ENGINE
GOVERNING SYSTEMS

AMBAC INTERNATIONAL

ECD 67-2110 and ECD 67-2112

SUPERSEDES ISSUE DATED DEC. 1984

Speed Control Unit

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INTRODUCTION

The ECD 67-2110 and -2112 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. The speed is adjustable via a 22-turn speed adjust control. The gain control adjusts the speed of response. The stability control is used to match the time constant of the engine governing system to the engine. A speed anticipation circuit is provided to minimize over-shooting 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 at the battery input terminals. A wide range of magnetic speed sensor and DC supply voltage amplitudes can be accepted. If the input signal from the magnetic speed sensor is lost, the speed control unit will sense this and shut down the system.

SPECIFICATIONS

OPERATION

—Governing Mode .... Isochronous
—Steady State Stability .... ± 0.25% or better
—Frequency Range .... 1K to 6K Hz continuous
—Speed Drift With Temperature .... ± 1% maximum
—Speed Trim Range — ECD 67-2110 .... ± 400 Hz.
—Speed Trim Range — ECD 67-2112 .... Full Frequency Range

POWER INPUT

—Magnetic Speed Sensor Signal .... 1.0-30 volts rms
—Supply .... 12-30 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 1
—Weight .... 0.48 kgs (1.1 lbs)
—Mounting .... Any position (See Installation Page 3)

RELIABILITY

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

ECD 67-2110

—Standard Unit .... Diesel and Carbureted Engines
Speed Trim Range ± 400 Hz.

ECD 67-2112

—Longer Dead Time Compensation .... Diesel and Carbureted Engines having longer dead time
—Remote Variable Speed .... Full Range Speed Adjustment

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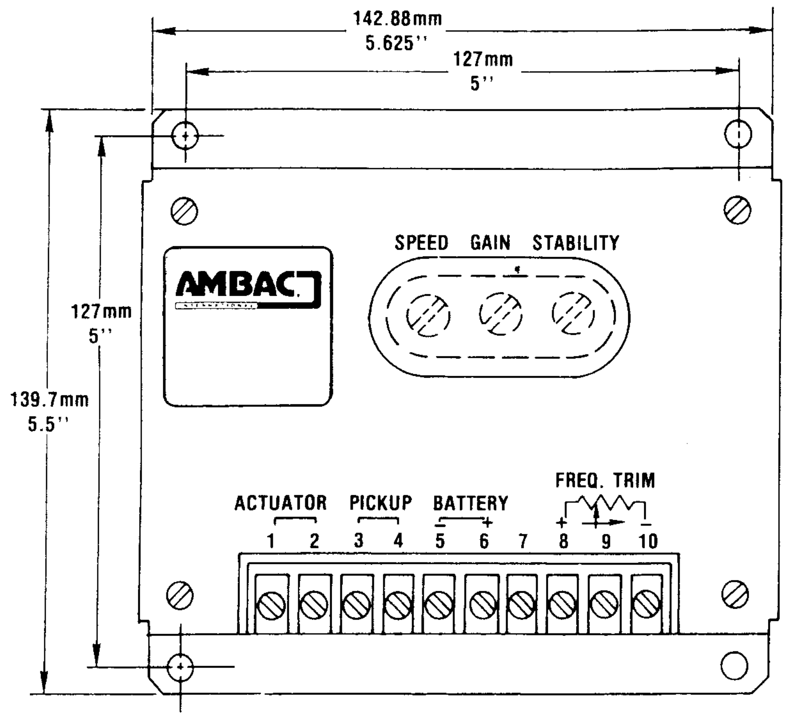


Figure 1. ECD 67-2110/2112 dimensions

DESCRIPTION

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 (1.0 volts rms to 30 volts rms for approximately sinusoidal signals). The magnetic speed sensor is connected to terminals "3" and "4", which have an input impedance of 20K-ohms. Terminal "4" is connected internally to the battery negative.

The speed sensor signal is amplified and shaped by the circuit to form constant width pulses. The average voltage of these pulses from the speed sensor amplifier section of the speed control unit is then fed into a summing circuit (see Figure 2). A speed sensor monitor circuit detects the pulses and, if the pulses disappear for longer than 0.1 second, the speed control unit will turn off the output circuit (current to actuator). This feature can be voided by connecting a jumper across posts A and B (see Figure 5 for post locations). In this way the governor will call for full fuel as soon as battery power is applied. During cranking the actuator will move to the full fuel position and remain there during starting and acceleration of the engine. The summing point of the speed sensor and the speed adjust control is the input to the dynamic control section of the speed control unit. A gain control is provided to adjust the speed control unit sensitivity. The gain is usually advanced (CW) as far as possible for best performance without instability. (See adjustment procedure Page 5).

The output actuator current switching circuit provides current to drive the actuator. The output transistor is alternately switched off and on at a frequency of 450 Hz., which is well beyond the natural frequency of the actuator, hence no visible motion from the switching results. The actuator responds to the average current to position the engine throttle. The output transistor is switched to reduce its internal power dissipation. The output of the circuit provides up to 10 amps at voltages up to 30 VDC. The output is suitable to drive the AGB, AGD and AGK actuators or a similar proportional electric actuator. A current monitor circuit will latch the output circuit off if actuator current exceeds 12 amps. To unlatch, turn DC supply voltage off.

An overshoot limiter circuit minimizes the overshoot of speed on start-up (typically less than 1.5%).

TYPE	VARIATION	APPLICATION
ECD 67-2110	Standard unit.	Diesel, turbocharged and carbureted engines. Narrow speed trim range (± 400 Hz.).
ECD 67-2112	Remote variable speed. Longer dead time compensation.	Full range remote speed adjustment. Engines with longer dead time.

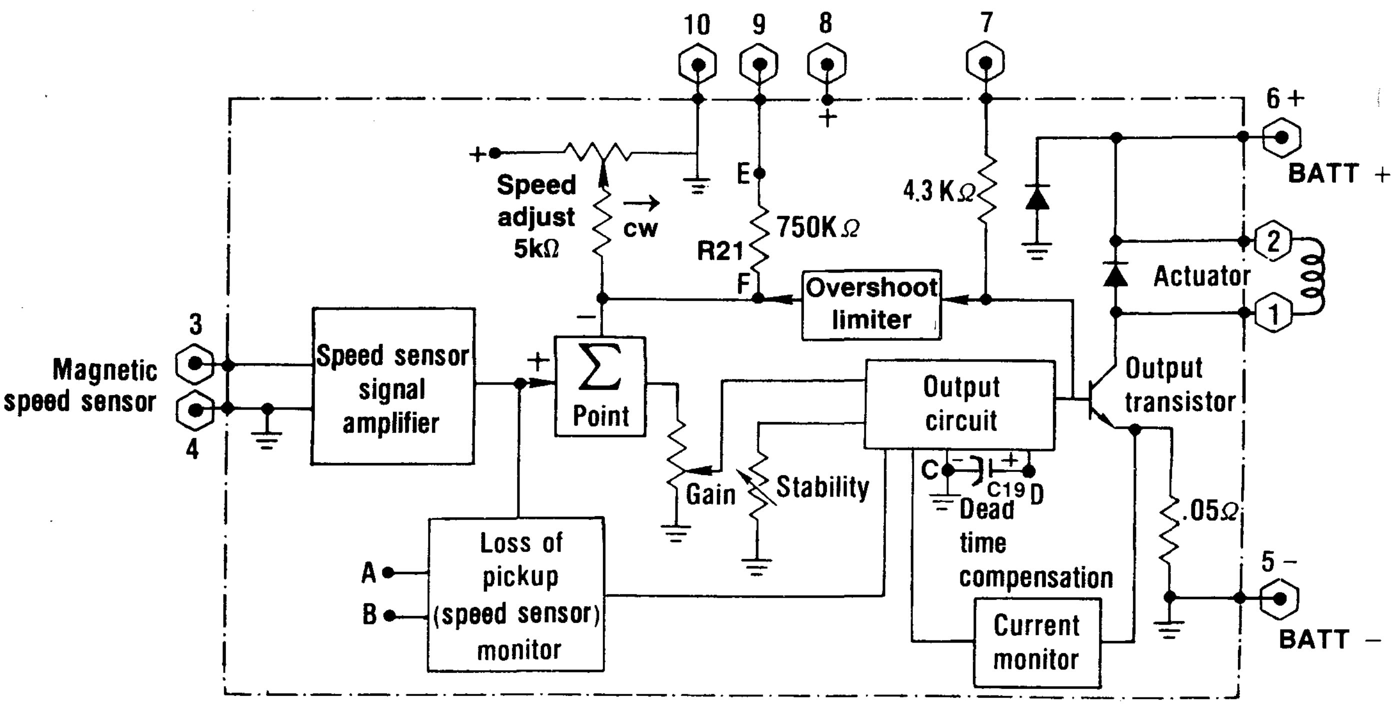
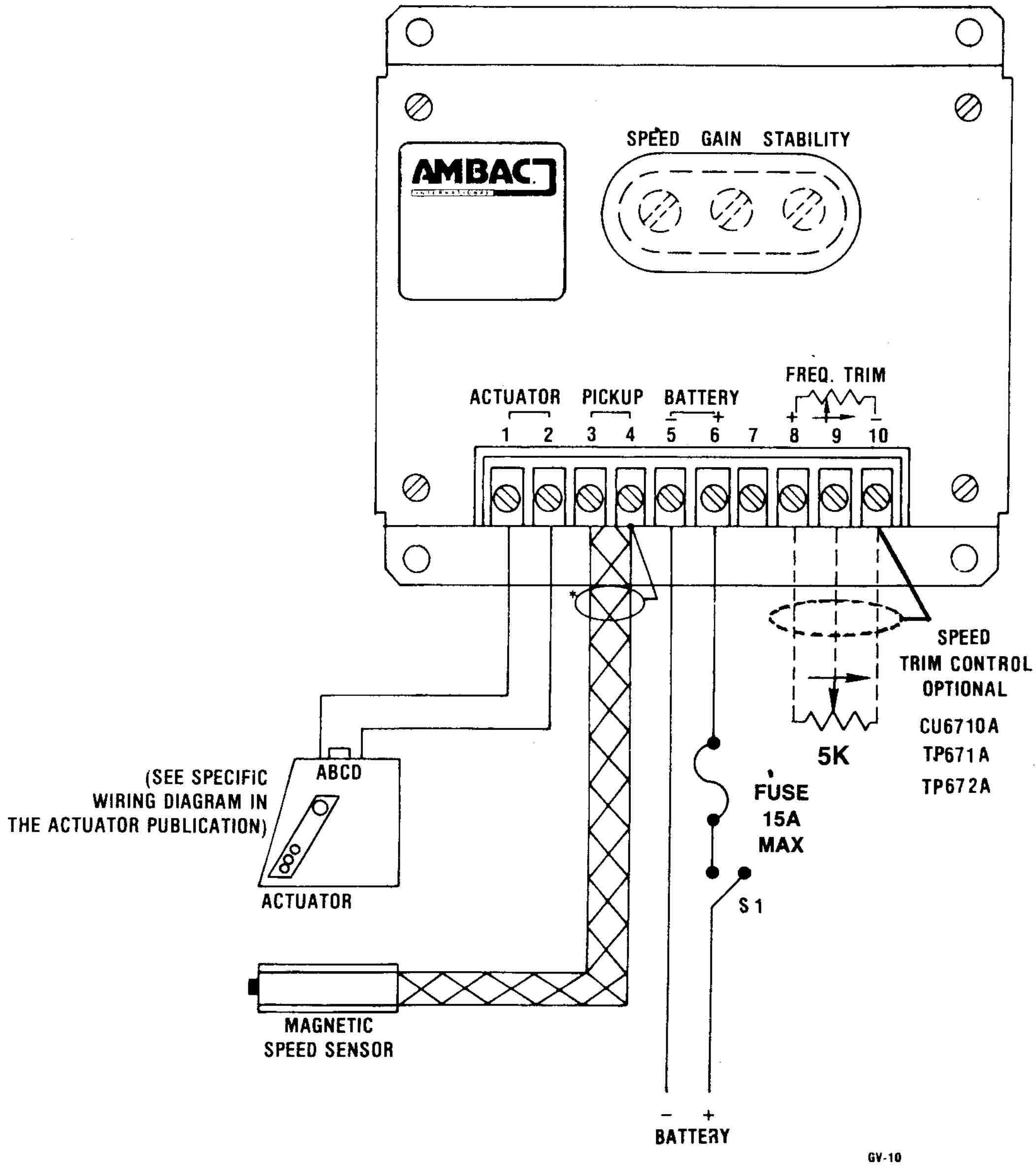


Figure 2. Functional schematic

INSTALLATION

The speed control unit is 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. If it is expected that water or mist will come in contact with the speed control unit, mount it vertically so that condensation will not accumulate in the speed control unit.

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, and 6 of the speed control unit. An external fuse or circuit breaker is recommended in series with terminal 6, the positive (+) battery input terminal. The magnetic speed sensor leads are twisted and/or shielded for their entire length and are connected to terminals 3 and 4. Connect the shield to terminal 4 **only.** Do not connect the shield at the magnetic speed sensor end. If a speed trim control is used, connect it using shielded wire. Connect the shield to terminal 10. Actuator connections should be made according to the actuator publications.



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

Figure 3. Wiring to ECD 67-2110/2112 speed control unit

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ADJUSTMENTS

> 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-points.

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 (Page 7).

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 results 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 4 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 RANGE

The speed trim range is controlled by R21 which is installed across posts E and F, and is 750 K-ohm on the ECD 67-2110 (39 K-ohm on ECD 67-2112). Reducing R21 increases trim range. To increase speed trim range on the ECD 67-2110, add a 43 K-ohm resistor across posts E and F. (See Figure 5).

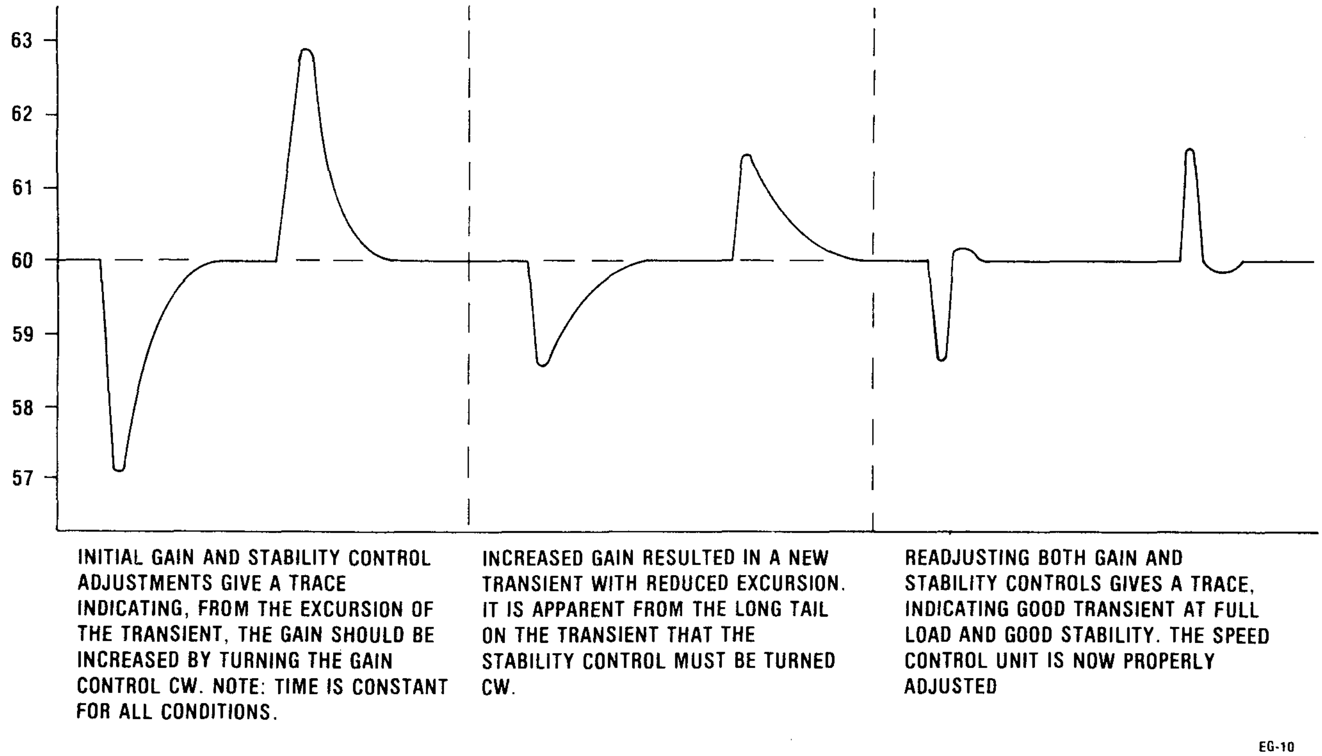

Figure 4. Typical performance chart

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TROUBLESHOOTING

Symptom: 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	1.0 volt 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	6-5	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	7-5	8.5 ± 2 VDC control, 12 ± 2 VDC while cranking.	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 1000 micro-Fd (12V) capacitor 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 5.

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. The amount of dead time compensation provided by the speed control unit is controlled by C19 which is parallel to posts

C and D, and is 22 micro-Fd on the ECD 67-2110 (150 micro-Fd on the ECD 67-2112). On the ECD 67-2110, a 22 micro-Fd (10V, polarized) capacitor may be connected from post C (−) to post D (+) to increase the dead time compensation. (See Figure 5).)

Another cause of instability is in the linkage arrangement. Any binding or high friction loads can cause instability. Use uniball joints in each end of the linkage rod. A maximum of 10 degrees misalignment of the linkage rod can be tolerated. Calculate the ratio of throttle motion to actuator motion and design the rod length and position on the throttle arm and actuator arm accordingly. The rod length should be such that the actuator is slightly off the stop when the throttle lever is in full shutoff position. Similarly, the rod length should be such that the actuator is slightly off the full travel stop when the throttle lever is in full fuel position. Before starting, make sure the linkage is free of any obstruction or binding. Manually push the actuator arm to full fuel position and release it. It must spring instantly to the shutoff position.

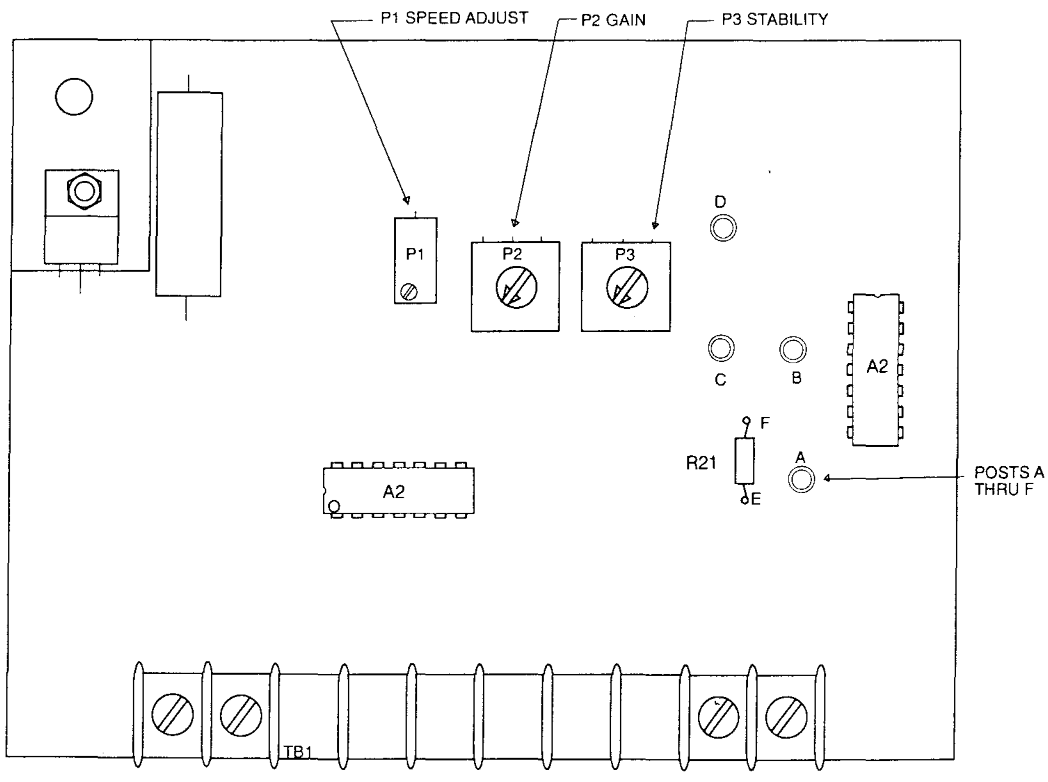

Figure 5. Controls and post locations