PORTABLE TEST UNIT
TSE 671C

INTRODUCTION

The TSE 671C is a portable test instrument used to test the UTDS speed control units. Testing capabilities include the CU 671C, CU 673C, ECD 67-2000 and ECD 67-5000 series speed control units, and the governor section of the ECQ-1000 series. For ECJ series speed control units consult the factory. There are three modes of operation.

1. The first mode of operation is as a test set to check speed control units prior to installation. It has an internal power section permitting it to be used when AC is available. The speed control unit is connected to the set using the wired connector which is an integral part of the test set. Engine performance with load changes can be simulated to test the speed control unit.
2. The second mode of operation is to use the DC voltage from the engine battery to power the test set and, thereby, test the speed control unit, as above, while the engine is not running.
3. The third mode of operation is to interpose the test set between the speed control unit on the engine by using the two integral connectors connecting wiring harness which are part of the test set. In this mode, the engine can be run normally while the test set monitors the operation of the speed control unit.

OPERATING CONTROLS AND FUNCTIONS (See Figure 1)

POWER SECTION (Pos. 1, 2, 3 and 4)

115 VAC POWER SWITCH (Pos. 4)

115/220 VAC 50-400 Hz. - .3 Amps. with pilot lamp (Pos. 2) (Internal 1 amp. fuse slow blow). When this switch (Pos. 4) is turned "ON", an internal converter will furnish 15 VDC to the speed control unit. The 15 volt supply will be to the speed control unit, not to the actuator. With switch (Pos. 4) in "ON" position, the power supply is considered to be "INTERNAL" (Coming from the internal converter).

EXTERNAL - INTERNAL SWITCH (Pos. 3)

Selection of **internal** or **external** power supply is made with the "EXTERNAL" - "INTERNAL" switch (Pos. 3). When **internal** supply is selected, the voltage selection switch (Pos. 1) **must be set to 12 volts** as the internal converter is supplying 15 VDC. The "internal" supply will power the governor speed control unit and the test set in the first mode of operation. The test set is arranged such that the actuator is disconnected from the speed control unit when the internal power supply is used. An "external" power supply (battery) when used, will power the test circuit, the speed control unit and the actuator, in the second and third modes of operation. When "external" (battery) supply is selected (Pos. 3), voltage selection switch (Pos. 1) must agree with the battery voltage and must also agree with the actuator wiring (i.e., 12V, 24V or 32V).

DROOP SWITCH (Pos. 12)

This switch, when in the "ON" position, will add droop (speed decrease with load increase) when testing CU 671C or CU 673C series control units. A fixed amount of droop (approximately 4% or ½ maximum amount of droop obtainable when using CU 6711A droop control) will be obtained. It is used to insure the governor responds to droop signals. It can also be used to stabilize an otherwise unresponsive engine when the test set is used in the third mode application.

DEAD TIME FILTER SWITCH (Pos. 13)

This is used when testing CU 671C and CU 673C series speed control units to add extra dead time compensation. In the jumper position, a jumper is added between terminals M and H of the speed control unit. This adds the 10 mfd capacitor in the speed control unit into the circuit on units above serial no. 2R6240. For speed control units below 2R6240 switch to capacitor, this adds the capacitor externally to terminals M and H of the speed control unit. The center position is off. No connections are made to M and H.

NORM/REV. SWITCH (Pos. 14)

This switch should be in the normal position for most units. The reverse position is used when testing ECD-5111's and ECD 67-7000's above SN 2L 23000 and CU 673C-9 and CU 673C-29. The center position of normal/reverse switch is used when jack position 20 is used for position sensing.

ENGINE SIMULATOR SECTION (Pos. 5, 6, 7, 8 & 9)

This section is used to simulate signals to the speed control unit as would be generated from typical engines when the unit is used as a test set in the first or second mode operation.

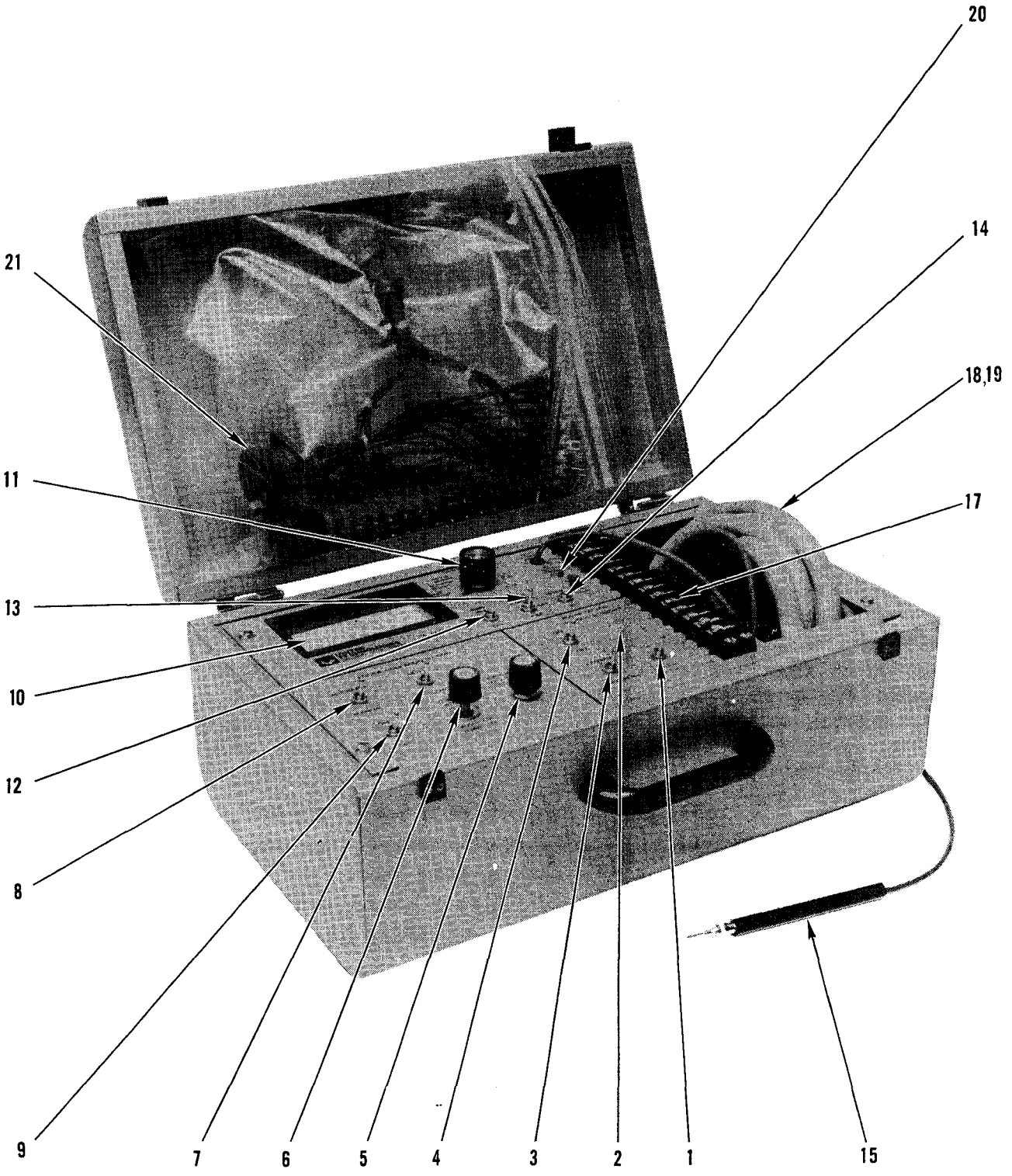

Figure 1. Operating controls and functions

WARNING
IF THE ON-OFF SWITCH (POS. 9) IS LEFT IN THE **ON** POSITION AND THE ENGINE STARTED, LOSS OF CONTROL MAY RESULT. IF THE TEST SET IS TO BE USED WHILE THE ENGINE IS RUNNING (THIRD MODE OPERATION), SWITCH (POS. 9) **OFF.**

AUTOMATIC-MANUAL SWITCH (Pos. 8)

When the simulator switch (Pos. 9) is turned "ON", automatic closed loop control results by turning "Auto-Man" switch (Pos. 8) to "automatic" (first and second mode operation only). This brings the simulated frequency to the set frequency of the speed control unit. The speed control unit frequency setting can then be read on the meter (Pos. 10) when the meter switch (Pos. 11) is turned to the "frequency" position. If the frequency adjust of the speed control unit is turned, the meter will read out the new frequency. Set the frequency before installing it on an engine. As long as the speed control unit is operating properly, it will bring the simulated frequency to the set frequency. With switch the speed control unit controls the internal engine simulation frequency.

MANUAL POSITION OF SWITCH (Pos. 8)

Simulation allows the internal oscillator frequency to be controlled by the manual frequency adjust control (Pos. 5). The internal engine simulation is controlled in this mode by the manual frequency adjust (Pos. 5) rather than by the speed control unit. The speed control unit is fully active and the various terminals (Pos. 17) can be tested for normal response in the MANUAL position of switch (Pos. 8). Such tests are described later. Test on terminal L (Pos. 17) will show 5.1 volts when the simulated frequency equals the speed control units set frequency, for "C" series speed control units.

FAST-SLOW SWITCH (Pos. 7)

This is used to select the delay response of typical engine types. Naturally aspirated, higher speed Diesels tend to have a faster response to load changes. Carbureted engines tend to have a slower response to load changes. To simulate a fast responding engine, switch (Pos. 7) to fast. If simulating a slow resonding engine, switch (Pos. 7) to slow. Obviously, the fast-slow simulation will not agree exactly with the response characteristics of any particular engine.

LOAD SWITCH & ADJUST (Pos. 6)

This is used to simulate step loads being applied to the hypothetical engine. Response of the speed control unit, under these simulated load changes, can be seen on meter (Pos. 10). Response may also be seen by placing probe (Pos. 15) into terminal L (Pos. 17) "C" series only. Pressing the load switch (Pos. 6) applies the simulated load step. Releasing pressure on the load switch (Pos. 6) removes the simulated load step and the speed control unit should indicate a return to the original load. The speed control unit response will differ according to the selected position of the FAST-SLOW switch (Pos. 7) and the setting of the gain and stability controls on the speed control unit.

MANUAL FREQUENCY ADJUST (Pos. 5)

This is a 10-turn control used to change the frequency of the internal oscillator in the engine simulator section. This can be used only in modes 1 and 2 operation (engine not running). Switch (Pos. 3) on "INTERNAL", switch (Pos. 8) on "MAN" and switch (Pos. 9) in "ON" position. When selector switch (Pos. 11) is set to "FREQ", the simulated speed control unit frequency can be read on meter (Pos. 10). When selector switch (Pos. 11) is set to "0-10", the voltage on terminals (Pos. 17) can be read. For CU 671 will read less than 5.1 volts. Other tests can be performed as described later.

TERMINAL STRIP CONNECTIONS (Pos. 17)

Connections to each terminal of the speed control unit are represented on the terminal strip (Pos. 17). The letters at the terminals correspond to the letters on the terminals of the CU 671C and CU 673C speed control unit. Terminals F, G, H and T are ground connections. **All** connections are fed through unbroken from one connector to the other except terminals B and S. When the test instrument is used in line under engine control (mode 3 operation-engine running-Switch, Pos. 9, "OFF"), terminals B and S are reinstated such that all connections to the speed control unit are unbroken.

METER SWITCH (Pos. 11)

This is used to change the function of the internal meter. The DC Voltmeter (Pos. 10) with a range of 0-10, 0-30 and 0-50 is used to measure voltages at the terminal strip (Pos. 17) for diagnosis. The frequency position will indicate on the meter the speed control unit frequency setting when the unit is used as a test set (engine not running). The actuator dither is a measurement of the switching rate (frequency) of the actuator voltage. Usually the switching rate will be between 40-300 Hz. For CU 671C and CU 673C speed control units an observed reading above 40 Hz (the yellow mark in the meter) is considered satisfactory. The calibration is 600 Hz full scale.

THE MAGNETIC SPEED SENSOR

This position of the switch (Pos. 11) will give an AC measurement of the pickup voltage. 20 VAC full scale is the calibration. Any value over 1 VAC (red mark) is satisfactory.

Turn "AUTO-MAN" switch (Pos. 8) to manual and rotate the manual frequency adjust (Pos. 6) until mid scale is read on the meter. Any deviation noticed will be a measurement of real speed change of the engine.

To calibrate the meter (Pos. 10), use the speed trim control (CU 6710A) to change engine speed by 1%.

TERMINAL STRIP (Pos. 17)

Terminal Voltages, Resistance and Terminal Function of CU 671C-7 and CU 673C-7 speed control units

Terminal	Typical DC Voltage	Function
A	5. Volt (approx.) varies with the setting of the stabiity control.	Feedback capacitor
B	From 2V. to Battery Voltage	Actuator connection
C	Battery Voltage	Battery supply
D	Battery Voltage	Actuator connection
E	10.2 (with 24V - 32V Supply) Battery Voltage (with 12 V Supply)	12 volt supply jumper
G (F)(H)	0	Ground
J	0-10.2 V.	Frequency trim
K	10.2 VDC	Regulated supply
L	5.1 on speed (Approx.)	Speed signal
M	2.5 - 7.5 VDC	Feedback filter capacitor
N	1-9	Droop voltage
P	5.1 VDC	Regulated 5.1 volts
R	3.5 V (approx.) (Note 1)	Load sharing input
S	0.25 - 30 VAC RMS (Note 2)	Magnetic pickup signal
T	0	Ground side of magnetic pickup

NOTE 1: With external high impedance meter, this value will be 4.9V.
NOTE 2: Turn Meter Switch (Pos. 11) to "Mag-Pickup".

OPERATION OF TSE 671C AS A TEST UNIT

For Mode 1 operation (see page 1 for explanation). Place the selector switches in the following positions for 115/230 VAC operation:

Selector Switch (Pos. 11)	- 0-10 V.
DC Voltmeter Probe (Pos. 15)	- Terminal B
Droop (Pos. 12)	- Off
Dead Time Filter (Pos. 13)	- Off (Center)
Norm/rev. (Pos. 14)	- Norm - sec. pg. 1 Norm/Reverse Switch
"Fast-Slow" Switch (Pos. 7)	- Fast
AC Power (Pos. 4)	- On
Power Switch (Pos. 1)	- 12 volts
External-Internal Switch (Pos. 3)	- Internal
Eng. Simulation (Pos. 9)	- On
"Auto-Man" Switch (Pos. 8)	- Automatic
"Fast-Slow" Switch (Pos. 7)	- Fast
Manual Freq. Adj. (Pos. 5)	- Any position

Plug the power cord into 115/230 VAC outlet. The pilot lamp (Pos. 2) will go on. The test set is now ready to be connected to the speed control unit using the harnesses provided (Pos. 19) and adapter cable (Pos. 21) for CU 673C-7.

For Mode 2 operation (see page 1 for explanation). Switch positions same as on page 4 except:

1. Disconnect the power cord from the AC outlet. Pilot lamp (Pos. 2) will go out. Or turn power switch (Pos. 4) to "OFF".

2. Change the position of the following two switches:
   (a) "EXTERNAL - INTERNAL" switch (Pos. 3) EXTERNAL.
   (b) Power Switch (Pos. 1) to the same voltage as the battery supply, (12V or 24V or 32 VDC).

3. Connect to the battery using terminal "C" positive and terminal "G" negative to (Pos. 17).

The test set is now ready to be connected to the speed control unit using the harnesses provided (Pos. 19).

OPERATION (Mode 1 and Mode 2)

Set the switches for Mode 1 or Mode 2 operation as per above. Connect the test set to the speed control unit using wiring harnesses (Pos. 19). Put probe (Pos. 15) into terminal "B" (Pos. 17).

The meter (Pos. 10) should read 6 volts approximately. This reading will be higher than 6 VDC if the supply voltage is greater than 12 volts. The speed control unit will be reacting to internal engine simulation (allow several seconds). If instability is noted on the meter, adjust the gain and/or the stability controls on the speed control unit counterclockwise. Load may now be applied by depressing the load simulation button (Pos. 6). The actuator voltage (terminal B) will reduce to approximately 4.0 volts on the meter. Releasing the button (Pos. 6) will release the simulated load and the meter will indicate the original 6 or more volts on terminal B.

To measure the frequency set point of the speed control unit, turn the selector switch (Pos. 11) to "frequency". Read the frequency setting on the meter (Pos. 10) frequency scale. If more accuracy is desired, an external frequency counter may be connected from terminal S to T. To adjust the frequency setting of the speed control unit, turn the speed adjust on the control unit clockwise to increase the frequency set point. The meter will indicate the increased set point.

For "C" series control units the speed control unit response is measured on terminal L. To do this, turn the selector switch (Pos. 11) to "0-10". Place the probe (Pos. 15) into terminal L (Pos. 17). A 5.1 volt reading should be obtained. Alternately apply and remove load with the load button (pos. 6) and note the voltage change. As load is applied the voltage at L will momentarily increase and then return to original 5.1 volts. Higher voltages than 5.1 on terminal L indicate simulated speeds lower than the speed control unit frequency set point. Actuator voltage at terminal B will change toward minimum voltage (full throttle) as simulated load is applied. Values of approximately 5.1 volts on terminal L indicate the speed control is at the frequency set speed and controlling. At this point, the gain and stability controls on the speed control unit may be adjusted for different responses and their effect monitored. A speed control unit cannot be set for stable operation with the gain and stability controls and then be installed on an engine with an expectation of the same stable operation and performance. The engine simulation is only typical and is used to test the speed control unit response. Exact simulation of a given engine cannot be obtained.

Open loop operation may be obtained by switching the "AUTO-MAN" switch (Pos. 8) to manual. Monitor terminal B and note the voltage change as the manual frequency adjust (Pos. 5) is turned slowly (CW increases the frequency of the internal oscillator). The manual frequency adjust is controlling an internal oscillator as the speed information source. When this internal oscillator reaches the setting of the governor control, terminal B will react by changing its voltage from 2 volts to battery voltage or vice versa.

OPERATION OF TSE 671C AS IN-LINE TEST INSTRUMENT (Engine will be running)

Place the selector switches in the following positions:

Meter Switch (Pos. 11)	0-30V
Droop Switch (Pos. 12)	Off
Norm/Rev. (Pos. 14)	Norm
Dead Time Filter (Pos. 13)	Off
AC Power Switch (Pos. 4)	Off
Power Switch (Pos. 1)	Battery voltage (12 or 24, 32 VDC)
External-Internal Switch (Pos. 3)	External
"ON-OFF" Switch (Pos. 9)	Off
"AUTO-MAN" Switch (Pos. 8)	Manual
Manual Freq. Adj. (Pos. 5)	Full CCW (counter-clockwise)
Voltmeter Probe (Pos. 15)	Terminal B

CAUTION
THE POWER SWITCHES (POS. 1, 3, 4 AND 9) MUST BE IN THE ABOVE POSITIONS BEFORE CONNECTING THE TEST SET TO THE EXISTING HARNESS AND STARTING THE ENGINE.

WARNING
IF LEFT IN ON POSITION CONTROL OF ENGINE WILL BE LOST.

Using harness (Pos. 18 and 19), connect the test unit in line with the existing harness to the speed control unit for CU 671C and CU 673C. All the original governor functions will be maintained with the test set is connected in line. The engine may be started and stabilized. The speed sensor voltage may be measured at terminal S by turning the meter switch (pos. 11) to "MAG. PICKUP" (any meter reading above the red mark on the voltmeter scale, while cranking, is adequate voltage). The actuator switching frequency may be monitored by turning the meter switch to "ACT. DITHER". Any reading above the yellow mark on the meter scale represents frequency above 40 Hz., which is satisfactory. An internal speed measuring circuit, identical to the speed sensor in the governor speed control unit, (using the magnetic speed sensor signal as a speed signal) is available by turning the meter switch (Pos. 11) to "SPEED SENSOR". With the governor in control at a steady state speed, turn the manual frequency adjust (Pos. 5) CW until a reading of 5.0 volts is obtained. Voltage will vary with speed over a limited frequency range. Calibration may be obtained by noting the generator frequency at the 5.0 volt level. Then turn the speed trim (CU 6710A) until the generator frequency is 0.6 cycle higher (1% speed change on 60 Hz. sets). The meter will indicate approximately a 0.5 volt change indicating 2% per volt calibration. The limit of range for the speed measuring circuit is from 1-10 volts of continuous adjustment with the manual frequency adjust control (Pos. 5). Steady state speed stability may be monitored at the meter (Pos. 10). If an oscilloscope is available, an excellent true speed error can be measured by inserting the oscilloscope probe into the "Internal speed sensor" test point (Pos. 16). Pictures taken on an oscilloscope will provide copies of actual governor performance. Usually the recovery time is considerably shorter, but the transient depth is deeper than most other recording instruments indicate. The steady state stability is easier to read because of the increased resolution with the oscilloscope. The sluggish response of a recording instrument's pen can account for major errors in the measured steady state stability of an engine generator set. It is interesting to note that the individual cylinder firing and compression strokes and their resultant changes in engine speed can be seen on most installations with the oscilloscope.

On CU 671C and CU 673C speed control units a dead time filter capacitor (Pos. 13), may be added to further examine engine performance. The dead time filter capacitor will double the delay compensation and tend to eliminate low frequency surge. (See Section EG 50-1 or EG 50-1A, Page 7).

Should engine performance improve with the addition of the dead time filter capacitor, this capacitor may be externally added to the speed control unit as per Section EG 50-1 or EG 50-1A, Page 7.

Also on the CU 671C and CU 673C units the droop may be added by droop switch (Pos. 12). The speed of the engine will then change as load is applied and removed.

EXTERNAL INSTRUMENTATION

Greater accuracy may be obtained from the test instrument if better instrumentation is available. Instruments such as a frequency counter, an oscilloscope and precise high impedence voltmeter can provide more accurate settings and a better understanding of the test set measurements. As mentioned above, a frequency counter may be connected across the pickup signal S to T (T being ground) for accurate frequency settings. An oscilloscope can be used to check the wave forms on the terminals and can be used with the internal speed sensor (Pos. 16). Terminal L of the CU 671C and CU 673C will give the engine transient and steady state analysis.

ACTUATOR TEST

If a bench test of the speed control unit and the corresponding actuator is desirable, (for mode 1 or mode 2 operation, engine not running), a DC battery may be connected to terminal C Positive (Pos. 17) and terminal G Negative (Pos. 17). Make sure switch (Pos. 4) is "OFF", switch (Pos. 3) is "EXTERNAL" and switch (Pos. 1) corresponds to battery voltage. Repeat tests on terminal L as per page 4 and monitor the actuator response.

CALIBRATING THE METER (Pos. 10)

The meter calibrating adjustments are on the circuit board attached to the bottom of the case. Remove the (4) four screws holding the panel and lift the entire panel board out. The meter calibration is the trim control located toward the middle of the board. Connect an accurate, external 10V meter between terminal P and terminal G (ground). Set the meter switch (pos. 11) for 0-10V position. Connect probe (pos. 15) to terminal "P". Connect a known good "C" series control unit to test set in mode 1 operation.

Terminal G is to read 0 while terminal P is to read 5.1V. Turn the calibrating adjustments slowly until the meter reads the same as the external meter on the CU 671C.