SECTION 4

VOLTAGE REGULATORS & ALTERNATOR CONTROL UNITS

ALTERNATOR - REGULATOR DESIGN

An alternator has a self-limiting characteristic which controls current flow in the charging circuit. It does not, however, control voltage or incorporate relay provisions in the field circuit. Thus, either a Transistorized Alternator Regulator, a Solid-State Regulator or an Alternator Control Unit will be included in the alternator charging circuit.

TRANSISTORIZED VOLTAGE REGULATOR (SILICON TYPE) (C611002-0105)

The amount of voltage delivered by an alternator must be regulated to protect the charging circuit. For early 1978 210 Series aircraft & all 1978 188 Series aircraft, (refer to the appropriate Parts Catalog for actual serialization) the 95-ampere alternator installation uses a transistorized regulator, encompassing transistors, diodes, resistors and capacitors in its circuitry.

The regulator maintains the charging system voltage at a constant level by controlling the current delivered to the alternator field coil (rotor) through transistors and printed circuitry, rather than the vibrating contacts of mechanical voltage regulators.

When the engine is started and the alternator portion of the master switch is turned on, battery voltage is supplied to the alternator field through a two transistor output stage of the voltage regulator. As the alternator begins to supply current, battery voltage will increase, when battery voltage reaches approximately 28 volts, the zener diode, suddenly reduces its resistance and switches on the driver transistor, When the driver transistor switches on, the power output transistor is switched off stopping current flow to alternator field, as the output of alternator drops, voltage to battery and zener diode drops. This increases the zener diode resistance and switches off the driver transistor, which allows power output transistor current to flow to alternator field again. This constant switching procedure allows the regulator to control the voltage output of the alternator.

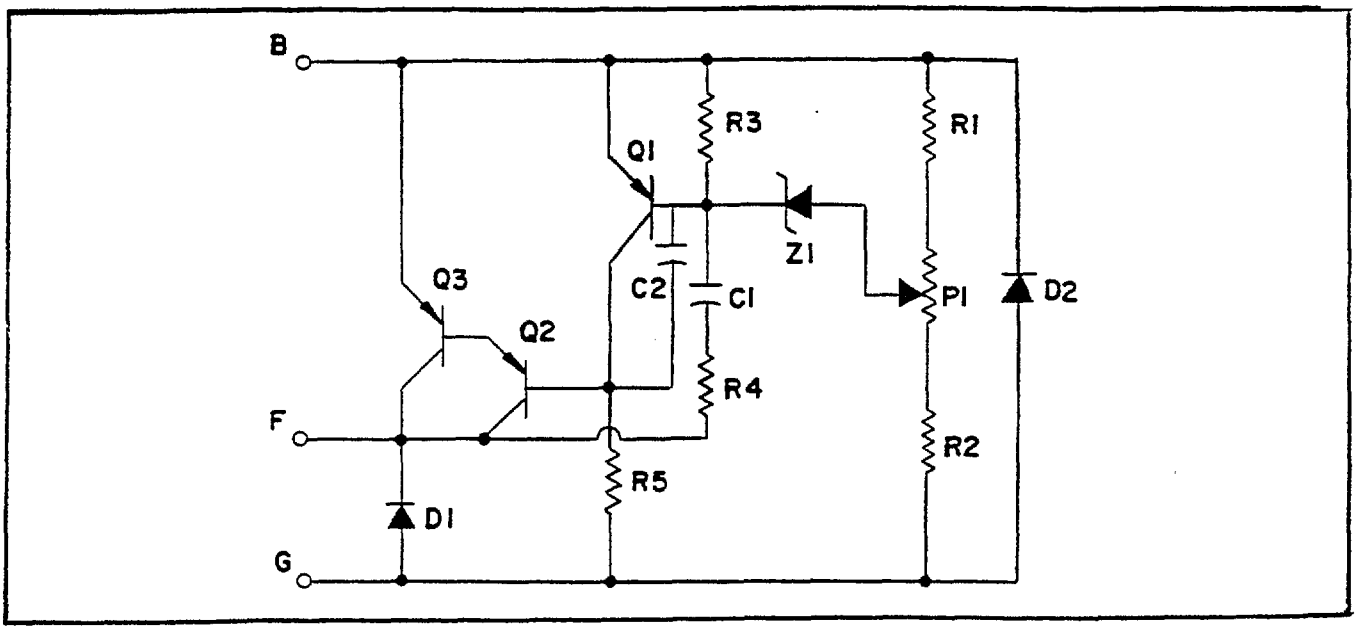

Figure 4-1. Transistorized Voltage Regulator Schematic (C611002-0105)

Transistorized Voltage Regulator Adjustment (Refer to Figure 4-2).

Transistor regulator calibration is achieved by adjustment of potentiometer P1. Capacitor C1 in series with R4 resistor causes the switching action of transistors to be faster or slower to raise or lower voltage. The

oltage setting can be taylored to meet the requirement of a given aircraft to maintain no less than 1, 260 attery specific gravity. Adjusting P1 clockwise decreases voltage and counterclockwise increases voltage.

CAUTION

Use an insulated screwdriver to adjust potentiometer, shorting of the potentiometer case to regulator housing may cause serious damage to regulator.

a. Connect an accurate voltmeter across alternator output.

b. Adjust voltage carefully; change in increments of 0.3 volts or less, with adequate time between to allow stabilization of battery specific gravity. One or more flight checks as a time interval is suggested.

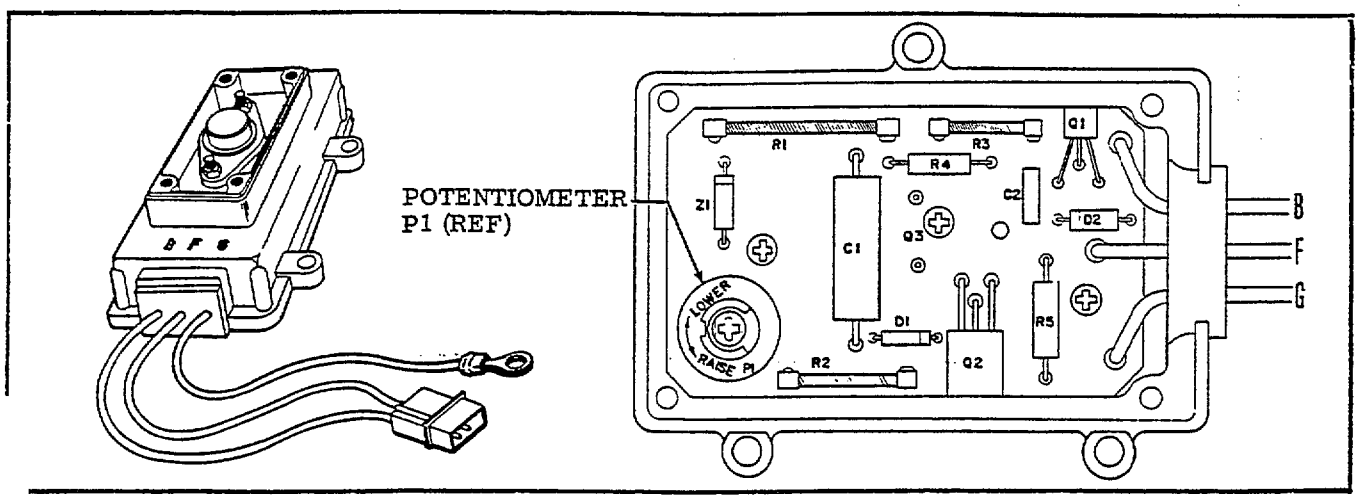

Figure 4-2. Transistorized Voltage Regulator Adjustment (C611002-0105)

Transistorized Regulator Specifications - Transistor Voltage Limiter (C611002-0105)

Type:	Transistorized for use with self current limiting alternator.
Terminals:	Multiple connector incorporated in harness.
Voltage Limiter:	Adjustable by turning screw driver adjustment counterclockwise to raise voltage and clockwise to lower voltage.

Transistorized Regulator Bench Test (C611002-0105) (Refer to Figure 4-3)

Bench testing can be utilized to determine if regulator is set within specified voltage limits at specified temperatures.

a. Use bench equipped with 95-amp alternator.

b. Connect regulator B terminal to load ammeter.

c. Connect F terminal to alternator field circuit ammeter.

d. Connect G terminal to common ground.

e. Battery specific gravity minimum 1.260.

f. Adjust carbon pile to produce 7 ampere indication on load ammeter.

g. Adjust alternator speed to obtain a field current of 0.3 to 0.7 amperes.

h. Regulated air blast capable of maintaining temperatures from 60° to 90° (within 7°).

i. Operate regulator for 10 minutes to stabilize temperature. Read regulated voltage at the regulator B terminal. The voltage shall be within limits shown in chart for the specified temperature range.

Air Blast Temperature	Voltage Limit
60° to 67°	27.4 to 28.0
68° to 74°	27.4 to 28.0
75° to 83°	27.4 to 28.0
84° to 90°	27.4 to 28.0
90° to 97°	27.4 to 28.0

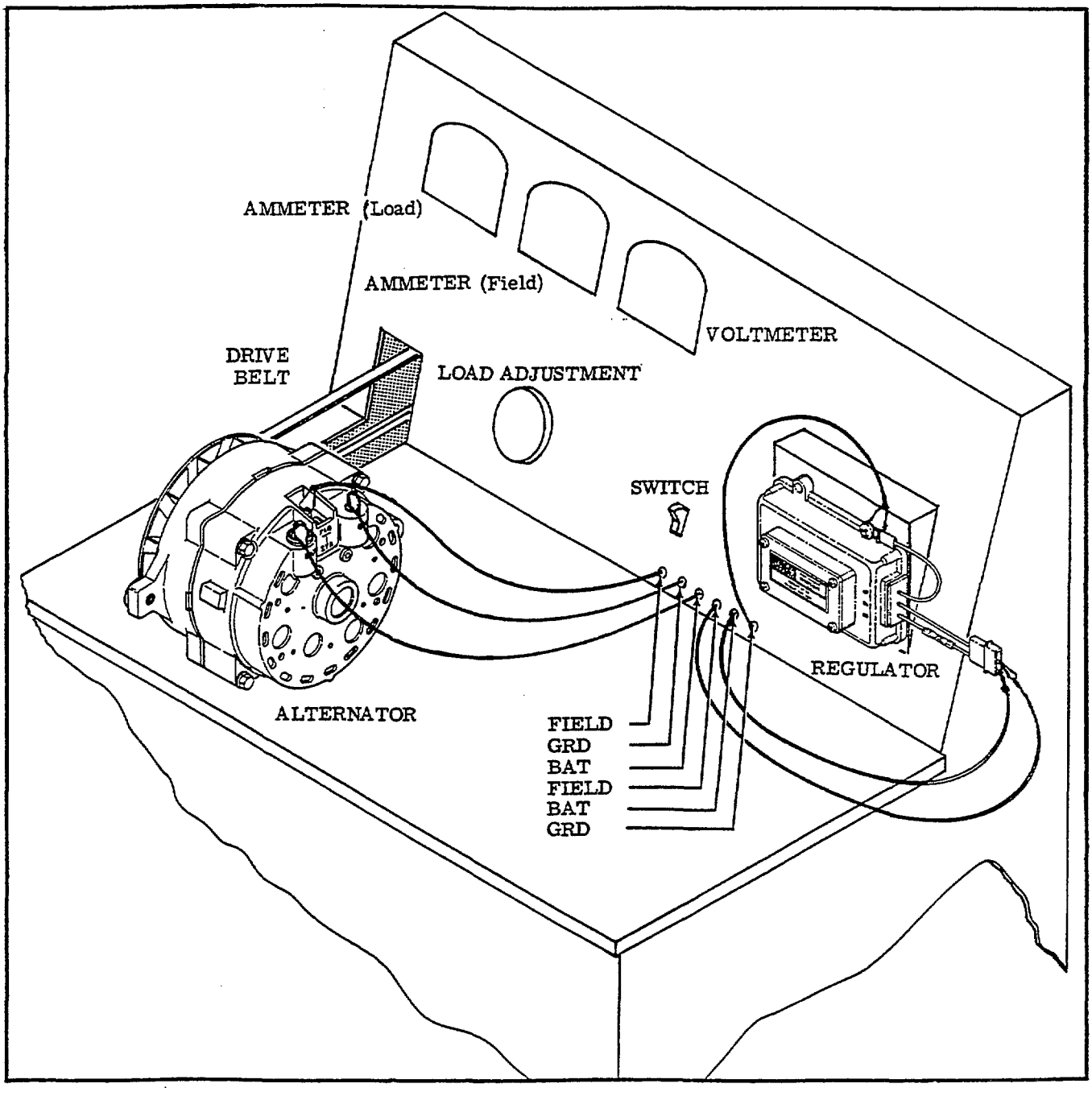

Figure 4-3. Typical Bench Test Set-Up for Transistorized Regulators

SOLID-STATE 28-VOLT VOLTAGE REGULATOR (C611004-0101 or C611004-0102)

A solid-state voltage regulator (C611004-0101) is available to control 28-volt, negative ground aircraft alternators on early 1979 188 Series aircraft and also as an alternate to the C611002-0105 transistorized regulator for all early 1978 210 Series aircraft. (Refer to the appropriate Parts Catalog for actual serialization.) Voltage regulation is accomplished by comparing the bus voltage to a precision internal reference voltage and supplying current to the field of the alternator in order to keep the bus voltage at its specified value, independent of load, speed and temperature. All components of the regulator are conservatively rated in order to provide the maximum reliability and safety. The C611002-0105 transistorized regulator may be used as an alternate if the C611004-0101 regulator is not available.

Another 28-volt solid-state voltage regulator (C611004-0102) was introduced on all late 1978 210 and P210 Series Models and all late 1979 188 Series Models. (Refer to the appropriate Parts Catalog for actual aircraft serialization.) These two solid-state regulators are not interchangeable, the difference between the regulators is the preset voltage setting (see the "28-Volt Solid-State Regulator Specifications" for preset voltage setting differences).

Solid State Regulator Service Procedures (C611004-0101 or C611004-0102)

The solid-state voltage regulators (C611004-0101 and C611004-102) are designed to be long lasting, trouble free regulators. The regulators should be considered non-repairable items and with most regulators containing only an internal voltage limiter adjustment. The following paragraphs define which regulators have a voltage limiter adjustment and which ones do not have.

Solid-state regulators having a regulator manufacturer's date prior to 4-1-78 are equipped with a voltage limiter adjustment pot. These units can be identified by a rubber plug-button installed in the voltage limiter adjustment access hole (see figure 16A).

On regulators with a manufacturer's date of 4-1-78 thru 8-1-78, the voltage regulator cannot be adjusted since the access hole and adjustment pot do not line-up. However, since some of these units were recycled by the manufacturer the access hole and adjustment pot may be lined-up. To determine if the unit can be adjusted, peel-up the manufacturer's decal and see if the access hole and adjustment pot align.

Regulators with a manufacturer's date of 8-1-78 and on, do have an aligning access hole and voltage limiter adjustment pot. Therefore, voltage adjustments can be made on these units. It is also necessary on these units to peel-up the manufacturer's decal to gain access to the adjustment pot.

Solid-State Voltage Limiter Adjustment (C611004-0101 or C611004-0102)

To adjust the voltage limiter, refer to Figure 4-4 and proceed as follows:

1. To gain access to the voltage limiter adjustment screw, remove the rubber plug from the front of the regulator on units manufactured prior to 4-1-78, or carefully peel-up the manufacturer's decal on the front of the regulator on units with a manufacturer's date of 4-1-78 and on.

CAUTION

Use care not to bend the manufacturer's decal any more than necessary since after adjustment, the decal must be replaced to keep out moisture.

2. To adjust the voltage limiter insert a screwdriver, or Allen wrench, in the adjustment access hole and rotate counterclockwise to increase the voltage setting, or clockwise to decrease the voltage setting.

NOTE

The C611004-0101 voltage regulator has been preset at the factory to provide 27.7 ±0.3 volts at 70°F and the C611004-0102 voltage regulator has been preset to provide 28.8 ±0.3 volts at 70°F. Never shift the voltage setting more than 0.3 volts, from previous setting. Always allow an adequate time interval between each new voltage setting in order to obtain an accurate stabilized specific gravity battery reading.

3. After readjusting the voltage limiter, replace the plug-button or using a good commercial grade of contact cement, reinstall the manufacturer's decal.

CAUTION

Decal should be reinstalled in such a manner to prevent moisture from getting into the adjustment access hole.

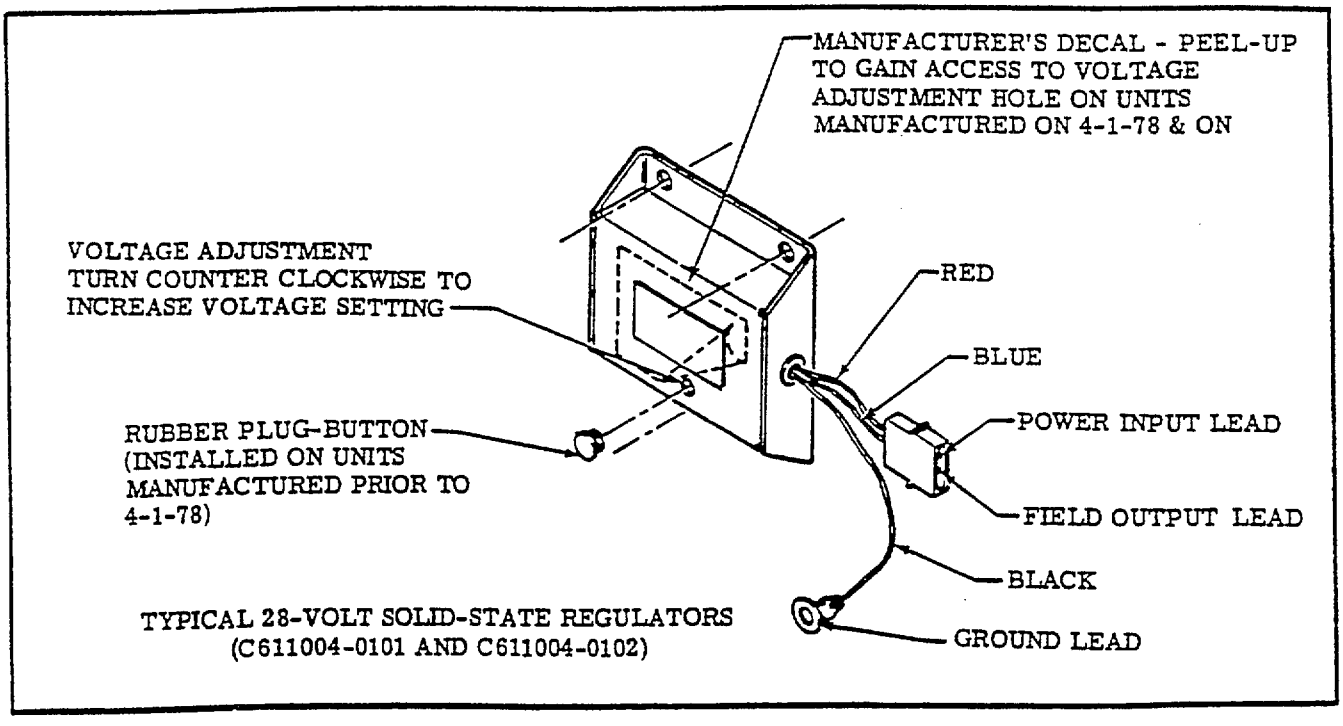

Figure 4-4. Typical Solid-State Voltage Regulators (C611004-0101 and C611004-0102)

SHOP NOTES:

28-Volt Solid-State Regulator Specifications (C611004-0101 and C611004-0102)

Type:	Two unit design. solid-state voltage regulator with integrated transistorized voltage limiter. For use with self current limiting alternator.
Terminals:	Two pin connector and ground terminal.
Voltage Limiter:	Adjustable by rotating screw driver. or Allen wrench. adjustment counter-clockwise to raise voltage (clockwise to lower voltage).
Voltage Setting:	27.7 ±0.3 volts (C611004-0101) 28.8 ±0.3 volts (C611004-0102)
Voltage Regulation:	±0.4 volts
Field Current:	3.0 amps maximum continuous
Operating Temperature:	-40°F to +155°F
Operating Altitude:	Sea level to 35,000 Ft.
Weight:	0.5 Lbs. Maximum

28-VOLT ALTERNATOR CONTROL UNIT (C611005-0101. C611005-0102 and C611005-0103) AND LOW VOLTAGE WARNING LIGHT

An Alternator Control Unit (ACU) as shown in Figure 4-5, has been incorporated in all 1979 & on 210, T210 & P210 Series aircraft and all 1981 & on T182, R182, TR182, U206, TU206, 207 & T207 Series aircraft. The Alternator Control Unit, consists of a combination voltage regulator and high-low voltage sensing devices. The ACU is installed on the forward side of the firewall on all 182 Series aircraft and all 1979 thru 1980 210 Series aircraft. The ACU is installed on the aft side of the firewall on all 1981 & on 210 Series aircraft and all 1981 & on U206 and 207 Series aircraft. The Low Voltage warning light (Red) is installed on the instrument panel, close to the ammeter. The warning light will illuminate upon a signal from the Alternator Control Unit, to alert the pilot of an ACU malfunctioning condition or system.

The following information will provide the service technician with service/parts information necessary to maintain and test the new Alternator Control Unit and the ACU Tester. The following information only outlines testing procedures to enable the technician to isolate malfunctions to either the Alternator Control Unit or the Alternator. If malfunctions are traced to the Alternator, refer to the "TROUBLE SHOOTING and ALTERNATOR BENCH TESTS" in "Sections 6 & 7", of this manual for isolation of alternator malfunctions.

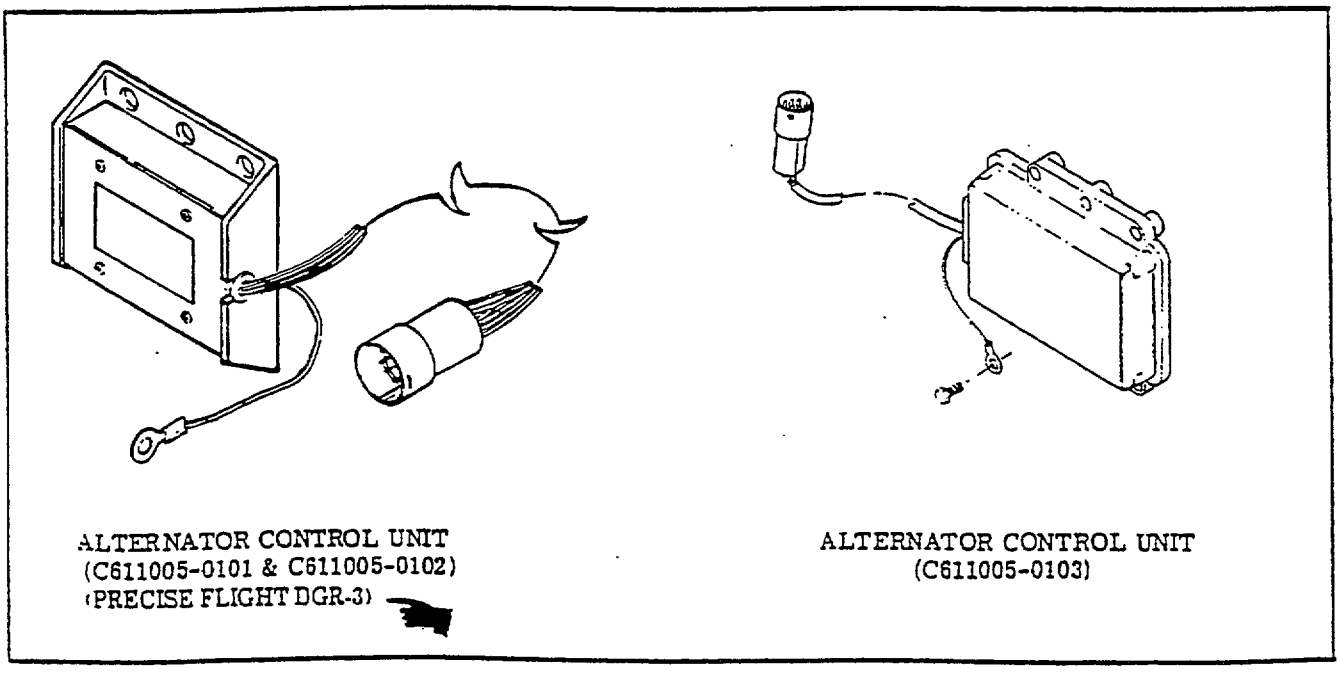

Figure 4-5. Alternator Control Unit (C611005-0101. C611005-0102 and C611005-0103)

Alternator Control Unit (C611005-0101, C611005-0102 and C611005-0103) Operations

The Alternator Control Unit will provide high voltage protection by removing the excitation voltage from the alternator field when a high bus voltage is sensed. After a high voltage condition, the sensor can be reset by cycling the ALT half of the Master Switch, OFF and back ON again when the C611005 ACU is installed. When the PFT DGR-3 ACU is installed an overvoltage condition will cause the regulator 5 amp circuit breaker to open. The circuit breaker must be reset to restore operation. When a low bus voltage is sensed, the Low Voltage warning light will illuminate (Red) and will be extinguished automatically when the condition is corrected.

NOTE

Illumination of the Low Voltage warning light and ammeter discharge indications may occur during low RPM conditions with an electrical load on the system (such as during a low RPM taxi). Under these conditions, the light will go out at a higher RPM. The master switch need not be recycled since an over-voltage condition has not occurred to de-activate the alternator system.

The field voltage will automatically be removed from the alternator anytime a high voltage is sensed causing the Low Voltage warning light to illuminate. With the warning light illuminated and the alternator shut down, the battery will then supply system current, as shown by a discharge rate on the ammeter.

To determine if the Low Voltage warning light illumination is caused by a high or low voltage condition (during normal RPM operation), the Low Voltage warning light and ACU may be tested by turning the alternator switch OFF and back ON again. If the warning light does not illuminate again, normal alternator charging has resumed; however, if the light does illuminate again, a malfunction has occurred, and the ACU system should be check out as outlined in the "TROUBLE SHOOTING" write-up in "Section 6", of this manual using the ACU Tester Assembly.

Alternator Control Unit Service Requirements (C611005-0101, C611005-0102 and C611005-0103)

The Alternator Control Unit has been designed to provide a long lasting and trouble free voltage regulator with high-low voltage sensors. The Alternator Control Unit is a non-repairable item.

Alternator Control Unit Specifications (C611005-0101, C611005-0102 and C611005-0103)

Type: Solid-state, combination 28-volt voltage regulator with high and low voltage sending circuits.

Terminals: Seven pin connector and ground terminal.

Environmental Requirements:

1. Operational Temperature Range: -25°F to +175°F
2. Storage Temperature Range: -65°F to +200°F
3. Altitude: Sea level to 35,000 Ft.

Electrical Requirements:

1. System Polarity: Negative ground

Preset Factory Voltage Settings:

1. Regulator Specification:
   a. Voltage Set Point - 27.7 ±0.3 volts DC at 70°F on Units manufactured prior to 5-15-78 and 28.8 ±0.2 volts DC at 70°F on Units manufactured on 5-15-78 and on.
2. High Voltage Sensor Specification:
   a. Static Tripout Set Point - 31.8 ±0.3 volts DC at 70°F.
3. Low Voltage Sensor Specification:
   a. Set Point - 24.5 ±25 volts DC at 70°F

MODEL T303 28-VOLT ALTERNATOR CONTROL UNITS (C611007-0101) AND EQUALIZATION FUNCTIONS

T303 Alternator Control Unit (C611007-0101) Description and Operation

All 1982 and on T303 model aircraft are equipped with two alternator control units (ACU's), mounted under the floorboard behind pilots seat (see figure 4-6), to provide electrical control functions for both alternators.

The 1982 and on T303 ACU's are solid state and provide voltage regulation plus high voltage protection and low voltage sensing. Should either alternator system cause an over-voltage condition, the alternator control units disconnect their respective alternators from the bus. In the event of a high voltage condition, one or both alternators may be disconnected from the buses. Should a low-voltage condition occur, the ACU's will illuminate an amber light, labeled LOW V, on the pilot's annunciator panel to warn of the condition. Each ACU continually monitors the output of each alternator; should an alternator fail completely or have zero output, an amber light, labeled L. ALT OFF or R. ALT OFF located on the annunciator panel, will illuminate to indicate a loss of alternator output.

Load sharing between the alternators is achieved by internal paralleling circuitry in the ACU's. The load on each alternator is monitored by means of the alternator shunts. The ACU's adjust the alternator field excitation such that each alternator is carrying approximately half the load (± 15 amps). Should the paralleling system fail, the alternators will revert to two independent systems. Under these conditions, the alternator and ACU with the highest regulating point will continue to carry the electrical load. If this alternator becomes overloaded, the other one will automatically pick up the excess electrical load.

A low voltage amber warning light is also installed in the annunciator panel, labeled LOW V, to warn the pilot anytime the voltage falls below approximately 24.5 volts, as sensed by either alternator control unit.

A volt-ammeter and selector switch are mounted on the left side of the instrument panel so that electrical system operation can be monitored. Depending on the position of the selector switch, the load placed on the left or right alternator, the battery charge or discharge current, or the system voltage can be selected and indicated via the volt-ammeter.

Model T303 Alternator Control Unit Specifications (C611007-0101)

The alternator control unit has been designed to provide long lasting and trouble free operation. The alternator control unit is a non-repairable item and is to be replaced with a new unit when found to be defective.

Type: Solid state, provides voltage regulation plus high voltage protection and low voltage sensing as well as containing a paralleling circuit for load sharing between the alternators.

Environmental Requirements:

1. Operating Temperature Range: -25°F to +175°F (-31.6°C to +79.4°C)
2. Storage Temperature Range: -65°F to +200°F (-53.8°C to +99.3°C)
3. Altitude Range: Sea Level to 35,000 Ft.

Electrical Requirements:

1. Connector: A sixteen pin connector which utilizes pins 1 through 12. Pins 13 through 16 are not used.
   - Pin 1: Connected to the Field Exciter circuit of ACU.
   - Pin 2: Connected to + Remote Sensor circuit of ACU.
   - Pin 3: Connected to + Power In circuit of ACU.
   - Pin 4: Connected to Low Voltage Annunciator Lite circuit of ACU.
   - Pin 5: Connected to - Remote Sense circuit of ACU.
   - Pin 6: Connected to Alternator OFF Annunciator Lite circuit of ACU.
   - Pin 7: Connected to Alternator OFF Sense circuit of ACU.
   - Pin 8: Connected to Low Voltage Sense circuit of ACU.
   - Pin 9: Connected to Line Contactor circuit of ACU.
   - Pin 10: Connected to - Current Sense circuit of ACU.
   - Pin 11: Connected to Equalizer circuit of ACU.
   - Pin 12: Connected to Power Ground circuit of ACU.
2. Supply Voltage: Operating voltage ranges from 22 to 32-volts DC. Unit will not trip out with supply voltage ranging from 10 to 31-volts DC.
3. Supply Current: 5-amperes maximum DC in normal operation.
4. System Polarity: Negative Ground System.
5. System Battery: Unit will operate without a battery connected to the aircraft bus. With no battery connected, the unit operates normally except regulation is degraded 10%. (See the following "Regulation Section" for regulation range of operation.) Paralleling is not available without a battery.

6. Regulation Section: The Regulator is designed to sense a voltage at the alternator and regulate a field current output.
   a. Voltage Set Point: 28.7+0.5/-0.5 volts DC at 70°F(21°C).
   b. Regulation: 28.7+0.4/-0.8 volts DC throughout operating temperature range and load range. Load range is 10-amps minimum to maximum rated alternator output.
7. Low Voltage Sensor Section: The low voltage sensor is designed to sense a voltage between pins 8 and 12 and supply a warning signal.
   a. Low Voltage Sensor Set Point: 24.5±0.50 volts at 70°F(21°C).
   b. Low Voltage Sensor Reset Point: 25.0±0.50 volts. Switching point does not vary more than ±1.0 volts throughout the temperature range.
8. High Voltage Sensor Section: The high voltage sensor section is designed to sense a voltage between pins 10 and 5 and interrupt as follows:
   a. High Voltage Dynamic Tripout Set Point: 31.8 ±0.6 volts DC at 70°F(21°C). Trip point does not vary more than ±1.0 volts from 70°F(21°C) set point throughout the temperature range. In no case will the trip point exceed 32.2 volts.
9. Secondary High Voltage Circuit: The circuit is designed to disconnect the power input of pin 3 if line contactor and field excitation voltage is still being supplied when a high voltage condition is sensed.
   a. Secondary High Voltage Circuit Trip Point: 34.5 ±3.0 volts DC.
10. Overcurrent Protection Circuit: Designed to sense current through the power input (Pin 3) and protect the line contactor circuit and regulation circuit.
11. Alternator OFF Sensor Section: The alternator OFF sensor is designed to sense a voltage between pins 7 and 12 and supply a warning.
12. Line Contactor Circuit Section: The unit is designed to sense a voltage between pins 10 and 5 and operate the coil of the line contactor.
13. Paralleling Circuit: The unit contains a circuit to sense alternator current output through an external shunt and influence the field output of the regulator in order to assure balanced alternator load sharing.
14. Selective Trip Capability: The unit incorporates circuitry that, in the event of an overvoltage condition, will trip only the ACU/Alternator system that is causing the problem, off the line.
15. Voltage Regulation, Overvolt Protection, Alternator Out Sensing, Line Contactor Circuitry, Paralleling Circuitry and Low Voltage Warning: These circuits are designed to be independent to the extent that failure of any one does not disable the other circuits.

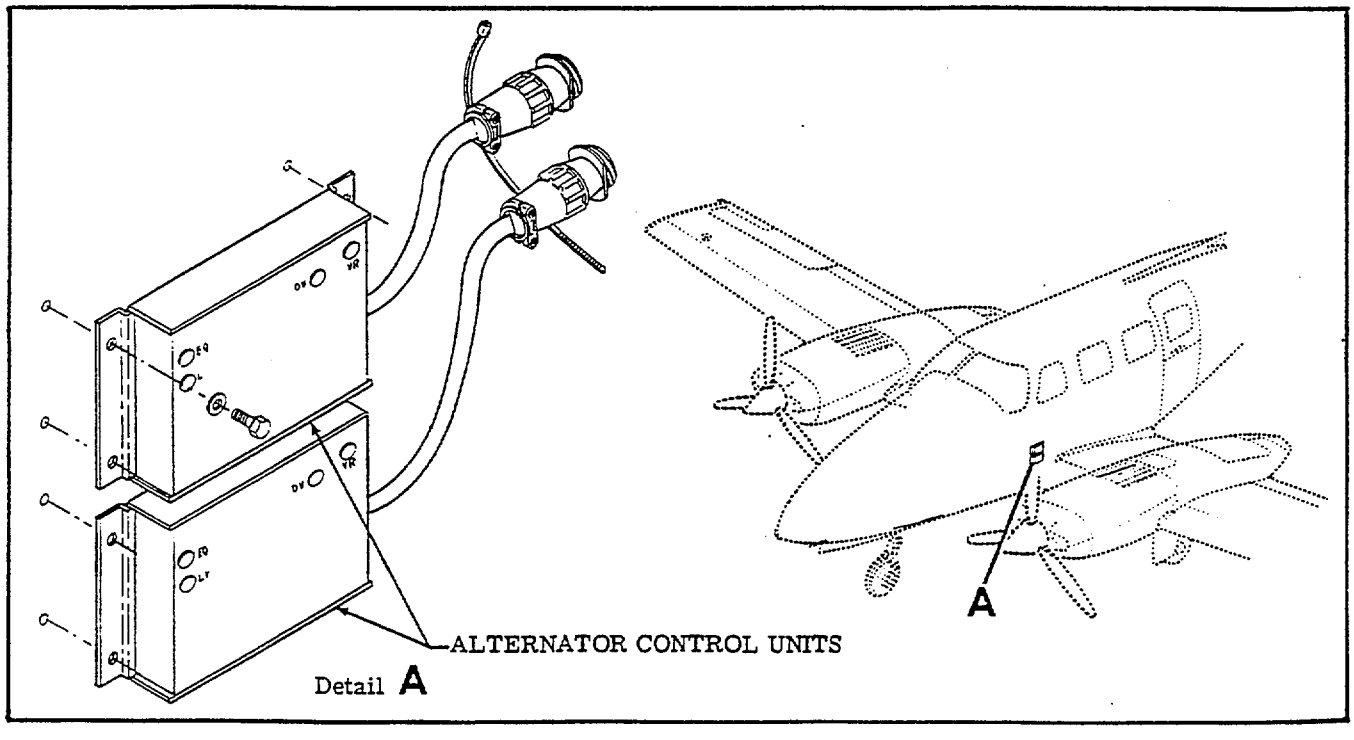

Figure 4-6. Alternator Control Unit (T303 Models Only)

MODEL 208, 208A AND 208B ALTERNATOR CONTROL UNIT (C611008-0101)

208, 208A AND 208B Alternator Control Unit (C611008-0101) Description and Operation

Model 208, 208A and 208B airplanes may be equipped with an alternator control unit (ACU), mounted on two brackets located in the lower forward left hand cabin sidewall structure just forward of the circuit breaker panel. This unit provides electrical control functions for the 95-amp standby alternator, which is part of a standby electrical system designed to automatically supply power to the main busses if the system voltage drops below a preset level.

Model 208, 208A and 208B ACU is solid state and provides voltage regulation plus high voltage protection and low voltage sensing. Should the alternator system cause an over-voltage condition, the alternator control unit disconnects the alternator from the bus. In the event of a high-voltage condition, alternator may be disconnected from bus. Should a low-voltage condition occur or alternator fail completely, the ACU will illuminate an amber annunciator light, labeled STBY ELECT PWR INOP.

Model 208, 208A and 208B Alternator Control Unit Specifications (C611008-0101)

The alternator control unit has been designed to provide long lasting and trouble free operation. The alternator control unit is a non-repairable item and is to be replaced with a new unit when found to be defective.

Type: Solid state, provides voltage regulation, high voltage protection and low voltage sensing.

Environmental Requirements:

1. Operating temperature range: -25°F to +175°F (-31.6°C to +79.4°C)
2. Storage temperature range: -65°F to +200°F (-53.8°C to +99.3°C)
3. Altitude range: Sea level to 35,000 ft.

Electrical Requirements:

1. Connector: A sixteen pin connector which utilizes pins 2 thru 7, 9 and 10 and 12 and 13.
   - Pin 2: Connected to + remote sensor circuit of ACU.
   - Pin 3: Connected to + power in circuit of ACU.
   - Pin 4: Connected to Stby elect pwr on circuit of ACU.
   - Pin 5: Connected to - remote sensor circuit of ACU.
   - Pin 6: Connected to Stby elect pwr inop circuit of ACU.
   - Pin 7: Connected to alternator off sensor circuit of ACU.
   - Pin 9: Connected to line contactor circuit of ACU.
   - Pin 10: Connected to - current sensor circuit of ACU.
   - Pin 12: Connected to power ground circuit of ACU.
   - Pin 13: Connected to field exciter circuit of ACU.
2. Supply Voltage: Operating voltage ranges from 22 to 32 volts DC. Unit will not trip out with supply voltage ranging from 10 to 31 volts DC.
3. Supply Current: 5-amperes maximum DC in normal operation.
4. System Polarity: Negative ground system.
5. System Battery: Unit will operate without a battery connected to the airplane bus. With no battery connected, the unit operates normally except regulation is degraded 10%. (See the following "Regulation Section" for regulation range of operation.)
6. Regulation Section: The regulator is designed to sense a voltage at the alternator and regulate a field current output.
   a. Voltage Set Point: 27.5 +0.2/-0.1 VDC at 70°F (21°C).
   b. Regulation: 27.5 +0.2/-0.6 VDC throughout operating temperature range and load range. Load range is 10-amps minimum to maximum rated alternator output.
7. Standby Electric Power-on Sensor Section: The alternator-on sensor is designed to sense a voltage between pins 2 and 10 and supply a warning signal as follows:
   a. Sensor Set Point: 10.0 ±1.0 AMPS at 70°F (21°C). Switching point not to vary more than ±2.0 AMPS throughout the temperature range.
   b. Sensor Reset Set Point; 9.0 ±1.0 AMPS. Switching point not to vary more than ±2.0 AMPS throughout the temperature range.

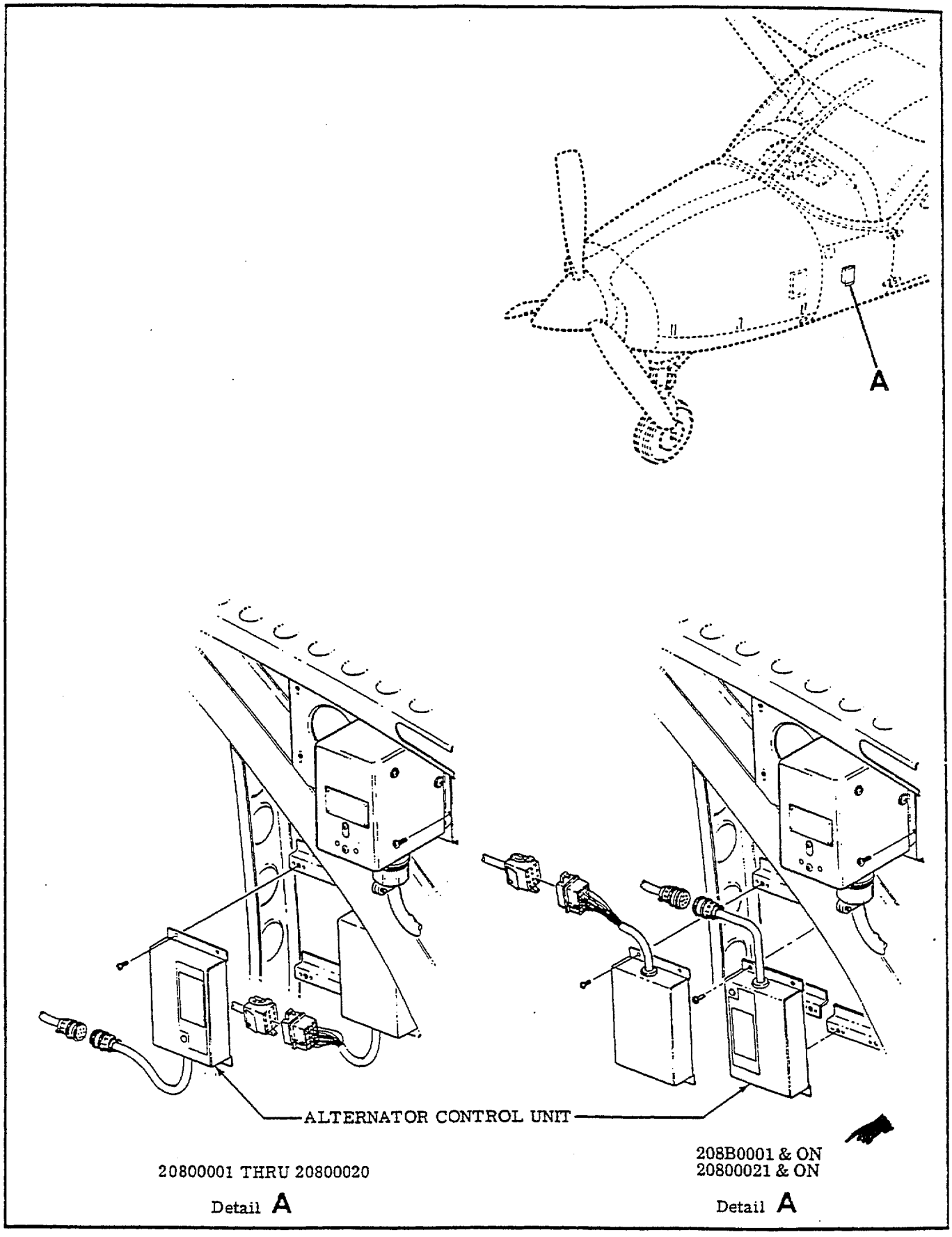

Figure 4-7. Alternator Control Unit (208, 208A and 208B Models Only)

8. High Voltage Sensor Section: The high voltage sensor section is designed to sense a voltage between pins 10 and 5 and interrupt as follows:
    a. High Voltage Dynamic Tripout Set Point: 31.8 ±0.3 volts DC at 70°F(21°C). Trip point does not vary more than ±0.5 volts from 70°F(21°C) set point throughout the temperature range. In no case will the trip point exceed 32.3 volts.
9. Secondary High Voltage Circuit: The circuit is designed to disconnect the power input of pin 3 if line contactor and field excitation voltage is still being supplied when a high voltage condition is sensed.
    a. Secondary High Voltage Circuit Trip Point: 34.5 ±1.8 volts DC.
10. Overcurrent Protection Circuit: Designed to sense current through the power input (Pin 3) and protect the line contactor circuit and regulation circuit.
11. Standby Electric Power-Inop Sensor Section: The alternator off sensor is designed to sense a voltage between pins 7 and 12 and supply a warning as follows:
    a. Standby Electric Power - Inop Sensor Set Point: 6.0 ±0.3 volts at 70°F(21°C). Switching point not to vary more than ±0.5 volts from set point throughout the operating temperature range.
    b. Standby Electric Power - Inop Sensor Reset Point: 7.0 ±0.3 volts at 70°F(21°C). Switching point not to vary more than ±0.5 volts from set point throughout the operating temperature range.
12. Line Contactor Circuit Section: The unit is designed to sense a voltage between pins 10 and 5 and operate the coil of the line contactor.