BASIC BLOCK

CONNECTING ROD BEARINGS

The connecting rod bearings fit tightly in the bore in the rod. If bearing joints or backs are worn (fretted), check bore size. This can be an indication of wear because of a loose fit.

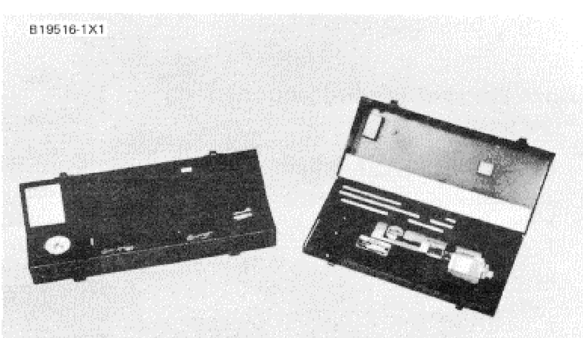
Connecting rod bearings are available with 0.63 mm (.025 in.) and 1.27 mm (.050 in.) smaller inside diameter than the original size bearings. These bearings are for crankshafts that have been ground (made smaller than original size).

MAIN BEARINGS

Main bearings are available with a larger outside diameter than the original size bearings. These bearings are for cylinder blocks that have had the bore for the main bearings "bored" (made larger than the original size). The size available is 0.63 mm (.025 in.) larger outside diameter than the original size bearings.

CYLINDER BLOCK

The bore in the block for main bearings can be checked with the main bearing caps installed without bearings. Tighten the nuts that hold the caps to the torque shown in the SPECIFICATIONS section. Alignment error in the bores must not be more than 0.08 mm (.003 in.). Special Instruction, Form No. SMHS7606 gives instructions for the use of 1P4000 Line Boring Tool Group for alignment of the main bearing bores. The 1P3537 Dial Bore Gauge Group can be used to check the size of the bores. Special Instruction, Form No. GMG00981 is with the group.



1P3537 DIAL BORE GAUGE GROUP

PROJECTION OF CYLINDER LINERS

Tools Needed:

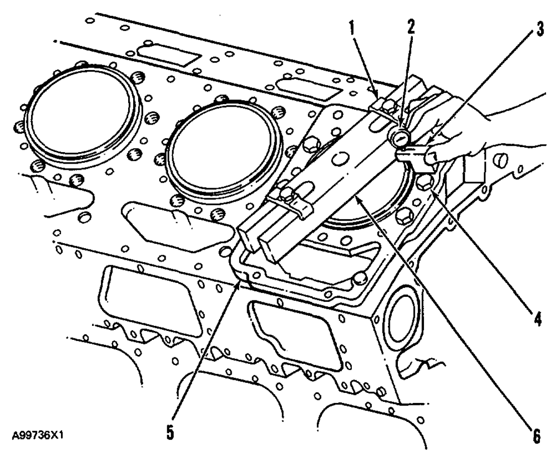
8B7548 Puller Assembly (Crossbar).
Two 2H465 Plates.
Two 8F6123 3/4"-16NF Bolts, 140 mm (5.5 In.) long.
Four Washers (3/4"-Copper).
Four S1575 3/4"-16NF Bolts, 76 mm (3.0 in.) long.
8T455 Liner Projection Tool Group.

Check liner projection above the spacer plate as follows:

1. Make sure the top surface of the cylinder block, the liner bores, spacer plates and liner flanges are clean and dry.

2. Install a new gasket and spacer plate (5) on the cylinder block.

3. Install the cylinder liners in the cylinder block without seals or bands.



MEASURING LINER HEIGHT PROJECTION

1. 3H465 Plate. 2. Dial indicator. 3. 1P2402 Gauge Body. 4. S1575 Bolt. 5. Spacer plate. 6. 8B7548 Puller Assembly (Crossbar).

4. Hold the spacer plate and liner in position as follows:
   a. Install four bolts (4) and washers around each cylinder liner as shown. Tighten the bolts evenly to a torque of 95 N-m (70 lb. ft.).

   b. Install crossbar (6), plates (1) and the two 8F6123 Bolts. Be sure the crossbar is in position at the center of the liner and the liner surface is clean. Tighten the bolts evenly to a torque of 70 N-m (50 lb. ft.).

c. Check the distance from the bottom edge of crossbar (6) to the top edge of the spacer plate. The distance on each end of the crossbar must be the same.

5. Use 8T455 Liner Projection Tool Group to measure liner projection.

6. To zero dial indicator (2), use the back of 1 P5507 Gauge with dial indicator (2) mounted in 1P2402 Gauge Body (3).

7. Liner projection must be 0.059 to 0.199 mm (.0023 to .0078 in.). Make the measurement to the outer flange of the liner, not the inner ring. The maximum difference between high and low measurements made at four places around each liner is 0.05 mm (.002 in.).

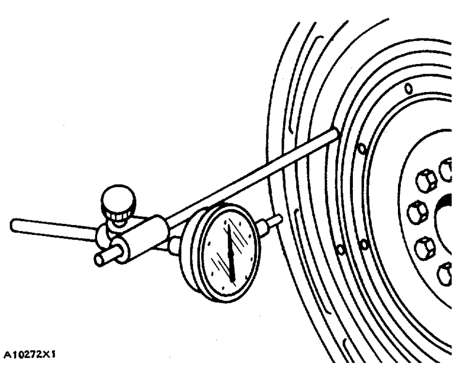
NOTE: If liner projection changes from point to point around the liner, turn the liner to a new position within the bore. If still not within specifications, move liner to a different bore.

NOTE: When liner projection is correct, put a temporary mark on the liner and spacer plate so when the seals and band are installed, the liner can be installed in the correct position.

FLYWHEEL AND FLYWHEEL HOUSING

Tools Needed:
8S2328 Dial Indicator Group.

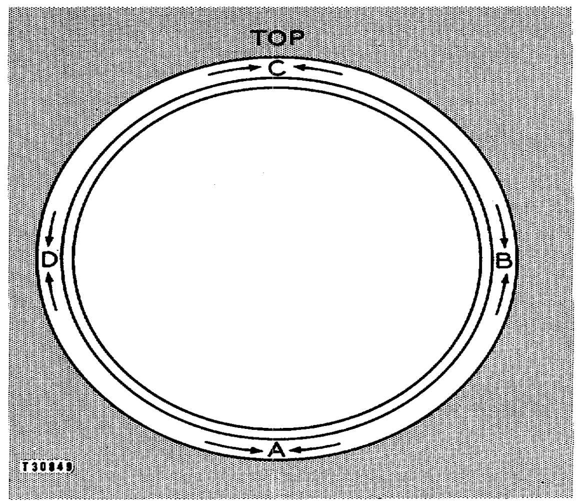
Face Run Out (axial eccentricity) of the Flywheel Housing



8S2328 DIAL INDICATOR GROUP INSTALLED

1. Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch the face of the flywheel housing.

2. Put a force on the crankshaft toward the rear before the indicator is read at each point.



CHECKING FACE RUNOUT OF THE FLYWHEEL HOUSING
A. Bottom. B. Right side. C. Top. D. Left side.

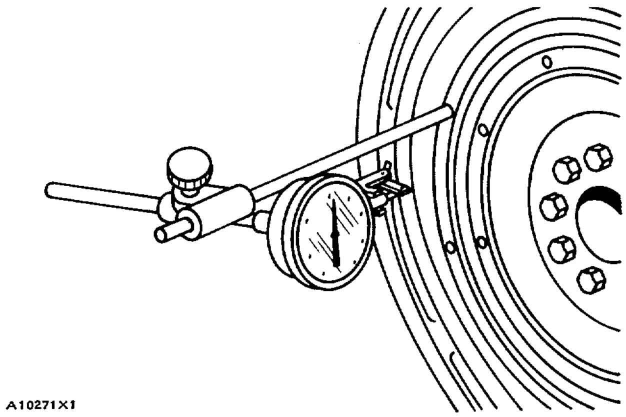
3. With dial indicator set at "O" (zero) at location (A), turn the crankshaft and read the indicator at locations (B), (C) and (D).

4. The difference between lower and higher measurements taken at all four points must not be more than 0.30 mm (.012 in.), which is the maximum permissible face run out (axial eccentricity) of the flywheel housing.

Bore Runout (radial eccentricity) of the Flywheel Housing

1. Fasten the dial indicator as shown so the anvil of the indicator will touch the bore of the flywheel housing.

2. With the dial indicator in position at (C), adjust the dial indicator to "O" (zero). Push the crankshaft up against the top of the bearing. Write the measurement for bearing clearance on line 1 in column (C) in the CHART FOR DIAL INDICATOR MEASUREMENTS.



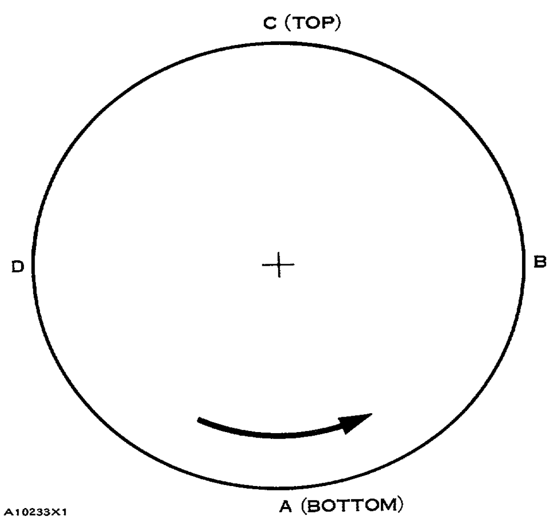
8S2328 DIAL INDICATOR GROUP INSTALLED

NOTE: Write the dial indicator measurements with their positive (+) and negative (-) notation (signs). This notation is necessary for making the calculations in the chart correctly.

3. Divide the measurement from Step 2 by 2. Write this number on line 1 in columns (B) & (D).

4. Turn the crankshaft to put the dial indicator at (A). Adjust the dial indicator to "O" (zero).

5. Turn the crankshaft counterclockwise to put the dial indicator at (B). Write the measurements in the chart.



CHECKING BORE RUNOUT OF THE FLYWHEEL HOUSING

6. Turn the crankshaft counterclockwise to put the dial indicator at (C). Write the measurement in the chart.

7. Turn the crankshaft counterclockwise to put the dial indicator at (D). Write the measurement in the chart.

CHART FOR DIAL INDICATOR MEASUREMENTS					
	Position of dial indicator				
	Line No.	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	••	•	••

*Total Vertical eccentricity (out of round).

**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity.

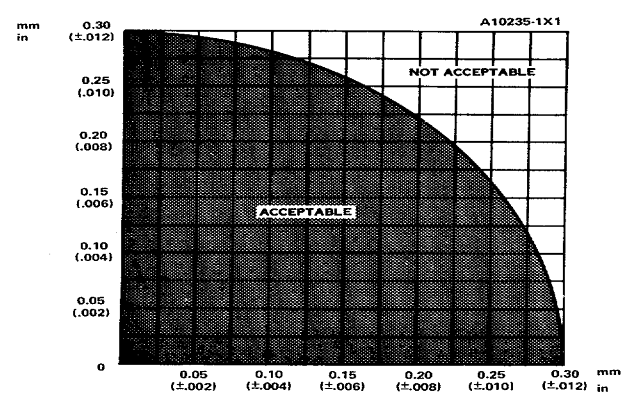
A10234X5

8. Add lines I & II by columns.

9. Subtract the smaller number from the larger number in line III in columns (B) & (D). The result is the horizontal eccentricity (out of round). Line III, column (C) is the vertical eccentricity.

10. On the graph for total eccentricity, find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.

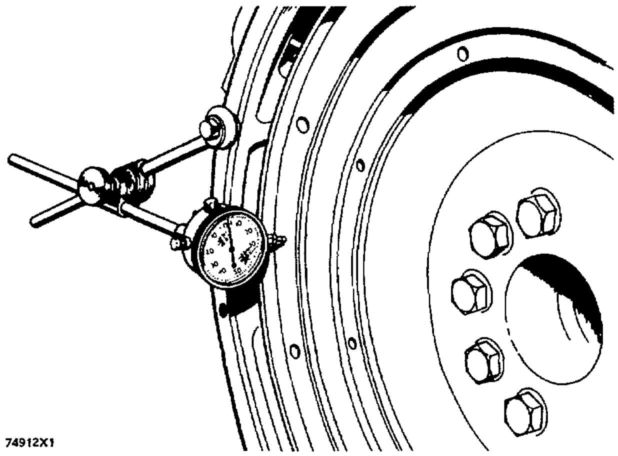
11. If the point of intersection is in the range marked "Acceptable", the bore is in alignment. If the point of intersection is in the range marked "Not Acceptable", the flywheel housing must be changed.



GRAPH FOR TOTAL ECCENTRICITY

Face Runout (axial eccentricity) of the Flywheel

1. Install the dial indicator as shown. Always put a force on the crankshaft in the same direction before the indicator is read so the crankshaft end clearance (movement) is always removed.



CHECKING FACE RUNOUT OF THE FLYWHEEL

2. Set the dial indicator to read "0" (zero).

3. Turn the flywheel and read the indicator every 90°.

4. The difference between the lower and higher measurements taken at all four points must not be more than 0.15 mm (.006 in.), which is the maximum permissible face runout (axial eccentricity) of the flywheel.

Bore Runout (radial eccentricity) of the Flywheel

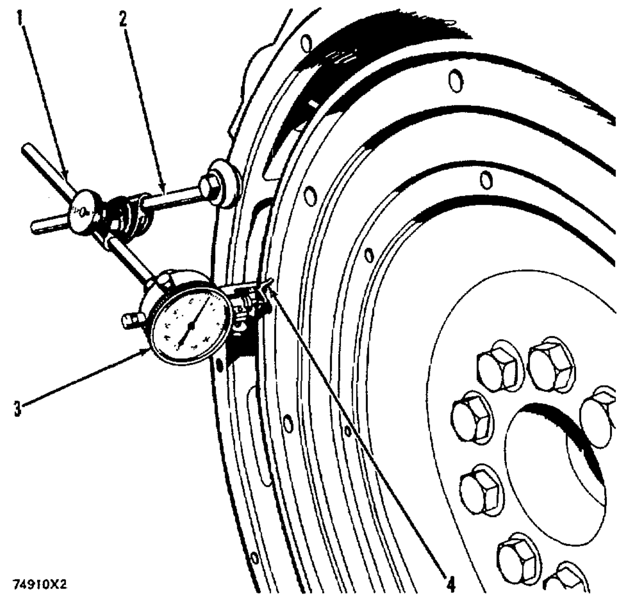
1. Install the dial indicator (3) and make an adjustment of the universal attachment (4) so it makes contact as shown.

2. Set the dial indicator to read "0" (zero).

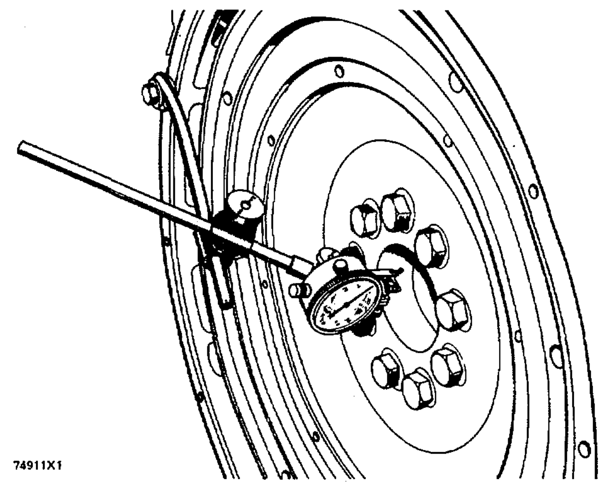
3. Turn the flywheel and read the indicator every 90°.

4. The difference between the lower and higher measurements taken at all four points must not be more than 0.15 mm (.006 in.), which is the maximum permissible bore runout (radial eccentricity) of the flywheel.

5. Runout (eccentricity) of the bore for the pilot bearing for the flywheel clutch, must not exceed 0.13 mm (.005 in.).



CHECKING BORE RUNOUT OF THE FLYWHEEL
1. 7H1945 Holding Rod. 2. 7H1645 Holding Rod. 3. 7H1942 Indicator. 4. 7H1940 Universal Attachment.



CHECKING FLYWHEEL CLUTCH PILOT BEARING BORE

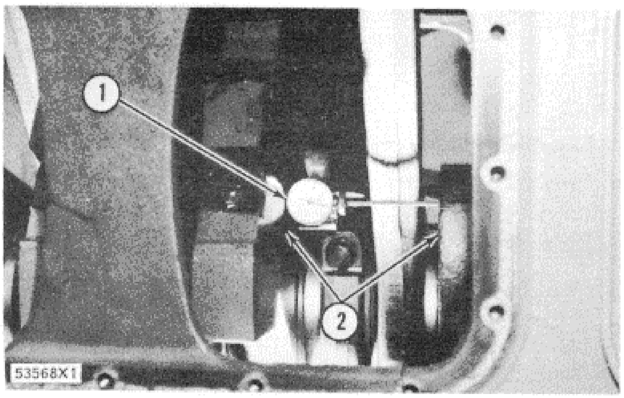
CHECKING CRANKSHAFT DEFLECTION (BEND)

The crankshaft can be deflected (bent) because the installation of the engine was not correct. If the engine mounting rails are not fastened correctly to the foundation mounting rails, the cylinder block can twist or bend and cause the crankshaft to deflect. This deflection can cause crankshaft and bearing failure.

The crankshaft deflection must be checked after the final installation of the engine. The check must be made with the engine cold and also with the engine at the temperature of normal operation. The procedure that follows can be used to check crankshaft deflection with the engine either cold or warm.

1. Remove an inspection cover from the cylinder block that will give access to the connecting rod journal of the crankshaft nearest to the center of the engine.

2. Turn the crankshaft in the direction of normal rotation until the center of the counterweights just go beyond the connecting rod.



MEASURING DEFLECTION OF THE CRANKSHAFT (TYPICAL EXAMPLE)
1. Dial gauge. 2. Mounting face.

3. Install a Starrett Crankshaft Distortion Dial Gauge No. 696 with Starrett No. 696B Balancer Attachment between the counterweights as shown. Put dial gauge (1) within 6.4 mm (.25 in.) of counterweight mounting surface (2). Turn the dial of the indicator to get alignment of the zero and the pointer. Turn the indicator on its end points until the pointer of the indicator will not move from zero.

4. 4. Turn the crankshaft in the direction of normal rotation until the indicator almost makes contact with the connecting rod on the other side of the crankshaft.

NOTE: Do not let the indicator make contact with the connecting rod.

5. The dial indicator reading must not change more than 0.03 mm (.001 in.) for the approximately 300 degrees of crankshaft rotation. Now turn the crankshaft in the opposite direction to the starting position. The dial indicator must now read zero. If the dial indicator does not read zero, do the procedure again.

If the dial indicator reads more than 0.03 mm (.001 in.), the cylinder block is bent. Loosen the bolts that hold the engine mounting rails to the foundation mounting rails and adjust the shims to make the engine straight again. Also check to see if the engine mounting bolts have enough clearance to let the engine have expansion as it gets hot.

VIBRATION DAMPER

Damage to or failure of the damper will increase vibrations and result in damage of the crankshaft.

If the damper is bent or damaged, or if the bolt holes in the damper are loose fitting, replace the damper. Replacement of the damper is also needed at the time of crankshaft failure (if a torsional type).

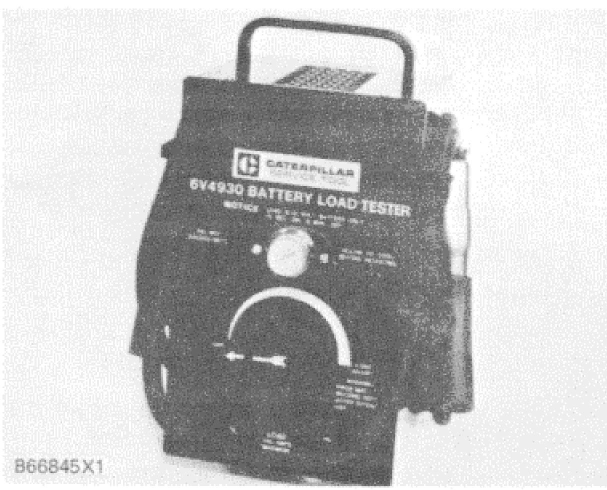
ELECTRICAL SYSTEM

TEST TOOLS FOR ELECTRICAL SYSTEM

Tools Needed:
6V4930 Battery Load Tester.
8T900 AC/DC Clamp-On Ammeter.
6V7070 Heavy-Duty Digital Multimeter or
6V7800 Regular-Duty Digital Multimeter.

Most of the tests of the electrical system can be done on the engine. The wiring insulation must be in good condition, the wire and cable connections must be clean and tight, and the battery must be fully charged. If the on-engine test shows a defect in a component, remove the component for more testing.

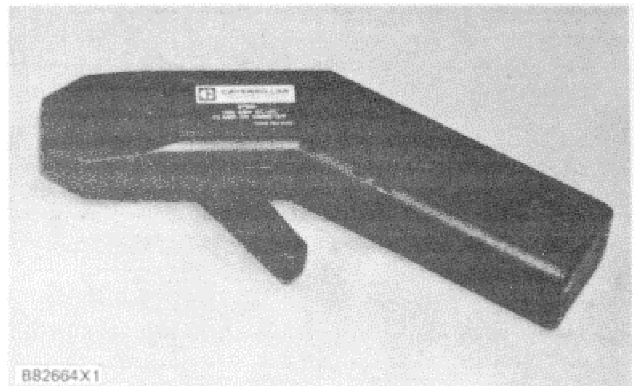
The service manual TESTING AND ADJUSTING ELECTRICAL COMPONENTS, Form No. REG00636 has complete specifications and procedures for the components of the starting circuit and the charging circuit.



6V4930 BATTERY LOAD TESTER

The 6V4930 Battery Load Tester is a portable unit in a metal case for use under field conditions and high temperatures. It can be used to load test all 6, 8 an 12V batteries. This tester has two heavy-duty load cables that can easily be fastened to the battery terminals, and a load adjustment knob on the front panel permits a current range up to a maximum of 700 amperes. The tester also has a thermometer to show when the safe operating temperature limit of the unit has been reached.

NOTE: Make reference to Special Instruction Form No. SEHS8268 for more complete information for use of the 6V4930 Battery Load Tester.

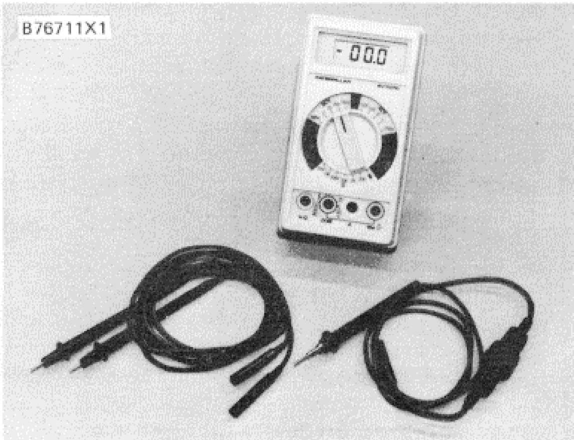


8T900 AC/DC CLAMP-ON AMMETER

The 8T900 AC/DC Clamp-On Ammeter is a completely portable, self-contained instrument that allows electrical current measurements to be made without breaking the circuit or disturbing the insulation on conductors. A digital display is located on the ammeter for reading current directly in a range from 1 to 1200 amperes. If an optional 6V6014 Cable is connected between this ammeter and one of the digital multimeters, current readings of less than 1 ammeter can then be read directly from the display of the multimeter.

A lever is used to open the jaws over the conductor [up to a diameter of 19 mm (.75 in.)], and the spring loaded jaws are then closed around the conductor for current measurement. A trigger switch that can be locked in the ON or OFF position is used to turn on the ammeter. When the turn-on trigger is re- leased, the last current reading is held on the display for 5 seconds. This allows accurate measurements to be taken in limited access areas where the digital display is not visible to the operator. A zero control is provided for DC operation, and power for the ammeter is supplied by batteries located inside the handle.

NOTE: Make reference to Special Instruction Form No. SEHS8420 for more complete information for use of the 8T900 Clamp-On Ammeter.



6V7070 HEAVY-DUTY DIGITAL MULTIMETER

The 6V7070 Heavy-Duty Digital Multimeter is a completely portable, hand held instrument with a digital display. This multimeter is built with extra protection against damage in field applications, and is equipped with seven functions and 29 ranges. The 6V7070 Multimeter has an instant ohms indicator that permits continuity checks for fast circuit inspection. It also can be used for troubleshooting small value capacitors.

The 6V7800 Regular-Duty Digital Multimeter (a low cost option to the Heavy-Duty Multimeter) is also available; however, the 6V7800 Multimeter does not have the O1A range or the instant ohms feature of the 6V7070 Multimeter.

NOTE: Make reference to Special Instruction Form No. SEHS7734 for more complete information for use of the 6V7070 and 6V7800 Multimeters.

BATTERY

⚠ WARNING

Never disconnect any charging unit circuit or battery circuit cable from battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery. Damage to the charging unit will result if the connections (either positive or negative) between the battery and charging unit are broken while the charging unit is in operation. This is because the battery load is lost and there is an increase in charging voltage. High voltage will damage, not only the charging unit, but also the regulator and other electrical components.

Load test a battery that does not hold a charge when in use. To do this, put a resistance across the main connections (terminals) of the battery. For a 6, 8 or 12V battery, use a test load of three times the ampere/hour rating (the maximum test load on any battery is 500 amperes). Let the test load remove the charge (discharge) of the battery for 15 seconds and with the test load still applied, test the battery voltage. A 6V battery in good condition will show 4.5V; and 8V battery will show 6V; a 12V battery will show 9V. Each cell of a battery in good condition must show 1.6V on either a 6, 8 or 12V battery.

CHARGING SYSTEM

The condition of charge in the battery at each regular inspection will show if the charging system operates correctly. An adjustment is necessary when the battery is constantly in a low condition of charge or a large amount of water is needed (more than one ounce of water per cell per week or per every 50 service hours).

When it is possible, make a test of the charging unit and voltage regulator on the engine, and use wiring and components that are a permanent part of the system. Off-engine (bench) testing will give a test of the charging unit and voltage regulator operation. This testing will give an indication of needed repair. After repairs are made, again make a test to give proof that the units are repaired to their original condition of operation.

Before the start of on-engine testing, the charging system and battery must be checked as shown in the Steps that follow:

1. Battery must be at least 75% (1.240 Sp. Gr.) fully charged and held tightly in place. The Battery holder must not put too much stress on the battery.

2. Cables between the battery, starter and engine ground must be the correct size. Wires and cables must be free of corrosion and have cable support clamps to prevent stress on battery connections (terminals).

3. Leads, junctions, switches and panel instruments that have direct relation to the charging circuit must give correct circuit control.

4. Inspect the drive components for the charging unit to be sure they are free of grease and oil and have the ability to operate the charging unit.

Alternator Regulator Adjustment (Delco-Remy)

When an alternator is charging the battery too much or not enough, an adjustment can be made to the output voltage of some alternators. Make reference to the SPECIFICATIONS section to find all testing specifications for the alternators and regulators.

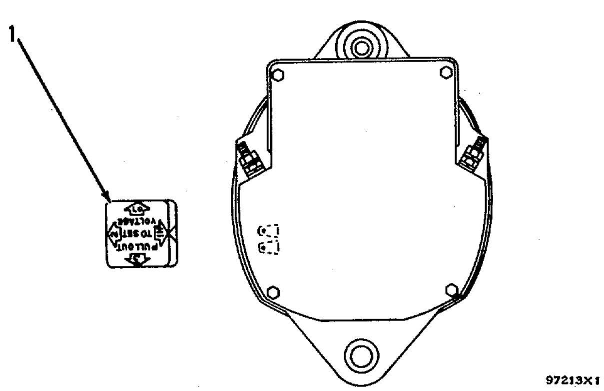
Delco-Remy 24V 60A (4N3986 Alternator)

No adjustment of voltage output can be made on this alternator. If the voltage and ampere output is not correct, the alternator must be repaired or replaced.

Delco-Remy 32V 60A (4N3987 Alternator)

To make an adjustment to the voltage output, pull out voltage adjustment cap (1). Turn the cap 90° and install it again into the alternator. The voltage adjustment cap has four positions: HI, LO, and two positions between the high and the low setting.

The 4N3987 Alternator can be adjusted for either 30 or 32 volts. A replacement alternator shipped from the factory will be adjusted for 32V (16 battery cells) systems. Where the alternator is to be used in a 30V (15 battery cells) system, pull out voltage adjustment cap (1) and change from the HI position to position 3.



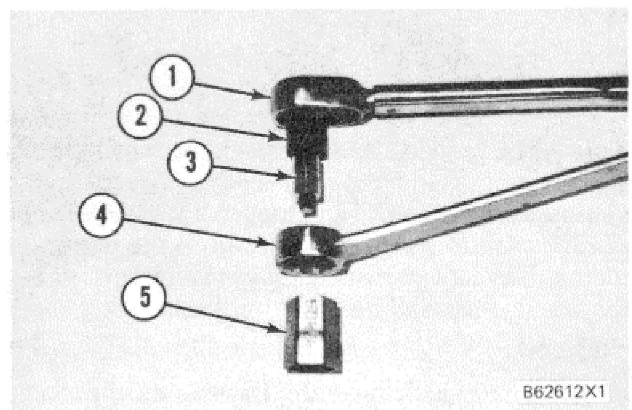
CAP TYPE REGULATOR ADJUSTMENT

1. Voltage adjustment cap.

No adjustment can be made to change the rate of charge on these alternator regulators. If the rate of charge (ampere output) is within 10 amperes of rated output (marked on the alternator frame) the regulator is good. An over or under charged battery condition can be corrected sometimes by an adjustment to the voltage. If rate of charge is not correct, a replacement of the regulator is necessary.

Alternator Pulley Nut Tightening (Delco-Remy)

Tighten nut that holds the pulley to a torque of 100 ± 10 N ·m (75 Z± 5 lb. ft.) with the tools shown.



TOOLS TO TIGHTEN ALTERNATOR PULLEY NUT 1. 5P7425 Torque Wrench. 2. 8S1588 Adapter (1/2" female to 3/8" male). 3. FT1697 Socket. 4. 8H8517 Combination Wrench (1 1/8"). 5. FT1696 Wrench.

STARTING SYSTEM

Use the multimeter in the DCV range to find starting system components which do not function.

Move the start control switch to activate the starter solenoid. Starter solenoid operation can be heard as the pinion of the starter motor is engaged with the ring gear on the engine flywheel.

If the solenoid for the starter motor will not operate, it is possible that the current from the battery did not get to the solenoid. Fasten one lead of the multimeter to the connection (terminal) for the battery cable on the solenoid. Put the other lead to a good ground. A zero reading is an indication that there is a broken circuit from the battery. More testing is necessary when there is a voltage reading on the multimeter.

The solenoid operation also closes the electric circuit to the motor. Connect one lead of the multimeter to the solenoid connection (terminal) that is fastened to the motor. Put the other lead to a good ground. Activate the starter solenoid and look at the multimeter. A reading of battery voltage shows the problem is in the motor. The motor must be removed for further testing. A zero reading on the multimeter shows that the solenoid contacts do not close. This is an indication of the need for repair to the solenoid or an adjustment to be made to the starter pinion clearance.

Make a test with one multimeter lead fastened to the connection (terminal) for the small wire at the solenoid and the other lead to the ground. Look at the multimeter and activate the starter solenoid. A voltage reading shows that the problem is in the solenoid. A zero reading is an indication that the problem is in the start switch or the wires for the start switch.

Fasten one multimeter lead to the start switch at the connection (terminal) for the wire from the battery. Fasten the other lead to a good ground. A zero reading indicates a broken circuit from the battery. Make a check of the circuit breaker and wiring. If there is a voltage reading, the problem is in the start switch or in the wires for the start switch.

A starter motor that operates too slow can have an overload because of too much friction in the engine being started. Slow operation of the starter motor can also be caused by a short circuit, loose connections and/or dirt in the motor.

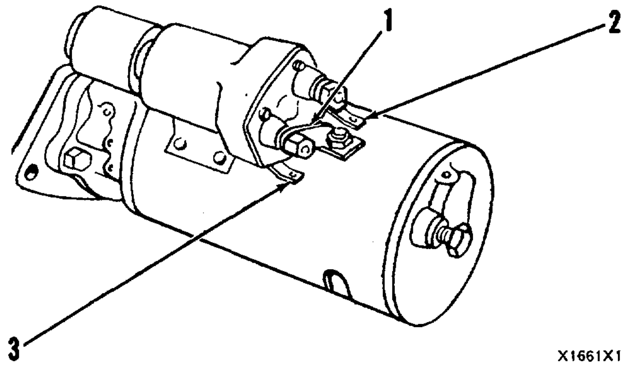
Pinion Clearance Adjustment

When -the solenoid is installed, make an adjustment of the pinion clearance. The adjustment can be made with the starter motor removed.

1. Install the solenoid without connector (1) from the MOTOR connections (terminal) on solenoid to the motor.

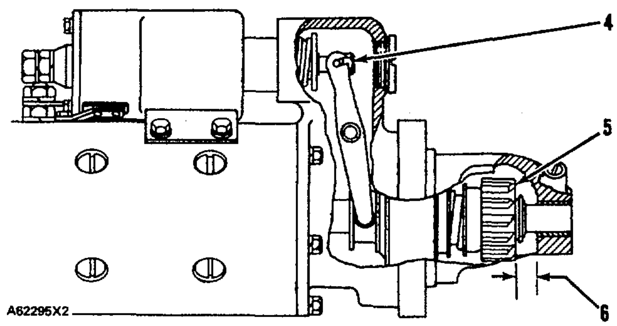
2. Connect a battery, of the same voltage as the solenoid, to the terminal (2), marked SW.

3. Connect the other side of the battery to ground terminal (3).



CONNECTION FOR CHECKING PINION CLEARANCE
1. Connector from MOTOR terminal on solenoid to motor. 2. SW terminal. 3. Ground terminal.

4. Connect for a moment, a wire from the solenoid connection (terminal) marked MOTOR to the ground connection (terminal). The pinion will shift to crank position and will stay there until the battery is disconnected.



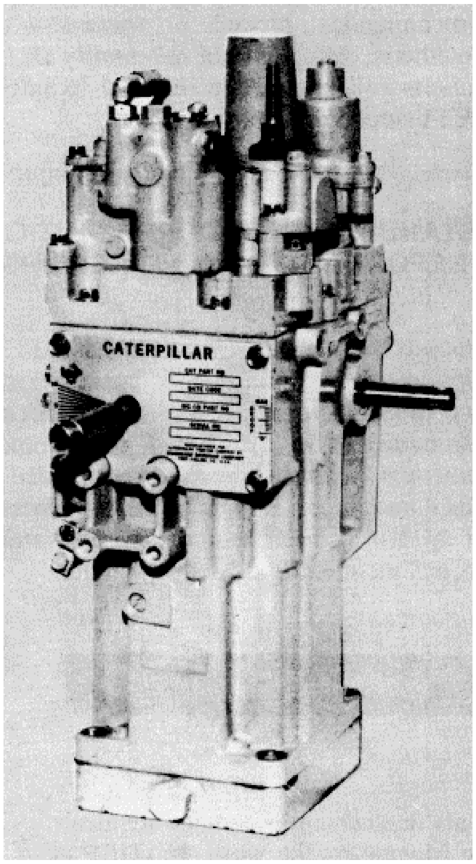
PINION CLEARANCE ADJUSTMENT
4. Shaft nut. 5. Pinion. 6. Pinion clearance.

5. Push the pinion toward the commutator end to remove free movement.

6. Pinion clearance (6) must be 8.4 to 9.9 mm (.33 to .39 in.).

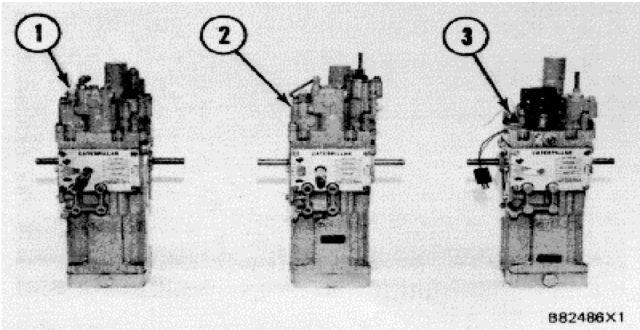
7. To adjust pinion clearance, remove plug and turn nut (4).

FORM NO. SENR3028



SERVICE MANUAL
CATERPILLAR
3161 GOVERNOR

GOVERNOR TYPES

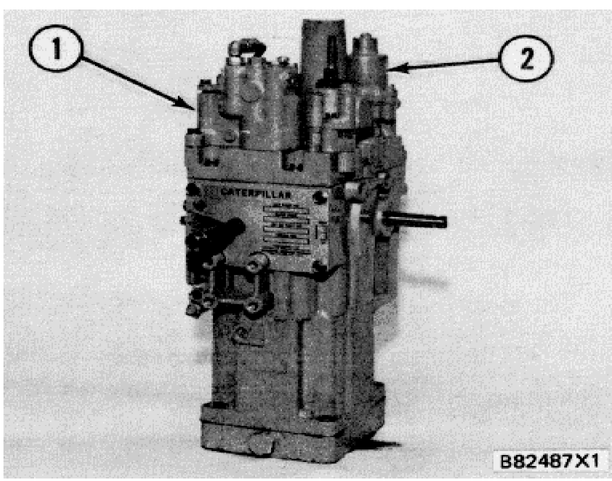


3161 GOVERNORS
1. 3161 Standard Governor. 2. 3161 Governor with Torque Rise. 3. 3161 Generator Set Governor.

The 3161 Standard Governor (1), the 3161 Governor with Torque Rise (2) and the 3161 Generator Set Governor (3) are the three arrangements of this governor that are available.

A mechanical head cover, a pneumatic head cover and a speed adjusting motor head cover are the three top covers available for use with any of the 3161 governors. These top covers make each governor adaptable for use with optional controls. The optional controls can be factory installed or added to a governor already in service without any

3161 STANDARD GOVERNOR



3161 STANDARD GOVERNOR
1. Pneumatic speed setting control. 2. Air fuel ratio control.

The 3161 Standard Governor is the base governor.

The 3161 Standard Governor is equipped with:

A pneumatic speed setting control (I) or manual mechanical speed control.

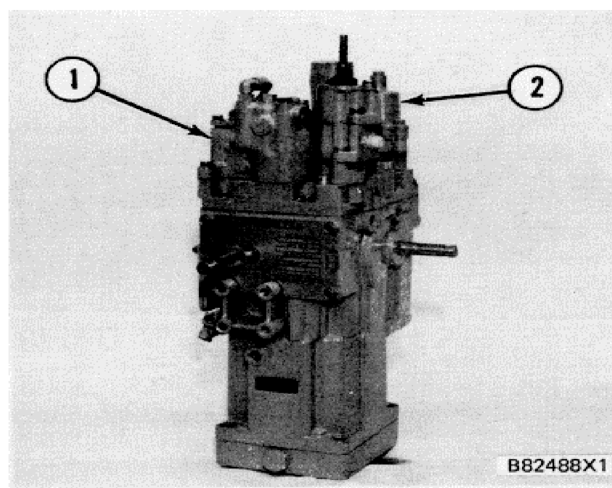
An air fuel ratio control (2).

The optional controls for this governor are:

1. Manual mechanical speed control (or pneumatic speed setting control).
2. Manual shutdown.
3. Pressure (pneumatic or hydraulic) shutdown.
4. Electric "energize to shutdown" solenoid.
5. Electric "energize to run" solenoid.
6. Pneumatic mid-speed control.

The shutdown controls (manual, pneumatic and electric) can be used separately or together as needed.

3161 GOVERNOR WITH TORQUE RISE



3161 GOVERNOR WITH TORQUE RISE
1. Pneumatic speed setting control. 2. Air fuel ratio control.

The 3161 Governor with Torque Rise is a standard base governor with the torque rise components installed.