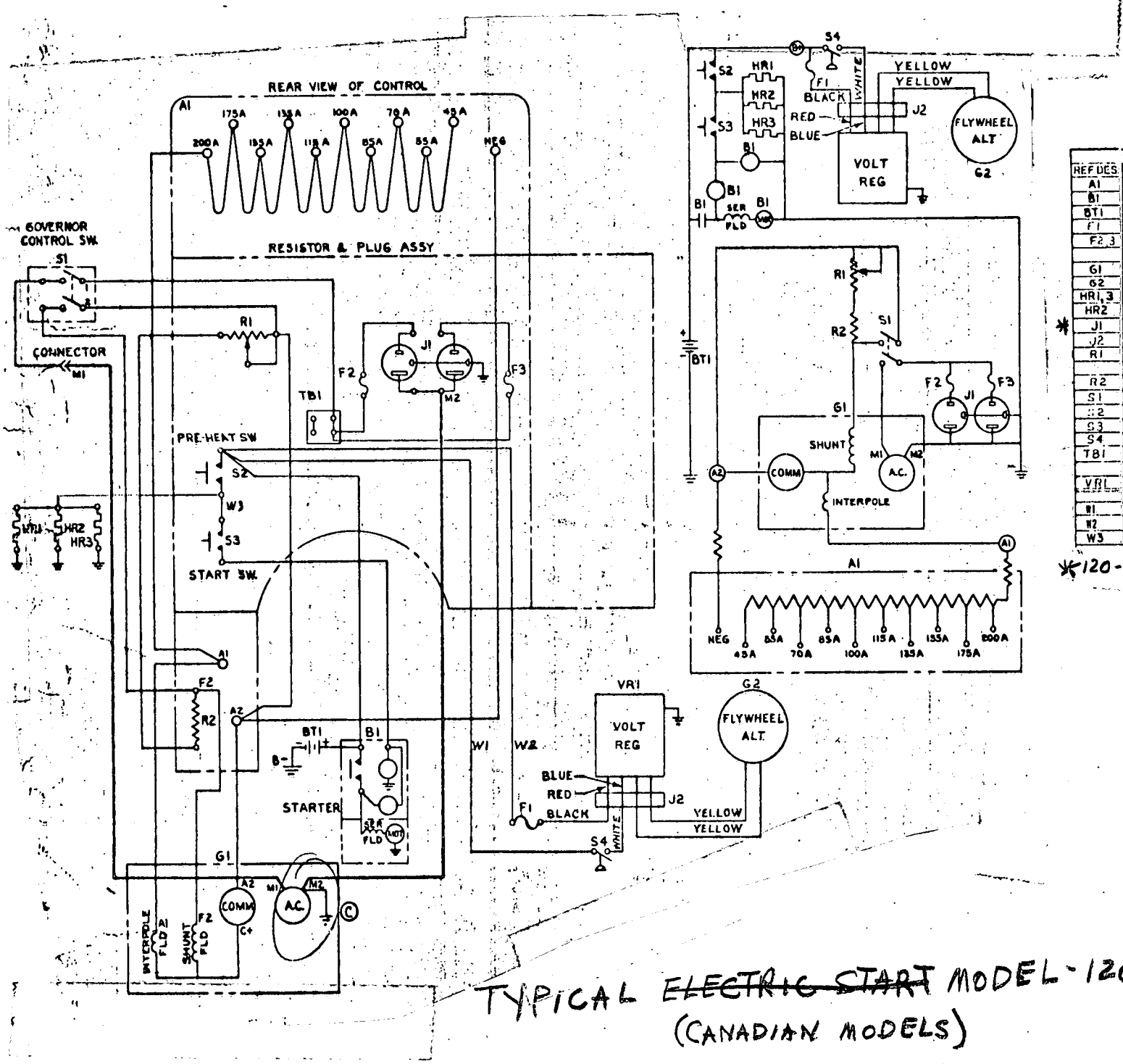
PARTS LIST	
REF. DES.	DESCRIPTION
A1	RESISTOR & PLUG ASSY
B1	STARTER & SOLENOID
BT1	BATTERY, 12 V.
CR1	RECTIFIER - BRIDGE
F1	FUSE, 20 A.
	HOLDER - FUSE
G1	GENERATOR
G2	ALTERNATOR - FLYWHEEL
HR1, 3	PLUG - GLOW
HR2	HEATER - MANIFOLD
* J1	RECEPTACLE - DUPLEX
R1	RHEOSTAT, 3.5 OHM, 100 W.
	KNOB
R2	RESISTER - CORRIB, 5.5 OHM, 160 W.
S1	SWITCH, GOV. CONTROL
S2	SWITCH, PREHEAT
S3	SWITCH, START
S4	SWITCH, LOW OIL PRESS
VR1	VOLTAGE REGULATOR
W1	HARNESS - VOLTAGE REGULATOR
	CONTROL BOX
	COVER - CONTROL BOX
	PLATE - CONTROL BOX
	BRACKET - CONTROL BOX MTG.
	PANEL, CONTROL
	BRACKET - RESISTER MTG.
	SHOCK MOUNT
	GROUND STRAP
	WASHER
	TUBE
X	120-VOLT
X	240-VOLT

*120-VOLT RECEPTACLE SHOWN

6.0DJB-331E
6.0DJB-5331E
6.0DJB-332E
6.0DJB-5332E

TYPICAL ~~ELECTRIC START~~ MODEL - 120/240 V ~~PRIOR TO SPEC T~~ (12 V)

~~6.0~~ PRIOR TO SPEC T



REF DES	PARTS LIST DESCRIPTION
A1	RESISTOR & PLUG ASSY
B1	STARTER & SOLENOID
BT1	BATTERY, 12 V.
F1	FUSE, 30A.
F2,3	FUSE, 15A.
	HOLDER-FUSE
G1	GENERATOR
G2	ALTERNATOR-FLYWHEEL
HR1,3	PLUG-GLOW
HR2	HEATER-MANIFOLD
* J1	RECEPTACLE-DUPLEX
J2	CONNECTOR
R1	RHEOSTAT, LEAD ASSY
	KNOB
R2	RESISTOR ASSY
S1	SWITCH-GOV. CONTROL
S2	SWITCH-PRE-HEAT
S3	SWITCH-START
S4	SWITCH-LOW OIL PRESS
TB1	TERMINAL BLOCK
	MARKER STRIP
VR1	VOLT REGULATOR
W1	LEAD ASSY
W2	LEAD ASSY
W3	JUMPER, SOLENOID S2-S3

*120-VOLT RECEPTACLE SHOWN

6.0 DJB-331E38
6.0 DJB-5331E38
6.0 DJB-332E38
6.0 DJB-5332E38

TYPICAL ~~ELECTRIC START~~ MODEL - 120/240 VOLT

(CANADIAN MODELS)

12MT