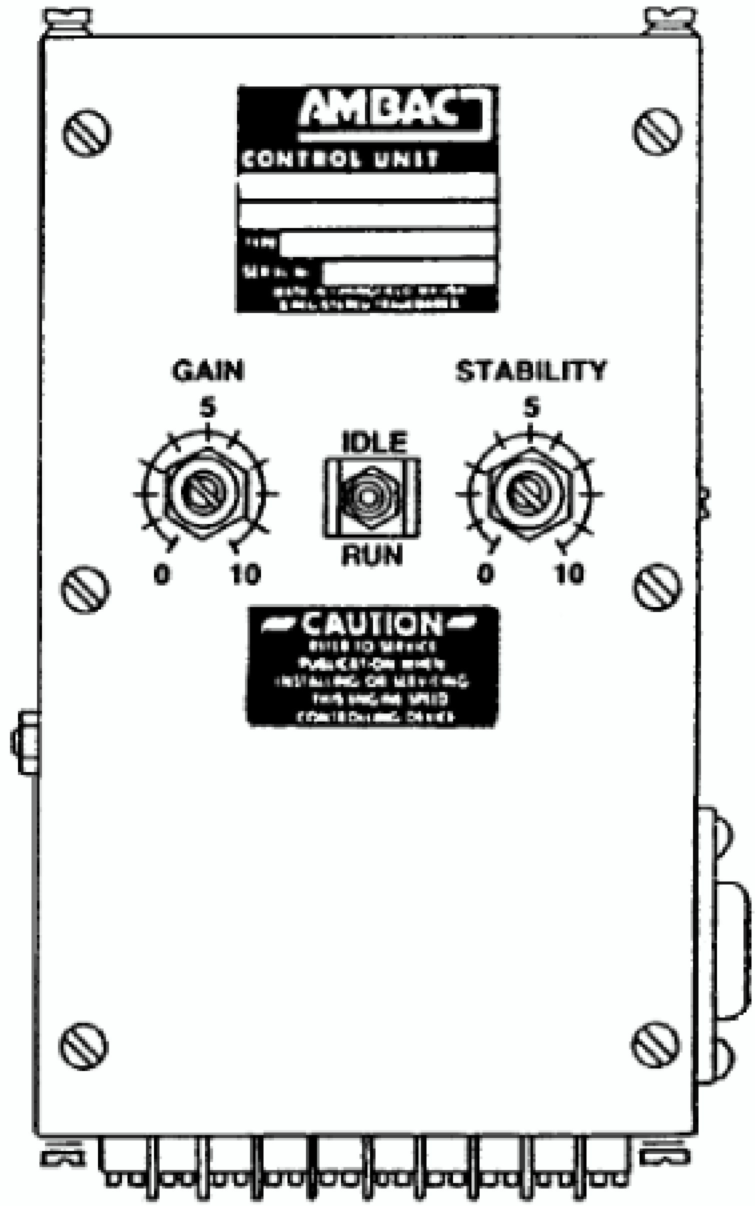
ENGINE GOVERNING SYSTEMS

AMBAC INTERNATIONAL

CU 673C
CW 673C



SPEED CONTROL UNIT

FEATURES

- Compatible with all accessories
- Isochronous and droop operation
- Temperature compensated
- Output current up to 30 amps
- Phase lock loop operation
- Fail-safe speed signal
- Reverse voltate protected
- Vibration and moisture protected

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INTRODUCTION

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, a "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.

The CW673C speed control units are suitable for use with all "AMBAC" actuators except the high output AGK 2200 and AGK 1600. They are adaptable to a wide variety of diesel carbureted gas, gasoline, and gas turbine engines typically up to 500 HP and practically any rotating device that must be speed controlled.

The CW 673 speed control units are suitable for use with "AMBAC" high output AGK 2200 and AGK 1600 actuators. They are adaptable to a wide variety of diesel, carbureted gas, gasoline and gas turbine engines typically up to 1000 HP, and practically any rotating device that must be speed controlled.

SPECIFICATIONS

CW 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 (See Note) .... ±200 Hz

POWER INPUT

- Magnetic Speed Sensor Signal .... 1.0-30 volts rms
- Supply .... 12-40 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 .... 1.13kgs. (2.5 lbs.)
- Mounting .... Any position (See Installation Page 6)

RELIABILITY

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

NOTE: CW 673C speed is remotely variable over full frequency range. (See Table A)

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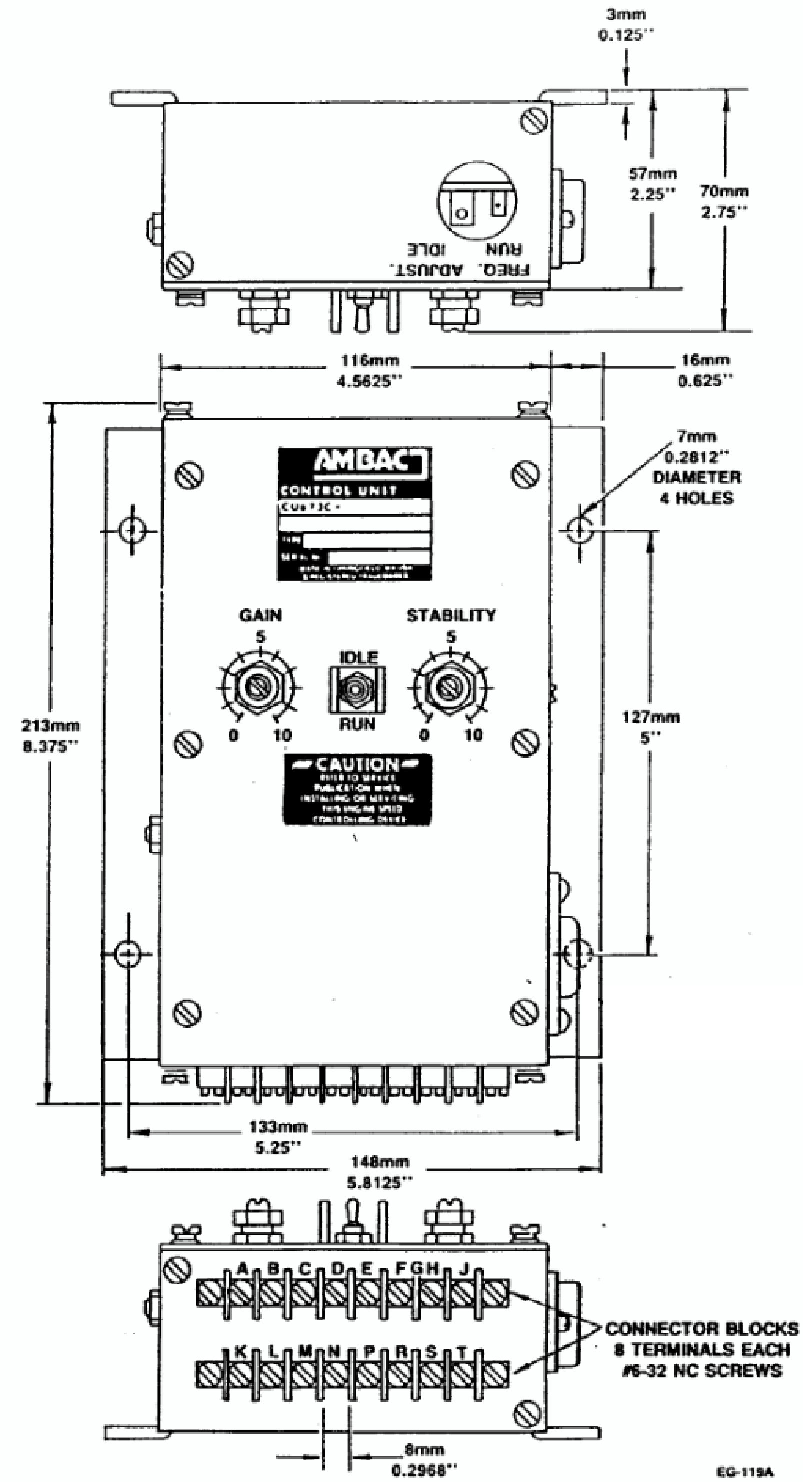

Figure 1. Dimensions for CW 673C speed control unit

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DESCRIPTION

The speed control units are 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 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 CW 673C speed control unit has sufficient current capacity to handle all "AMBAC" actuators, except the AGK 2200 and AGK 1600.

The CW 673C speed control unit has sufficient capacity to handle the high output AGK 2200 and AGK 1600 actuators.

The speed control unit is available in several types reflected as a suffix (-) number to suit various engine application needs (see Table A). These variations should be considered when the governor systems are designed.

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 Figure 2).

ATTENTION

We have consolidated this product line in order to achieve some production efficiencies and provide aftermarket service parts that meet the needs of our customer. The CW673C-30U has superseded the CU673C-7, CU673C-17, CU673C-23, CW673C-7, and CW673C-17. There may be a few additional features that you may not require or that you may be able to use; but whether you use them or not, these added features will not decrease the long lasting life of our speed controllers. Please refer to the installation instructions and wire diagram.

Table "A" - Speed controller variations

Pickup Signal and Amplifier

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 engine speed. The flywheel ring gear is normally used because of the ease of speed senor installation and because of the high frequency speed sensor signal.

Other signals may be used for a speed signal instead of the output of the flywheel. The governor will accept any signal if the frequency is proportional to engine speed, and in the frequency range of the governor (300 to 10K Hertz). 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 input amplifier is very tolerant to signal wave form. It is required only that a non-sinusoidal signal have a minimum of 1.0 volts peak-to-peak and a maximum of 30 volts rms at all engine speeds from cranking to maximum. The speed control unit has an input impedance of 5.1 K-ohms between terminal "S" and terminal "T". Terminal "T" is connected internally to the battery negative.

The input amplifier protects the system if the input signal is not strong enough. In the absence of any signal from the magnetic speed sensor, the speed sensor amplifier goes into a local oscillation of about 12K Hertz. Since this frequency is above the maximum reference frequency, the phase detector considers the engine in "overspeed" and the actuator moves to the fuel shutoff position. This provides inherent fail safe protection against loss of speed sensor signal.

Since there is no speed sensor signal with the engine stopped, the oscillation of the speed sensor signal amplifier keeps the actuator in the fuel shut-off position until the engine is cranked. After a few teeth have passed the magnetic speed sensor, enough signal is provided to block the input amplifier oscillation. At this time, the actuator moves to the full fuel position and remains there during starting and acceleration of the engine.

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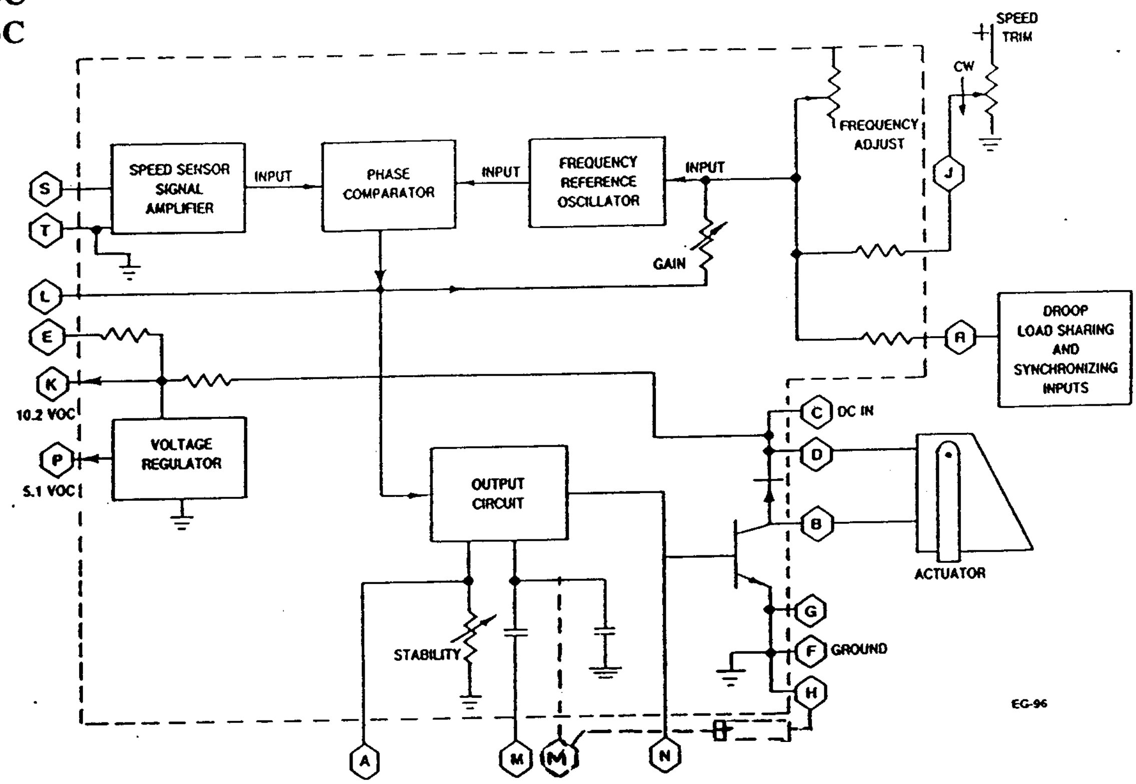

Figure 2. Functional Schematic

Frequency Reference Oscillator

A wide range, temperature compensated, voltage controlled oscillator is used as the speed reference to the speed control system. The frequency setting is adjusted by applying 0 to 10 volts at the frequency reference oscillator input. Zero volt represents a frequency of 10K Hz, while 10 volts represent a frequency of 300 Hz. The internal frequency adjust provides this voltage setting. Use of an external speed trim control enables small adjustments to the reference oscillator (± 200 Hz). For a wide range of remote speed control, use CU 673C-17 or CW 673C-30U. If one is not available, a reconnection of internal jumpers can be made. (Refer to Section EG 70-7 for detailed instructions.)

Two external inputs are available to adjust the frequency reference oscillator. Terminal "J" is the input from the speed trim control which provides minor trimming of engine speed. A wide range of speed adjustment is attainable if a CU 673C-17 or CW 673C-30U is used. Terminal "R" is the input from accessories such as load sharing, droop, or automatic synchronizing. When the speed control unit is controlling an engine, the reference oscillator does not maintain a constant frequency but deviates from its nominal RPM which occurs during load change. The reference oscillator is forced by the phase comparator to track the engine speed sensor input, described below. Thus, the voltage representing speed error is the amount of voltage required to drive the reference oscillator off frequency as far as the engine is off speed at that moment.

Phase Comparator Circuit

This circuit is used to force the reference oscillator to track the engine speed sensor signal. The phase comparator circuit detects the phase difference between the input signal through the input amplifier and the signal from the reference oscillator. When the engine changes speed, the signal from the input amplifier changes frequency. The phase comparator circuit measures the amount the engine signal is ahead or behind the reference oscillator signal. Its voltage output is used to force the reference oscillator to the same frequency as the signal from the engine. In this way, the phase comparator output is proportional to the speed error. (When used in this way, the phase comparator and the reference oscillator make up a "Phase Lock Loop"). The gain control is used to couple the phase comparator output to the reference oscillator. By increasing the coupling, for example, a small voltage deviation from the phase comparator corresponds to a large frequency deviation, and vice versa (see Figure 3).

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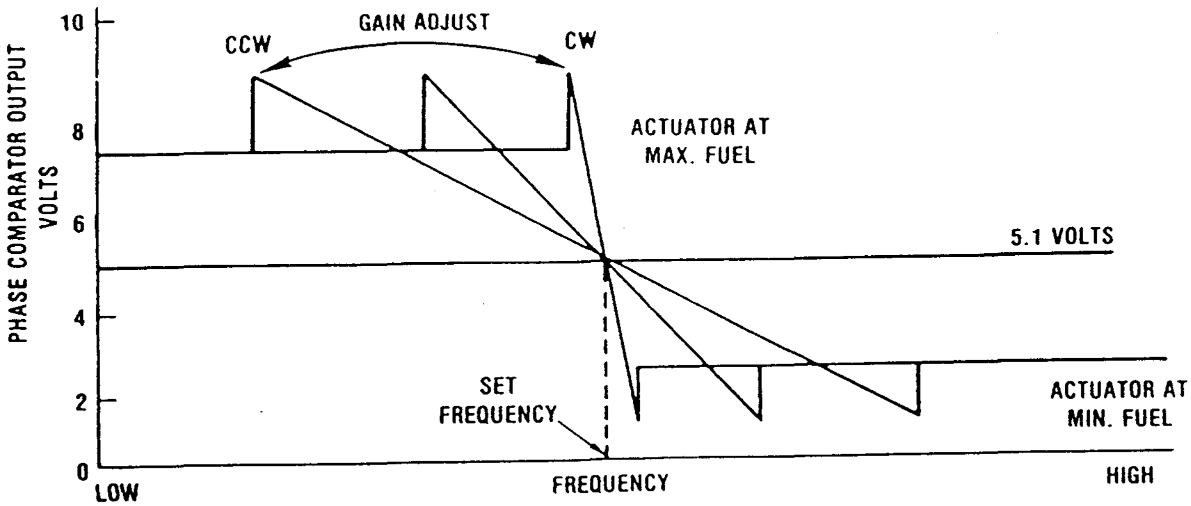

Figure 3. Phase comparator output versus frequency

The phase comparator output is measured at terminal "L". This is an important terminal, it is used to monitor governor performance and function. The voltage on terminal "L" can be measured with a voltmeter. A reading of 5.1 VDC indicates the engine is on governed speed. A reading in excess of 5.1 VDC indicates an under-speed condition while readings of less than 5.1 VDC indicate overspeed conditions.

Figure 3 indicates voltage at terminal "L" with different gain settings. As indicated by the curve, the gain should be turned CW as far as possible without causing instability.

Dynamic Control and Output Circuit

This circuit allows isochronous governing by introducing temporary droop during a load change for stability purposes. It provides an adjustable means to control the magnitude and time constant of the temporary droop to match the dynamic characteristics of the engine. If spec droop governing is desired, an external speed droop control potentiometer is connected as shown in Figure 4. (Refer to Section EG 70-2 for more details.)

The output current switching portion of the circuit provides current to drive the actuator . The output transistor is alternately switched off and on at a frequency of 200 Hz which is well beyond the natural frequency of the actuator.

The actuator responds to the average current from the transistor and moves in proportion to this average current to position the engine throttle. The output transistor is switched to reduce power dissipation. The output of the CU 673C provides up to 10 amps at voltages up to 40 VDC. The output of the CW 673C provides up to 30 amps at voltages up to 40 VDC.

CAUTION:
ON CW 673C UNITS, DO NOT SHORT THE INSULATED NUT OR THE SIDE-MOUNTED TRANSISTOR TO GROUND

Shorting out the transistor will apply full voltage across the actuator and will force the actuator to the full fuel position. To test the system before starting the engine, momentarily 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.

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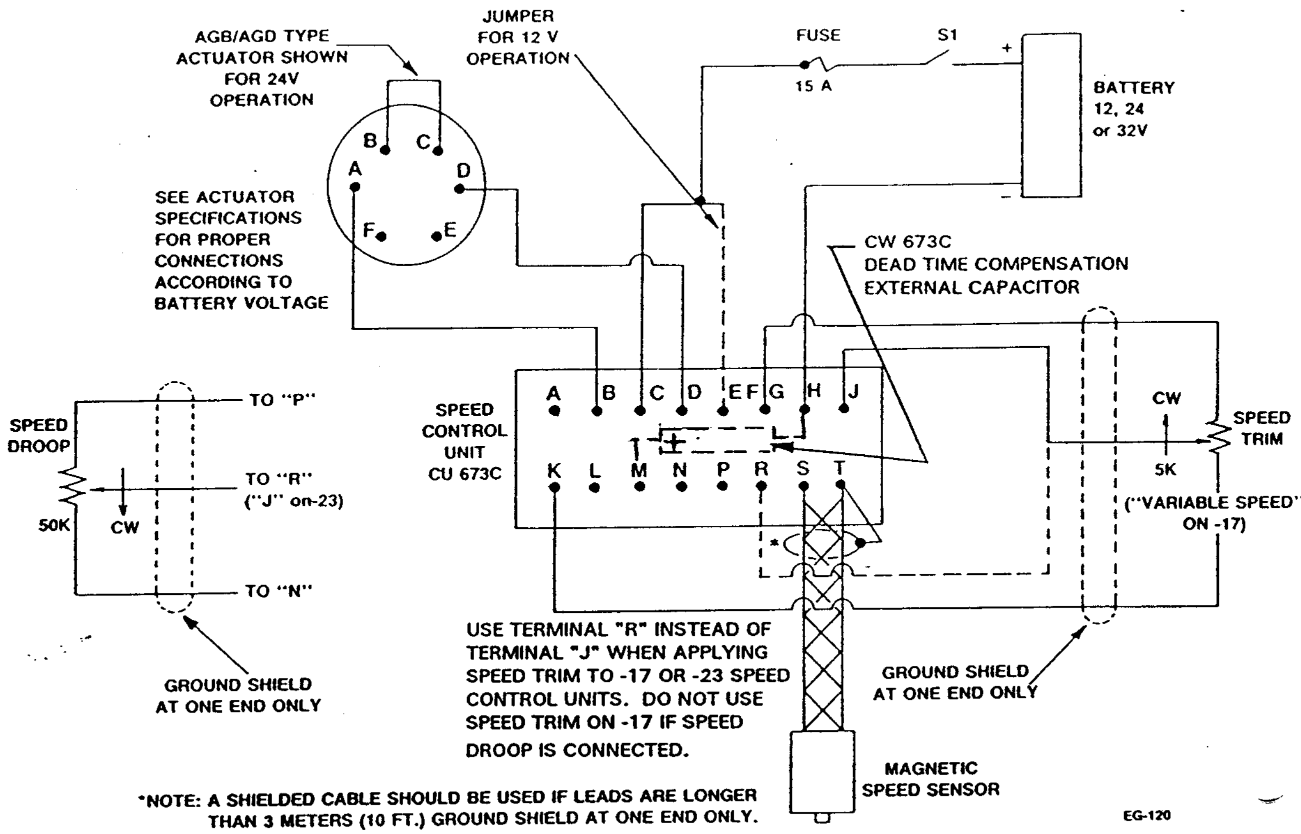

Figure 4. Wiring to CW 673C speed control unit

INSTALLATION

The speed control unit is rugged enough for mounting in the control cabinet or engine mounted enclosure. Care should be taken to ensure 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 expected that water or mist will come in contact with the speed control unit, mount it vertically so the condensation will not accumulate in the speed control unit.

Wiring to the speed control unit is shown in Figure 4.

For the CU 673C speed control units, 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 H of the speed control unit. In CW 673C systems, the leads from the battery to the speed control unit and from the speed control unit to the actuator should be at least #14. If these leads are over 3 meters (10 ft.) long for the AGK 1600 or over 12 meters (33 ft.) long for the AGK 2200 actuator, they should be at least #12 wire. All other leads may be any convenient size consistent with the mechanical integrity of the cable. Even though the maximum actuator currents exists for only short intervals, the wiring must be capable of handling this current or the transient performance of the governor will suffer. Connections to terminals "J" and "R" should be shielded (Figure 4).

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 than 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.

ADJUSTMENTS

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

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

INITIAL ENGINE START

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. The actuator may momentarily move to the full fuel position then return to the no fuel position.

C. MOMENTARILY connect terminal B to ground (terminal G, F, H, or battery negative). On CU 673C-7 and -23 only, the large insulated nut at the side of the unit may be used instead of terminal B. 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 9)".

Crank the engine. During cranking, the actuator will move the fuel control 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 clockwise 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 control counter-clockwise 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 clockwise until instability results. Then back-off slightly counter-clockwise (one major division) beyond the point where stability returns.

B. Turn the stability control clockwise until instability results. Then back-off slightly counter-clockwise (one major division) 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 clockwise 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 5 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.

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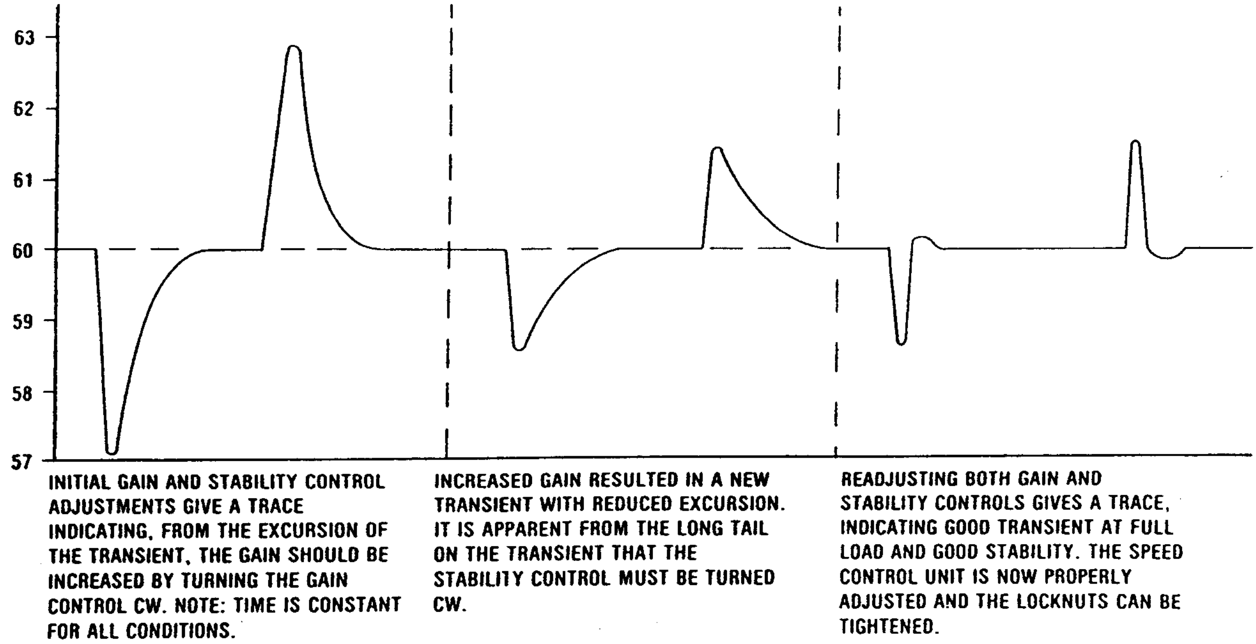

Figure 5. Typical performance chart

TROUBLESHOOTING

LOW FREQUENCY INSTABILITY

On CU 673C speed control units, when low frequency instability or surge (0.5 to 3Hz) is experienced, a simple jumper wire connection can be installed between terminals "H" and terminal "M". On CW 673C units, install an additional polarized 10VDC capacitor between terminal "M" (+) and terminal "H" (-). Typical total capacitive values are 22 μf with AGK 2200 and AGK 1600 actuators. This will increase the engine dead time filter compensation and tend to eliminate low frequency instability or surge.

HIGH FREQUENCY INSTABILITY

On CU 673C and CW 673C units, when rapid instability or surge (about 8Hz) occurs, a jumper connection can be made between terminals "M" and "N". This will decrease the dead time compensation and tend to eliminate the instability. For slight instability problems, place a 5.1K resistor from terminals "M" to "N".

NOTE: Do not install both "M" to "H and "M" to "N" jumper connection - no improvement in performance will result.

UNSATISFACTORY ENGINE PERFORMANCE

When poor transient performance is caused by the speed control unit gain adjustment being at or near its lowest point, a 6.2K ohm resistor can be applied between terminals "L" and "P". This will expand the range of the gain control.

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) will indicate the possible fault. Should all 5 voltage tests indicate normal values, the defect is probably the actuator or in the wiring to the actuator.

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TROUBLESHOOTING *(CONTINUED)*

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	10.0 ± 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.

OTHER TROUBLESHOOTING TESTS

SYMPTOM	TEST	PROBABLE TROUBLE
Engine overspeeds	Determine voltage on terminal "L" Should be less than 5.1 VDC.	1. Frequency set too high. Turn frequency adjust CCW. 2. Defective speed control unit.
Engine overspeeds	Measure the voltage across the insulated nut located on the side of the control unit. Should be more than 2.5 VDC.	1. Output transistor shorted. (Defective speed control unit.) 2. Wiring to actuator incorrect.
Throttle does not move	Measure battery voltage at the battery while cranking. Must be at least 75% of nominal battery voltage.	1. Insufficient battery voltage. Put a momentary connection from terminal "B" on the control unit to ground (terminal "G") while cranking. 2. Replace with battery of higher amp hour rating.
Throttle does not move	Ground the insulated nut located on the side of the speed control unit, except on CU 683C-10 speed control units. Throttle should move to full open position.	1. Wiring to actuator or battery incorrect. 2. Actuator or linkage bound. 3. Defective actuator.