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ELECTRIC FUEL CONTROL GOVERNOR

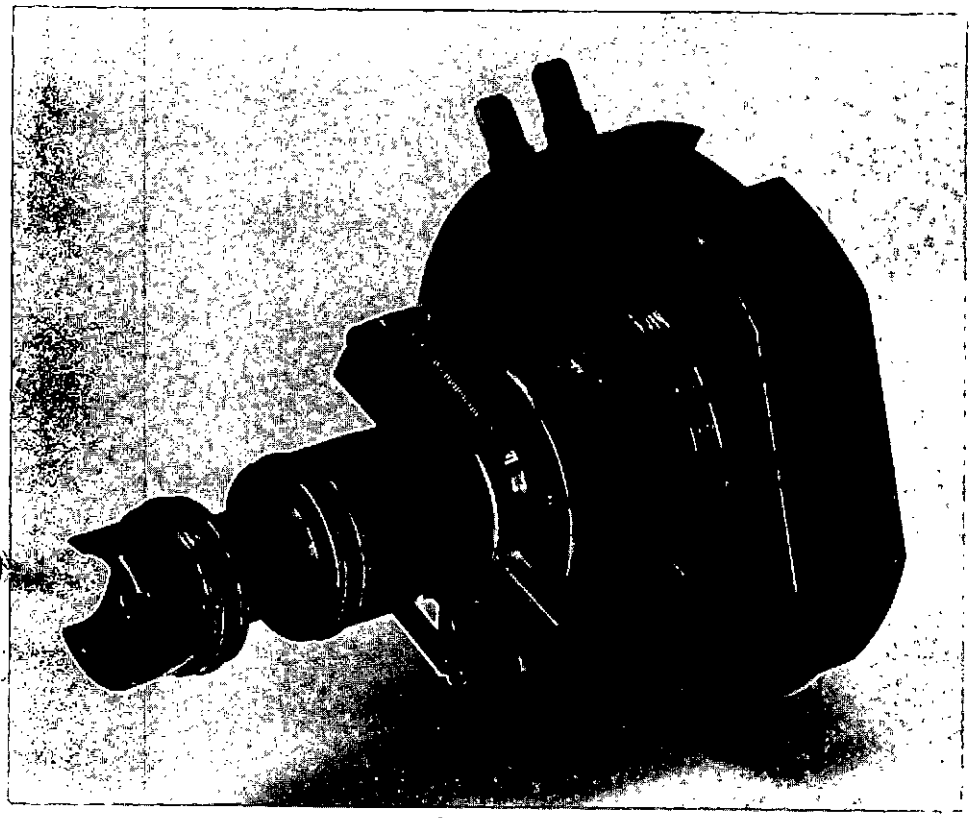


Fig. 1, Electric Fuel Control Governor Actuator

Contents

Service Tools (Or Equivalent) Required

Tool Number	Tool Name
ST-752	Mechanics Hand Tool Set
ST-1320	Hand Held Tachometer
ST-1321	Electrical Multitester
3375599	Barrel Puller
3376457	EFC Governor Plug Tool
	EFC Governor Screwdriver
	Cycle (Frequency) Meter
	24 Volt DC Batteries

INTRODUCTION

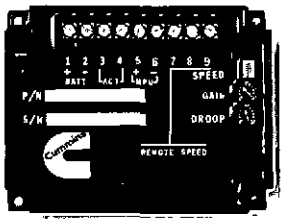
A new Electric Fuel Control (EFC) governor is now available for Cummins engines with the PT fuel system, Fig. 1.

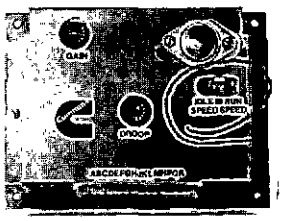
During the fourth quarter of 1981 a limited number of these governors will be installed on Cummins Generator Set engines.

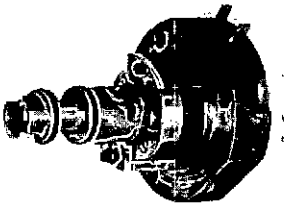
This publication contains the preliminary instructions for the installation, adjustment and troubleshooting of the Cummins EFC Governor.

GOVERNOR DESCRIPTION

The Cummins EFC Governor is an electrical sensing system that can be adjusted for 2-1/2 to 5% engine speed droop. This governor will provide rapid fuel rate changes to improve the transient response to the load change and provide less than +- 1/4% steady state stability under constant load conditions.







Remote Engine Mounted

1. Magnetic Pickup 2. Controllers 3. Actuator

Fig. 2, The EFC Governor consists of three components

1. The magnetic pickup is in the flywheel housing. It senses the engine speed and sends an electrical signal to the controller.

2. The controller compares the engine speed with the speed that has been preset in the controller. It sends an electrical signal to the actuator.

3. The electrical signal in the actuator will make the actuator shaft rotate. When the actuator shaft rotates, it is similar to a throttle shaft that opens and closes. This rotation will control the engine speed/horsepower.

The controller and actuator are electrically operated. They do not require an engine drive system, external linkage or hydraulic system.

FUEL FLOW THROUGH THE FUEL PUMP

1. The fuel pump assembly is a standard automotive governor fuel pump.

2. The throttle shaft is set in the full open position.

3. The fuel flows through the fuel pump to the AFC cavity.

4. The actuator is mounted in the AFC cavity.

5. The actuator controls the engine speed/horsepower. The standard automotive governor cut off is set about 120 RPM higher than the engine operating RPM.

6. From the actuator, the fuel flows to the shut-down valve and then to the injectors.

PART DESCRIPTION

Magnetic Pickup

1. The magnetic pickup is an electromagnetic device that is mounted in the flywheel housing, Fig. 3. When the flywheel gear teeth pass the pickup, an alternating current (A.C.) voltage is induced, one cycle for each gear tooth.

2. The magnetic pickup sends an electrical signal to the electric speed controller. The input signal strength from the magnetic pickup must be at least 1.5 volts root mean square (RMS) for the system to function properly.

3. If an engine-mounted controller is used, the magnetic pickup wires are connected to terminals 13 and 14 of the terminal block in the engine instrument panel. Internal wiring connects terminals 13 and 14 of the terminal block with terminals D and E of the engine mounted controller.

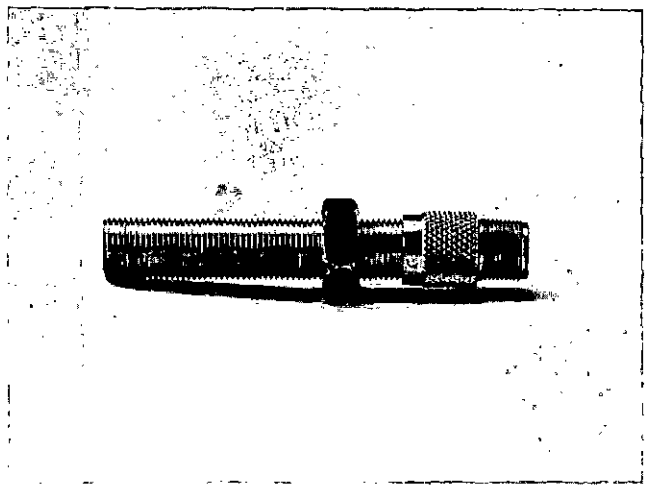


Fig. 3, Magnetic Pickup.

4. If a remote-mounted controller is used, the magnetic pickup wires are connected to terminals 5 and 6 of the remote mounted controller.

5. Terminal E of the engine mounted controller and terminal 6 of the remote mounted controller are internally grounded.

ELECTRIC SPEED CONTROLLER

The speed controller is an all electric solid-state module which compares the pulses from the magnetic pickup, which are directly proportional to the engine speed, with the speed control reference set point. A current output is supplied to the actuator which rotates the actuator shaft to control the fuel flow to the engine. The signal strength from the magnetic pick-up must be at least 1.5 volts RMS.

Two types of the electric speed controller are available, depending on customer requirements.

The engine-mounted speed controller, Fig. 4, uses a plug-in circuit board for mounting on a printed circuit board in the Cummins Engine instrument panel enclosure, Fig. 5. All of the circuitry is sealed with a silicone epoxy for environmental and vibration protection.

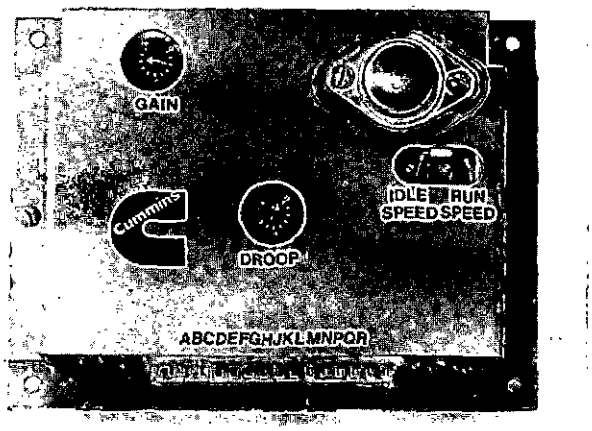


Fig. 4, The engine mounted speed controller.

The remote-mounted speed controller has an internal circuit board that is set in a die cast aluminum case, Fig. 6. The circuit board is sealed with a silicone filled epoxy to prevent damage from environmental and vibration conditions. Use of the remote-mounted controller allows the speed adjusting potentiometers to be mounted at a second location on a control panel.

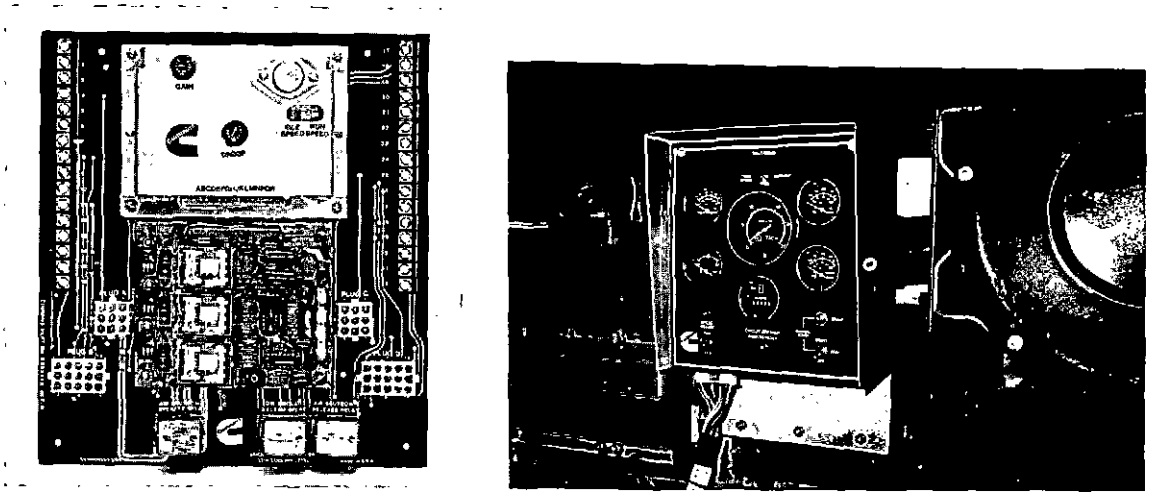


Fig. 5, The controller and the printed circuit board inside the engine instrument panel and the engine instrument panel.

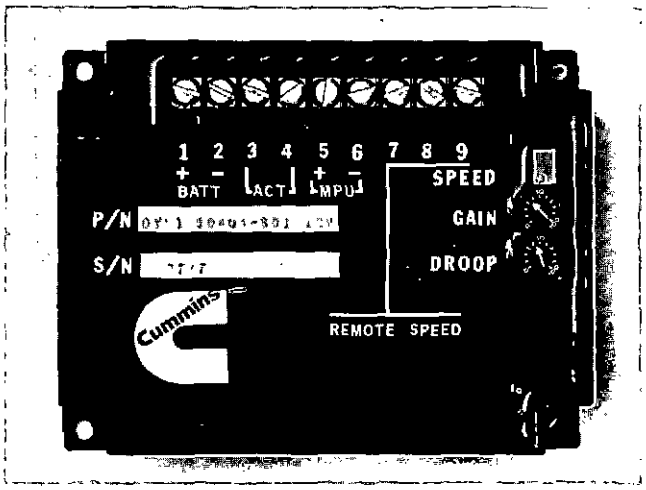


Fig. 6, The remote mounted speed controller.

ACTUATOR

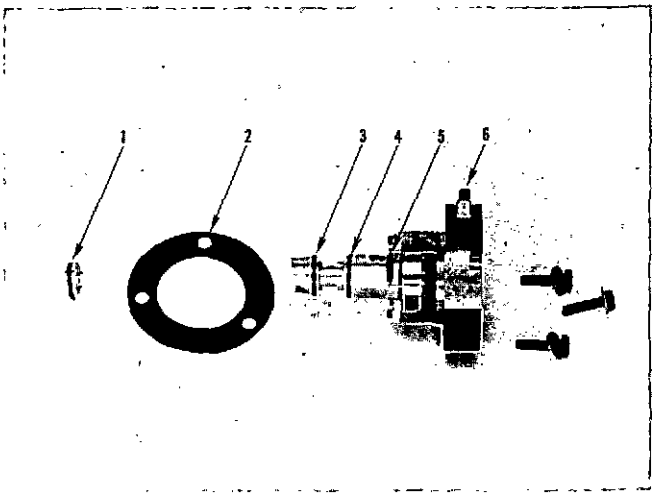
The actuator is an electromagnetic rotary solenoid valve in the AFC cavity of the PT (type G) AFC fuel pump, Fig. 7. By regulating the fuel pressure, the valve determines the engine speed and/or horsepower.

The fuel port in the actuator shaft is designed to provide linear output from the Cummins PT (type G) fuel pump. This rotary operated port improves the engine transient response to

load changes. The actuator is positioned electrically by the controller. When the controller electrical signal changes, the actuator shaft rotates to control the flow of fuel through the port to the engine.

When the load on the engine increases, the engine will slow down. This will make a decrease in the magnetic pickup signal. The signal change will go to the controller and then to the actuator. This signal decrease will make the actuator shaft rotate and increase the fuel rail pressure.

When the engine is being started or when the electrical system is turned off, the actuator is in the full fuel position. The engine is started in the standard procedure.



Ref. No.	Part No.	Description
1	193734	O-Ring
2	3029854	Gasket
3	145504	O-Ring
4	145505	O-Ring
5	3029853	Return Spring
6		Electrical Connections

Fig. 7, The electric fuel control actuator.

Installation of the Electric Fuel Control (EFC) Actuator

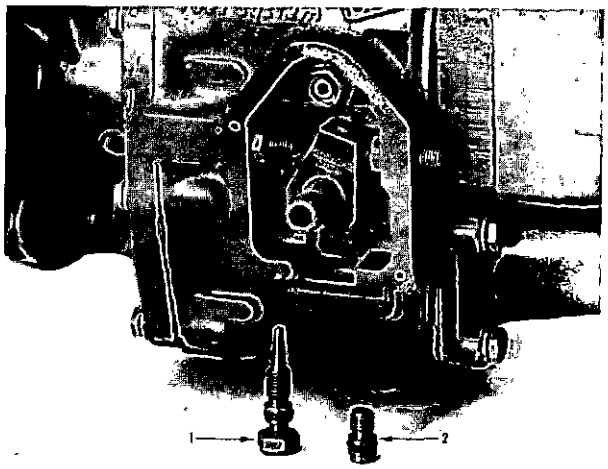
1. Remove the fuel pump if it is on the engine. When changing to the EFC governor system, use the following instructions for installing the EFC actuator in the fuel pump.

2. Remove the AFC no-air plug, Part No. 3004293 and replace it with the no-air needle valve, Part No. 214144. The AFC no-air plug is located directly above the throttle shaft, Fig. 8.

3. Turn the AFC no-air needle valve until it touches the no-air seat in the fuel pump housing. Tighten the jam nut.

4. Remove the AFC cover plate and use a pair of snap ring pliers to remove the snap ring, Fig. 9.

5. Thread one of the previously removed 1/4-20 capscrews into the AFC barrel plug, Fig. 10. Pull out the barrel plug with a pair of pliers. Discard the three original AFC cover plate capscrews.



1. No air needle valve
   Part No. 214144

2. AFC no air plug
   Part No. 3004293

Fig. 8, The AFC no-air needle valve location.

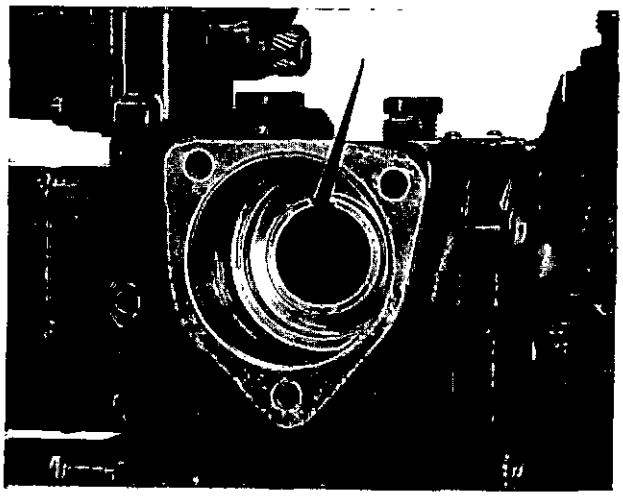


Fig. 9, The AFC barrel plug snap ring.

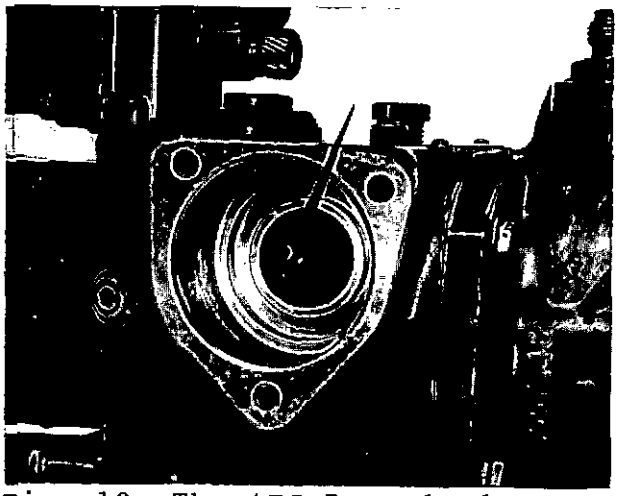


Fig. 10, The AFC Barrel plug with the puller capscrew installed.

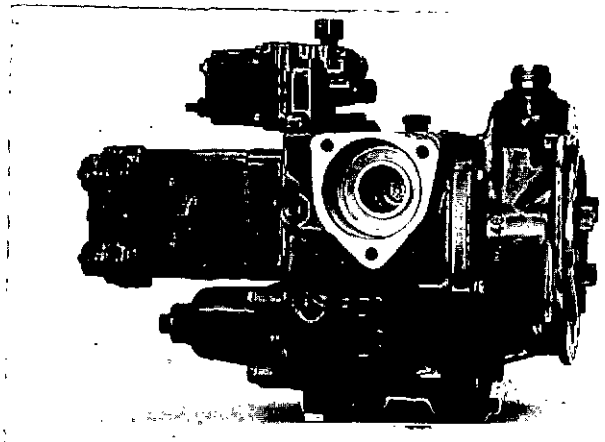


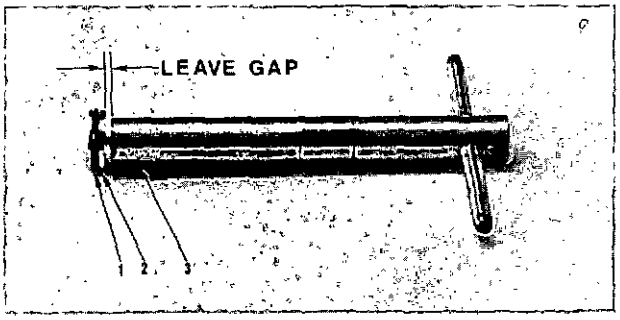
Fig. 11, The fuel pump housing with the AFC barrel plug removed.

6. If the fuel pump has a functional AFC, use the AFC barrel puller, Service Tool 3375599 to remove the barrel. The AFC cannot be used with an EFC Governor.

   The AFC cavity is now ready to install the EFC governor actuator, Fig. 11.

7. Install the O-ring plug, Part No. 3029300, on the Governor Plug Tool, Part No. 3376457, approximately three turns. Install the O-ring, Part No. 193734 on the plug.

Caution: Do not tighten the O-ring plug to the plug tool or the tool can not be removed after the plug is inserted in the pump AFC cavity, Fig. 12.



Ref. No.	Part No.	Description
1	193734	O-ring
2	3029300	Plug
3	3376457	Service Tool

Fig. 12, The EFC governor plug tool with the O-ring plug.

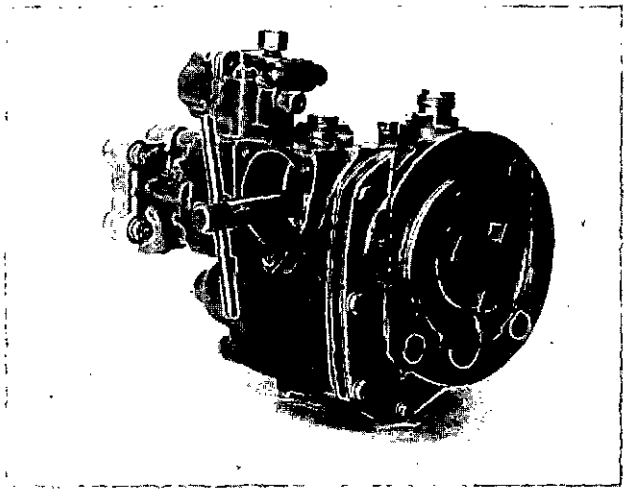


Fig. 13, Installing the O-ring plug in the AFC cavity.

8. Lubricate the O-ring with clean engine oil before installing the plug in the housing.

9. Press firmly until the O-ring plug is seated in the pump housing, Fig. 13.

10. Carefully unscrew the plug tool.

11. Apply and remove 24 volts DC across the two actuator connectors to test the solenoid and to observe actuator operation. The actuator will make a loud click when the actuator shaft hits the internal stop. Removing voltage from the actuator connectors will allow the force of the springs to return the actuator shaft to its original position.

12. Install the EFC gasket, Part No. 3029854 on the actuator. The gasket will fit only one way.

    Caution: Do not use any gasket adhesive or sealant on this gasket.

13. Check that all of the mounting holes are lined up.

14. Lubricate the actuator O-rings with clean engine oil.

15. Insert the actuator in the AFC cavity of the fuel pump housing. The actuator flange will be approximately 3/8 inch (9.5mm) from the fuel pump housing, Fig. 14.

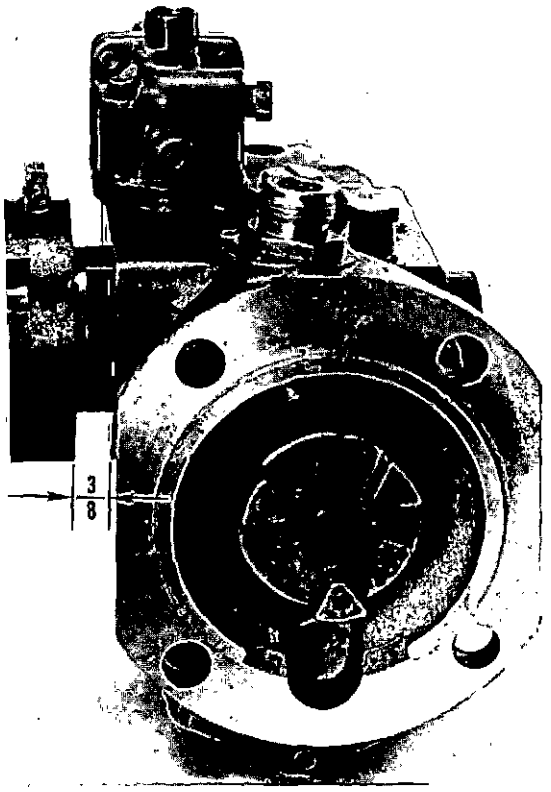


Fig. 14, The actuator is inserted in the AFC cavity.

Fig. 15, Installing the actuator in the fuel pump AFC cavity.

16. Use the palm of the hand. Push firmly and rotate the actuator approximately 30 degrees clockwise until the actuator flange contacts the fuel pump housing, Fig. 15.

17. Rotate the actuator counterclockwise until the mounting holes are aligned.

18. Install the three 1/4-20 x 1" hex head capscrews with flat washers. Do not use lockwashers. Tighten the capscrews until they are finger tight. These capscrews must be grade five or better.

19. The actuator capscrews must be tightened in the following procedure:

    a. Tighten the mounting capscrews 1/8 of a turn, in the sequence shown in Fig. 16, until they are seated.

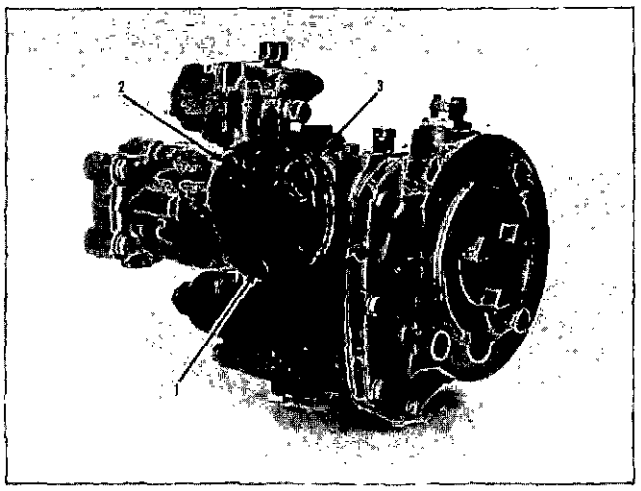


Fig. 16, The actuator capscrew torque sequence.

    b. Tighten the capscrews to 48 in-lb [5.4 N m] torque.

    c. Tighten the capscrews to a final torque of 84 in-lb. [9.5 N m].

This procedure will make sure that the actuator is properly installed and is not binding. A final check is to apply and remove 24 volts across the two actuator connectors. The operation of the actuator should have a similar sound as it did before installing in the fuel pump housing. If the actuator sounds as if it is not operating, or operating slower than before, loosen all of the capscrews and tighten them again as described in the previous procedure.

This completes the installation of the actuator in the fuel pump housing, Fig. 17.

The fuel pump can now be calibrated (Refer to the Fuel Pump Calibration Cumulative Supplement). The throttle shaft must be locked in the full open position. After the calibration, the fuel pump can be mounted on the engine.

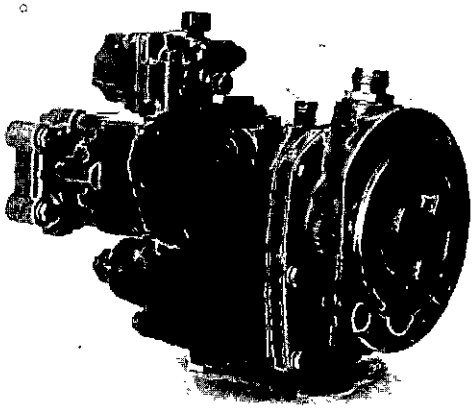


Fig. 17, The actuator installed in the AFC cavity.

Installation of the Magnetic Pickup

1. The magnetic pickup screws into the flywheel housing.

2. Remove the pipe plug in the flywheel housing that aligns with the flywheel gear teeth. Make sure a gear tooth is centered in the pickup hole. Rotate the flywheel to center a gear tooth in the hole.

3. If the flywheel housing does not have a pipe plug that aligns with the flywheel gear teeth, drill and tap a hole in the housing.

   a. Drill a 37/64 inch [14.68 mm] hole in the housing.

   b. Tap a 5/8 - 18 UNF-2A hole in the housing.

4. Screw the magnetic pickup all of the way down until it contacts the flywheel gear tooth. The pickup will screw in very easy, do not use excessive pressure to install the pickup.

5. Back the pickup out .020 to .040 inch [.51 to 1.02 mm] from the flywheel gear tooth.

   a. If you can not get a feeler gauge between the magnetic pickup and the flywheel gear tooth, back the pickup out 1/2 to 3/4 of a turn.

6. Tighten the locknut down on the flywheel housing.

7. Plug the electrical connection into the pickup.

Note: The plug for the electrical connection in the pickup will only fit one way. The plug from the pickup to the engine mounted controller will only fit one way. The electrical connection between the pickup and the engine mounted controller can not be made wrong.

On the remote mounted controller or if the connection wires are broken, the "B" post is positive on the magnetic pickup.

Power Source

The source voltage is 24 volts D.C. The maximum input current at 24 volts is approximately 3.9 amps. (Refer to figure 18 or 20 for the specific wiring.)

Caution: Do not connect the speed controller to a battery charger.

SYSTEM ADJUSTMENTS
ENGINE MOUNTED SPEED CONTROLLER

The engine-mounted speed controller has four potentiometers for making system adjustments. These components are mounted on the controller which is located inside the engine instrument panel box:

The GAIN control is a one-turn potentiometer. It is used to adjust the sensitivity of the governor. A clockwise rotation of the potentiometer knob will decrease the response time to load changes.

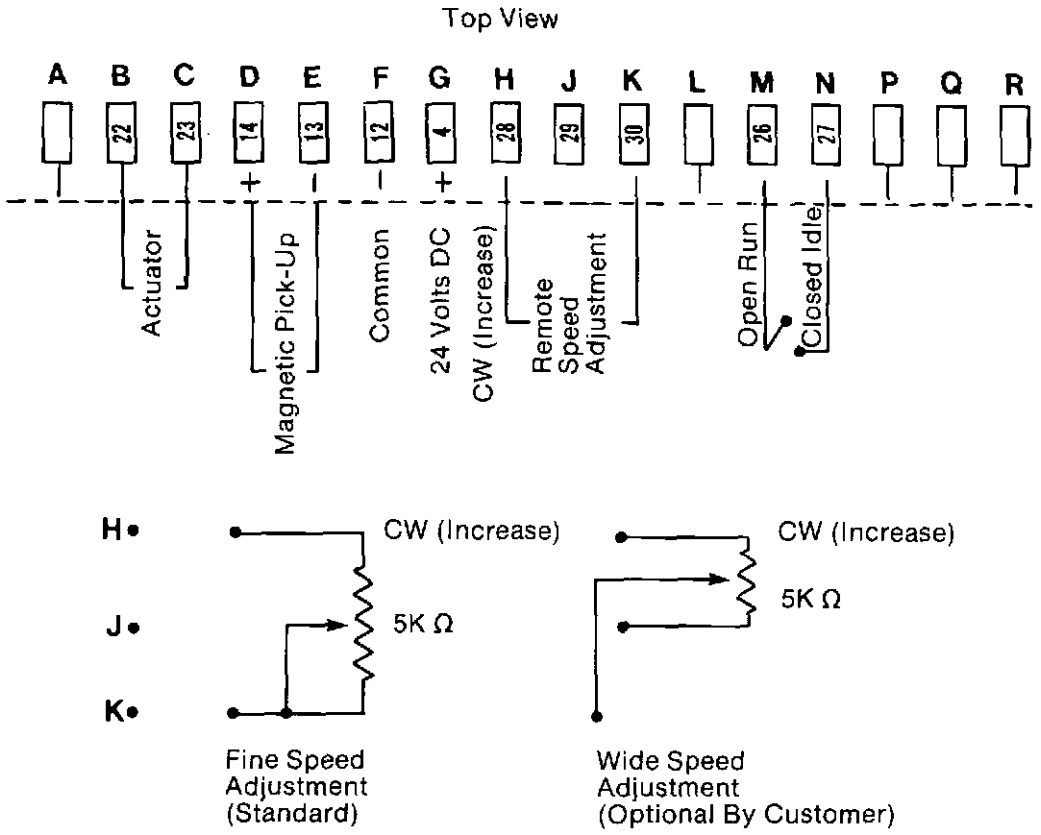
The DROOP control is a one-turn potentiometer. It is adjustable for 2 1/2 to 5% speed droop. A clockwise rotation will increase the droop.

The IDLE SPEED control is a 10-turn potentiometer for adjusting the idle speed. A clockwise rotation will increase the idle speed.

The RUN SPEED control is a 10 turn potentiometer for setting the desired no-load governed speed. A clockwise rotation will increase the run speed.

An IDLE-RUN switch, located on the engine instrument panel, is used when setting idle speed and run speed. With the switch in the "idle" position, the engine will run at idle; with the switch in the "run" position, the engine will operate at governed speed when running under load, or at no-load governed speed when no load is applied.

Also located on the engine instrument panel is the SPEED ADJUST potentiometer which is used for fine speed adjustment after RUN SPEED, DROOP, and GAIN have been set. A modification to the system is possible to allow a wide speed adjustment in place of the fine speed adjustment. See Fig. 18 for the wiring details.



Note: Letters refer to the plug-in connector terminals on the controller. Numbers are the equivalent terminal connections on the terminal blocks in the engine instrument panel enclosure.

Fig. 18, The engine mounted speed controller wiring.

Preliminary Adjustments

1. The IDLE-RUN switch must be in the "run" position to make the governor adjustment.

2. The SPEED ADJUST potentiometer must be adjusted to its midpoint. Turn the screw ten turns counterclockwise, then turn the screw five turns clockwise.

3. Set the DROOP and GAIN potentiometers at the 50 position.

NOTE: If desired, the engine can be started with IDLE-RUN switch in the IDLE position. The governor adjustments must be made with the switch in the RUN position.

Governed Speed Adjustment

1. Start the engine. Do not apply the load to the engine. Use the RUN SPEED potentiometer and a cycle meter to set the no-load governed speed.

CAUTION: Do not use a tachometer to adjust generator set engine speed, use a cycle (frequency) meter.

2. Generators which are to operate at 1800 RPM, 60 Hz full load, must have the engine no load governed speed adjusted to:

61.8 Hz (1854 RPM) for 3% speed droop
63 Hz (1890 RPM) for 5% speed droop

For generators which are to operate at 1500 RPM, 50 Hz full load, the engine no-load governed speed must be adjusted to:

51.5 Hz (1545 RPM) for 3% speed droop
52.5 Hz (1575 RPM) for 5% speed droop

Idle Speed Adjustment

1. Set Idle-Run switch in the "idle" position. The engine will decelerate from no-load governed speed to idle.

2. Adjust the IDLE SPEED potentiometer to obtain an engine speed between 600 and 650 RPM. Use a hand-held tachometer or other service tool to make the idle speed adjustment.

Droop Adjustment

1. Set idle-run switch in the "run" position. The engine will accelerate from idle to no-load governed speed.

2. Close the main line circuit breaker and apply the rated load.

3. Check the cycle meter to make sure the full load governed speed is correct.

4. If the full load governed speed is not correct, remove the load on the engine. The engine speed will increase to the no-load speed.

5. Adjust the DROOP potentiometer to the required speed droop (3%, 5%, etc). Check the droop on the cycle meter.

NOTE: The droop adjustment is made when the engine is at no-load speed.

6. The engine no-load governed speed must be as indicated in Step 2 under "Governed Speed Adjustment". If it is not, repeat the procedure in Step 1 under "Governed Speed Adjustment" as often as needed; it will usually take two or three times.

If the rated KW load is not available, the full load governed speed, based on the available load, can be calculated according to the formula in the "Equations" section of this bulletin.

Gain Adjustment

1. Close the main line circuit breaker and apply approximately 1/4 of the rated load.

2. Make sure the engine speed is constant. If the engine speed is constant, turn the GAIN potentiometer clockwise slowly until the engine speed is not constant.

a. Slowly turn the potentiometer counterclockwise until a constant speed is achieved. Turn the potentiometer counterclockwise an additional 1/2 division, Fig. 19.

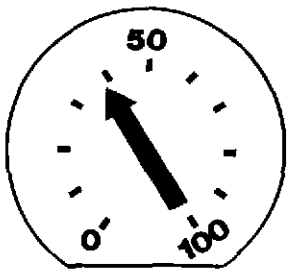


Fig. 19, The gain potentiometer.

The above steps can be repeated until the desired droop and constant speed are obtained.

Fine Speed Adjustment

After the gain adjustment is made, the full load governed engine speed may require a minor adjustment to equal the desired speed (i.e. 60 Hz, 1800 RPM or 50 Hz, 1500 RPM). Use the SPEED ADJUST potentiometer on the engine instrument panel for fine speed adjustments of less than +- 100 RPM.

SYSTEM ADJUSTMENT
REMOTE MOUNTED SPEED CONTROLLER

Follow the engine mounted speed controller instructions for setting governed speed, droop and gain with the remote mounted speed controller. Figure 20 provides wiring details for three wiring versions and the following instructions list the steps to follow while making system adjustments, depending on which of the three wiring versions is used.

Fine Speed Adjustment With The Idle-Run Switch - Standard Wiring

Follow the procedure for Option 1 with the IDLE-RUN switch in "run" position, then move the IDLE-RUN switch to "idle". The engine speed will decrease to idle. Use the remote mounted idle potentiometer to adjust engine idle speed to 600 - 650 RPM. Moving the IDLE-RUN switch to the "run" position will increase

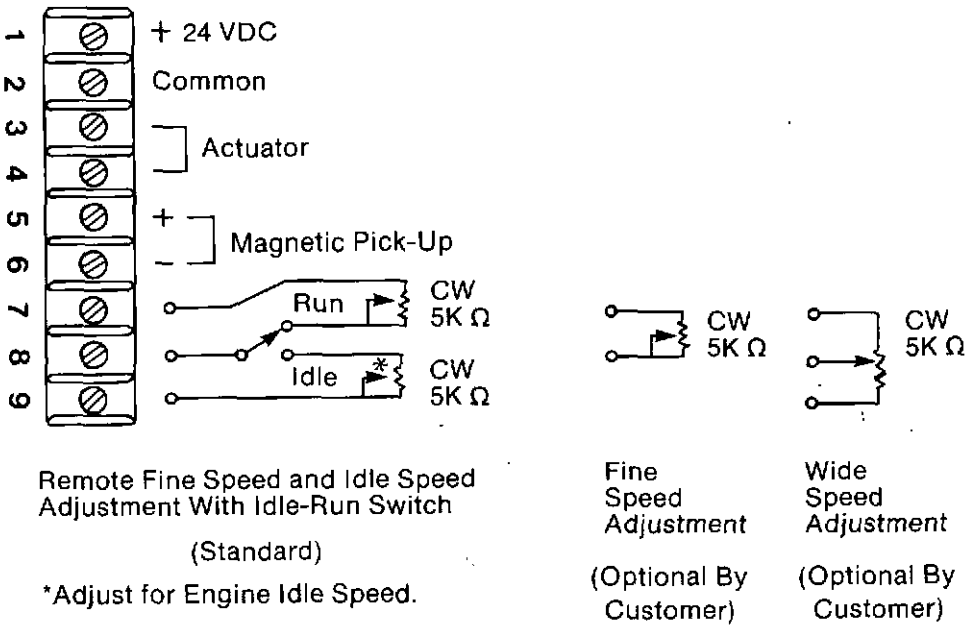
the engine speed to the previously set governed speed. The fine speed adjustment potentiometer can be wired by the customer for a wide speed adjustment, Fig. 20.

Option 1 - Fine Speed Adjustment Only - By Customer

Set the desired governed speed with the SPEED potentiometer on the controller, when the fine speed adjustment potentiometer is at its midpoint. This will allow a fine speed increase or decrease of the governed speed of approximately 100 RPM.

Option 2 - Wide Speed Adjustment Only - By Customer

Prior to setting governed speed, turn the controller SPEED potentiometer counterclockwise 10 turns. This will allow the remote mounted wide speed adjustment potentiometer to control the engine from idle to governed speed.



Remote Fine Speed and Idle Speed Adjustment With Idle-Run Switch

(Standard)

*Adjust for Engine Idle Speed.

Fine Speed Adjustment

(Optional By Customer)

Wide Speed Adjustment

(Optional By Customer)

Fig. 20, The speed variations on a remote mounted controller

COMPONENT SPECIFICATIONS
Actuator and Controller

OPERATION

Governing Mode	: 2-1/2 to 5% droop
Steady State Stability	: Less than +- 1/4%
Operating Frequency Range	: 1K to 5K Hz
Idle Frequency Range	: 200 to 2200 Hz
Response Time	: 15 miliseconds

POWER

Operating Voltage	: 24 Volts D.C. +- 6 Volts Continuous
Ground Polarity	: Negative ground (case isolated)
Power Consumption	: 94 Watts
Normal Operating Current	: 3.9 amps at 24 volts

ENVIRONMENTAL

Ambient Operating Temp.	: -40 to 185 F [-40 to 85 C]
Maximum Temp. Drift	: +- 1%
Relative Humidity	: 0 to 100% non condensing

PHYSICAL

REMOTE MOUNTED CONTROLLER

Dimensions	: 5.75" x 4.44" x 2.15 [146mm x 113mm x 55mm]
Weight	: 2 lbs. [.9 kg]
Mounting	: Any position, typically in enclosure
Case Material	: Die cast aluminum

CONTROL PANEL MOUNTED PLUG-IN CONTROLLER

Dimensions	: 5.5" x 4.1" x 1.3" [140mm x 104mm x 33mm]
Weight	: 1 lb. [.45 kg]
Mounting	: 16 pin plug-in receptacle

PROTECTION FEATURES

High voltage protection (32 V-DC continuous)
Reverse of supply polarity
Surge protection (80 V-DC, 10 msec transient)

Vibration Protection	:(Remote Mounted Controller)	Entire printed circuit board sealed with silicone filled epoxy.
	:(Plug-In Controller	Circuit Board sealed with silicone epoxy.

MAGNETIC PICKUP SPECIFICATIONS

Thread Size	: 5/8 - 18 UNF-2A
Tap Drill Size	: 37/64
Proximity to Gear Teeth	: .020 min. - .040 max. (Approximately 1/2 to 3/4 turn)
Temperature Range	: -67 to 221 F. [-55 C. to 105 C.]
Output	: 1.5 volts RMS minimum
Impedance	: 50 to 1100 ohms

Table 1: Electric Fuel Control Governor Parts

PART NO.	DESCRIPTION
3029298	Actuator Low Flow (For use on engines up to VTA-1710)
3029855	Actuator High Flow (For use on KT(A) - 2300 and 3067 engines)
3029299	Controller (For Remote Mounting, Enclosed)
3032733	Controller (Plug-In type, for mounting in Cummins Engine Instrument Panel or Generator Control Panel Enclosure)
213272	Magnetic Pickup (For SAE #1 or #0 Flywheel Hsg.)
3003916	Magnetic Pickup (For SAE #00 Flywheel Hsg.)
3015105	Remote Speed Potentiometer (See Figure 4 or 6)
104215	Idle-Run Toggle Switch

EQUATIONS

To calculate the operating (governed) speed under full load when the rated KW load is not available, use the following formula:

$$S_{AL} = S_{NL} - \left[\frac{\text{Available KW Load}}{\text{Rated KW}} \times (S_{NL} - S_{FL})\right]$$

Where

S_{AL} = Speed at Available KW Load

S_{FL} = Speed at Full KW Load

S_{NL} = Speed at No Load

TROUBLESHOOTING

REMOTE MOUNTED CONTROLLER

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
I. Engine Cranks won't start	Fuel not available to engine.	1)Is 24 V-DC available at fuel solenoid? If not -	1)Check power on switch. 2)Reset Circuit Breaker. 3)Reset overspeed stop switch. 4)Check safety controls. 5)Check wiring.
		2)24 V-DC is available but fuel not getting to injector rail.	1)Remove pipe plug at fuel shutoff valve. Install a hose and drain into a container. Crank engine with permissive start switch on. CAUTION: Be careful when cranking engine. An open fuel line can be a fire hazard. a. If fuel comes out, install pipe plug. Refer to controller failure b. If fuel does not come out, manually override fuel shut-off solenoid by turning manual knob fully clockwise. 1. If fuel now comes out, replace fuel shut-off solenoid. 2. If fuel still does not squirt out, turn the manual override knob counterclockwise until it stops. Now check fuel supply lines, valves and fuel filters for blockage.

TROUBLESHOOTING
REMOTE MOUNTED CONTROLLER

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
II. Engine cranks but will not start or runs below idle speed.	Controller failure.	With permissive start switch on the engine instrument panel in the "run" position, measure the DC voltage between terminals #4 (positive) and terminal #2 on the controller. This voltage should be 1.5 volts less than battery voltage. If voltage is less than 20 VDC when batteries are fully charged.	Replace controller.
III. Engine operates above required no-load governed speed. Speed may be controlled by the mechanical governor internal to the P.T. fuel pump or engine may over-speed on startup.	No DC Power.	Measure battery voltage at the controller terminal #1(positive) and terminal #2. This should be same as battery voltage.	1)Check wiring and connections. 2)If battery's voltage is low, charge battery.
	No voltage or low voltage from magnetic pickup.	Measure the AC voltage between terminals #5 and #6 at the controller while cranking engine. Meter must read 1.5 volts or greater. (AC input impedance of meter must be 5000 ohm/volt or greater.)	1)Check wiring between controller and magnetic pickup adapter for continuity. 2)Check for correct installation of magnetic pickup. (See installation procedure.) 3)Inspect tip of magnetic pickup for any damage or metal chips that have accumulated. 4)Replace magnetic pickup.
	Controller failure.	Disconnect actuator leads from the controller terminals #3 and #4 and connect to terminals #1 and #2. The actuator will close off fuel flow and prevent engine from being started. If so-	Replace controller.

TROUBLESHOOTING
REMOTE MOUNTED CONTROLLER

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
III.		If engine starts and operates above no-load governed speed or overspeeds on startup.	Check for battery voltage at the two connectors on the actuator. If 24 V-DC is not available check wiring. If voltage is present remove actuator wires from controller terminals #1 and #2 and reconnect to terminals #3 and #4. Now refer to actuator failure.
	Actuator failure.	Disconnect actuator leads from the controller (terminals #3 and #4). Connect the actuator leads across battery voltage. Apply and remove the voltage to the actuator leads. A loud click should be heard as the actuator hits the internal stops. If no sound is heard -	Replace actuator.
IV.			
Engine has low power, will not pick up a load and has very rough performance.	Actuator return springs broken or missing.	Apply 24 V-DC to actuator. A loud click will be heard when the voltage is applied and removed.	Remove the actuator and install new return springs.

REMOTE MOUNTED CONTROLLER
RESISTANCE TEST OF SPEED CONTROLLER

Stated readings are approximate and can vary as much as +- 25% from the tabulated values. The impedance of the ohmmeter must be 20,000 ohm/volt or greater.

CAUTION: The controller must be completely disconnected before taking any resistance measurements.

Plus Meter Lead at Terminal #	Minus Meter Lead at Terminal #	Resistance in Ohm (+-25%)
1	2	4,500
2	1	Infinite
3	2	2,600
4	2	5,000
5	2	Infinite
6	2	0
7	2	0
8	2	2,000
9	2	3,000

RESISTANCE TEST OF ACTUATOR COIL

With the actuator leads disconnected, the coil resistance at 70 F. [21 C] must be 7.2 ohm +- 15%.

TROUBLESHOOTING

PLUG-IN CONTROLLER (ENGINE MOUNTED)

1. CAUTION

1. The controller must remain plugged into the printed circuit board in the instrument panel.

2. All of the measurements must be made at the terminal blocks on the printed circuit board (see Figure 5).

DO NOT TAKE MEASUREMENTS AT THE PIN

CONNECTORS ON THE CONTROLLER.

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
I. Engine Cranks but won't start	Fuel not available to engine.	1)Is 24 V-DC available at fuel solenoid? If not -	1)Check power on switch. 2)Reset circuit Breaker. 3)Reset overspeed stop switch. 4)Check safety controls. 5)Check wiring.
		2)24 V-DC is available but fuel not getting to injector rail.	1)Remove pipe plug at the fuel shut-off valve. Install a hose and drain into a container. Crank engine with permissive start switch on. CAUTION: Be careful when cranking engine. An open fuel line can be a fire hazard. a. If fuel comes out, install pipe plug. Refer to controller failure. b. If fuel does not come out, manually override fuel shut-off solenoid by turning manual knob fully clockwise.

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
I. (Cont'd.)			1. If fuel now comes out, replace fuel shut-off solenoid. 2. If fuel still does not come out, turn the manual override knob counterclockwise until it stops. Now check fuel supply lines, valves and fuel filters for blockage.
II. Engine cranks but will not start or runs below idle speed.	Controller failure.	With permissive start switch on the engine instrument panel in the "run" position, measure the DC voltage between terminals #22 (positive) and terminal #12 on the controller. This voltage should be 1.5 volts less than battery voltage. If voltage is less than 20 V-DC when batteries are fully charged.	Replace controller.
III. Engine operates above required no-load governed speed. Speed may be controlled by the mechanical governor internal to the P.T. fuel pump or engine may overspeed on start-up.	No DC Power.	Measure battery voltage at the controller terminal #4 (positive) and terminal #12. This should be same as battary voltage.	1) Check wiring and connections. 2) If battery's voltage is low, charge battery.

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
III. (Cont'd.)	No voltage or low voltage from magnetic pickup.	Measure the AC voltage between terminals #14 and #13 at the controller while cranking engine. Meter must read 1.5 volts or greater. (AC input impedance of meter must be 5000 ohm/volt or greater).	1)Measure wiring between controller and magnetic pickup adapter for continuity. 2)Check for correct installation of magnetic pickup. (See installation procedure). 3)Inspect tip of magnetic pickup for any damage or metal chips that have accumulated. 4)Replace magnetic pickup.
	Controller failure.	Disconnect actuator leads from the controller terminals #22 and #23 and connect to terminals #12 and #4. The actuator will close off fuel flow and prevent engine from being started. If so-	Replace controller.
		If engine starts and operates above no-load governed speed or overspeeds on start-up.	Check for battery voltage at the two connectors on the actuator. If 24 V-DC is not available, check wiring. If voltage is present, remove actuator wires from controller terminals #22 and #23 and reconnect to terminals #12 and #4. Now refer to actuator failure.
	Actuator failure.	Disconnect actuator leads from the controller (terminals #22 and #23). Connect the actuator leads across battery voltage. Apply and remove the voltage to the actuator leads.	Replace actuator.

FAILURE	POSSIBLE CAUSE	INVESTIGATION	ACTION
III. (Cont'd.)		A loud click should be heard as the actuator hits the internal stops. If no sound is heard -	Replace actuator.

PLUG-IN CONTROLLER
RESISTANCE TEST OF SPEED CONTROLLER

The stated readings are approximate and can vary as much as +-25% from the tabulated values. The impedance of the ohm meter must be 20,000 ohm/volt or greater.

CAUTION: Unplug the controller from the printed circuit board before taking any measurements.

Plug Meter Lead at Terminal #	Minus Meter Lead at Terminal #	Resistance in Ohms (+-25%)
G	F	4,500
F	G	Infinite
B	F	4,500
C	F	2,500
D	F	Infinite
E	F	0
H	F	0
J	F	3,000
K	F	2,000
M	F	1,200
N	F	9,500

RESISTANCE TEST OF ACTUATOR COIL

With the actuator leads disconnected, the coil resistance at 70 F. [21 C] must be 7.2 ohm +-15%.