PG ENGINEERED CONTROL

ELECTRIC GOVERNOR INSTALLATION MANUAL

Replacing an Obsolete Barber Coleman® / Woodward® Speed Controller
With
Precision governors E-361 Controller

On Engines with a
Zenith® Carburetor and
Integral throttle Actuator.

Note the E-361 has a 2.25 amp current limit. If additional current is required for larger actuators, the E-361 can on request be factory modified to provide for 4.5 amps of current.

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GENERAL

The following information is intended as an aid to properly installing a Precision Governor Electric Governors E-361. Since these governors are used on a wide range of engines in many different applications, much of the information is somewhat general in nature. If you need assistance concerning a specific detail on your application, please consult Precision Governors Application Engineering at 815/229-5300.

These instructions presume no electrical test equipment other than a multimeter for making the electrical measurements called for on the following pages. If no meter is available, inexpensive but adequate meters, are available from many consumer electronics stores such as Radio Shack.

Many "governor problems" turn out to be installation problems, particularly in first-time applications. Careful attention to the directions provided will go far toward a successful installation made in the least amount of time.

This manual is intended for use when replacing a Barber Coleman / Woodward brand controller in an application using a Zenith carburetor and integrated throttle actuator.

The E-361 is available with a 8 pin terminal strip (E-361C) or with a 8 pin Packard Disconnect (E-361D).

QUICK-START INSTRUCTIONS

If you are experienced in installing and adjusting Electric Governors, follow these steps. Otherwise, refer to the more detailed instructions which begin on Page 4, starting with "Governor Assembly".

1) Mount Controller in a dry, fairly cool location. Accessibility for adjusting is required.
2) Wire per the attached schematic, Figure 1. BE SURE TO OBSERVE CORRECT POLARITY. Note some wire locations are different than the original controller. Refer to Figure 1.
3) Set the machine to command high engine speed. Adjust the engine speed to the desired value using **Speed-set** pot. See Figure 2. Turn CW to increase speed, CCW to decrease speed.
4) Set Gain as required, using **Gain** pot. See Figure 2. CW increases sensitivity. Load and unload the engine to check for proper gain.
5) Set mid and idle speeds.

CARBURETOR IDLE ADJUSTMENT

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The carburetor has no idle adjustment stop screw. The mechanical idle is adjusted by disconnecting the actuator wires then loosening the 3 actuator mounting screws and turning the actuator to obtain the desired idle speed. This should be set with a fully warmed up engine and hydraulic system. This setting must be at least 100 RPM below the lowest governed speed. Setting this too low may cause the engine to stall during operation while setting this too high may create delays in engine governing or cause the engine to continue running after power has been removed. Tighten the screws. After turning off the engine, reconnect the actuator. Failure to turn off the engine may result in the engine over-speeding.

MOUNTING--CONTROLLER

The replacement controller will require new mounting holes to be drilled.

The controller is water and weather resistant when the cover plate is filleted with RTV by the user. However, attention to the following points will enhance its performance and reliability:

Select a reasonably **cool, dry,** and **vibration free** location.

The rear cover will probably need to be removed during set-up in order to make adjustments for speed-setting and gain. You may wish to defer final installation until this is done.

After completing these adjustments, **replace** cover, and **seal** with a finger-fillet of RTV. Mount so that water cannot pool on this cover. Mounting with this cover out of sight discourages "fiddling".

WIRING

The E-361C controller will require wiring changes when replacing the Barber Coleman / Woodward controller. The E-361D does not require any wiring changes. Simply plug the E-361D into the existing machine wiring harness.

E-361C:
See Figure 1 for the controller wiring changes.

The original controller wires on pins 3 and 4 must be moved to the E-361 pins 5 and 6 (the order is not important)

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Wires attached to pins 1,2,7, and 8 of the original controller governor should be connected to the same pins on the E-361.

If the machine had a wire connected to pin 9 of the Barber Coleman governor, this wire should be connected to pin #1 of the E-361 in addition to the original power wire. This pin is simply a + battery supply for the speed select switches.

E-361D Wiring:
Refer to Figure 1 for pin functionality. E-361D terminal “A” corresponds to E-361C pin 1, terminal “B” to pin 2, terminal “C” to pin 3,etc. Again, the E-361D does not require wiring modifications.

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A properly functioning engine electrical system will supply 13.5-14.8 VDC when the engine is running. If wiring size is adequate, with good connections and proper grounds, you will get this reading between the wires to terminals 1 & 2 of the 8 pin terminal strip when the Governor is controlling engine speed. Verify this.

CAUTION:
Improper hook-up can damage electronics. Re-check wiring *before* applying power.

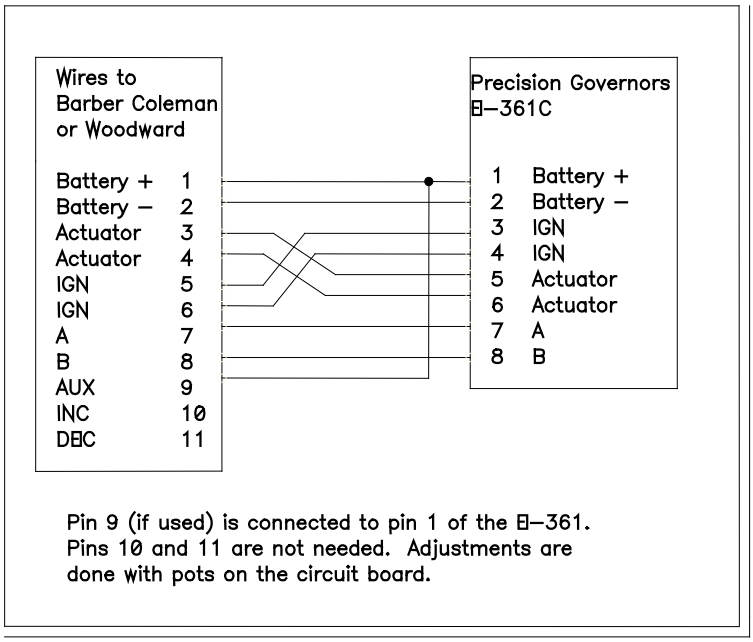

Figure 1 Retrofit Wiring

CHECK-OUT & INITIAL START-UP PROCEDURES

Assuming that the Governor Assembly and Controller are mounted and the wiring is run and checked, proceed as follows:

1) Turn ignition switch **on**. Do not start engine. The throttle actuator should cycle or click once immediately after power up. It will the return to the rest position until the engine is cranked.

2) Use a Multimeter to check battery voltage at battery terminals, and record. Now check voltage at the machine connection points for terminals 1 & 2 (1 is +, 2 is -).This voltage reading should be the same as at battery. If not, shut down, and correct wiring.

3) Before proceeding, familiarize yourself with the locations of the **Speed Set** pot and the **Gain** Pot, see Figure 2. Read the section on **Adjustments.**

4) Start engine then set machine controls to obtain high engine speed. Adjust the speed-set as needed to get the desired high engine speed. If engine speed surges, reduce Gain a little, as required. Keep in mind than readjustment of the set speed may be required after gain adjustments.

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5) Re-check voltage between the connections for terminals A & B as in step 2. Voltage reading should be between 13.5--14.6 VDC. If less, look for undersized wiring somewhere in the system, or for other components wired in parallel with the Governor.

6) Carefully adjust **Gain**. You are looking for the best compromise between quick response and good stability. Make very small adjustments, then load and unload engine. Usually, a good set-up is one that makes 1 to 3 small bounces and then steadies down after a large load change. Too much **Gain** shows up as a rapid (once per second) instability, most commonly at light loads. Too little **Gain** shows up in large over-shoots on start-up or large load changes, and generally sluggish operation. A good initial setting for the gain is to turn fully counterclockwise and then turn clockwise 3/8 of a turn. Changing the gain may affect the set speed.

7) Integral Adjustment. This adjustment is typically not critical for most applications. A good initial setting for the integral is to turn fully counterclockwise and then turn clockwise 3/8 of a turn. This adjustment affects how long the controller takes to completely recover from a load change. If, after applying a load, the engine recovers below set speed then creeps up to the set speed over several seconds, this adjustment may be increased. If, after a load application, the engine recovers to a speed above set speed and then creeps down to the set speed, this adjustment may be decreased. Setting this too high may also introduce a slow engine speed wander at lower engine speeds or load factors. Changing the integral will affect the set speed.

8) Make final adjustment to the Speed-set. This is the highest speed to be run. This adjustment must be made before the Aux speed adjustments are done as the slower speeds are based on the high set speed.

9) Set machine controls to obtain the Aux speeds (if used). Adjust the AS1 and AS2 pots as needed to obtain the desired lower speeds. The controller has the ability to control 2 lower speeds. Either speed can be medium or low. Set the middle speed before setting the idle speed. Refer to Table 1 to determine the correct controller adjustment for each desired speed. If a governed idle speed is desired and the machine originally commanded low speed when neither of the Aux terminals was powered, the diode labeled D16 will need to be removed from the PCB. Clip one lead of this component. The location of D16 is illustrated in Figure 2. D16 is the only vertical component located between the black integrated chips labeled AR1 and AR6. If it is not known which adjustment is used for a particular speed on the machine, measure voltages on both Aux terminals and refer to Table 1. As machines have different speed settings and wiring differs between machines, consult machine service manuals for machine specific wiring and speed settings. Precision Governors does not have information as to how particular machines are configured, wired, or the proper speed settings.

10) Re-install the back cover on the control unit. Add a finger fillet of RTV around the edge of this cover to seal against dirt and moisture. Final-mount the controller.

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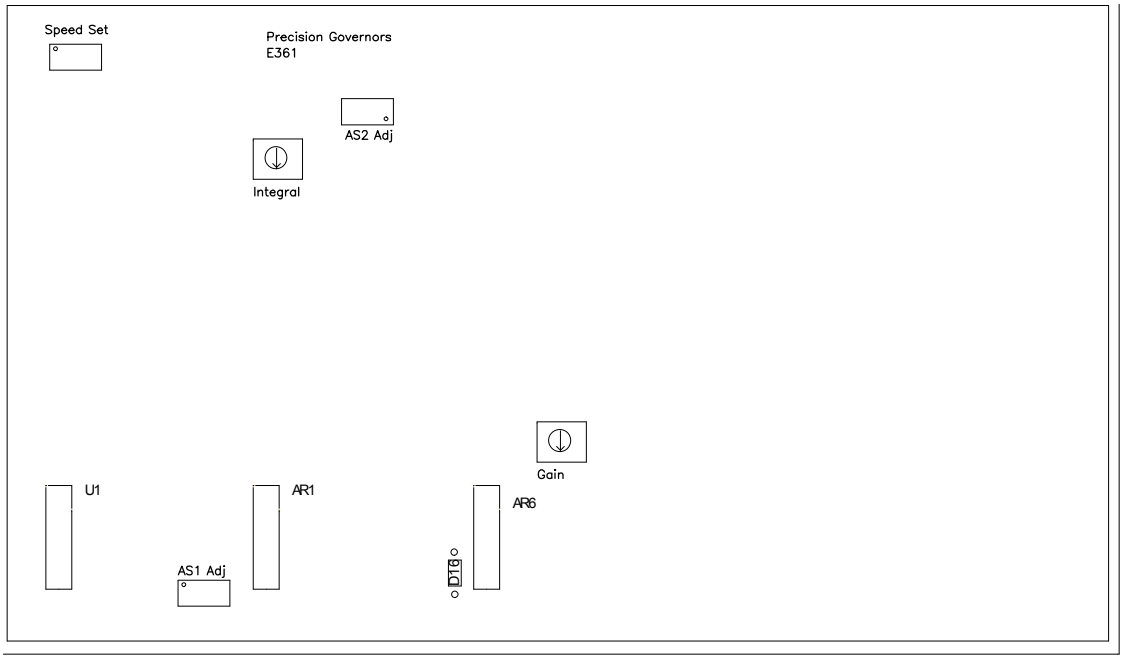

Figure 2 E-361 ELECTRONICS--ADJUSTMENT LOCATIONS

Speed	Connection at		Speed Adjustment
	A / Aux 1 / Orange	B / Aux 2 / Green	
Carb Idle*	Open	Open	Carburetor Idle
Low Idle**	Open	Open	The "AS" adjustment Not used for Mid Speed.
Aux Speed 1	12 Vdc	Open	AS2
Aux Speed 2	Open	12 Vdc	AS1
High	12 Vdc	12 Vdc	Speed Set

Table 1 Speed Adjustment

*If D16 is present on the PCB, Carb Idle is used when neither Aux terminal has voltage applied.
** If D16 is not present or has a lead cut, the E-361 controls the idle to the lower of Aux 1 and Aux 2 settings.

GOVERNOR ADJUSTMENTS

MULTI-TURN ADJUSTMENT (SPEED-SET)

This adjustment is made by turning the 1/8" brass screw clockwise (CW) to increase speed, and counterclockwise (CCW) to decrease speed. The adjustment range of the pot is 25 full turns, and one full turn will change speed about 100-200 rpm. This pot is protected by a slip clutch at each end, and will not be harmed by moderate over-adjustment. However, the Governor will not function while the pot is past full travel.
If you suspect you may have over-adjusted the Speed-set pot, or have lost track of where you are, turn the pot 25-30 turns CCW, then back 10-12 turns CW to get back into the range of normal adjustment.

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SINGLE-TURN ADJUSTMENT (GAIN, AUX SPEEDS, FACTORY ADJUST)

This pot is 3/8" square and has a 1/8" plastic screw in its center. **Be gentle!** This pot turns 270°, and over-turning will break the internal stops, making adjustment impossible. Turning this pot CW increases speed or governor sensitivity, while turning CCW decreases speed or sensitivity.

TROUBLESHOOTING

We will discuss Troubleshooting in two general categories:

A) Governor won't work
B) Governor works, but can't be set up to give satisfactory performance

There is, of course, some overlap between these categories. Read both sections and apply the fixes that seem appropriate.

During troubleshooting, be prepared to control the engine manually to prevent overspeeds.

A. Governor won't work.

No reaction from Governor. Actuator output never moves, engine off or engine running. Can be caused by:

1. No power.
2. Incorrect electrical hook-up.
3. No speed signal to Governor.
4. Damaged Actuator.
5. Damaged Controller.

1. No power Use a Multimeter to check for 12-15 VDC between terminals 1 & 2 on the controller. Check during engine off and engine running conditions. If voltage is absent or low, check for:

a. Wiring error
b. Hook-up on wrong side of ballast resistor
c. Low battery
d. Bad Voltage Regulator
e. Bad ground connection
f. Corroded terminals
g. Undersized wiring

2) Incorrect Electrical Hook-up Re-check all wiring and connections to the governor assembly and controller.

3) No speed signal to Controller

a. Check the voltage between terminals 3 or 4 and ground with the engine running. You should see 5-30 VDC.
b. The above check does not guarantee a good speed signal, but its absence proves that there is a problem

4. Damaged Actuator: See Actuator Troubleshooting, below.
5. **Internal Governor fault** If steps 1-4 above have not revealed the problem, the Governor may have been damaged, either in shipping or during hook-up and test.

B. Governor reacts, but can't be set up to give proper performance

This kind of trouble usually falls into 3 main categories:

1. Actual Governor malfunction

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2. Governor installation problems and improper installation
3. Governor not tuned or adjusted for engine/application

1. **Actual Governor malfunction** The Governor was engine-tested for proper operation just prior to being shipped. Unless damaged in shipment or by improper handling, it should be serviceable. To check for proper operation, proceed as follows:
   a. Control the engine speed manually (if possible).
   b. By carefully varying engine speed, you should be able to feel the actuator come to a neutral force position. This engine speed is the approximately the set speed for which the Governor is adjusted. If grossly incorrect, reset **Speed set** pot.
   c. No rubbing or binding should be felt during these movements.

If steps 1a. through 1d. can be accomplished as described, the Governor is probably OK. It recognizes underspeed, overspeed, onspeed, and is not binding internally. If the above steps cannot be accomplished satisfactorily, there is probably an actual Governor malfunction.

2. **Installation and adjustment problems**
   a. If actuator is unable to move freely look for:
      1. Actuator or carburetor binding
      2. Low voltage at Governor during operation: Measure the voltage as discussed previously and observe voltage during operation.
   b. Governor experiences sudden, momentary spikes toward max. or min. at random intervals, then recovers.
      1. Look for loose wiring or momentary shorts in wiring.
      2. Noise or occasionally missing speed signal.

3. **Governor not tuned or adjusted for engine/application**
   The basic adjustment to set sensitivity/stability is the Gain pot. A good starting point for many engines is full CCW, then CW 1/3 turn. (See "Governor adjustment" section.) To increase stability, turn CCW. If satisfactory governing cannot be achieved with this one adjustment, the **factory** adjustment may be needed. Normal starting point for this adjustment is fully CCW, then CW 1/4 turn . (Before changing this pot, mark the original position.)

Damaged Actuator. As the throttle actuator on this system is not a Precision Governor Product, please refer to original service information for detailed troubleshooting information. Precision Governors does not manufacture a bolt in replacement for this throttle actuator.

Precision Governors has measured the resistance of a known good 12 volt actuator at 2.9Ω. Actuator voltage measured while running an unloaded 2.5L Ford engine at 1500 –2000 RPM were 1.9-2.1 volts and at 2600 RPM with load were 2.9 volts. The actuator should be near wide open with 6-8 volts present. Steady state voltage readings stayed with 0.3 volts of the average value measured on the machine. The average voltage will vary with engine speed and load. If the steady state value changes considerably without engine speed changes, the actuator or carburetor may be “sticky”. If the actuator voltage measures near 0 volts, the controller may be attempting to reduce engine speed below the mechanical idle setting or (for idle speed) may be configured for a carburetor idle. Reduce the mechanical idle speed, configure the controller for controlled idle, or increase the selected engine speed adjustment to regain control.

Any sticky feeling, rubbing, or binding in the actuator or carburetor can be the cause of engine instability. These should be repaired.

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It is up to the technician to decide if the actuator is functioning properly or not.

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