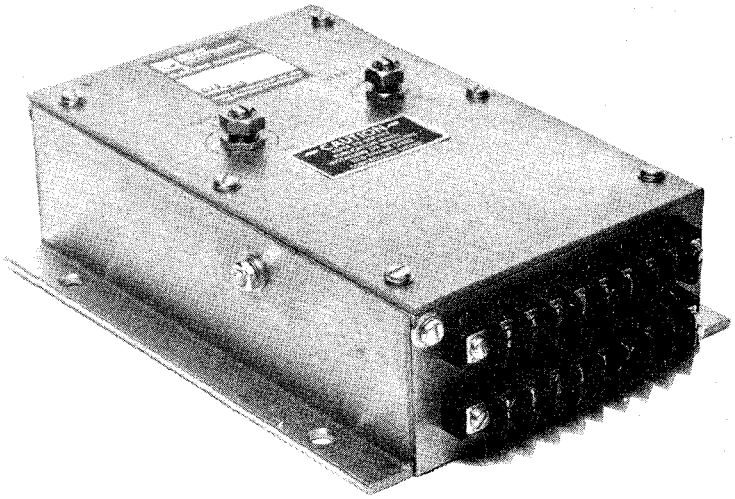
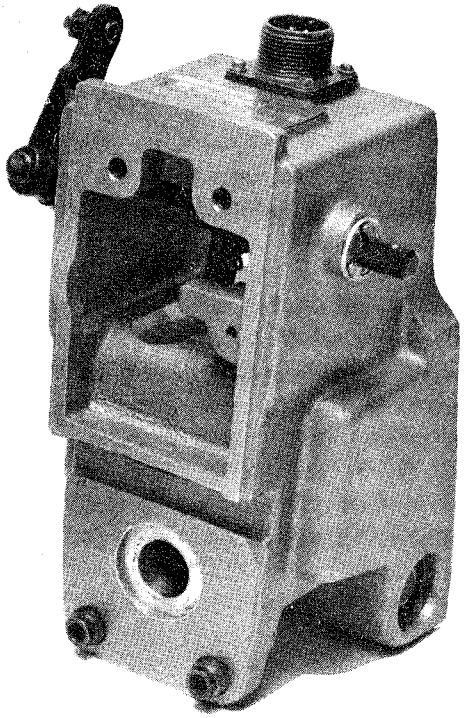
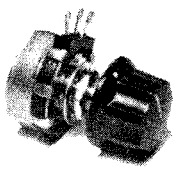
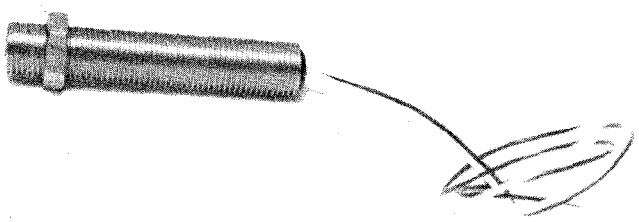
EGB-RR-250
FOR ROLLS-ROYCE C & CV RANGE DIESEL ENGINES









SYSTEM INTRODUCTION

This publication will provide information pertaining to the application of the United Technologies engine governing system incorporating the AGB 250 integral actuator.

Any information associated with this system, but not included in this publication can be obtained by contacting the United Technologies Diesel Systems Engine Governing System, 3664 Main St., Springfield, Massachusetts 01107, Tel. No. 413/781-2200 - Telex No. 955419. For information about engine applications or the supply of conversion parts refer to Rolls-Royce Motors Diesel Div., Shrewsbury, England, Tel. No. 0743 52262.

The United Technologies EGB-RR-250 Engine Governing Systems are designed to provide precise engine speed control for Rolls Royce engine applications using the Robert Bosch in-line PEP fuel injection pump. Engine speed is precisely maintained at any selected set point and transients due to load changes are minimized. The significant feature of this engine governing system is the unique integral actuator which eliminates use of external fuel system control linkage and engine actuator brackets. The actuator is electrically operated so it requires no engine drive nor hydraulic input. It is designed to have no sliding parts or gears and typically outlasts the life of the engine. The system provides the utmost in performance because the fuel injection pump rack is directly connected to the electric actuator thus minimizing delays to insure fast response.

The difference between the EGB-RR-250C and the EGB-RR-250D is the speed control unit. The CU 673C-10 has excellent performance and a wide range of accessories, while the ECD 67-2110, has low cost and good performance and is ideal for single running sets.

The basic **EGB-RR-250C** engine governing system consists of the following components:

UTDS Part No.	**RR Description**	
CU 673C-10	OD 19150	Speed Control Unit
AGB 250	OD 19148	Integral Actuator
MP 675	OD 18571	Magnetic Speed Sensor
CU 6710A	OD 18999	Speed Trim
EC 1249-2	OD 19076	Electric Conn.

Various accessories can be utilized with the EGB-RR-250C engine governing system. Available governor system accessories are: speed trim controls, speed droop controls, speed ramp modules, idle-run modules, load anticipation modules, automatic synchronizers and various non-precise and precise load sharing modules.

The EGB-RR-250D engine governing system includes all the components of EGB-RR-250C with the exception of CU 673C-10 speed control unit. Instead the ECD 67-2110 (R.R. Part No. OD 19151) takes its place.

Both basic systems maintain engine speed by utilizing speed information supplied by the magnetic speed sensor. The speed information is then compared to the desired set speed by the speed control unit. An adjustment to the fuel system is performed by the integral actuator to the degree which is calculated by the speed control unit. Under isochronous operation, the engine speed set point will be maintained regardless of engine load within the engine load carrying capabilities.

SPEED CONTROL UNIT (CU 673C-10)

The speed control unit contains all solid state electronic circuits which sense speed from a magnetic speed sensor or other suitable signal source. A controlled output current is provided by the speed control unit to a proportional electric actuator for throttle control. The performance is isochronous.

Three integral adjustments are provided to achieve the desired performance. A "Frequency Adjust" which can adjust the speed control range by 30:1 and "Gain" control to increase or decrease governor response sensitivity and a "Stability" control to match the time constant of the governor to that of the engine. All adjustments are accessible from the top of the speed control unit (see Figure 1).

SPEED CONTROL UNIT (ECD 67-2110)

This speed control unit contains all solid state electronic circuits which sense speed from a magnetic speed sensor or other suitable signal source and, in turn, provides a controlled output current to a proportional electric actuator for throttle control.

The performance of the speed control unit is isochronous. A 6:1 speed range is adjustable via a 22-turn speed adjust control. A gain control to adjust its response and a stability control to match the time constant of the engine governing system to the engine are adjustable through the top cover. A speed anticipation circuit is provided to minimize overshooting of speed on engine start-up or from lug-down. Output transistor protection is added to protect against accidental shorts to the terminals of the speed control unit or actuator. Reverse voltage polarity protection is provided by a diode network addressing the battery input terminals. Wide tolerances of input signals and DC supply voltages are also featured. If the input signal from the magnetic speed sensor is lost for any reason, the speed control unit will sense this and shutdown the system.

ACTUATOR (AGB 250)

The actuator is a linear electro-magnetic throttle positioning device which is integral to all Robert Bosch (RB) PEP fuel injection pumps. It may also be utilized on other types of in-line fuel injection pumps with the use of an interface plate. It positions the engine fuel throttle according to the amount of current flowing from the speed control unit through the actuator. An external fuel shutoff lever is available to achieve emergency engine shutdown. The complete family of speed control units is suitable for use with the AGB 250 series actuator and will provide other governor system fail-safe features.

The significant features of an engine governing system utilizing the integral actuator are the elimination of external fuel system control linkage and engine actuator brackets. The actuator requires no engine drive for hydraulic input. It is designed to have no sliding parts or gears, requires no maintenance and typically outlasts the life of the engine. The system provides the utmost in performance because the fuel injection pump rack is directly connected to the actuator, thus minimizing delays and insuring fast response. It is completely self-contained except for the wires connecting it to the speed control unit.

MAGNETIC SPEED SENSOR

The magnetic speed sensor responds to the number of ring gear teeth, or other types of ferrous projections, which pass the tip of the speed sensor, by inducing an electrical pulse within the coil. The pulses are then sent into the speed control unit. In effect, the magnetic speed sensor signals the number of teeth per second which pass the tip. This signal is directly proportional to engine speed.

SPEED TRIM CONTROL (CU 6710A)

The external speed trim control is normally mounted on the engine control panel and is used to make small adjustments in the engine speed which, in turn, gives proportional adjustments in generator output frequency.

The range of the speed trim control is ± 200 Hz. (The number of teeth per second passing the tip of the magnetic speed sensor). A trim range of $\pm 5\%$ would be obtained for a 60 Hz generator with an engine ring gear of 132 teeth, resulting in an RPM range of 1800 $\pm$ 90 RPM's and generator output frequency of 60 Hz $\pm$ 3 Hz.

SPECIFICATIONS

CU 673C SERIES SPEED CONTROL UNIT PERFORMANCE CHARACTERISTICS

- Isochronous ..... ±0.25% regulation or better
- Droop ..... 0-5% regulation
- Steady-state Stability ..... ±0.25% or better
- Frequency Range ..... 300-10K Hz continuous
- Speed Drift With Temperature ..... ±1% maximum
- Speed Trim Range ..... ±200 Hz.

POWER INPUT

- Magnetic Speed Sensor Signal ..... 0.25-30 volts rms
- Supply ..... 11-40 VDC (transient and reverse voltage protected)
- Polarity ..... Negative Ground (Case isolated)
- Power Consumption ..... 60mA (continuous) plus actuator current

ENVIRONMENTAL

- Temperature Range ..... −55° to + 85°C (−65° to + 185°F)
- Relative Humidity ..... up to 100%
- Case ..... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions ..... See Figure 1
- Weight ..... 1.13 kgs (2.5 lbs)
- Mounting ..... Any position (See Installation Page 10)

RELIABILITY

- Tested 100%
- Vibration ..... All printed circuit boards are conformally coated on both sides

MATING CONNECTOR

- Actuator to Speed Control Unit ..... CB 6712A
- Magnetic Speed Sensor ..... CB 6713A

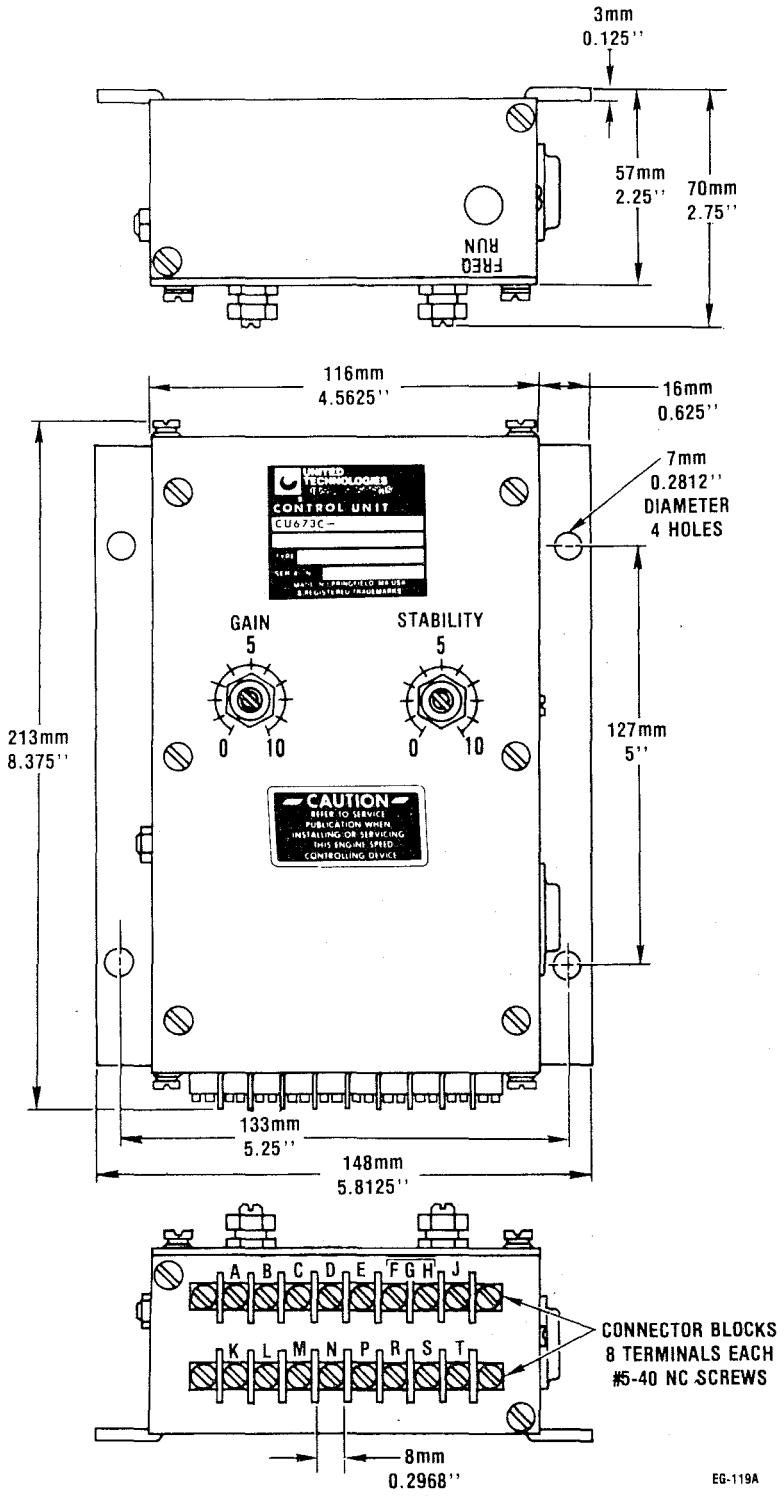


Figure 1. CU 673C speed control unit dimensions

SPECIFICATIONS

ECD 67-2110 PERFORMANCE CHARACTERISTICS

OPERATION

- Governing Mode ..... Isochronous or Droop, 5% maximum (optional)
- Steady State Stability ..... ± 0.25% or better
- Frequency Range ..... 1K to 6K Hz continuous
- Speed Drift With Temperature ..... ± 1% maximum
- Speed Trim Range ..... ± 200 Hz.

POWER INPUT

- Magnetic Speed Sensor Signal ..... 0.25-30 volts rms
- Supply ..... 10-30 VDC (transient and reverse voltage protected)
- Polarity ..... Negative Ground (Case isolated)
- Power Consumption ..... 60mA (continuous) plus actuator current
- Maximum Actuator Controllable Current at 25 °C (77 °F) ..... 10 Amperes

ENVIRONMENTAL

- Temperature Range ..... −40° to + 85 °C (−40° to + 180 °F)
- Relative Humidity ..... up to 100%
- Case ..... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions ..... See Figure 2
- Weight ..... 0.82 kgs (1.8 lbs)
- Mounting ..... Any position (See Installation Page 10)

RELIABILITY

- Tested 100%
- Vibration ..... All printed circuit boards are conformally coated on both sides

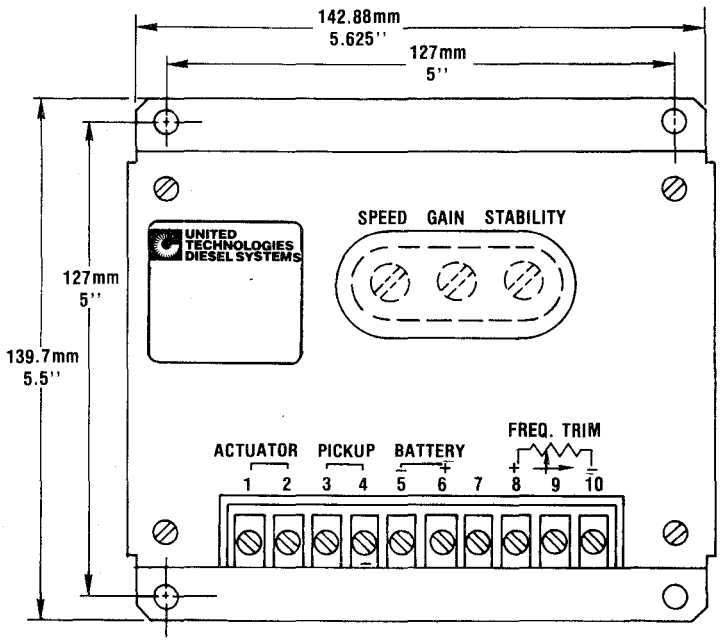


Figure 2. ECD 67-2000 series dimensions

SPECIFICATIONS

AGB-250 ACTUATOR PERFORMANCE

POWER INPUT

- Operating Voltage ..... 12, 24, or 32 VDC
- Normal Operating Current ..... 4A at 12 VDC
  2A at 24 or 32 VDC
- Maximum Current (Instantaneous) ..... 8A at 12 VDC
  4A at 24 or 32 VDC

ENVIRONMENTAL

- Temperature Range ..... −54° to + 93°C (−65° to + 200°F)
- Relative Humidity ..... up to 100%
- Case ..... Fungus proof and corrosion resistant

PHYSICAL

- Dimensions ..... See Figure 3
- Weight ..... 3.75 kgs (8.3 lbs)
- Mounting ..... Integrally mounted on the rear of the RB PEP fuel injection pump directly replacing the existing mechanical governor (See Installation Page 10)

RELIABILITY

- Tested 100%

MATING CONNECTOR

- Use ..... EC1249-2 (6 pins)
- For CU671C series speed control units use ..... EC1248-6 (17 pins)
- Wiring harness for CU671C (includes both connectors prewired) CB679
- For CU673C series speed control units use CB6711A

VARIATIONS

- AGB 250 A3 ..... With temperature probe and KT 6731
- AGB 250 A6 ..... Without temperature probe and without KT 6731

KITS

- KT 6729 ..... Required when pump mechanical governor is removed in the field
- KT 6731 ..... Actuator mounting kit, with fuel injection pump rack dust boot
- KT 6733 ..... Actuator mounting kit without fuel injection pump rack dust boot.

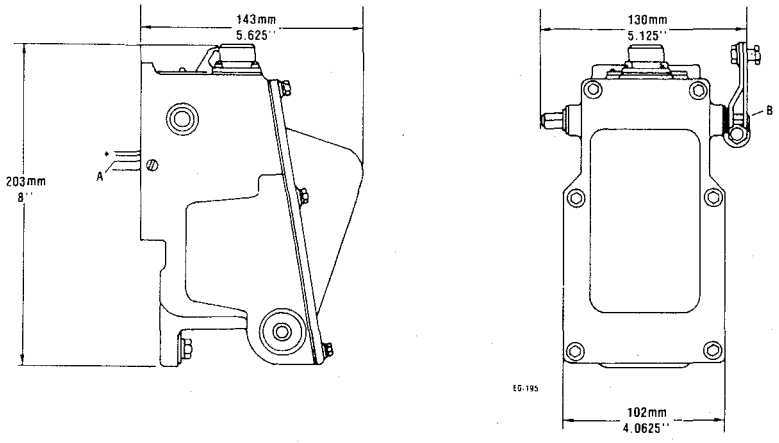


Figure 3. AGB 250 actuator dimensions

SPECIFICATIONS

MAGNETIC SPEED SENSOR

- Dimensions (Unshielded) ..... See Figure 4 and Table A
- Thread Size ..... 5/8 - 18 UNF-2A
- Tap Drill Size ..... 37/64"
- Proximity to Gear Teeth ..... 0.75mm (0.030 in.)
- Temperature Range ..... −55° to 105°C (− 65° to + 225°F)
- Output ..... 0.50 to 30 volts RMS is recommended to input to the speed control unit
- Resistance ..... 50 to 500 ohms

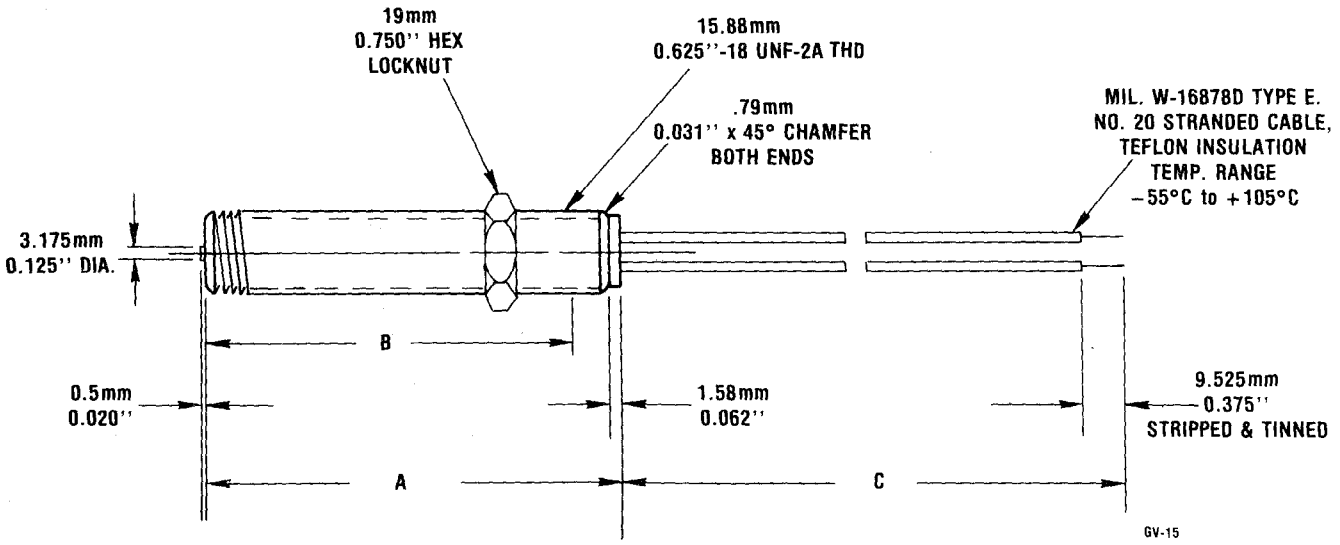


Figure 4. Unshielded magnetic speed sensor dimensions

CAT. NO.	DIMENSION A	DIMENSION B MAX. USABLE THREAD LENGTH	DIMENSION C WIRE LEAD LENGTH
MP 675	76mm 3 inches	67mm 2-5/8 inches	305mm 12 inches
MP 676	127mm 5 inches	118mm 4-5/8 inches	305mm 12 inches

Table A
Unshielded magnetic speed sensor dimensions

SPECIFICATIONS

CU 6710A SPEED TRIM CONTROL

PERFORMANCE

- Type ..... RV 4 per MIL-R-94, variable resistor, linear taper
- Rating ..... 5,000 ohms, 2.25 watts maximum
- Life ..... 100,000 cycles
- Rotation ..... 312° (single turn)

ENVIRONMENTAL

- Temperature Range ..... −55° to + 120° C (− 65° to + 250 °F)
- Construction ..... Dust, splash, and corrosion resistant

PHYSICAL

- Dimensions ..... See Figure 5

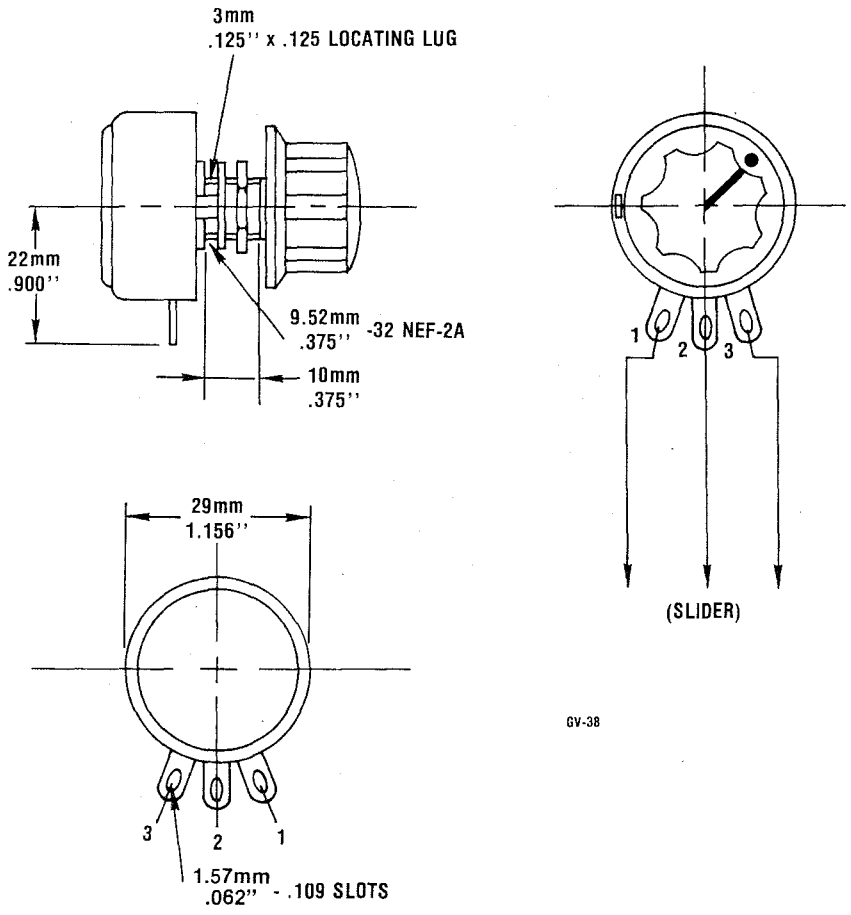


Figure 5. CU 6710A speed trim control dimensions

SYSTEM DESCRIPTION

SPEED CONTROL UNIT (CU 673C-10)

The speed control unit is designed to operate on 12, 24 or 32 VDC systems. For 12 volt operation, one jumper connection is added externally. For 12 volt operation, the speed control unit will operate from 11 to 18 volts. In the 24 - 32 volt connections, the speed control unit will operate from 13 to 40 volts. The speed control unit has sufficient current capacity to handle up to 30 amps.

The speed control unit compares the engine high frequency speed signal with the frequency of the reference oscillator signal. The speed control unit supplies the proper current to the electric actuator which, in turn, controls the engine power to minimize the difference between the frequency of the two signals. (See Section EG 50-1A).

CAUTION
ON "C" SERIES (– 10) UNITS
DO NOT
SHORT THE INSULATED NUT ON THE SIDE
OF THE CASE TO GROUND

The "C" series (– 10) can accept a momentary short from the speed control unit terminals "B" to "F" to force the actuator to the full fuel position. Measuring the voltage from terminals "B" to "D" indicates the voltage across the actuator.

SPEED CONTROL UNIT (ECD 67-2110)

The control circuits are designed to operate directly from a 12 or 24 VDC battery system. An internal 10 volt regulator supplies all DC power to the control circuits.

The engine speed signal is usually obtained from a magnetic speed sensor mounted in close proximity to the teeth of a ferrous gear that is driven by the engine. The frequency of the speed sensor signal is proportional to the engine speed. The flywheel ring gear is normally used because of the high frequency pickup signal. The speed control unit will accept any signal if the frequency is proportional to engine speed, and in the frequency range of the speed control unit (1K to 6K Hz). The signal strength must also be within the range of the input amplifier (0.25 volts rms to 30 volts rms for approximately sinusoidal signals). When a magnetic speed sensor is used it is connected to terminals "3" and "4". The speed control unit has an input impedance of 10,000 ohms between terminal "3" and terminal "4". Terminal "4" is connected inernally to the battery negative.

The significant differences between the CU 673C-10 type and the ECD 67-2110 are as follows:

CU 673C-10	ECD 67-2110
Advantages	**Advantages**
- Most precise and best performance. - Accepts all accessories.	Lower cost. Simple operation. Small size-suitable for single set operation where control accessories are not required.

ACTUATOR (AGB 250)

An AC frequency signal (proportional to speed) generated by the magnetic speed sensor is constantly fed into the speed control unit. The signal is compared with the present frequency (speed setting). If the frequencies are not identical, a change in current from the speed control unit changes the magnetic force in the actuator. The change causes an angular rotation of the actuator shaft and linear repositioning of the fuel injection pump racks.

Rack position is proportional to the amount of current flowing thru the actuator coils and is counter balanced by internal springs. A mechanical overide of the fuel rack is provided through the shaft. This shaft can be connected to an external electric or pneumatic solenoid or a manually operated shutdown device to move the fuel rack to the no-fuel position and hence shut down the engine. The actuator housing is sealed against engine environment with gaskets at all openings so steam or other water based cleaning will not affect the system's operation. **No maintenance is necessary.**

SYSTEM INSTALLATION

The speed control units are rugged enough for mounting in the control cabinet or engine mounted enclosure. Care should be taken to insure that the speed control unit is not subjected to extreme heat, as the life of electronic devices is always related to heat. If it is expectd that water or mist will come in contact with the speed control unit, mount it vertically so the condensation will not accumulated in the speed control unit.

Wiring to the speed control unit should be as shown in Figure 7 for CU 673C-10 and Figure 8 for ECD 67-2110.

SPEED CONTROL UNIT (CU 673C-10)

The leads from the battery to the speed control unit and from the speed control unit to the actuator should be #16 or larger. These are the leads that are connected to terminals B, C, D, E, and G of the speed control unit. All other leads may be any convenient size consistent with the mechanical integrity of the cable. Even though the maximum actuator currents exist for only short intervals, the wiring must be capable of handling this current or the transient performance of the governor will suffer.

Twist the leads from the magnetic speed sensor for their entire length. The speed sensor leads may need to be shielded if they are longer then 3 meters (10 ft.) or if external interference becomes a problem in governing. The shield is to be grounded **only** to terminal "T" of the speed control unit. Do not ground either of the speed sensor leads.

SPEED CONTROL UNIT (ECD 67-2110)

Leads to the battery and the actuator from the speed control unit should be #16 or larger. These are the leads that are connected to terminals 1, 2, 5, & 6 of the speed control unit. An external fuse or circuit breaker is recommended in series with terminal 5, the positive (+) battery input terminal. The magnetic speed sensor leads are twisted and/or shielded for their entire length. Connect leads to terminals 3 & 4. Connect the shield to terminal 4 **only**. Do not connect the shield at the magnetic speed sensor end. Actuator connections should be made according to the actuator publications.

MAGNETIC SPEED SENSOR

The speed sensor is mounted in the gear case or flywheel bell housing. The speed sensor can be screwed in (with the engine stopped) until the tip strikes the top of the gear tooth, then backed out ¾ of a turn and secure it by the locknut. The threaded hole should be relatively perpendicular to the centerline of the crankshaft and a spot face should be provided for a flat surface to anchor the locknut securely. Any ferrous gear may be used as long as the frequency and amplitude meet the speed control unit specification.

The wire leads from the speed sensor should be twisted for their entire length up to the speed control unit. The speed sensor leads may need to be shielded if they are exceptionally long 3 meters (10 ft.) or if external interference from spark ignited engines or external equipment is encountered.

Do not ground either of the speed sensor leads. Only the shielded wire is to be grounded to one specific terminal on the speed control unit. One of the speed sensor input terminals on the speed control unit is commonly connnected to ground and should be utilized for the shield connection. The shield should not be connected at the speed sensor end.

SPEED TRIM CONTROL (CU 6710A)

1. Drill the mounting holes at a convenient location and in accordance with Figure 6.
2. Solder any convenient size stranded copper wire to the control terminals.
3. Connect the leads to the appropriate speed control unit terminals in accordance with the wiring chart.

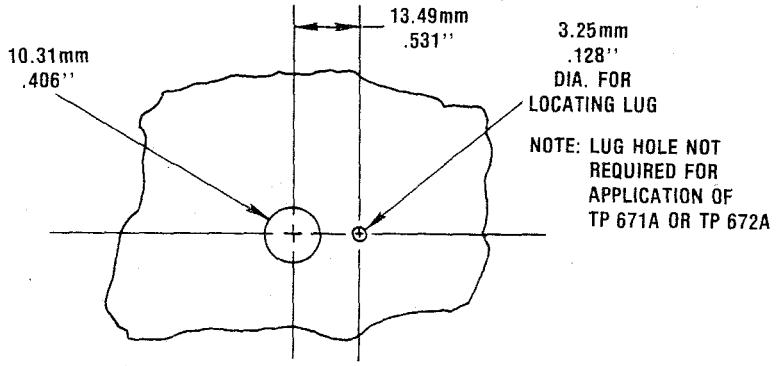


Figure 6. Speed trim control mounting holes

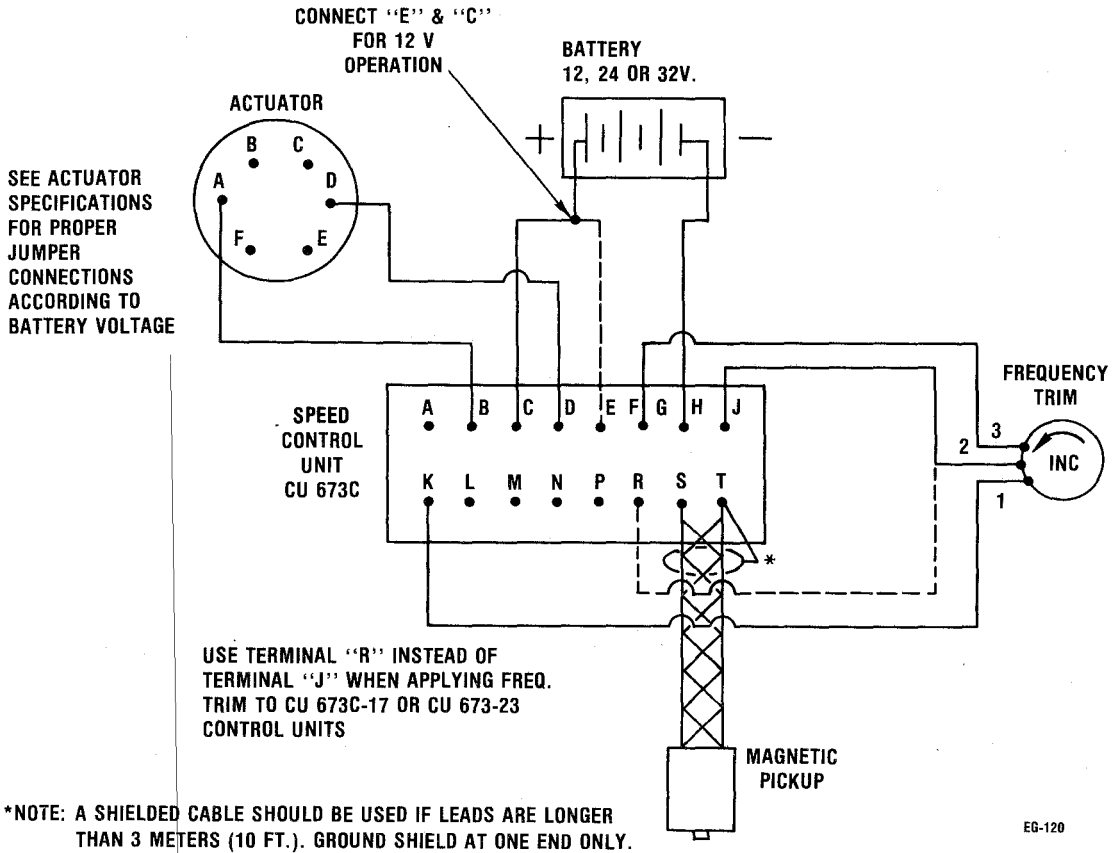
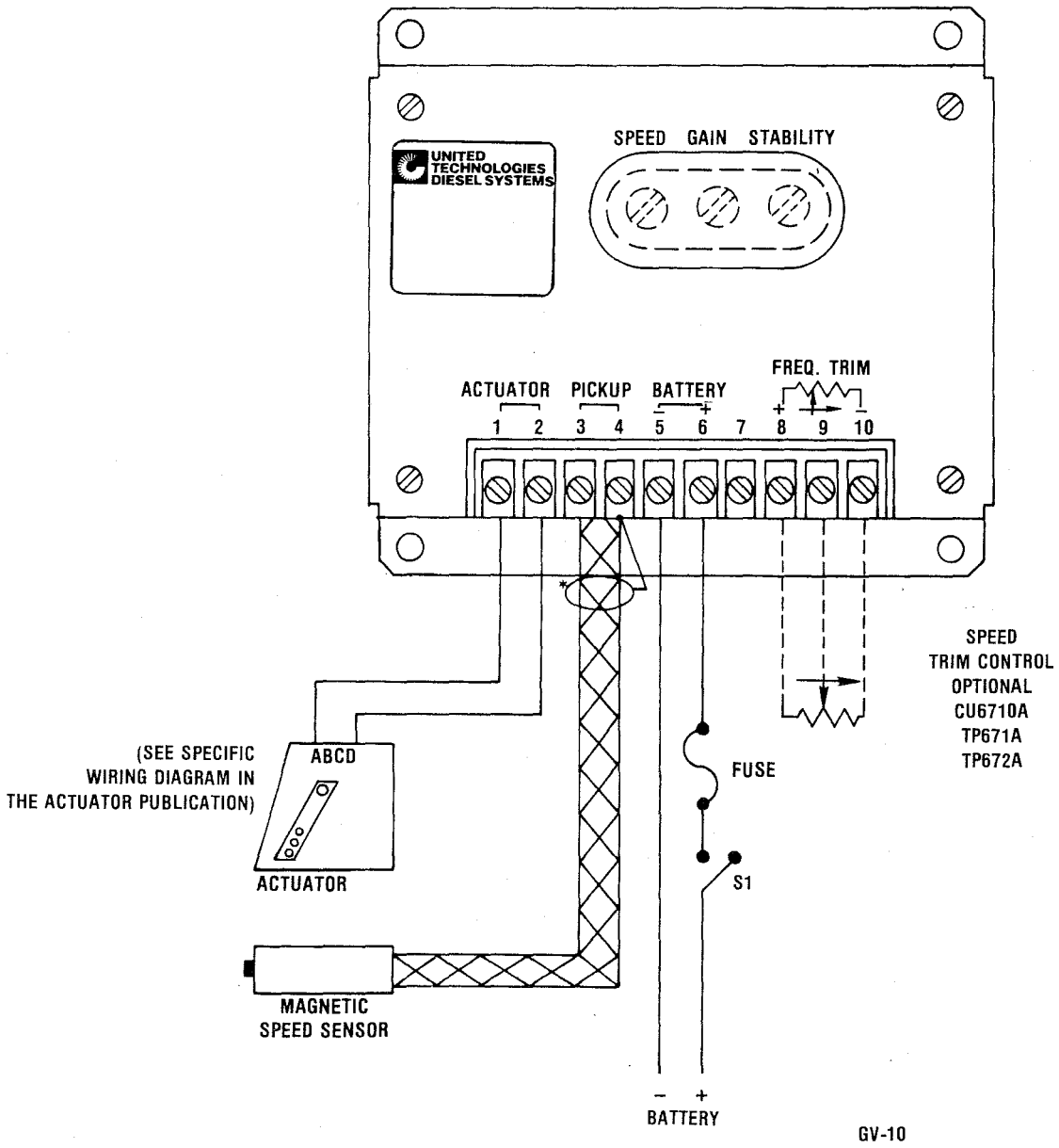


Figure 7. Wiring to CU 673C series speed control unit



*NOTE: A SHIELDED CABLE SHOULD BE USED IF LEADS ARE LONGER THAN 3 METERS (10 FT.). GROUND SHIELD AT ONE END ONLY.

Figure 8. Wiring to ECD 67-Series speed control unit

ACTUATOR (AGB 250)

The leads from the speed control unit to the actuator should be at least #18 for 24 volt and 32 volt and #16 wire for 12 volt operation. Large gauge wire is necessary for long wire lengths to compensate for current losses.

12 VOLT OPERATION

Connect the following actuator terminals together with jumpers at the mating half of the connector (see Figure 9).

1. A to C
2. B to D
3. A & D to their respective terminals at the speed control unit. (SEE TABLE B.)

24 VOLT OPERATION

Connect the following actuator terminals together with jumpers at the mating half of the connector (see Figure 10).

1. B to C
2. A & D to their respective terminals at the control unit. (SEE TABLE B.)

32 VOLT OPERATION

To use with 32 volt supply, wire the connector as for 24 volt operation but add a 1.5 ohm, 25 watt resistor or a 2 ohm, 50 watt adjustable resistor, set to 1.5 ohms. Then wire the resistor in series with terminal A of the actuator (see Figure 11).

SPEED CONTROL UNIT	ACTUATOR TERMINALS	
	A	D
CU 671C SERIES*	B	D
CU 673C SERIES	B	D
ECD 67-2000 SERIES	1	2

*NOTE: For droop operation, see Droop Control Literature EG 70-2.

Table B
Wiring chart for AGB 250 actuators

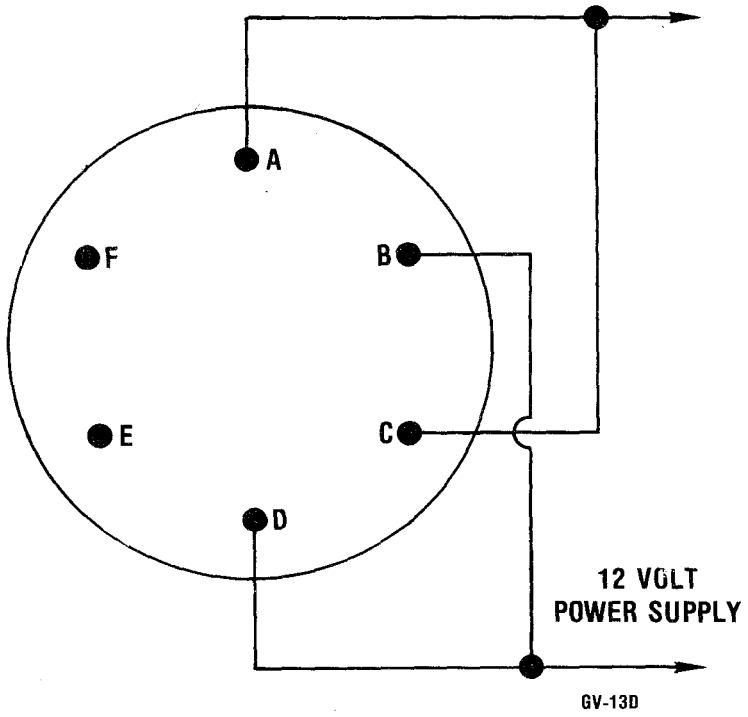


Figure 9. Wiring to AGB 250 actuator for 12 volt operation

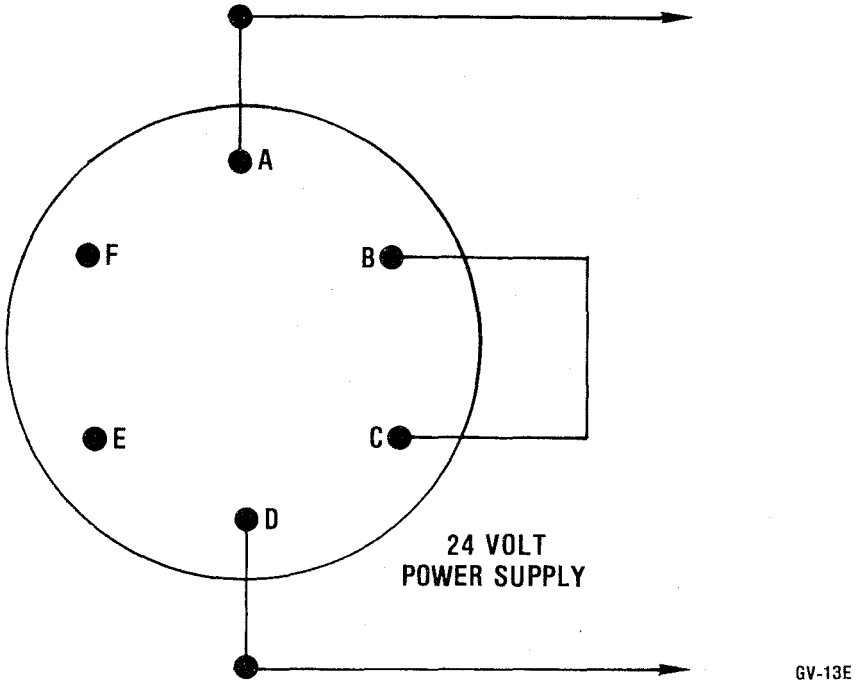


Figure 10. Wiring to AGB 250 actutor for 24 volt operation

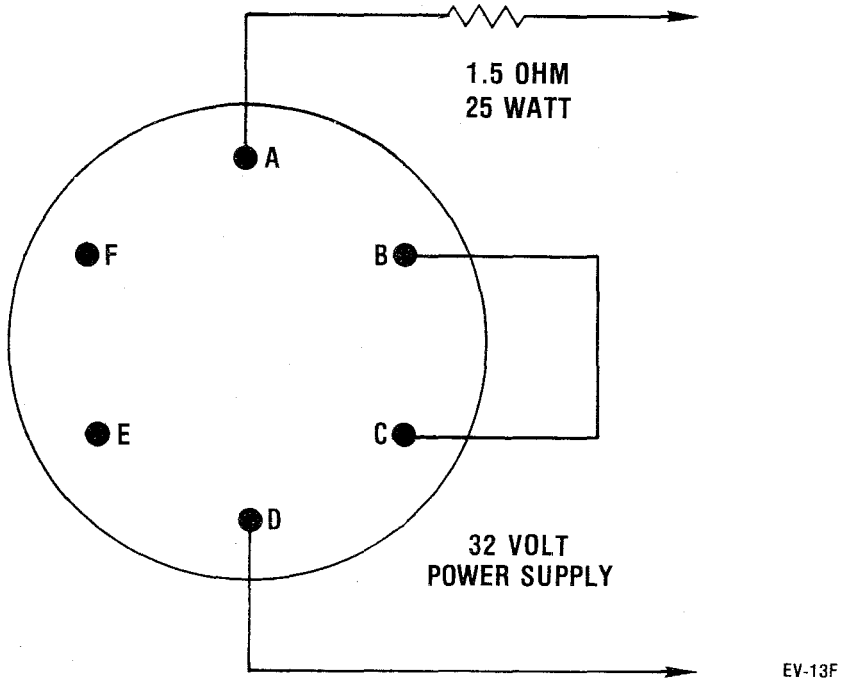


Figure 11. Wiring to AGB 250 actuator for 32 volt operation

CAUTION:
THE ENGINE SHOULD BE EQUIPPED WITH AN INDEPENDENT OVERSPEED SHUTDOWN MECHANISM TO PREVENT RUNAWAY WHICH CAN CAUSE EQUIPMENT DAMAGE OR PERSONNEL INJURY.

Integral Actuator Mounting Procedure (refer to Figure 12).

NOTE: If pump still has a mechanical governor attached consult RB agent or instructions in KT 6729.

1. Remove cover (Pos. 27), gasket (Pos. 28) and packing material from actuator housing. Retain the six screws and lock washers. Remove bottom two bolts and lock washers holding bearing retainer to pump.

2. Fasten bellows (Pos. 1) to pump rack ring using clamp (Pos. 2). Position locking screw horizontally as shown in diagram. Screw head to left.

3. Secure rack connector link (Pos. 3) to rack using two socket head screws and lock washers (Pos. 4 & 5).

4. Fasten bellows (Pos. 1) to rack connector link (Pos. 3) with clamp (Pos. 6). do no overlap edge of rack connector (Pos. 3) with bellows or clamp. Note position of locking screw as shown in diagram. Screw head to left.

5. Assemble "O" ring camshaft dust seal (Pos. 7) to housing using grease to hold "O" ring in place. Also apply a small amount of grease to the face of the internal stop lever (Pos. 22) as viewed from cover side.

6. Back off two spacer adjusting screws (Pos. 8) so spacers will not contact surface "S" when installed.

7. Mount actuator to pump using gasket (Pos. 9) with two socket head screws and lock washer (Pos. 10 and 11) and two hex head screws, lockwashers and flat washers (Pos. 12, 13 and 14).
   NOTE: Snug hex screws only -- **DO NOT** torque to requirement. Torque socket head screws (Pos. 10) to 7-9 Nm (9.5-12.25 lb. ft.).

8. Remove one hex head screw, lock washer and flat washer (Pos. 12, 13 and 14) and bring spacer adjusting screw (Pos. 8) with a screwdriver to just contact face "S" on pump cover. Re-insert hex head screw, lock washer and flat washer and snug tighten only.

9. Repeat Step 8 with other hex screw, lockwasher and flat washer (Pos. 12, 13 & 14). Torque hex screws to 7-9 Nm (9.5 - 12.25 lb. ft.).

10. Install spring (Pos. 15) and spring seat (Pos. 33) and L bracket (Pos. 16) fastening with shoulder screw (Pos. 17) and locknut (Pos. 18) to rack connector link (Pos. 3) and rod end bearing (Pos. 19). Torque to 4-5 Nm (5.5-6.75 lb. ft.).
    NOTE: Check that L bracket (Pos. 16) is free to slide along spring retaining pin (Pos. 20) with no binding when rack is manually moved to maximum fuel position. **THIS IS AN IMPORTANT TEST** - binding can cause loss of control resulting in engine damage.

11. A full fuel stop is available to limit the fuel rack's maximum travel. With the rack manually held in its maximum position toward the pump, turn adjusting screw CW (Pos. 21) until it contacts the inner stop lever (Pos. 22). Back off the adjusting screw approximately one full turn CCW. Further CW adjustment limits the maximum fuel level. After adjusting, lock screw with locking nut (Pos. 34). A low fuel stop is available to limit the fuel rack cutoff position if required. Adjust by turning screw (Pos. 25) located on the armature fuel rack linkage tab. After adjustment, lock screw with nut (Pos. 26). Torque to 2 Nm. (2.75 lb.ft.)

12. Adjust the actuator connecting link (Pos. 19, 23 & 24) so it is 52 to 54 mm long from hole center to hole center. Install the link between the rack connector link (Pos. 3) and the actuator using shoulder screw (Pos. 17) and locking nut (Pos. 18). Check to be sure rod end bearings are properly aligned to eliminate binding when the actuator moves and lock in this position using locking nut (Pos. 23)

13. The linkage may be further optimized after the complete governor system is installed and wired by temporarily inserting an ammeter is one of the wires between the speed control unit and the actuator or by measuring the voltage across the actuator. Measure the actuator current at no load and at full load or measure the voltage across the actuator with no load and full load. The current required for any governing condition indicates the actuator position to satisfy that condition. It is desirable to have an appreciable current difference (1.0 amp), indicating

actuator movement, no load to full load. Suggested current values are given below which will insure adequate current spread to insure stable governor operation. The current values correspond to 8° of actuator travel.

AGB 250 ACTUATOR

	12 Volt	24 Volt
No Load	2.5 amps, 4 volts	1.5 amps, 9 volts
Full Load	4 amps, 6 volts	2.5 amps, 15 volts

14. Assemble cover (Pos. 27) and gasket (Pos. 28) to actuator using two drilled hex head screws (Pos. 29) and lockwasher (Pos. 30) at cover top locations.
    NOTE: Drilled heads provide for lockwiring a seal to screws after actuator is assembled and adjusted. Complete cover assembly using four hex head screws (Pos. 31) and lock washers (Pos. 32). Torque all six screws to 4-5 Nm (5.5 - 6.75 lb-ft.).

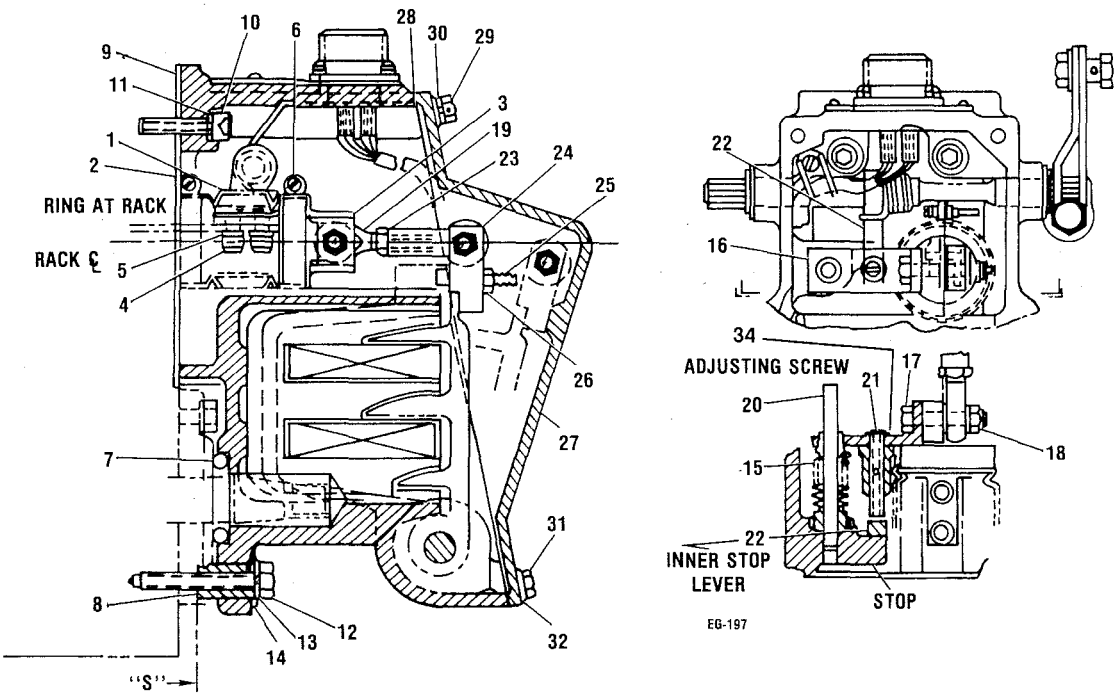


Figure 12. Actuator assembly parts location

ACTUATOR ASSEMBLY PARTS LIST

Pos.	U.T.D.S. Part No.	Qty.	Description
1	BW 674	1	BELLOWS
2 & 6	HP 675	2	CLAMP
3	LK 677	1	RACK CONNECTOR LINK
4	SC 2233-8M	2	SOCKET HEAD SCREWS
5	WA 2012-5M	2	LOCKWASHER
7	GA 1210	1	"O" RING
8	SR 6711	2	ADJUSTING SPACERS
9	GA 6771	1	ACTUATOR GASKET
10	SC 2224-25M	2	SOCKET HEAD SCREWS
11	WA 2012-6M	2	LOCKWASHER
12	SC 2212-40M	2	HEX HEAD SCREWS
13	WA 2010-6M	2	LOCKWASHER
14	WA 674	2	FLAT WASHER
15	SP 676	1	ACTUATOR SPRING
16 & 21	BK 6728 A	1	STOP "L" BRACKET
17	SC 672	2	SHOULDER SCREW
18	NT 1305-4M	2	LOCKING NUT
19	BG 673	1	ROD END BEARING
20	Applied at Factory		
22	Applied at Factory		
23	NT 4-5 CA	1	NUT
24	BG 672	1	ROD END BEARING
25	SC 2153	1	LOW FUEL STOP SCREW
26	NT 4-3 BL	1	LOCKING NUT
27	CV 6754	1	ACTUATOR COVER
28	GA 6710	1	COVER GASKET
29	SC 2216-16M	2	HEX HEAD SCREWS (drilled)
30 & 32	WA 2010-5M	6	LOCKWASHER
31	SC 2211-16M	4	HEX HEAD SCREWS
33	GU 672	1	SPRING SEAT
34	NT 4-5 ZN	1	LOCKING NUT

SYSTEM ADJUSTMENTS

CAUTION
DO NOT CONNECT THE SPEED CONTROL UNIT TO A BATTERY CHARGER

BENCH ADJUSTMENTS-REQUIRES TEST SET TSE 671C

All speed control units are factory set at approximately 1000 Hz. (usually 450-500 engine RPM's). If it is desired to reset the frequency of the speed control unit before it is installed on the engine, it can be done as follows:

1. Count the number of teeth on the gear to be used for the frequency signal. If the number of teeth cannot be easily ascertained, assume a number less than the probable actual number. this can be corrected when the engine is running.

Number of Gear Teeth and Frequency

Engine Type	Gear Teeth#	Frequency	
		1500 RPM	1800 RPM
C6	156	3900	4680
C8	175	4375	5250
CV8	175	4375	5250

2. Determine the required operating frequency from the formula:

$$\text{Frequency (hz)} = \frac{\text{Gear RPM x number of teeth}}{60}$$

3. Use United Technologies Test Set TSE 671C.

   a) Set the test stand control switches as per instructions in Section EG 100-1.

   b) Turn the selector switch on the test stand (position 11) to "frequency". The frequency setting will be indicated on the meter. If the frequency is other than as calculated per paragraph 2 above, insert a small screwdriver through the opening in the speed control unit rear cover marked "FREQ. ADJUST". Turn the control CW to increase frequency and CCW to reduce the frequency set point.

   c) Set the gain control at mid-range position and stability control at full CCW position.

   d) The speed control unit is now ready for installation on the engine. If the bench adjustment has been properly performed, governed engine speed will be close to the desired value. Final stability and gain adjustments must be made with the engine running because they involve the response characteristics on the individual engine. (See next section "On Engine Adjustments".)

4. If the United Technologies Test Set is not available, adjust the frequency as per instructions below.

ON ENGINE ADJUSTMENTS

CAUTION:
THE ENGINE SHOULD BE EQUIPPED WITH AN INDEPENDENT OVERSPEED SHUTDOWN MECHANISM TO PREVENT RUNAWAY WHICH CAN CAUSE EQUIPMENT DAMAGE OR PERSONNEL INJURY.

1. Speed Control Unit Frequency Adjustment

If the speed control unit fequency has been preset as in Bench Adjustment above, move on to Section 2. If bench type test equipment was not available, proceed as follows to adjust the speed control unit frequency on the engine.

a) Plan to overcome the actuator manually until adjustment is completed and the speed control unit is in control. Two people are usually required for this method.

b) Adjust the gain control to its approximate midrange position. The stability control should be adjusted to its extreme CCW position.

c) If the speed setting in unknown, turn the 22 turn frequency adjust control on the speed control unit CCW to obtain the lowest possible reference oscillator frequency. This will give the lowest possible engine governed speed. Start the engine, operating the throttle manually. Turn the frequency adjust control CW until the desired governed speed is obtained. If the engine is very unstable, it may be necessary to decrease the gain control (CCW) before the frequency adjustment can be completed.

2. Performance Adjustments

This speed control unit has the desirable characeristics of being quickly and easily adjusted to a good initial operating point as follows:

a) Check that the stability control is in its extreme CCW position.

b) Start engine. While observing normal precautions, allow the governor to control the engine. If the engine is unstable, turn the gain control CCW until stability is obtained. Adjust governor frequency control to the proper engine speed.

c) Turn the gain control CW until instability results. Then back-off slightly CCW (one major division) beyond the point where stability returns.

d) Turn the stability control CW until instability results. Then back-off slightly CCW (one major division) beyond the point where stability returns.

e) Excellent performance should result from these adjustments. Trimming of all adjustments, i.e. gain stability and frequency, can be made under various load conditions and load changes to get exactly the desired governing characteristics.

3. Final Trimming of the Governor

If a load bank and a recorder are available, use them to make traces per Figure 13.

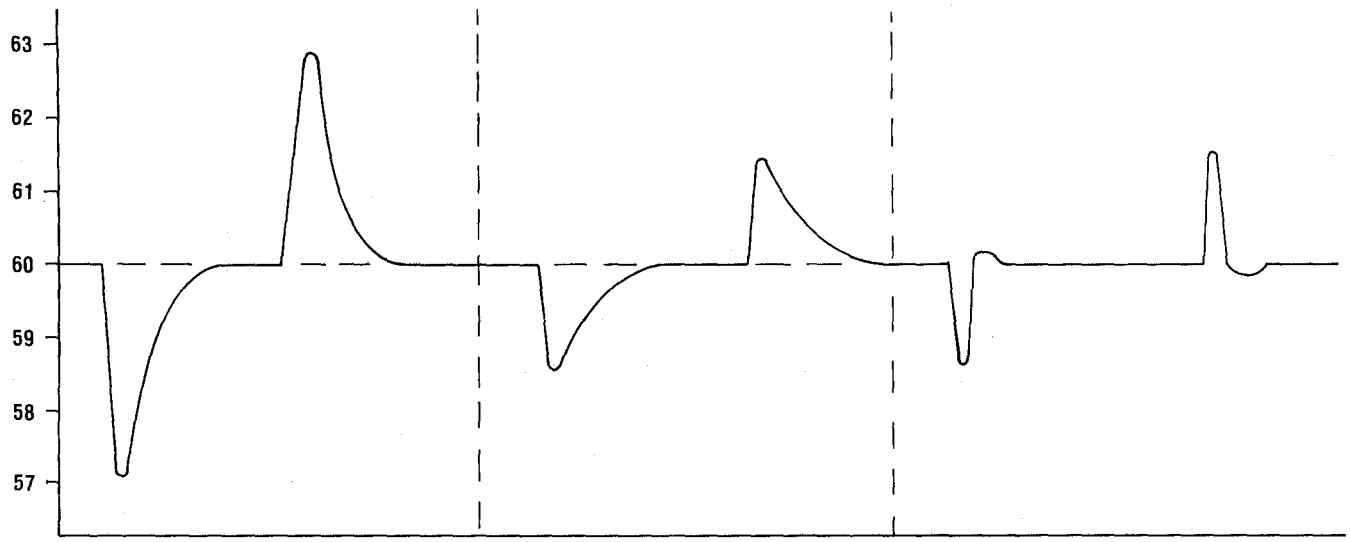


Figure 13. Typical performance chart

SPEED CONTROL UNIT (ECD 67-2110)

> CAUTION
> THE ENGINE SHOULD BE EQUIPPED WITH AN INDEPENDENT OVERSPEED SHUTDOWN MECHANISM TO PREVENT RUNAWAY WHICH CAN CAUSE EQUIPMENT DAMAGE OR PERSONNEL INJURY.

STARTING THE ENGINE INITIALLY

The speed control unit has been adjusted at the factory for starting conditions and will control the engine at approximately idle speed (1000 Hz. speed sensor signal). The following adjustments or checks should be made prior to starting the engine.

A. Pre-set the gain, stability, and if used, the external speed trim control to their mid-ponts.

B. Apply DC power to the engine governing system thru the wiring system by closing the switch S1. The actuator may momentarily move but should remain in the no fuel position.

C. MOMENTARILY connect terminal 1 to terminal 5. This should cause the actuator to snap into the maximum fuel position, If not, check for wiring defects or consult the "Trouble-shooting Section".

Crank the engine. During cranking, the actuator will move the fuel control to the maximum fuel position. Once started, the engine will be controlled at a low idle by the engine governing system.

GOVERNOR SPEED ADJUSTMENTS

Increase the engine speed to the desired governed speed by turning the "speed adjust" control in a CW direction. If used, final precise speed adjustment may be made with the external Speed Trim control. If at any time the engine governing system becomes unstable, turn the gain and stability controls CCW until the engine is stable.

PERFORMANCE ADJUSTMENTS

Once the engine is at governed speed, the two performance adjustments, gain and stability can be made as follows:

A. At no load, turn the gain control CW until instability results. Then back-off slightly CCW (1/8 turn) beyond the point where stability returns.

B. Turn the stability control CW until instability results. Then back-off slightly CCW (1/8 turn) beyond the point where stability returns. Excellent performance should result from these adjustments.

C. Load may now be applied to the engine. If necessary, repeat A and B above until optimum performance is obtained. Normally, the critical condition for gain and stability adjustment is at no load.

NOTE: Optimum adjustment of both controls is in the furthest CW position without causing instability, and will result in the best response and stability under all operating conditions. Backing off slightly from this position will allow for changing conditions that may affect the dynamic response of the engine. If a load bank and a recorder are available, use them to verify the performance using Figure 13 as a guide. If a stable system cannot be obtained, refer to the "Trouble-shooting Section.

The previous procedures should result in a high performance isochronous governed speed control system.

SPEED TRIM CONTROL (CU 6710A)

Set the external speed trim control to approximately the midrange position. When the engine has been started, and running at no load, turn the speed adjustment on the speed control unit until the approximate desired engine speed is attained. Make final engine speed adjustments by turning the external speed trim control CW to increase engine speed or CCW to decrease engine speed.

All minor speed corrections are made with the speed trim control, not with the speed control unit speed adjustment. If it is desirable to bring the speed trim control back to midrange, the speed control units speed adjustment can be turned to accomplish this.

SYSTEM TROUBLE SHOOTING

SPEED CONTROL UNIT (CU 673C-10)

If the governor does not operate, measuring, in sequence, voltage between the various speed control unit terminals and ground (Terminals F, G, H and T are ground) will indicate the possible fault. Should all 5 voltage tests indicate normal values, the defect must be in the actuator or in the wiring to the actuator. (See Section on Defective Actuators.)

TERMINALS	NORMAL VALUE	PROBABLE CAUSE OF NON-NORMAL READING
S	1.0 VAC - RMS minimum while cranking.	1. Defective magnetic speed sensor. 2. Gap too large between speed sensor and gear teeth. 3. Improper or defective wiring to the speed sensor.
K	10.1 ± 0.20 VDC while energized (Internal regulated DC supply)	1. DC power not connected or low battery voltage. 2. Speed trim control shorted, ground or miswired. 3. Wiring error. 4. Defective speed control unit.
L	Above 5.1 VDC while cranking. (Inverse speed error signal.) Above 5.1 volts is under speed signal. Below 5.1 volts is over speed signal. On speed will indicate a steady 5.1 volts.	1. Frequency adjust set too low. Turn CW. 2. Defective speed control unit.
N	8.5 to 9.5 VDC while cranking. (Proportional actuator voltage.)	1. Defective speed control unit. 2. Battery voltage may be too low while cranking.
B	2.5 VDC maximum while cranking. (Transistor voltage.)	1. Output transistor open (defective speed control unit). 2. Defective actuator. 3. Error in wiring to actuator.

ERRATIC OR UNSTABLE GOVERNING

A. INSUFFICIENT MAGNETIC PICKUP SIGNAL

Although the speed control unit will govern well on. 0.5 volts RMS signal if it is a clean sine wave, a signal from the magnetic speed sensor of 3 volts RMS at full speed will eliminate any possibility of missed or extra pulses. This signal is measured at terminals "S" and "T".

B. ELECTRICAL NOISE OR UNWANTED DROOP

If noisy electrical devices are present, such as magnetos, solid state ignition systems battery chargers or regulators which emit radio frequency interference (RFI), then unstable governing or droop may be noticed. The speed control unit has internal filters which provide some protection from radio frequency interference. Excessive levels of RFI must be treated separately. A metal shield placed around the emitting source will help. Placing the governor harness and speed control unit as far away as possible from the emitting source will help. Always twist the leads from the magnetic speed sensor all the way back to the speed control unit. Shield the speed sensor leads with the shielding connected to terminal "T" of the speed control unit **only**. Raise the magnetic speed sensor voltage by reducing the gap between the speed sensor and the ring gear. A gap of 0.030" will provide a strong signal. If noise is still present, a capacitor (1,000 mfd, 12 - 20 volts) may be connected across the speed trim control, terminal K + to terminal F −. This will reduce external interference coming from the power supply. When extreme RFI is encountered, it may be necessary to shield all the leads to the speed control unit. The shield should be grounded at terminal "G" of the speed control unit.

C. DEFECTIVE ACTUATOR

Should the coils of the actuator become open or shorted, replace the actuator. If the coils are not open or shorted, the wiring or connectors are defective.

D. LOW SPEED SURGING OR PERIODIC INSTABILITY

Each engine has certain response characteristics to which the governor must be adjusted to match. The increase or decrease of speed, as load on the engine changes, can be reduced to a minimum by proper adjustment of the gain control. Turning the gain control CW will shorten the amount of speed change. Too much gain adjustment will result in rapid throttle movement, which is instability. The amount of time which the engine needs to completely regain the set speed, after a load change, can be reduced to a minimum by turning the stability control CW. Excess CW adjustment will cause instability, usually in the form of a low frequency surge.

The governor system can be properly adjusted by the following procedure. Under no load conditions, turn the gain control CW until instability occurs. Then back off (CCW) until stability is restored. Next, turn the stability control CW until instability occurs. Then back off (CCW) until stability is restored. Once more, adjust the gain control as above. Apply various loads up to full load to insure that stability is fixed at all loads. If not, reset the gain and stability adjustments, as above, under whatever load condition indicates some instability.

If the gain control is nearly full CCW or the engine is unstable at any position of the gain and stability control, proceed as follows:

Note the frequency of instability. In the instance of slow speed surging of about 1-3 oscillations per second, modifying the speed control for added dead time compensation (derivitive) will improve performance and stabilize the system. Connect a jumper from terminals "M" to "H" (if serial number is less than 2R 6239, an external capacitor is required--see Service Letter EG-3 for details). Readjust the gain and stability as mentioned above. Some improvement must be noticed or the cause of instability lies elsewhere.

If the frequency of instability is very fast, such as 8-10 oscillations per second, then the dead time compensation can be reduced. Jumper "M" to "N". Readjust the gain and stability as above. For slight instability problems, place a 5.1 K ohm resistor from terminals M to N.

If the governor system allows for stable operation but speed overshoot is experienced because the gain control is almost fully CCW, a modification can be made to extend the gain control setting. Apply a 6.8K ohm resistor from terminal "L" to terminal "P". This will center the gain adjustment and improve its stability.

SPEED CONTROL UNIT (ECD 67-2110)

Governor is inoperative or throttle does not move measurements to be made with standard VOM.

STEP	TERMINALS	NORMAL MEASUREMENT	POSSIBLE CAUSES OF ABNORMAL MEASUREMENTS
1	3-4	0.5 volts rms minimum while cranking engine (AC measurement)	1. Gap too large between magnetic speed sensor and gear teeth. 2. Shorted or improper wiring to magnetic speed sensor 3. Defective magnetic speed sensor
2	5-6	Battery voltage (DC measurement 5 − and 6 +)	1. Improper wiring of battery circuit or fuse blown.
3	8-10	10 volts ± 0.5 V. from the internal supply (DC measurement 8 + and 10 −)	1. Inadequate battery voltage. 2. Short across trim control circuit. 3. Defective speed control unit.
4	5-7	4.5V., ±1V (control energized only(12.5V., ± 1V (while cranking engine DC measurement) (5 − and 7 +)	1. Magnetic speed sensor fail safe feature defective. 2. Defective speed control unit.
5	1-5	2 volts maximum but not less than 0.5V while cranking engine - voltage to transistor (DC measurement 1 + and 5 −)	1. Speed setting lower than cranking speed. 2. Output transistor defective. 3. Error in actuator wiring. 4. Actuator defective.

NOTE: If no measurements can be made as indicated in Steps 3, 4 and 5, the possible cause may be a damaged circuit board. Check continuity of terminals 2 and 6. If open, CORRECT BATTERY SUPPLY POLARITY CONNECTIONS and add an external jumper connection between terminals 2 and 6.

Erratic or Unstable Governing or Unwanted Droop

If noisy electrical devices are present, such as magnetos, solid state ignition systems, battery chargers or regulators which emit radio frequency interference (RFI), unstable governing or droop may be noticed. The speed control unit has internal filters which provide some protection from radio frequency interference. Excessive levels of RFI must be treated separately. A metal shield placed around the emitting source will help and/or placing the governor harness and speed control unit as far away as possible from the emitting source. Always twist the leads from the magnetic speed sensor all the way back to the speed control unit. Shield the speed sensor leads with the shielding connected to terminal "4" of the speed control unit **only.** Raise the magnetic speed sensor voltage by reducing the gap between the speed sensor and the ring gear. A gap of 0.020" will provide a strong signal. If noise is still present, a capacitor (1,000 mfd, 12-20 volts) may be connected across the speed trim control, terminal 8 + to terminal 10 −. This will reduce external interference coming from the power supply. When extreme RFI is encountered, it may be necessary to shield battery leads to the speed control unit. The shield should be grounded at terminal "5" of the speed control unit.

Periodic Instability (Extra Dead Time Compensation)

Each engine has certain response characteristics to which the engine governing system must be adjusted to match. The increase or decrease of speed, as load on the engine changes, can be reduced to a minimum by proper adjustment of the gain control. See performance adjustments, Page 20.

A capacitor, 10 mfd, 10 volt (polarized), may be connected from post C (−) to post D (+) to increase the dead time compensation. (See Figure 14.) Dead time is the time between power strokes plus fuel system delays which can cause slow periodic oscillations or instability when the dead time becomes excessive.

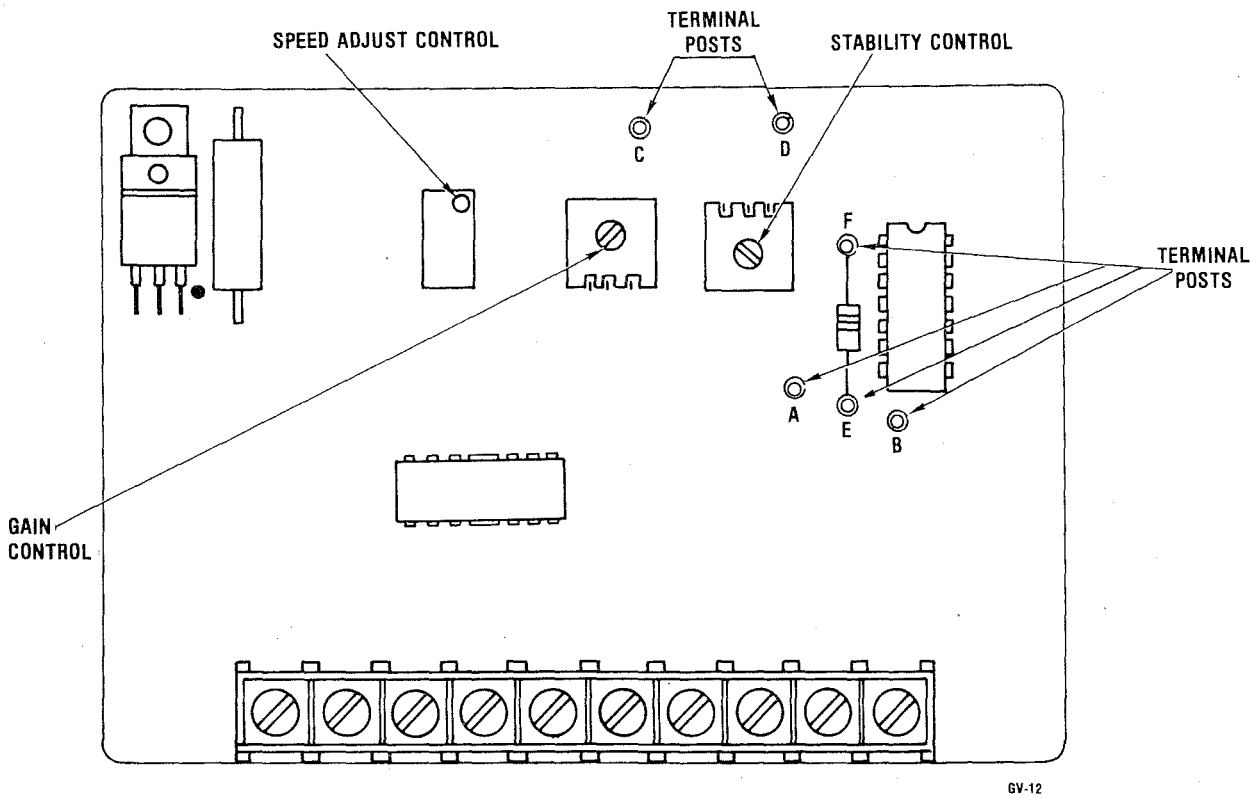


Figure 14. Controls and post locations

ACTUATOR (AGB 250)

SYMPTOM	TEST	PROBABLE TROUBLE
Engine overspeeds or throttle does not move	For CU 673C-10: Ground terminal B by shorting it to terminal F. For ECD 67-2110: Ground terminal 1 by shorting it to terminal 5. The rack should move to the full fuel position.	Actuator linkage bound or fuel shut off lever holding rack closed