Aerolineas Argentinas

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CHAPTER 24 – ELECTRICAL POWER

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ELECTRICAL POWER - DESCRIPTION AND OPERATION

1. General

A. The electrical power system is a network consisting of three, 3-phase, 400 cycle 115/200 volt, generating and interconnecting bus arrangements. Electrical power is supplied from isolated generators located on each engine and from an APU generator of the same rating in the tail cone (Fig. 1). Single phase transformers are used to reduce a portion of this power to 28 volts ac, and transformer rectifiers fed from the 3-phase bus connections are used to furnish 28 volts dc. A battery is installed in the lower forward section to furnish emergency power to certain critical loads when the basic sources are de-energized.

B. The generating system consists of the two main ac load busses energized by two isolated brushless generators each driven by a constant speed drive (CSD). In the event of generator failure, selected loads carried by that generator are automatically relayed to the other running generator by means of two transfer bus relays. An identical generator driven by the auxiliary power unit turbine may be used in flight as well as on the ground to supply 3-phase 400-cycle power when necessary. Provisions are made for connecting conventional ground power supplies to external power receptacles. A 3-phase receptacle near the nose wheel well on the lower right side of the body is used for external dc power and those airplanes provided with a external dc receptacle, the receptacle is located below the battery in the lower equipment bay and is used for external dc power (Fig. 1). None of the three generators on the airplane can be operated in parallel with others or with a 3-phase ground supply. The APU generator speed is controlled by a mechanical governor in the turbine fuel line. Engine-driven generator speed is controlled by a mechanical governor in each CSD.

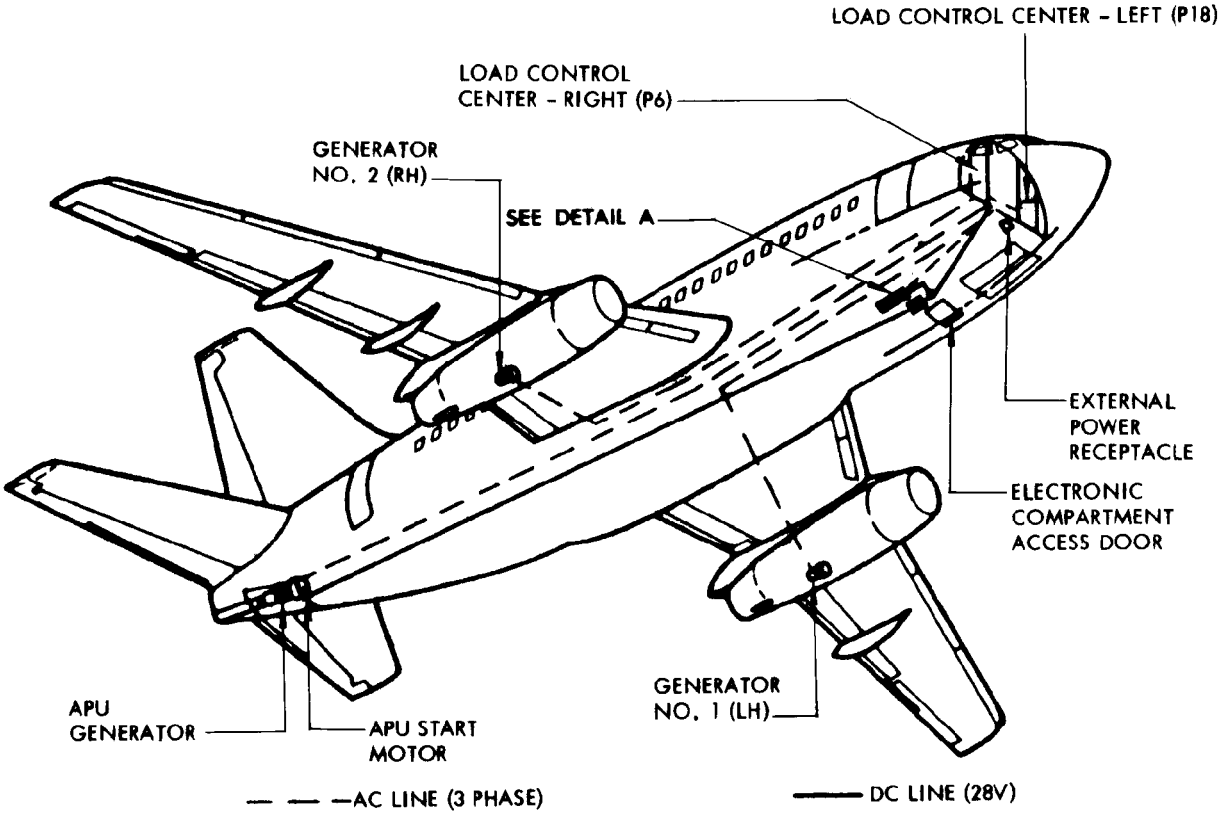
C. A generator control unit (GCU) is provided to regulate and control each of the three generators. They perform the following functions:

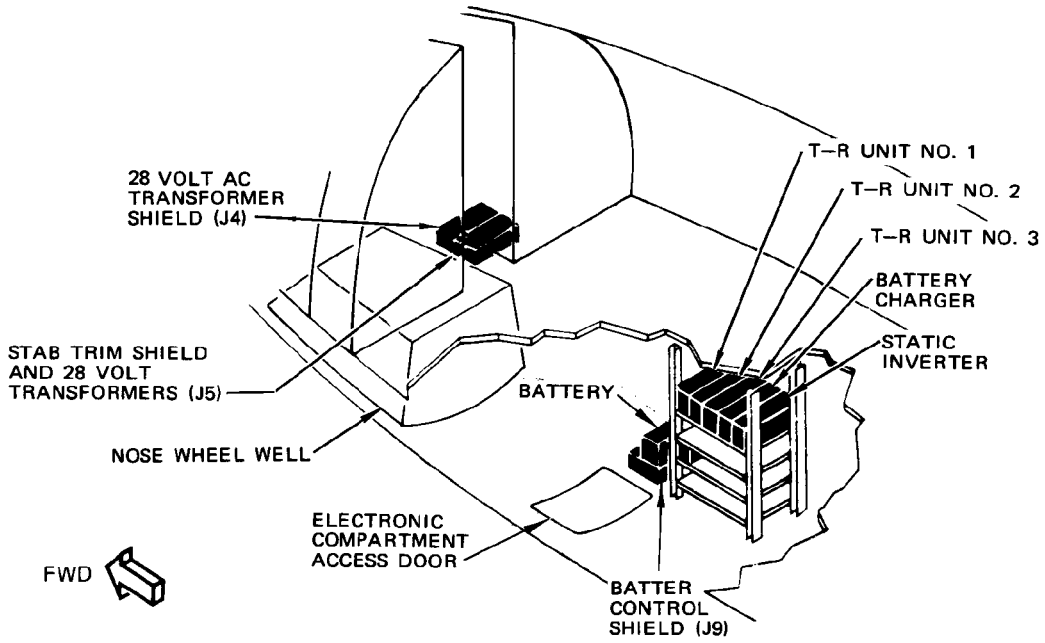
(1) Regulation of the average of the three phase voltages which may exist at the end of the generator feeders (considering an estimated length of 50 feet).

(2) Provision of excitation power for normal, overload, and fault conditions by means of a transformer rectifier unit within the GCU and connected to the generator output through boost current transformers used in conjunction with the transformer rectifier.

(3) Provision of adjustment for generator no-load voltage. (The point of adjustment is marked to show the direction of rotation required to lower or raise the line-to-neutral voltage between 110 and 120.)

(4) Limitation of power input to the generator shaft to 160 horsepower, by means of a current signal supplied to the regulator in the GCU by three current transformers. (This power limit is based on a generator efficiency of 77%.)





DETAIL A

Electrical Power System Component Location
Figure 1

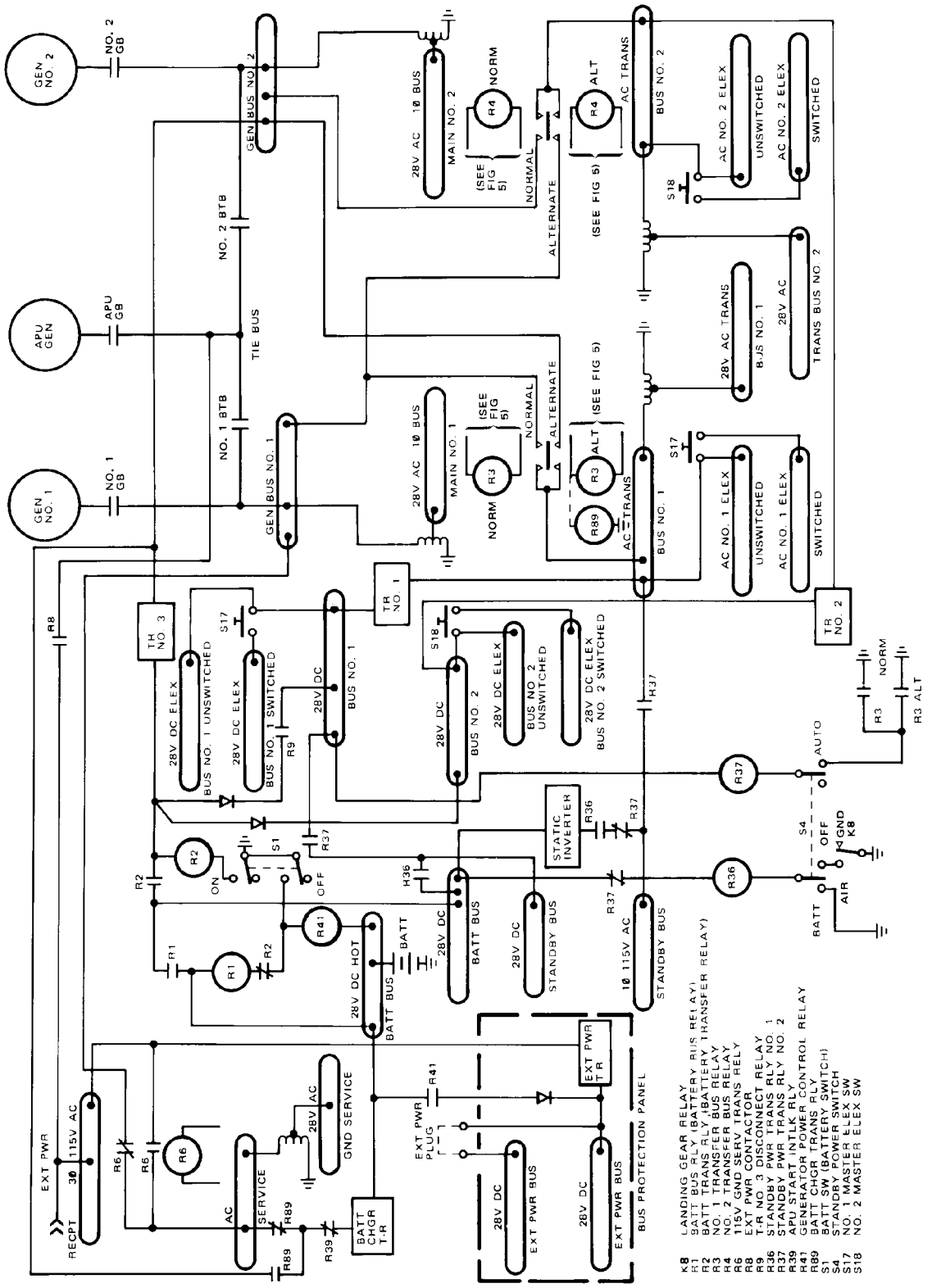
(5) Protection from abnormal system conditions such as overvoltage, undervoltage, differential current, overcurrent, overfrequency or underfrequency. An anticycling protection feature within the control system prevents cycling of the system when fault conditions exist, and the manual switches in the control cabin are held in the ON position.

D. Control of the electrical system is more automatic than for systems which may be operated in parallel. Since the generators in the system cannot be operated in parallel, control of the transfer bus is automatic, so that the operating generator is transferred to pick up bus loads of the tripped generator when that generator stops functioning. The transfer bus contactor has a magnetically held relay with a "center-off" position. The transfer bus control has a preferred source, with the control circuit so arranged that transfer of power under normal operating conditions should not occur. The right and left generator breakers and bus tie breakers, the APU generator breaker and the external power contactor are all electrically interlocked and automatically trip the operating source of the bus when another source is switched to this bus.

2 Operation

E. With the airplane on the ground, all engines shut down, external 3-phase power connected to the receptacle, and if the power source is of the correct voltage, (with no negative sequence voltage condition) then the external power contactor (EPC) will close when the ground power (EP) switch is placed on the ON position.

NOTE: Placing the ground power switch to ON sends a trip signal to the APU generator breaker (GB) and to engine generator breakers No. 1 and 2 (GBl-GB2). With the APU generator powering the airplane, closing the ground power switch (EP) will trip the APU GB and allow the external power contactor (EPC) to close. The bus tie breakers (BTB) will close, connecting external power to the load buses (Fig. 2). The dc power for closing the EPC and BTBs is supplied from a transformer-rectifier (T-R) unit in the bus protection panel (BPP). The transformer-rectifier provides dc power for control and protection when ac power is connected to the external power receptacle. If external power goes into an undervoltage, overvoltage, or negative sequence voltage condition, the EPC will be de-energized.

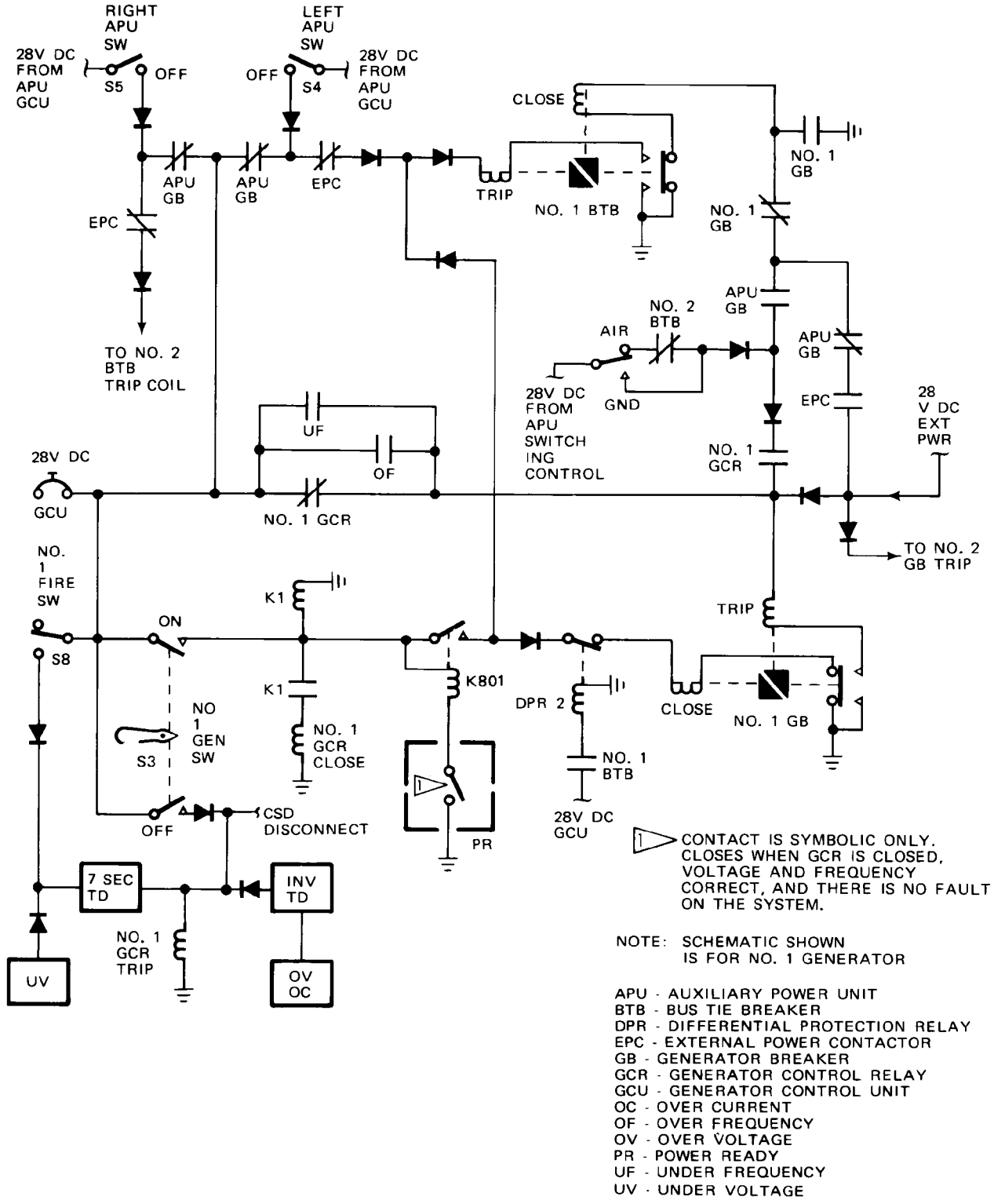


Electrical Power System Bus Diagram
Figure 2

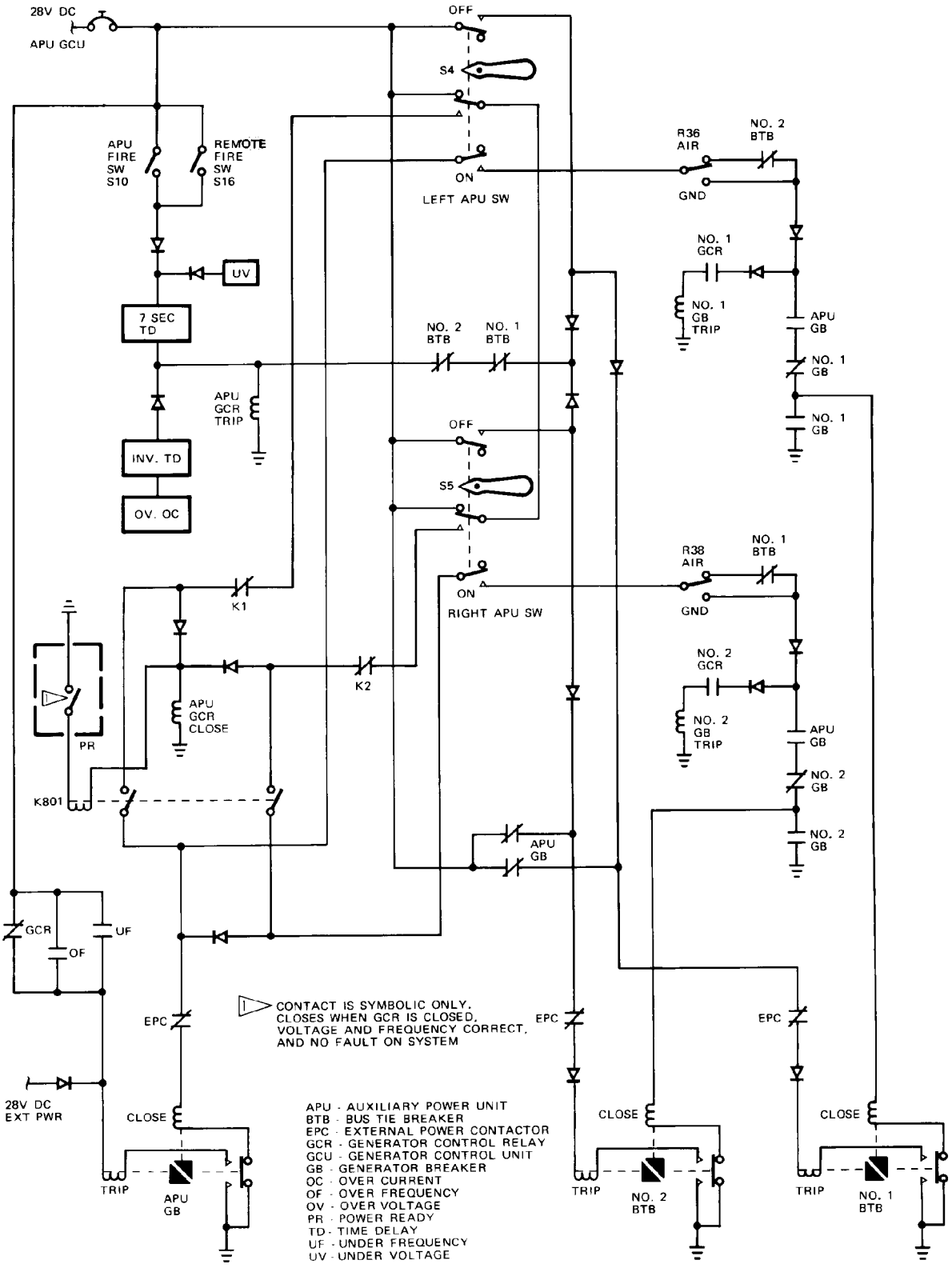
F. With the airplane on the ground, all engines shut down, all generator control relays (GCR's) closed, and power being supplied to the main buses through both BTB's from the APU, if engine No. 1 is started (and a few seconds allowed for its generator to come up to speed and voltage), the No. 1 generator breaker (GB) will not close and take over generator bus No. 1 until No. 1 generator control switch is placed in the ON position, and No. 1 BTB is tripped. Then No. 1 GB automatically closes and No. 1 generator supplies the No. 1 main bus. If APU power is removed from the airplane before the No. 2 engine is started, power will be lost to the No. 2 load bus. When the No. 2 engine is started, it will automatically take over the No. 2 load bus when No. 2 generator control switch is placed in the ON position. The same sequence will hold if external power is being used instead of the APU (Fig. 3).

G. With neither airplane engine running, the APU GCR closed, APU generator voltage and frequency correct, the external power contactor (EPC) tripped, either left or right APU control switch in the ON position, the APU GB will close (Fig. 4). Closing the APU GB connects the APU generator to the TIE BUS (Fig. 2). When the left and/or right APU control switch is placed in the ON position, the associated BTB closes and APU power is connected to the No. 1 and/or 2 main bus. Control and protection of the APU is provided by the APU generator control unit (GCU). The BTB's wil1 close with power from the APU GCU or from the battery. The BTB's wil1 trip when the APU GB is tripped or when either APU switch is momentarily placed in the OFF position. The APU generator will shut down automatically when the APU turbine is shut down. The APU generator field is de-excited by momentarily placing both APU control switches in the OFF position if APU generator is powering both buses.

H. When the APU generator is supplying power to a main load bus through its associated BTB and an engine is started, the BTB will be tripped when the generator control switch is placed in the ON position and the voltage and frequency are correct. When the BTB is tripped, the engine-driven generator will be automatically connected to the bus and the differential protection switching relays (DPR's) will be de-energized. When the engine is shut down, the engine-driven generator will reach an underfrequency condition, thereby tripping the GB and disconnecting the generator from the load bus. When the generator reaches an undervoltage condition, a time delay is started. After 7 seconds the GCR will automatically trip and de-excite the field. Momentarily placing the generator control switch in the OFF position will also trip the GCR and GB.

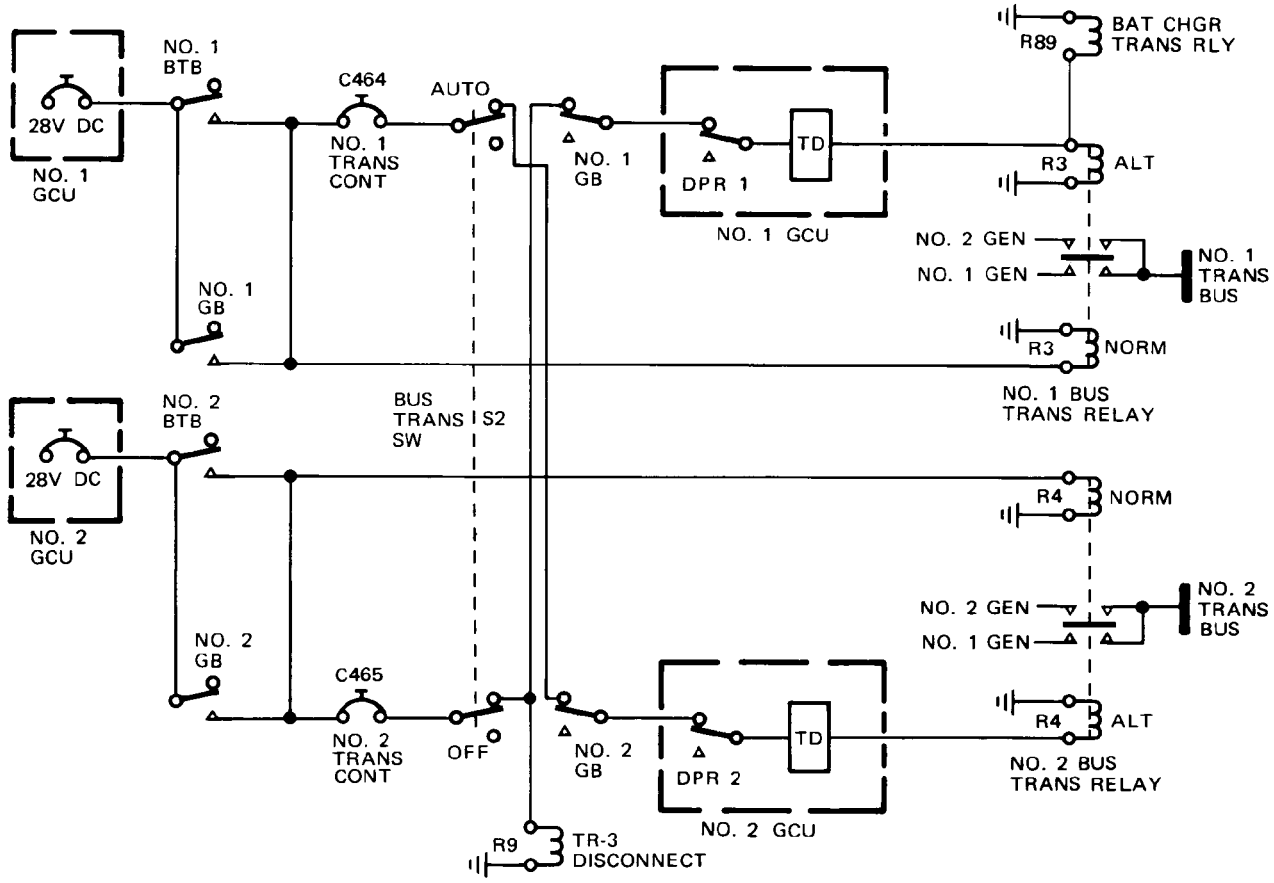


Engine-Driven Generator Control Diagram
Figure 3



APU Generator Control Diagram
Figure 4

I. When both No. 1 and 2 generators are supplying power to the main load buses, No. 1 and 2 GB's will be closed. Transfer buses No. 1 and 2 will be energized with bus transfer relays No. 1 and 2 both in the normal position (Fig. 5). Bus transfer switch S2 on forward overhead panel must be in the AUTO position. Should generator No. 2 stop functioning, loads supplied from the No. 2 transfer bus will be automatically transferred to the No. 1 generator. This is accomplished by energizing the alternate coil of the No. 2 bus transfer relay through normally closed contacts of No. 2 GB. A time delay permits the circuit to mechanically clear previous connections before the No. 2 bus transfer relay closes. A similar sequence takes place should generator No. 1 stop functioning instead of No. 2. Lights on the forward overhead panel P5 indicate when the buses are de-energized. Should generator No. 1 or 2 be connected to the No. 1 and 2 main load buses respectively with the bus transfer switch S2 in the OFF position, No. 2 or 1 transfer bus OFF light respectively on the overhead panel will be on, indicating that transfer buses No. 1 or 2 are de-energized.



Transfer Bus Control Diagram
Figure 5

GENERATOR FEEDER CU-AL SPLICES - APPROVED REPAIRS

1. General
   A. The installation of copper (Cu)/aluminum (Al) generator feeder cables requires the use of an inline splice at the transition point. The fabrication of these splices is unique and special tools are required. Three methods are provided for insulation of the splice: tape wrap, potting, or tape and sleeve. Engine splices are located above engine nacelle by the vapor barrier forward of the front wing spar (WBL 198). APU splices are located on right side outboard of APU shroud (STA 1110). Some airplanes have inline splices on the breaker end located on right outboard side of the nose wheel well (STA 259). Later airplanes have a design improvement using improved AMP inline splices on the generator end and copper-aluminum terminal lugs on the aluminum feeder cables at the breaker end of the generator feeders.
2. Equipment and Materials (Fig. 801)
   A. Crimping tool
   B. Die set
   C. Splices
   D. Insulation method 1, tape wrap
      (1) General purpose cleaning solvent
      (2) Type B film: Permacel - P412, Hwy 1, New Brunswick, NJ 08903; Oak Materials Group - E125-2 or E125-3, McCaffrey St., Hoosick Falls, NY 12090; Minnesota Mining and Mfg. Co. - Scotch 3082 (no longer procurable).
      (3) Polymide tape, Minnesota Mining and Mfg., Co. - Scotch 61 preferred, or bondable TFE fluorocarbon film - Scotch 60, 62, 63, or polymide (H-film) - Scotch X-1205, Dodge Industries - E234-2, Borden Co. - Mystic 7367
   E. Insulation method 2, potted
      (1) Transparent Tubing, Rayclad Tubes Inc. - Thermofit TFE-R
      (2) Potting Compound, Products Research Co. - PR1933
   F. Insulation method 3, tape and sleeve
      (1) Items (1) and (2) same as method 1
      (2) Heat-shrink tubing, Raychem Inc. - Thermofit PD (MS-70)
3. Preparation
   A. Determine method of insulation to be performed; if methods 2 or 3 are to be used, prepare per 6.B. or 6.C., steps (1) thru (3).
   B. Select proper splice for wire sizes to be joined (Fig. 801).
   C. Strip wires to be spliced according to wire type (Fig. 801) and strip length (Fig. 801).

4. Splicing (AMP Cu-Al splices)
   A. Insert conductors into crimp barrels of splice without distorting strands having primary insulation tight against splice.

      CAUTION: FAILURE TO MATE PROPER SIDE OF SPLICE TO COPPER WIRE MAY RESULT IN SPLICE DAMAGE.

      (1) When using AMP part No. 53527-1, blue band on end of splice is to be mated with copper wire.
      (2) When using AMP part No. 52524 for 4 gage copper wire, remove insert from end and mate this side with copper wire.

   B. Crimp splice-wire assembly using proper tooling (Fig. 801). Position splice in stationary die with crimp mark aligned with edge of die. Then reposition splice in stationary die for uncrimped half with splice rotated approximately 180 degrees.
   C. Inspect splice
      (1) The edge of transition must be within 1/16 inch from crimp index mark.
      (2) A certification mark must be centrally located and visible in the bottom of the crimp impression. The mark is a well formed cylindrical button having a symmetrical fully formed pap protruding from its exact center.
      (3) The crimp impressions on each end of the wire splice termination must be on opposing sides.
      (4) Check that splice is aligned such that copper and aluminum conductors are mated to proper end.
         (a) For AMP part No. 53527-1, check that copper wire is inserted into blue band side of splice.
         (b) For AMP part No. 52524, when used with 4 gage copper wire, check that copper wire is inserted into side of splice that insert was removed from.

Splices and Crimping Tools						
ALUMINUM INSPECTION HOLE PLUG P/N: 269-31499-0						
STRIP LENGTH ±1/16		ALUM WIRE SIZE	COPPER WIRE SIZE	SPLICE P/N (AMP)	AMP POWER UNIT *[3]	
A	B				DIE SET	TOOL HEAD
3/4	1-3/8	0	4 *[1]	277163-1 53528-1 *[4]	59877-1	AMP 69066
3/4	1-1/4	2	4	277159-1 52525 *[4]	68009	(MOD Z) OR 69993
7/16	1	4	4 *[1]	277165-1 53527-1 *[4] 277158-1 *[2] 52524-1 *[2]	68008	
7/16	1	4	6	277158-1 52524 *[4]	68008	

A - CONDUCTOR STRIP LENGTH

B - TOTAL STRIP LENGTH, CONDUCTOR PLUS OUTER INSULATION FOR MULTI-LAYER INSULATED WIRE

*[1] 1/8-INCH BLUE BAND ON COPPER SIDE OF SPLICE

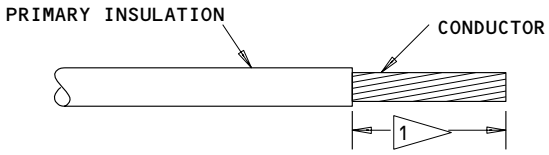
*[2] OPTIONAL - REMOVE INSERT AND USE FOR 4 GAGE COPPER

*[3] NO. 69120-1, 115 VOLTS (60HZ)
NO. 69120-2, 230 VOLTS (60HZ)
NO. 1-69120-0, 220 VOLTS (50HZ)

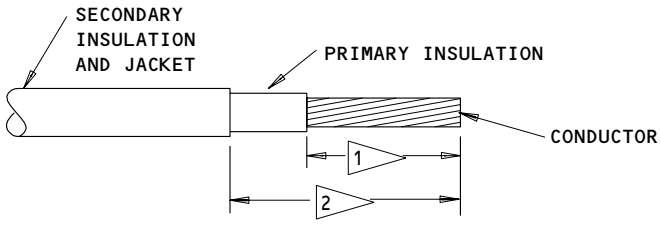
*[4] ALTERNATIVE

5. Insulation of Splice Assembly
   A. Method 1: Tape Wrap Method (Fig. 803)
      (1) Clean splice and at least 1-1/2 inches of outer wire insulation, using general purpose cleaning solvent and a clean cloth. Allow to air dry.
      (2) Build up all voids between splice and wire insulation to prevent abrupt step or sharp edge using Type B film.
      (3) Spiral wrap splice area with Type B film. Three layers of film are required, each with 50% overlap, and extending 1-1/4 ±1/4 inches over outer insulation.

CONDUCTOR	INSULATION	STRIP TYPE	STRIP LENGTH
ALUMINUM OR COPPER	SINGLE LAYER (SUCH AS BMS 13-31, 13-35 etc.)	STRAIGHT SEE DETAIL A	SEE FIG. 801



STRAIGHT STRIP
DETAIL A



STEP STRIP
DETAIL B

1 CONDUCTOR STRIP LENGTH PER FIGURE 801

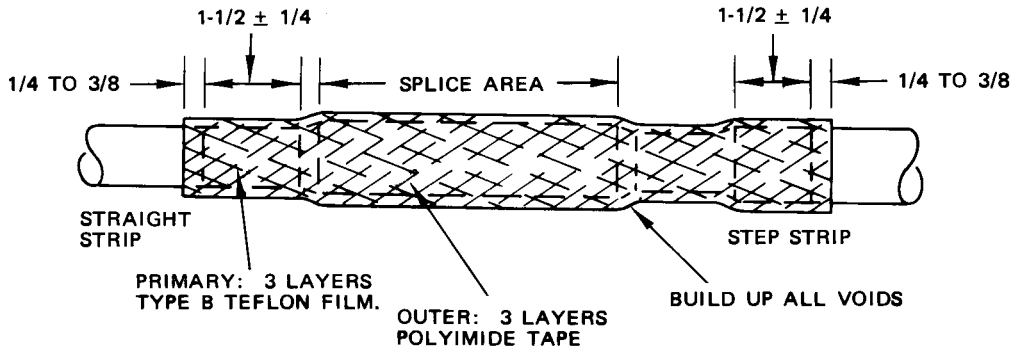
2 TOTAL STRIP LENGTH PER FIGURE 801

Wire Stripping Methods
Figure 801

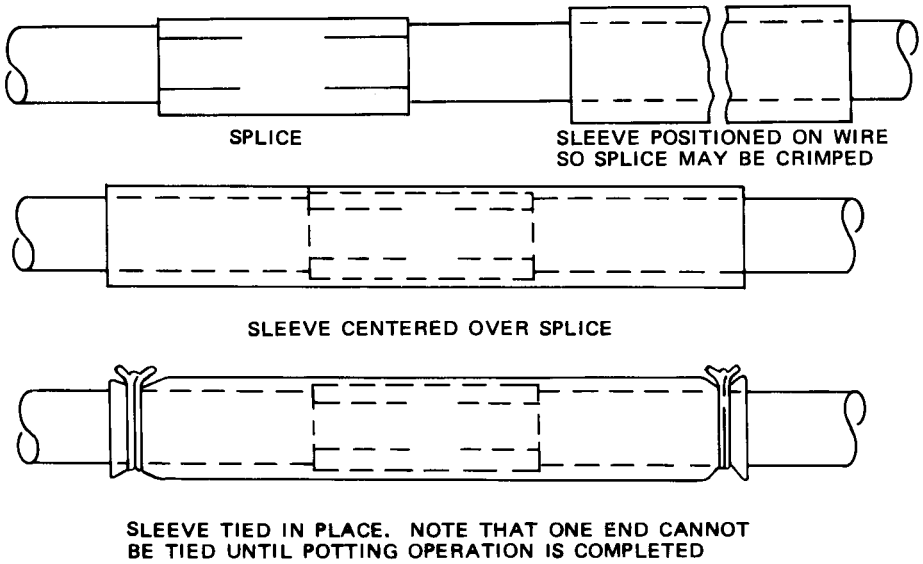
(4) Apply 3 layers of Polymide tape (preferred) or bondable TFE fluorocarbon film or polymide (H-film) over Type B film. Wrap each layer spirally with 50% overlap. Reverse direction of spiral with each layer. Extend tape 1/4 to 3/8 inch beyond each end of Type B film.

B. Method 2: Potted Splice Method (Fig. 802)
   (1) Select transparent TFE-R sleeve that is large enough to allow 1/8 to 1/4 inch of potting compound to encompass largest portion of splice area.
   (2) Cut sleeve to length that will allow potting compound to extend 1-1/4 ±1/4 inch over outer insulation including any jacket.
   (3) Slide sleeve over wire and out of the way. Complete splice assembly.
   (4) Center sleeve over splice area and tie one end with Type IV tying material.
   (5) Pot splice with PR-1933 compound.
   (6) When potting operation is completed, tie other end of sleeve.

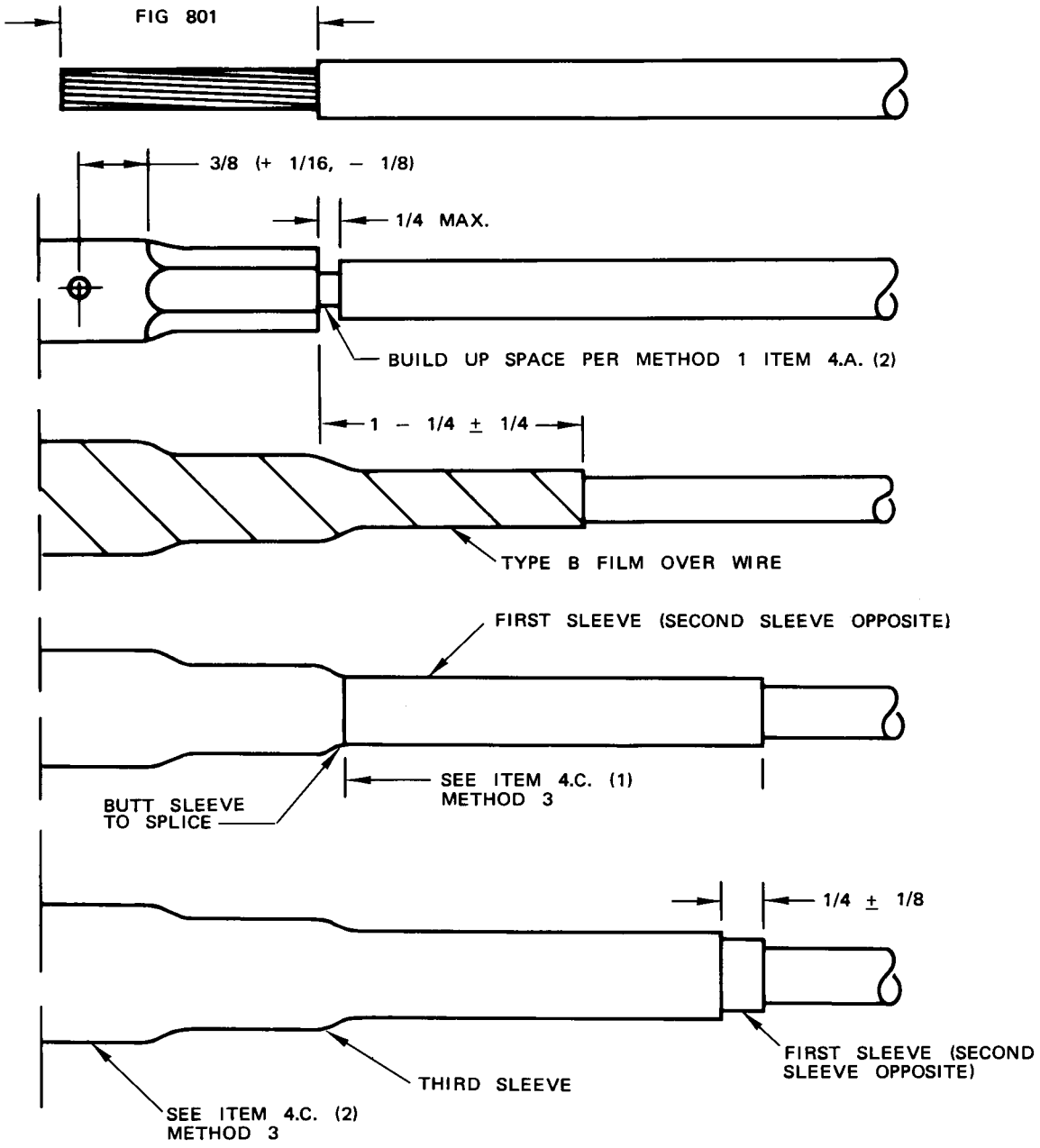
C. Method 3: Tape and Sleeve Method (Fig. 803)
   (1) Select two heat shrinkable sleeves that are large enough to fit over taped wire areas and that will fit tightly over wires when shrunk into place. Cut sleeves long enough to extend 1 ±1/4 inch beyond taped area, when shrunk in place per step (5) below.
   (2) Select third heat shrinkable sleeve that is large enough to fit over taped splice and that will fit tightly when shrunk into place. Cut sleeve to length that will extend to within 1/4 ±1/8 inch of ends of two sleeves (step (1) above).
   (3) Slide sleeves over wires and out of the way. Complete splice assembly.
   (4) Clean and insulate the splice area per Method 1, steps (1), (2), and (3).
   (5) Slide small sleeves over tape until they are butted against ends of splice. Shrink into place.
   (6) Center large sleeve over assembly. Shrink into place.



Insulation Method 1
Figure 803



Insulation Method 2
Figure 802



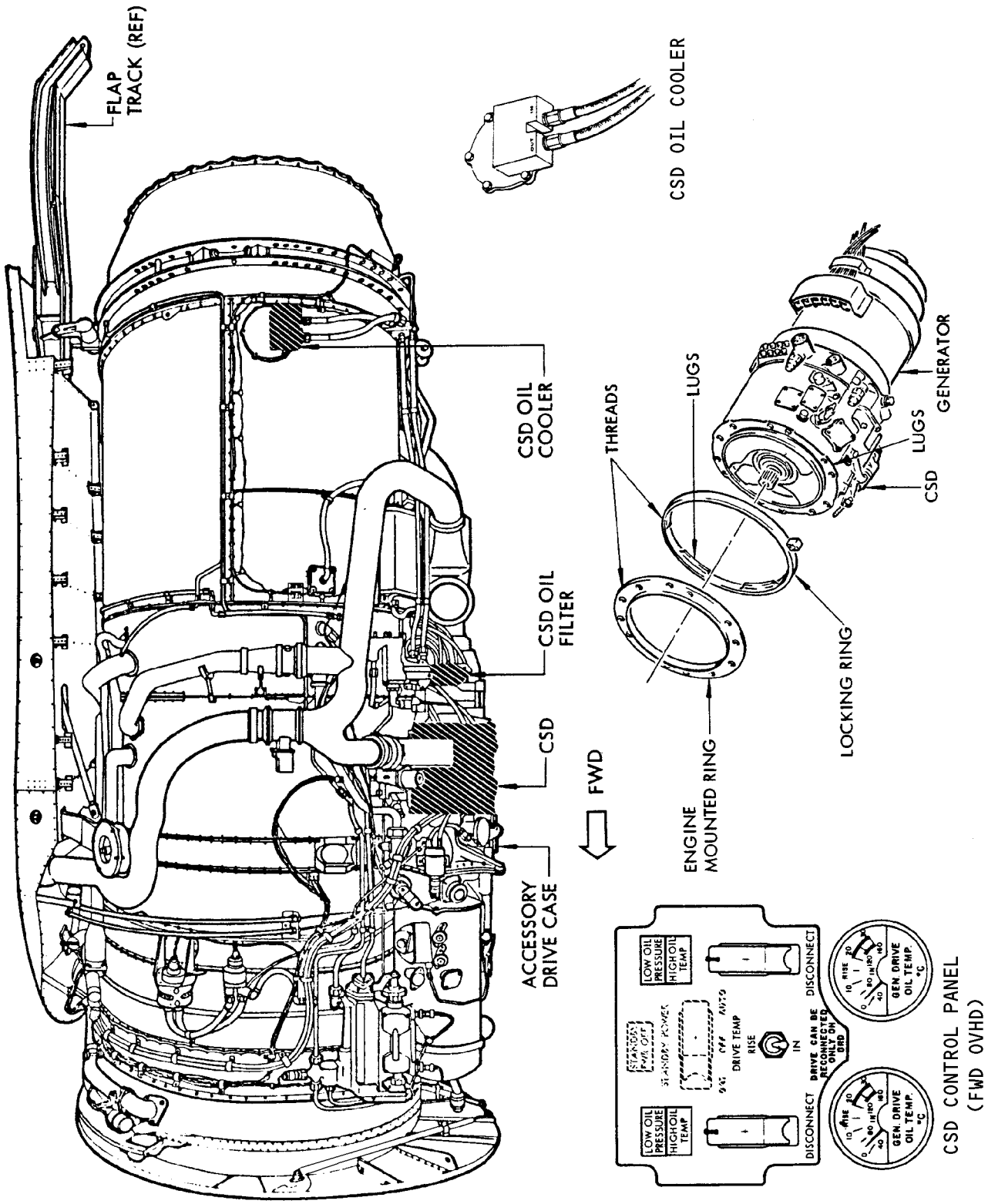
Insulation Method 3
Figure 803

ELECTRICAL POWER PRECAUTIONS - MAINTENANCE PRACTICES

1. General
   A. The electrical power precautions are contained in Chapter 20, Standard Wiring Practices, document D6-54446 (Ref 20-00-10).

AC GENERATOR DRIVE SYSTEM - DESCRIPTION AND OPERATION

1. General
   A. The two engine driven 400 cycle ac generators are rotated by constant speed drive systems to obtain a generator speed of 6000 rpm. The drive system contains a mechanical differential hydraulically controlled drive unit attached to the aft side of the engine accessory gear case (Fig. 1). The drive unit acts as the support for the ac generator.
   B. Manual controls, monitoring lights and dial indicators for the drive systems are on the forward overhead panel in the control cabin (Fig. 1). Lights indicate drive low oil pressure and high oil temperature. Dial indicators show actual drive oil temperature and drive oil temperature rise, by means of a selector switch. A disconnect switch provides for stopping a system through an electrical solenoid-operated mechanical disconnect device included in the drive unit. Sensors in the drive obtain a charge pressure indication and the out and in temperatures of the oil to and from the cooler.
   C. The oil within the drive unit functions to absorb the heat, to serve as the lubricant, and also to transmit some torque as the hydraulic medium. Oil is forced through a line filter and external cooler by a scavenge pump which picks up hot oil as it collects in the sump, coming from drains, from seepage and from lubrication points in the drive unit. Cool oil is returned to the al1-attitude reservoir by the scavenge oil system. The swirl chamber in the reservoir removes and expels air carried by the oil. The normal temperature rise of the oil through the drive unit is about 10°C at continuous full load with an inlet oil temperature of 120°C, at normal input speeds.
   D. A charge pump moves oil from the reservoir to the governor and control cylinder and replenishes oil as required at the stationary port plate and at various lubricated surfaces. A charge relief valve restricts oil passage downstream from the port plate to ensure adequate supply of oil for the control, for the variable and fixed hydraulic displacement units, and for the lubrication nozzles. Separately confined oil in the input spline cavity lubricates the splines incidental to the input shaft and the connection to the engine.
   E. The input shaft accepts torque supplied by the engine at various speeds and delivers torque to the input end of the planetary differential gear unit in the drive. Depending on the difference between output speed and 6000 rpm, the variable displacement hydraulic unit will boost or retard the speed of the planetary differential output gear to maintain a 6000 rpm output speed, as required by the governor.



ac Generator Drive System Component
Figure 1

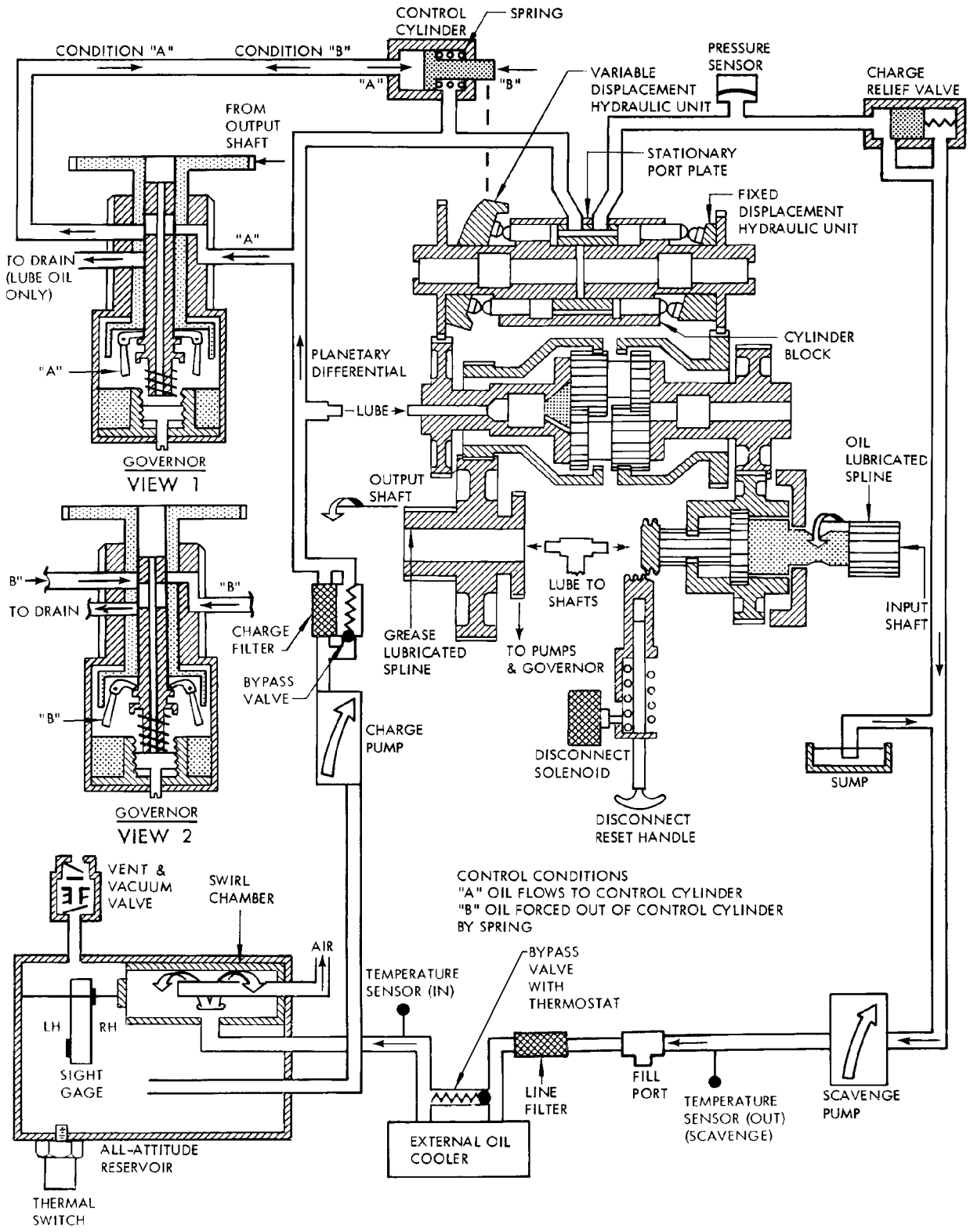
F. The governor is driven directly by a gear on the output shaft and wil1 port oil to, or drain oil from, the control cylinder depending on the required speed correction. The piston in the control cylinder wil1 adjust the angle of the wobbler as required by the variable displacement hydraulic unit. It is the angular position of the wobbler that determines the amount and direction of the oil delivered to the fixed unit and the consequent speed adjustment made to the differential gears.

2. Constant Speed Drive Unit (CSD)

A. Each engine-driven generator is supported by and driven through an in-line type, variable ratio drive unit which transmits the torque to drive the generator at a constant speed from the variable speed accessory drive pad on the airplane engine. The drive unit or constant speed drive (CSD) is attached to the engine with a quick-attach-detach (QAD) device consisting of three interlocking threaded rings which takes the place of mounting studs (Fig. 1). The CSD output end attaches to the ac generator by means of 12 studs. The generator mounting nuts only need to be loosened to remove the generator. A typical engine-driven CSD and generator installation is shown in figure 1. The accessory mounted ring of the QAD device is attached to the drive unit with studs. The engine mounted ring is fastened to the accessory drive pad on the engine with flat head screws. Gaskets, not shown on Fig. 1, make the input spline cavity oil tight.

B. Each CSD consists essentially of two positive displacement axial slipper piston type hydraulic units and a mechanical differential which performs the speed summing function. The hydraulic units are the same in physical size, one unit having a variable hydraulic displacement unit and a variable angle wobbler and the other having a fixed angle wobbler and, therefore, a fixed displacement. The hydraulic units rotate independently and are positioned on opposite sides of a common stationary port plate (Fig. 2).

C. The variable displacement hydraulic unit runs at a fixed ratio with respect to the transmission input speed. Because the wobbler angle of the variable displacement unit is continuously variable in both directions (from full positive wobbler angle to zero angle to full negative wobbler angle), the displacement of the variable displacement hydraulic unit is continuously variable from zero to full rated displacement in both directions. The fixed displacement hydraulic unit is driven by oil delivered by the variable displacement hydraulic unit. The fixed displacement hydraulic unit will therefore run at any speed from zero to full rated speed in either direction.



ac Generator Drive System Schematic
Figure 2

D. The working pressure between the two hydraulic units is proportional to the torque being transmitted to the generator. At the lower input speeds, the variable displacement unit acts as a hydraulic pump to supply flow to the fixed unit which is added to the input speed through the differential. At the "straight through" input speed, torque is transmitted directly through the differential unit and the fixed unit is not rotating. The variable displacement unit wobbler will be slightly offset from the zero angle so that some pumping will be accomplished and leakage losses made up. At input speed above "straight through," the variable angle wobbler is set to allow negative displacement of the variable displacement hydraulic unit. The working pressure, in this case, is manipulated to allow the fixed displacement hydraulic unit to be motored by the differential and subtract from the input speed. The variable displacement unit is acting as a motor. The multiple piston hydraulic unit in the mechanical differential type CSD unit handles only a portion of the power transmitted, therefore it is reduced in size. Since power losses are less in mechanical differentials than for multiple piston type hydraulic units, heat rejection is low resulting in high efficiency. The weight of a drained mechanical differential type drive unit or transmission is approximately 73.3 pounds.

3. CSD Mechanical Differential and Hydraulic Units

A. The differential is of the folded type with planet gears in the center and input and output ring gears on the outside to complete the assembly. The planet gears rotate about their own axes and also revolve about the centerline of the planet gear carrier. The planet gear carrier is driven by the drive input. The variable displacement hydraulic unit is also driven by the transmission input. The fixed displacement hydraulic unit is hydraulically coupled to the variable displacement unit and is connected to the differential through the input ring gear. The output ring gear of the differential is connected to the transmission output. Constant speed of the output ring gear is maintained by either adding to or subtracting from the speed of the planet gears by controlling the direction of rotation and speed of the input ring gear. The governor and pumps are driven by a constant speed output gear. Figure 3 shows the transmission epicyclic gearing schematically and illustrates the relationship of the differential with the rest of the power train.

B. Differential

(1) The differential consists of a carrier shaft, two planet gears, and two ring gears - input and output ring gear. The ratio between the ring gears and the carrier shaft is 2:l.

(2) At any speed and load condition, a torque load is imposed on the output ring gear by the output gear. Input torque is supplied by the input gear turning the carrier shaft. (See figure 3.) If there were no torque on the input ring gear, it would run freely at whatever speed would allow the output ring gear to stop. Because the carrier shaft to ring gear ratio is 2:l, the speed of the input ring gear at this condition would be double that of the carrier shaft. Since a given output speed is desired, the input ring gear must be constrained.

(3) If the input ring gear is constrained to zero speed, the output ring gear will run at double the carrier shaft speed. If the input ring gear is forced to rotate in a direction opposite to that of the carrier shaft, the output ring gear will run at a speed more than double that of the carrier shaft. If the input ring gear is allowed to rotate in the same direction as the carrier shaft, the output ring gear will run at a speed less than twice that of the carrier shaft. Thus, the differential is a "speed summer" or "adding" device which is controlled through the input ring gear to add to or subtract from the speed of the engine gearbox to achieve the desired output.

C. Variable Hydraulic Unit

(1) The variable hydraulic unit consists of a cylinder block, reciprocating pistons, a variable angle wobbler, and a control piston. The variable unit is connected to the aircraft engine by direct gearing; consequently, the speed of the cylinder block is always proportional to the input speed and the direction of rotation is always in the same direction.

(2) When the transmission is operating in "overdrive," the variable hydraulic unit will function as a hydraulic pump (Fig. 3). To enable the variable unit to pump oil, the governor ports control oil to the control piston which in turn positions the wobbler so oil will be compressed as the pistons are forced into the rotating cylinder block. This high pressure (working pressure) oil is ported to the fixed hydraulic unit.

(3) As the input speed increases and the need to add speed decreases, the governor will port less oil to the control cylinder until the variable wobbler is in a position approximately normal to the pistons. When the face of the variable wobbler is approximately perpendicular to the pistons, no oil (except that required to provide for power losses due to leakage) is pumped or received by the variable unit. At this time the transmission is operating in "straight through drive."

(4) When the transmission is operating in "underdrive," the variable hydraulic unit will function as a motor. To enable the variable unit to operate as a motor (receive oil from the pumping unit), the governor ports oil away from the control cylinder causing the wobbler to be positioned so the volume for accommodating oil in the piston bores on the high pressure side is increased; consequently, oil flows from the fixed hydraulic unit to the variable unit.

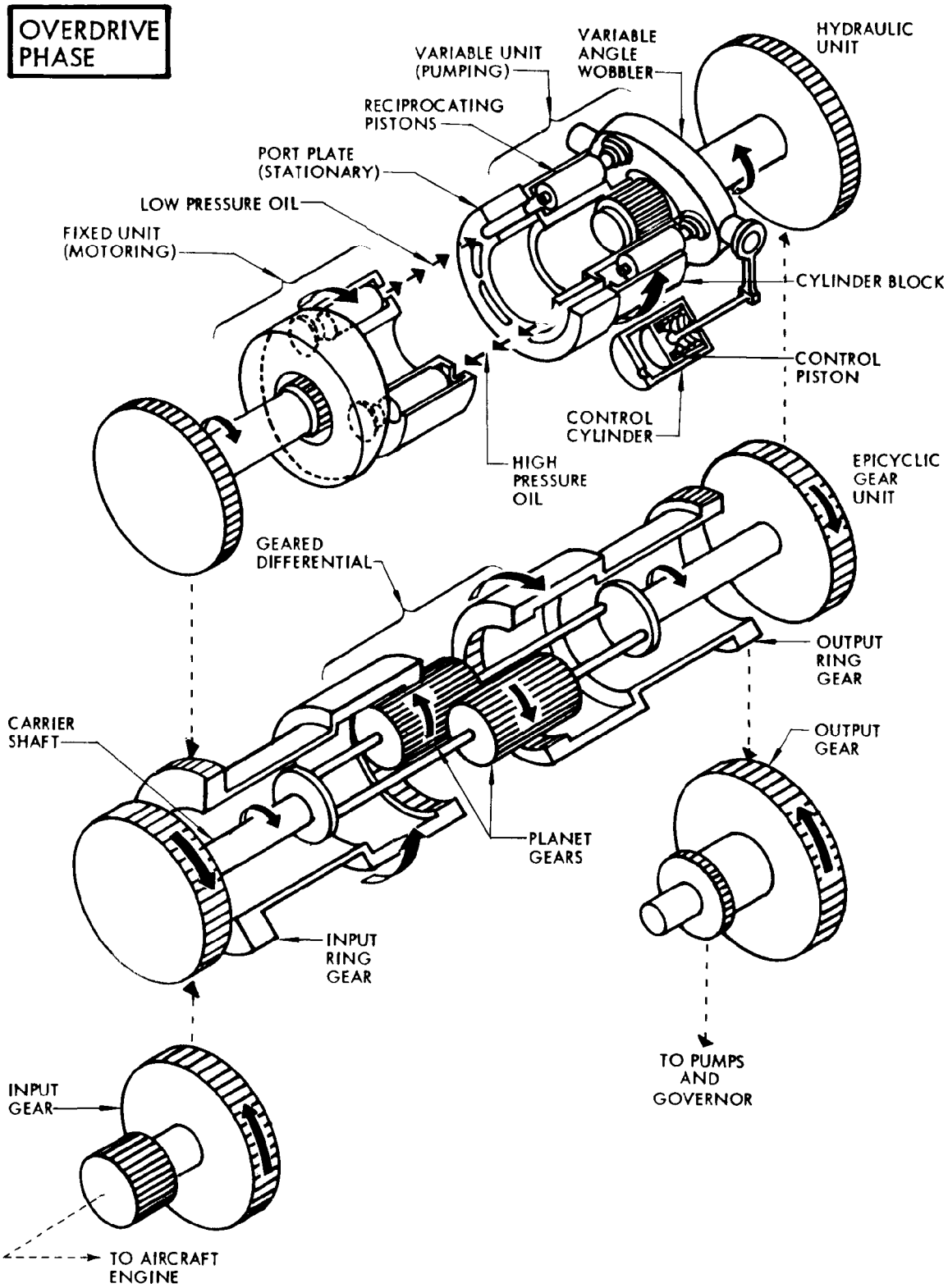
D. Fixed Hydraulic Unit

(1) The fixed hydraulic unit consists of a cylinder block, reciprocating pistons and a fixed angle wobbler. The direction of rotation and speed of the fixed hydraulic unit is determined by the volume of oil pumped or received by the variable hydraulic unit. This volume of oil is determined by the angular position of the variable wobbler and the speed of the variable block. Refer to paragraph C, Variable Hydraulic Unit.

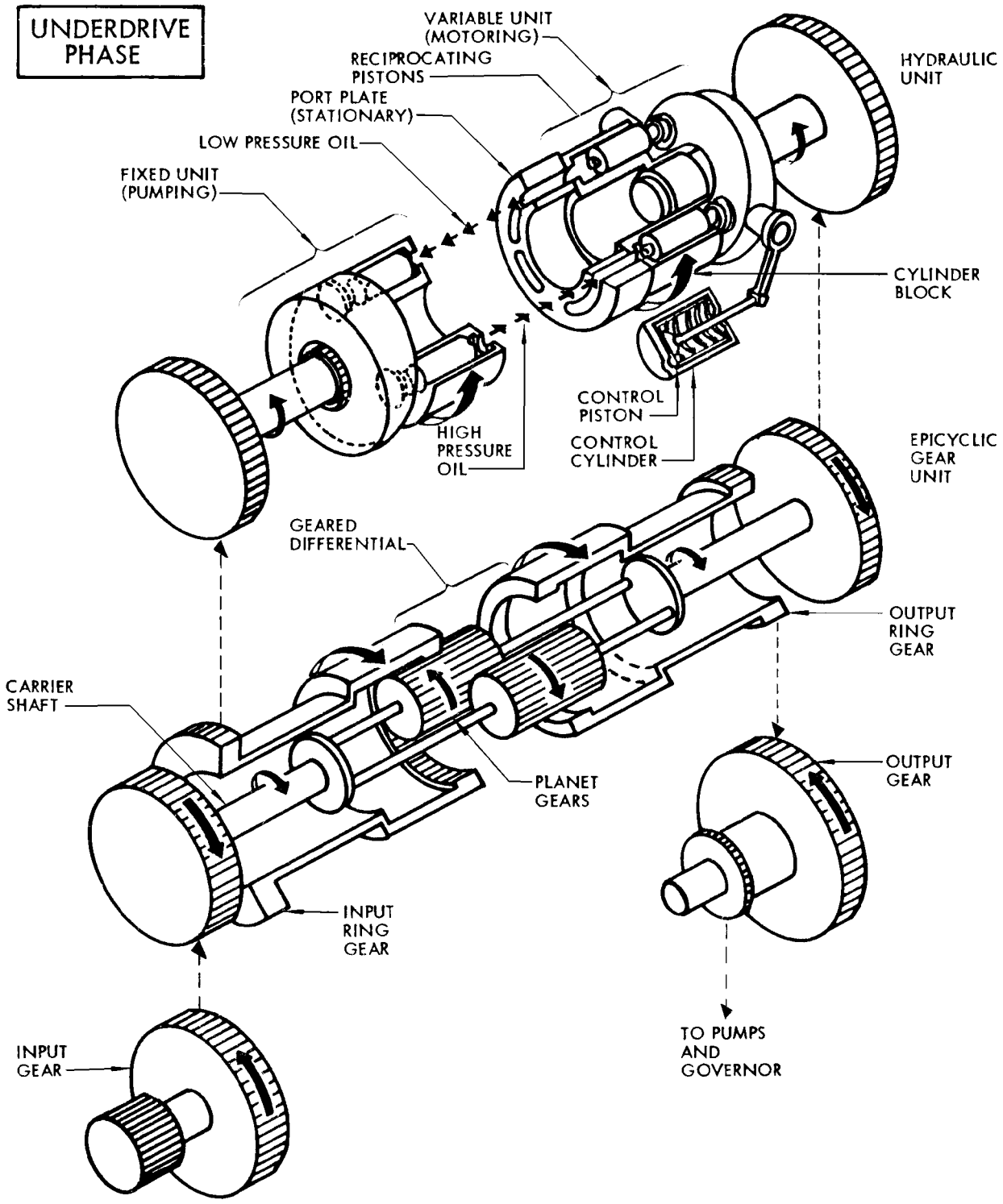
(2) When the transmission is operating in "overdrive," the fixed hydraulic unit functions as a hydraulic motor. High pressure oil pumped from the variable unit forces the fixed unit pistons to slide down the inclined wobbler face thus causing the cylinder block to rotate. The block's rotation forces the input ring gear to turn in a direction opposite to the carrier shaft rotation and adds to the speed of the engine gearbox through the differential, thus maintaining constant output speed. Refer to paragraph B, Differential.

(3) As the input speed increases and the need to add speed to the output decreases, the variable hydraulic unit pumps less oil to the fixed hydraulic unit until the cylinder block stops rotating. At this time the transmission is operating in straight through drive.

(4) When the transmission is operating in "underdrive," the fixed hydraulic unit functions as a pump. The variable wobbler in the variable hydraulic unit is positioned so the variable hydraulic unit can receive oil from the fixed hydraulic unit. The fixed hydraulic unit's pistons are forced into the cylinder block as they slide up the inclined wobbler face thus pumping high pressure oil to the variable hydraulic unit and allowing the cylinder block to rotate in the direction opposite to that of overdrive operation. The opposite block rotation allows the input ring gear to turn in the same direction as the carrier shaft rotation and subtracts speed from the speed of the engine gearbox through the differential, thus maintaining constant output speed.



CSD Gear Differential and Hydraulic Unit Schematic
Figure 3 (Sheet 1)



CSD Gear Differential and Hydraulic Unit Schematic
Figure 3 (Sheet 2)

4. Governing System
   A. The basic governor is a spring-biased, flyweight-operated hydraulic control valve. It functions to control porting of transmission charge oil to the control cylinder. (See figure 2.) The rotating sleeve in the governor is driven by the output gear and hence is responsive to transmission output speed. Flyweights pivoted on this sleeve move a valve stem located within the sleeve against the bias of a spring. During steady state operation, supply pressure is reduced to the required control pressure by orificing action at the edges of the stem control groove. Depending on valve stem position, charge oil is ported to the control piston or control oil is drained to the transmission case.
   B. The control cylinder is the actuator which responds to the porting functions of the governor. The affective area of the spring loaded side of the piston in the control cylinder is considerable less than the opposite end. Therefore, the piston will compress the spring with equal pressure on both sides of the piston. (See VIEW 1, figure 2.) When the governor allows the oil to drain from the control cylinder as in VIEW 2, the spring assisted by charge pressure on the small area of the piston allows the spring to relax. Small increments of such piston movements results in speed control within narrow limits.
5. Hydraulic System
   A. The hydraulic system consists of the charge pump, the scavenge pump and the charge relief valve (Fig. 2).
   B. The charge pump is located in the hydraulic circuit between the al1-attitude reservoir and the transmission. The charge pump supplies oil to the cylinder blocks, governor, control piston, and the lubricating system.
   C. The scavenge pump is located in the hydraulic circuit between the transmission sump and the external oil cooler. The scavenge pump picks up lube oil and internal leakage and pumps it through the external oil cooler into the al1-attitude reservoir.
   D. The charge relief valve regulates the operating pressure of the charge oil system. (See figure 2.) The valve accomplishes this function by metering the discharge of oil from the charge oil system to maintain the preset charge pressure. The charge pump draws oil from the reservoir and delivers a constant volume of oil to the charge relief valve cylinder. The piston in the relief valve cylinder is moved back by oil pressure compressing the spring. Oil is bled to the scavenge lime as determined by spring pressure against charge pressure acting on the piston. The oil under charge pressure is used for control in the governor and control valve and to replenish the oil used in the multiple piston hydraulic units through the stationary port plate.
6. All-Attitude Reservoir and Air Separator
   A. The all-attitude reservoir performs the following functions:
      (1) Separate entrained air from the system oil.

(2) Provide a supply of deaerated oil to the transmission through a wide range of acceleration loadings and aircraft attitudes. The reservoir contains no moving parts, and performs its functions automatically, utilizing the energy of the transmission scavenge oil.

B. Scavenge oil pumped thru the cooler returns to the transmission reservoir via the swirl chamber. This return oil, which is highly aerated, enters the swirl chamber at high velocity through a tangential inlet, causing a swirling action which creates a vortex within the swirl chamber. Air entrained in the entering oil, having a lower density than the oil, moves to the center of the vortex and escapes the case. The oil, relieved of its entrained air, moves along the wall of the swirl chamber and out into the reservoir (Fig. 2).

C. As described above, return oil is always deaerated and ported to the reservoir, regardless of transmission attitude. The inlet suction port is located in approximately the center of volume of the reservoir, and the volume of oil contained within the reservoir is such that, regardless of transmission attitude, the inlet port will always be surrounded by oil (Fig. 2). Static pressure in the reservoir is approximately the same as case pressure.

7. Integral Oil or Charge Filter and Filter Bypass

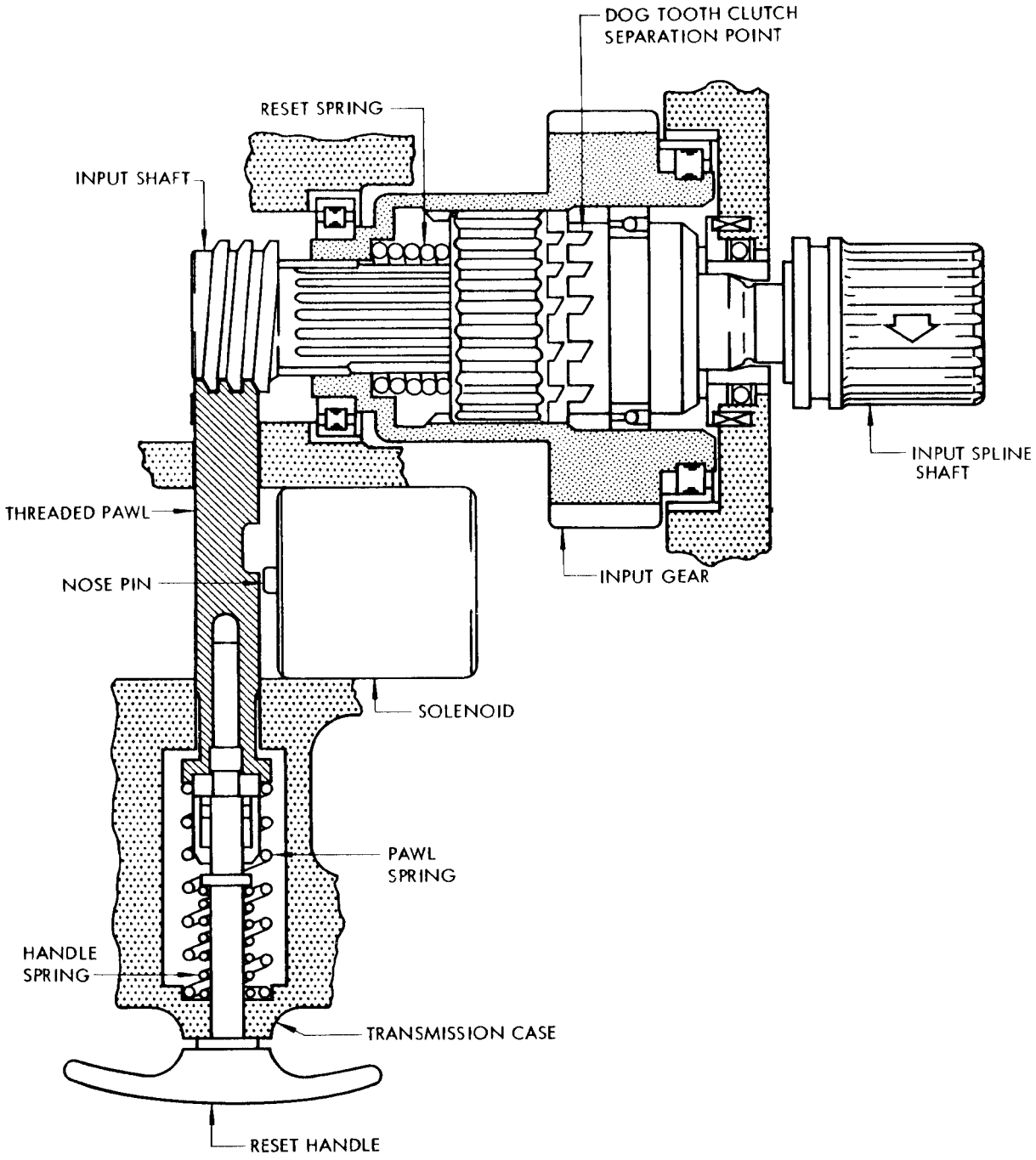
A. The integral or charge filter is equipped with a bypass around the filter element to ensure a flow of oil in case the element becomes completely clogged. On some CSD units with plain filter caps, the bypass valve is inside the filter element. On later CSD units, the bypass or relief valve is located in the integral oil filter cap assembly. The filter has a mechanical snap-out indicator to show when the filter is clogged.

8. Generator Drive Disconnect

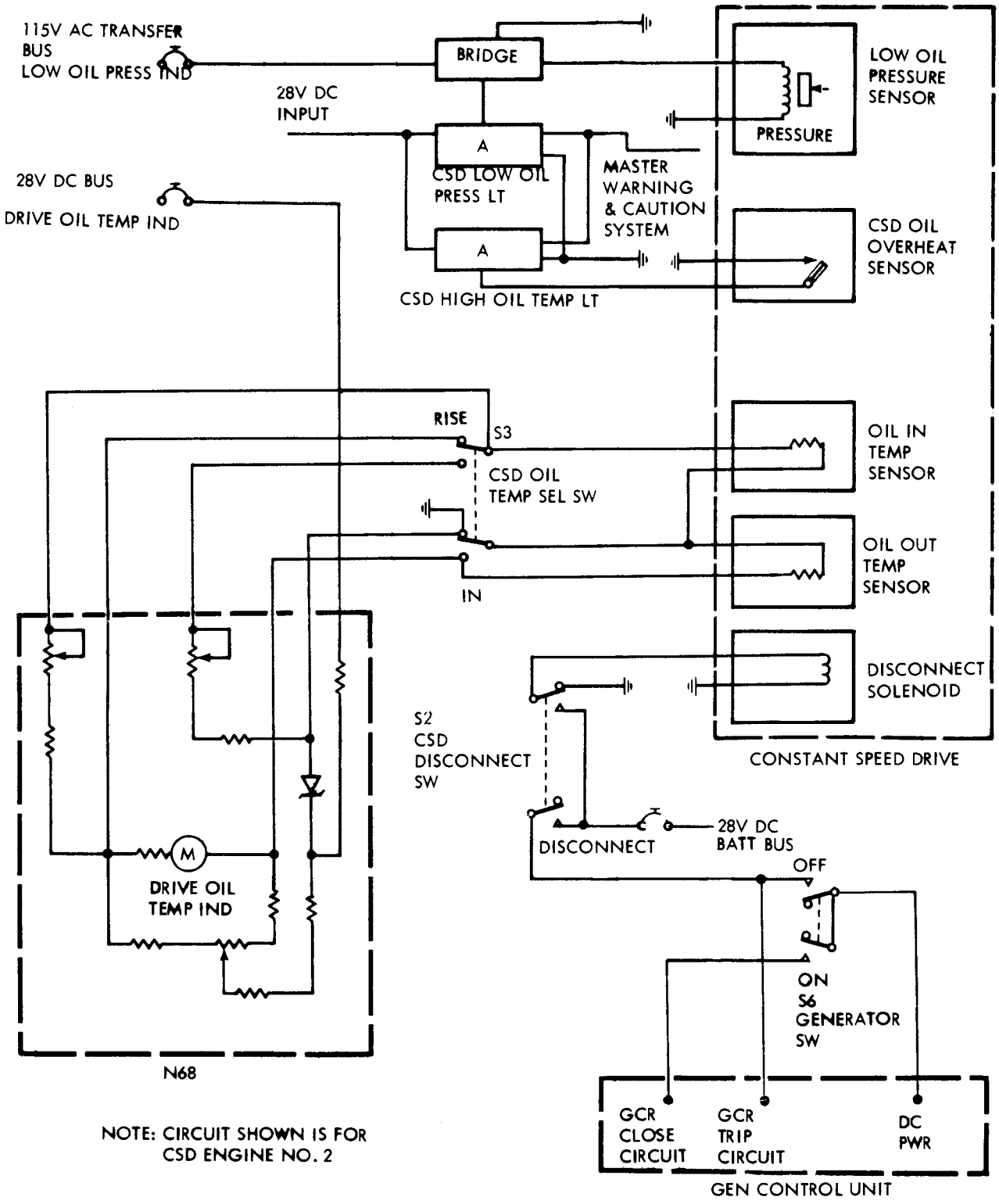
A. The disconnect is an electrically-actuated device which decouples the input shaft from the input spline shaft in the event of a transmission malfunction. When the disconnect solenoid is activated by a crew member, a spring-loaded pawl moves into contact with threads on the input shaft (Fig. 4 and 5).

B. The input shaft acts as a screw in a threaded hole, and input rotation causes the input shaft to move away from the input spline shaft, separating the driving dogs on the two shafts. When the driving dogs have been separated, the input spline shaft, which is still being driven by the aircraft engine, spins freely in the transmission without causing transmission rotation. Reset may be accomplished, only on the ground following engine shutdown, by pulling out on the reset handle until the solenoid nose pin snaps into position.

9. Generator Drive Cooling
   A. Heat generated within the drive causes the drive oil temperature to rise. The scavenge pump forces the heated oil through the scavenge or line oil filter then through the external oil cooler and into the al1-attitude reservoir. Fan air from the engine passes over the inside portion of the cooler unit thereby cooling the oil. The cooler is located on the left side of the engine aft of the drive. (See figure 1.) The engine fan supplies the cooling air at all times in flight and on the ground. A line oil filter, which filters scavenge oil, is located in the oil out line between the drive unit and the CSD oil cooler. The filter functions as a protective device to prevent contamination of the oil cooler in the event of drive failure.
10. Operation
   A. The drive unit of the constant speed drive system accepts torque from the engine at various speeds and delivers torque to the generator at a constant speed through the output shaft. The output shaft drives the governor, the scavenge pump and the charge pump. (See figure 2.) The charge pump maintains oil pressure at the stationary port plate for the fixed and variable displacement hydraulic units, and for speed control purposes by the governor and control cylinder. The piston of the control cylinder positions the movable portion of "wobbler," of the variable displacement hydraulic unit, in response to the oil pressure differences caused by the valve action of the governor. The governor ports oil to or from the control cylinder in response to small output speed changes. The hydraulic unit transmits only a portion of the input torque to the output shaft. The major portion of the torque is transmitted by the planetary differential gear train.
   B. The planetary differential output speed is regulated by the combined action of the variable and fixed hydraulic units. The route the torque takes through the combined differential and hydraulic units is as follows:
      (1) The input gear drives the carrier shafts through the center of the differential to the variable end of the hydraulic unit (Fig. 3).
      (2) The variable hydraulic unit causes the required direction of rotation and speed of the fixed hydraulic unit.
      (3) The fixed unit drives the input ring gear in either direction and at various speeds, delivering torque through the planet gears to the output ring gear.
      (4) The output ring gear drives the output gear at the required 6000 rpm.
      (5) The overdrive and underdrive schematics of figure 3 indicate the constraining or assisting action furnished by the hydraulic unit to the differential. It will be noticed that in overdrive the variable unit is pumping and in underdrive the variable unit is motoring.



Generator Drive Disconnect Mechanism
Figure 4



Generator Constant Speed Drive Electrical Circuit
Figure 5

C. Heat generated by the drive unit is absorbed by the oil which collects in the sump. The scavenge pump forces this hot oil through the line filter, the external oil cooler, and into the swirl chamber of the al1-altitude reservoir. (See figure 2.) The temperature is sensed at two points by identical sensors connected to dual scale indicators on the overhead panel (P5-5). Oil temperature and temperature rise may be read on the indicators by means of the pushbutton switch also on the P5 panel.

D. For the hydraulic unit to function properly and also to be properly lubricated, the charge pump must maintain about 200 psi at the stationary port plate. (See figure 2.) The pressure sensor located downstream from the port plate, signals the caution light on the overhead panel when oil pressure is below a minimum safe value of 100 to 150 psi. When the low pressure light comes on the master caution light also comes on. Both lights should be off during normal operation. (See figure 6.) Refer to Master Warning and Caution Lights - Description and Operation, Chapter 33.

E. Rotation of the drive unit can be stopped by the disconnect in the input shaft. (See figure 5.) The solenoid is energized by pushing the disconnect switch on the overhead panel (P5-5) to ON. The nose pin is retracted releasing a spring-loaded pawl, and the resulting action wil1 disengage the rotating input shaft from the differential gear. Re-engagement should be attempted only with the engine shut down and after it comes to a complete stop. Re-engagement is accomplished by pulling downward on the disconnect reset handle until a stop is felt, and then releasing the T-handle.

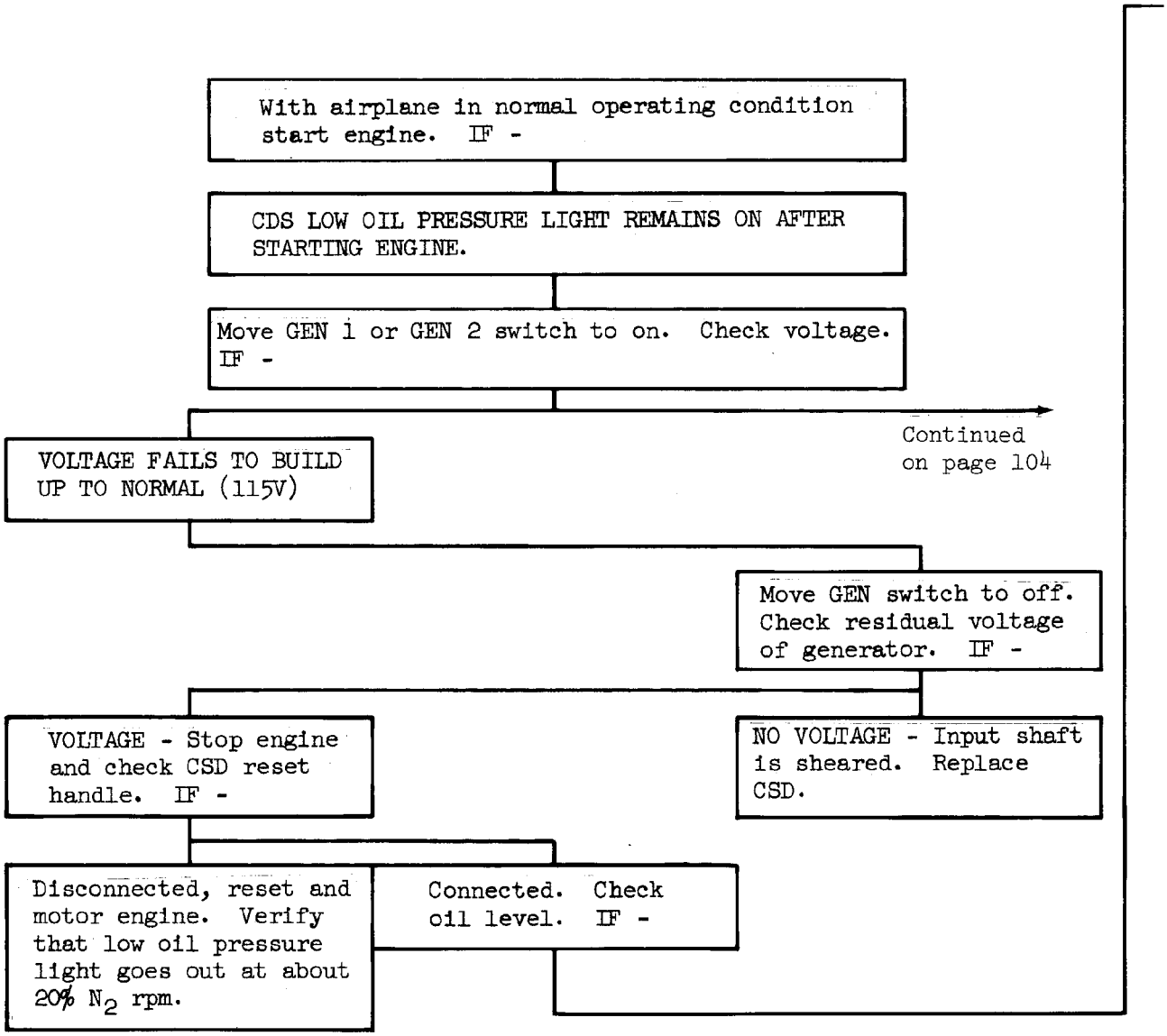
F. The CSD is geared directly to the engine and operates whenever the engine is running. Operation of the CSD is monitored by observing the CSD low oil pressure light, the CSD oil temperature indicator, and the output voltage and frequency of the generator it drives.

AC GENERATOR DRIVE SYSTEM – TROUBLESHOOTING

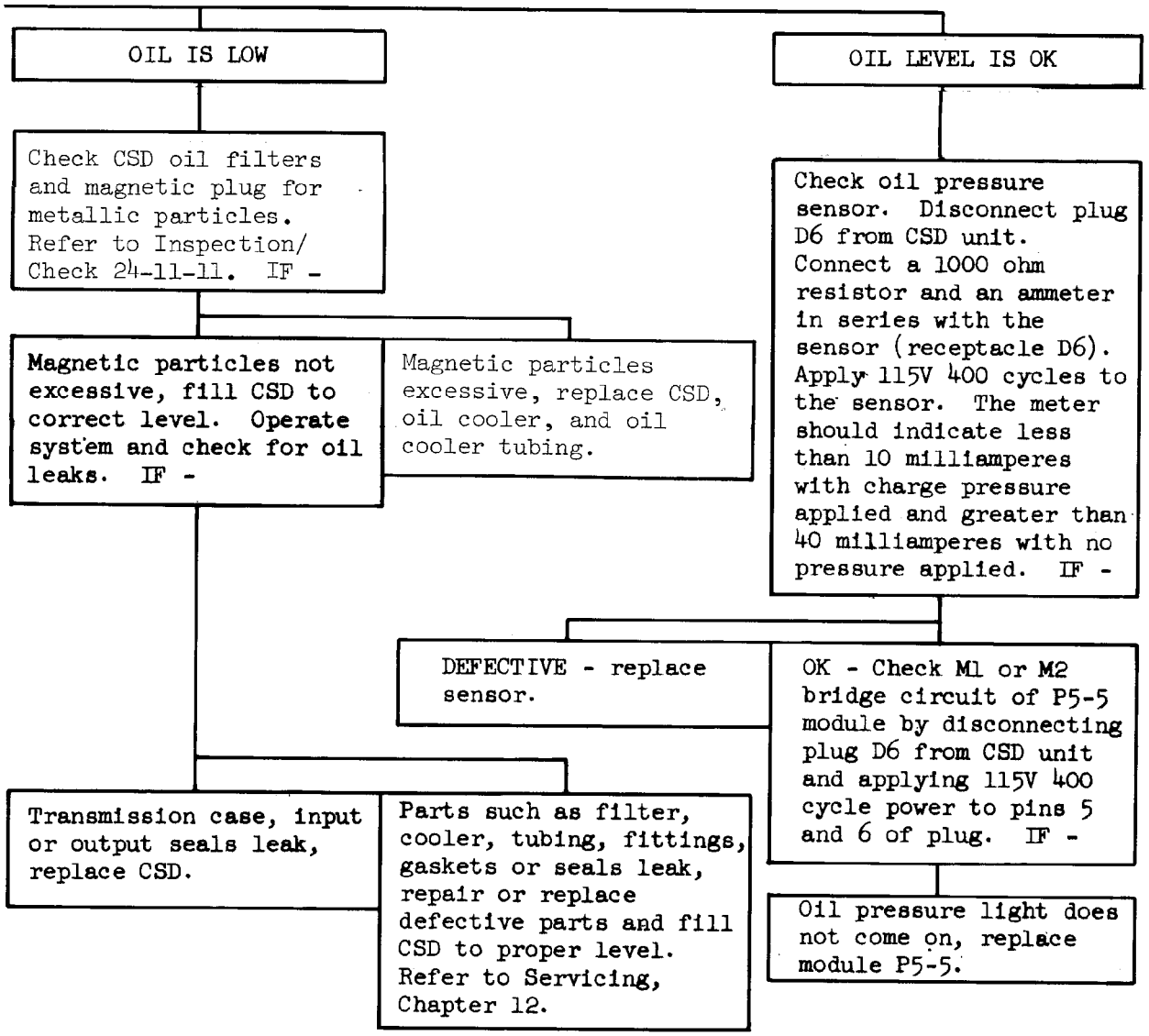
1. General
   A. Troubleshooting charts on the following pages are set up to aid in locating causes of specific symptoms that may appear in starting and operating the ac generator constant speed drive system. The charts are arranged so that by starting at the top and proceeding downward the trouble may be isolated and corrected. Such trouble charts cannot be given for every possible trouble that may occur, but may be used as a guide in isolating troubles not listed.

      CAUTION: BEFORE RECONNECTING A DISCONNECTED CSD TO PERFORM TROUBLE SHOOTING, CHECK CSD OIL FILTER PRESSURE DIFFERENTIAL INDICATORS, CSD OIL LEVEL AND CONDITION, AND CSD MAGNETIC PLUG PER 24-11-11, I/C. RECONNECTING A CSD WITH FAULTS IN THESE AREAS MAY RESULT IN SEVERE DAMAGE TO THE CSD.

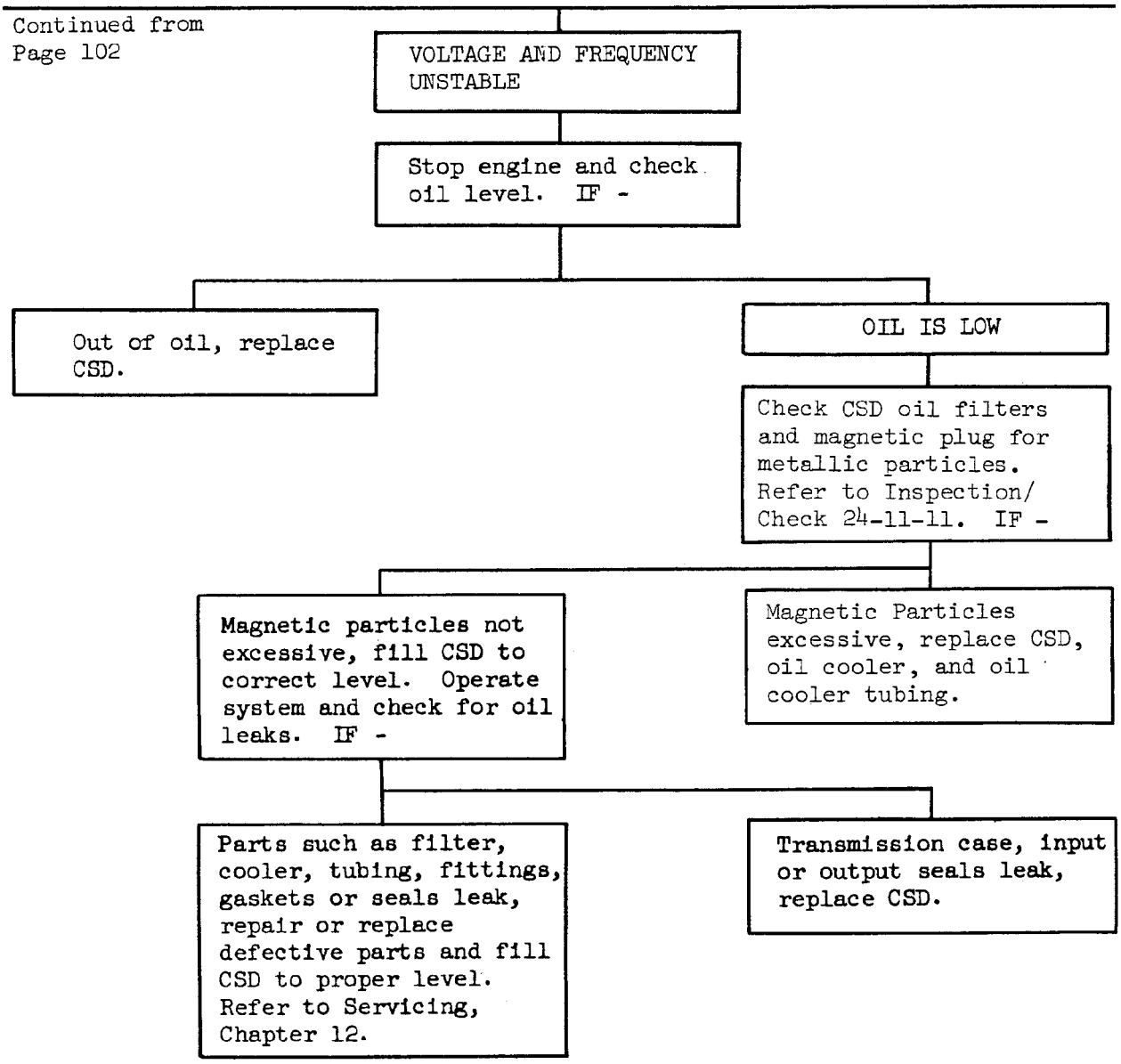
2. Trouble Charts



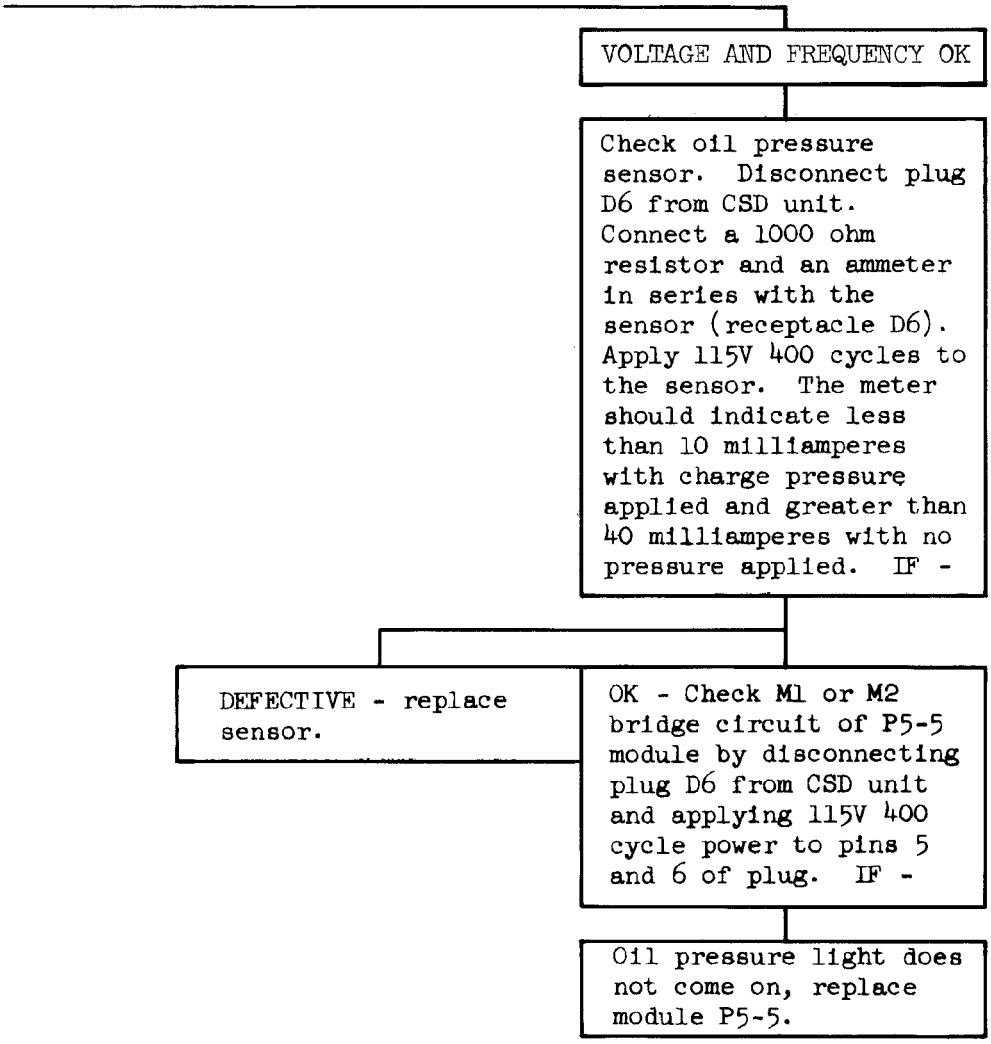
ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 1)



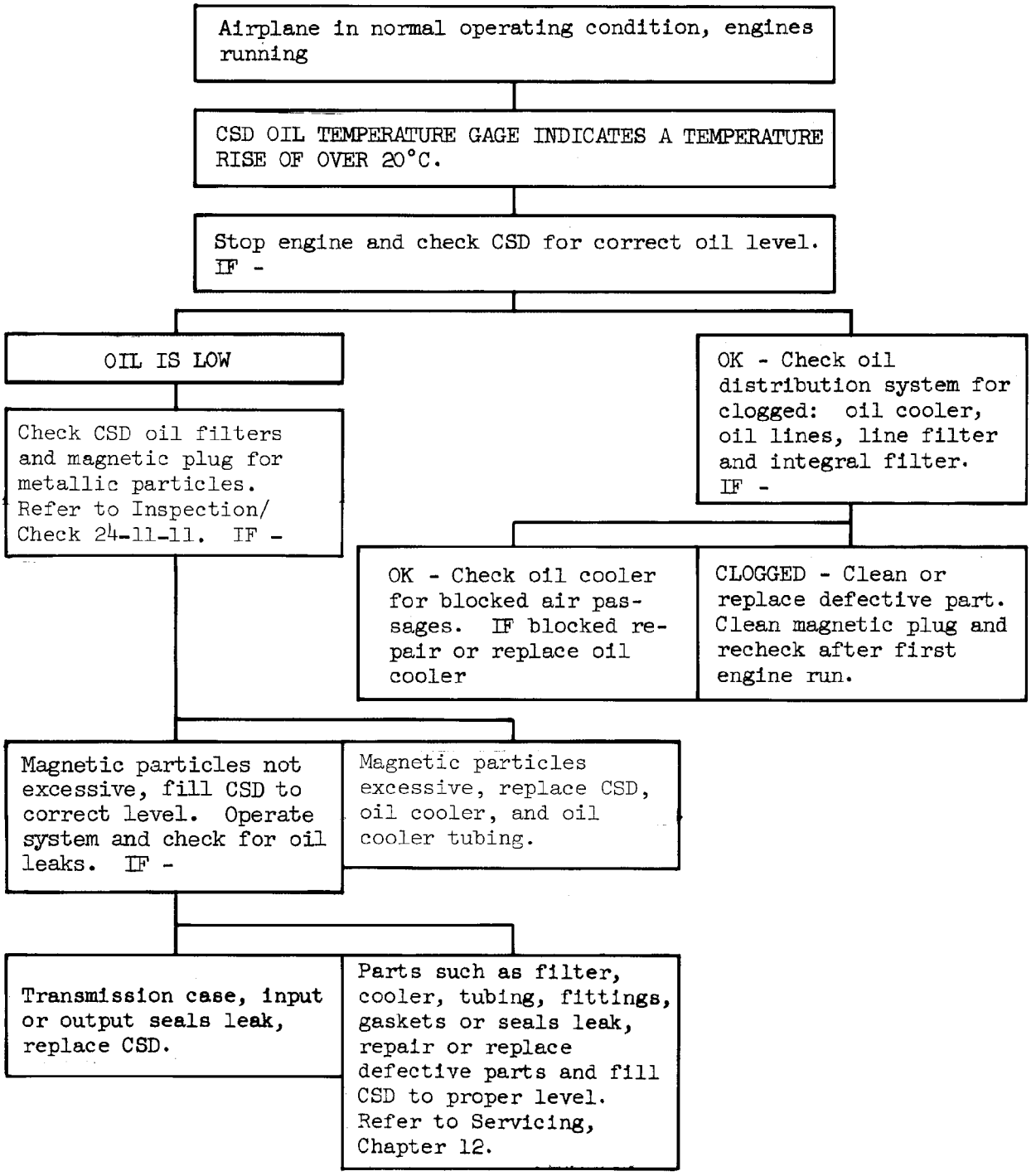
ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 2)



ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 3)

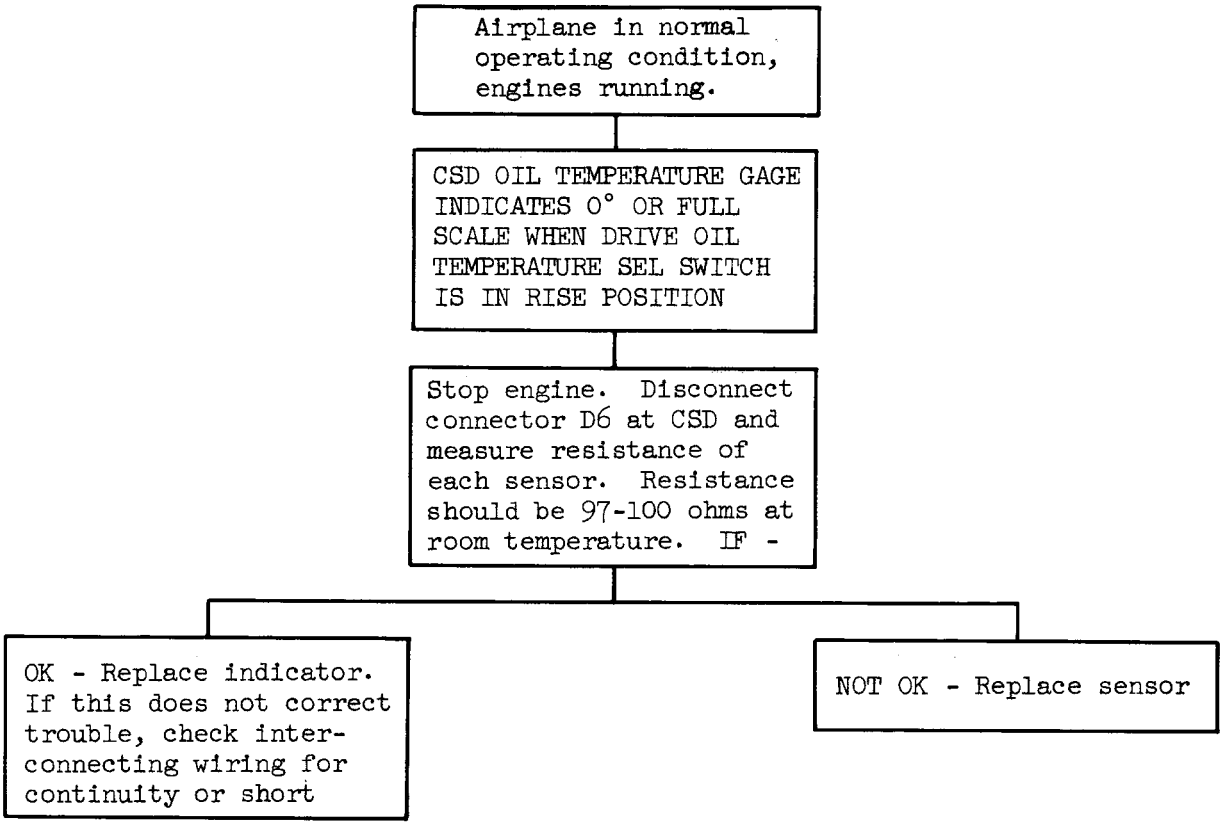


ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 4)



NOTE: Oil cooler may be loosened and swung out from engine casing to check for oil leaks and heat exchanger damage without disconnect-

ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 5)



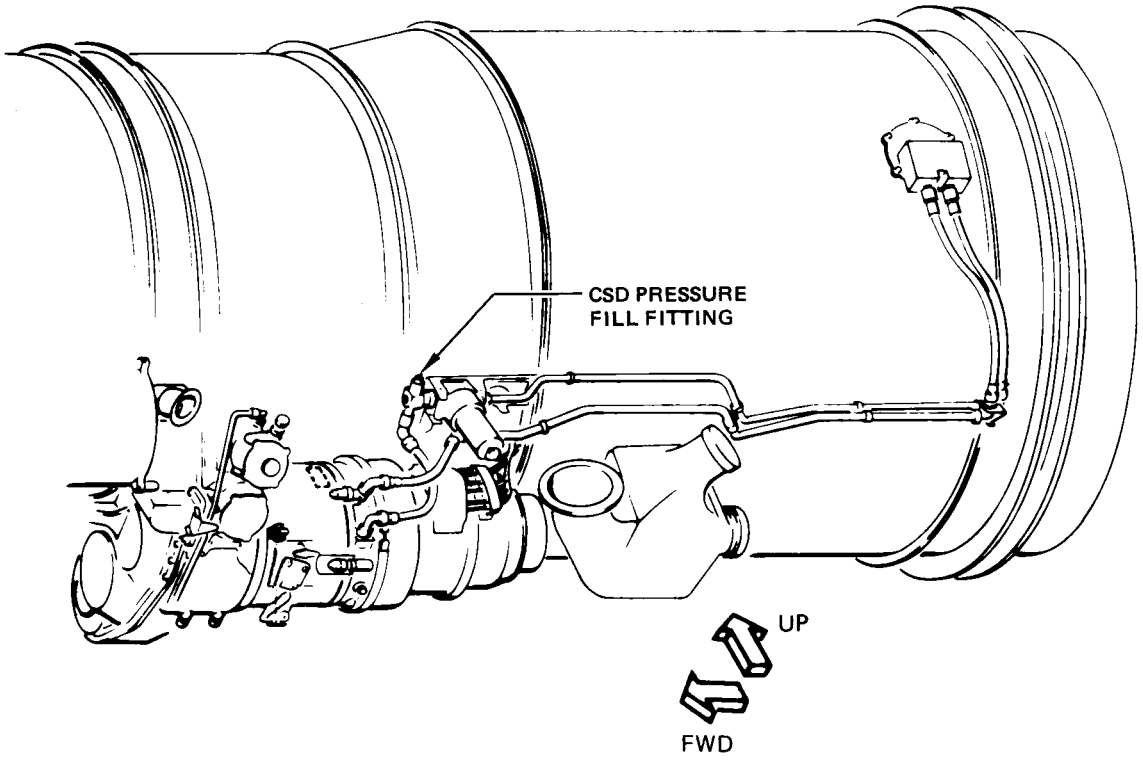
ac Generator Drive System - Troubleshooting
Figure 101 (Sheet 6)

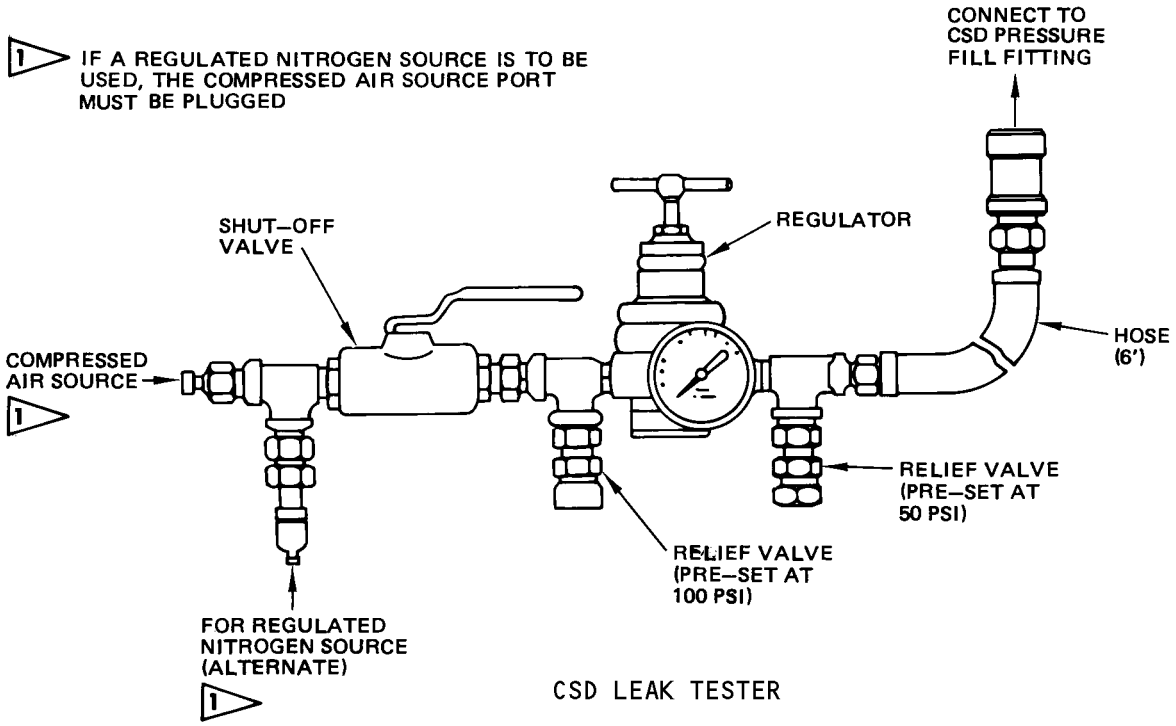
AC GENERATOR DRIVE SYSTEM - MAINTENANCE PRACTICES

1. General
   A. This section provides a procedure for pressurizing the CSD hydraulic system to check for oil leaks with the engines shut down.
2. Equipment and Materials
   A. CSD leak tester (Fig. 201), consisting of the following:
      (1) Hose adapter OMP 2506-3, Ozone Metal Products, 101-32 101st St., Ozone Park, Long Island, N.Y.
      (2) Flexible hose (approximately 6 feet in length), capable of withstanding 100 psi
      (3) Relief valve, pre-set at 50 psi
      (4) Regulator with 0 to 100 psi pressure gauge
      (5) Relief valve, pre-set at 100 psi
      (6) Shut-off valve
      (7) Fittings, as required
   B. Dry compressed air source, or a regulated nitrogen source (100 psi maximum).
3. Check CSD Hydraulic System For Leaks
   A. Position the shut-off valve to OFF and shut off the regulator valve to prevent pressurization of CSD.
   B. Connect hose adapter to CSD pressure fill fitting.
   C. Connect the other end of tester to the compressed air or regulated nitrogen source.
   D. Turn the shut-off valve to ON and adjust the regulator to 25 PSIG.

      CAUTION: DO NOT EXCEED 50 PSIG TO THE CSD. DAMAGE TO CSD MAY RESULT.

   E. Turn shut-off valve to OFF.
   F. Pressure should bleed off to a slightly lower value (due to CSD vent valve setting) and then stabilize.
   G. If pressure continues to lower, visually check for leak source. If leak source is not apparent, check system for leaks using soap suds or equivalent leak detector fluid.
   H. Depressurize CSD and disconnect tester.
   I. If required, repair leak and repeat check.





CSD LEAK TESTER

Constant Speed Drive Leak Check
Figure 201

GENERATOR CONSTANT SPEED DRIVE - REMOVAL/INSTALLATION

1. General
   A. The generator constant speed drive (CSD) and the ac generator may be removed and installed as a complete assembly or as separate units. If these operations are being performed without the aid of a cradle assembly, it will be easier to remove and install them separately. A quick-attach-detach (QAD) locking ring facilitates removal and installation of the CSD or of the CSD and generator assembly.

      CAUTION: DURING ALL MAINTENANCE ON CONSTANT SPEED DRIVE, CLEANLINESS IS ABSOLUTELY ESSENTIAL. TAKE ALL POSSIBLE PRECAUTIONS TO PREVENT FOREIGN MATTER FROM ENTERING DRIVE SYSTEM.

   B. Replace line oil filter element and check oil and magnetic plug each time CSD is replaced. Flush oil cooler if oil shows signs of sludging. Replace oil cooler and tubing if bright metal deposits of chips or flakes are on the magnetic plug. Replace oil cooler and tubing if CSD is being replaced due to a possible internal failure and there is evidence of contamination in the system. Check CSD for wear (Ref 24-11-11 I/C) if the removed CSD is to be reinstalled.
2. Equipment and Materials
   A. Oil - MIL-L-7080, or any oil conforming to Pratt & Whitney specification PW-521B Type I or Type II (Ref 20-30-21)
   B. Anti-fretting compound - Sundstrand 730691 (preferred); Sundstrand 718050 (alternative); Sundstrand 688272 (alternative); or 1:1 mixture by weight of molybdenum disulfide, MIL-M-7866, and Rheotemp 500 (or Texaco Unitemp 500) grease (alternative) (Ref 20-30-21)
   C. Lubricant, O-ring - Acryloid HF866 (preferred) or HF825 (alternative) (Ref 20-30-21)
   D. Adapter Assembly, AC Generator and Constant Speed Drive for supporting CSD and/or generator during removal/installation, Boeing F70333-25

      NOTE: Boeing F70333-25 replaces F70333-1 replaces F80011-1, -16; F70333-24 replaces F70333-21 assembly.

      Boeing F70333-21, -24 adapter assembly and jack includes a commercially available jack plus F70333-1, -25.

   E. Cleaning Solvent - P-D-680 (Ref 20-30-31)
3. Remove Generator Constant Speed Drive
   A. Open control panel circuit breakers TEMP and LOW PRESS for generator drive and generator control circuit breaker No. 1 and 2 on panel P6 corresponding to generator CSD being removed.
   B. Disconnect main electrical connector. (Use manufacturer's recommended procedures for disconnecting connections. Do not pull on wires.)

C. Disconnect and plug oil lines.

WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY. PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

NOTE: If necessary, loosen release screws on quick-release clamps and move engine firewall fire detection sensing element to one side (Ref 26-11-11, R/I).

D. Remove ac generator (Ref 24-21-11).

NOTE: If proper equipment is available to handle the weight, generator may be left assembled to CSD. Removal of generator is optional.

E. Drain oil from drive tank (capacity about 4-1/2 quarts) by removing tank drain plug and loosening gravity fill plug. Replace tank drain plug and tighten both plugs finger-tight.

NOTE: Drain into 2-gallon can.

F. Drain oil from drain sump (capacity about 1 pint) and replace drain plug. Tighten plug finger-tight (use 3/4-inch wrench to remove plug).
G. Drain oil from drive input spline cavity (capacity 1-1/2 quarts) and replace drain plug
(1) Tighten the drain plug to 190-210 pound-inches.
H. Attach cradle assembly to drive housing.
I. Remove QAD tension bolt.
J. Provide adequate support for CSD.
K. Rotate quick-attach-detach (QAD) ring until locking lugs disengage. If necessary apply a brass drift to locking ring boss on QAD ring.

CAUTION: DO NOT HAMMER ON QAD TENSION BOLT OR PUT DRIFT THRU HOLE IN QAD BRACKET, DAMAGE TO TENSION BOLT OR SWIVEL NUT MAY RESULT.

L. Remove drive from engine.

4. Prepare to Install Generator Constant Speed Drive (Fig. 401 and 402)
A. Check input end of CSD housing for O-ring groove and O-ring.
B. Check quick-attach-detach (QAD) ring and input end of CSD for damage to locking lugs. Check condition of splines on CSD input and in female mating drive connection in engine.

CAUTION: DO NOT USE DRIVE WITH DAMAGED OR DEFECTIVE SPLINE.

C. Clean CSD input spline with solvent and check that all antifretting compound (if present) has been removed. Apply thin coating of CSD oil to spline.

CAUTION: BE CERTAIN SPLINE IS CLEAN BEFORE CSD OIL IS APPLIED. ANTIFRETTING COMPOUND RESIDUE (IF PRESENT) MAY CAUSE ACCELERATED SPLINE WEAR.

D. Drain CSD housing and replace drain plug. Tighten plug finger-tight.

NOTE: Preservative oil in drive unit must be drained before installation. Flushing is not required.

E. If QAD ring is on engine pad, spray exposed inner diameter with WD-40 lubricant. If QAD ring is not on engine, install per steps (1) thru (5).

NOTE: Adapter plate must have O-ring retainer groove and may have three aligning inserts spaced 120 degrees on periphery.

(1) Place new gasket on engine accessory drive pad with extra hole for CSD locating pin at about 5 o'clock position of engine pad, when looking forward (Fig. 401).
(2) Lubricate O-ring with Acryloid and install O-ring in adapter plate retainer groove.
(3) Thread QAD ring on adapter plate. Lubricate locking lugs with anti-fretting compound.
(4) Install adapter plate and QAD ring assembly with locating hole matching hole in gasket. Secure with screws. Torque from 180 to 210 pound-inches (12 places).
(5) Install screened orifice plug in engine pad, at approximately 12 o'clock position when looking forward. Discard solid plug if one is found in this location. Wet spline cavity must have vent to engine gearbox.

F. Lubricate drive O-ring with Acryloid and install O-ring in drive retainer groove.

5. Install Generator Constant Speed Drive (Fig. 401 and 402)
   A. Lubricate QAD locking ring and adapter plate threads with anti-fretting compound and install constant speed drive gasket on CSD unit.
   B. Position QAD locking ring with boss just below 3 o'clock position of engine pad, when looking forward.
   C. Using cradle adapter assembly as a support for constant speed drive, align locating pin with hole in the QAD adapter plate.
   D. Mate drive input end to the QAD assembly.
   E. Rotate the QAD ring until locking lugs are firm and locking bolt may be threaded into swivel nut.

      NOTE: Drive lugs must engage quick-attach-detach lugs while ring is rotated.

   F. Lubricate CSD lug bolt, washer, and associated bracket area with CSD oil. Also, lubricate threads of swivel nut on QAD locking ring boss.
   G. Thread CSD lug bolt into QAD ring swivel nut.
   H. Relieve overhung weight of CSD and/or generator by lifting at rear end and torque the CSD lug bolt from 90 to 100 pound-inches. With a brass drift, tap the exposed outer diameter of the QAD ring to center QAD ring and eliminate false torque readings. Torque bolt from 90 to 100 pound-inches. Repeat tapping and torque procedure until a minimum of 72 pound-inches is obtained at beginning at the retorque step, then torque CSD lug bolt to final value of 90 to 100 pound-inches. Check for a minimum clearance of 3/16 inch between bracket and locking ear.

      NOTE: If the QAD ring dimension is less than 3/16 inch minimum, remove the CSD and check for wear or damage on the QAD ring and the CSD. Replace parts as necessary and install the QAD ring and/or the CSD.

   I. Loosen the lug bolt, without backing off the QAD ring, until a torque value of zero (0) is obtained. Lockwire bolt to QAD ring.
   J. Remove cradle adapter assembly.
   K. Install ac generator, if generator was not assembled to CSD before installation of CSD (Ref 24-21-11, R/I).
   L. Remove all oil remaining in generator drive oil cooler and connecting plumbing.

      CAUTION: USE EVERY PRECAUTION TO PREVENT ANY FOREIGN MATERIAL IN OIL COOLER OR PLUMBING FROM ENTERING CSD. REPLACE OIL COOLER IF CONTAMINATED. ALSO CLEAN THOROUGHLY ALL TUBING BETWEEN COOLER AND DRIVE UNIT.

M. Remove teflon oil line plugs, install fittings, connect oil lines, and install drain plugs.
   (1) Tighten connections to following values:

       NOTE: Replace engine firewall fire detection sensing element and tighten release screws on quick-release clamps (Ref 26-11-11 R/I).

       (a) Oil-in fitting to case: 120 to 150 pound-inches.
       (b) Oil-out fitting to case: 90 to 110 pound-inches.
       (c) Magnetic plug: 15 to 20 pound-inches.
       (d) Magnetic plug body: 30 to 40 pound-inches.
       (e) Output seal drain fitting: 60 to 80 pound-inches.

N. Connect main electrical connector and attach electrical harness to CSD.

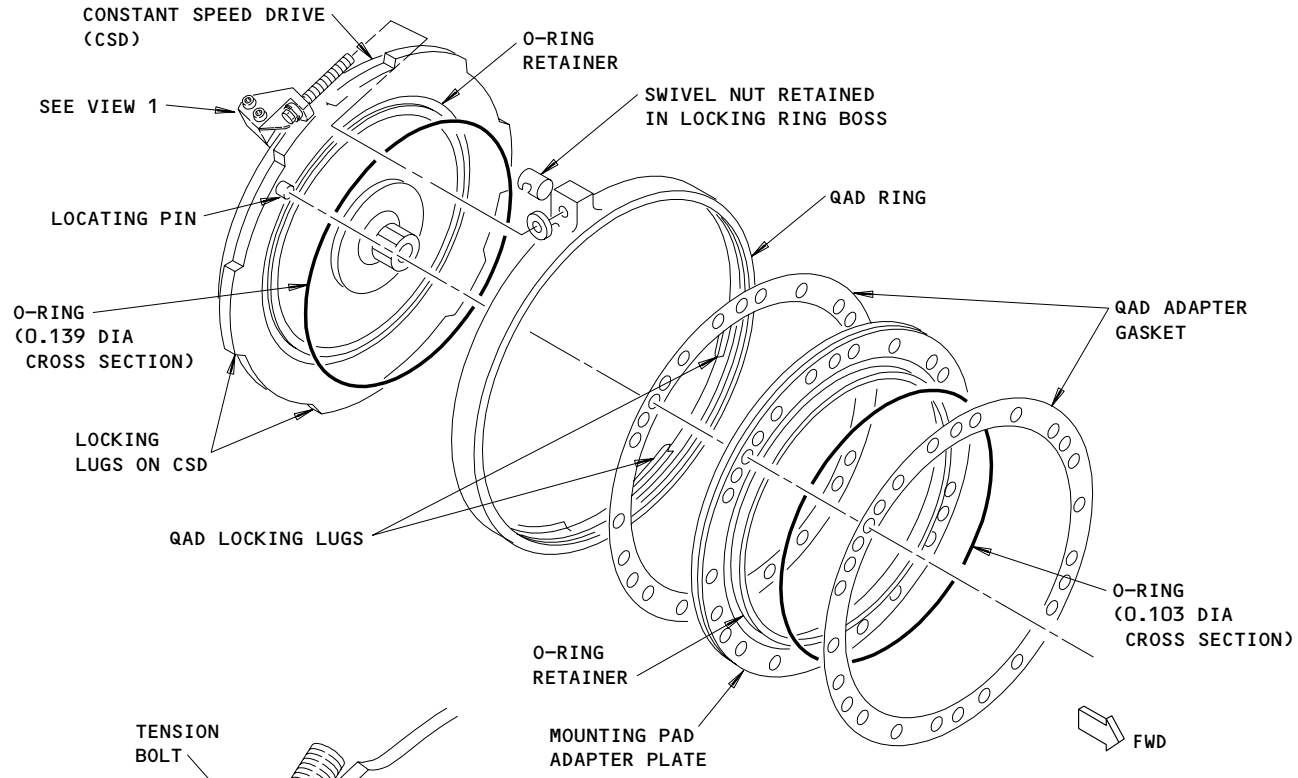
   CAUTION: BEFORE CONNECTING MAIN ELECTRICAL CONNECTOR, CHECK THAT ELECTRICAL POWER IS OFF.

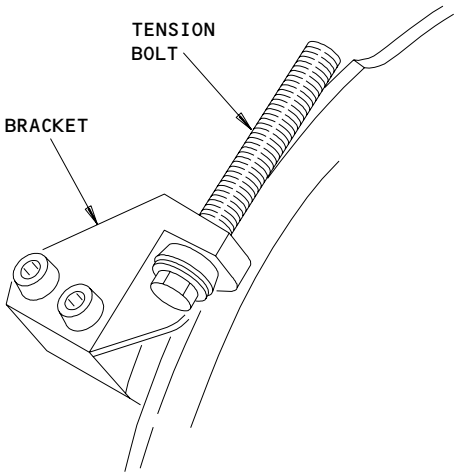
O. Fill CSD with oil (Ref 12-13-21).
P. Fill drive input spline cavity through fill-check-valve with same oil as used in engine. Remove cavity-stand-pipe cap on engine gear case and add oil until it appears at pipe opening. Replace cap and torque to 40 to 50 pound-inches.
Q. Check for leakage between engine gear case and constant speed drive case 30 minutes after filling.
R. Close all circuit breakers opened for removal/installation of CSD.
S. Reset constant speed drive disconnect clutch.
   (1) To reset disconnect pull down handle until a stop is reached or solenoid nose pin snaps into position in pocket of disconnect pawl.
T. Prime constant speed drive before starting engine.
   (1) Motor engine at approximately 20% N2 rotor speed for 1 minute (Ref Chapter 71). Constant speed drive is primed when LOW OIL PRESSURE indicator light on forward overhead panel goes off, or with RESID VOLTS switch pressed a residual voltage is indicated on the ac voltmeter

       NOTE: If low oil pressure light remains on after motoring, start engine and verify that light goes off before N2 reaches idle RPM. If light still remains on, shut down engine and replace CSD.

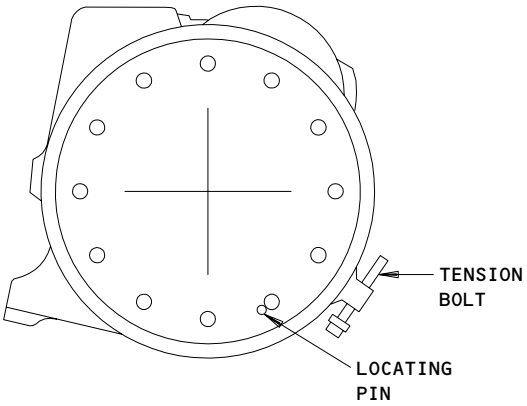
6. Check CSD and Generator Operation With Engine Operating
   A. Start engine and run at idle.

      CAUTION: DO NOT EXCEED IDLE SPEED.





NOTE: THIS DETAIL ROTATED TO SHOW TENSION BOLT MORE CLEARLY.



VIEW 1

NOTE: THIS VIEW SHOWS TRUE ORIENTATION OF TENSION BOLT, ETC.

ac Generator Drive Installation
Figure 401

B. Close generator control (field) relay by momentarily moving a generator control switch for (GEN 1, or GEN 2) on the forward overhead panel to ON. Voltmeter should read 115 volts and frequency meter reading should be between 399 and 401 Hz.

CAUTION: SHUT DOWN ENGINE IMMEDIATELY IF VOLTAGE AND FREQUENCY DO NOT REGISTER.

(1) If frequency is outside the range 399 to 401 Hz, adjust CSD (Ref 24-11-11, A/T).

C. Check newly installed generator output voltage and for phase reversal.

WARNING: EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED EQUIPMENT. THE CURRENTS INVOLVED CAN BE FATAL.

(1) Open the load control center panels (P6-11 or P6-12) for access to leads from generator No. 1 or 2 respectively, with the generator breakers open. Panel P6-4 may be opened for access to the No. 1 and 2 bus for a check with the generator breakers closed (Ref 24-50-0, D&O).
(2) By using a phase sequence indicator check phase rotation which should be 1-3-2 at the generator or A-B-C at the circuit breakers in P6 panels above.
(3) If phase rotation is backward, check output leads at generator. Two output leads are reversed.
(4) Check generator voltage by setting selector switch to GEN 1 or GEN 2 and momentarily placing GEN 1 or 2 switch on pilots' forward overhead panel to ON. AC voltmeter should read about 115 volts.
(5) Close load control center panels P6-11 and/or P6-12.

D. Shut down engines.

E. Check oil level at sight gage after stopping engine.

NOTE: Do not reservice if oil remains within applicable operating range on sight gage. If oil level is below operating range, reservice to proper level (Ref 12-13-21, SRV).

F. Check CSD for oil leaks after first engine operation following drive installation. There should be no leakage at following locations:
(1) Oil supply and return line connections.
(2) Oil pressure warning switch mountings.
(3) CSD case, and at QAD locking ring and spline cavity joining surfaces.
(4) CSD drain lines and at disconnect reset gland.
(5) Oil supply line fill valve.
(6) CSD line oil filter.

(7) Oil cooler and fittings.

(a) Check portion of oil cooler which projects into engine fan air stream by removing hex nuts (6 places) and swinging cooler assembly out of engine casing. It should not be necessary to disconnect the IN and OUT oil lines at the cooler for this check.

NOTE: Cooler damage may have resulted from foreign objects ingested by the engine.

(b) Install oil cooler. Tighten and lockwire hex nuts (6 places).

GENERATOR CONSTANT SPEED DRIVE - ADJUSTMENT/TEST

1. General
   A. The constant speed drive governor can be adjusted to change the output speed. Allowable generator output frequency is 400 ±4 Hz. If frequency is out of tolerance, the governor should be adjusted to provide generator output frequency of 400 ±1 Hz.
   B. The constant speed drive disconnect can be tested by a static check or a dynamic check.
2. Adjust Generator Constant Speed Drive
   A. Check that filter and magnetic plug show no indication of contamination or failure.

      WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY. PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

      NOTE: If filter or magnetic plug show indication of failure or contamination, or if frequency is unstable or erratic, or if frequency goes out of limits and stays out upon application or removal of loads, replace constant speed drive rather than adjust governor.

   B. Start and run engine (Ref 71-09-100, Operating Procedure) for 3 minutes to allow system to reach operating temperature.
   C. Check that frequency is stable during application or removal of load.
   D. Record frequency to determine amount of adjustment necessary.

      NOTE: If frequency is 400 ±4 Hz, no adjustment is necessary.

   E. Remove lockwire and insert screwdriver in adjustment screw slot on lower forward area of drive unit.
   F. Turn adjustment screw clockwise to increase frequency, counterclockwise to decrease frequency. One full turn is equal to approximately 2 Hz.
   G. Adjust as necessary to bring frequency to 400 ±1 Hz.
   H. After adjustment, secure screw with safety wire.
   I. Shut down engine if engine operation is no longer required (Ref 71-09-100).
3. Generator Constant Speed Drive Disconnect Test
   A. Following are two disconnect tests; only one need be performed. If engines are not operating, static-test the disconnect. If engines are running, dynamic-test the disconnect.
      (1) Static disconnect test.
         (a) Set BAT switch on P5 overhead panel to ON.

(b) Remove lockwire and raise guard on DISCONNECT switch on P5 forward overhead panel and actuate switch.
(c) Slowly pull disconnect reset handle on CSD to outward limit of travel, noting the amount of hand force required. A click will be felt as the disconnect reset handle is pulled. Operation of the handle should be smooth, require moderate force, and should not bind.
(d) Allow handle to return slowly to the maximum inward position.
(e) Slowly pull handle to outward limit of travel, noting the amount of hand force required. The force will be less than that required to pull handle first time. There will be no click as the handle is pulled.
(f) Close and lockwire DISCONNECT switch guard on P5 panel.
(g) Set BAT switch on P5 overhead panel to OFF.

(2) Dynamic disconnect test.
(a) Set BAT switch on P5 overhead panel to ON.
(b) Start and run engine at idle speed (Ref 71-09-100, Operating Procedure).
(c) Turn ac meters selector switch to GEN 1 or GEN 2 as applicable.
(d) Check that voltage is indicated on ac voltmeter.
(e) Remove lockwire and raise guard on DISCONNECT switch on P5 panel and actuate switch.

CAUTION: DO NOT ACTUATE DISCONNECT BELOW MINIMUM ENGINE IDLE SPEED. DAMAGE MAY OCCUR AS A RESULT OF INCOMPLETE DISCONNECT. DO NOT ACTUATE THE DISCONNECT SWITCH FOR PERIODS LONGER THAN 3 SECONDS. ALLOW A MINIMUM OF 60 SECONDS BETWEEN ACTUATION PERIODS. CSD MAY BE DAMAGED.

(f) Check that voltage falls to zero and the following lights come on:
1) CSD LOW OIL PRESSURE (P5 panel)
2) ELEC (P7 lightshield)
3) MASTER CAUTION (P7 lightshield)
(g) Shut down engine and wait until N1 and N2 rotors stop rotating (Ref 71-09-100).

CAUTION: DO NOT ATTEMPT TO RESET DISCONNECT WITH ENGINE ROTATING.

(h) Slowly pull disconnect reset handle on underside of CSD to outward limit of travel. A click will be felt as the reset handle is pulled.

(i) Start and run engine at idle speed (Ref 71-09-100, Operating Procedure). Check that reset has connected CSD to engine by checking the following.
   1) Check CSD oil temperature. Temperature should rise slightly.
   2) Check CSD LOW OIL PRESSURE light. Light should go off.

(j) Restore system to normal.
   1) Shut down engine (Ref 71-09-100).
   2) Press ELEC and MASTER CAUTION lights to reset.
   3) Close and lockwire DISCONNECT switch guard on P5 panel.
   4) Set BAT switch on P5 panel to OFF.

GENERATOR CONSTANT SPEED DRIVE - INSPECTION/CHECK

1. Generator Constant Speed Drive Check
   A. General
      (1) The internal wear of the constant speed drive is determined by observing the amount of magnetic material collected by the magnetic chip plug. The chip collector is a threaded plug supporting a permanent magnet.
   B. Remove and Check Magnetic Chip Collector

      WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY.

      PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

      (1) Remove only inner plug with 9/16-inch hex. Do not remove 3/4 inch lockwired drain plug. A check valve prevents oil loss when magnetic plug only is removed.
      (2) Check material collected by magnetic chip collector.
         (a) A small amount of metallic fuzz is normal. Clean and replace the magnetic plug.
         (b) A heavy deposit of fuzz indicates excessive wear. Clean and replace magnetic plug. Recheck after next engine run. If a heavy deposit of fuzz is on chip collector after engine run, replace CSD, oil cooler and associated tubing.
         (c) Bright metal deposits of chips or flakes. Replace the CSD, oil cooler, and associated tubing.
   C. Install Magnetic Chip Collector
      (1) Clean magnetic plug, removing all fuzz with brush and compressed air.
      (2) Torque from 15 to 20 pound-inches and lockwire.
   D. Check oil level at sight gage after shutdown (Ref 12-13-21, SRV).
   E. Check line oil filter pressure differential indicator.
      (1) Change CSD if pressure differential indicator button is in the out position.
   F. Examine oil in CSD.
      (1) Visually examine the oil in the sight glass. If oil shows signs of abnormal discoloration (dark or black) due to contamination, sludging, coking, excessive temperature, or if oil mixing is suspected, replace CSD and flush oil cooler.

GENERATOR DRIVE OIL COOLER - REMOVAL/INSTALLATION

1. General
   A. The generator constant speed drive (CSD) system should not remain open while oil cooler is being serviced, cleaned or repaired. Have a spare cooler and bypass relief valve assembly available and instal1 immediately.
2. Remove Generator Drive Oil Cooler
   A. Open engine cowl panels (Ref Chapter 12, Nacelle and Engine-To-Wing Access Doors and Panels).
   B. Disconnect oil IN flex tube line from lower right side of oil cooler and discard O-ring (Fig. 401).

      WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY. PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

      (1) Collect oil in suitable container and discard this oil.
   C. Disconnect oil OUT flex tube line from lower left side of oil cooler and discard O-ring.
   D. Cap ends of flex tube lines to prevent contamination of constant speed drive system.

      CAUTION: TAKE ALL POSSIBLE CARE TO PREVENT ANY EXTRANEOUS MATERIAL FROM ENTERING ANY PART OF CSD SYSTEM.

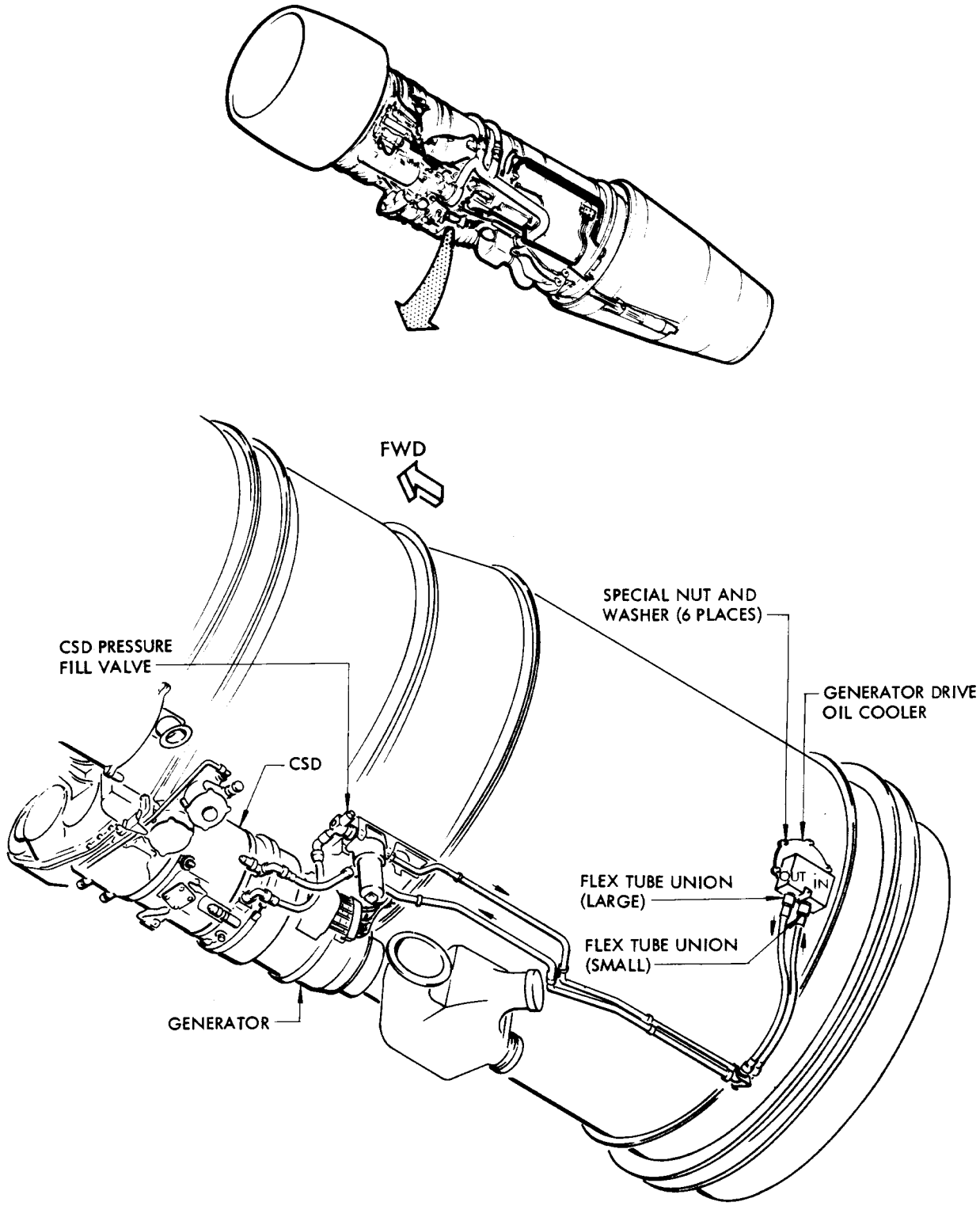
   E. Remove special nuts and washers from CSD oil cooler.
   F. Remove generator drive oil cooler.
3. Install Generator Drive Oil Cooler
   A. Install generator drive oil cooler gasket on engine fan bleed air pad.

      NOTE: Faying surfaces must be clean and free of pieces of old gasket.

   B. Position generator drive oil cooler with ports down to meet flex tube connections.
   C. Slide cooler into place.

      CAUTION: EXERCISE CARE TO PREVENT DAMAGE TO GASKET.

   D. Install washers and special nuts. Do not tighten until all nuts are engaged on studs fixed in engine pad.
   E. Tighten nuts 44 to 49 pound-inches torque.
   F. Remove caps from cooler OUT port and large diameter or OUT flex tube.
   G. Wet O-ring with engine oil MIL-L-7808 and install in flex tube fitting.
   H. Connect flex tube to OUT port on cooler. Tighten flex tube union.



Generator Drive Oil Cooler Installation
Figure 401

I. Remove caps from cooler IN port and smaller diameter flex tube.
J. Wet O-ring with engine oil MIL-L-7808 and install in flex tube fitting.
K. Connect flex tube to IN port on cooler. Tighten flex tube union.
L. Fill CSD with oil. Refer to Constant Speed Drive Servicing, Chapter 12.
M. Start engine and check oil cooler for oil leaks.
N. Close engine cowl panels.

GENERATOR DRIVE LINE OIL FILTER - UNIT SERVICING

1. General
   A. The need for changing the line filter element or cartridge is determined by the condition of the CSD as revealed by the accumulation of iron particles on the magnets of the magnetic drain plug chip collector, by the number of hours since the last filter change and by whether the drive system has been overheating. Newer filters, P/N 7581418, have differential-pressure pop-out indicators which indicate when the filter requires replacing. If heavy deposits of iron fuzz are found on the magnets of the chip collector, the further examination of the filter would determine the condition of the drive. If chunks of metal are found on the filter the drive should be removed (Ref 24-11-11, I/C).

      CAUTION: DURING ALL MAINTENANCE ON CONSTANT SPEED DRIVE, CLEANLINESS IS ABSOLUTELY ESSENTIAL. TAKE ALL POSSIBLE PRECAUTION TO PREVENT FOREIGN MATTER FROM ENTERING DRIVE SYSTEM.

   B. When the CSD is changed, for whatever reason, the CSD line filter element should be changed. If the CSD overheats the line filter should be checked for sludging. If carbon particles are found, the CSD system should be drained and reserviced, and the CSD line filter element changed (Ref 12-13-21).
2. Equipment and Materials
   A. Petrolatum - VV-P-236 (Vaseline)
3. Change Line Oil Filter Element (Fig. 301)
   A. Remove line oil filter element.

      WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY. PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

      CAUTION: TAKE ALL POSSIBLE PRECAUTIONS TO PREVENT FOREIGN MATTER FROM ENTERING DRIVE SYSTEM.

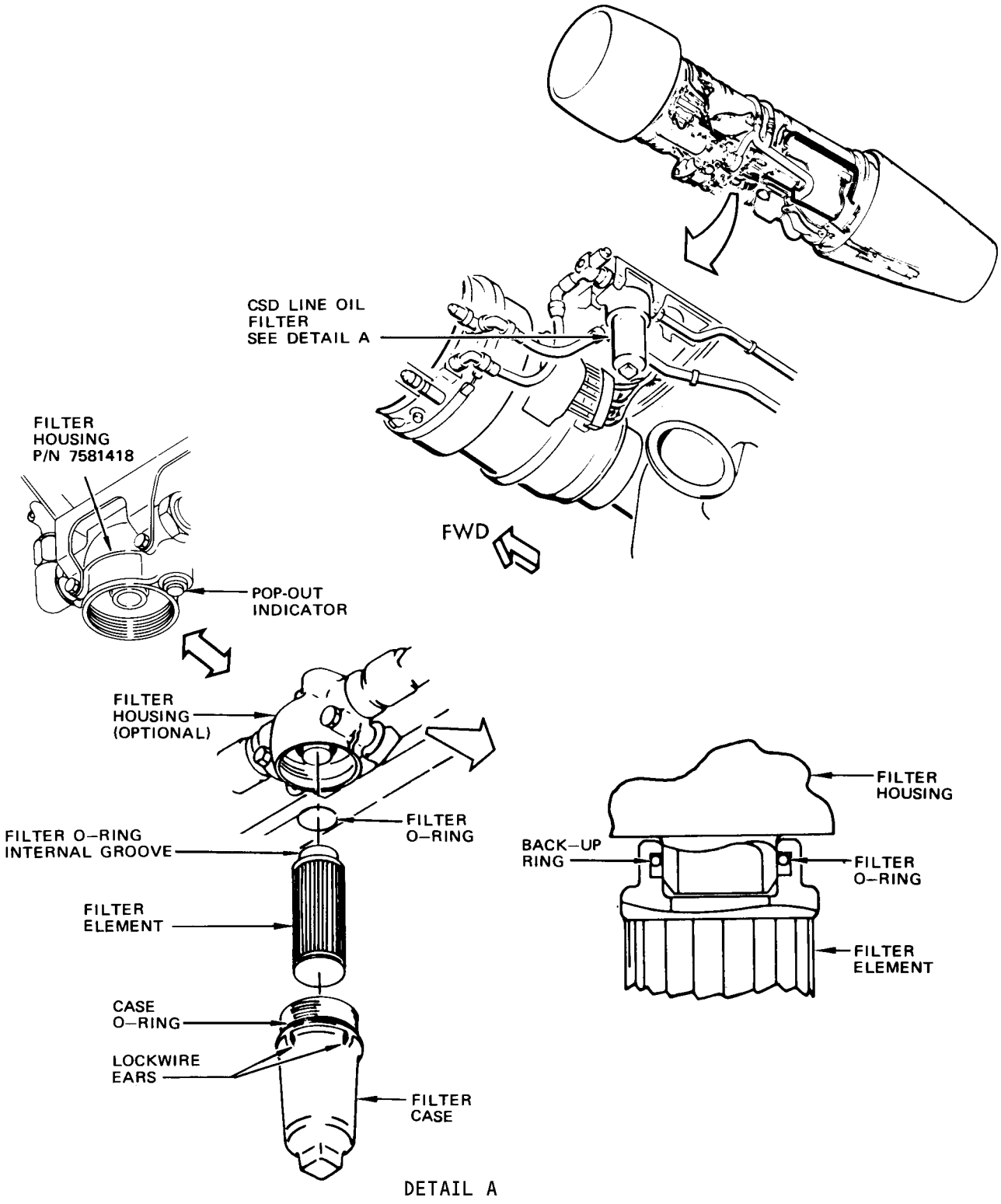
      (1) Remove locking wire.
      (2) Unscrew filter case and discard case O-ring.
      (3) Remove filter element and discard filter O-ring.
      (4) Remove filter O-ring from inside of mouth of filter element.
   B. Install Line Oil Filter Element (Fig. 301)
      (1) Install new filter O-ring inside of mouth of filter element.
      (2) Coat filter case thread with small amount of Petrolatum.

(3) Install new case O-ring. Install filter case, torque to 240-360 (case without pop-out indicator) or 300-360 (case with pop-out indicator) pound-inches, and lockwire.

C. Service CSD with oil (Ref 12-13-21)

CAUTION: DO NOT OVERFILL DRIVE. OVERHEATING AND SLUDGING CAN RESULT IN DRIVE DAMAGE.

D. Motor engine and check CSD oil system for leaks.



Generator Drive Line Oil Filter Element Installation
Figure 301

GENERATOR DRIVE INTEGRAL OIL FILTER - UNIT SERVICING

1. General
   A. The need for changing the integral oil filter element is determined by the condition of the CSD as revealed by the accumulation of iron particles on the magnets of the plug, by the number of hours since the last filter change and by whether the drive system has been overheating. If heavy deposits of iron fuzz are found on the chip collector, the further examination of the filter would determine the condition of the drive. If chunks of metal are on the filter replace drive, oil cooler and associated tubing (Ref 24-11-11, I/C).

      CAUTION: DURING ALL SERVICING AND MAINTENANCE ON CONSTANT SPEED DRIVE, CLEANLINESS IS ABSOLUTELY ESSENTIAL. TAKE ALL POSSIBLE PRECAUTION TO PREVENT FOREIGN MATTER FROM ENTERING DRIVE SYSTEM.

   B. If the CSD overheats, check the integral oil filter for sludging. If carbon particles are on the filter, drain and reservice the CSD system, and the change CSD integral oil filter element.
   C. If the pressure differential indicator button is extended, check the integral oil filter for sludging or metal chunks, and drain and reservice the CSD system.
2. Integral Oil Filter Element - Removal/Installation (Fig. 301)
   A. Remove integral oil filter element.

      WARNING: USE EXTREME CARE WHEN DRAINING CSD OIL OR REMOVING CSD COMPONENTS. HOT OIL CAN CAUSE INJURY. PROLONGED CONTACT WITH CSD OIL CAN CAUSE DERMATITIS. OIL WILL STAIN CLOTHING AND CAN SOFTEN PAINT.

      CAUTION: TAKE ALL POSSIBLE PRECAUTIONS TO PREVENT FOREIGN MATTER FROM ENTERING DRIVE SYSTEM.

      (1) Remove cap screws and washers from filter cap assembly. 301).
      (2) Remove filter cap assembly and filter element and discard O-ring.
      (3) Separate filter element assembly from cap assembly.

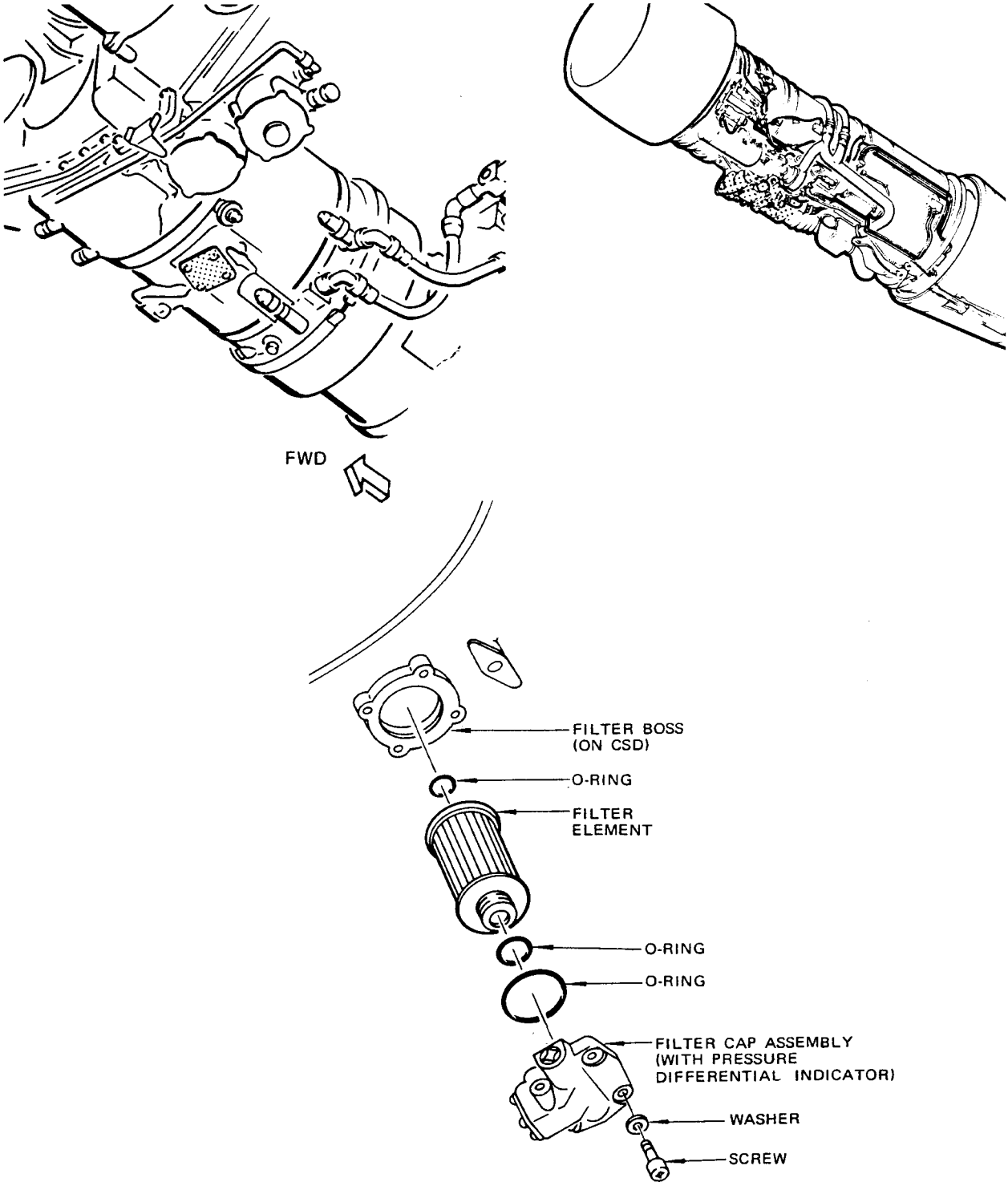
         NOTE: O-ring may bind, but filter element is removed by twisting and pulling from filter cap assembly.

      (4) Discard filter element.
      (5) Clean filter cavity in CSD with lint-free cloth and oil.

B. Install integral oil filter element.
   (1) Install O-rings on filter element. Wet O-rings sparingly with CSD oil to facilitate assembly.
   (2) Install O-ring in filter cap assembly.
   (3) Plug filter element into filter cap.
   (4) Insert filter element complete with O-rings and cap into filter cavity of CSD.
   (5) Install cap screws with washers. Torque screws from 48 to 53 pound-inches.

       NOTE: Do not attempt to draw filter element into cavity by tightening screws. Always be sure filter cap flange is contacting filter boss before installing and torqueing screws.

   (6) Fill CSD with oil (AMM 12-13-21).
   (7) Push indicator button on filter cap to reset pressure differential indicator, if actuated (Fig. 301).
   (8) Motor engine and check CSD at filter cap assembly for leaks.



BYPASS VALVE IN CAP CONFIGURATION

Generator Drive Integral Oil Filter Installation
Figure 301

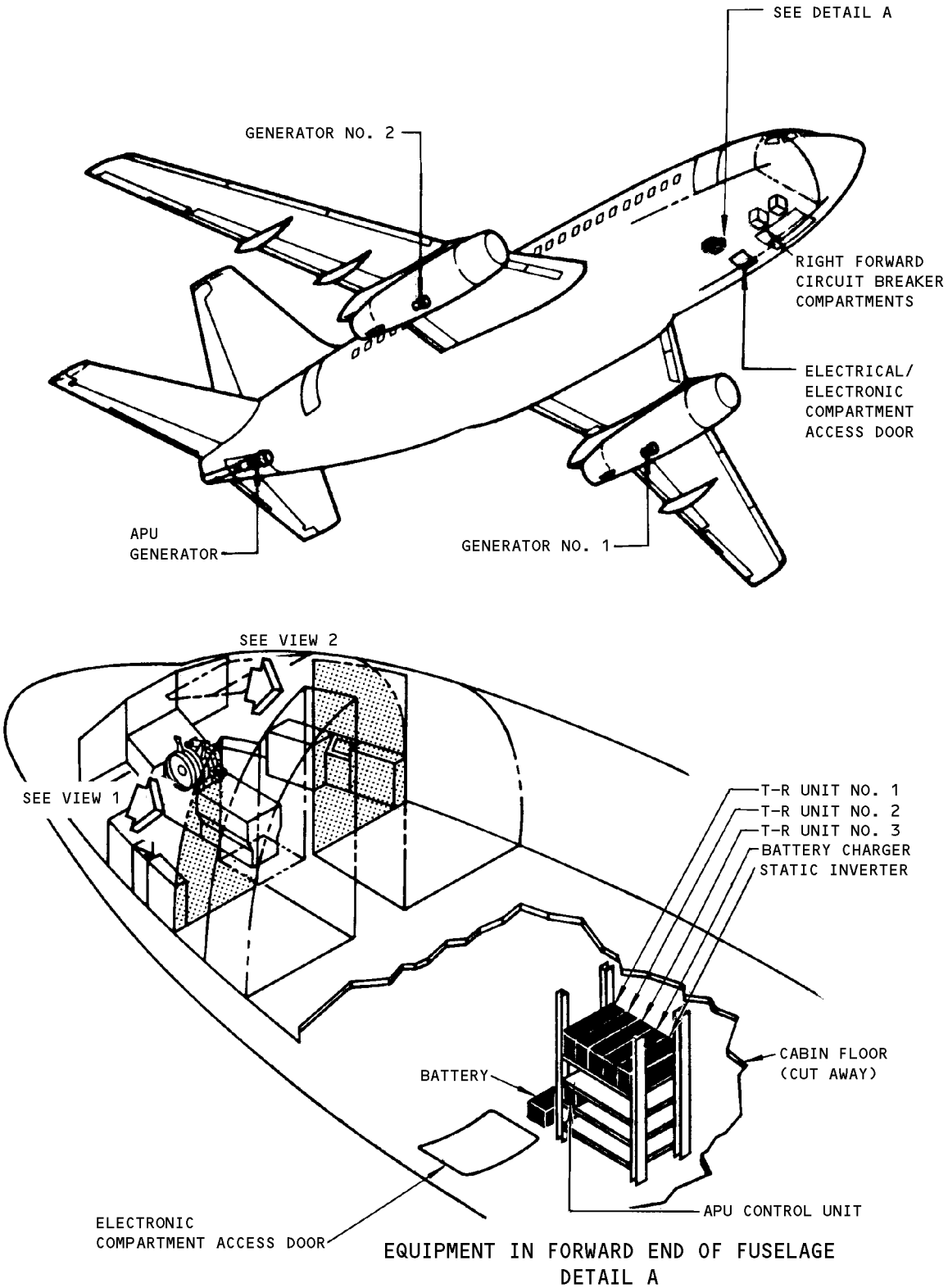
AC GENERATION SYSTEM - DESCRIPTION AND OPERATION

1. General

A. Energy for operation of all electrical loads on the airplane except when external power is used is provided by three 3-phase, 115/200-volt, 400-cycle, alternating current systems (See figure 2.) Two of these electrical generating systems are driven from the accessory gearbox on the engines by a hydromechanical constant speed drive unit (CSD), to supply constant frequency ac electrical power. When the engine is operating within its normal speed range, power of the correct frequency is delivered through the CSD to the electrical system. Neither of the engine driven systems is arranged to be operated nor connected in parallel with the other system and attempts should not be made to alter connections to obtain parallel operation. A third power unit (auxiliary power unit) is mounted to the airplane structure in the tail cone. For further details on the auxiliary power unit (APU), refer to Chapter 49. An external power receptacle is installed which enables using a conventional ground power unit for furnishing ac power on the ground. Switching is provided so that external power may be fed throughout the airplane by closing the external power contactor, which ties the ground power unit to the tie bus. Alternatively, external power may be fed only to selected ground servicing circuits. The APU generator cannot be operated in parallel with external power, nor can either of the ground power sources be operated in parallel with the airplane generators

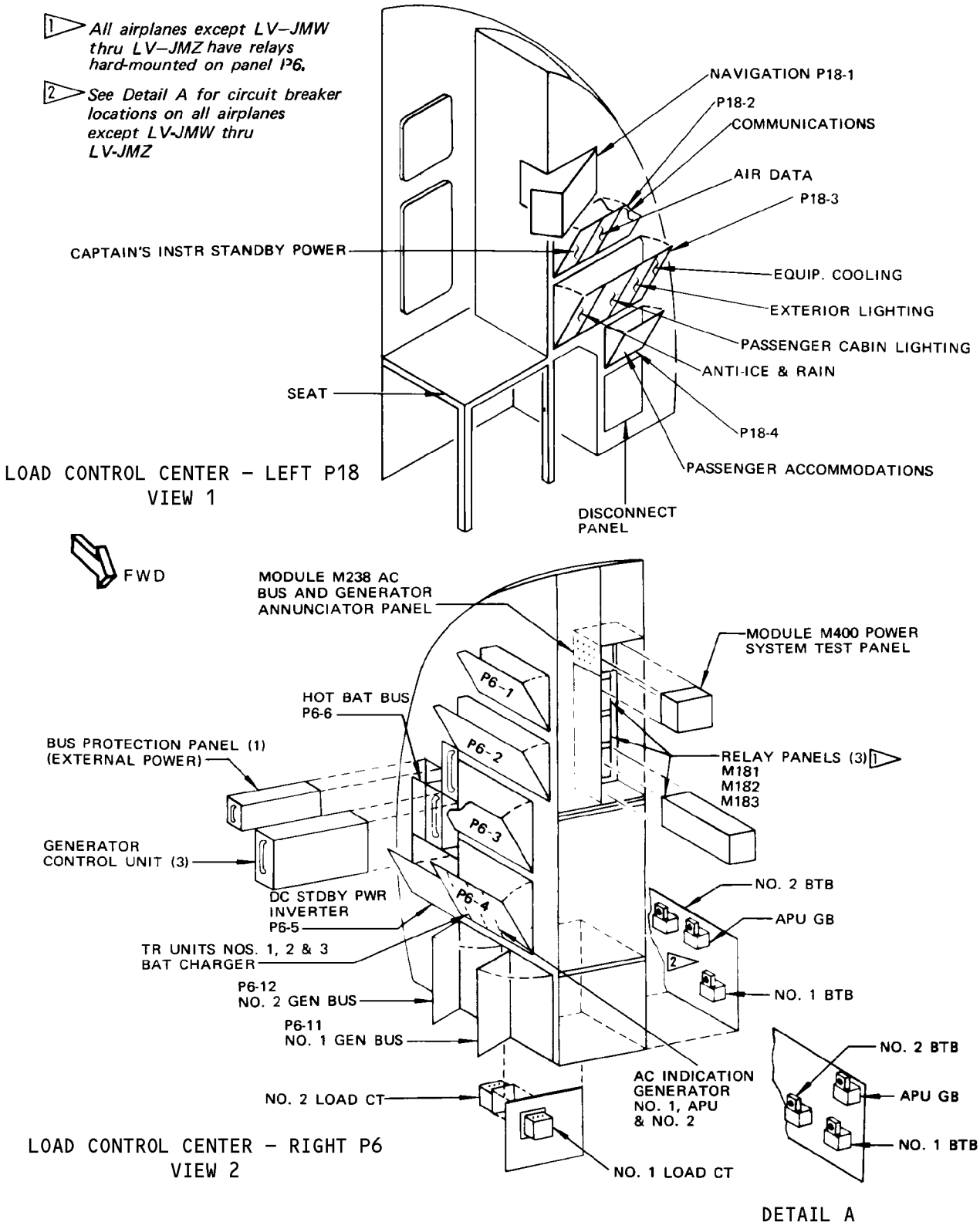
B. Standby ac power is available when no other 400 cycle source is operating. An inverter, energized by 28 volt dc power from the storage battery, supplies single-phase 400-cycle 115 volt power for critical communication and navigation equipment. This inverter and standby power transfer relays No. 1 and No. 2 connect to ac and dc busses to make up the standby power system. The inverter is located adjacent to the battery charger in the E3 electrical/electronic equipment racks in the electronic compartment (Fig. 2).

C. There are certain dc components required for control of the generation systems which are located in the electrical equipment racks. Except for circuit breakers on the P18 panels, most of the ac electrical power control components are located on the P6 panels. (See figure 2.) The space adjacent to and forward of equipment racks E3-1, E3-2, E3-3 and E3-4 contain the battery, the battery shunt and the battery charger thermal switch. The battery charger, T-R units No. 1, No. 2 and No. 3, and the standby static inverter are on equipment rack E3-1 to the right of the electronic compartment access door in the lower forward fuselage. The APU control unit module (M280) is beneath the No. 1 T-R unit on the E3-3 rack (Fig. 2).



EQUIPMENT IN FORWARD END OF FUSELAGE
DETAIL A

ac Generation System Component Location
Figure 1



ac Generator System Component Location
Figure 2

D. The generator control unit (GCU) is a multi-purpose device for regulating voltage, supplying exitation power, limiting power output, and protecting the generating system against a variety of electrical faults. The GCU contains protection circuits which shut down a generator when a deviation from normal operation occurs. The unit also contains an anticycling feature for instances when a control switch is manually held ON by a crew member. The GCU for each generator and for the APU generator are the same. A separate bus protection panel provides for the external power circuits and equipment and contains protective features for negative sequence, high phase overvoltage, undervoltage, and anticycling. The generator control units and bus protection panel are in the P6 panel on the control cabin aft bulkhead (Fig. 2). A functional block diagram of the generator control unit is shown (Fig. 5).

E. The voltage regulator, contained with in the GCU, supplies and controls the direct current required by the exciter field to maintain the proper exitation of the main generator field. The exitation requirement is determined by the voltage regulator as a function of generator output voltage. The voltage regulator is the static type specifically designed for this particular type of ac generator.

F. The current transformers in each generator system are so located that inputs for various control and protective functions such as overcurrent, power limiting, generator excitation boost, load differential protection, neutral differential protection, and metering are obtained from the generating and distributing system 3-phase power leads and/or bus connections. Three separate 3-phase current transformer (CT) assemblies are used in the aircraft to sense current for different purposes.
   (1) The differential protection neutral side current transformers, mounted on the power plant near the generator, sense current in the grounded feeders from generator terminals T4, T5, and T6. This arrangement is essentially the same for the three generators.
   (2) The differential protection load side assembly contains two sets of CT's identical to the neutral side. One set functions as the differential protection for the engine generator and the other for the APU generator. Both sets are capable of supplying the main load bus and are identified as T4 and T5. Each set contains six separate current coils. Switching of the outputs from the coils is done inside the generator control units by the differential protection relays.
   (3) The functions of measuring overcurrent, power limiting, boost, and current metering are accomplished by a CT assembly containing twelve coils. Nine of these coils furnish inputs to the generator control unit and three coils are connected to ammeters.

G. A test module is provided which contains selector switches, test jacks, and circuits that allow portable meters to be used to check performance of the airplane generation system.

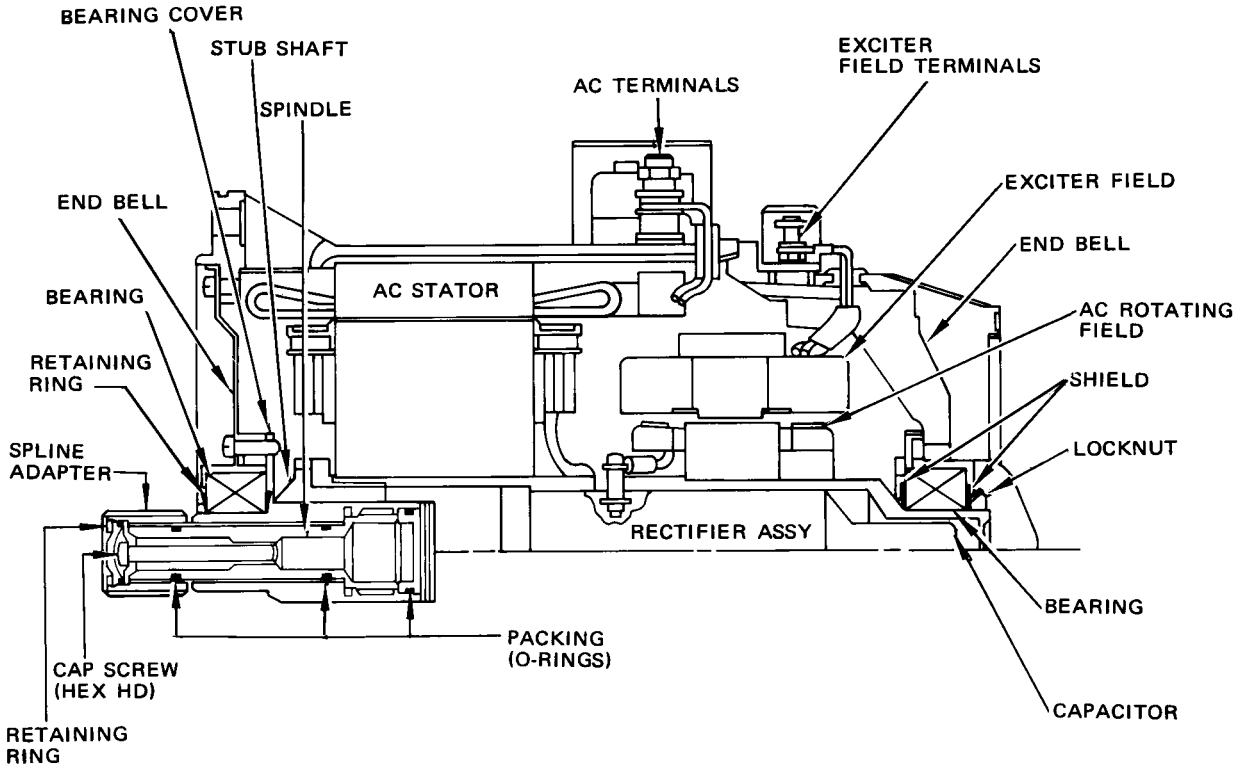
2. AC Generators

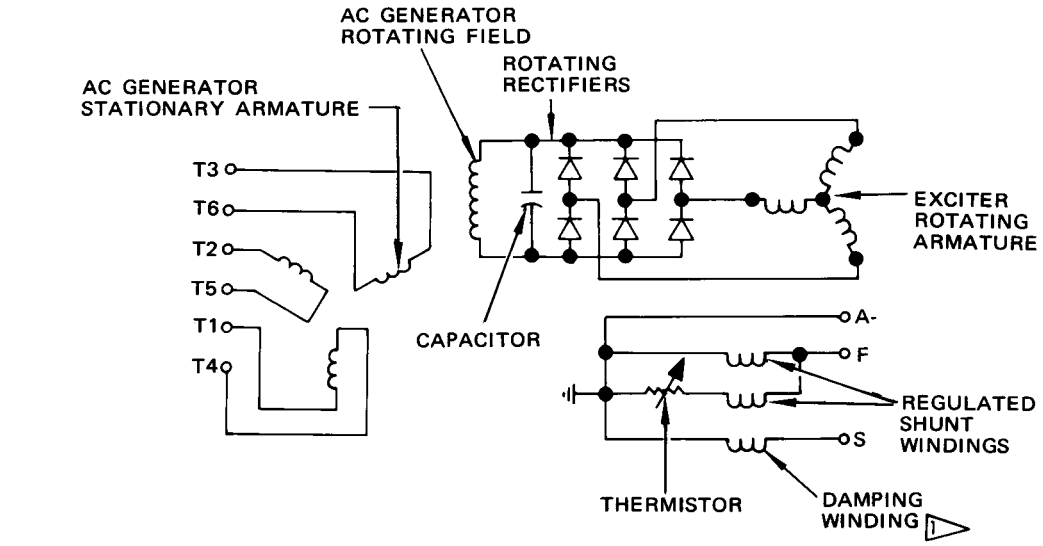
A. The generators are each 0.95 leading to .75 lagging power factor, 120/208 volts, 380/420 cps alternating current at 5700 to 6300 rpm. The units are designed without slip-rings, commutator, or brushes on either the main generator or the exciter. A rotating electromagnetic field causes the output voltage to be induced in the stationary generator armature. This rotating field is excited by an integral ac exciter, in which the output is converted to dc by rectifiers in the generator rotor shaft (Fig. 3). The two engine-driven generators are supported by the CSD transmission on the underside of the engine. Generator cooling is accomplished by ducting engine fan air from an air outlet on the engine through the generator. During both ground and inflight operation, air which has passed through the generator is directed overboard through an air exit in the engine cowling (Ref Chapter 75, Generator Cooling.) A complete generator assembly consists of an ac exciter generator, a rotating rectifier, and a main generator. The ac exciter consists of a six pole stationary dc field and a rotating armature. The operation of the unit is as follows:

(1) The exciter field is supplied dc power from the voltage regulator. This causes a 3-phase voltage to be developed in the exciter armature. The ac voltage is rectified and fed into the ac generator rotating field. This field generates the useful ac output voltage in the ac generator stator.

(2) The exciter stator has two windings; a shunt field winding connected between terminals F and A- and a stabilizing winding connected between terminals S and A- (Fig. 3). The stabilizing winding is not used with a transistorized-type voltage regulator.

(3) Current supplied by the voltage regulator to the shunt field winding provides excitation for the exciter generator. In so doing, the current controls the exciter output to the main ac generator. The shunt field winding consists of two wires wound in parallel in six series coils mounted on the six main poles. The coils are alternately reversed in polarity over the six poles, on one end both insulated wires are connected to a common F terminal. On the opposite end, one wire is connected directly to the A- terminal and the other wire is connected through a thermister to the A- terminal.





1 STABILIZING (DAMPING) WINDING NOT USED WITH TRANSISTORIZED VOLTAGE REGULATOR

ac Generator
Figure 3

(4) The thermister, mounted on the exciter frame, has an inverse temperature resistance characteristic. The high resistance at low or normal ambient temperature blocks current flow in one of the parallel wires and causes the overall shunt field resistance to be about that of the remaining single wire. At the higher temperature resulting from normal operation, the resistance of each single wire increases to approximately double. At the same time, the resistance of the thermister drops to a negligible value permitting approximately equal current to flow in each wire. The combined resistance of the two parallel wires at higher temperatures is approximately equal to that of the single wire at low temperature, temperature compensation is thereby provided.

(5) Six permanent magnets are mounted on the exciter frame between the six stator poles. These magnets, alternately reversed in polarity, provide a built-in residual voltage which results in main generator voltage build-up and eliminates the need for field flashing or for a starting relay.

(6) A stabilizing winding is wound directly over the shunt field coils. However, the winding is not used since a feed back circuit in the transistorized-type voltage regulator senses and damps out any voltage fluctuations or transients due to load switching or faults.

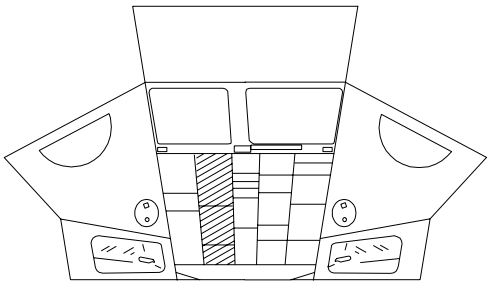
3. Generator Manual Controls

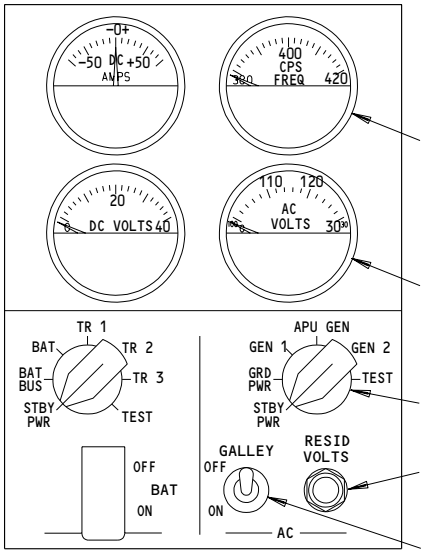
A. Manual controls and monitoring devices are provided on the forward overhead panel (P5) for the electrical power system (Fig. 4). These switches, knobs, indicators, and lights are accessible to the flight crew. Where latching-type contactors are used, the control switches are the momentary type. Three ammeters provide for monitoring output current in the three phases of both engine generators and the APU generator. The phase selector switch is located on the Module M400 generator test panel. (Fig. 2). A dc ammeter, a voltmeter and a selector switch on the forward overhead panel provide for monitoring dc power as indicated (Fig. 4).

4. Generator Control Relay (GCR)

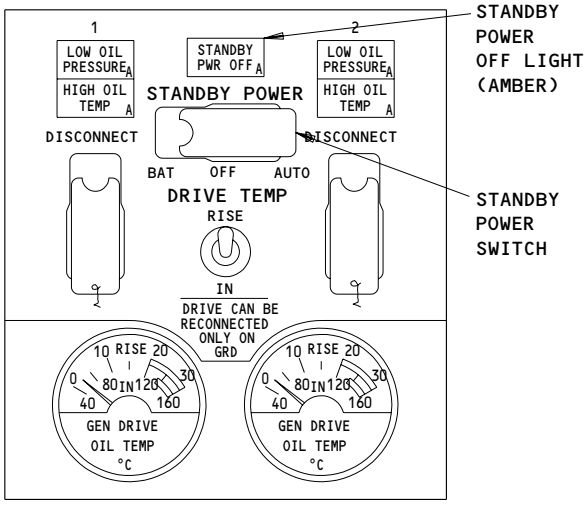
A. The generator (field) control relay (GCR), located in the generator control unit, energizes the generator field. The generator control relay and therefore, the generator field circuit are normally closed. The GCR's may be opened or closed by the generator switches on the pilot's forward overhead panel or opened by signals from the generator control unit protective circuits.

B. With the GCR closed, the generator voltage will build up with engine (or APU) speed and the voltmeter and frequency meter will read approximately l15 volts and 400 Hz at normal speed. The GCR trips with the generator breaker from differential fault or abnormal voltage and any time the generator switch is moved to OFF.

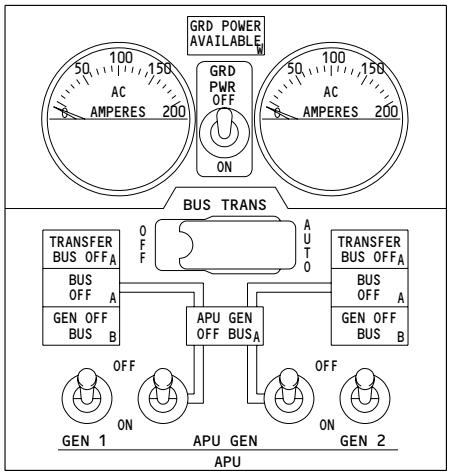




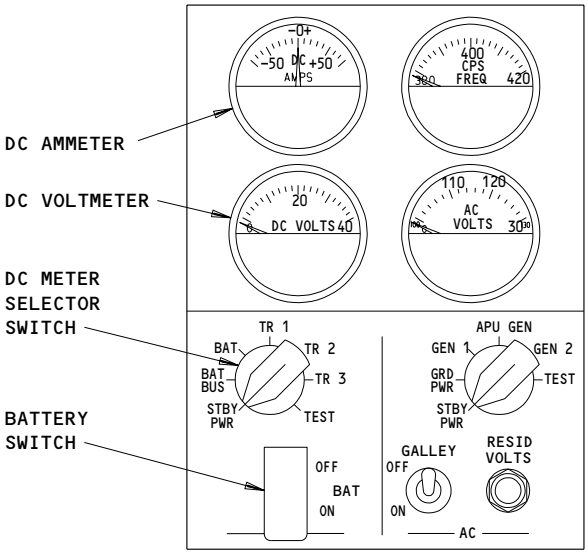
ELECTRICAL POWER PANEL (METERING) 1



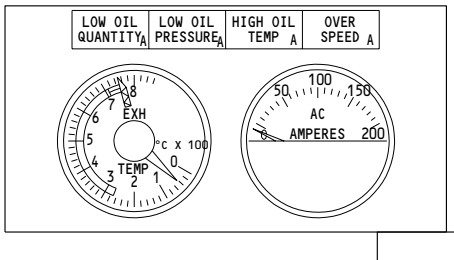
STANDBY POWER 1



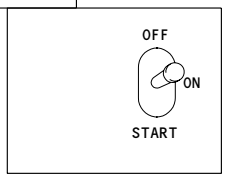
ELECTRICAL POWER PANEL (CONTROLS) 1



DC METERING 1

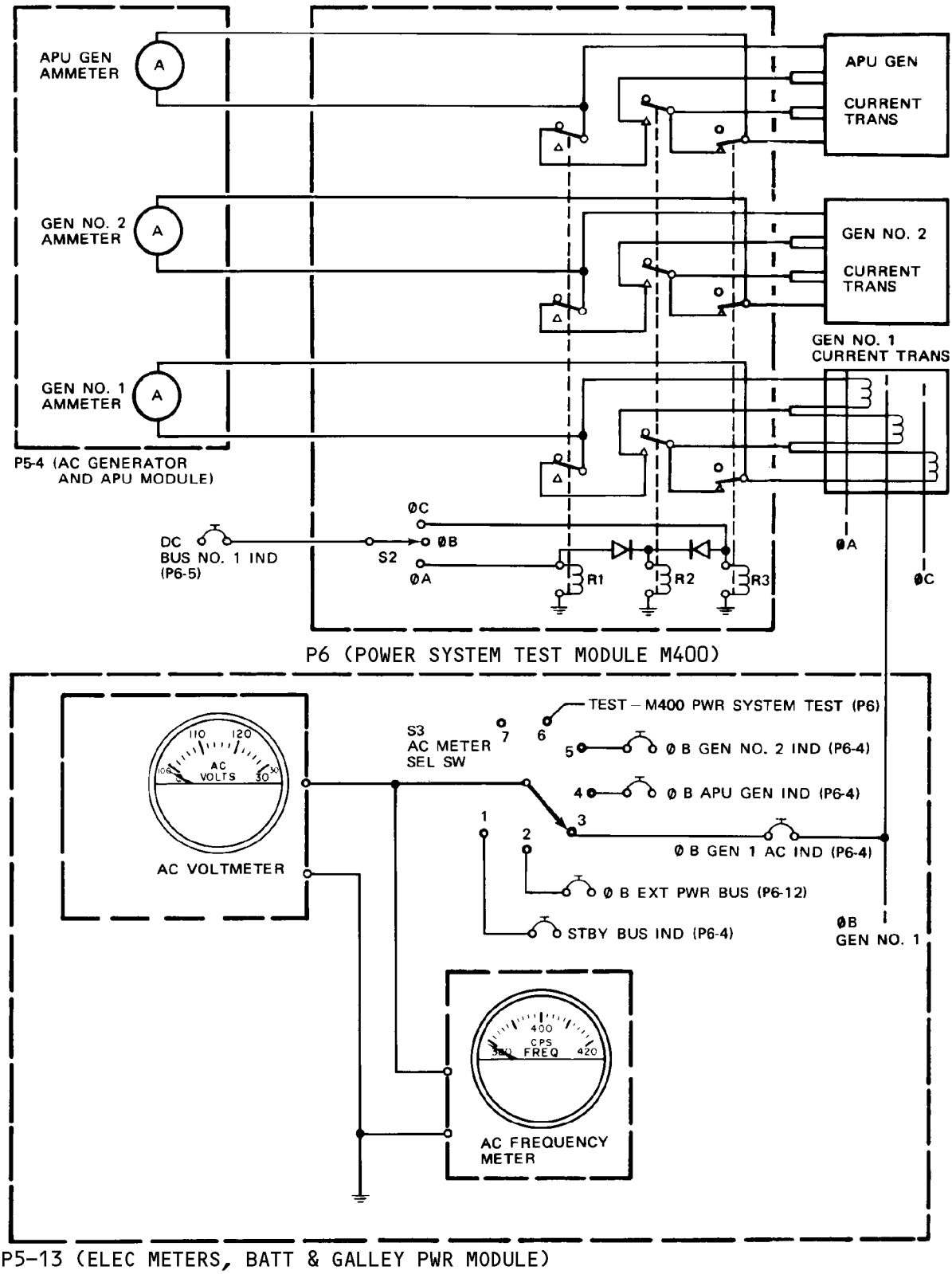


APU CONTROL AND MONITOR 1



1 TYPICAL ARRANGEMENT. SEE CHAPTER 31 FOR EXACT CONFIGURATIONS

ac/dc Power and APU/CSD Temp Indicators
Figure 4 (Sheet 1)



ac/dc Power and APU/CSD Temp Indicators
Figure 4 (Sheet 2)

C. If an engine or the APU is started with the GCR tripped or open, the generator voltage will not build up with engine speed, the voltmeter wil1 not indicate at normal engine speed, and, since the frequency meter is voltage sensitive, the frequency meter will read low. The GCR can be closed by moving the generator switch to ON whether the engine is running or not. Therefore, moving the generator switch momentarily to ON before engine start will close a tripped GCR and ensure voltage build up during engine acceleration. Moving the generator switch to ON after the engine is running will close a tripped GCR causing the voltage to build up and the generator breaker to close connecting the generator to the bus.

5. Generator Control Unit

A. The generator control unit (GCU) is designed for use in single generator operation only. The GCU provides automatic operation of the control functions for each generator system and provides signals to open the generator field by tripping the generator (field) control relay, to trip the generator breaker, and to trip the bus-tie breaker when a system fault occurs. The panel utilizes transistorized circuitry interconnected with hermetically sealed relays. These relays perform switching functions only and do not require adjustment.

B. There are several control and protective functions provided in the generator control unit (Fig. 5).

(1) The control functions are those of dc voltage indicator, generator breaker, field relay, bus-tie breaker, and the control of bus voltage and underspeed conditions.

(2) Protection is provided from overvoltage, undervoltage, overexcitation and underexcitation conditions. The unit also provides differential protection, exciter ceiling protection and (except with transistorized voltage regulators) stability protection.

C. In addition to the control and protective functions, the following provisions have been included:

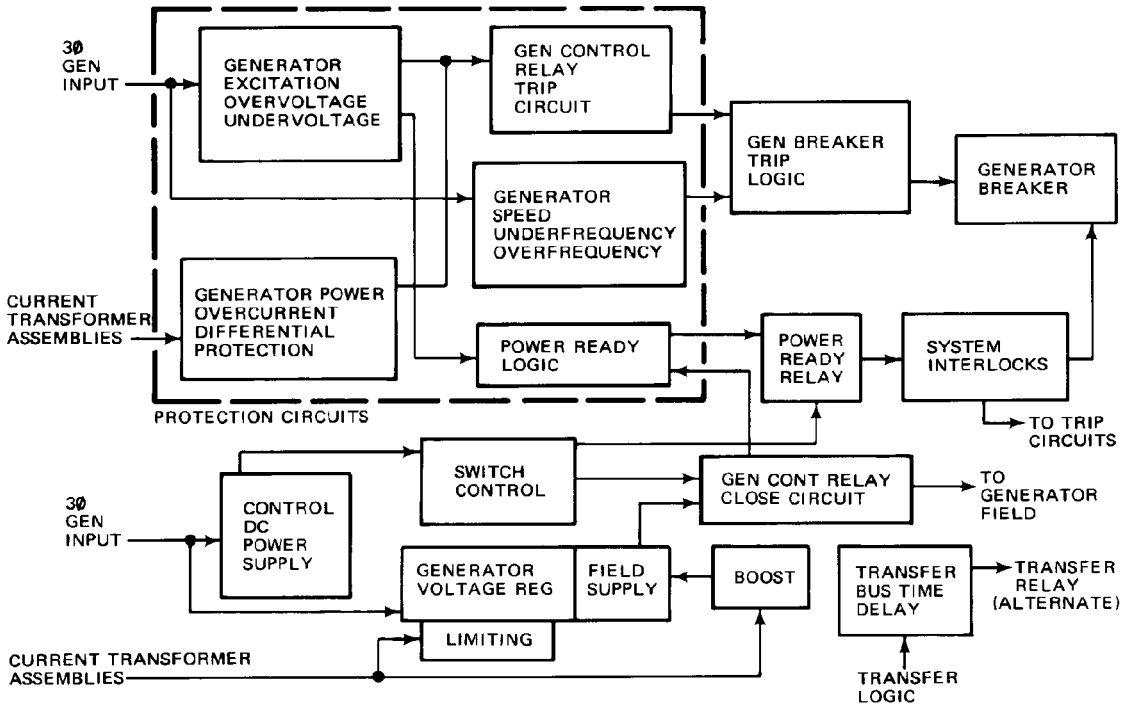
(1) An output is provided from the main connector to the electrical power annunciator panel, (Fig. 6), for sensing the operation of differential protection, overvoltage, undervoltage, overexcitation and underexcitation voltages.

(2) External monitoring of the stability protection circuit (where applicable) is provided for at a standard connector for a quick analysis of a faulted system. A diode is used to block external pickup which may cause false trip of the generator (field) control relay. An external monitoring amplifier of a vacuum tube voltmeter (VTVM) may be used to monitor the output of the sensing circuit.

D. The bus-tie breaker (BTB) connect the generator load bus to the three phase tie bus. This permits operation of two generators by means of automatic switching or permits feeding the generator load bus from the APU or ground power. The BTB can be closed or tripped manually from the forward overhead panel, or can be tripped automatically by a fault signal in the generator control unit.

E. The voltage regulator section is in the generator control unit. It regulates the average of the three-phase voltages as determined at the generator feeder ends and limits the height of phase voltages under unbalanced load or fault conditions. All dc or excitation power supplied to the generator exciter is controlled by the voltage regulator for all load conditions. This dc power is furnished by a T-R unit within the generator control unit. The voltage regulator will limit the input power to the generator to 160 horsepower by means of power limiting current transformers on the generator output feeder lines. The scheme used in the voltage regulator to limit generator power output is to sense system voltage by means of the boost current transformers and line current by means of the power limiting current transformers. These two signals are then combined to obtain a signal which is approximately proportional to the real load on the system. The output of the power control circuit is connected into the voltage regulator circuit in such a manner so that, when system real load approaches a value sufficient to cause excessive generator input torque, the signal from the power control circuit takes over and reduces the system voltage. In this manner, the system real load is limited so that the critical torque is not exceeded.

F. Protective functions of the generator control unit against abnormal system conditions are obtained by incorporating various sensing devices which supply a trip signal to the generator field (control) relay.
   (1) Overvoltage protection is obtained by supplying a signal to the generator field relay when the average three-phase voltage exceeds 127 to 133 volts line-to-neutral.
   (2) The undervoltage device applies a trip signal, also to the generator field relay within 5 to 9 seconds after the voltage drops and remains below 97 to 103 volts line-to-neutral on all three phases of the generator.



Generator Control Unit Functional Block Diagram
Figure 5

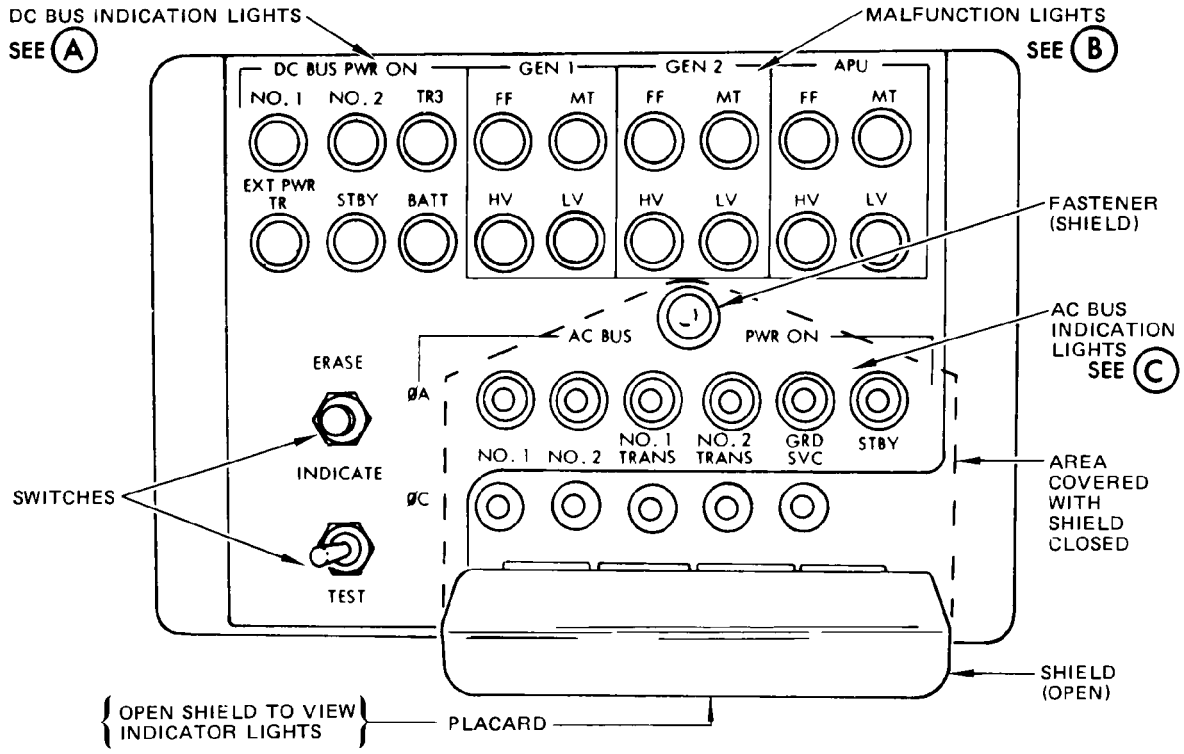
(3) The differential current sensing device and the connecting current transformers protect the generator, generator main bus and interconnecting feeders. Settings are high enough to prevent nuisance tripping and adjusted to trip the GFR in any event at 20 amperes differential current and above.

(4) The overcurrent protection locks out under frequency protection and trips the generator field relay through a time delay which holds long enough for the generator circuit breaker to open. The rating of the generator circuit breaker and the selection of the overcurrent current transformers is dependent on the generator rating, and are different for 30 and 40 kva machines. Overcurrent will lock out underfrequency protection.

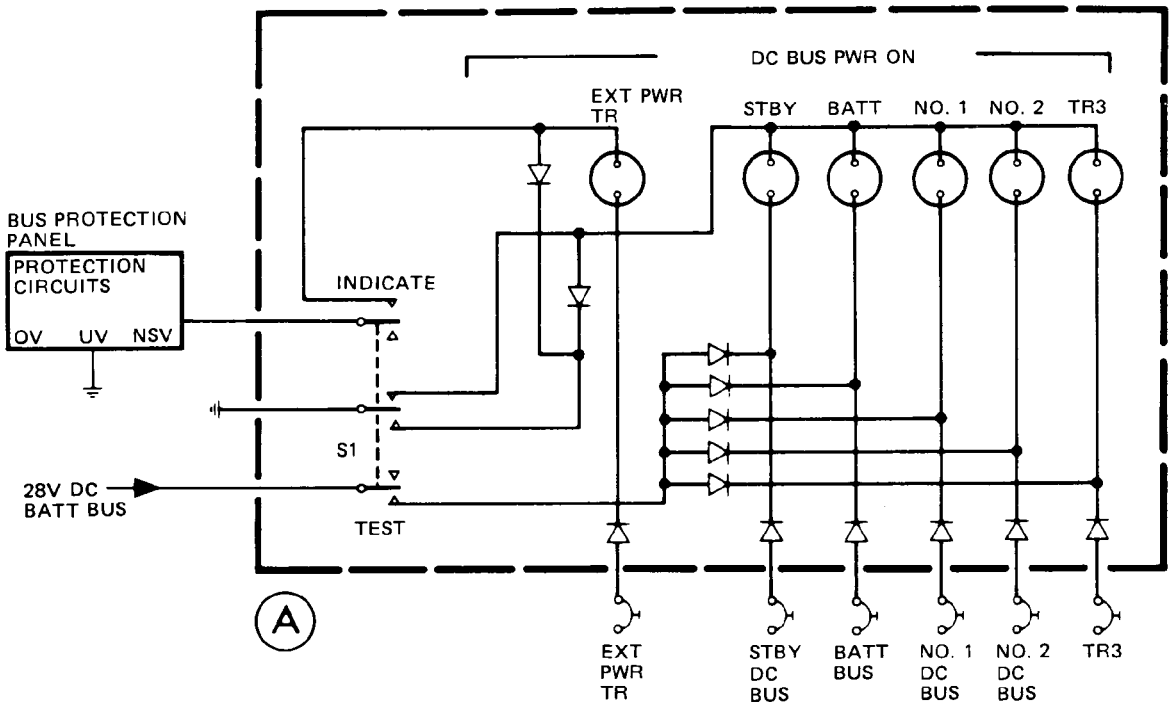
(5) The overfrequency and underfrequency circuits are set to operate at 425 to 435 cps and 360 to 370 cps respectively. A time delay of 0.25 to 0.60 second is provided to override frequency transients from the CSD. The circuit also provides for a lockout for undervoltage protection during normal shutdown of the system. The function of the circuit is to prevent application of power to loads at frequencies outside of the above limits.

G. Transfer bus control is automatic with manual override provided. The transfer bus relays (R3) and (R 4) are magnetically held in either normal or alternate positions with a center-off position. The transfer bus control has a preferred source, designed to minimize transfer of power under operating conditions. A time delay of 0.1 to 0.2 second is incorporated to override normal switching operations.

H. Control power or the necessary dc to operate a generator and its connecting channel is derived from that generator, backed up by the airplane battery system. With an engine running or the APU operating, the generating system is capable of being started and normally operated without the use of the battery system. Current drain on the battery system with the generating channel de-energized should not exceed 0.25 ampere, not considering indicating lights. The battery charging voltage will be 26 to 32 volts and between 23.5 and 18 volts on discharge. DC power from the GCU T-R is capable of tripping two contactors when the ac voltage is 115 for the system.

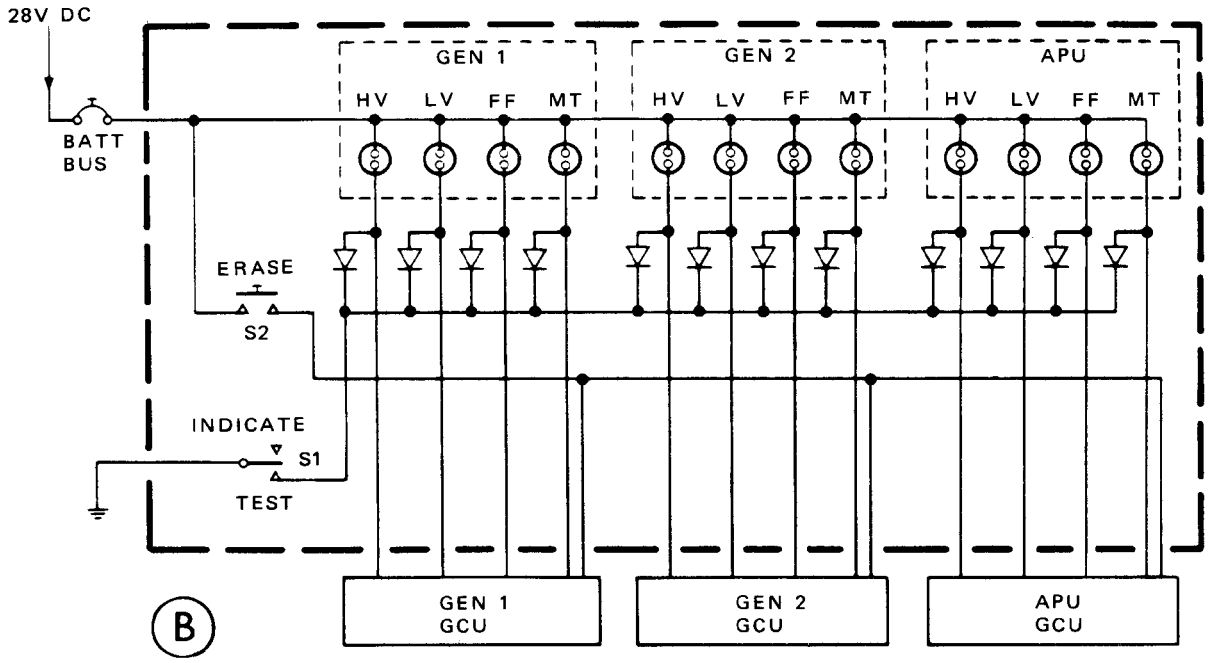


M238 ELECTRICAL POWER ANNUNCIATOR PANEL (P6 RIGHT-REAR)

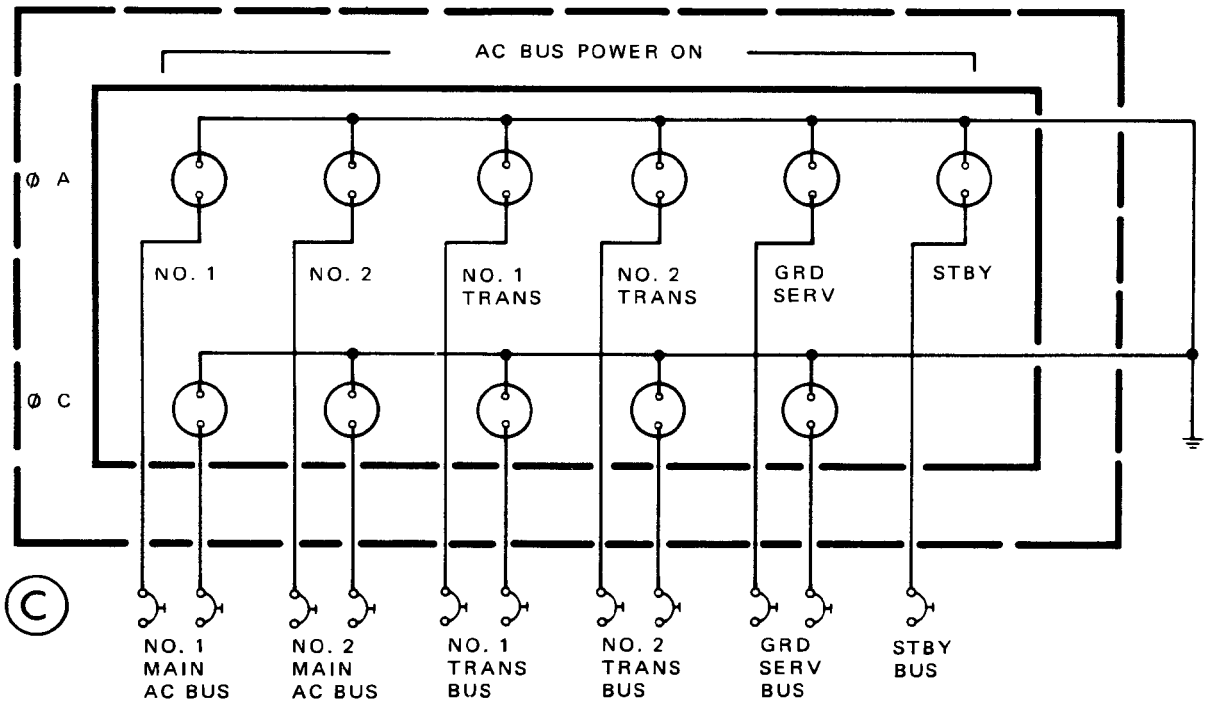


M238 ANNUNCIATOR PANEL DC BUS LIGHTS SCHEMATIC

Electrical Power Annunciator Panel
Figure 6 (Sheet 1)



M238 ANNUNCIATOR PANEL MALFUNCTION LIGHTS SCHEMATIC



M238 ANNUNCIATOR PANEL AC BUS LIGHTS SCHEMATIC

Electrical Power Annunciator Panel
Figure 6 (Sheet 2)

I. The electrical power annunciation panel is provided to indicate the position of the generator field relay and the source of the tripping signal. The annunciator lights are located on the P6 panel along with the lamp test switch (S1) and the annunciator erase switch (S2). This module M238 contains the indicator lights necessary for monitoring major portions of both the ac and dc electrical systems (Fig. 6).

6. Static Inverter
   A. The static inverter (refer to 24-54-0) is a transistorized power supply for changing 28 volts dc to single-phase 400 cycle 115 volts used for critical communication and navigation equipment. The inverter is secured in a standard ATR tray on the E3-1 shelf of the electronic racks in the lower forward section. All of the components in the electronic circuits of the inverter are the static type except the startup relay (K1). The output rating may be either 250 or 410 volt-amperes. A static inverter of the same rating as the unit removed should be installed when replacements are made.
   B. The inverter power circuit breaker (C30) on the P6-5 panel is the standby dc input connection to the inverter from the battery bus. However, ac output is dependent on an additional dc supply, which closes relay K1, inside the inverter, energizing the remaining portions of the circuits necessary for ac output. Placing the STANDBY POWER SWITCH on the forward overhead panel in the OFF position (Fig. 4). opens the turn-on signal to K1 only. To completely de-energize the inverter,
   C. the source from the battery bus must be opened or the battery bus deenergized, either by having the battery switch in the OFF position or opening the inverter circuit breaker (C30). In flight, the standby power switch (S4) on the pilots? forward overhead panel (P5-5) should be on AUTO and the battery switch should be ON. The battery switch provides a ground for both battery bus relay (R1) and battery transfer relay (R2) coils. The battery transfer relay (R2) will normally be energized by the output of T-R No. 3, holding open the supply to the coil of battery bus relay (R1). Then, with S4 in the AUTO position, the dc standby bus is energized from the No. 1 dc bus. Since the coil circuit is complete for the standby power transfer relay (R37), it is closed. When all airplane generator power fails, dc bus No. 1 is de-energized, R37 relaxes, and the battery connects to the dc standby bus. To accomplish this, the battery switch must be ON, the battery transfer relay (R2) relaxes as T-R No. 3 goes dead, the battery bus relay (R1) closes, energizing the battery bus, and the standby power transfer relay No. 1 (R36) closes.
   D. A connector attached to the rear of the inverter enclosure disconnects all connecting wires when the two forward hold downs are loosened and the unit is pulled out. The forks on the front hold downs are adjustable.

7. Test Module
   A. The power system test module M400 is a switch panel with current transformer selecting relays and portable meter jacks, for testing the airplane power system. It permits measuring dc voltages and current values, and ac voltages, current values and frequency at various electrical system component connections throughout the electrical system. The module is located at the top of the load control center panel (P6). Jacks are provided so that calibrated portable meters may be connected to check the accuracy of meters on the pilots? overhead panel (P5).

B. The system test operation consists of selecting various combinations of settings on the two, eight position, multiple wafer, rotary switches (S1 and S2) mounted in M400, and observing the parameter on the airplane meters on P5. See the table in Fig 7 for the voltages and currents made available by the rotary switches. The dc and ac rotary switches on the pilots overhead panel are turned to the TEST position for meter readings of dc volts, ac volts, and frequency (Fig. 4). Generator ammeter readings are only dependent on the position of the S2 switch. The above tests are made by using only airplane facilities, but for additional flexibility for a more extensive test of the system, the generator control units (GCU's) and bus protection panel (BPP) are pulled out and a multiple T-connection is made to breakout boxes.

C. When using breakout boxes the two halves of the connector for the GCU or BPP are plugged with the connector halves of the breakout box. Switches and jacks on the breakout boxes provide additional connections to the electrical system which would otherwise be difficult to make, such as a separate source of three phase power when neither airplane generators nor external power circuits are used. During all such tests indicating lights on the pilots' panel P5 and the electrical power annunciator panel M238 are used to monitor which portions of the system are energized. The annunciator panel indicates four causes which result in the generator control relay tripping for one of the three airplane generators. These are: high or overvoltage (HV), low or undervoltage (LV), generator feeder faults (FF) and a manual trip (MT) due to a manual operation of the generator control switch. (See figure 6.) The feeder fault may be caused by an overcurrent condition or the annunciator panel may be indicating the operation of the differential protection circuit. The manual generator control relay trip annunciator is reset by momentarily closing the generator control switch. A separate reset switch is used to reset the remaining annunciators. The annunciator panel also has lights to indicate that power is on when any of the several ac and dc buses are energized.

8. Master Caution System Inputs

A. The electrical system contains equipment to provide signals to the flight crew when the system functions are abnormal. The system control components which operate due to abnormal conditions in conjunction with generators No. 1 and No. 2 causing the master warning system to function are, the generator breakers (C801 and C802) the generator bus tie-breakers (C804 and C805) and the generator transfer bus relays (R3 and R4). Refer to Master Warning and Caution Lights - Description and Operation, Chapter 33.

9. Main Power Circuit Breakers

A. Three-phase magnetic latch-type circuit breakers are used to connect the main engine generators to the generator load buses and to connect the APU generator to the common or tie bus. Identical circuit breakers (also known as contactors) connect this central tie bus to the generator load buses. The external power contactor is also this type of circuit breaker, but has a main contact rating of 175 amperes. The main contact rating of the other latch-type breakers or contactors mentioned above is 125 amperes. All of these circuit breakers have auxiliary contacts rated at 7.5 amperes for 28 volts dc, and contain an electromagnetic coil which actuates the switching mechanism to the on or off position, and permanent magnets for latching the mechanism in either the open or closed position.

B. The transfer bus contactors or transfer relays have a main contact rating of 50 amperes and are three-phase, double throw, center off, electrically held. Each transfer contactor contains two 28 volt dc coils, and will connect buses in one direction or the other depending on which coil is energized. The main contacts are open if 28 volt dc is not applied to either coil.

C. Thermal circuit breakers are largely protective devices to limit the current in particular wires or as safety devices for a component. The opening time for such circuit breakers is inversely related to the current flow in the breaker element. Single phase and three-phase thermal circuit breakers are used in the electrical system. An individual phase current which exceeds the breaker trip limit will open all three phases of a thermal circuit breaker. Most of the thermal circuit breakers are located in the left load control center on the P18 panels.

D. The magnetic latch-type circuit breakers mentioned above are located either in the right-hand load control center P6 or in the right-hand forward and aft compartments outboard of the nose wheel well. This later location contains the external power contactor and the generator No. 1 and No. 2 circuit breakers. This type of breaker is a three-pole electrically-operated, plunger-style solenoid unit. Input and output cables are connected to the A and B terminals respectively. The auxiliary switches and coil circuit connections are made through the multiple wire connector (Fig. 8).

M400 S1 (NUMBERED) SWITCH POSITION	M400 S2 (LETTERED) SWITCH POSITION						
	A	B	C	D	E	F	P5-13 METER
1	NO. 1 GEN FIELD	NO. 2 GEN FIELD	APU GEN FIELD				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
	NO. 1 MAIN BUS ØA	NO. 1 MAIN BUS ØB	NO. 1 MAIN BUS ØC	NO. 1 TRANS BUS ØA	NO. 1 TRANS BUS ØB	NO. 1 TRANS BUS ØC	AC VOLTS & FREQ
2	NO. 1 GCU DC	NO. 2 GCU DC	APU GCU DC				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
	NO. 2 MAIN BUS ØA	NO. 2 MAIN BUS ØB	NO. 2 MAIN BUS ØC	NO. 2 TRANS BUS ØA	NO. 2 TRANS BUS ØB	NO. 2 TRANS BUS ØC	AC VOLTS & FREQ
3	NO. 1 GB CLOSE COIL	NO. 2 GB CLOSE COIL	APU GB CLOSE COIL				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
	GROUND SERVICE BUS ØA	GROUND SERVICE BUS ØB	GROUND SERVICE BUS ØC	EXTERNAL POWER BUS ØA		EXTERNAL POWER BUS ØC	AC VOLTS & FREQ
4			E.P.C. COIL VOLTS				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
5			NO. 1 BTB CLOSE COIL				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
6			NO. 2 BTB CLOSE COIL				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
7			APU 95% SWITCH				DC VOLTS
	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS
8	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	GEN AC AMPS

NOTES:

1. TO READ: (1) DC VOLTS SET P5-13 DC SELECTOR SWITCH TO "TEST" AND ADJUST M400 S1 AND S2.
   (2) GEN AC AMPS ADJUST S2 FOR PHASE.
   (3) AC VOLTS AND FREQUENCY SET P5-13 AC SELECTOR SWITCH TO "TEST" AND ADJUST M400 S1 AND S2.
2. ALL READINGS CAN BE MADE ON P5-13 METERS OR ON PRECISION METERS CONNECTED TO AC OR DC TEST JACKS ON THE M400.
3. S2 IS NORMALLY LEFT IN "B" POSITION CONNECTING ALL 3 GENERATOR AMMETERS TO PHASE B AND LEAVING M400 SELECTOR RELAYS RELAXED.

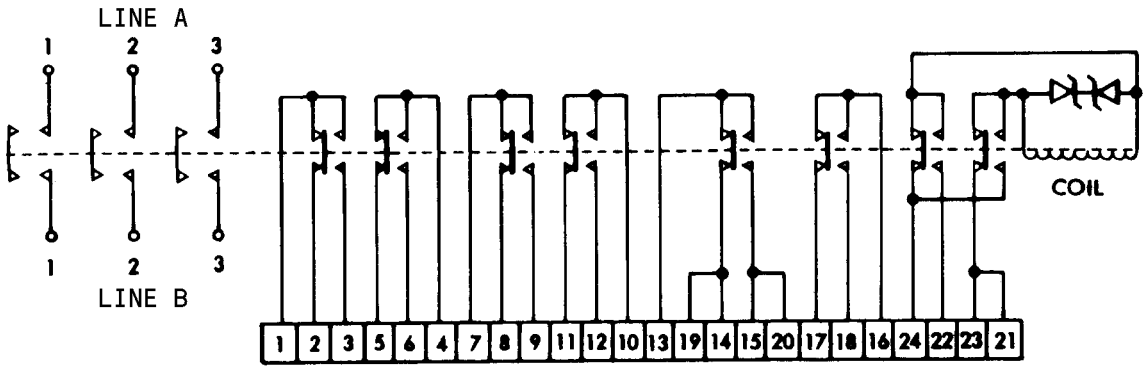
Electrical Power System Test Module Table
Figure 7

E. The magnetic latch-type circuit breaker has one magnet coil which is used for both the close and trip operations. A coil switch in the breaker assembly determines which way the current flows in the coil which in turn determines the resulting close or trip operation of the unit. Two diodes across the coil suppress power spikes generated when the coil circuit is opened following a trip or close signal. Other auxiliary switches are provided for electrical interlocking and circuit monitoring functions

10. System Operation

A. With the airplane on the ground, both engines shut down, APU shut down, external power disconnected, battery switch positioned to ON, generator control switch in the neutral position, all generator breakers (GB), generator control relays (GCR), and bus tie breakers (BTB) will be tripped (Fig. 9). When an engine is started, its associated GCR and GB will not close until the associated generator control switch is positioned to ON. When the switch is positioned to ON, K1 or K2 will close, providing voltage to close the GCR. Then, when generator output voltage and frequency are correct and there is no fault on the system, power ready relay K801 will close and provide voltage to close the GB, thereby energizing the associated load bus (Fig. 10). The same sequence will occur when starting the second engine. Both BTB's will remain trippe d. Positioning a generator control switch to OFF will trip the associated GCR and GB.

B. With both engine generators supplying power to the main load buses, transfer buses No. 1 and 2 will be energized with bus transfer relays No. 1 and 2 both in the normal position (Fig. 10). Bus transfer switch S2 on forward overhead panel must be in the AUTO position. Should generator No. 2 stop functioning, the loads supplied from the No. 2 transfer bus will be automatically transferred to the No. 1 generator. On airplanes after incorporation of SB 24-1034, galley loads will be automatically shed and hydraulic system B pump 2 will not transfer to Gen Bus No. 1 unless pump 1 is inoperative. The alternate coil of No. 2 bus transfer relay is energized thru normally closed contacts of No. 2 GB and normal coil of No. 2 bus transfer relay is de-energized. A time delay permits the circuit to mechanically clear previous connections before the No. 2 bus tr ansfer relay closes. A similar sequence takes place should generator No. 1 stop functioning instead of No. 2.

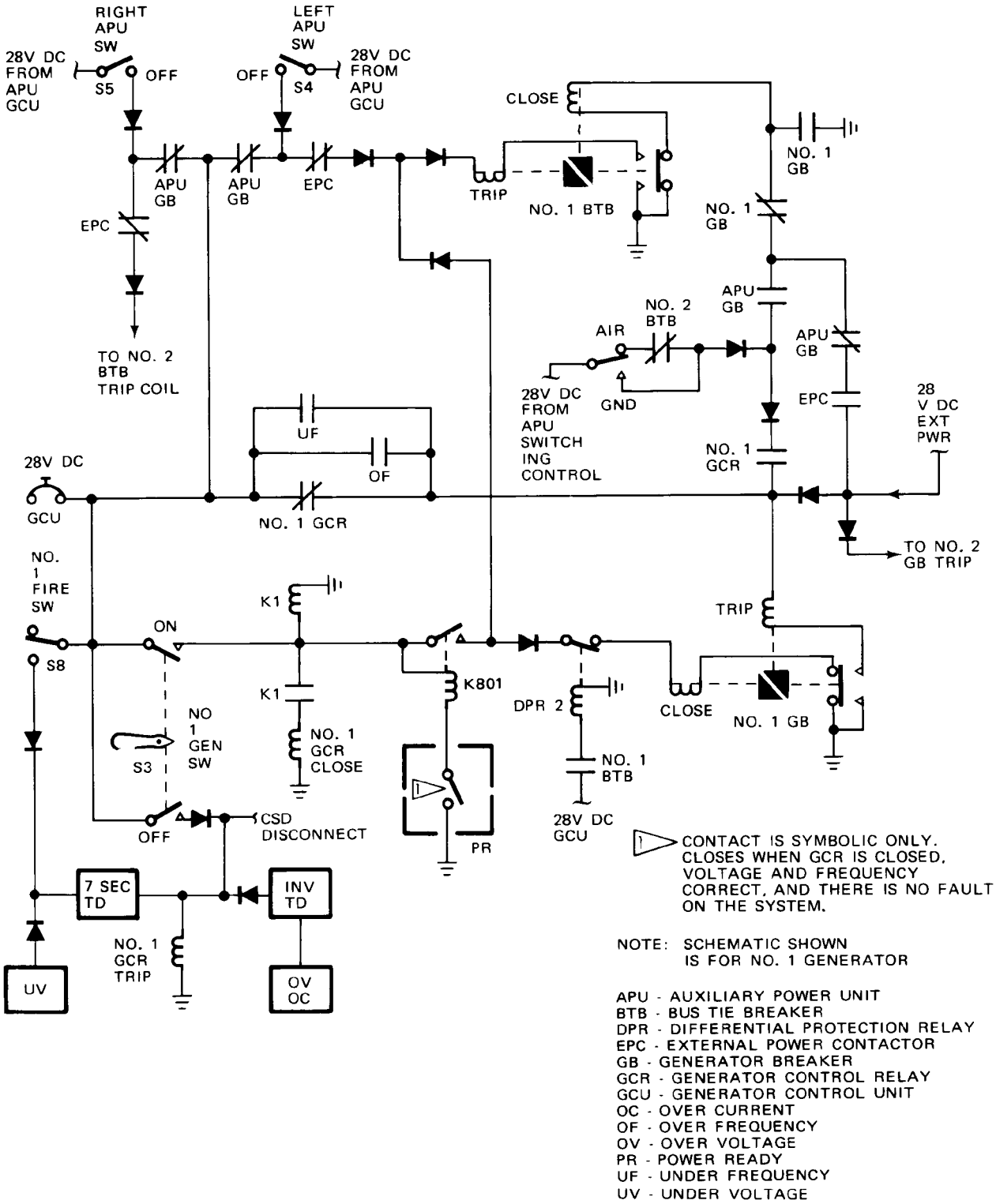


Magnetic Latch Type Circuit Breaker Schematic Diagram
Figure 8

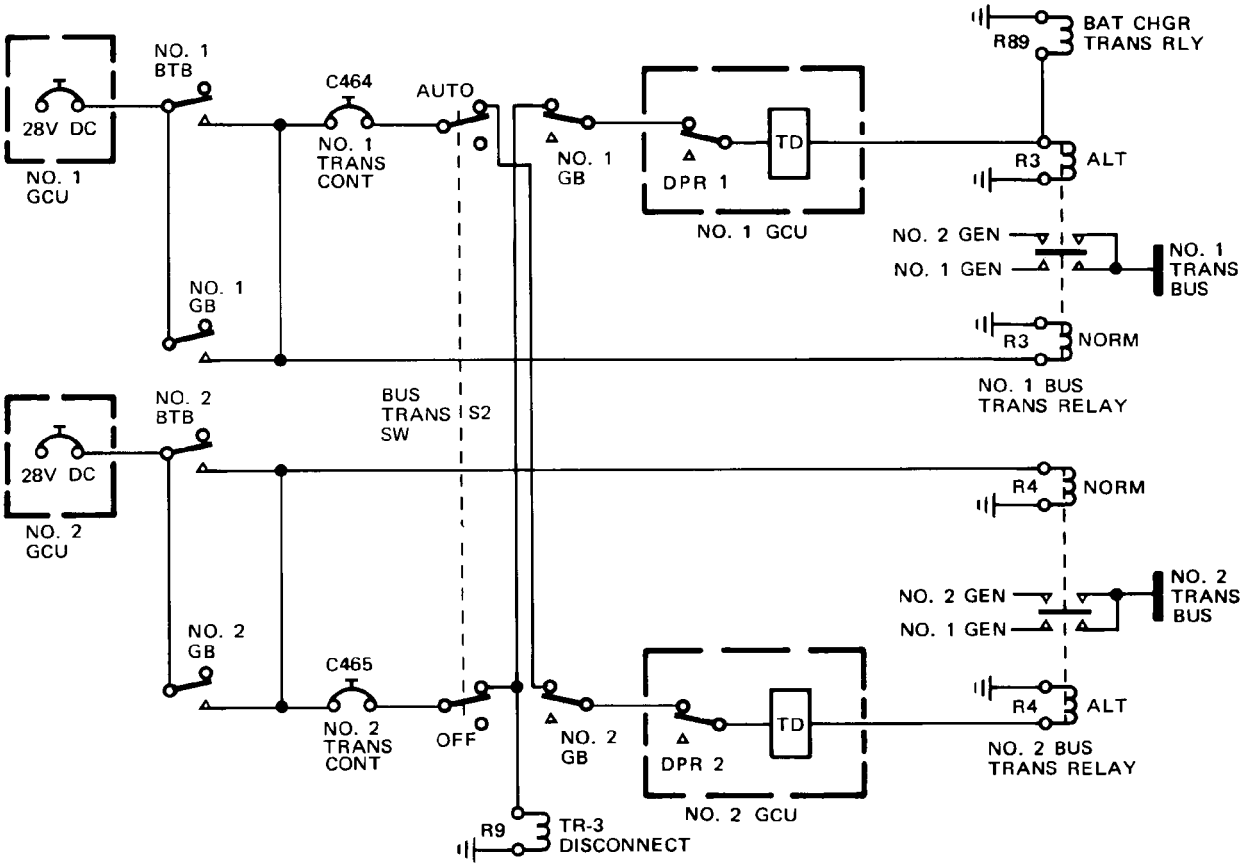
C. With neither engine running, external power contactor (EPC) tripped, APU operating, battery switch positioned to ON, closing either left or right APU control switch will close the APU GCR (Fig. 11). Then, when voltage and frequency are correct and there is no fault on the system, the APU GB will close, connecting the APU generator to the tie bus (Fig. 12). Positioning the left and/or right APU control switch to ON also closes the left and/or right BTB, thereby energizing either or both load buses. Closing a BTB energizes the associated differential protection relay (DPR) which prevents closing the associated engine GB. Positioning either APU control switch to OFF will trip the BTB and second control switch will trip the APU GCR, APU GB and second BTB.

D. With the APU supplying power to a main load bus through the associated BTB and an engine is started, the BTB will trip when the generator control switch is positioned to ON and engine generator voltage and frequency are correct. Tripping of the BTB will de-energize the DPR and allow the engine GB to close. The load bus will then be supplied by the engine generator.

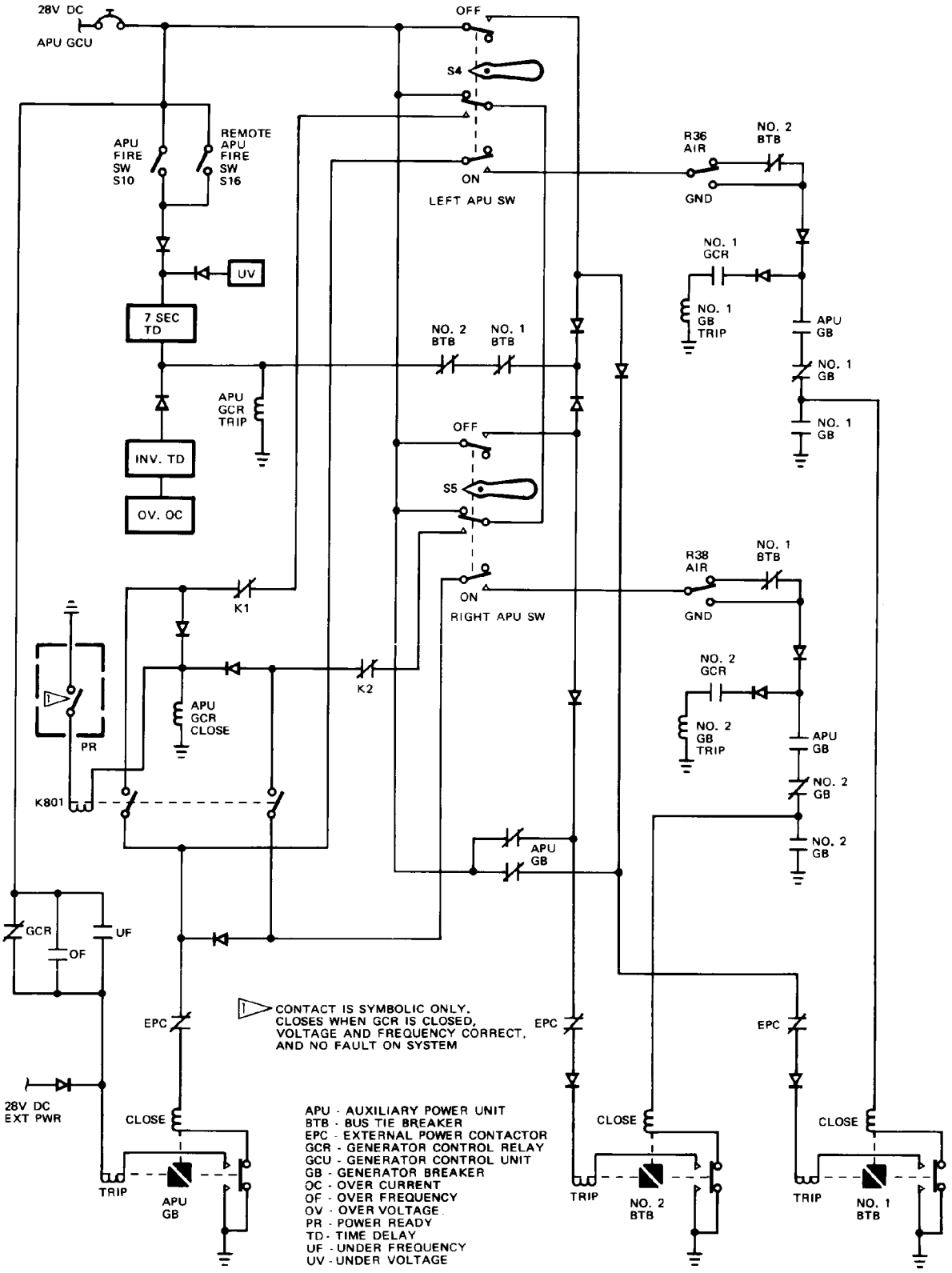
E. When an engine is shut down, the engine-driven generator will reach an underfrequency condition, thereby tripping the GB and disconnecting the generator from the load bus. When the generator reaches an undervoltage condition, a time delay is started. After 7 seconds, the GCR will automatically trip and de-excite the field. Momentarily placing the generator control switch in the OFF position will also trip the GCR and GB.



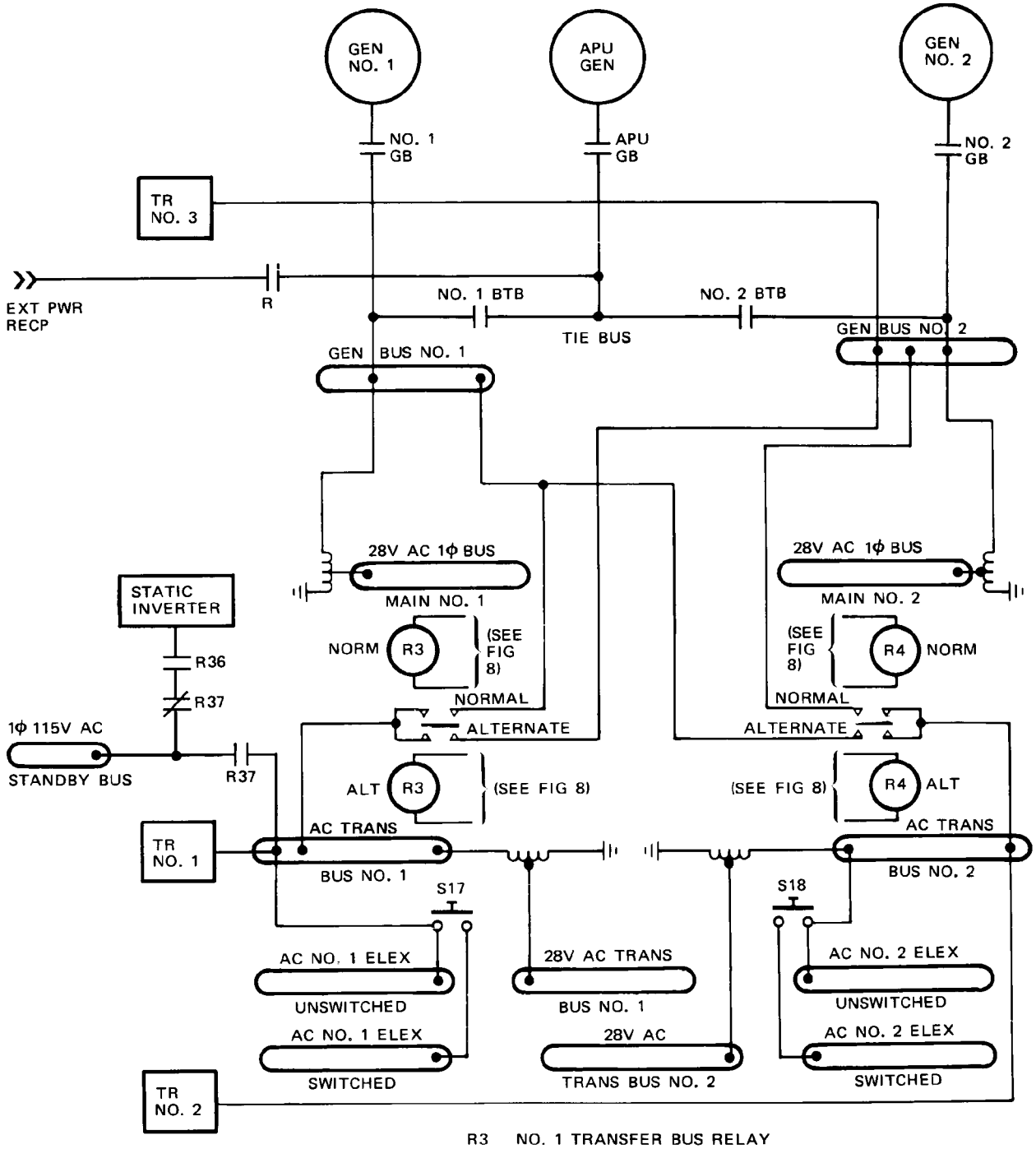
Engine-Driven Generator Control Diagram
Figure 9



Transfer Bus Control Diagram
Figure 10



APU Generator Control Diagram
Figure 11



R3 NO. 1 TRANSFER BUS RELAY
R4 NO. 2 TRANSFER BUS RELAY
R8 EXT PWR CONTACTOR
R36 STANDBY PWR TRANS RLY NO. 1
R37 STANDBY PWR TRANS RLY NO. 2
S17 NO. 1 MASTER ELEX SW
S18 NO. 2 MASTER ELEX SW

ac Generator System Bus Diagram
Figure 12

AC GENERATION - TROUBLESHOOTING

1. General

A. In an electro-hydromechanical and electronic system such as that used for AC generation, the location of trouble is not simple. Due to this fact a complete understanding of the system is quite essential. Symptoms of trouble may be difficult to interpret because protective devices function quickly, and in many instances the sequence of operation of protective devices is not noticed at the time of the original failure. For example if only a low voltage condition exists, as indicated on the annunciator panel, it will be noticed in the Annunciator Signaled Troubleshooting Chart that several probable causes are given for the signal: "Low voltage light comes on, on the annunciator panel." Other observed symptoms may often be considered before the choice of one of the five causes is made to begin the isolation procedure. The annunciator signaled troubleshooting charts, prepared as a guide as well as a procedure, are used in the following manner:

(1) Notice the signals on the annunciator panel.

(2) Consider the probable cause.

(3) Eliminate probable causes which do not apply by use of the isolation procedures given in column 3.

(4) Perform the easiest one first to clear the trouble when two remedies present themselves.

(5) Perform the preliminary checks recommended by the component vendor before removing the component. For example on a questionable CSD, check drive filter and magnetic drain plug. Replace CSD and line filter and clean the cooler lines if bright chips or flakes are found on the plug.

B. Use of "In Flight or Ground Check Analysis"

(1) This method of troubleshooting power system faults is based on a very accurate statement of what happens in the monitoring devices when a fault occurs. If the flight log says "generator one tripped off, couldn't get back on line," this tells the ground crew nothing and it will be necessary to re-establish the cause of trouble and carefully observe the operation of the various circuit breakers, lights, meters and annunciator panel signals. If in another instance the flight log says; "Generator No. 1 control relay (GCR) and generator breaker tripped. Closed generator control relay and the generator control relay retripped. FF and UV signal on the annunciator panel," the mechanic now has a rather complete story of the fault, and by reference to Table I will find the description of the above fault under the second line. This refers them, in the last column, to paragraph 4.F.(1)-(2). This paragraph lists the trouble as "APU switch remains in contact in off position," and tells the mechanic how to isolate the trouble. This method of troubleshooting depends upon completely accurate statements of monitoring indications after a fault has occurred and any statement less than complete can be misleading.

C. The troubleshooting charts and procedures on the following pages are used in locating a defective component which is causing symptoms of incorrect operation of the AC generation system. The above examples of procedures may be followed from the symptom listed, noting the possible cause, and then checking the component listed opposite this cause until the difficulty is eliminated.

D. Troubleshooting procedures cannot cover every possible fault that may develop in the system, however, the method outlined in the above procedures may be used to "shoot troubles" not listed. In addition to the above procedures for the use of annunciator signaled trouble charts, and in-flight analysis methods, the following troubleshooting routines should be followed in every instance.

2. General Troubleshooting Procedures

A. No specific set of routines can be given to cover all the problems which may present themselves to anyone correcting trouble. However, certain general precautions are considered helpful in electrical trouble shooting.

B. All checks should be started by ascertaining that 28 volt dc control power is available and that the necessary circuit breakers in these control circuits are closed, and that the circuit breakers for the generator control panels, the bus protection panel and the annunciator panel are closed. Where breakers have tripped or opened, the electrical wiring must be thoroughly checked for short circuits before assuming that the control system is in an operating condition.

CAUTION: DO NOT REMOVE ANY GENERATOR CONTROL UNIT WITHOUT FIRST OPENING THE GENERATOR CONTROL RELAY AND GENERATOR CIRCUIT BREAKER. TO DO SO MAY DAMAGE CURRENT TRANSFORMERS BY OPENING THE SECONDARY CIRCUIT.

C. Troubleshooting of circuits and components of the electrical generating and distribution systems is accomplished by utilizing the annunciator system, the warning and control systems and the electrical meters, battery and galley power module (P5-13) shown on diagram 24-28-11A as circuit analyzers. Switches on the forward overhead panel permit the use of airplane electrical meters and temperature indicators. The annunciator panel (module M238), located on the upper inner surface of the P6 panel, and shown on the diagrams 24-25-01, 24-27-21, and 24-35-01, contains lights which indicate when power is on the ac and dc busses and the cause of interruptions to the ac generators. A press-to-test button and an erase switch are provided for the ac generator annunciator lights. Connectors and checkout receptacles are located at various locations about the distribution system such as the power system test module M400 shown on wiring diagrams 24-28-21 and 24-28-31 and the P6-6 panel, on the load control center, where test apparatus and meters may be connected for circuit and component analysis.

D. Do not use meter probes in checking circuits from connectors, rather connect the meter, instrument or analyzer to a connector and make al1 connections by joining connectors, thereby avoiding joint or socket damage to connectors. The convenience afforded by the use of connectors may be offset by the trouble, which these connectors can cause if damaged by abuse or misuse. That is, extreme care must be exercised in opening and particularly closing electrical connectors or pin and wire damage will result. Connectors, which are suspected of mechanical damage or have collected moisture must be carefully cleaned and repaired. Succeeding cases of trouble may result from connector damage resulting from previous troubleshooting. That is, do not cause future troubles while troubleshooting.

3. Annunciator Signaled Troubleshooting Charts

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
High voltage light comes on, on the annunciator panel	Defective generator control unit	The GCR trips followed by the GCB. The high voltage light comes on, on the annunicator panel	Replace generator control unit for generator on which GCB tripped
Low voltage light comes on, on the annunciator panel	Defective generator	Check generator voltage by placing AC meter selector switch to questionable generator. Airplane's voltmeter shall read 115 ±2 volts	Change generator
	Defective gen field relay (GCR) contacts (K603A)	Check continuity through generator field relay, from pin B9 (B9 terminal on gen control unit) to terminal F on generator	Change control unit
	Defective voltage regulator	Replace with generator control unit in which the voltage regulator is known to be good	Change control unit
	Erroneous generator control unit TRIP	Check voltage of appropriate gen by placing METER SELECTOR SWITCH IN position and read voltage and frequency. If voltage and frequency are normal	Change generator control unit OV, UV, OC or DP circuit defect could cause an erroneous trip
	Partly broken CSD shaft partly damaged spline	Check to see if generator will take load	Change CSD or generator or both

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
	Exciter field open or shorted	Measure exciter field resistance at exciter terminals or at gen switch to ground on overhead panel. Resistance should be less than 8 ohms	Replace ac generator
Low voltage light comes on	Defective rotating rectifier	Check gen rotation, or check exciter field for short or open, or if test equipment is available) refer to 24-21-61, IC	Replace generator
	Defective fire switch or wiring. GCR and GCB trip using good GCU	Check generator. Check gen breaker. Undervoltage light comes on after time delay of 5-9 seconds. BTB trips on faulty generator feeders. Open connections to fire switch	Replace defective fire switch or repair wires
Feeder fault light comes on, on the annunciator panel	Defective C.T. or wiring not correctly connected to differential protection current transformers (in load control center)	Check continuity of C.T. and leads per wiring diagrams 24-23-11 or -21	Replace C.T. Correct or repair faulty wiring
	Incorrect routing of leads to or thru gen neutral C.T. (on side of engine)	Check continuity of C.T. and leads against wiring diagrams 24-21-11, 24-23-11 and 24-28-31	Replace C.T. Correct or repair faulty wiring
	Short or ground type fault on generator output wires within differential protection zone	Notice that GCR trips followed GCB	Repair damaged wires, or replace damaged parts

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
Feeder fault light comes o, on the annunciator panel followed by the GCR and GCB tripping	Overcurrent fault condition	Check generator feeder lines and connected loads for faults	Replace defective component or repair wiring
	Defective overcurrent sensing circuit	To test - use GCU with overcurrent sensing circuit known to be good	Replace generator control unit
Manual trip signal comes on, on the annunciator panel	Defective circuit to manual trip or GCR from gen switch	Check for shorts in those circuits used for manual trip	Repair or replace damaged wires
Transfer bus lights on generator annunciator panel go off and transfer bus off lights on pilots' overhead panel come on	Loss of power on transfer bus due to shorting of hydraulic B system pump transient suppression diodes	Check transient suppression diode CR4 for No. 1 hydraulic pump and diode CR8 for No. 2 pump for shorting. Diodes are located in P5 hydraulic pumps module	Replace faulty diode and reset 5-amp circuit breaker on generator control panel

4. Inflight or Ground Checkout Analysis of Electrical Generation System Malfunctions

   A. When a component in the electrical generation system fails to function properly during normal operation, evidence of this usually appears (1), as a signal on the annunciator panel (2), as an indication of circuit changes on the forward overhead panel (3), as a deactivation of a portion of the system due to failure of a piece of apparatus (4), as a trip action of a protective device following a sequence of events within the system (5), as an incorrect meter reading. Aside from a difference in general response of the entire airplane due to a major power failure, a malfunctioning unit or system will usually be made evident by one or more of these five categories.

B. The following listed failures are correlated with operating conditions as indicated by meters, switches and lights on the annunciator and pilots' center and forward overhead panel. To use the tabulated conditions, complete the analysis by locating the operating condition prevailing for the failure as listed in the tabulation Table I. The possible causes of the malfunction are given in the code to text references in the right-hand column of the tabulation.

C. AC Generator

(1) Drive shaft or stub shaft has failed.

(a) Operate engine with generator control (field) relay open. Check for generator rotation by measuring generator residual voltage. If 12 to 19 volts ac are indicated at the voltage regulator terminals T1, T2 and T3 to ground, the generator is rotating.

(2) Exciter field is open or shorted.

WARNING: AVOID CONTACT WITH METER TERMINALS AND EXPOSED WIRES WHEN MAKING TESTS WITH POWER ON THE AIRPLANE.

(a) Trip GCR generator control (field) relay by placing GEN No. 1, No. 2 or APU GEN switch to OFF. This will open the main generator breakers.

(b) Pull the three generator control circuit breakers C4, C5 and C6 on the load control center right (P6-4). See wiring diagram manual 24-21-11, -21 or -31 depending on generator number.

(c) Measure generator exciter field resistance. The field resistance measured from F to A terminals should be at least 8 ohms.

(3) Rotating rectifier has failed.

(a) Determine if generator rotates.

(b) Determine that exciter field is not open or shorted.

(c) Check voltage regulator by exchanging the generator control unit (GCU) for one that is known to function properly. Also check connections at voltage regulator terminals on the GCU for continuity and short circuits.

(d) If test equipment is available, check generator rotating rectifier (AMM 24-21-61).

(4) Shorted feeder lines.

(a) Remove generator feeder lines from generator terminals T1, T2 and T3.

(b) Check for open, or infinity on ohmmeter, between feeder lines, phase to phase, and phase to neutral. If continuity exists, the feeder lines are shorted.

D. Constant Speed Drive

(1) Input shaft has failed, generator shaft has sheared, disconnect has failed.

(a) With engine running, check residual voltage at generator terminals, and check that constant speed drive is not disconnected.

(b) If drive is connected and the residual voltage is zero, the input shaft or the disconnect unit has failed. If the low pressure light on the overhead panel is off and still no residual voltage, the generator shaft is sheared.

(c) If disconnect does not actuate properly, check circuit; if circuit checks, replace transmission.

1) Disconnect connector D6 from CSD wiring harness.
2) Measure resistance of CSD disconnect solenoid coil between pins 3 and 4 of wiring harness. Check that resistance is less than 100 ohms.
3) Check continuity to ground of pins 3 and 4 of connector D6.
4) Set meter to measure dc voltage and monitor voltage of pin 6 on D6.
5) Place BAT switch on P5 panel to ON. Set CSD DISCONNECT switch to ON.
6) Verify voltage on meter is approximately 28 volts while switch is held to ON and zero when switch is released.
7) Remove meter, restore airplane to normal, and lockwire switch.

(d) If disconnect does not reset properly, replace transmission.

(2) Disconnect unit has failed.

(a) Ref 4.D.(1)(c) and (d).

(3) Drive has failed internally.

(a) Remove and inspect magnetic drain plug. The presence of reasonably large pieces of bright metal on the magnetic plug indicates a drive failure.

NOTE: A small amount of fine or fuzzy granular material is normal.

BTB	GCB	GCR	Meter	Meter	Annunciator Signal	AC Ammeter Reading	Crct Lock Out *1	CSD Low Pres Lght	CSD Temp
Closed	Open	Open	Zero	Zero	FF	Zero		Off	Safe
Closed	Trip	Trip	Zero	Zero	FF_LV *1	Zero		Off	Safe
Trip	Trip	Closed	Zero	Zero	LV	Zero	LV	Off	Safe
Closed	Trip	Trip	Above 129	400	HV	--		Off	Safe
Closed	Trip	Trip	115	400	FF	--		Off	Safe
Open	One Trip	Trip	Zero		LV	Zero		Off	Safe
Closed	Open	Closed	Zero	Zero	No signal	Zero		On	Safe
Closed	Open	Closed	115	400	No signal	Zero		Off	Safe
Closed	Trip	Trip	--	--	LV	Zero	LV	Off	Safe
Closed	Trip	Trip	Below 97	--	LV	--	LV	Off	Safe
Closed	Open	Closed	115	400	No signal	Zero		Off	Safe
Open	Trip	Closed	115	400	LV	Zero	UF	Off	Safe
Open	Closed	Trip	Zero	Zero	LV	Zero	LV	Off	Safe
Closed	Trip	Closed	115	370	No signal	Goes to zero	UF *2	On	Caution
Open	Closed	Closed	115	--	No signal	Rises falls	--	Off	Low
Closed	Trip	Closed	115	435	No signal	--		Off	Safe
Closed	Open	Closed	115	Varies	No signal	--		Off	Safe

*1 LO occurs after a provided time delay.
*2 Either under frequency or overcurrent cause a low voltage (LV) lockout.

OPERATING CONDITION OR OTHER INDICATION	Refer to Paragraph 4
GCR will not close	H
BTB trips without closing generator switch	F1-2
Generator voltage will not build up	C1-C2-E3-F5
Occurs when starting engine. GCR trips after reclosing	E1
GCR trips when closing generator breaker	G
One GCR and one GCB trip	I
GCB will not close, BTB and GCR can be closed	D1-D2-D3-D4-H
GCB will not close	F8
Voltage and frequency normal with GCR closed and GCB open. Voltage and frequency below normal when closing GCB	C1-C3-E1
BTB trips, followed by GCR and GCB, GCR will not remain closed	C2-C3 E2-E3-F4-F5
BTB does not trip when closing generator switch	F3-F4-F5
GCB trips following heavy load and UF condition, tripping does not occur	J1
Undervoltage circuit not disabled by GCR trip circuit	F6
Drive slow to prime	D3-D4
Frequency varies for some time after starting engines. After running a while there are no variations	D5-D6
Generator carries less load than it should	E2
Frequency control potentiometer ineffective	F7

(4) Low oil level or drive not primed.
(a) Check oil level and priming requirements (AMM 24-10-0/201).
(5) Cold drive (low operating temperature)
(a) Operate the drive with generator not loaded for a limited period of time, until it is estimated that normal operating temperature has been reached.
(6) Low oil pressure sensor has failed or functions improperly when cold.
(a) Remove electrical connector from low oil pressure sensor. Check for continuity between pins 5 and 6 on pressure sensor assembly with 1000 ohm resistor in series with sensor.
(b) Apply 115 volts 400 cycles to sensor. There should be continuity between pins 5 and 6 on pressure sensor assembly. A milliammeter should show 10 milliamperes with charge pressure applied and greater than 40 milliamperes with no pressure applied. Retain 1000 ohms in series with sensor and meter.

E. Voltage Regulator Portion of Generator Control Unit
(1) Voltage regulator has failed internally.
(a) Check by substituting a generator control unit which contains a voltage regulator which is known to function properly.
(2) One or more voltage sensing leads are open.
(a) With generator running check for 115 volts ac at terminals T1, T2 and T3 to ground on voltage regulator portion of generator control unit at pins A39, A40 and A41 on the generator control unit.
(3) Three voltage sensing leads open.
(a) Refer to step (2)(a).

F. Control, Wires and Switches
(1) APU switch remains in contact in off position.
(a) With switch in OFF position there should not be a dc voltage at pins B10 or B25.
(2) Defective generator switch.
(3) Auxiliary relay has failed.
(a) Remove electrical module P5-4 from forward overhead panel.
(b) Replace either the auxiliary relay (K2) or (K2) or the module containing this relay.
(4) Defective APU generator switch circuit.
(a) Check wires and switch, repair or replace.
(5) Defective generator switch circuit.
(a) Check wires and switch, repair or replace.
(6) Undervoltage circuit not delayed 5-9 seconds in tripping the generator control relay.
(a) Reset the circuit and check time for low voltage annunciator light to come on.

(b) Operate generator switch (S3) or (S6) on the forward overhead panel and observe AC voltmeter. If voltage does not build up replace GCU.

(7) Frequency adjustment variable resistor ineffective.

(8) BTB interlock contacts not clearing circuit for GCB to close. That is, the normally open contacts remain closed.

(a) Check BTB control contacts or replace BTB.

G. Incorrect Routing of Leads To or Through Generator Neutral Current Transformers

(1) Check lead routing to wiring diagram. See Wiring Diagram Manual 24-23-11 and -21.

(2) Check position of current transformer and polarity of leads.

H. Generator Control Panel

(1) Check by replacing the generator control unit with one that is known to contain a control panel known to function properly.

I. Short on Tie Bus

(1) Remove ac power from airplane and check visually.

J. Transfer Bus Control

(1) Failure of generator transfer breaker control.

(a) Check by substituting a generator control unit is known to function properly.

(b) Remove wires from terminals on No. 1 bus tie breaker and transfer relay coils and check for dc supply. See Wiring Diagram Manual 24-24-01.

(c) Check for zero resistance between terminals of normally closed auxiliary contacts on generator control breaker. Any resistance reading indicates that the auxiliary contact fails to make proper contact.

NOTE: A wheatstone bridge is recommended for this test since heavy currents should not be passed through these contacts.

(2) Open interlock circuit between transfer relays No. 1 and 2.

(a) Remove ac power from airplane.

(b) Check dc supply from generator control unit through control interlocks of various breakers and contactors to coil of defective transfer relay.

5. Troubleshooting and Open Phase Condition

A. General

(1) An open phase can cause the circuit breakers to trip open for three phase loads like TRU's, hydraulic pumps and fuel boost pumps when they are brought on line. If the load checks out OK after further investigation, the problem may be an open phase. Other apparently unrelated symptoms such as cabin lights dimming and loss of instruments may also occur.

B. Fault Isolation and Repair Procedure

(1) Remove electrical power from the airplane (AMM 24-22-0).

(2) Open the engine firewall disconnect connector D410 and the wing disconnect connector (D5124P - left, D5126P - right).

(a) Inspect the contacts for signs of overheating and arcing.

(b) Repair contacts or replace connector if problems are found.

(c) If no problems are found, reconnect previously opened connectors.

(3) Inspect feeder terminations (terminal lugs) going into and out of the generator circuit breaker (C801 - LEFT, C802 - RIGHT) and transfer relay (R3 - XFR BUS 1, R4 - XFR BUS 2 located in P6 panel) for signs of overheating and arcing.

(a) Repair terminations and replace relay if any problems are found.

(4) Inspect feeder terminations at the generator for sign of overheating and arcing.

(a) Repair terminations if any problems are found.

(5) Check ground side feeders on generator to ENG GND lug for continuity.

(a) Repair wiring and terminations if any problems are found.

(6) If no problems are found, apply electrical power (AMM 24-22-0).

(7) Measure the voltage drop across the contacts of the generator circuit breaker (C801 - LEFT, C802 - RIGHT) and transfer relay (R3 - XFR BUS 1, R4 - XFR BUS 2) for each phase with load applied.

(8) If there is any significant voltage drop (greater than 1 volt ac) replace the GCB or Transfer relay.

NOTE: The load circuit breaker may trip open when trying to apply the load. If this happens, replace GCB and transfer relay.

(9) Measure the output voltage at the generator terminals with load applied. If the voltage is outside the limit of 115 ±5 volts ac on any phase, replace the generator (AMM 24-21-11).

(10) Remove electrical power if it is no longer necessary (AMM 24-22-0).

AC GENERATION SYSTEM - ADJUSTMENT/TEST

1. General
   A. The following procedure consists of two tests; par. 2 is the AC generation system test, par. 3 is the transfer bus control test.
      (1) The AC generation system test checks the various power source control and transfer circuits.
      (2) The transfer bus control test checks integrity of transfer control circuits and verifies ability of a single generator to accept a full load from a no-load condition.
2. AC Generation System Test
   A. General
      (1) The following system test consists of several subsystem tests. Before beginning these subsystems tests, make sure all meters display and operate correctly, and test press-to-test lights on electrical systems control panel. The electrical system should be prepared as for a normal flight with all components in readiness to be started and loaded. The loads used are from the system B hydraulic pumps.
   B. Test External Power and Control Circuits
      (1) Connect external power to P19 receptacle. Check that GRD POWER AVAILABLE light on panel P5 illuminates.
      (2) Set BAT switch on forward overhead panel P5 to ON.
      (3) Check that STANDBY POWER and BUS TRANS switches on panel P5 are set to AUTO.
      (4) Check that the following lights illuminate:
         (a) NO. 1 and NO. 2 TRANSFER BUS OFF (P5 ovhd panel)
         (b) NO. 1 and NO. 2 BUS OFF (P5 ovhd panel)
         (c) NO. 1 and NO. 2 GEN OFF BUS (P5 ovhd panel)
         (d) ELEC and MASTER CAUTION (P7 lightshield panel)
      (5) Reset MASTER CAUTION lights.
      (6) Turn meter selector switch on P5 panel to GRD PWR.
         (a) Check that voltmeter reading is 115 ±5 volts ac.
         (b) Check that frequency meter reading is 400 ±10 Hz.
   C. Test Auxiliary Power Unit (APU) Generator and Control Circuits
      (1) Start APU (Ref 49-11-0 MP), check that APU GEN OFF BUS light illuminates as APU reaches normal running speed, and turn ac meter selector switch to APU GEN.
         (a) Check that voltmeter reading is 115 ±5 volts ac.
         (b) Check that frequency meter reading stabilizes at 405-410 Hz with APU generator loaded.
      (2) Set left and right APU GEN switch to ON and then to OFF.
         (a) Press RESID VOLT switch and check that ac voltmeter reads 10 to 21 volts ac.

(3) Check APU alternate power source circuit.
(a) Open APU CONT circuit breaker on P6-5 panel. Check that APU does not shutdown by checking that meters read same as in (1)(a) and (b).
(b) Close APU CONT circuit breaker.

D. Test Engine Generator No. 1 and Control Circuits
(1) Start engine No. 1 (Ref 71-09-100, Operating Procedure) and turn ac meter selector switch to GEN 1 and verify that CSD LOW OIL PRESSURE light extinguishes.
(2) Set GEN 1 switch to ON and then to OFF.
(a) Press RESID VOLTS switch and check that ac voltmeter reading is 10 to 21 volts ac.
(3) Set GEN 1 switch to ON and check that ac voltmeter reading is 115 ±5 volts ac, indicating that control (field) relay has closed. Check that No. 1 and 2 TRANSFER BUS OFF, No. 1 BUS OFF, and No. 1 GEN OFF BUS lights extinguish.
(4) Set No. 1 and 2 HYD PUMP system B switches on P5 panel to ON and check that CSD LOW OIL PRESSURE light remains extinguished.
(5) Check that frequency is 400 ±5 Hz.

E. Test Engine Generator No. 2 and Control Circuits
(1) Start engine No. 2 (Ref 71-09-100, Operating Procedure), and turn ac meter selector switch to GEN 2, verify that CSD LOW OIL PRESSURE light extinguishes, and repeat 2.D.(2), (3) and (5) for GEN 2.
(a) Check that No. 2 BUS OFF and No. 2 GEN OFF BUS lights extinguish.

F. Test AC Power Source Transfer and Control Circuits
(1) With external power connected and all generators running, set GND PWR switch to ON. Check that No. 1 GEN OFF BUS, No. 2 GEN OFF BUS, and APU GEN OFF BUS lights illuminate.
(2) Test ground power to APU power transfer using left APU GEN switch.
(a) Set left APU GEN switch to ON, check that APU GEN OFF BUS light extinguishes and that NO. 2 BUS OFF light, ELEC light and MASTER CAUTION lights illuminate.
(b) Reset MASTER CAUTION lights.
(c) Turn dc meter selector switch on overhead panel to TEST and set system test module M400 switch S1 to 4 and switch S2 to C and check that no external power contactor coil holding voltage is indicated.
1) Check that dc voltmeter on panel P5-13 reads 0.
(d) Set switch S2 on power system test module M400 to A, B, and then C. Verify load indication on APU generator ammeter in switch positions A, B, and C.
(e) Set switch S2 to B.
(3) Test APU power transfer to engine generator No. 1 and No. 2.
(a) Set NO. 1 GEN switch to ON and check that No. 1 GEN OFF BUS light extinguishes and that APU GEN OFF BUS light illuminates.

(b) Set NO. 2 GEN switch to ON, check that NO. 2 BUS OFF and NO. 2 GEN OFF BUS lights extinguish.
(c) Set switch S2 on power system test module M400 to A, B, and then C. Verify load indication on No. 1 and No. 2 generator ac ammeters in switch positions A, B, and C.
(d) Set switch S2 to B.

(4) Test engine generators No. 1 and No. 2 transfer to ground power.
(a) Set GRD PWR switch to ON and check that NO. 1 GEN OFF BUS and NO. 2 GEN OFF BUS lights illuminate.

(5) Test ground power transfer to engine generators No. 1 and No. 2.
(a) Set No. 1 GEN switch to ON and check that NO. 1 GEN OFF BUS light extinguishes.
(b) Set No. 2 GEN switch to ON and check that No. 2 GEN OFF BUS light extinguishes.

(6) Test engine generators No. 1 and No. 2 transfer to APU power.
(a) Set left APU GEN switch to ON, check that NO. 1 GEN OFF BUS light illuminates and that APU GEN OFF BUS light extinguishes.
(b) Set right APU GEN switch to ON and check that NO. 2 GEN OFF BUS light illuminates.

(7) Test APU power to ground power transfer.
(a) Set GRD PWR switch to ON and check that APU GEN OFF BUS light illuminates.

(8) Test ground power to APU power transfer using right APU GEN switch.
(a) Set right APU GEN switch to ON and check that APU GEN OFF BUS light extinguishes and that NO. 1 BUS OFF, ELEC, and MASTER CAUTION lights illuminate.
(b) Set right APU GEN switch to OFF and check that NO. 1 and NO. 2 TRANSFER BUS OFF light, No. 1 and 2 BUS OFF lights, NO. 1 and NO. 2 GEN OFF BUS lights and APU GEN OFF BUS light illuminate.
(c) Reset MASTER CAUTION lights.

(9) Test ground sensing relays interlock using APU power.
(a) Set left APU GEN switch to ON and check that APU GEN OFF BUS, No. 1 TRANSFER BUS OFF, No. 2 TRANSFER BUS OFF, and No. 1 BUS OFF lights are extinguished.
(b) Press and hold GROUND SENSING test switch on landing gear module.
(c) Set right APU GEN switch to ON and check that lights are same as in step (a).
(d) Release GROUND SENSING test switch, set right APU GEN switch to ON and check that No. 2 BUS OFF light extinguishes.

3. Transfer Bus Control Test

A. General

(1) The following test is performed on the transfer bus control when engines and APU are running. If a generator trips off line or power transfer does not occur, troubleshoot generator, GCU and transfer bus relays (Ref 24-21-0, TS).

B. Prepare for Test
(1) Set GEN 1 and GEN 2 switches on panel P5 to ON. Check that No. 1 and 2 TRANSFER BUS OFF, No. 1 and 2 BUS OFF, and No. 1 and 2 GEN OFF BUS lights are extinguished.
(2) Load buses 1 and 2 to full available airplane load.

CAUTION: DO NOT EXCEED 111 AMPS ON ONE ENGINE GENERATOR OR 125 AMPS ON APU GENERATOR AS DAMAGE MAY RESULT.

(a) Turn on all lights (except emergency), galleys, air conditioning and fuel boost pumps.
(b) Set HYD PUMPS A1 and A2 switches to ON and set HYD PUMPS B1 and B2 switches to ON. Set FLT CONTROL A switch to ON and set FLT CONTROL B switch to ON.

C. Test Transfer Bus Control
(1) Set GEN 1 and GEN 2 switches to OFF. Check that No. 1 and 2 TRANSFER BUS OFF, No. 1 and 2 BUS OFF, and No. 1 and 2 GEN OFF BUS lights illuminate.
(2) Set GEN 2 switch to ON. Check that AC voltmeter reads 115 ±5 volts ac when meter selector switch is set to GEN 2. Check that No. 1 TRANSFER BUS OFF, No. 2 TRANSFER BUS OFF, No. 2 BUS OFF, and No. 2 GEN OFF BUS lights extinguish.
(3) Set GEN 2 switch to OFF. Check that No. 1 TRANSFER BUS OFF, No. 2 TRANSFER BUS OFF, No. 2 BUS OFF, and No. 2 GEN OFF BUS lights illuminate.
(4) Set GEN 1 switch to ON. Check that AC voltmeter reads 115 ±5 volts AC when meter selector switch is set to GEN 1. Check that No. 1 TRANSFER BUS OFF, No. 1 BUS OFF, No. 1 GEN OFF BUS, and No. 2 TRANSFER BUS OFF lights extinguish.
(5) Set GEN 1 switch to OFF. Check that NO. 1 TRANSFER BUS OFF, No. 1 BUS OFF, NO. 1 GEN OFF BUS, and NO. 2 TRANSFER BUS OFF lights illuminate.
(6) Set left-hand APU GEN switch to ON. Check that APU GEN OFF BUS, No. 1 TRANSFER BUS OFF, No. 2 TRANSFER BUS OFF, and No. 1 BUS OFF lights extinguish.
(7) Set left-hand APU switch to OFF. Check that APU GEN OFF BUS, No. 1 TRANSFER BUS OFF, No. 2 TRANSFER BUS OFF, and No. 1 BUS OFF lights illuminate.
(8) Set right-hand APU GEN switch to ON. Check that APU GEN OFF BUS, No. 1 TRANSFER BUS OFF, and No. 2 TRANSFER BUS OFF, and No. 2 BUS OFF lights extinguish.
(9) Set left-hand APU GEN switch to ON. Check that No. 1 BUS OFF light extinguishes.

4. Restore System to Normal
A. Turn off lights, galleys, air conditioning and fuel boost pumps if no longer required.

B. Remove generator power.
   (1) Shut down engines (Ref 71-09-100, Operating Procedure).
   (2) Shut down APU (Ref 49-11-0, MP).
   (3) Place BAT switch to OFF.

ENGINE-DRIVEN AC GENERATOR - REMOVAL/INSTALLATION

1. Equipment and Materials
   A. Dow Corning DC4 or Mobilgrease 28 (Ref 20-30-21)
2. Remove Generator (Fig. 401)
   A. Open engine cowl panels.
   B. Remove generator and exciter terminal covers.
   C. Remove generator and exciter terminal leads from studs.

      NOTE: Observe terminal markings and tag each lead to ensure correct installation later. If necessary, loosen release screws on quick-release clamps and move engine firewall fire detection sensing element to one side (Ref 26-11-11, R/I).

   D. Remove exhaust duct support bracket (4) by removing bolts at duct support plate (5), hook assembly, and exhaust duct (6).
   E. Remove exhaust duct and electrical bracket assembly (6) from collector ring (7).
   F. Remove nut from tee-bolts locking two halves of collector ring and remove collector ring.
   G. Remove generator cooling air inlet duct.
      (1) Remove clamp (1) between two portions at inlet cooling air duct.
      (2) Remove clamp (2), disconnect jumper, and remove elbow (3) or forward portion of inlet cooling air duct along with air blast connector cap (9).
   H. Loosen generator mounting nuts around generator flange (12 places).

      NOTE: Generator mounting holes are slotted to permit generator removal with nuts left on studs. Nuts must be backed off about 1/2 inch to permit rotation of generator frame without interference from nuts. It may be necessary to tap generator with rubber mallet to permit rotation.

   I. Support generator.
   J. Rotate generator frame counterclockwise, viewed from aft, until studs line up with flange openings, move straight aft until studs clear generator flange.
   K. Remove air blast connector cap (9) and duct support plate (5) from generator frame.

      NOTE: Note the position of cooling air blast connector cap elbow in relation to generator prior to cap removal for ease of installation.

3. Install Generator (Fig. 401)
   A. Install duct support plate (5) and generator air blast connector cap (9) on generator frame in the same position as removed.
   B. Loosen nuts on CSD studs leaving a gap of approximately 1/2 inch between CSD flange and underside of the nuts. Lubricate generator spline with approximately 1/2 cubic inch of anti-fretting compound.
   C. Apply thin coating of DC4 or Mobilgrease 28 around generator mating surface on output end of transmission.

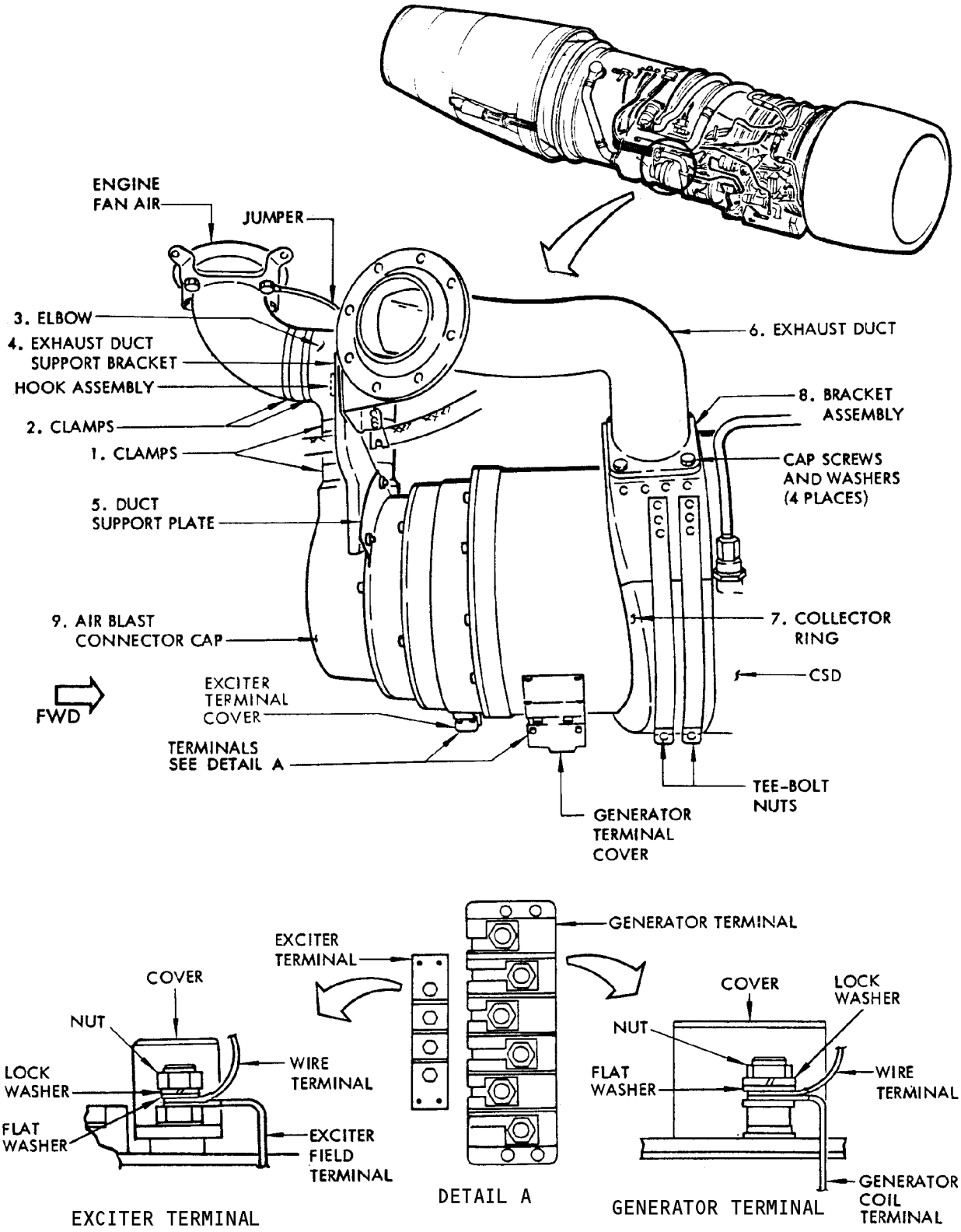
      NOTE: Apply in a continuous coating around mating surface. Do not leave any bare spots and ensure there are no open areas around studs.

   D. Raise generator into position on support so that generator flange holes and studs on constant speed drive align. Position generator so that terminal blocks are on left side of engine, so that the terminals line up with the generator lead wire terminals.
   E. Mate generator and drive splines and slide generator forward. Keep flange holes and studs in alignment.

      CAUTION: AVOID ROUGH HANDLING WHEN MATING MALE AND FEMALE SPLINES. SERIOUS DAMAGE MAY RESULT FROM GENERATOR STRIKING DRIVE SEAL RETAINER.

   F. With generator flange in position against generator drive pad, rotate generator clockwise viewed from aft so that stud shanks fully penetrate slots in generator mounting flange.
   G. Torque nuts from 160 to 190 pound-inches torque.
   H. Place cooling air collector ring (7) around generator flange and instal1 tee-bolt nuts holding halves of collector ring together. Tighten tee-bolt nut locking collector ring halves.
   I. Install exhaust duct (6), and bracket assembly (8).
   J. Install cooling air inlet duct on generator, tighten clamps and jumper fasteners.
   K. Install exciter leads to terminals (Ref WDM 24-21-11, -21). Assemble terminals, flatwasher, lockwasher and nut in that order. Tighten exciter terminal nuts from 20 to 25 pound-inches. Remove all tags attached in step 2.C.
   L. Install generator leads to terminals. Assemble terminals, flatwasher, lockwasher and nut in that order. Tighten generator terminal nuts from 115 to 125 pound-inches. Remove all tags attached in step 2.C.

      NOTE: Replace engine firewall fire detection sensing element and tighten release screws on quick-release clamps (Ref 26-11-11 R/I).



Engine Driven AC Generator Installation
Figure 401

M. Check generator for voltage outputs.
   (1) Motor engine on which voltage output check is to be made.

       WARNING: EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED EQUIPMENT. THE CURRENTS INVOLVED CAN BE FATAL.

   (2) Set selector switch to GEN 1 or GEN 2 AND MOMENTARILY PLACE GEN 1 or 2 switch on pilots' forward overhead panel to ON. AC voltmeter should indicate an output, the magnitude of which is dependent upon engine motoring RPM at the time.
N. Install covers on generator and exciter terminals.
O. Close engine cowl panels.

AC APU GENERATOR - REMOVAL/INSTALLATION

1. General
   A. The ac APU generator is identical to the engine driven generators. The installation of the APU generator differs from the others in this respect; it has a duct support bracket assembly installed on the exciter end cover with six screws, and two ears on the bracket have elongated holes used to hold the current transformer mount assembly. Nut plates are used with all the bolts for the current transformer and mount installation.
   B. The APU generator may be removed with the APU installed or, for better access, with the APU removed and lowered.
2. Equipment and Materials
   A. Anti-fretting compound - Sundstrand 730691 (preferred); Sundstrand 718050 (alternative); Sundstrand 688272 (alternative); or 1:1 mixture by weight of molybdenum disulfide, MIL-M-7866, and Rheotemp 500 (or Texaco Unitemp 500) grease (alternative) (Ref 20-30-21)
3. Remove APU AC Generator (Fig. 401)
   A. If APU is not to be removed, open APU compartment access door and remove APU lower shroud (Ref 49-11-0 R/I).
   B. If APU is to be removed, remove APU and lower onto aero stand (Ref 49-11-0 R/I).
   C. Remove current transformer mount, current transformer and ground bus bar angle as one assembly with wires attached.

      NOTE: It should not be necessary to disturb current transformer wire connections to the transformers or to the ground bus bar angle. However, the generator control connector may be separated to obtain working space. If current transformer wires are removed they must be tagged for positive identification for installation.

   D. Remove generator cooling air crossover duct.
   E. Remove ac generator and exciter terminal covers.
   F. Remove all terminal leads from generator and exciter studs.

      NOTE: Observe terminal marking and tag each lead to ensure correct installation.

G. Remove ac generator.
(1) Loosen generator mounting nuts around generator flange (12 places).

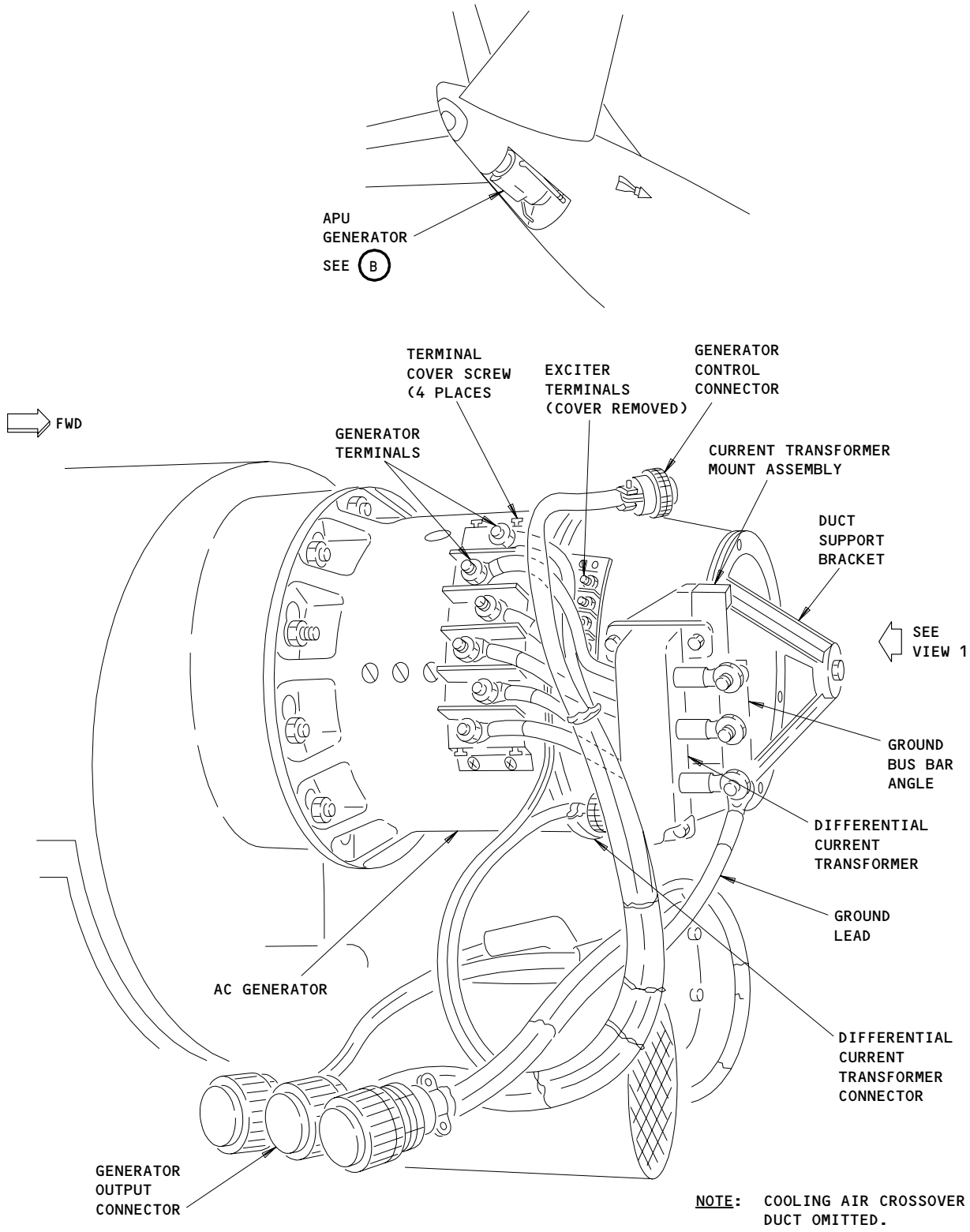
NOTE: Generator mounting holes are slotted to permit generator removal with nuts left on studs. Nuts must be backed off about 1/2 inch to permit rotation of generator frame without interference from nuts. It may be necessary to tap generator with rubber mallet to permit rotation.

(2) Support generator.
(3) Rotate generator frame counterclockwise, viewed from free end, until studs line up with flange openings, move straight away from APU turbine until studs clear generator flange.

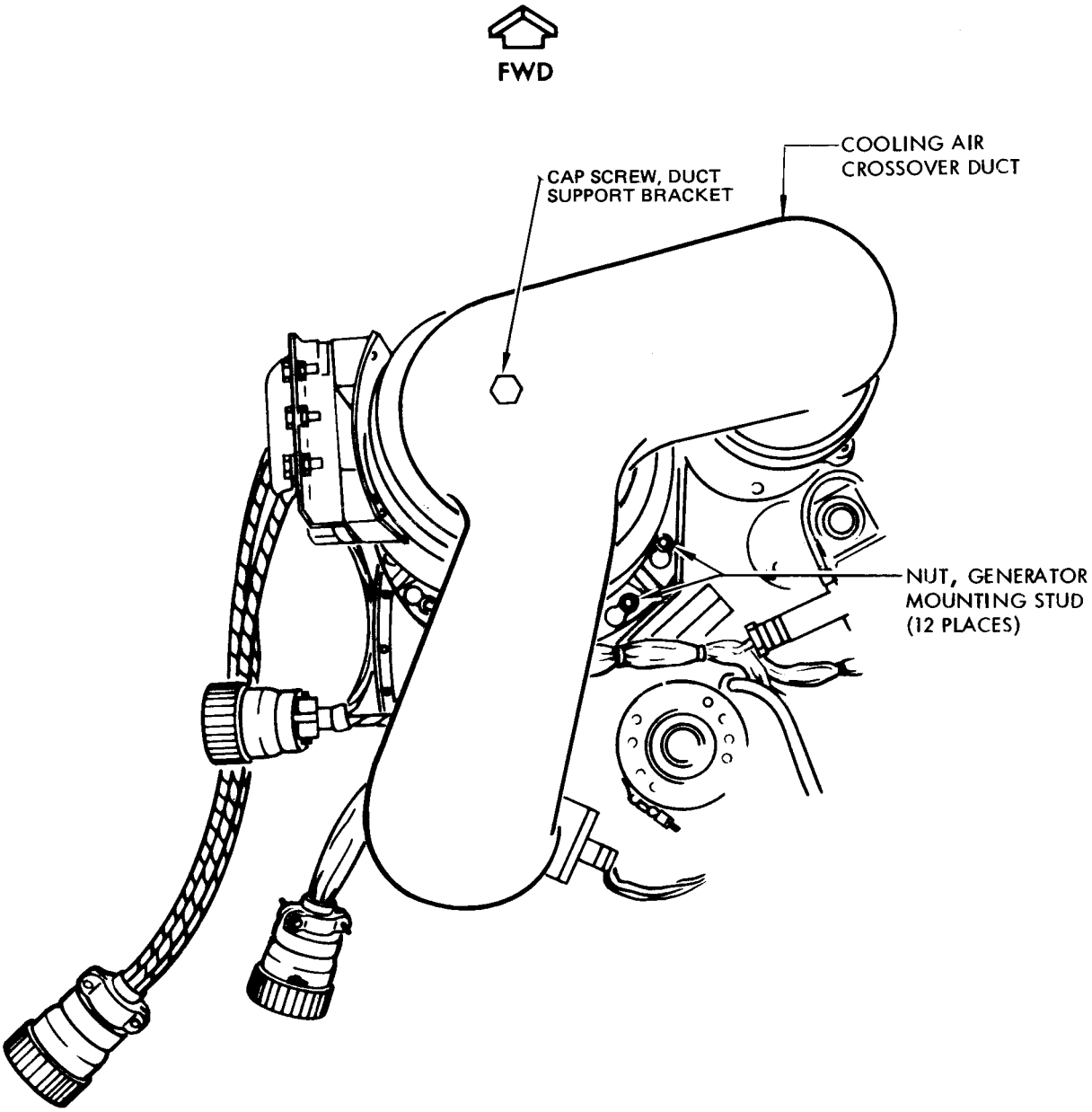
4. Install APU AC Generator (Fig. 401)
A. Install ac generator.
(1) Loosen nuts on APU turbine studs leaving a gap of approximately 1/2 inch between APU turbine flange and underside of the nuts. Lubricate generator spline with approximately 1/2 cubic inch of anti-fretting compound.
(2) Place generator into position on support so that generator flange holes and studs on APU turbine align. Position generator so that terminal blocks are on left side when generator is viewed from free end and ground bus bar angle will be vertical.
(3) Mate generator and APU turbine splines and slide generator slotted holes over turbine flange studs keeping holes and studs in alignment.

CAUTION: AVOID ROUGH HANDLING WHEN MATING MALE AND FEMALE SPLINES. SERIOUS DAMAGE MAY RESULT FROM GENERATOR STRIKING TURBINE.

(4) With generator flange in position against turbine flange, rotate generator clockwise (as seen from free end) so that stud shanks fully penetrate slots in generator mounting flange.
(5) Tighten generator mounting stud nuts from 160 to 190 inch-pounds.
B. Install current transformer mount, current transformer and ground bus bar angle as one assembly with wires attached.
C. Install ac generator cooling air inlet duct.



ac APU Generator Installation
Figure 401 (Sheet 1)



VIEW 1

ac APU Generator Installation
Figure 401 (Sheet 2)

D. Install all wires on generator and exciter terminals. Remove all tags attached in step 3.F. above.
   (1) Check that each wire and terminal build-up is exactly as it was prior to removal.

NOTE: Install the red lead to terminal F to match the short yellow exciter lead. Install the gray lead to terminal A to match the short black exciter lead.

   (2) Install the exciter leads to the terminals. Tighten the exciter terminal nuts to 20 - 25 inch-pounds.
   (3) Install the generator leads to the terminals. Tighten the generator terminal nuts to 115-125 inch-pounds.

E. Install ac generator and exciter terminal covers.
F. Raise the APU into its normal operating position and complete all connections and attachments (AMM 49-11-0 R/I) or install APU lower shroud (AMM 49-11-0 R/I).
G. Test ac APU generator (AMM 24-21-0).

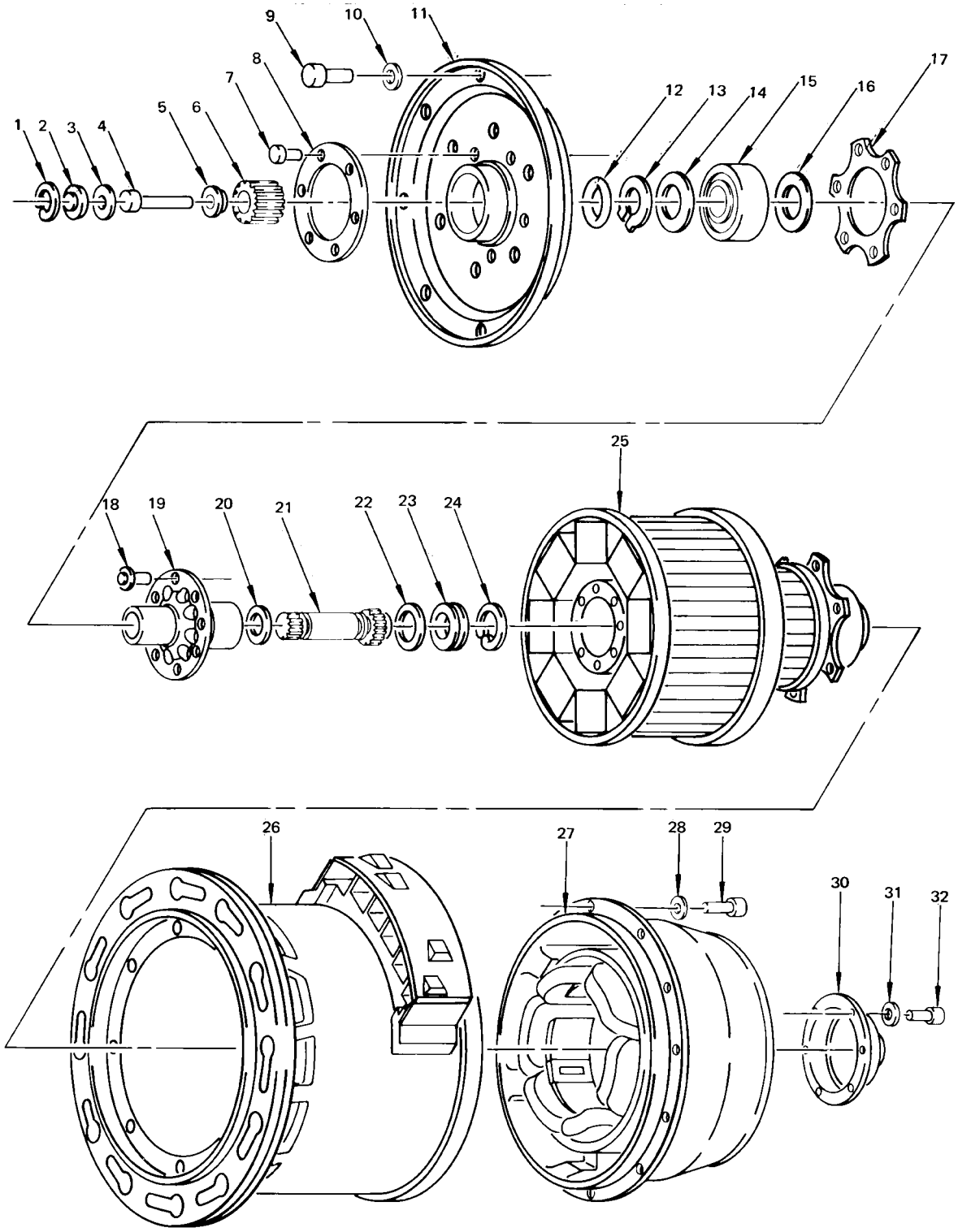
AC GENERATOR SPLINE ADAPTER AND SPINDLE - REMOVAL/INSTALLATION

1. General
   A. The spline adapter used to drive the generator consists of 14 parts, seven of which are used with the spline adapter and the other seven with the generator spindle. It is recommended that both the spline adapter and the mating generator spindle be replaced when the thickness of the worn spline teeth is about one half that of the teeth on a new part. To gain access to the generator spindle, the drive-end bearing must be removed, which requires a mechanical puller. An arbor press will be required for the installation of the generator bearings.
2. Equipment and Materials
   A. Lubricant - Aeroshell 14 or equivalent (molytemp); 1:1 mixture by weight of Molybdenum Disulphide MIL-M-7866 and Rheotemp 500 (or Texaco Unitemp 500) grease; or Sundstrand 688272 (Ref 20-30-21)
   B. O-Ring Guide Tool - Part No. 915B555-1, Westinghouse Aerospace Division, Lima, Ohio
   C. Mechanical Puller - Part No. 918B448-1, Westinghouse Aerospace Division, Lima , Ohio
   D. Puller Adapter - Part No. 918B450-1, Westinghouse Aerospace Division, Lima , Ohio
   E. Press Adapter - Part No. 910C176-1, Westinghouse Aerospace Division, Lima, Ohio, (2 required)
   F. Moly-Sulphide and Oil; equal parts of purified Molybdenite No. 7-218 and oil, Esso Standard Oil Co., 15 W. 51 St., New York, New York
   G. Arbor Press, U.S. Government Procuring Service Stock No. 3444-244-1241 or Dake Corp., Grand Haven, Michigan, Part No. 1-1/2B
3. Remove AC Generator Spline Adapter and Spindle (Fig. 401)
   A. Remove generator (Ref 24-21-11).
   B. Place generator in a horizontal position.
   C. Hold spline adapter (6) by hand while removing screw (4).
   D. Remove the 12 screws (29) and washers (28) attaching end bell (27) to stator frame (26).
   E. Position generator vertically so that generator spindle (21) is down and remove eight screws (9) and washers (10). Pull end bell (11) from generator stator (26).
   F. Lift generator armature-rotor (25) and stator-end bell assembly from generator stator (26).
   G. Remove retaining ring (13) and outer bearing shield (14).
   H. Remove drive-end bearing (15) with bearing cover (17) using mechanical puller and puller adapter.

      NOTE: Do not use bearing cover (17) to remove drive-end bearing (15).

I. Insert jaws of puller adapter between drive-end bearing (15) and bearing cover (17). Remove inner bearing shield (16) and bearing cover (17).

NOTE: No parts which are questionable with regard to wear should be retained for reassembly. When possible, bearings should be replaced with new, clean, properly lubricated bearings.



ac Generator Spline Adapter and Spindle Installation
Figure 401

AC Generator Spline Adapter and Spindle Installation			
1	RETAINING RING	17	BEARING COVER
2	SPINDLE COVER	18	SCREW
3	O-RING	19	STUB SHAFT
4	SCREW	20	O-RING
5	SHOULDERED WASHER	21	GENERATOR SPINDLE
6	SPLINE ADAPTER	22	O-RING
7	SCREW	23	SEAL RETAINER
8	BACKING RING	24	RETAINING RING
9	SCREW	25	GENERATOR ARMATURE-ROTOR
10	WASHER	26	GENERATOR STATOR
11	END BELL	27	END BELL
12	O-RING	28	WASHER
13	RETAINING RING	29	SCREW
14	OUTER BEARING SHIELD	30	BEARING COVER
15	DRIVE-END BEARING	31	WASHER
16	INNER BEARING SHIELD	32	SCREW

J. Remove eight screws (18) and remove stub shaft (19) by tapping around the joining surfaces with a raw hide or soft faced mallet.
K. Remove retaining ring (24).
L. Remove generator spindle (21) and seal retainer (23) by tapping with a soft faced mallet as necessary.
M. Remove and discard O-rings (3), (12), (20), and (22).

4. Install AC Generator Spline Adapter and Spindle (Fig. 401)
   A. Lubricate generator spindle (21) and stub shaft (19) with lubricant before assembly. Fill spline voids of generator spindle (21) completely.
   B. Use O-ring guide tool and install O-rings (20 and 22) on generator spindle (21).
   C. Attach seal retainer (23), generator spindle (21), and retaining ring (24) to stub shaft (19).
   D. Attach stub shaft (19) with eight screws (18) to generator armature-rotor (25). Torque screws from 40 to 50 pound-inches and lockwire.
   E. Coat inside and outside cylindrical surfaces of drive-end bearing (15) with a thin film of moly-sulfide and oil.
   F. Position generator armature-rotor (25) in press adapter and place bearing cover (17) and outer bearing shield (16) with flare of shield away from drive-end bearing (15) on stub shaft (19).
   G. Press drive-end bearing (15) on stub shaft (19) with press adapter.

      NOTE: When properly assembled, outer portion of inner bearing shield (16) should not contact drive-end bearing (15).

H. Place drive-end bearing (15) on end bell assembly (27). Align bearing cover (17) with holes in end bell and install bearing cover (30) using six screws (32) and washers (31). Torque screws from 30 to 36 pound-inches and lockwire.

NOTE: Bearing cover (17) can be positioned to end bell (27) by temporarily using two No. 10-32 screws approximately 6 inches long before end bell (27) is attached to generator (26).

I. Position generator stator (26) with drive end down on blocks. Carefully place armature-end bell assembly on generator stator and install 12 screws (29) and washers (28). Torque screws from 27 to 33 pound-inches and lockwire.

NOTE: Check that all screws are evenly tightened before torquing.

J. Position generator horizontally. Install outer bearing shield (14) on drive end of stub shaft (19) with flare of shield away from bearing and install retaining ring (13).
K. Attach end bell (11) to generator stator (26) by lightly tapping bearing insert of end bell onto drive-end bearing (15). Install eight screws (9) and washers (10). Torque screws from 30 to 36 pound-inches and lockwire.

NOTE: Check that all screws are evenly tightened before torquing.

L. Connect bearing cover (17) to end bell (11) using screws (7) and backing ring (8). Torque screws from 30 to 36 pound-inches and lockwire.

NOTE: Bearing cover (17) can be positioned prior to installing end bel1 (11) by temporarily using two No. 10-32 screws approximately 6 inches long.

M. Install O-ring (12) on spindle using O-ring guide tool.
N. Fill all spaces in generator spindle (21) , spindle splines, and inner splines of spline adapter (6) with lubricant and install spline adapter (6) on splines of generator spindle (21).
O. Install screw (4) and shouldered washer (5) and torque screw from 83 to 108 pound-inches.
P. Install O-ring (3) on spindle cover (2).
Q. Install spindle cover (2) and retaining ring (1) in spindle adapter.
R. Install generator (Ref 24-21-11).

NOTE: If mating output spline in CSD has any indication of wear, the new generator input adapter spline should not be used until the CSD output spline has been replaced.

MAIN POWER CIRCUIT BREAKERS - REMOVAL/INSTALLATION

1. Removal/Installation Main Power Circuit Breakers in Right Load Control Center P6
   A. General
      (1) Three main power circuit breakers, the No. 1 and No. 2 bus tie breakers and the APU generator breaker are located in the lower rear compartments in the right load control center P6. Access to the circuit breakers in the P6 right load control center is obtained by loosening two screws on the edge of each panel and swinging the panels forward (Fig. 401).
   B. Remove Main Power Circuit Breakers in Right Load Control Center P6

      WARNING: BE SURE ALL POWER IS OFF BEFORE TOUCHING ANY CONDUCTOR IN CONTROL COMPARTMENTS.

      (1) Open circuit breaker compartment by loosening two screws on the inboard edges of panels P6-11 and P6-12 and swing the circuit breaker panels forward (Fig. 401).
      (2) Remove circuit breaker coverplate by removing two flat lead screws.
      (3) Disconnect electrical connector.
      (4) Remove six electrical cables from circuit breaker terminal studs using care not to drop such parts as nuts or washers into compartments.
         (a) Tag each cable as it is disconnected with correct identification to facilitate reconnection.
         (b) Observe the order and position in which cable terminals, plain washers, lockwashers, and nuts are placed on each terminal stud.

            NOTE: Where more than one cable is attached to a stud it may be advisable to use a lacing cord and tie parts together and tag for each stud.

      (5) Remove four breaker mounting screws and remove circuit breaker from compartment.

         NOTE: Nutplates are provided on breaker supports.

   C. Prepare to Install
      (1) Examine each cable terminal and adjacent cable for discoloration caused by overheating and for signs of corrosion.
      (2) Clean off corrosion with very fine sandpaper or a rubber eraser.

         CAUTION: DO NOT USE METALLIC OXIDE ABRASIVES.

(a) If corrosion is excessive or terminal and/or cable is discolored from overheat, defective end portion of cable should be cut off and a new terminal installed if cable length is adequate. Refer to Terminal Installation, Notes Section of the Wiring Diagram Manual. If proper cable length cannot be obtained, fabricate a new cable assembly, using old cable as a sample.

D. Install Main Power Circuit Breakers in Control Center P6

(1) Place breaker in correct mounting position so that breaker terminals are placed according to the tags on the cables. Align mounting holes and install four mounting screws.

(2) Remove breaker terminal cover by removing two cover screws.

(3) Install cables on terminal studs in same sequence and position as observed when removed in step B.(4). Observe proper terminal buildup. Tighten nuts on studs to torque values given on terminal cover.

CAUTION: DO NOT OVERTORQUE.

(4) Connect electrical connector.

NOTE: Use care in joining connectors since bent or damaged pins can result in circuit breaker failure.

(5) Install breaker terminal cover and tighten two screws.

(6) Close load control center panels P6 and secure with attached screws.

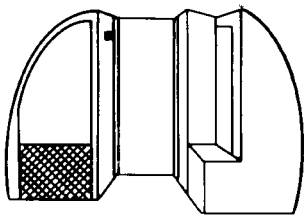
(7) On airplanes prior to incorporating SB 24-1037, gain access thru panel 3105 in nose wheel well and check that there is no interference between the APU circuit breaker wire bundle and flight control cable if wire bundle was displaced during APU generator circuit breaker replacement.

CAUTION: ABRASION BETWEEN THE APU GENERATOR WIRE BUNDLE AND THE FLIGHT CONTROL CABLE CAN CAUSE ARCING THAT MAY RESULT IN SEVERANCE OF THE FLIGHT CONTROL CABLE.

2. Removal/Installation Main Power Circuit Breakers in Right Forward Compartment, Outboard Nose Wheel Well

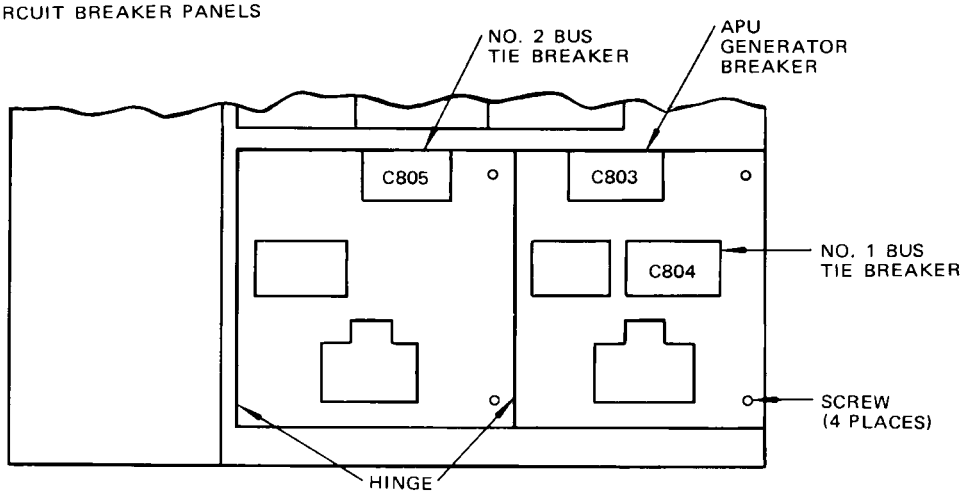
A. General

(1) The main power circuit breakers, the No. 1 and No. 2 generator breakers and the external power contactor are in the right forward compartments outboard of the nose wheel well. Access to the right forward compartments is gained through the nose wheel well by removing both the forward and aft access doors from the right-hand inner wall in the nose wheel well (Fig. 402).



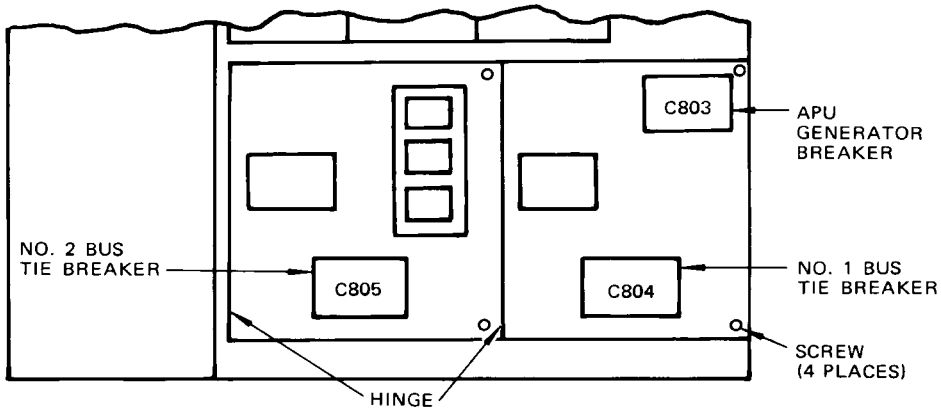
FWD

CIRCUIT BREAKERS
LOCATED TO REAR OF
HINGED CIRCUIT BREAKER PANELS



EFFECTIVITY

AR LV–JMW THRU LV–JMZ
VM TJ–CBA AND TJ–CBB
ZD ALL EXCEPT G–BECG AND ON



EFFECTIVITY

AR ALL EXCEPT LV–JMW THRU LV–JMZ
VM TJ–CBD AND ON
ZD G–BECG AND ON

Load Control Center–Right (P6) Cercuit Breaker Location
Figure 401

B. Remove Main Power Circuit Breakers in Right Forward Compartment, Outboard Nose Wheel Well.

WARNING: BE SURE ALL POWER IS OFF BEFORE TOUCHING ANY CONDUCTOR IN COMPARTMENT.

(1) Remove two access doors from right inner wall of the nose wheel well (Fig. 402).

NOTE: Only No. 1 generator breaker is accessible from the aft access door.

(2) Remove circuit breaker cover plate by removing two flat head screws.
(3) Remove six electrical cables from circuit breaker terminal studs using care not to drop such parts as nuts or washers into compartment.
(a) Tag each wire as it is disconnected with correct identification to facilitate reconnection.
(b) Observe the order and position in which cable terminals, plain washers, lockwashers, and nuts are placed on each terminal stud.

NOTE: Where more than one cable is attached to a stud, it may be advisable to use a lacing cord and tie parts together and tag for each stud.

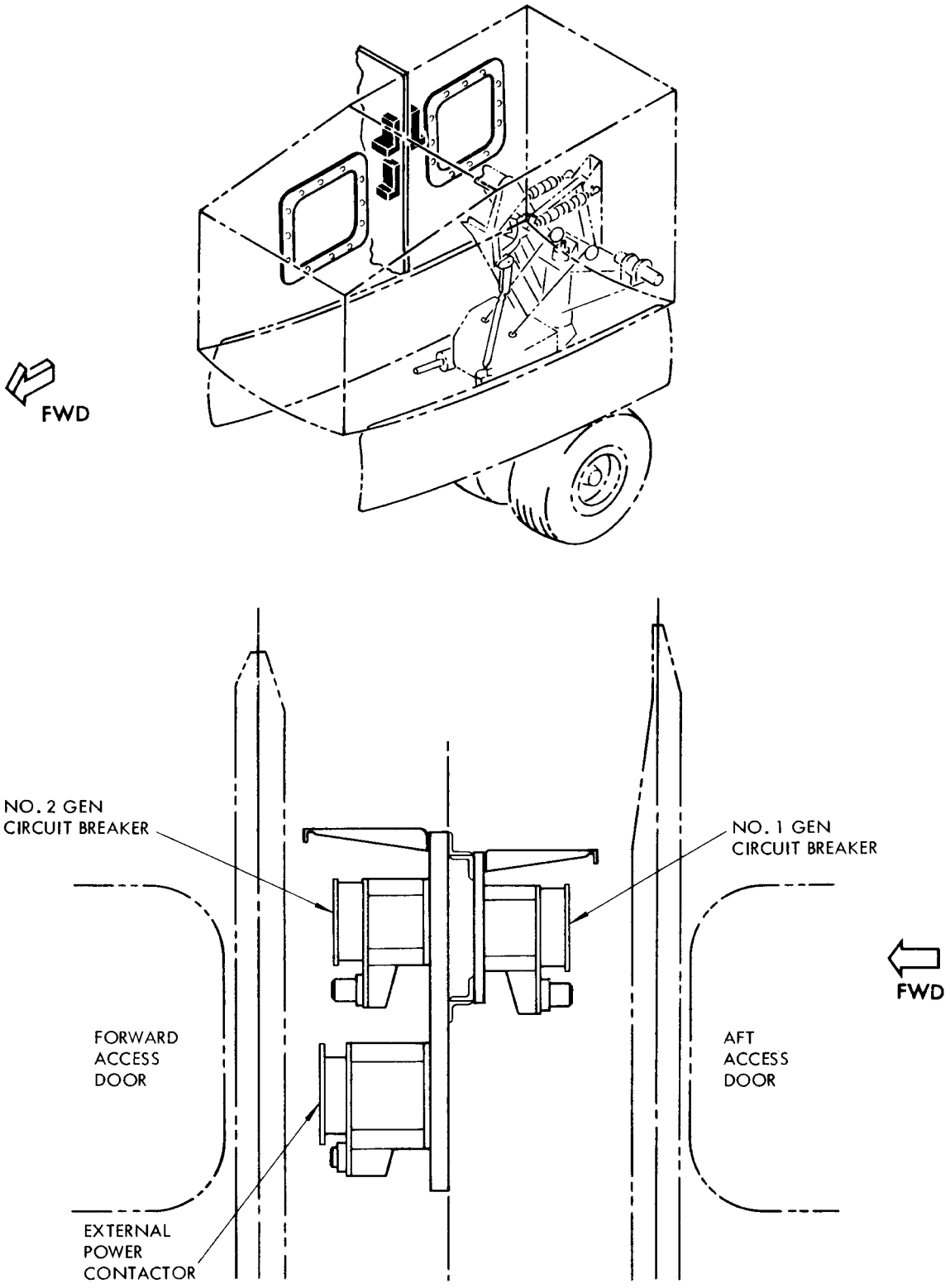
(4) Disconnect electrical connector.
(5) Remove four breaker mounting screws and remove circuit breaker from compartment.

NOTE: Nutplates are provided on breaker supports.

C. Prepare to Install
(1) Examine each cable terminal and adjacent cable for discoloration caused by overheating and for signs of corrosion.
(2) Clean off corrosion with very fine sandpaper or a rubber eraser.

CAUTION: DO NOT USE METALLIC OXIDE ABRASIVES.

(a) If corrosion is excessive or terminal and/or cable is discolored from overheat, defective end portion of cable should be cut off and a new terminal installed if cable length is adequate. Refer to Terminal Installation, Notes Section of the Wiring Diagram Manual. If proper cable length cannot be obtained, fabricate a new cable assembly, using old cable as a sample.



Main Power Circuit Breaker Installation
Figure 402

D. Install Main Power Circuit Breakers in Right Forward Compartment, Outboard Nose Wheel Well

(1) Place breaker in correct mounting position so that breaker terminals are placed according to the tags on the cables. Align mounting holes and install four mounting screws. (See figure 402.)

(2) Remove breaker terminal cover by removing two flat head screws.

(3) Install cables on terminal studs in same sequence and position as observed when removed in step B.(3). Observe proper terminal buildup. Tighten nuts on studs to torque values given on terminal cover.

CAUTION: DO NOT OVERTORQUE.

(4) Connect electrical connector.

NOTE: Use care in joining connectors since bent or damaged pins can result in circuit breaker failure.

(5) Install breaker terminal cover and tighten two screws.

(6) Install two access doors on right inner wall of nose wheel well.

GENERATOR ROTATING RECTIFIER - INSPECTION/CHECK

1. General
   A. The following procedure checks the generator rotating rectifier and the wiring to generator field terminals. If DS1 light does not indicate as in steps 3.A.(2) and (3), repair wiring to generator field terminals or replace generator.
   B. Equipment and Materials
      (1) Rotor Fault Indicator, Part Number 939D192-1 Westinghouse Electric Corp., Aerospace Elec Div. V83843
      (2) Connectors, Part Number 3260, ITT Pomona Electronics Division V24253
2. Prepare for Test
   A. Remove electrical power from airplane.
   B. Place BAT switch on panel P5 to ON.
   C. Set GEN 1, GEN 2, right APU GEN, and left APU GEN switches on panel P5 to OFF.

      CAUTION: DO NOT SET GEN 1, GEN 2, AND APU GEN SWITCHES TO ON WHEN ROTOR FAULT INDICATOR IS CONNECTED TO M400 MODULE OR DAMAGE TO ROTOR FAULT INDICATOR MAY RESULT.

   D. Provide external electrical power.
   E. Start APU (Ref 49-11-0 MP) and Engines No. 1 and 2 (Ref 71-09-100, Operating Procedure). Verify that generators are not providing electrical power (that GCR's are open) by checking that GEN 1, GEN 2, and APU GEN MANUAL TRIP lights on M238 module are illuminated.

      NOTE: If manual trip lights are not illuminated, check that external power is off, set applicable GEN switch to OFF, and check that applicable MANUAL TRIP lights are illuminated.

   F. Set left switch of power system test module M400 in panel P6 to H and set right switch to 1.
   G. Connect connector to each DC jack on M400 module.
   H. Clip black lead of rotor fault indicator to DC- connection on M400 module and red lead of rotor fault indicator to DC+ connection on M400 module.
3. Test Generator Rotating Rectifier
   A. Test engine No. 1 generator.
      (1) Set left switch on M400 module to A.
      (2) Set S1 on rotor fault indicator to DS1 MUST BE ON and hold in position. Check that DS1 light on rotor fault indicator illuminates.

(3) Set S1 to DS1 MUST GO OFF and hold in position. Check that DS1 light extinguishes.

NOTE: DS1 light may flash momentarily as S1 is moved from DS1 MUST BE ON to DS1 MUST GO OFF.

(4) Release S1 and allow switch to return to OFF.

B. Test Engine No. 2 generator.
(1) Set left switch on M400 module to B. Repeat steps A. (2) thru (4).

C. Test APU generator.
(1) Set left switch on M400 module to C. Repeat steps A.(2) thru (4).

4. Return System to Normal
A. Set left switch on M400 module to H.
B. Disconnect rotor fault indicator leads and connectors from M400 module.
C. Shut down APU (Ref 49-11-0) and engines (Ref 71-09-100) if no longer required to be operating.
D. Remove external electrical power if no longer required.

CURRENT TRANSFORMERS - REMOVAL/INSTALLATION

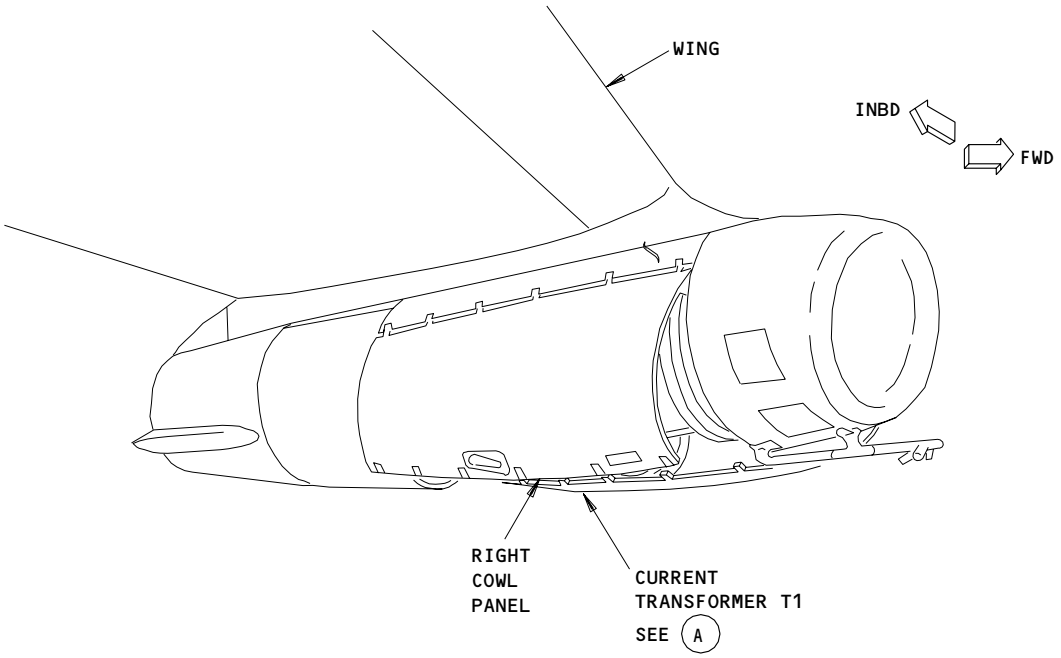
1. General
   A. Removal and installation of each current transformer is identical; however, location and access is different. Transformer T1 is on the lower right side of engine; transformer T2 is on the APU near the generator; transformer T4 is in panel P6-11; transformer T5 is in panel P6-12; transformers T7, T8, and T9 are on the right forward ceiling of the electronic compartment.
2. Remove Current Transformers (Fig. 401)
   A. Remove electrical power (Ref 24-22-0 MP).

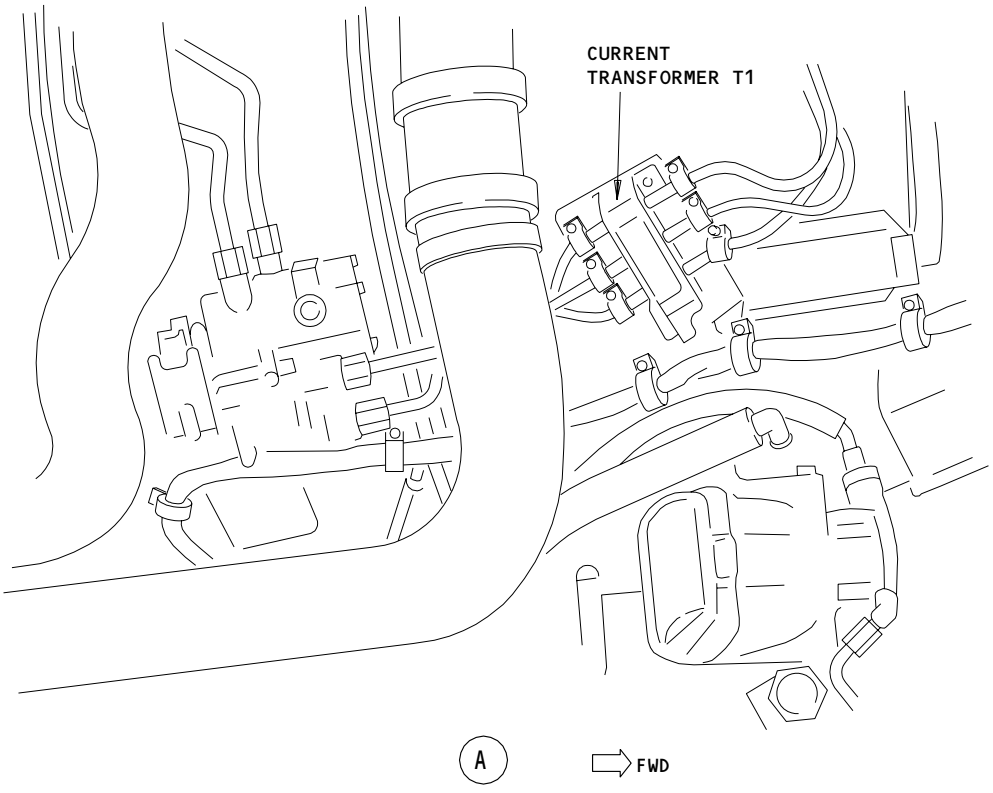
      WARNING: REMOVE ELECTRICAL POWER FROM AIRPLANE PRIOR TO REMOVING OR INSTALLING CURRENT TRANSFORMERS. HIGH VOLTAGE PRESENT CAN BE FATAL.

   B. Gain access to current transformer.
      (1) For T1, open right cowl panel (Ref 71-11-11).
      (2) For T2, remove APU lower shroud.
         (a) Open APU compartment access door latches and open access door. Install door support rods.
         (b) Support shroud, open shroud latches, and remove shroud.

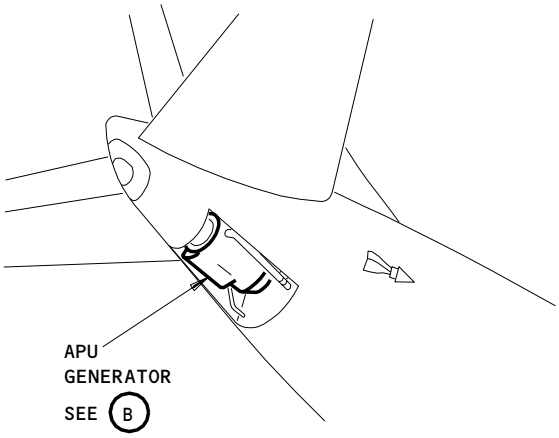
            CAUTION: EXERCISE EXTREME CARE NOT TO DAMAGE SHROUD DRAIN LINES WHEN HANDLING SHROUD.

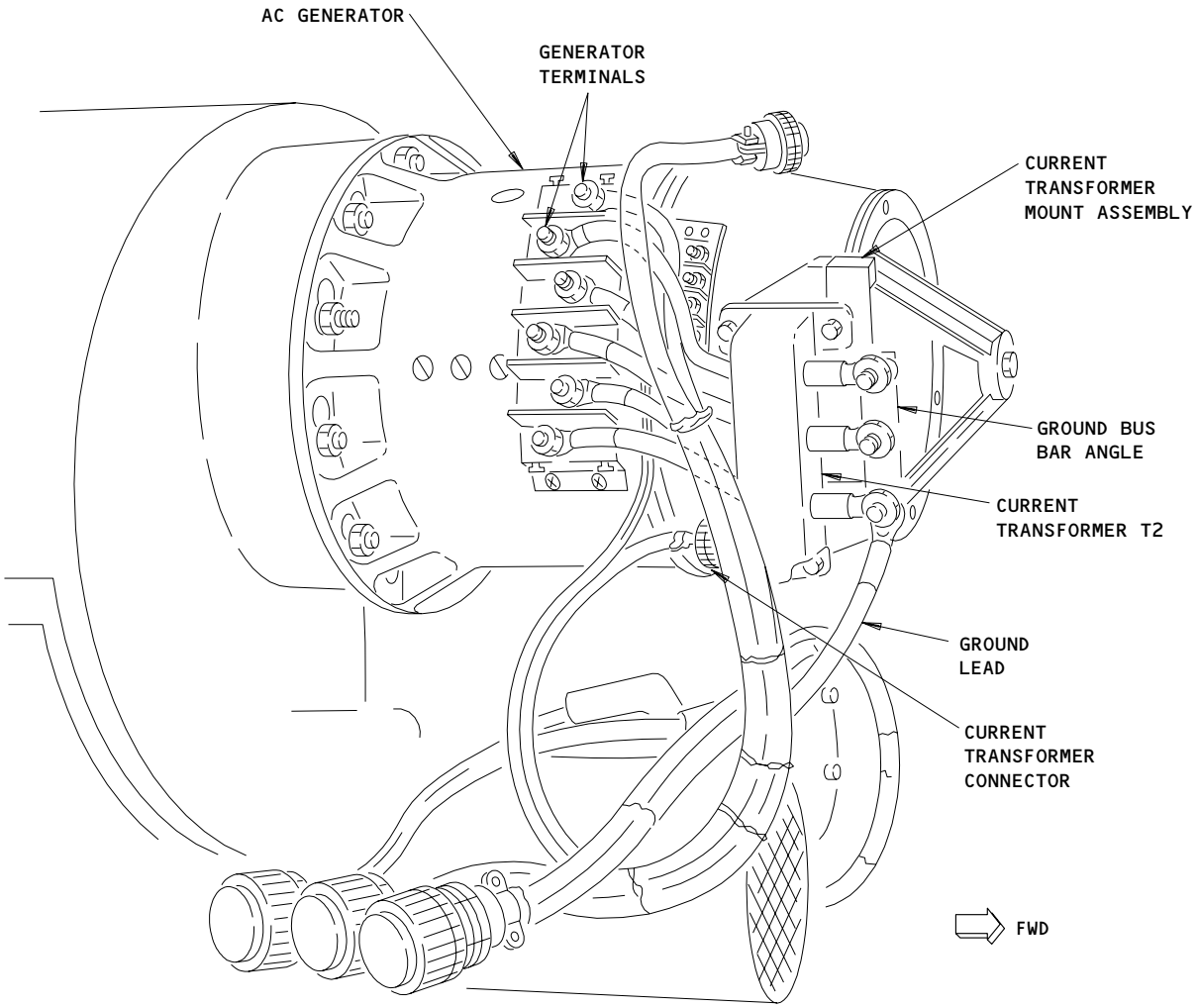
      (3) For T4 or T5, loosen two screws on inboard edge of panel P6-11 (for T4) or P6-12 (for T5) and swing panel forward.
      (4) For T7, T8, or T9, enter electronic compartment above the nose wheel well through the electronic compartment access door.
   C. Remove electrical connector from current transformer.
   D. Tag and remove each lead running through current transformer. Identify lead by:
      (1) Name and equipment number of device from which lead was removed.
      (2) Terminal on device from which lead was removed.
      (3) Hole on current transformer where lead runs through (left, right, or center).
   E. Remove mounting fasteners from current transformer and remove current transformer.
3. Install Current Transformer (Fig. 401)
   A. Install current transformer with fasteners.





Current Transformer Component Location
Figure 401 (Sheet 1)

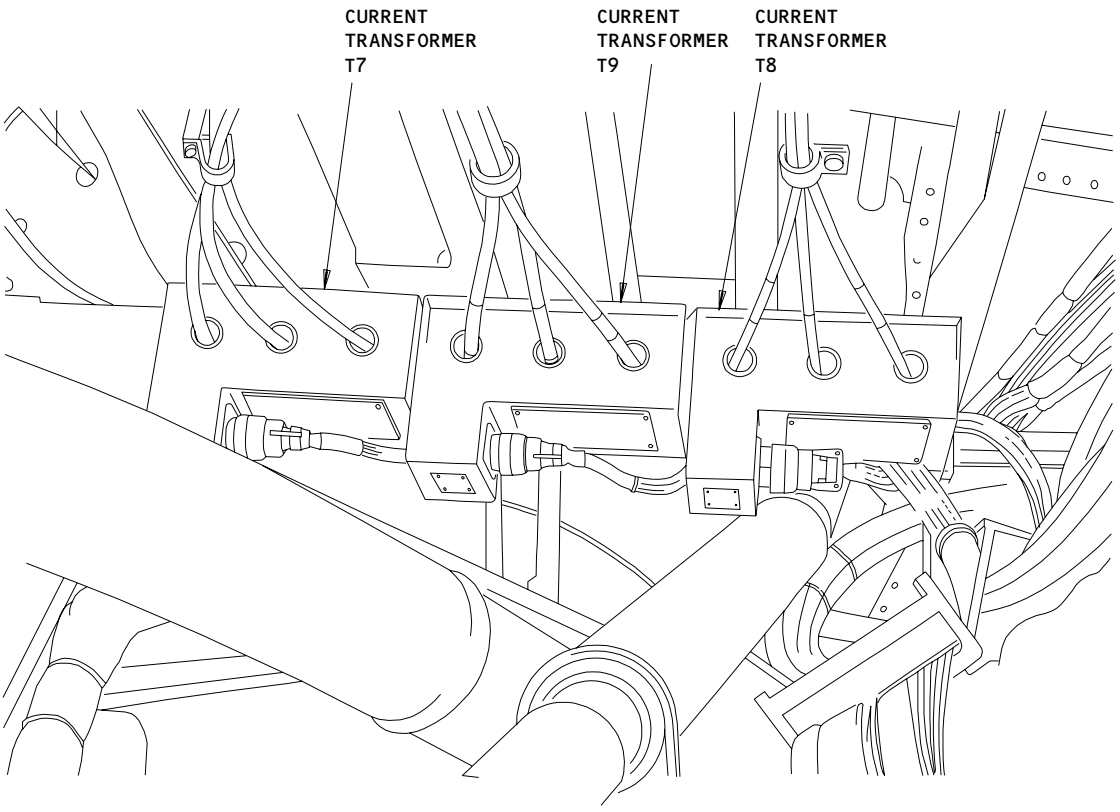




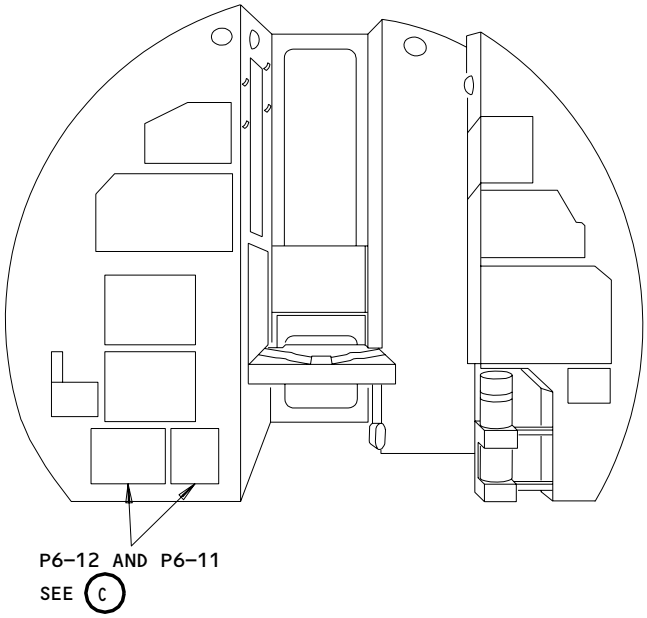
NOTE: COOLING AIR CROSSOVER DUCT OMITTED.

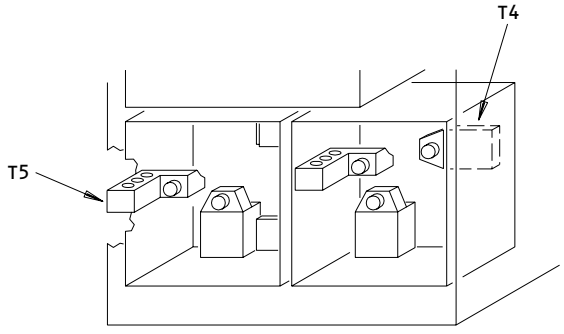
B

Current Transformer Component Location
Figure 401 (Sheet 2)



ELECTRONIC COMPARTMENT ABOVE RIGHT FORWARD CEILING OF NOSE W/W STA 285, RBL 50





C

Current Transformer Component Location
Figure 401 (Sheet 3)

B. Install leads through holes in current transformer to applicable terminal.

CAUTION: CHECK THAT LEADS PASS THROUGH PROPER HOLES IN CURRENT TRANSFORMER. INCORRECT INSTALLATION WILL RESULT IN CIRCUIT MALFUNCTION.

C. Install electrical connector on current transformer.
D. Close access panel or shroud as applicable.
   (1) Close right cowl panel (Ref 71-11-11).
   (2) Install APU lower shroud.
      (a) Position lower shroud against upper shroud and close shroud latches.

CAUTION: MAINTAIN A MINIMUM CLEARANCE OF 0.18 INCH BETWEEN ENGINE PLUMBING, FIRE DETECTOR, CLAMPS, AND INSIDE SURFACE OF LOWER SHROUD. EXERCISE EXTREME CARE NOT TO DAMAGE SHROUD DRAIN LINES WHEN HANDLING SHROUD.

      (b) Disengage APU compartment access door support rods and stow rods. Close and latch access door.
   (3) Close P6-11 or P6-12 panel and tighten screws.
   (4) Close electronic compartment access door.
E. Test current transformer by testing ac generation system (Ref 24-21-0).

GENERATOR CONTROL UNIT - REMOVAL/INSTALLATION

1. Remove GCU (Generator Control Unit)
   A. Remove all electrical power from airplane (Ref 24-22-0 MP).

      CAUTION: ALL ELECTRICAL POWER MUST BE REMOVED FROM THE AIRCRAFT DURING REMOVAL/INSTALLATION OF GCU TO PREVENT POSSIBLE DAMAGE TO CURRENT TRANSFORMERS OR GCU.

   B. Remove GCU (Ref 20-10-111).
2. Install GCU

   CAUTION: ALL ELECTRICAL POWER MUST BE REMOVED FROM THE AIRCRAFT DURING REMOVAL/INSTALLATION OF GCU TO PREVENT POSSIBLE DAMAGE TO CURRENT TRANSFORMERS OR GCU.

   A. Install GCU (Ref 20-10-111).
3. Test Generator Control Unit
   A. Test Engine Generator and Control
      (1) On the P5-4 panel, make sure the following switches are OFF:
          (a) BUS TRANS
          (b) GRD PWR switch
      (2) When the No. 1 generator control unit (GCU) is changed start engine No. 1. When the No. 2 GCU is changed start engine No. 2. (AMM 71-09-100/201).
      (3) On the P5-13 panel, put the AC meter selector switch to the GEN position of the GCU being tested. Make sure the following indications are shown:
          (a) The AC VOLTS meter shows 0 volts.
          (b) The AC FREQ shows 0 Hz.
      (4) On the P5-5 panel, make sure the following lights are OFF:
          (a) LOW OIL PRESSURE
          (b) HIGH OIL TEMP
      (5) On the P5-4 panel, put the GEN switch of the GCU being tested to ON then OFF.
      (6) On the P5-13 panel, push the RESID VOLTS switch, make sure the following is shown:
          (a) AC voltmeter shows 10 to 21 volts.
      (7) On the P5-4 panel, make sure the following lights are ON:
          (a) TRANSFER BUS OFF
          (b) BUS OFF
          (c) GEN OFF BUS
      (8) On the P5-4 panel, put the GEN switch of the GCU tested to ON. Make sure the following lights for the generator being tested are OFF:
          (a) TRANSFER BUS OFF
          (b) BUS OFF

(c) GEN OFF BUS

(9) On the P5-13 panel, make sure the following is shown:
(a) AC voltmeter shows 115 ±5 volts.
(b) Frequency meter shows 400 ±5 Hz.

NOTE: Voltage indicates the control (field) relay has closed.

(10) On the P5-4 panel, put the BUS TRANS switch to AUTO, make sure the following lights are OFF:
(a) Left and right TRANSFER BUS OFF
(b) Left and right BUS OFF

NOTE: The GEN OFF BUS light will remain ON for the engine not being tested.

(11) On the P5-13 panel, make sure the following is shown:
(a) AC voltmeter shows 115 ±5 volts.
(b) Frequency meter shows 400 ±5 Hz.

B. Airplanes without electrical load shedding, do the following:
(1) On the P5-8 panel, put the HYD PUMPS B ELEC 1 and 2 switches ON.
(2) On the P5-8 panel, make sure the LOW PRESSURE lights are OFF.
(3) On the P5-13 panel, make sure the following is shown:
(a) AC voltmeter shows 115 ±5 volts
(b) Frequency meter shows 400 ±5 Hz.
(4) On the P5-4 panel, make sure the AC AMPERES shows a current.
(5) On the P5-5 panel, make sure the following lights for the GCU being tested are OFF:
(a) LOW OIL PRESSURE
(b) HIGH OIL TEMP
(6) Restore airplane to normal.

C. Airplanes with electrical load shedding, on the P5-8 panel, do the following for the GCU tested:
(1) Put the HYD PUMPS B ELEC switch for the GCU being tested to ON.
(a) If the No. 1 GCU is tested, put the HYD PUMPS B ELEC 1 switch to ON.
(b) If the No. 2 GCU is tested, put the HYD PUMPS B ELEC 2 switch to ON.
(2) Make sure the LOW PRESSURE light is OFF.
(a) If the No. 1 GCU is tested, the left LOW PRESSURE light is OFF.
(b) If the No. 2 GCU is tested, the right LOW PRESSURE light is OFF.
(3) On the P5-5 panel, make sure the following lights are OFF:
(a) LOW OIL PRESSURE
(b) HIGH OIL TEMP

(4) Put the other HYD PUMPS B ELEC switch to ON.
  (a) If the No. 1 GCU is tested, put the HYD PUMPS B ELEC 2 switch to ON.
  (b) If the No. 2 GCU is tested, put the HYD PUMPS B ELEC 1 switch to ON.
(5) Make sure the LOW PRESSURE light remains ON.
  (a) If the No. 1 GCU is tested, the right LOW PRESSURE light remains ON.
  (b) If the No. 2 GCU is tested, the left LOW PRESSURE light remains ON.
(6) Put the HYD PUMPS B ELEC switch for the GCU being tested OFF.
  (a) If the No. 1 GCU is tested, put the HYD PUMPS B ELEC 1 switch to OFF.
  (b) If the No. 2 GCU is tested, put the HYD PUMPS B ELEC 2 switch to OFF
(7) Make sure the LOW PRESSURE light comes ON.
  (a) If the No. 1 GCU is tested, the left LOW PRESSURE light comes ON.
  (b) If the No. 2 GCU is tested, the right LOW PRESSURE light comes ON.
(8) Make sure the other LOW PRESSURE light goes OFF.
  (a) If the No. 1 GCU is tested, the right LOW PRESSURE light goes OFF.
  (b) If the No. 2 GCU is tested, the left LOW PRESSURE light goes OFF.

4. Test APU Generator Control Unit

A. Test APU Generator and Control
(1) Start the APU (AMM 49-11-0/201).
(2) On the P5-4 panel, make sure the GRD PWR switch is OFF.
(3) On the P5-13 panel, put the AC meter selector switch to the APU position.
(4) On the APU control panel the following lights are OFF:
  (a) LOW OIL QUANTITY
  (b) LOW OIL PRESSURE
  (c) HIGH OIL TEMP
  (d) OVER SPEED
(5) The APU AC AMPERES meter shows no current.
(6) On the P5-4 panel, make sure the following lights are ON:
  (a) APU GEN OFF BUS
  (b) TRANSFER BUS OFF
  (c) Left BUS OFF
  (d) GEN BUS OFF
(7) On the P5-4 panel, put the left APU GEN switch to ON.
(8) On the P5-13 panel, make sure the following is shown:
  (a) AC voltmeter shows 115 ±5 volts.
  (b) Frequency meter shows 400 +10/-5 Hz.

(9) On the P5-4 panel, make sure the following lights are OFF:
  (a) APU GEN OFF BUS
  (b) TRANSFER BUS OFF
  (c) Left BUS OFF
  (d) GEN BUS OFF
(10) On the P5-8 panel, put the HYD PUMPS B ELEC 1 switch to ON.
(11) On the P5-13 panel, make sure the following is shown:
  (a) AC voltmeter shows 115 ±5 volts.
  (b) Frequency meter shows 400 +10/-5 Hz.
(12) Make sure the AC AMPERES shows current.
(13) On the P5-8 panel, put the HYD PUMPS B ELEC 1 switch to OFF.
(14) On the P5-4 panel, put the left APU GEN switch to OFF.
(15) On the P5-13 panel, make sure the following is shown:
  (a) AC voltmeter shows 0 volts.

(16) On the P5-4 panel, make sure the following lights are ON:
  (a) APU GEN OFF BUS
  (b) TRANSFER BUS OFF
  (c) Right BUS OFF
  (d) GEN BUS OFF
(17) Make sure the APU AC AMPERES meter shows no current.
(18) On the P5-4 panel, put the right APU GEN switch to ON.
(19) On the P5-13 panel, make sure the following is shown:
  (a) AC voltmeter shows 115 ±5 volts.
  (b) Frequency meter shows 400 +10/-5 volts.
(20) On the P5-4 panel, make sure the following lights are OFF:
  (a) APU GEN OFF BUS
  (b) TRANSFER BUS OFF
  (c) Right BUS OFF
  (d) GEN BUS OFF
(21) On the P5-8 panel, put the HYD PUMPS B ELEC 2 switch to ON.
(22) Make sure the AC AMPERES shows current.
(23) On the P5-13 panel, make sure the following is shown:
  (a) AC voltmeter shows 115 ±5 volts
  (b) Frequency meter shows 400 +10/-5 Hz.
(24) On the P5-8 panel, put the HYD PUMPS B ELEC 2 switch to OFF.
(25) On the P5-4 panel, put the right APU GEN switch to OFF.
(26) On the P5-4 panel, make sure the following lights are ON:
  (a) APU GEN OFF BUS
  (b) TRANSFER BUS OFF
  (c) Right BUS OFF
  (d) GEN BUS OFF
(27) Airplanes with electrical load shedding, do the B Hydraulic System Power Source Transfer With APU Operating Test (AMM 24-21-0/501).
(28) Airplanes without electrical load shedding, do the following:
  (a) On the P5-4 panel, put both APU GEN switches to ON.

(b) Make sure the following lights on the P5-4 panel are OFF:
1) APU GEN OFF BUS
2) Left and right TRANSFER BUS OFF
3) Left and right BUS OFF
(c) Make sure the following lights on the P5-4 panel are ON:
1) Left and right GEN BUS OFF
(d) On the P5-8 panel, put both HYD PUMPS B ELEC 1 and ELEC 2 switches to ON.
(e) On the P5-8 panel, make sure the following lights are OFF:
1) Left and right OVERHEAT
2) Left and right LOW PRESSURE
(f) On the P5-4 panel, put the left APU GEN switch to OFF.
(g) On the P5-8 panel, make sure the left LOW PRESSURE light is OFF.
(h) On the P5-4 panel, put the BUS TRANS switch to OFF.
(i) On the P5-8 panel, make sure the left LOW PRESSURE light is ON.
(j) On the P5-4 panel, put the BUS TRANS switch to AUTO.
(k) On the P5-8 panel, make sure the left LOW PRESSURE light goes OFF.
(l) On the P5-4 panel, put the APU GEN switches to the following positions:
1) Left APU GEN to ON
2) Right APU GEN to OFF
(m) On the P5-8 panel, make sure the left and right LOW PRESSURE lights are OFF.
(n) On the P5-4 panel, put the BUS TRANS switch to OFF.
(o) On the P5-8 panel, make sure the right LOW PRESSURE light is ON.
(p) On the P5-4 panel, put the right APU GEN switch to ON.
(q) On the P5-8 panel, make sure the following lights:
1) Left LOW PRESSURE OFF
2) Right LOW PRESSURE OFF

5. Return the airplane to normal
A. Remove electrical power if no longer required (Ref 24-22-0/201).

GENERATOR CONTROL UNIT BLOCKING DIODE - ADJUSTMENT/TEST

1. General
   A. Each generator control unit blocking (GCU) diode (CR910) can be tested by measuring the voltage across the blocking diode circuit.
2. Test
   A. Generator Control Unit Test (Meter Test)
      (1) On the P5-13 panel, put the BAT switch in the ON position.

          NOTE: Do not use any other electrical power source. If another power source is used, the test results will not be accurate.

      (2) On the P6-4 panel, open the following control generator circuit breakers:
          (a) C4 Control Generator No. 1
          (b) C5 Control Generator No. 2
          (c) C6 Control Generator APU
      (3) On the P5-5 panel, do the following:
          (a) Make sure both BUS OFF and GEN OFF BUS lights are ON.
          (b) Press the APU GEN OFF BUS light and make sure the bus lights are ON.
      (4) On the P6 panel, attach the common (black) lead from the Fluke 87 meter (or equivalent), to the M400 Power System Test module, (-) DC jack.

          NOTE: The M400 switches can be in any position for this test.

      (5) On the Fluke 87 meter, do the following steps:
          (a) Select the diode function.
          (b) Attach the red lead to the volt, ohm, diode jack.
          (c) Black lead to the common jack.

              WARNING: THE CIRCUIT BREAKERS HAVE ELECTRICAL POWER. DO NOT TOUCH ANY OTHER OBJECTS OR DAMAGE TO EQUIPMENT OR PERSONNEL MAY OCCUR.

      (6) Open the P6-4 panel, and attach or touch the red lead to the load side of the following circuit breakers:
          (a) C4 Control Generator No. 1
              C5 Control Generator No. 2
              C6 Control Generator APU

(b) C5 Control Generator No. 2
(c) C6 Control Generator APU

NOTE: The load side of the circuit breaker is the terminal closest to the P6-4 panel hinge line.

(7) On the Fluke 87, make sure a positive voltage is measured.
(a) Replace the GCU, and repeat test for replacement GCU, if a positive voltage is not measured.

NOTE: A positive voltage is required to indicate the condition of the circuit. The amount of the voltage measured is not a requirement for this test.

(8) On the Fluke 87 meter, do the following step:
(a) Reverse the leads at the meter.
1) The red lead in the common jack.
2) The black lead in the volt, ohm, diode jack.
(9) Attach the red lead to the load side of the following circuit breakers:
(a) C4 Control Generator No. 1
(b) C5 Control Generator No. 2
(c) C6 Control Generator APU
(10) On the Fluke 87 meter, do the following steps:
(a) Make sure the meter reads OPEN CIRCUIT when attached or touched to each circuit breaker.
(b) Replace GCU and battery, and repeat test for replacement GCU, if an open circuit is not measured.
(11) Remove the red lead from the circuit breaker and the black lead from the M400 Power System Test module (-) DC jack.
(12) Close the P6-4 panel.
(13) Close circuit breakers C4, C5 and C6.
(14) On the P5-13 panel, put the BAT switch in the OFF position.

MANUAL CONTROL - MAINTENANCE PRACTICES (APPLY POWER)

1. General
   A. The following procedures outline application of electrical power to the buses. Maintenance or ground servicing may be performed by energizing the ac and dc buses from external power (ground power cart), APU power or engine-driven generator power. The procedures also outline removal of power from the airplane. In each procedure the BAT switch is placed to OFF after removal of power source. If the BAT switch is left in the ON position with no ac power on the airplane, the storage battery will discharge at a rate of approximately 10 amps per hour, fully discharging the battery after a few hours.
   B. When an external power supply or an APU generator is connected to the buses, the system will not parallel either power source with the main-engine driven generator power.
   C. The dc buses are supplied from transformer rectifier units TR1, TR2, and TR3. The TR units supply power to 28V dc bus 1 and 28V dc bus 2 from 115V ac generator bus 1 and 115V ac generator bus 2, respectively. TR3 is a backup for TR1 and TR2.

      WARNING: PRIOR TO APPLYING ELECTRICAL POWER INSURE THAT PERSONNEL ARE NOT EMPLOYED IN REMOVAL OR INSTALLATION OF ELECTRICAL OR ELECTRONIC EQUIPMENT. HIGH VOLTAGES PRESENT CAN BE FATAL.

   D. Power is supplied to the 115 volt ac standby bus from the 115 volt ac transfer bus 1 when the 115V ac generator bus 1 is energized, the STANDBY POWER switch is placed to AUTO and the BATTERY switch is placed to ON. The 115V ac generator bus 2 will supply transfer bus 1 when BUS TRANSFER switch is in AUTO position and only generator bus 2 is energized.
2. Apply External Power
   A. General
      (1) The airplane is provided with an ac external power receptacle located near the nose wheel well. Electrical power may be applied to the buses by connecting external power to the receptacle.
      (2) Ground service circuits (such as ceiling lights and service outlets) are energized from the ground service buses. Power may be applied to ground service buses without energizing all other buses by placing GROUND SERVICE switch on forward attendant's panel P13 to ON.
   B. Equipment and Materials
      (1) External power supply 115/200 volt ac, 3-phase, 400 Hz nominal.
   C. Apply power to buses.
      (1) Open external power receptacle door.

(2) Install power cable.

WARNING: PRIOR TO CONNECTING THE EXTERNAL ELECTRICAL POWER SOURCE CABLE TO THE AIRPLANE ENSURE THAT ELECTRICAL POWER IS REMOVED FROM THE CABLE. INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT COULD RESULT IF ELECTRICAL ARCING OCCURS.

(a) Insert connector into P19 receptacle and energize external power cable.
(b) Observe that CONN and NOT IN USE lights on P19 illuminate and that GROUND POWER AVAILABLE light on electrical systems control panel P5 illuminates.

NOTE: NOT IN USE light will not illuminate when refuel panel door is open.

(3) Check that BUS TRANS switch on P5 is set to AUTO.
(4) Place BAT switch on P5 to ON.
(a) Observe that TRANS BUS OFF, BUS OFF, and GEN OFF BUS lights above GEN 1 and GEN 2 switches on P5 illuminate.
(5) Supply power to buses.

CAUTION: LIMIT LOAD ON EXTERNAL POWER SYSTEM TO 175A OR DAMAGE TO EXTERNAL POWER SYSTEM COMPONENTS MAY RESULT.

(a) Place AC meter selector switch on panel P5 to GRD PWR and observe that voltmeter reads 115 ±5 volts ac and frequency meter reads 400 ±10 Hz nominal.
(b) Apply power to 115V ac generator bus 1 and 115V ac generator bus 2 by placing GROUND POWER switch on P5 to ON. Observe that NOT IN USE light on P19 extinguishes and that TRANS BUS OFF and BUS OFF lights on P5 extinguish.

D. Remove power from buses.
(1) Place GROUND POWER switch on P5 to OFF.
(a) Observe that TRANS BUS OFF and BUS OFF lights on P5 illuminate.
(2) Place BAT switch on P5 to OFF.
(a) Observe that TRANS BUS OFF and BUS OFF lights on P5 extinguish and NOT IN USE light on P19 illuminates.

(3) Remove external power connector from external power receptacle. Observe that CONN and NOT IN USE lights on P19 extinguish and GROUND POWER AVAILABLE light on P5 extinguishes.

WARNING: BEFORE REMOVING EXTERNAL POWER CONNECTOR INSURE POWER HAS BEEN TURNED OFF AND NO RESIDUAL VOLTAGE IS PRESENT AT CONNECTOR. ELECTRICAL SHOCK COULD RESULT IF VOLTAGE IS PRESENT.

CAUTION: BEFORE REMOVING EXTERNAL POWER CONNECTOR INSURE POWER HAS BEEN TURNED OFF AND NO RESIDUAL VOLTAGE IS PRESENT AT CONNECTOR. DAMAGE TO EQUIPMENT MAY RESULT IF ELECTRICAL ARCING OCCURS.

(4) Close external power receptacle door.

E. Supply power to ground service buses only.
(1) Install external power cable per 2.C.(1),(2), and (3).
(2) Place GROUND SERVICE switch on forward attendant's panel P13 to ON.

NOTE: GROUND POWER switch overrides GROUND SERVICE switch and deactivates GROUND SERVICE switch when placed to ON.

F. Remove power from ground service buses.
(1) Place GROUND SERVICE switch to OFF.
(2) Remove external power cable per 2.D.(3) and (4).

3. Apply APU Generator Power
A. General
(1) APU power may be used to power 115V ac generator bus 1, 115V ac generator bus, or both buses.

CAUTION: LIMIT CURRENT DRAIN FROM GENERATOR TO 165 AMPS. FAILURE TO DO SO MAY RESULT IN DAMAGE TO GENERATOR.

B. Apply power to buses.
(1) Place BAT switch on electrical systems control panel P5 to ON.
(2) Check that BUS TRANS switch on P5 is set to AUTO.
(3) Start APU (Ref 49-11-0 MP).
(a) Observe that TRANSFER BUS OFF, BUS OFF, and GEN OFF BUS lights above both GEN 1 and GEN 2 switches on panel P5 illuminate.
(b) After 15-30 seconds to allow APU to reach normal operating speed, observe that APU GEN OFF BUS light on P5 illuminates.

(4) Place INDICATE/TEST switch on annunciator lights module M238 on load control center right P6 to TEST.
(a) Observe that HV, LV, FF, and MT lights located below APU on module M238 illuminate while switch is held in place and extinguish when switch is released.
(5) Press ERASE switch on module M238.
(6) Place AC meters selector switch on panel P5 to APU GEN.
(a) Observe that voltmeter reads 115 ±5 volts ac and that frequency meter reads 400 ±5 Hz with APU generator loaded.
(7) Apply power to 115V ac generator bus 1 by placing left APU GEN switch on panel P5 to ON and apply power to 115V ac generator bus 2 by placing right APU GEN switch to ON.
(a) Observe that TRANSFER BUS OFF, BUS OFF, and APU GEN OFF BUS lights on P5 extinguish.

C. Remove power from buses.
(1) Place both APU GEN switches to OFF.
(a) Observe that TRANSFER BUS OFF, BUS OFF, and APU GEN OFF BUS lights on P5 illuminate.
(2) Shutdown APU (Ref 49-11-0 MP).
(3) Place BAT switch on P5 to OFF.

4. Apply Engine-Driven Generator Power

A. General
(1) Engine-driven generator power may be used to power all buses except external power buses. Each ac generator bus may be powered individually with one engine operating.

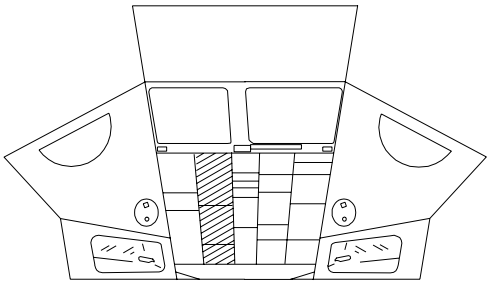
B. Apply power to buses.
(1) Place BAT switch on electrical systems control panel P5 to ON.
(2) Check that BUS TRANS switch on P5 is set to AUTO.
(3) Operate engine (Ref 71-09-100, Operating Procedure).
(a) Observe that TRANSFER BUS OFF, BUS OFF, and GEN OFF BUS lights above GEN1 switch on panel P5 when operating engine 1 and above GEN2 switch when operating engine 2 illuminate.
(b) Observe that LOW OIL PRESSURE light on P5 extinguishes.

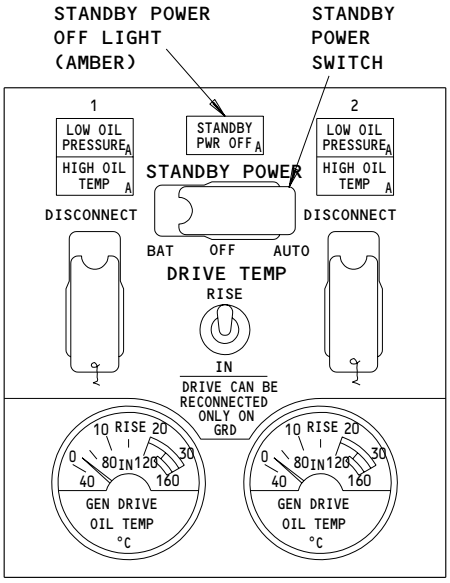
NOTE: Idle engine for 3 minutes to allow CSD to reach operating temperature.

(4) Place INDICATE/TEST switch on annunciator lights module M238 on load control center right P6 to TEST.
(a) Observe that HV, LV, FF, and MT lights located below GEN 1 for engine 1 or GEN 2 for engine 2 illuminate while switch is held in place and extinguish when switch is released.
(5) Press ERASE switch on M238 module.

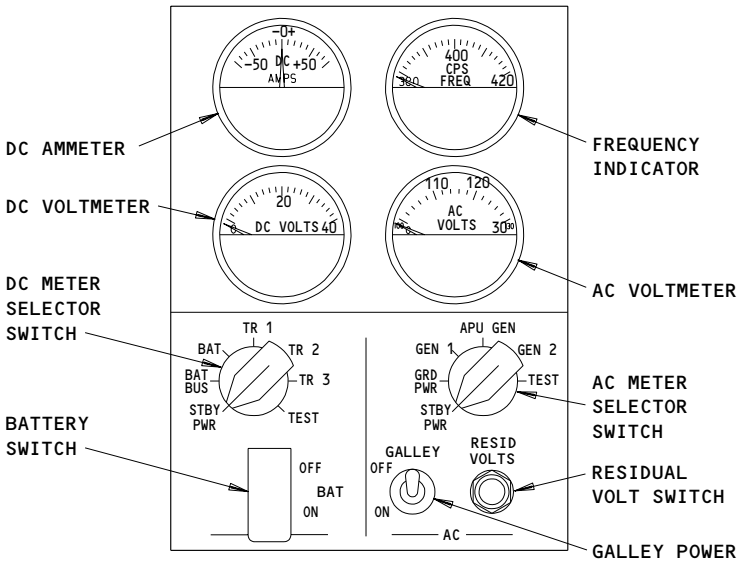
(6) Place AC meters selector switch on panel P5 to GEN 1 or GEN 2, as applicable.
  (a) Observe that voltmeter on panel P5 reads 115 ±5 volts ac and frequency meter reads 400 ±10 Hz nominal.
(7) With engine 1 operating, apply power to 115V ac generator bus 1 by placing GEN 1 switch to ON. With engine 2 operating, apply power to 115V ac generator bus 2 by placing GEN 2 switch to ON.
  (a) Observe that TRANSFER BUS OFF, BUS OFF, and GEN OFF BUS lights on P5 extinguish.

C. Remove power from buses.
(1) Remove power from 115V ac generator bus 1 by placing GEN 1 switch on panel P5 to OFF. Remove power from 115V ac generator bus 2 by placing GEN 2 switch to OFF.
  (a) Observe that TRANSFER BUS OFF, BUS OFF, and GEN OFF BUS lights on P5 illuminate.
(2) Shut down engine (Ref 71-09-100, Operating Procedure).
(3) Place BAT switch on P5 to OFF.

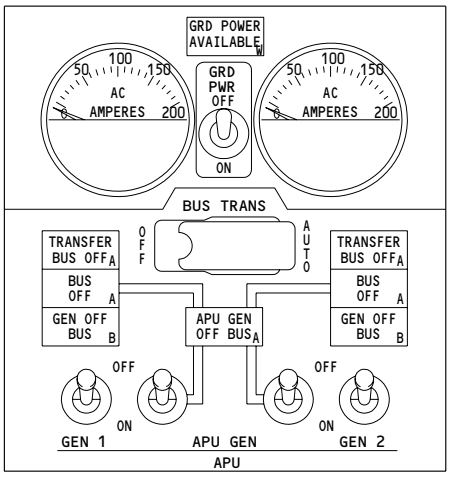




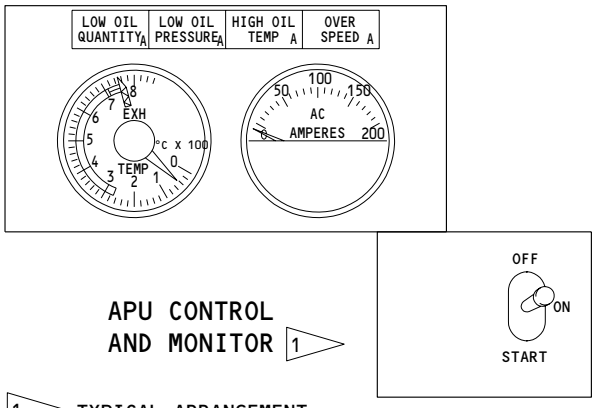
STANDBY POWER 1



ELECTRICAL POWER PANEL 1
(METERING)



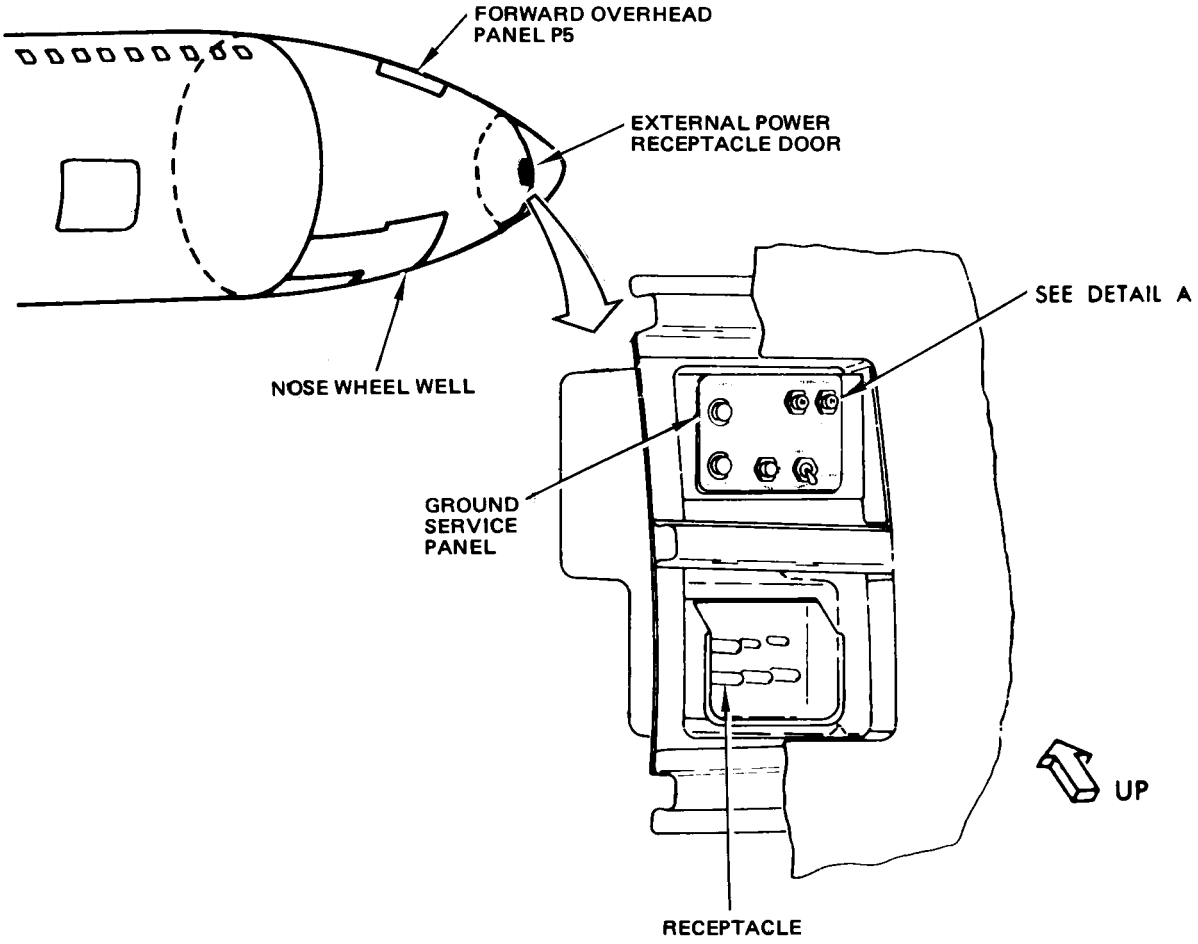
ELECTRICAL POWER PANEL 1
(CONTROLS)

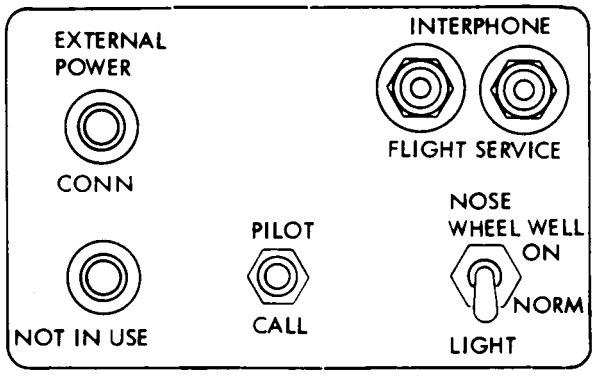


APU CONTROL AND MONITOR 1

1 TYPICAL ARRANGEMENT. SEE CHAPTER 31 FOR EXACT CONFIGURATIONS

Manual Control Component Location
Figure 201 (Sheet 1)



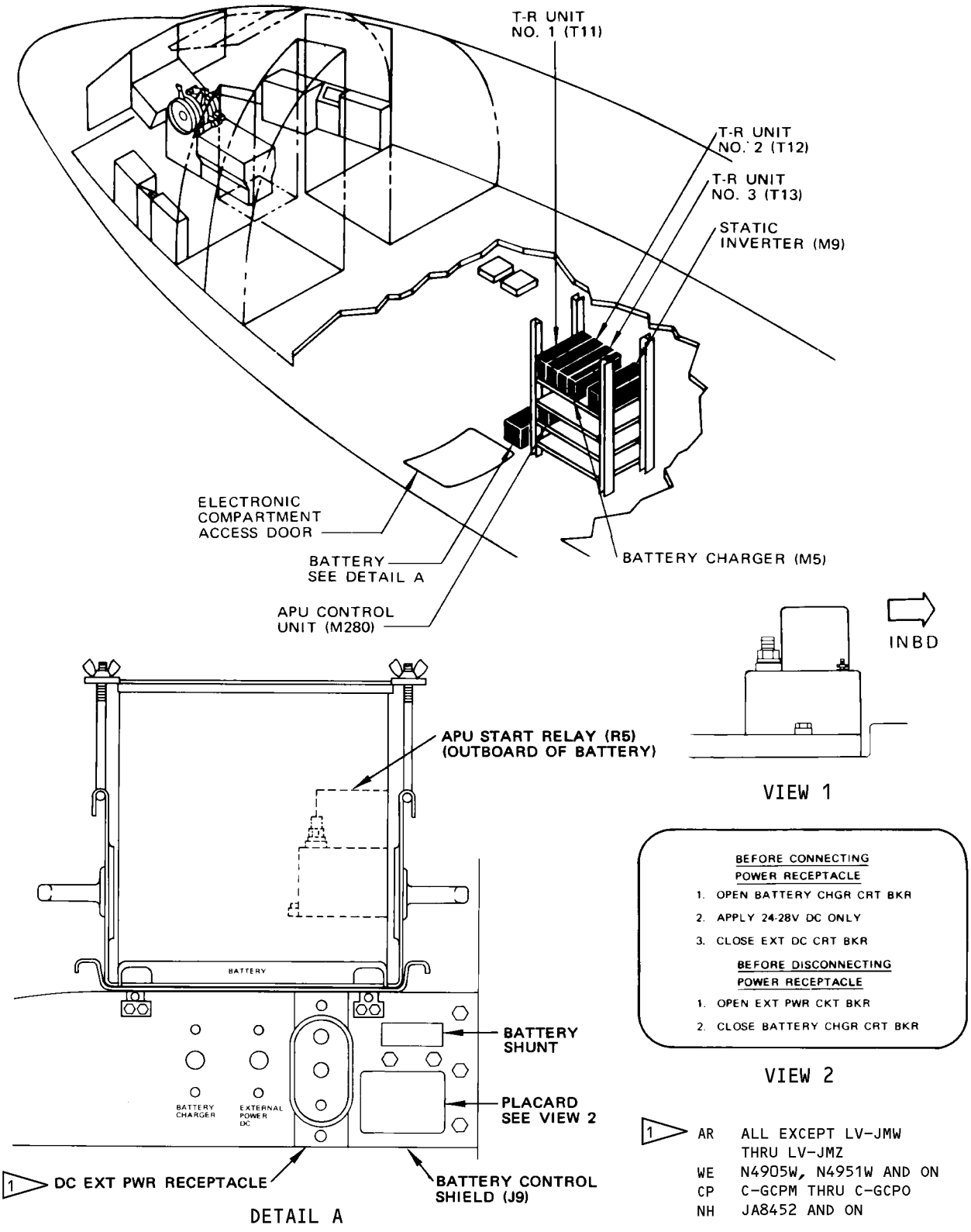


DETAIL A

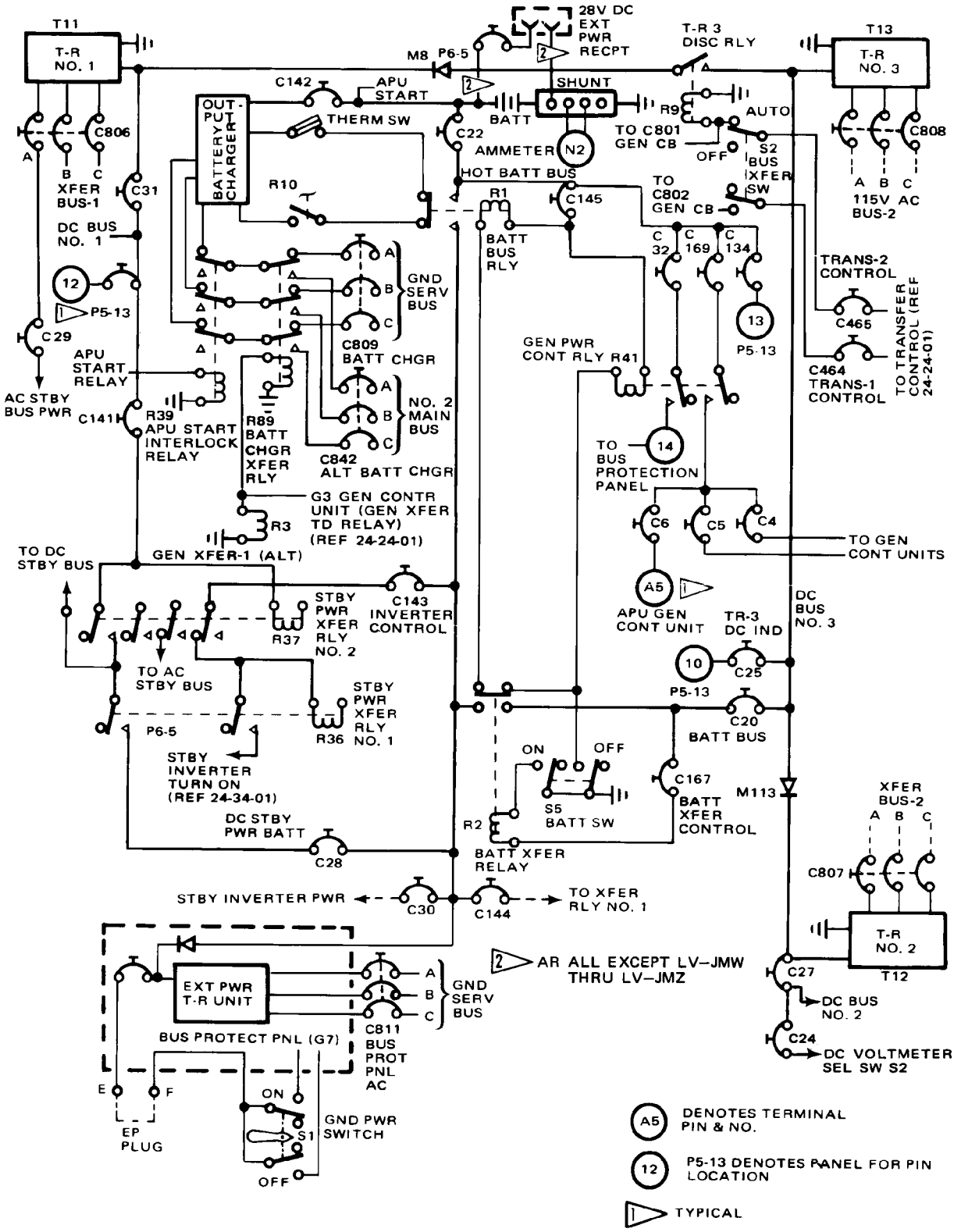
Manual Control Component Location
Figure 201 (Sheet 2)

DC GENERATION SYSTEM - DESCRIPTION AND OPERATION

1. General
   A. A portion of the 3-phase 400-cycle power on the aircraft is converted to 28-volt direct current by means of three unregulated silicone transformer-rectifier (T-R) units. This 28-volt dc power is required for the electrical system control circuits and for various dc components. A battery is used as a standby power supply for certain essential circuits and for short period dc loads when no basic power source is available. The standby power system obtains 115-volt single-phase 400-cycle power by converting battery power through a static inverter located in the lower forward compartment. Full wave rectifiers are located at various places in the aircraft to convert single-phase 115-volt ac power to 115 volts dc to supply receptacles used for electrical shavers.
   B. The three T-R units are located in the electronic compartment on shelf E3-1. (See figure 1.) T-R units No. 1 and No. 2 receive 3-phase, 115 volts ac from the No. 1 and No. 2 transfer busses respectively. (See figure 2.) T-R unit No. 3 is fed from the No. 2 generator bus, and provides dc through a dc tie bus to the 28-volt dc busses No. 1 and No. 2. The three T-R units have an output rating of 50 amperes at 28 volts dc.
2. Storage Battery
   A. A nickel-cadmium storage battery is located in the lower forward compartment to the right of the electric compartment access door. (See figure 1.) The battery receives power from a charger located on shelf E3-1 of the electrical rack adjacent to T-R unit No. 3. During normal operation the charger input is from the ground service bus through a circuit breaker and the APU start interlock relay R39. (See figure 2.) Should generator transfer relay-1 (ALT) R3 be energized, 3-phase power is transferred from generator bus-1 to generator bus-2 and the battery charger transfer relay R89 will also transfer 3-phase power from ground service to the No. 2 main bus. This provides an alternate power source for the battery charger should No. 1 generator bus fail. Since the ground service relay R6, in its relaxed position, connects the ground service bus to the No. 1 generator bus, the battery may be charged from all four 3-phase 400-cycle sources. Refer to 24-41-0.



dc Power System Component Location
Figure 1



dc Power Generation Circuit
Figure 2

3. Battery Charging Unit

A. The battery-charging unit is a regulated system designed to charge nickel-cadmium batteries. The charger is a limited pulse-type charger, which operates from a power source of 200 volts, 400 Hz, 3-phase, Y-system, 115 volts phase to neutral. The charger has two operating modes, which are functions of battery temperature and are externally controlled by a temperature switch located on the battery. In addition to the external mode control (temperature switch), the charger has an internal mode control which causes the charger to operate in the normal mode for only a limited time after pulsing has begun. After this limited time, pulsing ceases and the charger operates in the high temperature mode. Pulsing begins when the battery approaches the fully charged condition and the charger output current is approximately 16 amperes. The output voltage regulation curve changes slope at this point (Fig. 3). The charger is located in the electrical/electronic equipment compartment on shelf E3-1. The charger should not be operated with the output shorted or without some load.

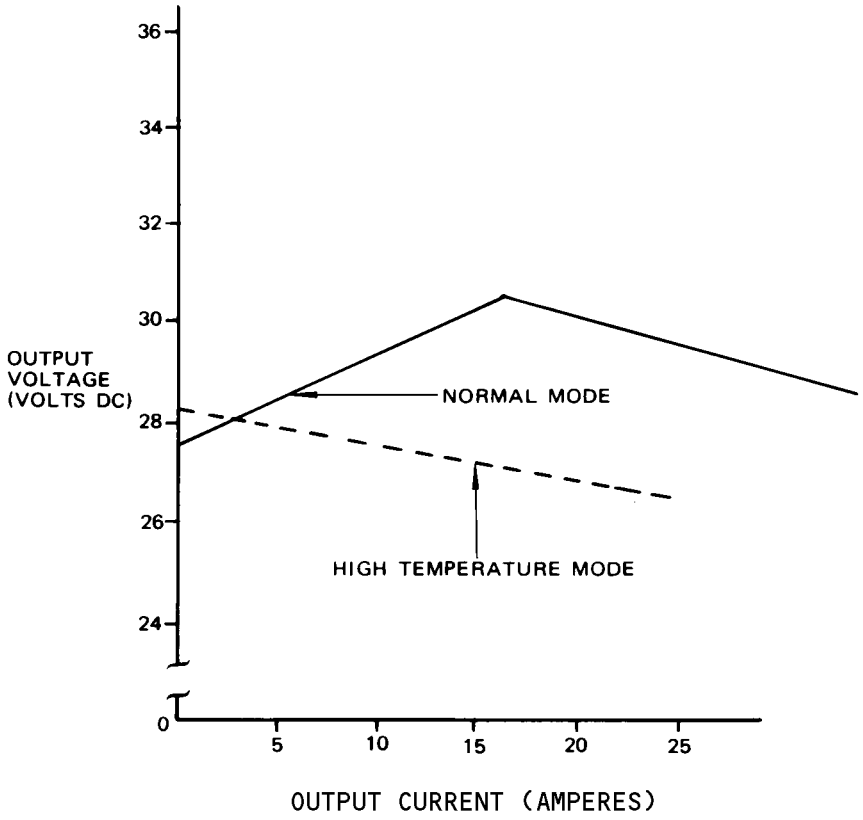
B. The charger operating modes are functions of either battery voltage or battery case temperature. Temperature is sensed by a thermal switch located on the battery. The thermal switch is a bimetallic element, which is held against the battery case by a spring. A high battery voltage, which results from the battery being fully charged, causes the charger output to pulse for a limited time and then go into the high temperature-operating mode. The two modes of charger operation are described in the following paragraphs (Fig. 3):

(1) The normal mode (battery temperature less than 115°F) provides rapid charging of the battery. The charger output is illustrated by the triangular plot in Fig. 3. Above approximately 16-ampere current, the charger acts like a normal unregulated transformer- rectifier supply. When the battery has sufficient charge so that charging current goes below 16 amperes, the charger provides the battery with a pulse charge for 90 to 170 seconds. The internal mode control then switches the charger to the high temperature mode.

(2) The charger uses the high temperature mode when the battery case temperature is above 115°F and also, when the battery is fully charged. Charger output in the high temperature mode is considerably less than when in the normal mode. A nearly constant voltage is provided through a current range of 0 to 25 amperes.

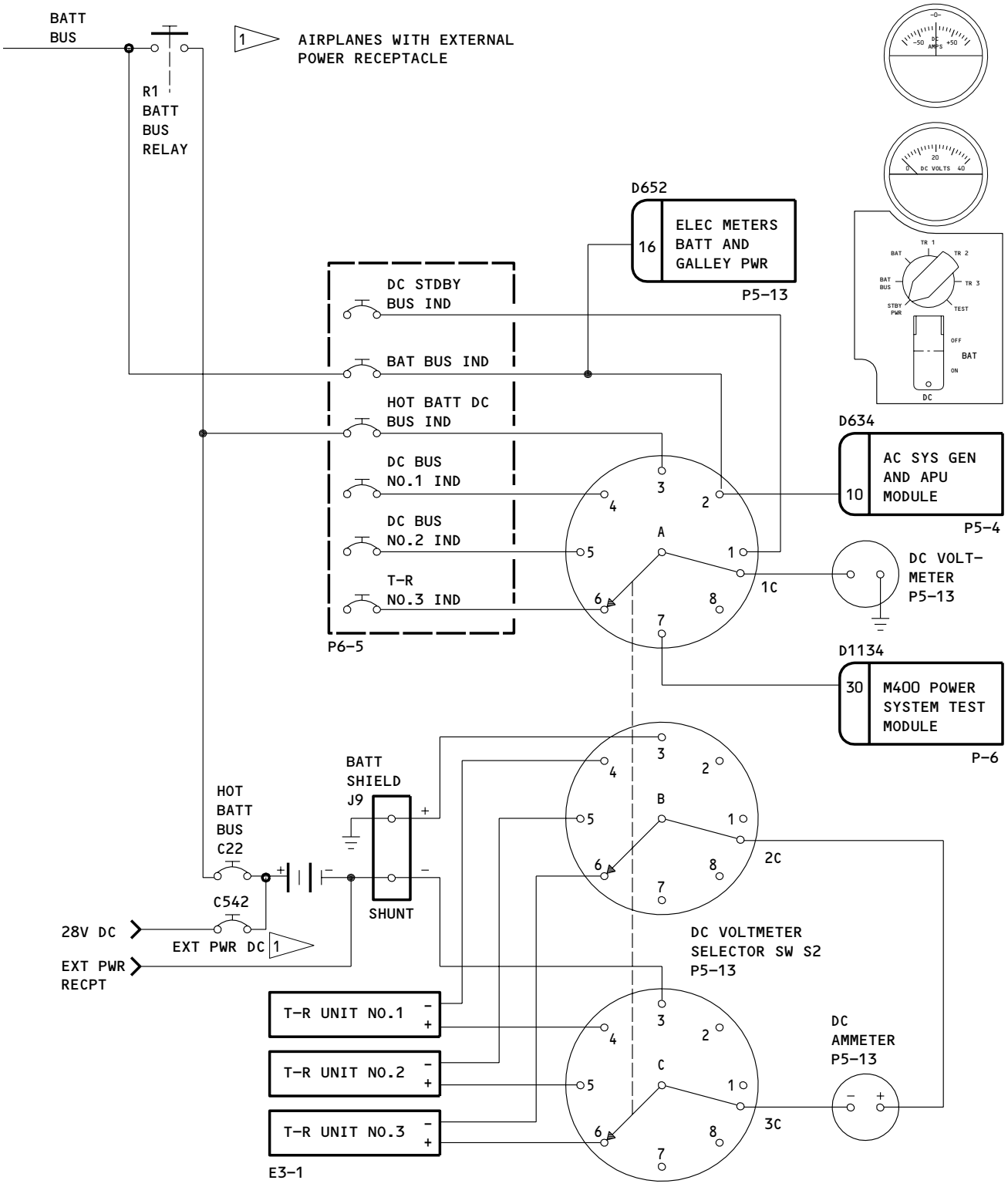
C. A momentary interruption of the input 3-phase voltage for more than 1 second causes the charger to pulse for 90 to 170 seconds and then switch to the high temperature mode.

D. When the battery switch is positioned to ON, battery bus relay R1 (Fig. 2) momentarily energizes through R2 to signal the battery charger. The battery charger now supplies the necessary output to maintain the battery at the new loads on the battery bus.



Battery Charger Modes of Operation
Figure 3

4. DC Indication
   A. A dc ammeter and a voltmeter are located on the forward overhead panel (P5). The ammeter operates in conjunction with special shunts in the negative or grounded connection to the airplane battery, and in the output circuits of the three T-R units. Airplanes incorporating SB 24-1027 have battery meter shunt replaced with wire bundle having critical length battery ground wire calibrated to serve as a shunt for dc ammeter. The ammeter may also be used to determine any current drain on the battery and to observe the performance of the battery charger. The dc voltmeter is used in conjunction with the same three wafer selector switch which enables voltages to be observed on dc buses No. 1, 2, and 3, or the output voltages of T-R units 1, 2, and 3 (Fig. 4). Positions on the selector switch on the forward overhead panel enable voltages to be observed on such buses as dc standby, battery and hot battery. The seventh or TEST position on the selector switch obtains a positive dc connection through the M400 power system test module. This enables functional tests to be made using the dc indicators.
5. DC External Power (AR ALL EXCEPT LV-JMW thru LV-JMZ)
   A. A dc external power receptacle permits connecting a 28-volt direct current ground supply to the battery circuit. The connection is made by inserting a three-pin plug into a mating receptacle located below the airplane battery on the control shield (J9) (Fig. 1). A placard is placed near the receptacle, which gives the procedure to be followed when connecting or disconnecting a dc external power supply. With the dc supply properly connected to the external power plug pins, the storage battery may remain connected or removed during application of external power. A circuit breaker is provided in the positive line to the receptacle to be used as called for on placard.
6. System Operation
   A. A converted power supply derived from two transformer-rectifier (T-R) units is the principal source of 28 volts dc. These units are backed up by a third T-R. T-R 3 is arranged to supply power to both the No. 1 and No. 2 dc buses (Fig. 2).
   B. When the bus transfer switch (S2) is in the AUTO position and the No. 2 transfer relay (R4) normal coil is energized, the T-R 3 disconnect relay (R9) is also energized and connects T-R 3 to the No. 1 dc bus.



dc Power System Indicators
Figure 4

DC GENERATION SYSTEM - ADJUSTMENT/TEST

1. Test DC Generation System Operation
   A. Test Battery Control and Indicator Circuits Using Airplane Battery

      NOTE: To obtain an indication from the M238 module, place IND-TEST switch (S2) in IND position.

      (1) Remove electrical power from airplane and set BAT switch and STANDBY POWER switch to OFF.
      (2) Open all dc circuit breakers on P6-5 and P6-6 panels except leave the following closed:
          (a) HOT BAT BUS (C22) on P6-6
          (b) DC BUS INDICATION HOT BAT (C134) on P6-5
      (3) Set dc meters selector switch to BAT and check that dc voltmeter indicates 26 ±4 volts.
      (4) Close the following circuit breakers:
          (a) BAT BUS CONT (C145) on P6-5
          (b) DC BUS INDICATION BAT (C26) on P6-5
      (5) Set BAT switch to ON and check that BATT light on electrical power annunciator module M238 comes on.
      (6) Set dc meters selector switch to BAT BUS and check that dc voltmeter indicates 26 ±4 volts.
      (7) Set BAT switch to OFF.
      (8) Check that BATT light on M238 goes off and the dc voltmeter indicates zero.

   B. Test Bus Protection Panel TR Unit Circuit

      NOTE: To obtain an indication from the M238 module, place IND-TEST switch (S2) in IND position.

      (1) Check that EXTERNAL POWER BUS PROT PANEL AC (C811) and EXTERNAL POWER GRD SERVICE (C812) circuit breakers on P6-12 panel are closed.
      (2) Provide external power to the airplane and check that the following lights are on.
          (a) EXTERNAL POWER CONN light on external power panel P19.
          (b) GRD POWER AVAILABLE light on overhead panel P5-4.
          (c) EXT PWR TR light on M238.
          (d) EXTERNAL POWER NOT IN USE light on external power panel P19.

   C. Test No. 3 TR Unit Circuit

      NOTE: To obtain an indication from the M238 module, place IND-TEST switch (S2) in IND position.

(1) Close BAT BUS (C20), DC BUS INDICATION TR NO 3 (C25), BAT TRANS CONT (C167), and FUELING & EXT PWR CONT (C32) circuit breakers on panel P6-5.
(2) Check that NO 1 TRANS CONT (C464), NO 2 TRANS CONT (C465), and TR UNITS NO 3 (C808) circuit breakers on panel P6-4 are closed; check that NO 2 GEN BUS MAIN DISTRIBUTION (C817) circuit breaker on panel P6-12 is closed.
(3) Set BAT switch to ON.
(4) Set GRD PWR switch to ON. Check that EXTERNAL POWER NOT IN USE light on external power panel P19 goes off and TR3 light on M238 comes on.
(5) Check that BATT light on M238 is on.
(6) Check that dc voltmeter indicates 26 ±4 volts when meters selector switch is set to TR 3 and BAT BUS.
(7) Open HOT BAT BUS (C22) circuit breaker on panel P6-6. Check that dc voltmeter reads 26 ±4 volts when selector switch is set to BAT BUS and zero when set to BAT.
(8) Set BAT switch to OFF. Check that BATT light on M238 goes off and dc voltmeter reads zero when selector switch is set to BAT and BAT BUS.
(9) Open TR UNITS NO 3 (C808) circuit breaker and check that TR3 light on M238 goes out.
(10) Set BAT switch to ON. Set meters selector switch to TR3 and check that voltmeter reads 0-1 volt.

D. Test No. 1 and 2 TR Units Circuits and Control

NOTE: To obtain an indication from the M238 module, place IND-TEST switch (S2) in IND position.

(1) Check that the following circuit breakers are closed:
  (a) CONTROL GENERATOR NO 1 (C4), CONTROL GENERATOR NO 2 (C5), CONTROL GENERATOR APU (C6), TR UNITS NO 1 (C806) on P6-4.
  (b) DC BUS POWER NO 1 (C31) and DC BUS INDICATION BUS NO 1 (C23) on P6-5.
  (c) HOT BAT BUS (C22) on P6-6.
  (d) TRANSFER BUS NO 1 NORMAL (C819) and NO 2 ALT (C822) on P6-11.
(2) Open TR UNITS NO. 2 circuit breaker (C807) on P6-4, and TRANSFER BUS NO 2 NORMAL (C821) on P6-12.
(3) Check that NO. 1 light on M238 is on.
(4) Set dc selector switch to TR 1.
  (a) Check that voltmeter indicates 26 ±4 volts.
  (b) Check that ammeter indicates load is present.
  (c) Check that NO 2 and TR3 lights on M238 do not come on.
(5) Close DC BUS POWER NO 2 (C27) and DC BUS INDICATION BUS NO 2 (C24) circuit breakers. Check that NO 2 and TR3 lights on M238 do not come on.

(6) Open TR UNITS NO 1 (C806) circuit breaker and check that NO 1 light goes out and that the voltmeter and ammeter read zero.
(7) Check that TR UNITS NO 2 (C807) circuit breaker on P6-4 and TRANSFER BUS NO 2 NORMAL (C821) circuit breaker on P6-12 are closed. Check the following:
  (a) NO 1 light on M238 remains out.
  (b) Voltmeter indicates zero (selector switch set to TR 1).
  (c) NO 2 light on M238 illuminates.
(8) Set dc meters selector switch to TR 2.
  (a) Check that the voltmeter indicates 26 ±4 volts.
  (b) Check that the ammeter indicates a load is present.
(9) Open TR UNITS NO 2 (C807) circuit breaker on P6-4.
  (a) Check that NO 2 light on M238 goes off and the voltmeter reads zero.

E. Test No. 3 TR Unit/Battery Bus Transfer Circuits and Control

NOTE: To obtain an indication from the M238 module, place IND-TEST switch (S2) in IND position.

(1) Check that BUS TRANSFER switch is set to AUTO.
(2) Close TR UNITS NO 3 (C808) circuit breaker on P6-4.
  (a) Check that NO 1, NO 2, and TR3 lights on M238 come on.
  (b) Check that dc voltmeter reads 26 ±4 volts when dc meters selector switch is set to TR 1, TR 2, and TR 3.
(3) Set BUS TRANSFER switch to OFF.
  (a) Check that NO 1 light on M238 goes off.
(4) Open TR UNITS NO 3 (C808) circuit breaker on P6-4.
  (a) Check that TR3 and NO 2 lights on M238 go off.
  (b) Check that BATT light on M238 remains on.

F. Test External DC Power (Airplanes with external dc power receptacle)
(1) Connect external dc power to battery control shield per placarded instructions and close EXTERNAL POWER DC (C542) circuit breaker on J9.
(2) Disconnect connector from airplane battery and isolate connector from structure.

CAUTION: HANDLE CONNECTOR CAREFULLY WHILE VOLTAGE IS APPLIED.

(3) Check that APU can be started from external dc power (Ref. 49-11-0, MP).

G. Restore Airplane to Normal
(1) Remove external dc power and connect battery connector.
(2) Close all circuit breakers remaining open on P6-4, P6-5, and P6-6 panels.
(3) Set BUS TRANSFER switch to AUTO and STANDBY POWER switch to AUTO.
(4) Remove external power if no longer needed (Ref. 24-22-0, MP).

(5) Set battery switch to OFF.

STORAGE BATTERY (NICKEL-CADMIUM) - SERVICING

1. General
   A. The nickel-cadmium storage battery must be serviced at regular intervals determined by operating conditions. The quantity of water consumed by the battery is determined by operating methods and ambient temperatures.
   B. Electrolyte level rises when the battery charges and lowers when the battery discharges. Distilled or demineralized water should be added to battery cells only when battery is fully charged.
   C. The only battery servicing allowed while the battery is on the airplane is checking electrolyte level, adding electrolyte, and cleaning spilled electrolyte.
   D. Safety Precautions
      (1) Keep any metallic objects such as tools; wire brushes, etc., away from exposed top of battery. Short circuits caused by such objects would be dangerous to personnel.
      (2) Remove spilled electrolyte from hands, clothing or other material immediately with water or 3 percent boric acid solution.
      (3) Never use hydrometers, droppers, syringes, or other tools on a nickel-cadmium battery, which have been in contact with a lead-acid battery.
      (4) Always allow battery to stand idle for 2 to 4 hours with vent caps loosened after being charged so that all gas may escape before adjusting electrolyte level.
      (5) Add only distilled or demineralized water to battery cells. Do not overfill battery.
      (6) Avoid spilling of electrolyte used in nickel-cadmium battery on airplane structure. In event of spillage refer to Corrosion Prevention Manual, Part I section 20-43-00 for approved methods of corrosion removal procedure.

          CAUTION: BATTER ELECTROLYTE SPILLAGE SHOULD BE REMOVED AS SOON AS POSSIBLE. IF NOT REMOVED IT CAN CAUSE CORROSIVE DAMAGE TO AIRPLANE STRUCTURE.

2. Equipment and Materials
   A. Distilled or demineralized water
   B. Liquid measuring container calibrated in cubic centimeters
   C. Dropper or syringe with small or finely drawn nozzle
   D. Polystyrene tube (open at both ends) approximately 6 inches long x 1/8 inch inside diameter.
3. Service Storage Battery

   NOTE: Perform following procedure as soon as possible after last flight before battery is to receive normal periodic servicing.

A. Determine battery state of charge.
   (1) Position DC METERS SWITCH on electrical systems control panel P5 to BAT.
   (2) Place BAT switch on P5 to ON.
   (3) Apply APU or engine driven power to 115V AC ground service bus (generator bus No. 1). Verify that external power is not connected to external power receptacle.
   (4) Open BATTERY CHARGER circuit breaker on P6-4 panel and close after a 2 second delay.
   (5) Observe dc ammeter on P4 upper panel. Battery is fully charged when charger has pulsed for 2 minutes.
   (6) Observe dc ammeter on P4 upper panel. Battery is fully charged when charger has pulsed for 2 minutes.

CAUTION: DO NOT ADD WATER UNLESS BATTERY IS FULLY CHARGED.

NOTE: When pulsing ceases, charge will switch on high temperature mode and charge at approximately 1/2 to 2 amperes.

B. Move BATTERY switch to OFF, disconnect battery from airplane system, and remove battery from battery shelf (Ref 24-31-11, R/I). Remove battery cover.

C. Check electrolyte level.
   (1) After battery is fully charged, wait 2 to 4 hours before checking electrolyte level. If time does not permit a 2 to 4 wait, check electrolyte level immediately after battery is fully charged.
   (2) Insert polystrene tube into filler opening. Touch top of plastic insert with tube.
   (3) Cover top of tube with index finger and remove tube from filler opening.
   (4) Electrolyte level in bottom of tube should be 3/4 inch immediately after battery is fully charged or 5/8 inch 2 to 4 hours after battery is fully charged.
   (5) Add distilled or demineralized water to bring electrolyte to proper level. Adjustments in electrolyte level may be made with a dropper or syringe. Measure water added to each cell. Do not overfill.

CAUTION: DO NOT CHECK BATTERY OR ADD WATER TO BATTERY USING EQUIPMENT OR WATER CONTAMINATED WITH LEAD-ACID BATTERY ELECTROLYTE.

NOTE: If more than 35 cubic centimeters or water per cell is being added during flight line servicing, the interval between services is too long. A cell that requires 45 or more cubic centimeters of water to bring to the required level should be suspected of being defective.

D. Replace battery cell filler caps and battery cover, install and connect battery to airplane system (Ref 24-31-11, R/I).

CAUTION: DO NOT LEAVE CELL FILLER CAPS OFF FOR EXTENDED PERIODS OF TIME AS BATTERY MAY BECOME CONTAMINATED.

E. Repeat 3.A.(1) thru (4) to verify battery is properly connected and fully charged.

STORAGE BATTERY (NICKEL-CADMIUM) - REMOVAL/INSTALLATION

1. General
   A. The battery is on a tray in the electronic equipment compartment to the right of the electronic compartment access door. The battery is vented to ambient by a louvered cover. A 115°F temperature switch is on right-hand side of the battery shelf (Fig. 401). Before installing the battery the temperature switch must be in the center of the mount so that the flat surface of the switch will contact the battery case.
2. Remove Storage Battery (Nickel-Cadmium)
   A. Move battery switch on forward overhead panel to OFF position.
   B. Disconnect battery cable connection by loosening hand knob and lifting plug off terminal pins.
   C. Loosen and lower the two knurled holddown knobs.
   D. Remove battery (with cover in place) in the battery holder.
   E. Loosen wing nuts and remove battery from battery holder.
3. Install Storage Battery (Nickel-Cadmium)
   A. Place battery (with cover in place) in battery holder and secure with wing nuts and T bolts.

      CAUTION: ENSURE PROPER COVER ALIGNMENT. IMPROPER ALIGNMENT WILL RESULT IN CELLS NOT BEING HELD DOWN PROPERLY. BEFORE INSTALLING BATTERY, CHECK THAT TEMPERATURE SWITCH IS CENTERED IN MOUNT SO THAT FLAT SURFACE OF SWITCH WILL CONTACT BATTERY CASE WHEN BATTERY IS INSTALLED.

   B. Place battery in holder on battery tray, and slide battery into position against temperature switch (Fig. 401).

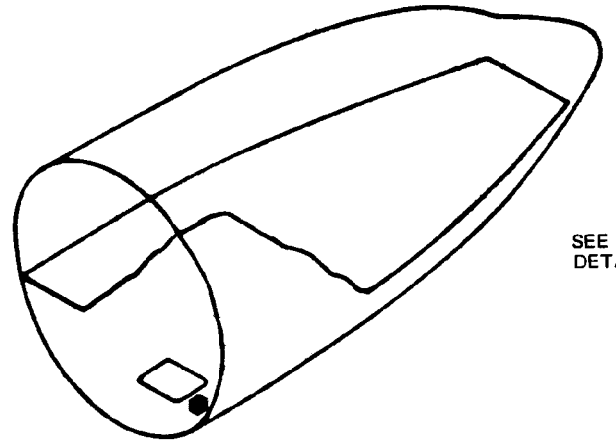
      NOTE: Switch may become cocked in mounting bracket. Check that flat heating surface of switch is against battery case.

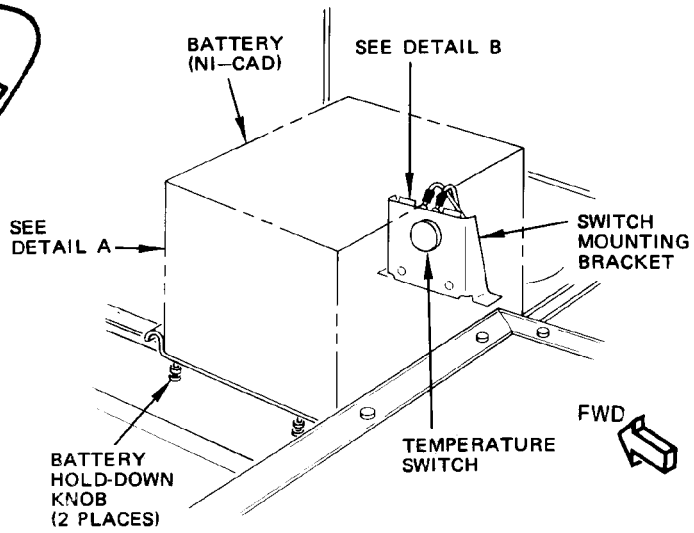
   C. Swing the two knurled battery hold-down knobs up into position and tighten.
   D. Inspect battery connector for signs of arcing, pitting and corrosion. If signs exist, remove and replace connector.

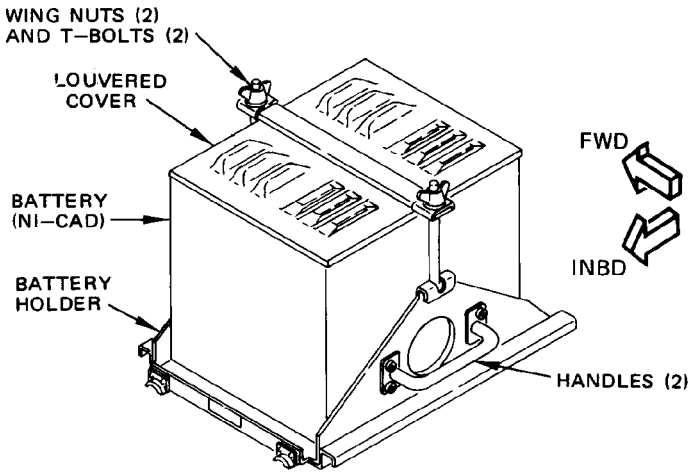
      NOTE: Pitted/corroded battery connector can cause excessive draining of the battery.

   E. Connect battery by pressing plug onto terminal pins and tightening hand knob.

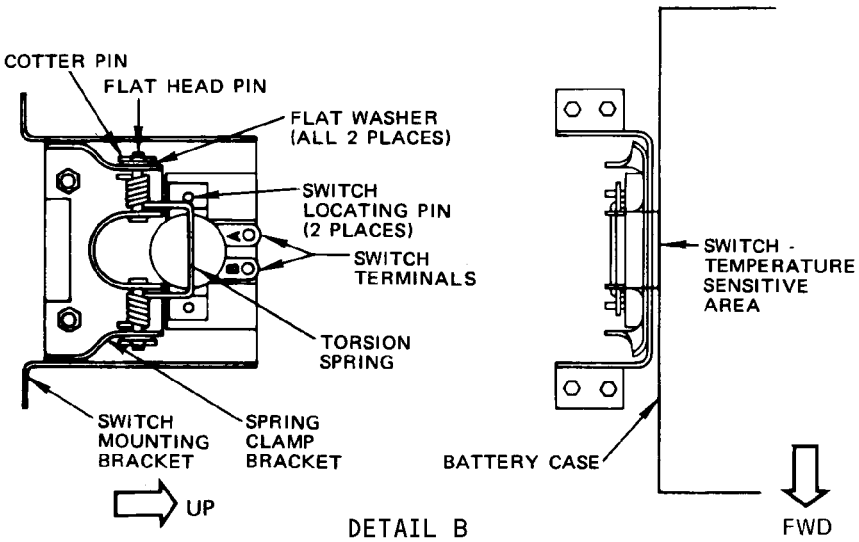
F. Test battery by opening the input breaker for TR unit No. 3, setting battery switch to ON, turning dc meter selector switch on forward overhead panel (P5) to BAT and noting that dc voltmeter reads approximately 24 volts and dc ammeter reads the discharge current of the applied battery bus load. Restore all circuit breakers and note battery charging current on the dc ammeter if ac power is on the airplane buses.
G. Set battery switch to OFF.







DETAIL A



DETAIL B

Battery Installation
Figure 401

STORAGE BATTERY (NICKEL-CADMIUM) - ADJUSTMENT/TEST

1. Storage Battery Test
   A. General
      (1) The three-phase input to the battery charger is obtained from the 115-volt ac ground service bus, or from the No. 2 main bus through the alternate battery charger circuit breaker. The three generators, external power, or the APU may be used for charging the battery.

          NOTE: External power can be used to charge the battery but cannot be used to test the battery. Upon application of external power, refuel relay R10 opens and causes the charger to operate in the high temperature mode. The charger does not pulse in the high temperature mode.

   B. Equipment and Materials
      (1) DC ammeter - 0- to 100-milliamp range
      (2) Resistor - 50 ohms
      (3) Power supply - 50 volts dc
   C. Test Nickel-Cadmium Storage Battery
      (1) Determine that battery is fully charged by observing battery charger pulsing while charging from APU or engine generator.

          NOTE: Battery normally will be charged if the airplane has recently terminated a flight and the battery was not used to operate equipment. With a limited pulse type charger, pulsing will start again if battery charger circuit breaker is opened and then closed, and battery is fully charged. Pulsing with a limited pulse type charger will continue only for approximately 2 minutes.

          (a) Start APU and apply power to all main ac buses. Disconnect external ac power cord from airplane.
          (b) Turn dc meter selector switch on forward overhead panel to BAT.
          (c) Open battery charger circuit breaker on P6-4 panel and close after a 2-second delay.
          (d) Observe battery voltage and charge current on dc meters. Meters should be pulsing if battery is fully charged.

              NOTE: Battery bus and hot battery bus circuit breakers on right load control center panel P6 must be closed to obtain a voltage indication.

(2) Allow battery to charge if not fully charged. A slowly decreasing indication of more than 16 amperes is a normal rate of charge.

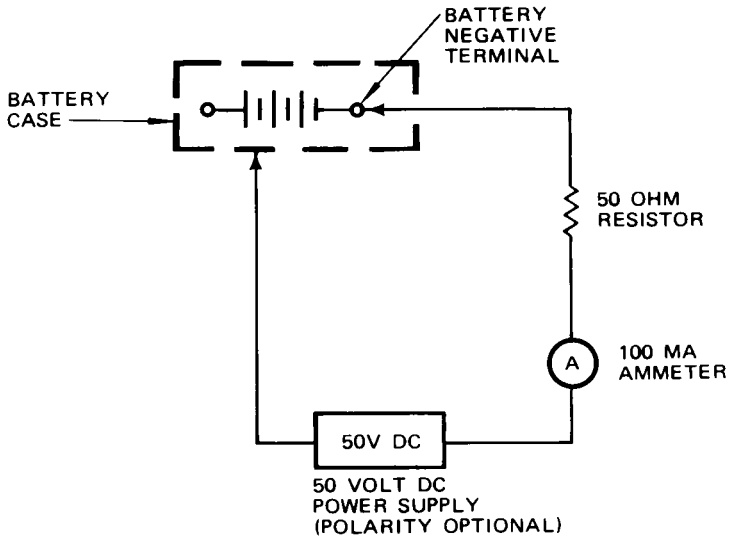
NOTE: Charge current may initially be quite high but should gradually reduce. If, after about 45 minutes for a discharged battery, pulsing has not started, remove battery.

In temperatures of 110°F or over, a discharged battery should be removed for recharging in a cool area, to prevent excessive gassing.

(3) Check leakage between battery cells and case (batteries with non-insulated steel cases).

CAUTION: BATTERIES WITH INSULATED CASES ARE NORMALLY NOT SUBJECT TO ELECTRICAL LEAKAGE BETWEEN CELLS AND CASE. HOWEVER, CARE MUST BE EXERCISED TO ELIMINATE ELECTROLYTE SPILLING ON BATTERY CASE; OTHERWISE LEAKAGE MAY OCCUR.

(a) Disconnect battery cable connection by loosening hand knob and lifting plugs off terminal pins.
(b) Connect 50-ohm resistor, 100-milliamp ammeter, and 50-volt dc power supply per figure 501.
(c) Place one probe of test apparatus to battery negative terminal pin and the other probe to battery case.
(d) Observe that current leakage does not exceed 50 milliamps. Maximum allowable current leakage is 50 milliamps.
(e) If leakage rate exceeds 50 milliamps, remove battery, flush with clean tap water and dry thoroughly in the sun or by applying forced warm air. Recheck leakage rate before reinstalling battery in airplane.



Battery Cell-to-Case Leakage Test
Figure 501

STORAGE BATTERY (NICKEL-CADMIUM) - INSPECTION/CHECK

1. Storage Battery (Nickel-Cadmium) Check
   A. General
      (1) To permit a complete examination of the storage battery, it is recommended that it be removed from the airplane. Removal will also permit examination of supporting parts such as the battery tray, cover and temperature switch.
   B. Check Storage Battery (Nickel-Cadmium)
      (1) Move battery switch to OFF and disconnect battery from the airplane system, and remove battery. Refer to Storage Battery (Nickel-Cadmium) - Removal/Installation.
      (2) Check general condition of the battery to locate any mechanical damage or evidence of spilled electrolyte. Spilled electrolyte wil1 require battery to be cleaned and may be an indication of cel1 damage. Refer to Storage Battery (Nickel-Cadmium) - Cleaning/Painting.
      (3) Check that color of cell separators is white. Salmon or brown colored separators are defective and should be removed. If separators are defective, return battery for overhaul.
      (4) Check for cloudy or colored electrolyte. This could indicate electrolyte contamination or damaged plates and separators.
      (5) Inspect rubber insulating liner bonded to underside of cover and insulating sleeves around intercell connecting links. If wear is noted, return to overhaul shop for replacement to prevent possible battery shorting.
      (6) Check for loose or corroded connections from battery through circuit breakers to busses and shunt.
         (a) Repair or replace defective connecting parts as required.
      (7) Check that electrolyte is up to a point 3/4 inch above the plastic insert immediately after charging or 5/8 inch above the insert 2 to 4 hours after charging. If not, add distilled water. Refer to Storage Battery (Nickel-Cadmium) - Servicing.

STORAGE BATTERY (NICKEL-CADMIUM) - CLEANING/PAINTING

1. Battery Cleaning
   A. General
      (1) Battery cells generate gas as indicated by bubbling during and for some time after a charge. The fine spray of water and potassium hydroxide (KOH), which escapes with the gas through the vents, reacts with the carbon dioxide in the air and deposits white crystals of potassium carbonate on the cell tops. This is not corrosion nor does it contain any corrosive properties.
   B. Equipment and Materials
      (1) Pail with clean tap water
      (2) Clean cloth
      (3) Nonmetallic brush
   C. Clean Battery
      (1) Remove crystalline deposits of potassium carbonate from battery, battery case, and cover with damp cloth and nonmetallic brush.
      (2) Wash entire battery with clean tap water and dry with clean cloth and dry air. Also clean and dry battery tray and support .

          NOTE: Keep all utensils and tools used on lead-acid batteries away from nickel-cadmium batteries.

BATTERY CHARGER UNIT - ADJUSTMENT/TEST

1. General
   A. The battery charge is maintained by a pulse-type battery charger (M5) capable of supplying 25 amperes continuously. The battery charger, located on E3-1 electrical shelf, uses 3-phase, 400 cps input power. A battery must be installed in the airplane as a part of the following tests. Battery charger output modes are tested.
   B. Equipment and Materials
      (1) Heat Gun
2. Battery Charger Test
   A. Test Charging Mode (Pulse Mode, Normal Mode)
      (1) Apply APU or engine-driven generator electrical power to 115V AC ground service bus (generator bus No. 1) (Ref. 24-22-0). Disconnect external power from airplane.
      (2) Set dc meter selector switch on P5 panel to BAT. The battery should charge as indicated by the dc ammeter.

          NOTE: External power may be used to charge battery; however, charger will not pulse when battery is charged. If external power is used to charge battery, switch to APU or engine-driven generator power before proceeding with test and disconnect external power from external power receptacle.

      (3) When battery is fully charged, charger will pulse. This pulsing is indicated by the dc ammeter swinging from zero amperes to more than 13 amperes every 1 to 60 seconds. The charger should pulse for only 1 to 3 minutes after battery has reached full charge. The charging cycle may be reinitiated for test purposes by opening BATTERY CHARGER circuit breaker on P6-4 panel to cut off input to the charger for 1 second and then closing the circuit breaker.
      (4) Remove electrical power if no longer required (Ref. 24-22-0).
   B. Test Constant Potential Mode (High Temperature Mode)
      (1) Establish condition 2.A.(3).
      (2) Open BATTERY BUS circuit breaker on P6-5. Check that charger stops pulsing, as shown by a steady current reading on the ammeter.
      (3) Close BATTERY BUS circuit breaker. Check that charger resumes pulsing per 2.A.(3).
      (4) On airplanes with a standby bus, relay, M328:
          (a) Set STANDBY POWER switch to BAT and check that charger stops pulsing as in (2).
          (b) Set STANDBY POWER switch to AUTO to restore normal operation.
      (5) Remove electrical power if no longer required (AMM 24-22-0).
   C. Test Battery Thermal Switch
      (1) Place battery switch to OFF and remove external power contactor from airplane.

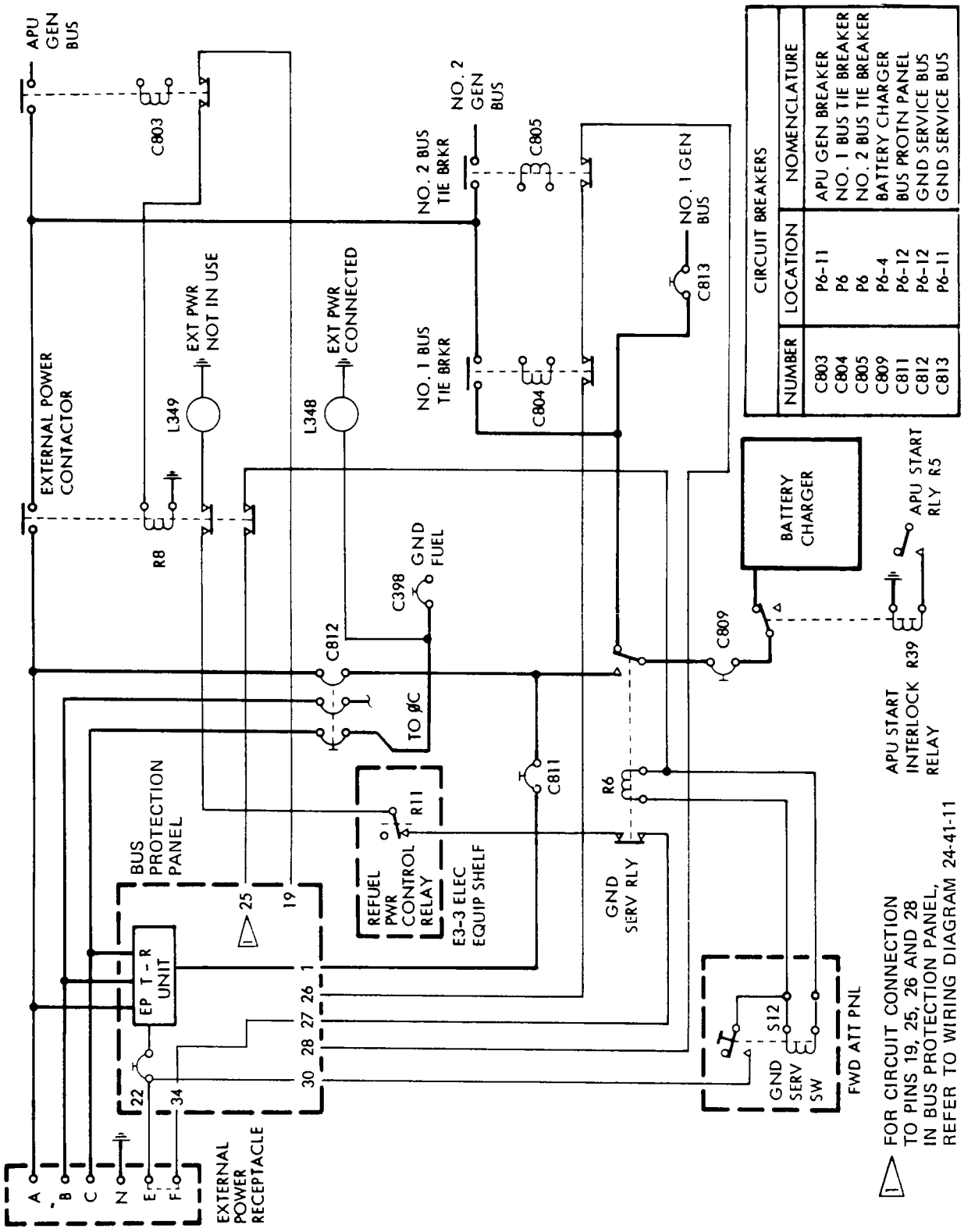
(2) Remove battery charger and check that resistance between pins 10 and 12 of battery charger tray disconnect is not greater than 5 ohms.
(3) Heat battery thermal switch until it activates. Check that resistance between pins 10 and 12 is now infinite (open circuited).

CAUTION: DO NOT ALLOW HEAT TO REMAIN ON THERMAL SWITCH LONGER THAN 5 SECONDS AFTER SWITCH ACTUATION TO PRECLUDE POSSIBLE DAMAGE TO SWITCH.

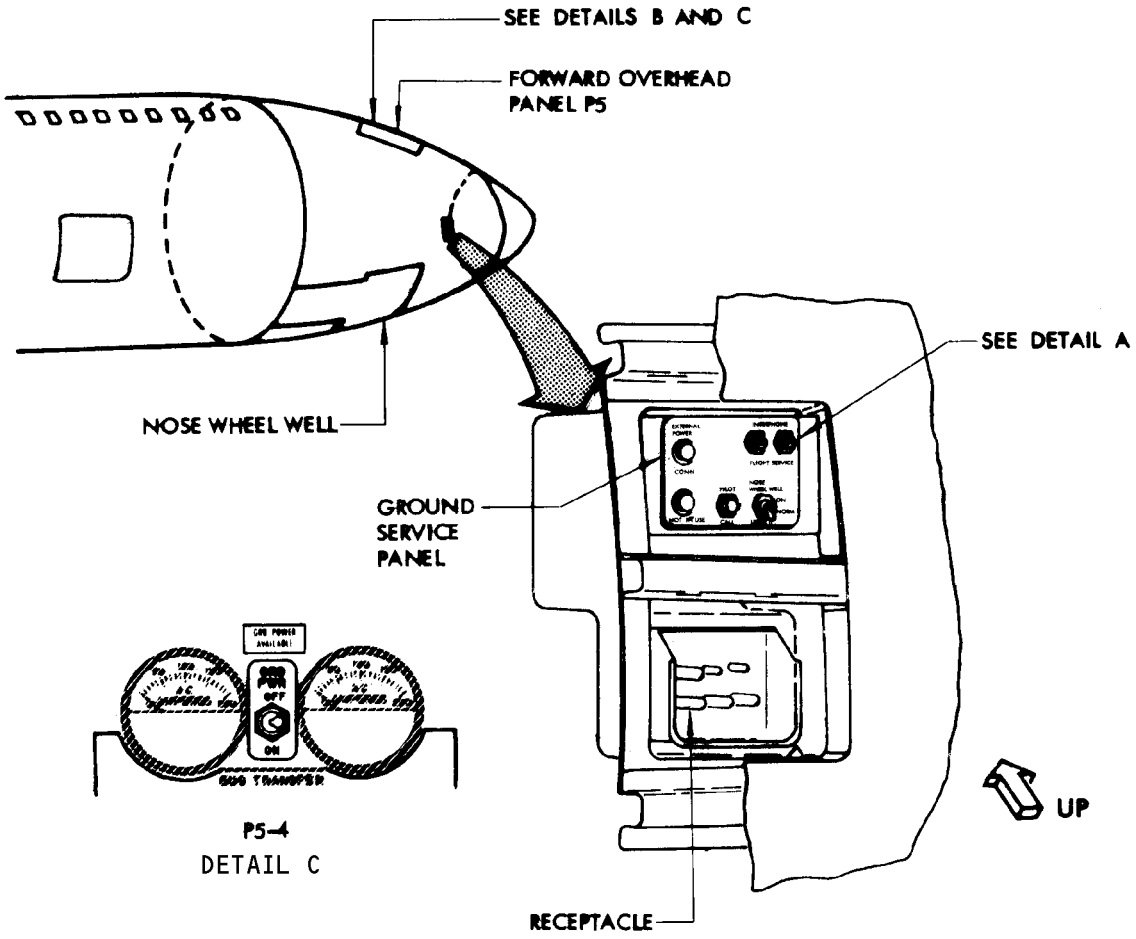
(4) After switch cools (and closes), check that resistance goes back to 5 ohms or less.
(5) Install the battery charger.

AC EXTERNAL POWER - DESCRIPTION AND OPERATION

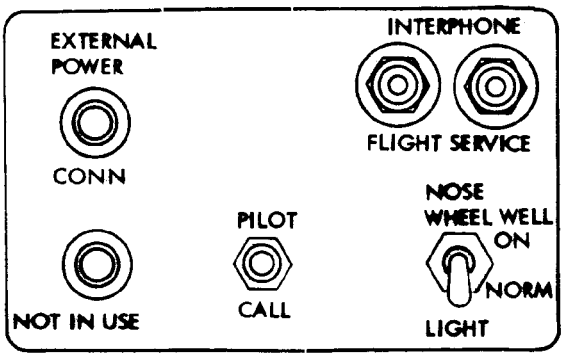
1. General
   A. The aircraft is fitted with electrical components and circuits including protective devices to enable external power to be used when engine or APU generators are inactive. External power receptacles provide for use of external 3 phase 400 cycle power in lieu of engine generated power. (See figure 1.) A ground service switch is provided which energizes a portion of the electrical power system for ground maintenance purposes. The switch is on the forward attendant's panel. A transformer-rectifier unit located within the bus protection panel converts a portion of the 400 cycle ground supply to dc for control of the electrical system and to supply power to the dc system through the ground service switch on the forward attendant's panel. The GROUND POWER switch on the overhead panel is used to trip or close the external power contactor. The selector switch is used to connect the voltmeter and frequency meter to the external power source. (See figure 2.)
   B. A bus protection panel (G7) is located adjacent to the generator control units in the load control center (P6). The panel functions to protect aircraft circuits and equipment against the following external power system abnormal conditions: overvoltage, undervoltage, negative sequence and anticycling. Overvoltage would be considered some potential of 130 (+ 3) volts line to-neutral. At this voltage the basic sensing circuit in the protection panel applies a trip signal to the external power contactor (R8). For undervoltage the panel uses an average 3-phase voltage sensing device which applies a trip signal to the external power contactor (R8) within 7 (+ 2) seconds after the voltage has dropped to 100 (+ 3) volts line-to-neutral. The negative sequence protection actuates a circuit which trips (R8) instantaneously. Anticycling is a condition in which bus protection prevents the control system from cycling when fault conditions exist and the switches in the control cabin are manually held in the ON position. Power required to operate the bus protection panel is derived from the ground power transformer-rectifier in the panel, backed by the aircraft battery system. The control system is capable of normal operation without relying on the battery system. The bus protection panel also controls the external power contactor, and the bus tie breakers when power is supplied to the load busses from external power, and contains tripping interlocks necessary to prevent paralleling of independent power sources. The bus protection panel supplies approximately a 5-ampere load for ground fueling and lighting circuits when external power is connected and the battery is de-energized or disconnected. The voltage of this power source is 28 (+ 2) volts with a 3-phase input to the aircraft of 115 volts line-to-neutral.



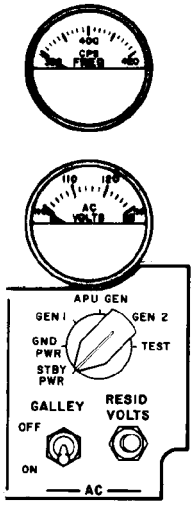
External Power System Schematic
Figure 1



P5-4
DETAIL C



DETAIL A



P5-13
DETAIL B

External or Ground Power Component Location
Figure 2

2. Operation

A. The airplane may be connected to 3-phase, 400-Hz, 115-volt external power with or without engine generators running. When the plug is inserted into the external power receptacle (Fig. 2), the GROUND POWER AVAILABLE light comes on near the ground power (GND PWR) switch on the overhead panel (P5.) The external power connected light at the external power receptacle also comes on. A jumper in the ground power plug connects pin F to E at the receptacle, so that the dc now supplied by the ground power T-R unit is available for all control purposes and for energizing both 28-volt dc external power buses. The external power NOT IN USE light at the receptacle will be ON. When the GND PWR switch (S1) is moved to ON, the NOT IS USE light goes out and the external power CONNECTED light, at the receptacle, remains on. Just before the EXT PWR contractor closes there is a short time delay while the generator breakers open, clearing any airplane generators from the tie bus. With the No. 1, 2 and the APU generator lines all open, the external power contactor R8 closes. Loads previously carried by airplane generators are now supplied from the ground source. The above sequence will take place whether or not there is a storage battery connected in the airplane or whether or not any generators are running when the external power plug is inserted.

B. When changing from ground power to engine-driven generator power it is recommended that the selector knob on the overhead panel be turned to the appropriate generator as that engine is started. Then the BUS TRANSFER switch should be moved to AUTO and the GEN switch on the monitored generator should be moved to ON, when the generator is up to speed, the low oil pressure light on the CSD indicator panel will go out. When frequency is approximately 400 Hz, and the voltage indicated is about 115 volts for this particular generator the external power contactor will drop out automatically., and the NOT IN USE light will come on, indicating to the ground crew that the plug may be pulled out of the receptacle. Arcing and considerable damage to the external power receptacle pins may result from pulling the plug before the NOT IN USE light is illuminated. The CONNECTED light goes off when the external power plug is pulled or if circuit breaker C812 is opened. The ground service relay R6, the refueling power control relay R11 and the external power contactor R8 must all be relaxed for the external power NOT IN USE light to be ON (Fig. 1). The jumper mentioned above must complete the circuit from pin E to F to light the entry lights. The DC supply to ground support equipment, such as ground fueling, is obtained from the pin E side of the circuit.

C. The battery may be charged from a 3-phase, 115-volt, 400-Hz ground power source (Fig. 1). An APU start interlock relay R39 is in the battery charger input circuit to protect the charger while operating the APU start motor from the airplane battery.

EXTERNAL POWER RECEPTACLE - REMOVAL/INSTALLATION

1. General
   A. This procedure has two tasks. One task is the removal of the external power receptacle. The other task is the installation of the external power receptacle.
   B. The external power receptacle is on the lower right side of the airplane. It is installed forward of the wheel well for the nose gear.
   C. The external power receptacle is part of the pressure seal of the airplane. You must seal the receptacle after you install it.
2. External Power Receptacle Removal (Fig. 401)
   A. Reference
      (1) 24-22-0/201, Manual Control
   B. Access
      (1) Location Zone
          202 Lower Nose Compartment

      (2) Access Panel
          1101 External Power Receptacle Door

   C. Procedure
      (1) Make sure all electrical power is off (Ref 24-22-0/201).
      (2) Disconnect all electrical power cables from the external power receptacles.
      (3) Open the door 1101 for the external power receptacle, if it is closed.
      (4) Open the forward panel on the right side of the nose wheel well to get access to the receptacle.
      (5) Disconnect the electrical leads from the receptacle:
          (a) Remove the three nuts that attach the conductor guard to the bracket.
          (b) Remove the three bolts that attach the conductor guard to the receptacle pan.
          (c) Remove the conductor guard.
          (d) Attach an identification tag to each lead.
          (e) Remove the nuts and washers that attach the six leads to the receptacle studs.
          (f) Disconnect the leads from the studs.
      (6) Remove the external power receptacle:
          (a) Remove the bolts and the washers that attach the receptacle to the receptacle pan.
          (b) Remove the external power receptacle and the safety guide from the outer side of the airplane.
3. External Power Receptacle Installation
   A. Consumable Materials
      (1) Sealant - BMS 5-95
   B. References
      (1) 24-22-0/201, Manual Control
      (2) 51-31-0/201, Seals and Sealing

C. Access
(1) Location Zone
202 Lower Nose Compartment

(2) Access Panel
1101 External Power Receptacle Door

D. External Power Receptacle
(1) Install the external power receptacle:
(a) Put the external power receptacle and the safety guide in their positions in the receptacle pan.

NOTE: Do this step out of the airplane.

(b) Install the four bolts and the four washers through the receptacle, the receptacle pan, and the insulation plate.
(c) Tighten the four bolts.
(d) Apply a pressure fillet seal with the sealant around the receptacle (Ref 51-31-0/201).

CAUTION: OBEY THE INSTRUCTIONS IN THE PROCEDURE TO APPLY THE SEALANT. IF YOU DO NOT OBEY THE INSTRUCTIONS, DAMAGE TO THE AIRPLANE SURFACE CAN OCCUR.

(2) Connect the electrical leads to the external power receptacle:
(a) Install the six leads on the receptacle studs of the external power receptacle.

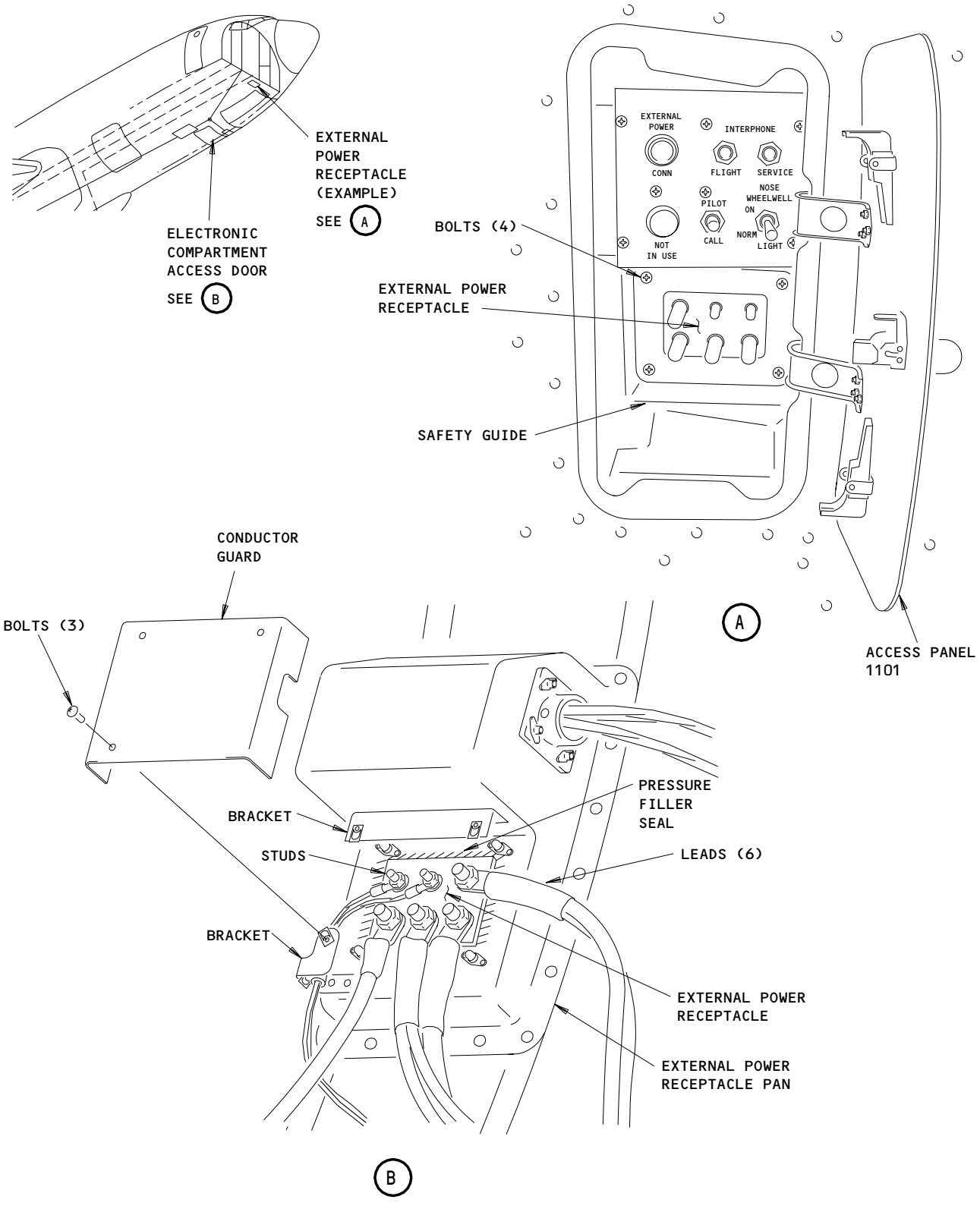
CAUTION: MAKE SURE YOU CONNECT THE CORRECT ELECTRICAL LEAD TO EACH RECEPTACLE STUD. AN INCORRECT INSTALLATION CAN CAUSE A MALFUNCTION OF THE CIRCUIT AND DAMAGE TO THE EQUIPMENT.

(b) Install the nuts and the washers on the receptacle studs.

CAUTION: DO NOT INSTALL THE WASHERS BELOW THE ELECTRICAL LEADS. THIS WILL CAUSE HEAT THAT CAN BURN THE RECEPTACLE STUDS.

(c) Remove the identification tags.
(3) Install the conductor guard.
(a) Put the conductor guard in its position above the receptacle studs.
(b) Install the three bolts that attach the conductor guard to the bracket.
(c) Tighten the bolts.

E. Do a test of the external power receptacle.
(1) Supply electrical power (Ref 24-22-0/201).
(2) Make sure the airplane operates satisfactorily.
(3) Remove electrical power, if it is not necessary (Ref 24-22-0/201).



External Power Receptacle Component Location
Figure 401

EXTERNAL POWER RECEPTACLE - INSPECTION/CHECK

1. External Power Receptacle Inspection
   A. Prepare External Power Receptacle for Examination
      (1) Remove external power from airplane.
      (2) Remove nose wheel well right-hand forward access door.
      (3) Remove external power receptacle terminal cover.
   B. Examine External Power Receptacle
      (1) Examine outboard side of external power receptacle for the following:
         (a) Cracked or loose pin and insulating support base.
         (b) Bent or loose pins.
         (c) Discolored or burned pins due to overheat.
      (2) Examine external power receptacle electrical cable connections for the following:
         (a) Discoloration of electrical cable terminals due to overheating or corrosion.
         (b) Correct assembly arrangement of electrical cable, washer, lock washer and nut, in that order, on each receptacle pin.
         (c) Loose receptacle pin terminal nuts.
            1) Check torque on 3/8-16 nuts. Tighten to 100-120 pound-inches torque when checking.

               CAUTION: DO NOT OVERTORQUE. PINS FAIL AT 200 POUND-INCHES.

            2) Check torque on #10-32 nuts on dc control pins E and F. Tighten to 20-22 pound-inches when checking.
   C. Restore Airplane to Normal Configuration
      (1) Install external power receptacle terminal cover.
      (2) Install nose wheel well right-hand forward access door.
      (3) Connect external power if needed on the airplane.
2. External Power Receptacle Check
   A. General
      (1) Repeated use, particularly in dusty localities, results in receptacle pin and plug socket wear which can cause poor electrical contact and overheating. Receptacle pin overheating can also be caused by loose or corroded connections of the electrical conductors to the inner ends of the pins. Wear, overheating and resulting oxidation along with corrosion, all cause pin and socket dimensions to change. Therefore, scheduled periodic checks of receptacle pins and ground power plug sockets should be made.

B. External Power Receptacle Pins Check

(1) General

(a) The 115 volt, 3 phase external power receptacle contains four ac input circuit pins 0.435 to 0.437 inch in diameter and two dc control circuit pins 0.310 to 0.312 inch in diameter. The six pins are fixed in an insulating plastic base and are threaded on the inboard ends to provide for connecting electrical cables. The pins are not removable for individual replacement. A damaged or undersized contact pin will require replacing the insulating support base containing the six pins.

(2) Equipment and Materials

(a) Ground Power Plug and Receptacle Wear Gauge Set - F70284-1 consisting of the following:

1) F70284-2, wear gage, ac power pin
2) F70284-3, wear gage, dc power pin
3) 1N-25, instrument scale

NOTE: The Wear Gage Set - F70284-1 is also used to check the external power unit (ground power supply) plug sockets.

(3) Check external power receptacle pins.

(a) Open GND SERV circuit breaker on right load control center P6 and push battery switch on overhead panel P5 to OFF.

(b) Check ac pins.

1) Try to put wear gage F70284-2 on AC pin A.

CAUTION: DO NOT USE EXCESSIVE FORCE TO PUSH WEAR GAGE ON PINS. THE WEAR GAGE IS A GO NO/GO GAGE AND SHOULD NOT FIT OVER THE PIN. TO MUCH FORCE ON THE PIN CAN CAUSE DAMAGE.

2) Repeat step 1) for pins B, C and N.
3) If any pins fail to pass test or are otherwise deformed, insulating support base including six pins should be replaced.

(c) Check dc pins.

1) Try to put wear gage F70284-3 on DC pin E.

CAUTION: DO NOT USE EXCESSIVE FORCE TO PUSH WEAR GAGE ON PINS. THE WEAR GAGE IS A GO NO/GO GAGE AND SHOULD NOT FIT OVER THE PIN. TO MUCH FORCE ON THE PIN CAN CAUSE DAMAGE.

2) Repeat step 1) for pin F.

3) If any pins fail to pass test or are otherwise deformed, insulating support base including six pins should be replaced.

(d) Close GND SERV circuit breaker panel on P6.

3. External Power Receptacle Neutral Pin to Main Landing Gear Grounding Stud Continuity Check

A. General

(1) This check examines for continuity between the neutral pin on the external power receptacle and the ground stud located on the airplane main landing gear.

B. Neutral Pin to Grounding Stud Continuity Check

(1) Equipment and Materials

(a) Low Resistance Ohmmeter

(2) Prepare to check the continuity between the receptacle pin and the main landing gear grounding stud.

(a) Remove electrical power from the airplane.

(b) Open the door to access the external power receptacle.

(3) Check the continuity between the receptacle neutral pin and the main landing gear grounding stud.

(a) Use the low resistance ohmmeter to measure the resistance from the neutral pin on the external power receptacle to the main landing gear grounding stud.

(b) Make sure the resistance does not exceed 0.1 ohms.

(c) If the resistance exceeds 0.1 ohms, examine the external power receptacle for damage according to the external power receptacle inspection described above.

(d) If the problem continues, examine and repair the wiring between the external power receptacle neutral pin and the associated ground stud.

(4) Put the airplane back to its usual condition.

(a) Close the access door for the external power receptacle.

BUS PROTECTION PANEL - REMOVAL/INSTALLATION

1. General
   A. This procedure contains two tasks. The first task is the removal of the bus protection panel (BPP). the second task is the installation of the BPP. After the installation, there is an operational test of the BPP.
   B. The BPP controls and monitors the external power. A cam-lock handle holds the BPP in the P6 panel.
2. Bus Protection Panel Removal
   A. References
      (1) 20-10-111, Electrical/Electronic Black Box
      (2) 24-22-0, Manual Control
   B. Access
      (1) Location Zones
          101 Left Control Cabin - P5 Forward Overhead Panel
          102 Right Control Panel - P6 Load Control Center Panel

   C. Procedure
      (1) Make sure that no electrical power is on the airplane (Ref 24-22-0).

          CAUTION: MAKE SURE THAT NONE OF THE AC OR DC BUSES ARE ENERGIZED WHEN YOU REMOVE THE BPP. ELECTRICAL POWER DURING BPP REMOVAL CAN CAUSE DAMAGE TO THE BPP.

          (a) Make sure that the GEN and APU GEN switches on the P5-4 panel are in the OFF position.
          (b) Make sure that the BAT switch on the P5-13 panel is in the OFF position.
          (c) Make sure that the external power cable is disconnected or not energized.
      (2) Remove the BPP (black box unit with cam-lock handles) (Ref 20-10-111).
3. Bus Protection Panel Installation
   A. Standard Tools and Equipment
      (1) External Power Supply - 115/200 volts ac, 3-phase, 400Hz
   B. References
      (1) 20-10-111, Electrical/Electronic Black Box
      (2) 24-22-0, Manual control
      (3) 24-41-0, AC External Power
   C. Access
      (1) Location Zones
          101 Left control Cabin - P5 Forward Overhead Panel
          102 Right Control Panel - P6 Load Control Center Panel
          115 Cargo Door - P13 Forward Attendant's Panel
          202 Lower Nose Compartment - P19 External Power Panel
          402 Right Wing - Outboard Leading Edge

(2) Access Panels
1101 External Power Receptacle Door
6540 Refueling Station Access Door

D. Procedure
(1) Make sure that no electrical power is on the airplane (Ref 24-22-0).

CAUTION: MAKE SURE THAT NONE OF THE AC OR DC BUSES ARE ENERGIZED WHEN YOU INSTALL THE BPP. ELECTRICAL POWER DURING BPP INSTALLATION CAN CAUSE DAMAGE TO THE BPP.

(a) Make sure that the GEN and APU GEN switches on the P5-4 panel are in the OFF position.
(b) Make sure that the BAT switch on the P5-13 panel is in the off position.
(c) Make sure that the external power cable is disconnected or not energized.
(2) If they are installed, remove the protective covers for the BPP and the shelf in the P6 panel.
(3) Install the BPP (black box unit with cam-lock handles) (Ref 20-10-111).
(4) Turn the DC meter switch on the P5-13 panel to BAT.
(a) Make sure that the DC voltmeter shows 24 ±4 volts.

E. Make Sure That the Bus Protection Panel Operates Correctly.
(1) Make sure the access door for the refueling station is closed.
(2) Open the external power receptacle door.
(3) Connect an external power cable to the P19 receptacle.

WARNING: BEFORE YOU CONNECT THE EXTERNAL POWER CABLE TO THE AIRPLANE, MAKE SURE THE EXTERNAL POWER CABLE IS NOT ENERGIZED. ELECTRICAL ARCS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

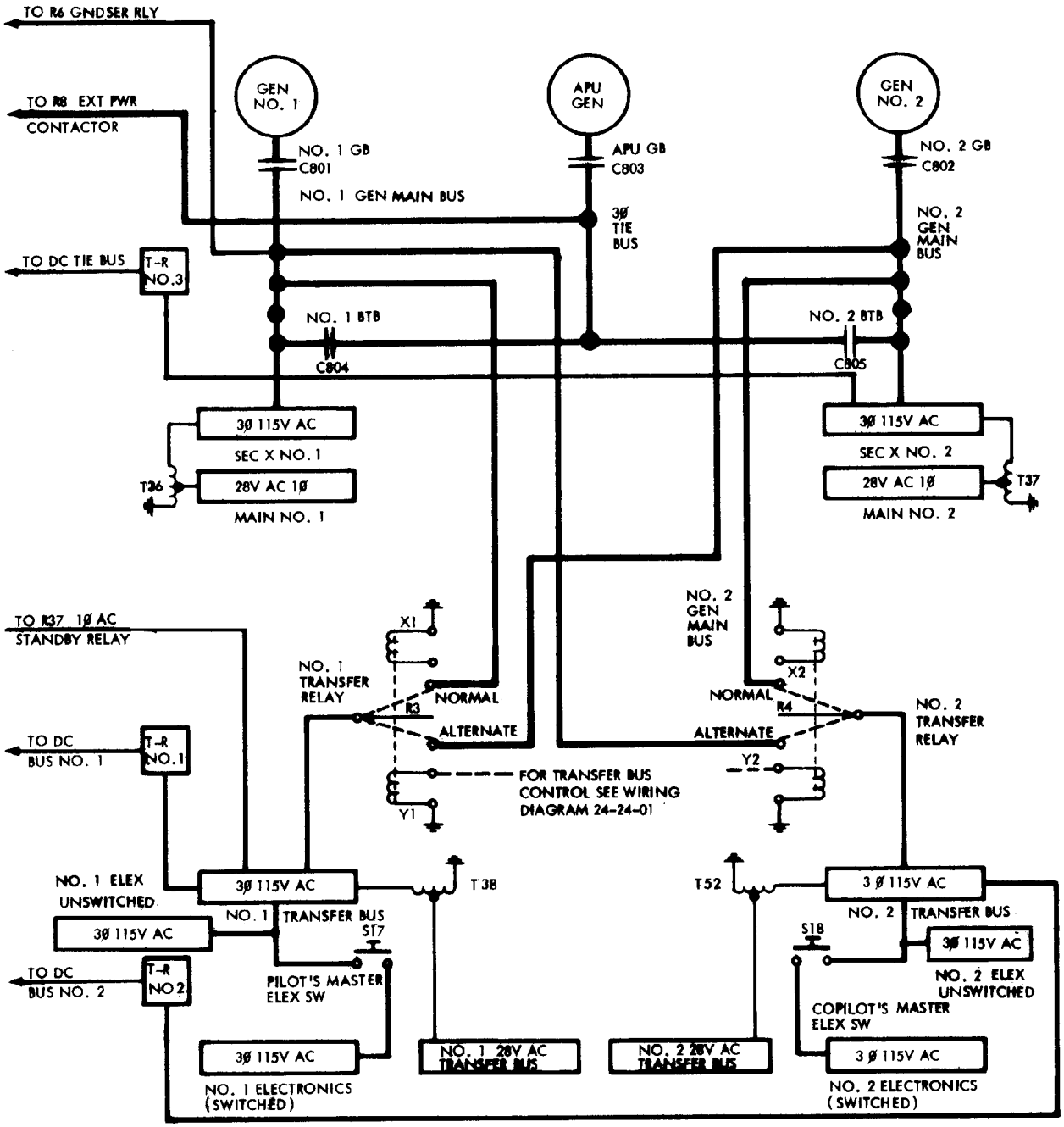
(4) Energize the external power cable.
(a) Make sure that the EXTERNAL POWER - CONN and NOT IN USE lights on the P19 panel come on.
(b) Make sure that the GRD POWER AVAILABLE light on the P5-4 panel comes on.
(5) Push the BAT switch on the P5-13 panel to ON.
(a) Make sure that these lights on the P5-4 panel come on:
1) TRANSFER BUS OFF 1 and 2
2) BUS OFF 1 and 2
3) GEN OFF BUS 1 and 2
(6) Push the GROUND SERVICE switch on the forward attendant's panel to ON.
(a) Make sure that the EXTERNAL POWER - NOT IN USE light on the P19 panel goes off.

(7) Push the GRD PWR switch on the P5-4 panel to ON.
    (a) Make sure that these lights go off:
        1) TRANSFER BUS OFF 1 and 2
        2) BUS OFF 1 and 2
    (b) Make sure that the GROUND SERVICE switch moves to the OFF position.
(8) Remove the external power if it is not necessary (Ref 24-22-0).

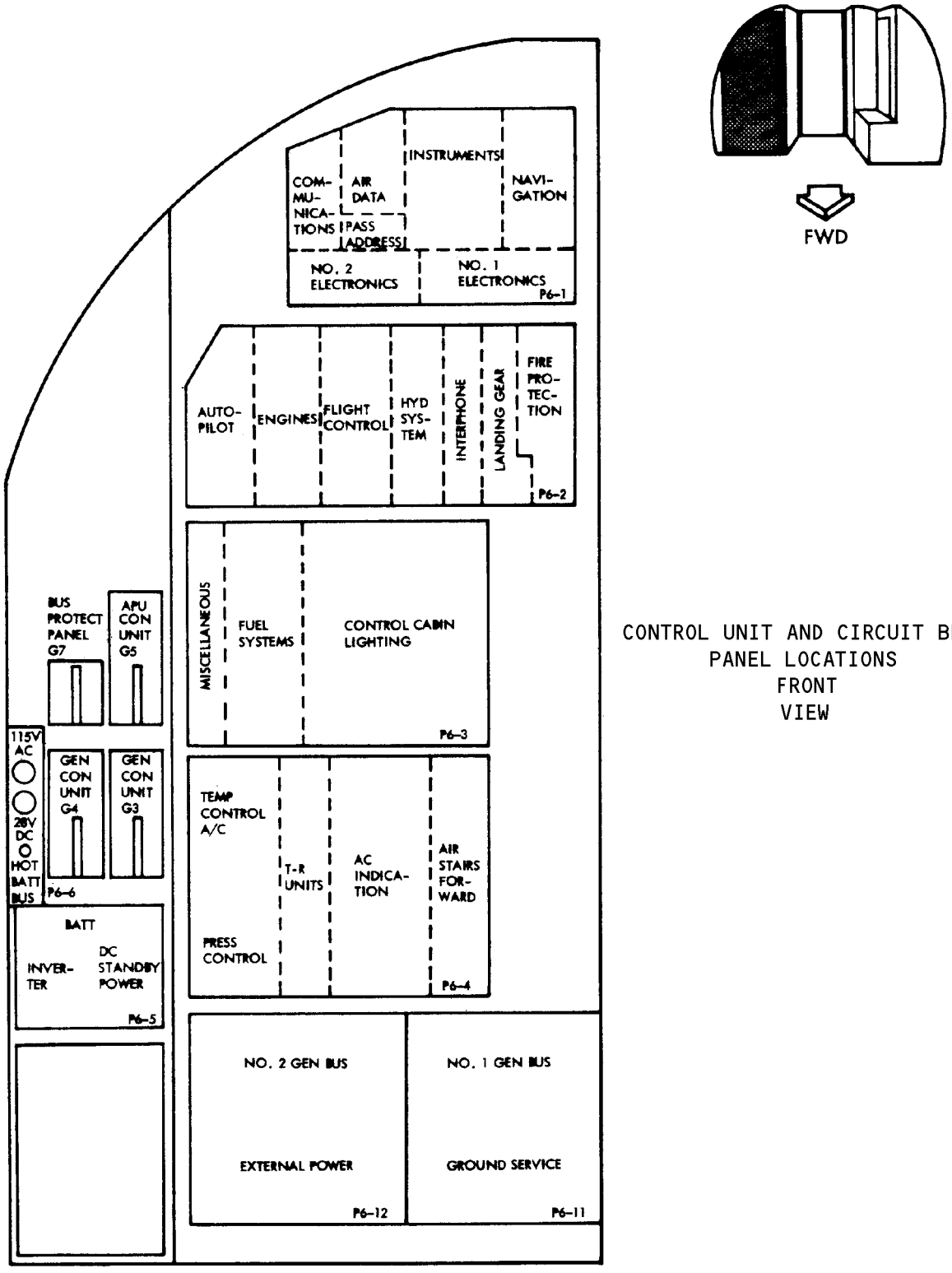
ELECTRICAL LOAD DISTRIBUTION - DESCRIPTION AND OPERATION

1. General
   A. The electrical loads on the airplane are distributed through three kinds of bus arrangements, 115-volt ac, 3-phase, 400-cycle, 28-volt ac single phase, 400-cycle, and 28 volt dc. The airplane system begins with the 115 volt ac 3-phase 400 cycle network, and branches out to 28 volt ac and dc bus systems (Fig. 1).
2. 115 Volt AC System
   A. The first of the three considered is the 115 volt ac system fed by the four 400 cycle, 3-phase sources. This system terminates in 3-phase 115 volt ac busses connected directly to the No. 1 and 2 generator busses, and includes two additional 3-phase 115 volt transfer busses connected to the No. 1 and 2 transfer relays. Since no two power sources of the electrical syste m can be operated in parallel a means of load transfer is provided (Fig. 1). The No. 1 and 2 transfer busses can be energized, through a transfer relay, from either generator main bus No. 1 or 2. Normally, each transfer bus is energized by its associated generator; however, in the event a generator stops delivering power causing the generator main bus to go dead, the transfer bus transfers automatically to the other generator main bus. As soon as power is restored, the transfer bus transfers back to its original position. Control logic is provided to ensure the transfer busses are energized any time a main generator bus is energized and the bus transfer switch on the pilots' forward overhead panel is in the AUTO or normal position. The control of the transfer relay is accomplished by auxiliary contacts on the generator and bus tie breakers. With the bus transfer switch in the OFF position, the transfer bus is dead when the generator main bus is de-energized. Except for the external power contactor and the generator No. 1 and No. 2 circuit breakers which are located in the right hand forward compartment outboard of the nose wheel well, the contactors, relays, main circuit breakers, and other major components necessary for electrical load distribution are located in the load control center panels (P6) (Fig. 3). The fronts of the panels contain circuit breakers relating to airplane systems as indicated along the tops of each separate panel, with the individual circuit breakers marked as they pertain to that system. The separate panels are hinged along the edge which permits swinging the panel forward. When the panels are opened in this manner switching components are accessible as indicated on Fig. 3. The control units for the three airplane generators, a receptacle panel to 115 volt ac and 28 volt dc (P6-6) and the dc system circuit breaker panel P6-5 are located on the left side of load control center (P6).

3. 28-Volt AC System
   A. The second system provides for additional loads which are connected to the above buses at a reduced voltage through 28-volt autotransformers. Such transformers are located at various points in the airplane and are connected to both the main and transfer buses mentioned above (Fig. 1). The loads connected to 28-volt ac buses are mostly used for airplane lighting, and for small amounts of power required for various indicators, showing temperature, pressure or position of actuators. For detailed information on the loads supplied by such transformers through 28-volt ac buses, see wiring diagrams.
4. 28-Volt DC System
   A. The third system is a network of 28-volt dc buses, supplied by various transformer-rectifiers (T-R units) which are energized with 3-phase 115-volt, 400-Hz power from the first system. T-R units No. 1 and 2 are connected to transfer buses and have a changeable input source (Fig. 1). T-R unit No. 3 is supplied from section X of the No.2 115-volt ac 3-phase bus. The loads connected to T-R unit output buses consist mostly of control actuators and operating coils for contactors and relays in the airplane electrical generating and distribution systems. In addition to the above three T-R units the system contains a T-R unit used to charge the airplane battery. The dc buses used in distributing the above dc loads are the battery bus, the hot battery bus, the No. 1 and 2 dc buses and the 28-volt dc standby bus. A fifth or external power T-R unit located within the bus protection panel provides a limited source of dc when external 115-volt ac 3-phase power is connected to the external power receptacle. The external power T-R unit provides a dc supply necessary to operate contactors and relays with only external power available. For a detailed utilization of dc power or load distribution for dc bus No. 1; for and 2, and for 28-volt dc standby bus, see wiring diagrams. Loads supplied from the battery bus are shown on a combined circuit breaker and wiring diagram.

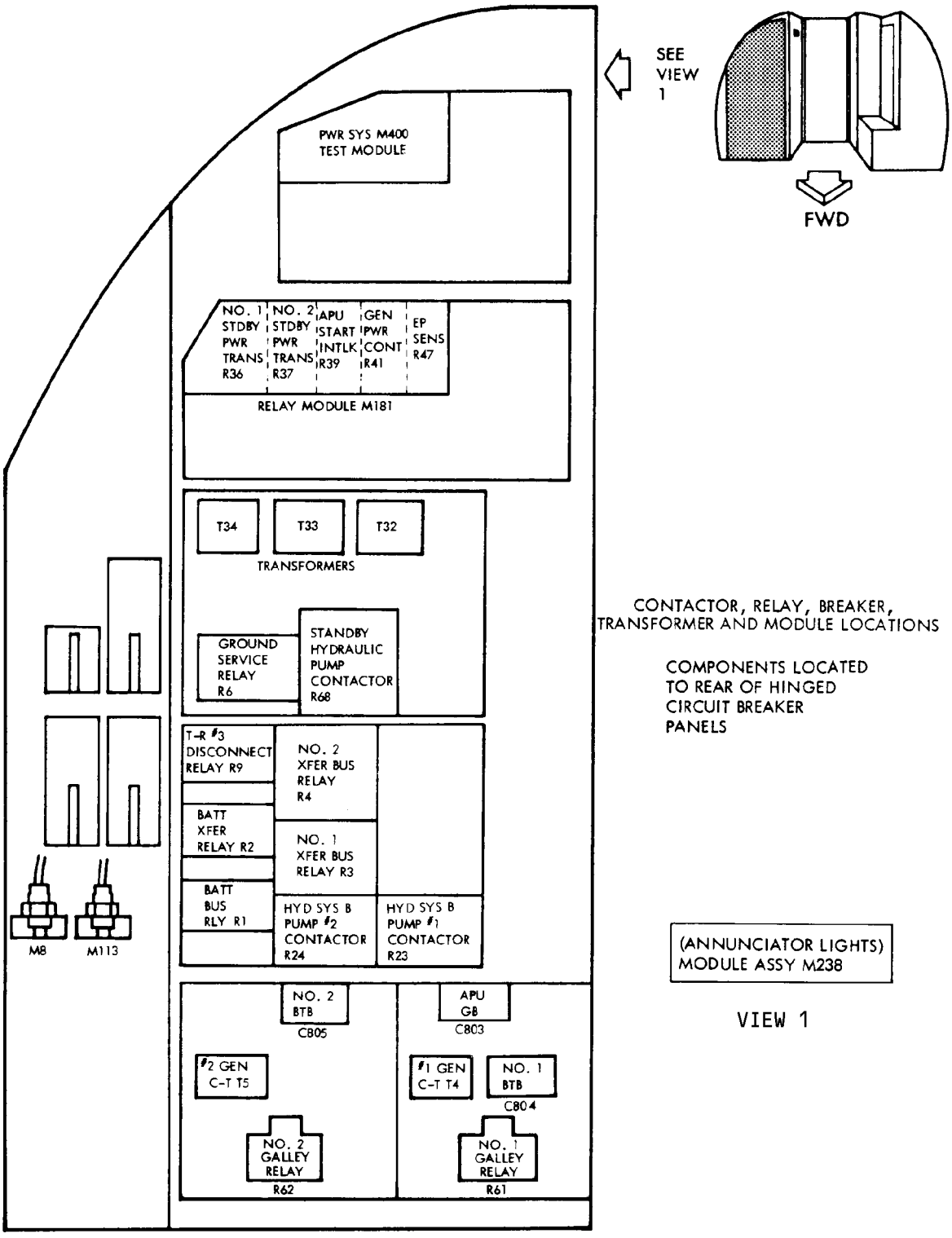


ac Electrical Bus Diagram
Figure 1



CONTROL UNIT AND CIRCUIT BREAKER PANEL LOCATIONS
FRONT VIEW

Load Control Center (P6) Component Location
Figure 2



Load Control Center - Right (P6) Component Location
Figure 3 (Sheet 1)

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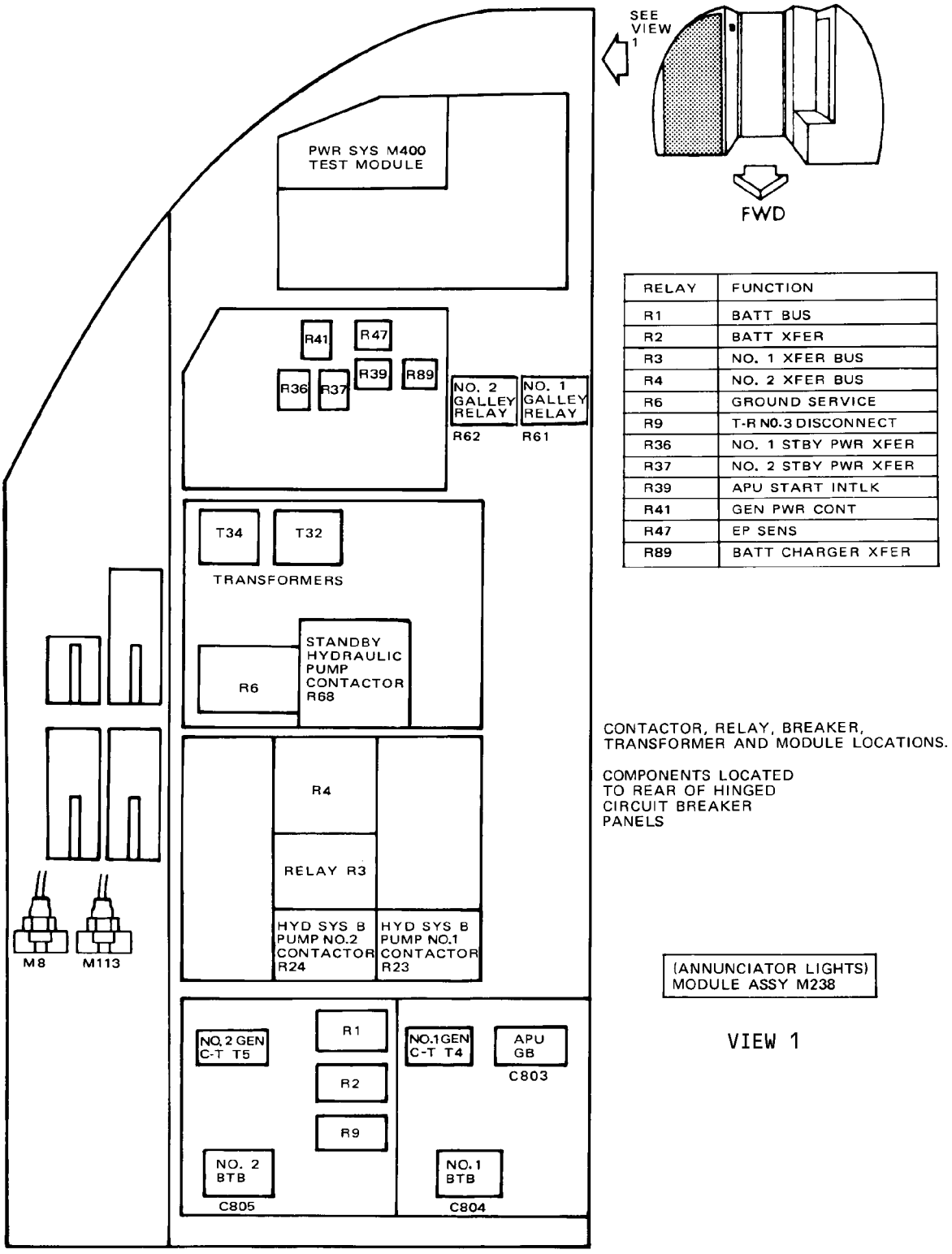
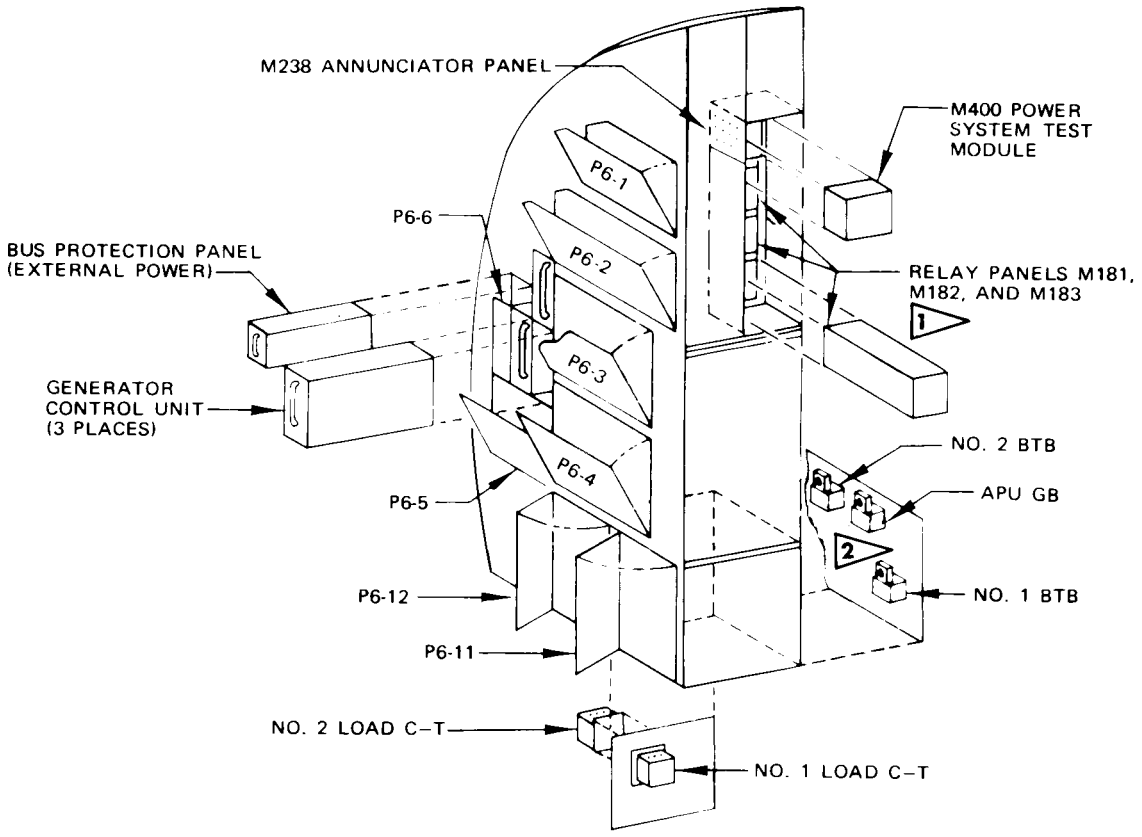


RELAY	FUNCTION
R1	BATT BUS
R2	BATT XFER
R3	NO. 1 XFER BUS
R4	NO. 2 XFER BUS
R6	GROUND SERVICE
R9	T-R NO.3 DISCONNECT
R36	NO. 1 STBY PWR XFER
R37	NO. 2 STBY PWR XFER
R39	APU START INTLK
R41	GEN PWR CONT
R47	EP SENS
R89	BATT CHARGER XFER

CONTACTOR, RELAY, BREAKER, TRANSFORMER AND MODULE LOCATIONS.

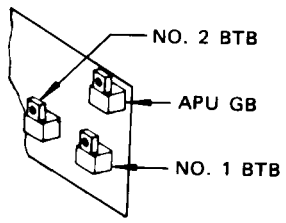
COMPONENTS LOCATED TO REAR OF HINGED CIRCUIT BREAKER PANELS

Load Control Center - Right (P6) Component Location
Figure 3 (Sheet 2)



1 ALL AIRPLANES EXCEPT PI N734N THRU N747N AND AR LV-JMW THRU LV-JMZ HAVE RELAYS HARD-MOUNTED ON PANEL P6.

2 SEE DETAIL A FOR CIRCUIT BREAKER LOCATIONS ON ALL AIRPLANES EXCEPT PI N734N THRU N747N AND AR LV-JMW THRU LV-JMZ.



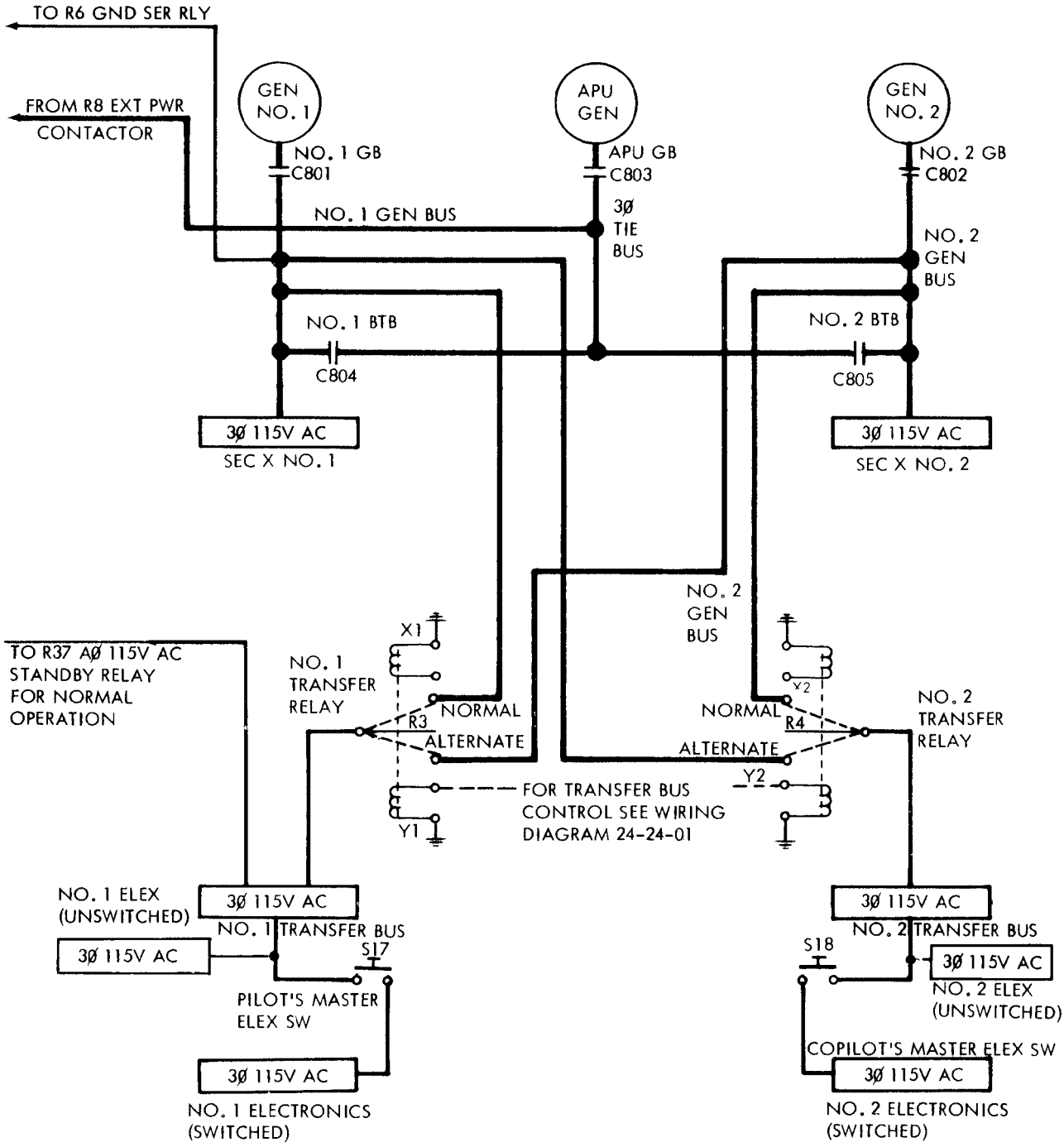
DETAIL A

Load Control Center - Right (P6) Component Location
Figure 3 (Sheet 3)

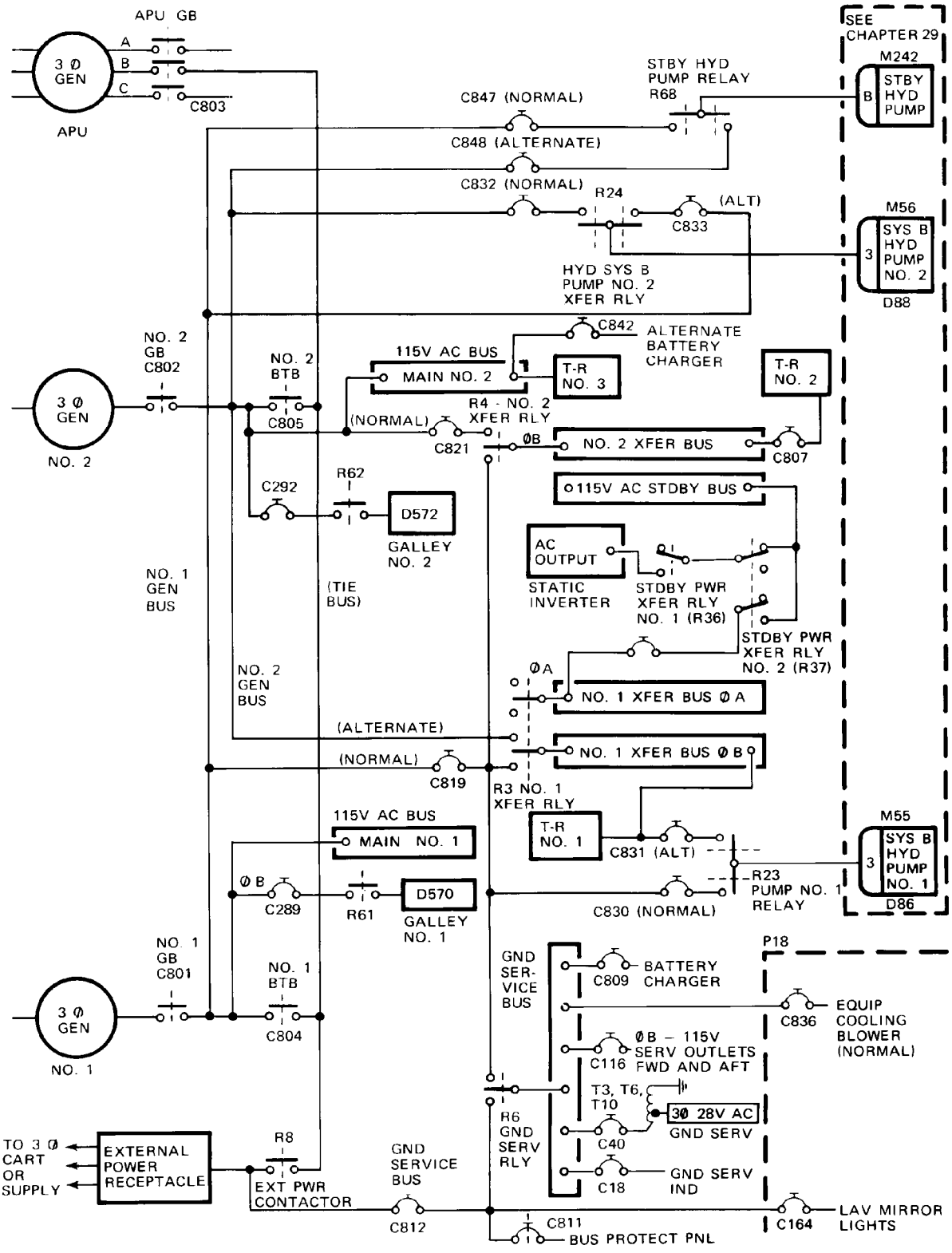
MAIN 115-VOLT AC POWER DISTRIBUTION - DESCRIPTION AND OPERATION

1. General

A. Three-phase 115-volt ac power is supplied by two engine generators and the APU generator in flight, and by a 3-phase 115 volt ac external source or the APU when the airplane is on the ground. Three-phase power from these four sources is distributed from the control cabin in the aircraft through bus systems located mainly in two panels, the load control center-right P6 and the load control center-left P18 and controlled from the forward and aft overhead panels P5. The load control centers P6 and P18 contain power distribution busses supplying power from the No. 1 and No. 2 generator busses, and from the No. 1 and No. 2 transfer busses. (Fig. 1) The load control centers panel P6 and panel P18 contain the contactors, relays, and the circuit breakers supplying power from various busses. Panel P6-11 contains transfer bus No. 1 and the alternate or transfer bus No. 2, which are load busses connected to generator bus No. 1 along with the 3-phase No. 1 section X portions. Power delivered from the three generators including the APU and from the external power source is electrically switched by circuit breakers C801, C802, C803 and the external power contractor R8, respectively. Circuit breakers C801 and C802 and the external power contactor R8 are located in the right hand forward compartment, outboard nose wheel well. A 3-phase tie bus permits connections to the four sources while using the two bus and wiring systems. Except for the power diverted by the No. 1 and No. 2 galley relays R61 and R62 all of the incoming power is distributed to busses terminating in large load relays or in miscellaneous circuit breaker panels P6-4, P6-3, P6-2 and P6-1 progressing upward as shown on figure 3. The load control center panels P6-11 and P6-12 are the circuit breaker locations for generators No. 1 and No. 2 respectively. Relays R3, R4, R23, R24 and R68 are transfer contactors used to change power sources and the switch operating loads to and from the above mentioned distribution busses (Fig. 2) With the No. 1 transfer relay R3 in the normal position and generator No. 1 supplying power through circuit breaker C819 shown on figure 2, the No. 1 pump relay R23 will be conducting power from the normal route through C830. When the No. 1 generator breaker opens however, R3 transfers the No. 1 transfer bus to the No. 2 generator bus, therefore the pump relay R23 must transfer to obtain power from the alternate source through C831.



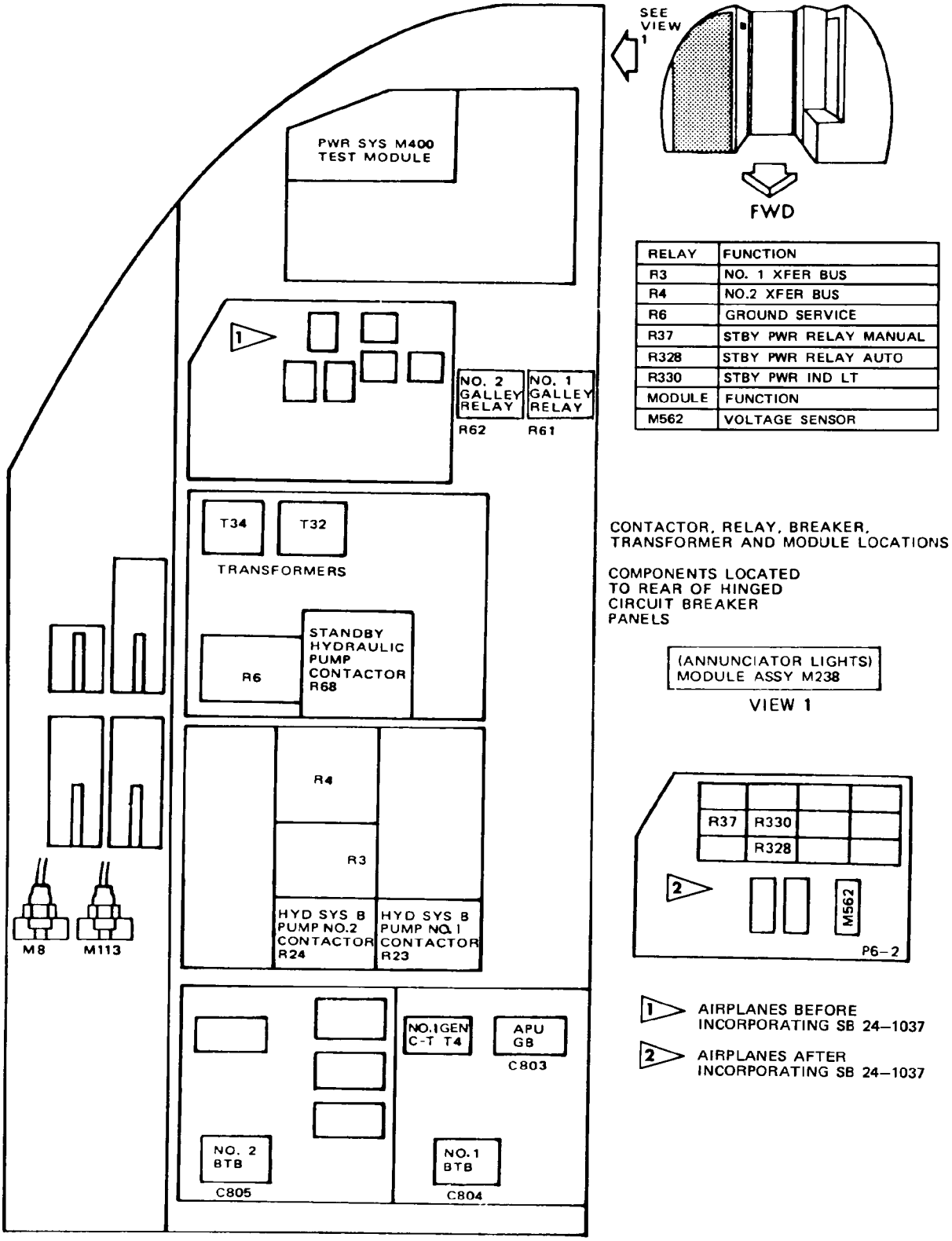
Main 115 Volt AC Power Distribution Bus Diagram (Single Line)
Figure 1



115-volt ac Power Distribution Diagram
Figure 2

B. The transfer relays are normally held in the preferred positions permitting the respective transfer buses to be energized by the corresponding generator buses. An alternate position and a center off position are provided. (Fig. 1.) In the event that power is lost from the No. 1 generator, a signal from the No. 2 GCU will switch the No. 1 transfer relay to the alternate position allowing the No. 2 generator to energize the No. 1 transfer bus and provide power for essential No. 1 generator loads. This signal is a function of proper generator breaker and BTB position and is time-delayed to eliminate nuisance transfers. If power is lost from the No. 2 generator, a similar transfer will take place so that the No. 1 generator will supply power for essential No. 2 generator loads.

C. The larger loads supplied by generator bus No. 1 are the system B hydraulic pump No. 1 or the alternate pump No. 2, the No. 1 galley, the standby hydraulic pump and window anti-ice. The No. 1 main ac bus supplies such large loads as the stabilizer trim actuator, fuel tank No. 2 forward boost pump, center fuel tank left boost pump, and two of the landing lights. (Fig. 2) Generator bus No. 2 in panel P6 supplies system B hydraulic pump No. 2 or the alternate pump No. 1, the No. 2 galley, fuel tank forward boost pump, fuel center tank right boost pump, and the other two landing lights.



RELAY	FUNCTION
R3	NO. 1 XFER BUS
R4	NO.2 XFER BUS
R6	GROUND SERVICE
R37	STBY PWR RELAY MANUAL
R328	STBY PWR RELAY AUTO
R330	STBY PWR IND LT
MODULE	FUNCTION
M562	VOLTAGE SENSOR

CONTACTOR, RELAY, BREAKER, TRANSFORMER AND MODULE LOCATIONS

COMPONENTS LOCATED TO REAR OF HINGED CIRCUIT BREAKER PANELS

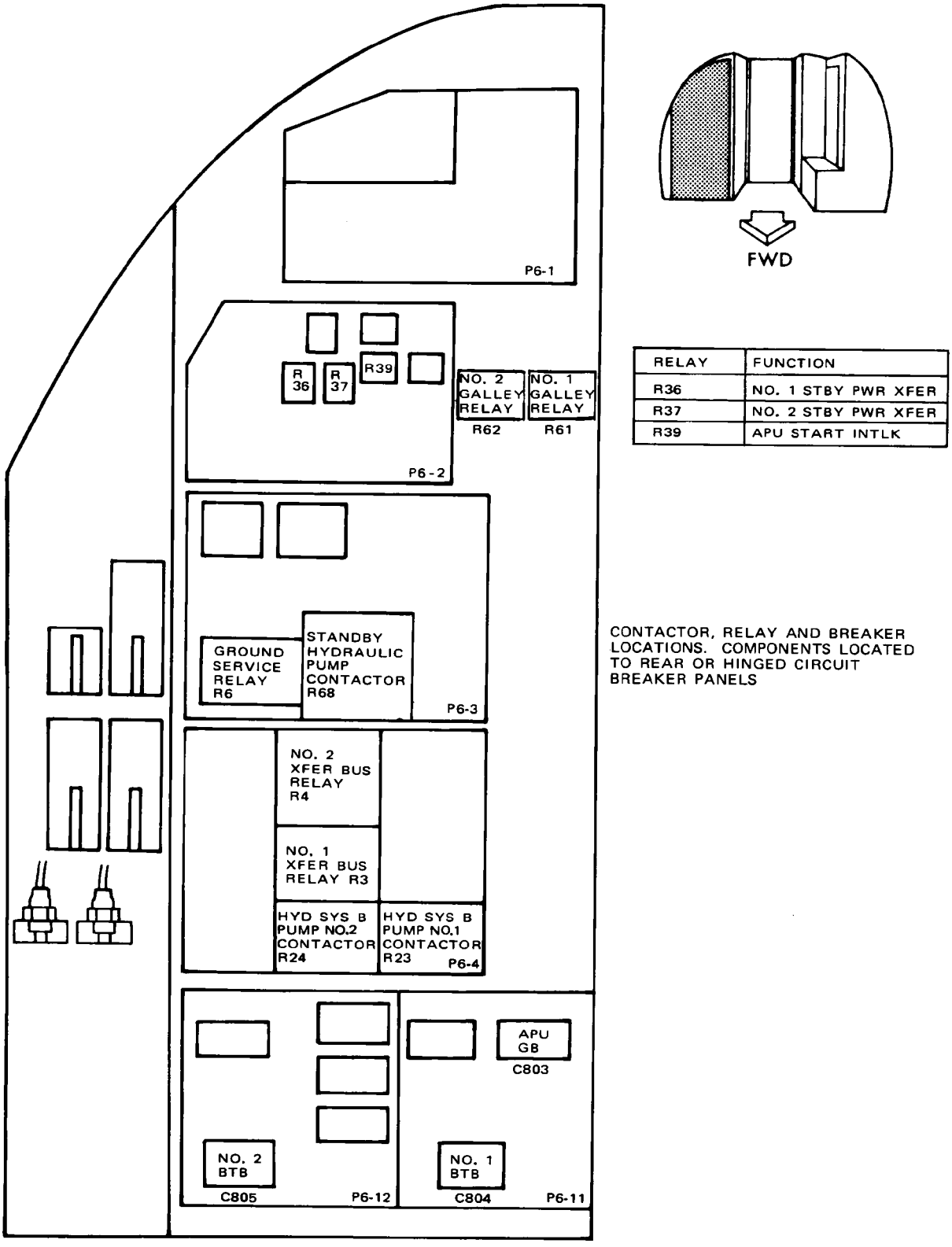
(ANNUNCIATOR LIGHTS) MODULE ASSY M238

VIEW 1

1 AIRPLANES BEFORE INCORPORATING SB 24–1037

2 AIRPLANES AFTER INCORPORATING SB 24–1037

ac Generator System Component Location
Figure 3 (Sheet 1)



RELAY	FUNCTION
R36	NO. 1 STBY PWR XFER
R37	NO. 2 STBY PWR XFER
R39	APU START INTLK

CONTACTOR, RELAY AND BREAKER LOCATIONS. COMPONENTS LOCATED TO REAR OR HINGED CIRCUIT BREAKER PANELS

ac Generator System Component Location
Figure 3 (Sheet 2)

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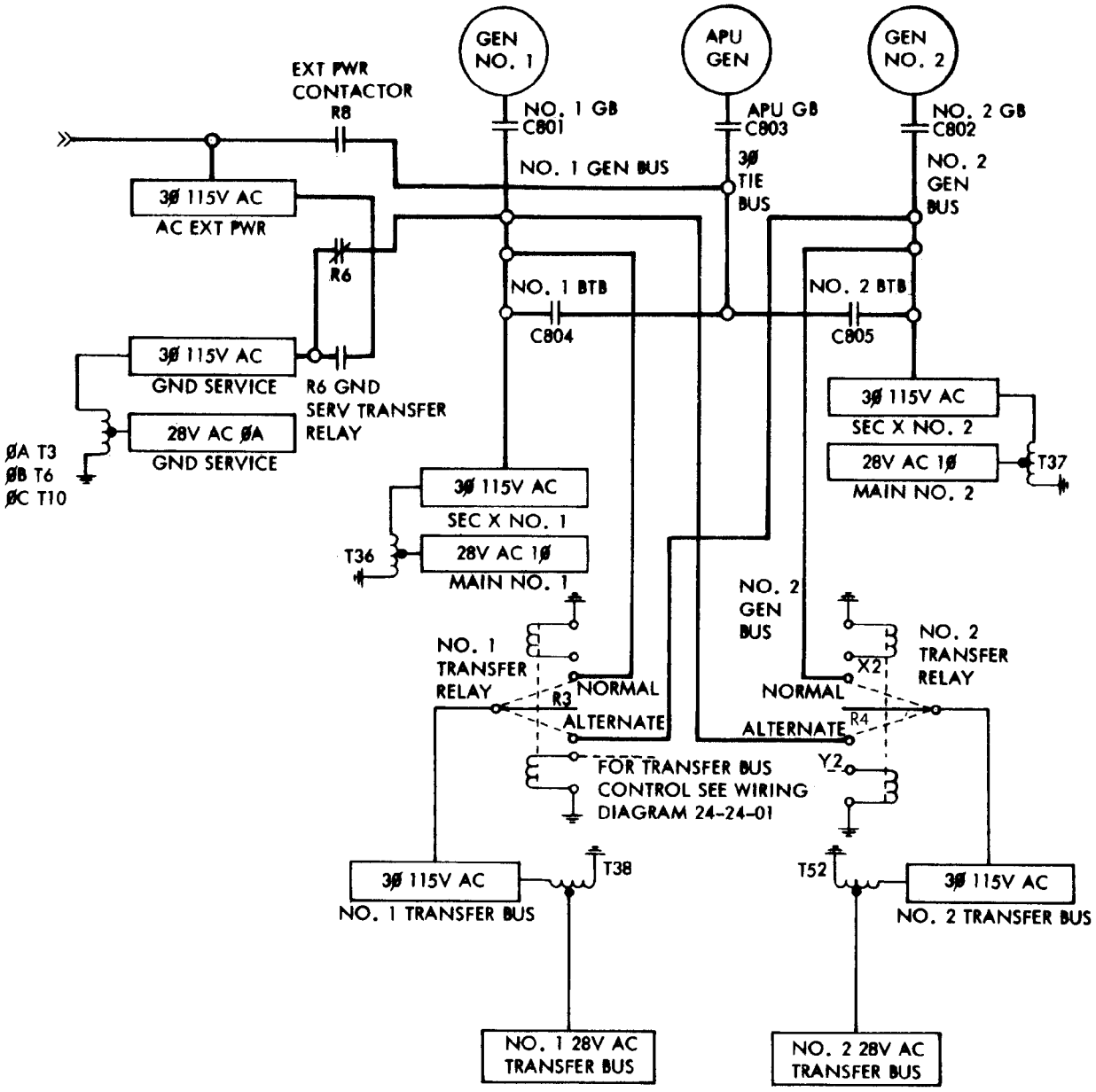
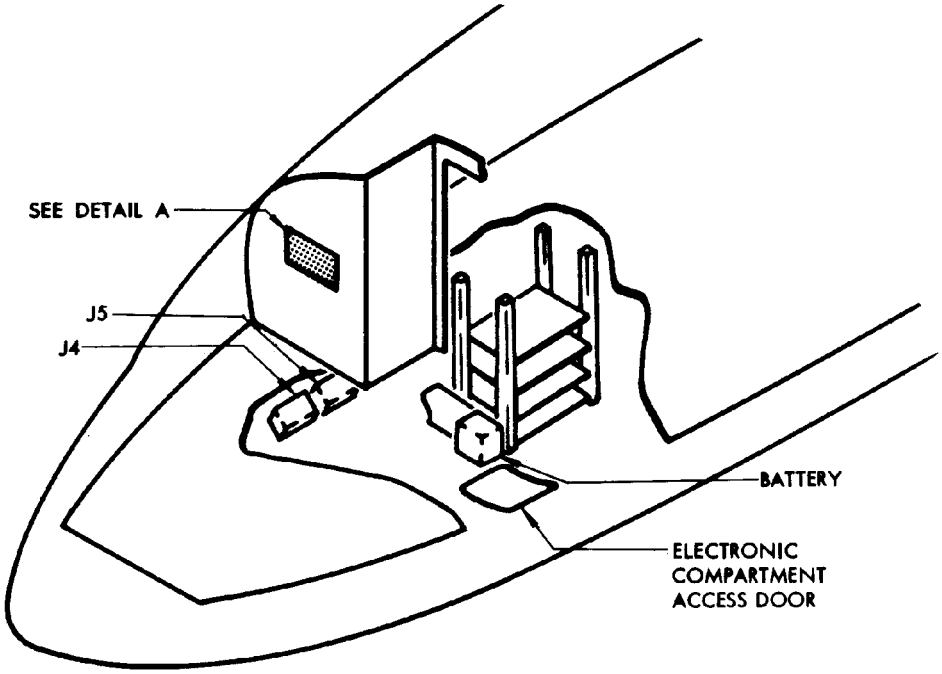
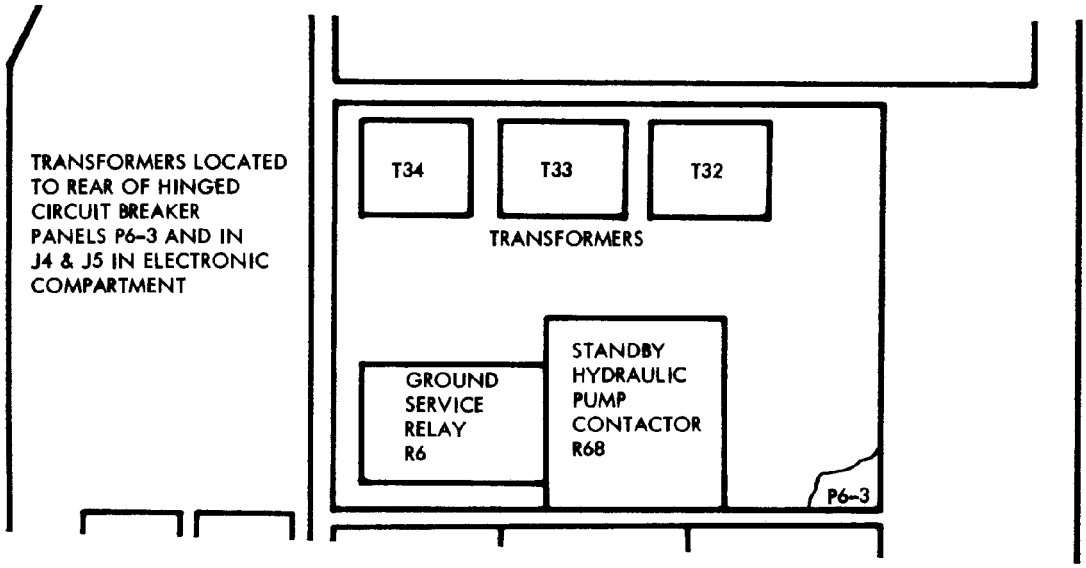
28 VOLT AC POWER DISTRIBUTION - DESCRIPTION AND OPERATION

1. General
   A. The 28-volt ac power used on the airplane is obtained from step down transformer type located at various points in the electrical system. Auto-transformers such as T36, T37, T38 and T52 (figure 1) have single phase, 115-volt, 400-cycle inputs with secondary taps of 24, 26, and 28 volts ac, depending on the application. The secondary taps on the auto-transformers are connected to 28 volts ac to buses which supply mostly lighting circuits. The X sections of both 3-phase, 115-volt ac bus No. 1 and 2 furnish 28-volt auto-transformers shown as single-phase main No. 1 and 2 single-phase, 28-volt transfer buses are fed from the 115-volt ac transfer buses No. 1 and 2.
   B. Auto-transformers T36 and T37 supply 28-volt buses shown as single-phase main No. 1 and 2 respectively. (See figure 1.) The auto-transformers are fed by X sections of both 3-phase, 115-volt ac bus No. 1 and 2. The No. 1 and 2 single-phase, 28-volt transfer buses are fed from the 115-volt ac transfer buses No. 1 and 2 respectively. The current transformers and terminal strips which are related to a particular bus are located adjacent to connected components.
   C. Single-phase ground service 28-volt ac transformers T3, T6 and T10 are fed from the 3-phase, 115-volt ac ground service bus phases A, B and C respectively and are located in junction box J4. The 28-volt main No. 1 transfer bus transformer T38 and the 28-volt main No. 1 bus transformer T36 shown on figure 1, are also in J4. Transformers T37 and T52, which are similar, but connected to No. 2 buses, are in junction box J5, along with cove lights 28-volt transformers T23 and T24. Junction boxes J4 and J5 are in the electronics equipment bay on the right-hand side. Control cabin lighting transformers T32, T33 and T34 are located in the space to the rear of panel P6-3.



28-volt ac Power Distribution Bus Diagram
Figure 1





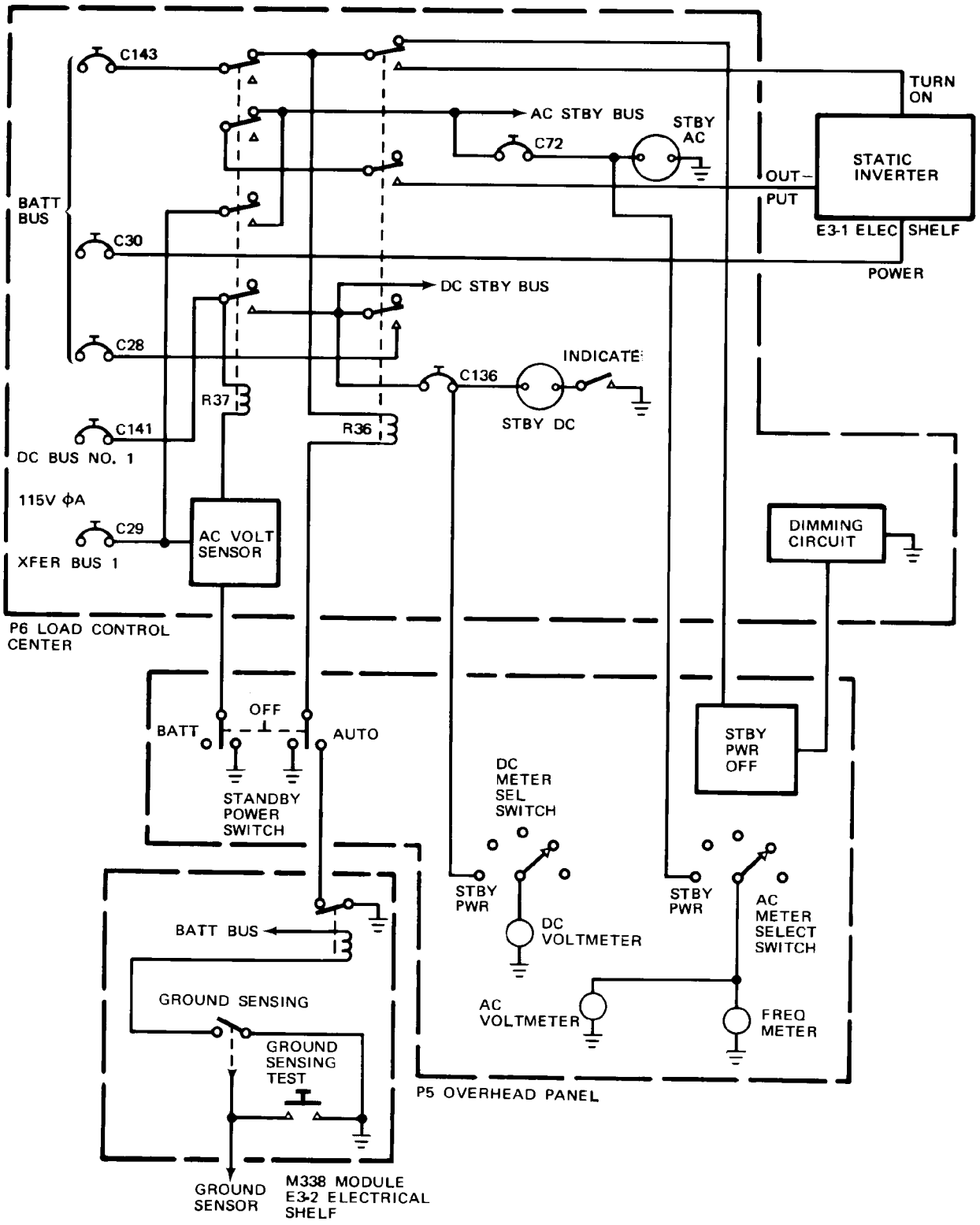
DETAIL A

28-volt ac Power Component Location
Figure 2

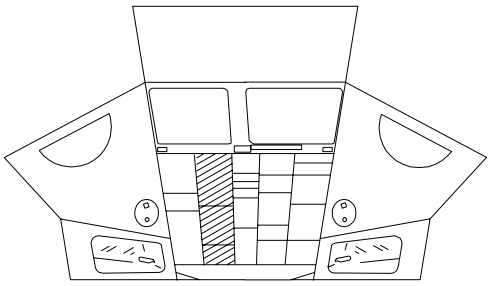
STANDBY POWER SYSTEM - DESCRIPTION AND OPERATION

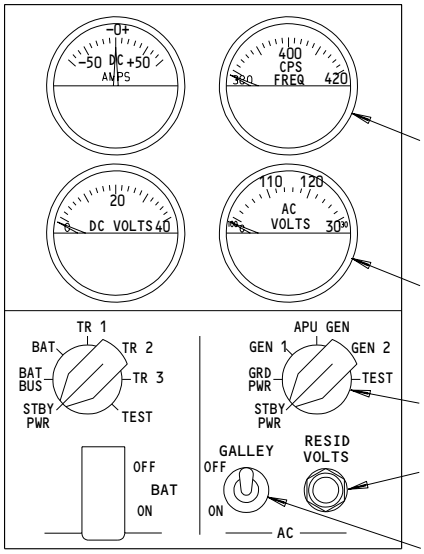
1. General
   A. The standby system is used to supply power to essential ac and dc systems. Under normal conditions, the standby power switch is in the AUTO position, the standby ac bus is energized from the 115-volt ?A transfer bus No. 1, and the standby dc bus is energized from the airplane dc bus No. 1. In the event of losing either the ac or dc normal power, the standby power transfer bus relay No. 1 (R36) is activated by the deactivation of the standby power transfer bus relay No. 2 (R37). This connects the dc standby bus to the battery bus and re-energizes the ac standby bus by activating the static inverter. (Fig. 1)
   B. During checkout of the system on the ground, or refueling the aircraft on battery power only, the standby system is activated by placing the standby power switch in the BATTERY position. This activates the power transfer bus relay No. 1 (R36) which connects the dc standby bus to the battery bus and the ac standby bus to the static inverter.
   C. During electrical smoke isolation procedures, the standby system is deactivated by placing the standby power switch in the OFF position.
2. Operation
   A. The ac standby power bus is a single-phase, 115-volt ac power source which is used to supply 400-Hz power to essential ac systems. (Fig. 1) A static inverter, energized by 28 volts dc from the storage battery through the batter bus, is the alternate source of single-phase, 400-Hz, 115-volt power to the ac standby bus. The power is used for essential communication and navigation equipment, so that the pilot's essential flight instruments will not be deactivated in the event all 400-Hz generated power becomes unavailable during flight.

B. Under normal conditions in flight the standby power switch on the P5 overhead panel should be in the AUTO position. (Fig. 2) A means is thereby provided for automatically transferring the ac and dc standby buses from the 115-volt O/A transfer bus No. 1 and the dc bus No. 1 respectively to the ac supply output from the static inverter and the battery bus through power transfer relays, R36 and R37. (Fig. 3) With the switch in the AUTO position, only the No. 2 standby power transfer relay (R37) is energized by the No. 1 dc bus and a ground generated by the ac voltage sensor when the 115-volt O/A transfer bus No. 1 is energized. When either the dc bus No. 1 or phase A of the No. 1 transfer bus becomes de-energized, transfer relay (R37) relaxes and relay No. 1 (R36) closes, transmitting a dc turn-on signal to the static inverter. Closure of relay No. 1 (R36) connects the inverter output ac through normally closed contacts in relay No. 2 (R37) to the 115-volt ac standby bus and the battery bus dc directly to the dc standby bus. Relay (R36) becomes energized from the battery bus through normally closed contacts in relay (R37) and a ground connection through the landing gear relay (K8). Relay (R36) will drop out on landing. (Fig. 4) To prevent this, the standby power switch may be moved to the BATT position. This supplies an alternate ground for relay (R36), keeping the inverter on as a supply for the 115-volt ac standby bus and the dc standby bus on the battery bus. The standby power switch OFF position provides for de-energizing the system during electrical smoke isolation procedures. (Refer to wiring diagram.) The standby power switch has three connections to ground: two for the coil of the standby power transfer relay (R36) and one for the coil of relay (R37 (Fig. 5) The standby power off light (L5), also on the overhead panel, comes on when both standby power transfer relays (R36 and R37) relax, indicating the loss of power on the standby buses.

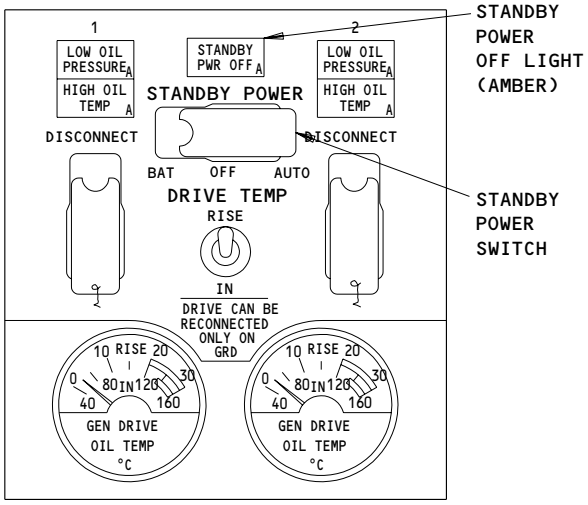


Standby Power System
Figure 1

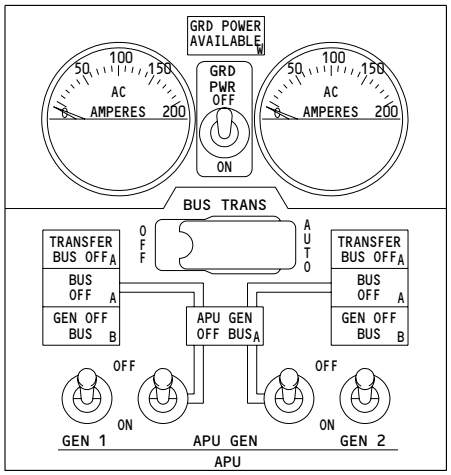




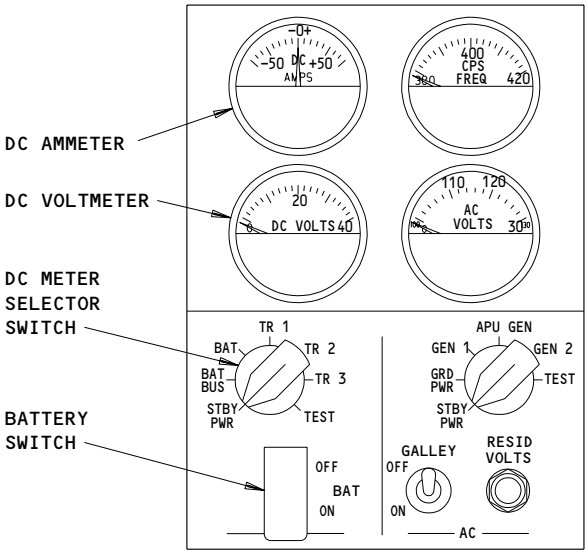
ELECTRICAL POWER PANEL (AC METERING) 1



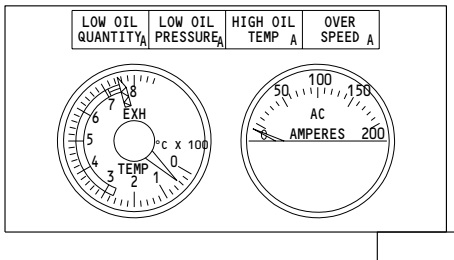
STANDBY POWER 1



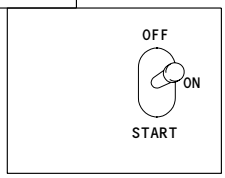
ELECTRICAL POWER PANEL (CONTROLS) 1



DC METERING 1

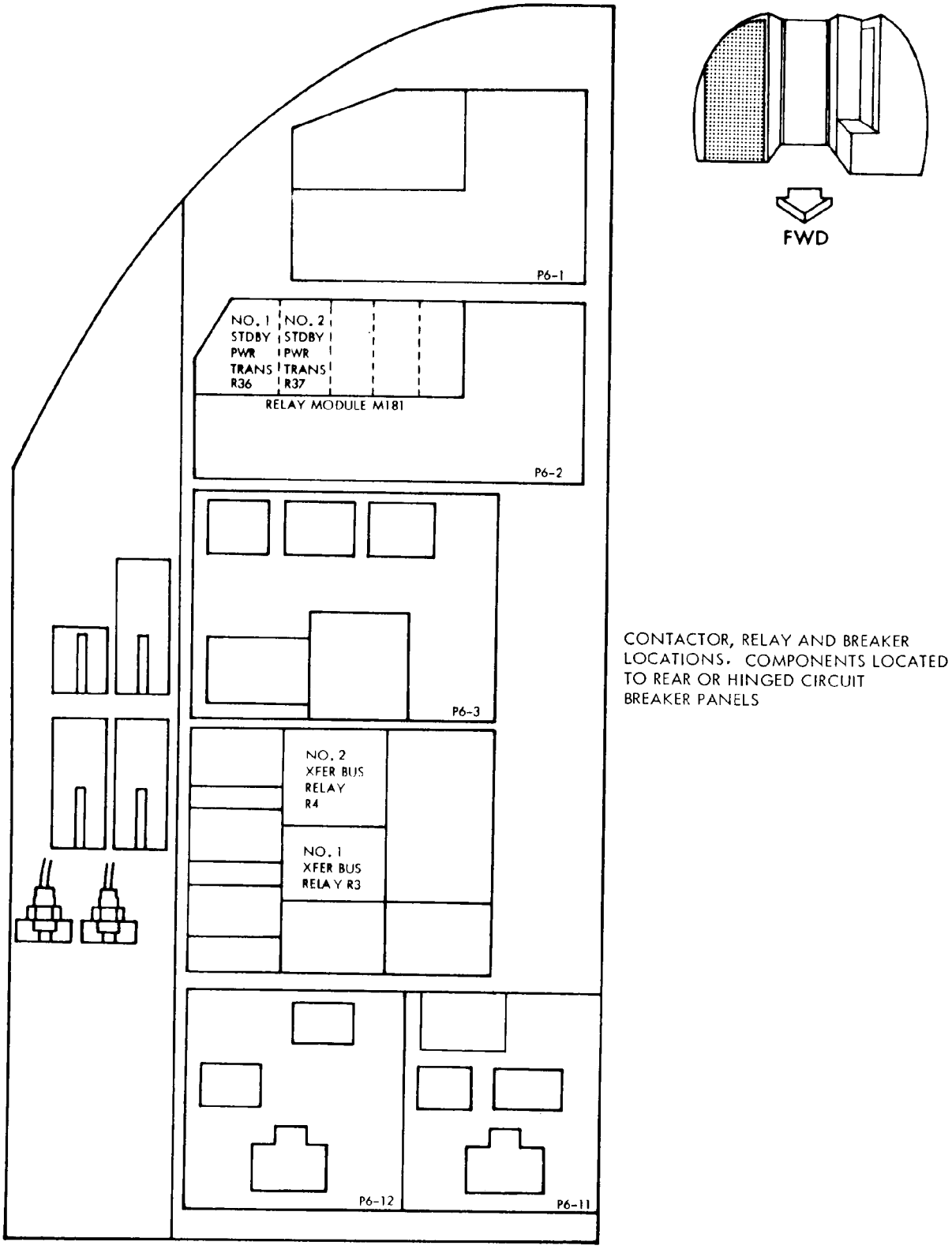


APU CONTROL AND MONITOR 1

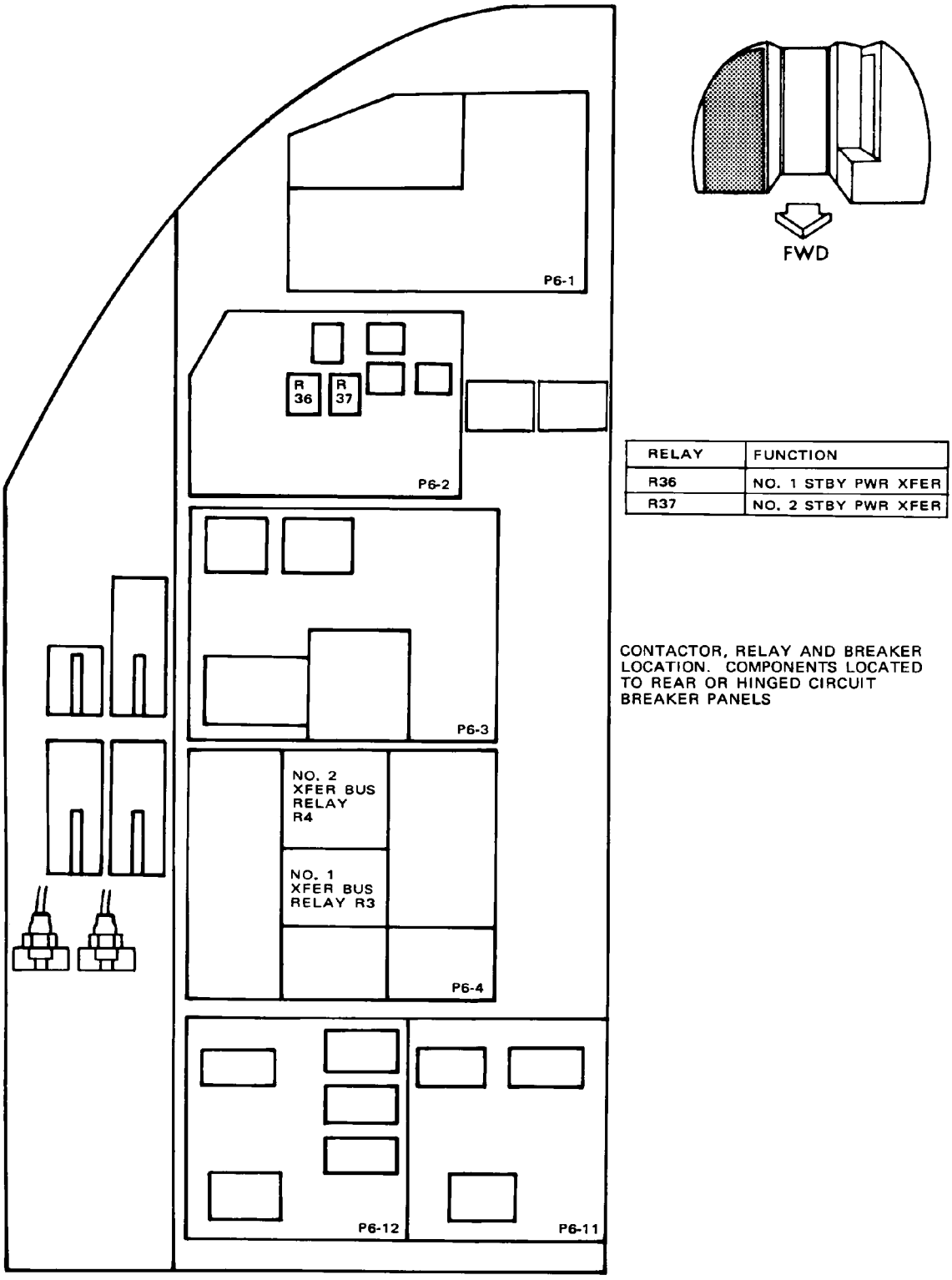


1 TYPICAL ARRANGEMENT. SEE CHAPTER 31 FOR EXACT CONFIGURATIONS

Standby Power System Control Location
Figure 2



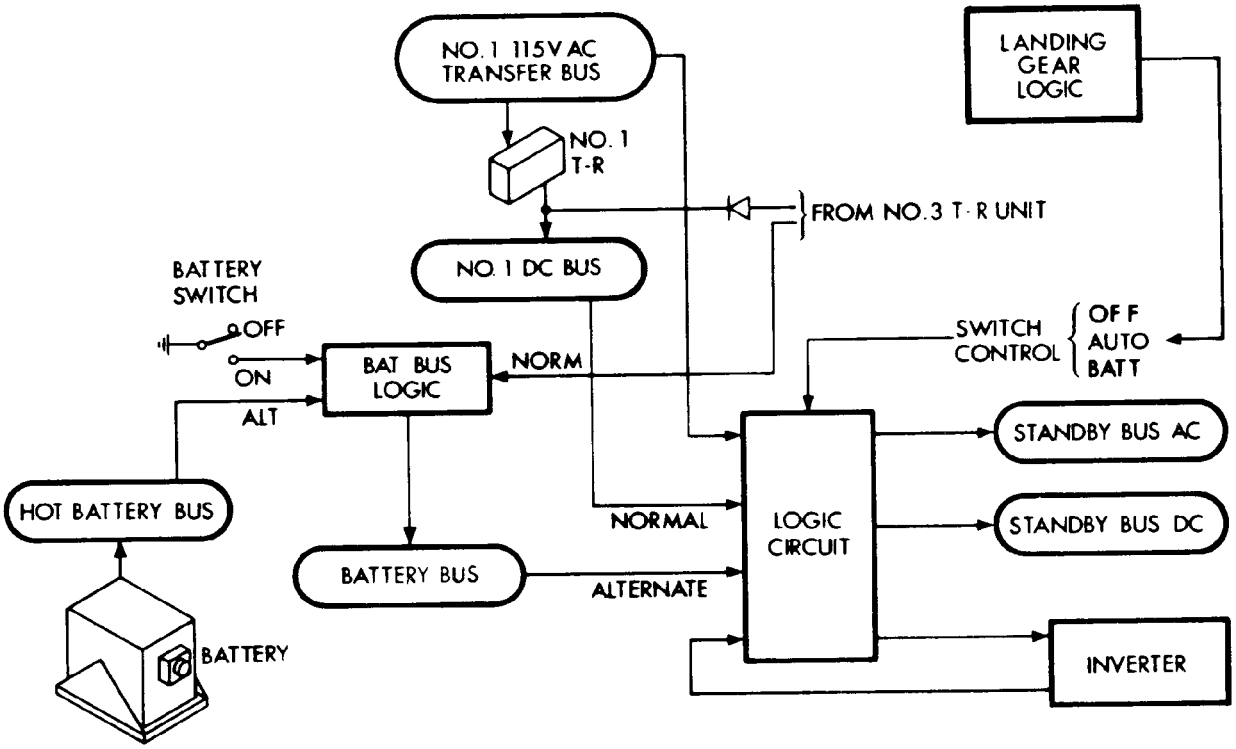
Standby Power System Component Location
Figure 3 (Sheet 1)



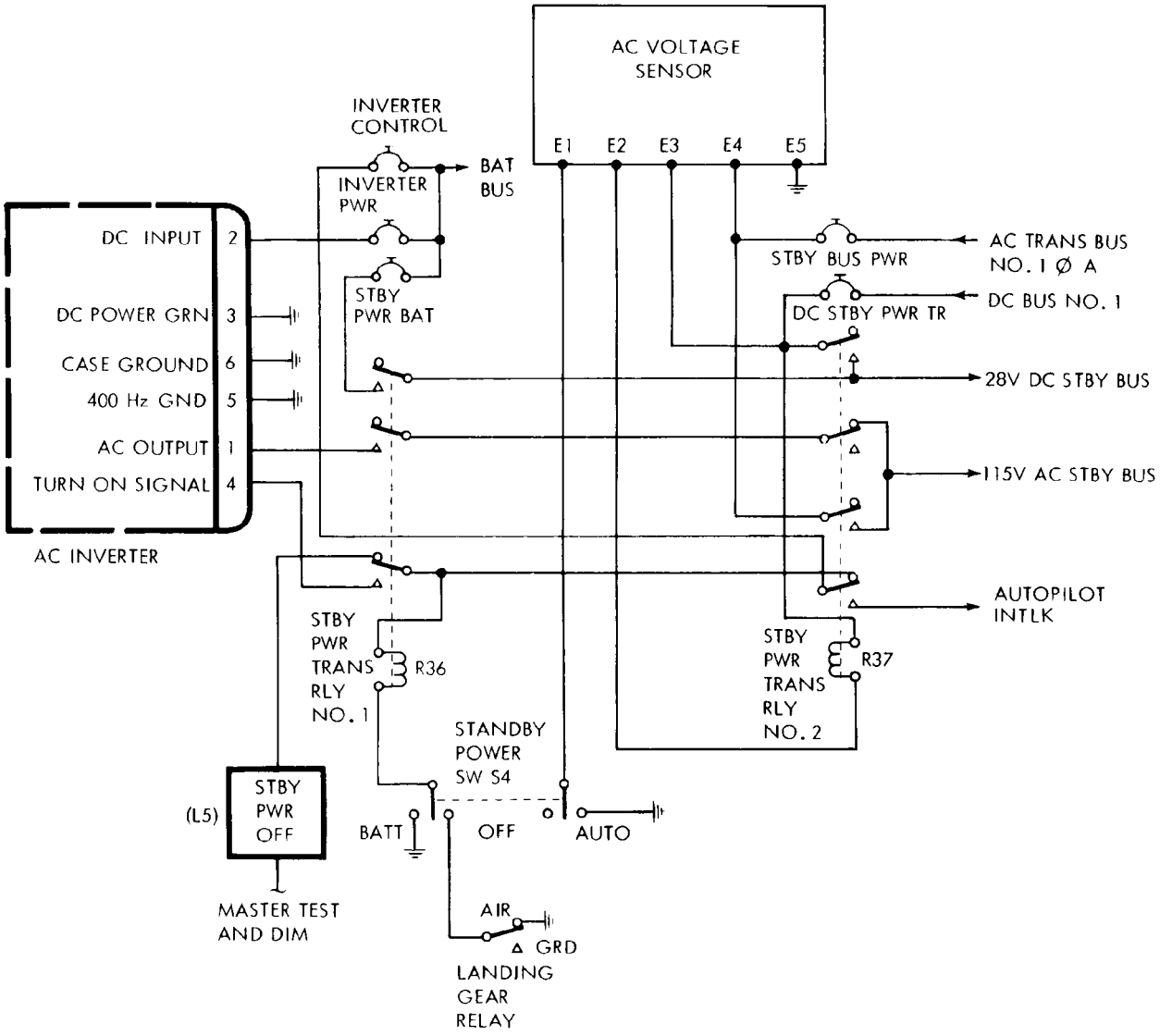
RELAY	FUNCTION
R36	NO. 1 STBY PWR XFER
R37	NO. 2 STBY PWR XFER

CONTACTOR, RELAY AND BREAKER LOCATION. COMPONENTS LOCATED TO REAR OR HINGED CIRCUIT BREAKER PANELS

Standby Power System Component Location
Figure 3 (Sheet 2)



Standby Power Distribution
Figure 4



Standby Bus Circuit Logic
Figure 5

STANDBY POWER SYSTEM - TROUBLESHOOTING

1. General
   A. Assume that there are no wiring malfunctions nor more than one problem in the system. If there is more than one malfunction or there are open or shorted wires, further isolation is necessary.
   B. If it is not practical to make the listed checks, replacement of the suspected part(s) may be more efficient for short ground-time maintenance. Refer to wiring diagram 24-34-01 and 24-50-00.

      WARNING: EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED PANELS. HIGH VOLTAGES PRESENT CAN BE FATAL.

2. Prepare for Troubleshooting
   A. Make sure that the battery is charged (AMM 24-31-11).
   B. Supply electrical power (AMM 24-22-0).
3. Standby Power System Troubleshooting Charts
   A. Set STANDBY POWER switch on P5 panel to BAT.
   B. Open STBY BUS PWR circuit breaker on P6-5 panel and DC STANDBY POWER TR circuit breaker on P6-4 panel.
4. Restore System to Normal
   A. Check that STANDBY POWER switch is set to AUTO.
   B. Remove electrical power, if no longer required (AMM 24-22-0/201).

STANDBY POWER SYSTEM - TROUBLE SHOOTING

1. General
   A. Assume that there are no wiring malfunctions nor more than one problem in the system. If there is more than one malfunction or there are open or shorted wires, further isolation is necessary.
   B. If it is not practical to make the listed checks, replacement of the suspected part(s) may be more efficient for short ground-time maintenance. Refer to wiring diagram 24-34-01 and 24-50-00.

      WARNING: EXERCISE EXTREME CAUTION WHEN WORKING AROUND ENERGIZED PANELS. HIGH VOLTAGES PRESENT CAN BE FATAL.

2. Prepare for Trouble Shooting
   A. Verify that battery is charged (Ref 24-31-11).
   B. Provide electrical power (Ref 24-22-0).

3. Standby Power System Trouble Shooting Charts
   A. Place STANDBY POWER switch on P5 panel to BAT.
   B. Open STBY BUS PWR circuit breaker on P6-5 panel and DC STANDBY POWER TR circuit breaker on P6-4 panel.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
No ac standby power (dc standby OK)		Check for 28v dc at pin 4 to ground (turn-on voltage) of connector D46. Check for 115v ac at pin 1 to ground (output voltage) of connector D46	
	Static inverter	If turn-on voltage is present, but output voltage is not present	Replace static inverter
	Relay R36	If turn-on voltage is not present	Replace R36
	Relay R36 or R37	If output voltage is present, but STANDBY PWR OFF light is off (light OK)	Replace R36. If not ok - replace R37
No dc standby power (ac standby OK)	Relay R36	None required	Replace R36
No ac or dc standby power	Relay R36 or 37	If STANDBY PWR OFF light is on	Replace R36
		If STANDBY PWR OFF light	Replace R37

Standby Power System - Troubleshooting
Figure 101 (Sheet 1)

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
No ac standby power (dc standby power OK) or no dc standby power (ac standby power OK)	Relay R37	None required	Replace R37
No ac or dc standby power (airplane on ground condition only)	Relay R37 not actuating	Check that STBY PWR OFF light is on	Replace ac voltage sensor. If not OK - Replace relay R37. If not OK - Replace standby power module
Failure of system to go to battery standby power with loss of 115v ac (flight condition simulated - GRD SENSING TEST switch actuated)	AC Volt Sensor	Open STDBY BUS PWR circuit breaker on P6-4 panel. Press GRD SENSING TEST switch. System should go to battery power. If not, place STANDBY POWER switch on pilot's fwd overhead panel to BAT.	
CAUTION: MAKE SURE LANDING GEAR PINS ARE IN PLACE AND AVOID PROLONGED ACTUATION OF TEST SWITCH OR DAMAGE TO PITOT OR DRAIN MAST HEATERS MAY RESULT. DISENGAGE YAW DAMPER USING P5 OVERHEAD PANEL SWITCH TO PREVENT INADVERTANT RUDDER MOVEMENT.			
		If system goes to battery standby power.	Replace ac voltage sensor
		If system does not go to battery power.	Replace R37

Standby Power System - Troubleshooting
Figure 101 (Sheet 2)

STANDBY POWER SYSTEM - ADJUSTMENT/TEST

1. General
   A. Major components of the standby power system are the static inverter, standby power transfer relays No. 1 and 2, ac voltage sensor, and the standby power switch. The standby power system should be tested after component replacement or after any other maintenance has been performed on the system.
   B. There are two standby power system tests: an expanded procedure and a short procedure. The expanded procedure tests the standby power system circuitry, the normal and battery supplies to the system, the ac voltage sensor, and the lights and annunciators on the P7 pilot shield and on the M238 annunciator lights module. The short procedure tests the system circuitry and the normal and battery supplies to the system.

      NOTE: Anytime the generator drive and standby power module (P5-5) is replaced, the standby power system must be tested per the expanded procedure.

2. Test Standby Power System (Expanded Procedure)
   A. Verify EMER EXIT LIGHTS switch on P5 overhead panel is in OFF position.

      CAUTION: EMERGENCY EXIT LIGHTING CONTROL SWITCH MUST BE IN OFF POSITION BEFORE REMOVING POWER FROM AIRPLANE. IF LEFT IN ARMED POSITION ALL EMERGENCY LIGHTS WILL COME ON AND BATTERIES WILL DISCHARGE.

   B. Provide 3-phase, 400-Hz, 115-volt power to external power receptacle.
   C. Set GROUND POWER switch on P5-4 to ON.
   D. Set BATT switch on P5-13 to ON.
   E. Open GENERATOR DRIVE OIL LOW PRESS circuit breaker on P6-4.
   F. Press MASTER CAUTION light to reset all caution and annunciator lights.
   G. Set STANDBY POWER switch on P5-5 to OFF and check:
      (1) STANDBY POWER OFF light on P5-5 illuminates
      (2) ELEC and MASTER CAUTION lights on P7 illuminate
   H. Press MASTER CAUTION light and check that MASTER CAUTION and ELEC lights extinguish.
   I. Set STANDBY POWER switch to AUTO and check that:
      (1) STANDBY POWER OFF light extinguishes.
      (2) STANDBY AC light on M238 illuminates.
      (3) STANDBY DC light on M238 illuminates when INDICATE-TEST switch is set to INDICATE.
      (4) ELEC light does not illuminate when ELEC light is pressed.
   J. Set AC and DC meter selector switches to STBY PWR and check that:
      (1) DC voltmeter reads 26 ±4 volts dc.
      (2) AC voltmeter reads 115 ±5 volts ac.
      (3) Frequency meter reads 400 ±10 Hz.

K. Actuate and hold the GROUND SENSING TEST switch on the M338 module.
L. Open AC STANDBY BUS POWER circuit breaker on P6-4 and check that:
   (1) DC voltmeter reads more than 22 volts.
   (2) AC voltmeter reads 115 ±5 volts ac.
   (3) Frequency meter reads 400 ±10 Hz.
M. Close AC STANDBY BUS POWER circuit breaker.
N. Open DC STANDBY POWER TR circuit breaker on P6-5 and check that:
   (1) DC voltmeter reads greater than 22 volts.
   (2) AC voltmeter reads 115 ±5 volts ac.
   (3) Frequency meter reads 400 ±10 Hz.
O. Close DC STANDBY POWER TR circuit breaker.
P. Release GROUND SENSING TEST switch on M338 module.
Q. Set STANDBY POWER switch to OFF and check that:
   (1) STANDBY POWER OFF light illuminates.
   (2) STANDBY AC light extinguishes.
   (3) STANDBY DC light does not illuminate when INDICATE-TEST switch is placed in INDICATE position.
   (4) Both AC and DC voltmeters indicate 0 volt.
R. Press MASTER CAUTION lights and check that MASTER CAUTION and ELEC lights extinguish.
S. Set STANDBY POWER switch to BATT and check that:
   (1) STANDBY POWER OFF light extinguishes.
   (2) STANDBY AC light illuminates.
   (3) STANDBY DC light illuminates when INDICATE-TEST switch is placed in INDICATE position.
   (4) DC voltmeter reads greater than 22 volts.
   (5) AC voltmeter reads 115 ±5 volts ac.
   (6) Frequency meter reads 400 ±10 Hz.
T. Restore standby power system to normal
   (1) Set STANDBY POWER switch to AUTO and check that:
      (a) DC voltmeter reads 26 ±4 volts dc.
      (b) AC voltmeter reads 115 ±5 volts ac.
      (c) Frequency meter reads 400 ±10 Hz.
   (2) Set GROUND POWER switch to OFF and check that STANDBY POWER OFF light illuminates.
   (3) Reset MASTER CAUTION and ELEC lights if necessary.
   (4) Remove external power if no longer required (Ref 24-22-0).
   (5) Set BATT switch to OFF.

3. Test Standby Power System (Short Test)
   A. Verify EMER EXIT LIGHTS switch on P5 overhead panel is in OFF position.

      CAUTION: EMERGENCY EXIT LIGHTING CONTROL SWITCH MUST BE IN OFF POSITION BEFORE REMOVING POWER FROM AIRPLANE. IF LEFT IN ARMED POSITION ALL EMERGENCY LIGHTS WILL COME ON AND BATTERIES WILL DISCHARGE.

B. Start APU (Ref. 49-11-0 MP) or provide 3-phase, 400-Hz, 115-volt power to external power receptacle.
C. Set BATT switch to ON if using external power.
D. Set DC meter selector switch to the following and check that DC voltmeter reads:
   (1) Zero at TR3 position.
   (2) Greater than 22 volts at BAT position
   (3) The same as at BAT position (or within 1/2 volt less) when at BAT BUS position.
E. If using external power, set GROUND POWER switch to ON. If using APU generator driven power, set right and left APU GEN switches to ON.
F. Set DC meter selector switch to the following and check that DC voltmeter reads:
   (1) 26 ±4 volts dc at TR3 position.
   (2) The same as at TR3 position (or within 1/2 volt less) when at BAT BUS position.
G. Set STANDBY POWER switch to OFF and check that STANDBY PWR OFF light illuminates.
H. Set AC and DC meters selector switches to STBY PWR and check that AC and DC voltmeters read zero.
I. Set STANDBY POWER switch to AUTO and check that:
   (1) STANDBY PWR OFF light extinguishes.
   (2) DC voltmeter reads 26 ±4 volts.
   (3) AC voltmeter reads 115 ±5 volts.
   (4) Frequency meter reads 400 ±10 Hz.
J. Set GROUND POWER switch to OFF or set right and left APU GEN switches to OFF and check that:
   (1) STANDBY PWR OFF light illuminates.
   (2) AC and DC voltmeters read zero.
K. Actuate and hold the GROUND SENSING TEST switch on M338 module and check that:
   (1) STANDBY PWR OFF light extinguishes.
   (2) DC voltmeter reads 26 ±4 volts.
   (3) AC voltmeter reads 115 ±5 volts.
   (4) Frequency meter reads 400 ±10 Hz.
L. Release GROUND SENSING TEST switch and check that:
   (1) STANDBY PWR OFF light illuminates.
   (2) AC and DC voltmeters read zero.
M. Set STANDBY POWER switch to BAT and check that STANDBY PWR OFF light extinguishes.
N. Set STANDBY POWER switch to AUTO and check that STANDBY PWR OFF light illuminates.
O. Set DC meter selector switch to TR3 and check that DC voltmeter reads zero.
P. Return standby power system to normal.
   (1) Remove electrical power if no longer required (Ref. 24-22-0).

(2) Set BATT switch to OFF.

GENERATOR DRIVE AND STANDBY POWER MODULE (P5-5) - REMOVAL/INSTALLATION

1. General

CAUTION: Cross connection possibility exists when working with this component. Clearly identify connections upon disconnection and perform a functional check upon reconnection.

A. This procedure has these tasks:
   (1) Removal of the Generator Drive and Standby Power Module
   (2) Installation of the Generator Drive and Standby Power Module
B. The Generator Drive and Standby Power Module, P5-5, is located on the P5 Overhead Panel in the flight compartment.

2. Remove Generator Drive and Standby Power Module
A. Remove electrical power (Ref 24-22-00/201).
B. Holding module panel in place to prevent falling, loosen the quarter turn fasteners.

CAUTION: CARE MUST BE TAKEN TO ENSURE NO DAMAGE OCCURS TO ELECTRICAL CABLES AT REAR OF MODULE.

C. Remove module to gain access to electrical connectors.
D. Disconnect electrical connectors from module.
E. Attach protective covers to the electrical connectors.

3. Install Generator Drive and Standby Power Module
A. Remove electrical power (Ref 24-22-00/201).
B. Remove protective covers from the electrical connectors in the overhead panel bay.
C. Inspect electrical connectors for damage or defects.
   (1) Clean or repair electrical connectors if necessary.

NOTE: Observe the CAUTION above when working with the P5-5 Generator Drive and Standby Power Module on the P5 overhead panel. The associated electrical connectors can be cross connected as follows; D2 and D4 with each other and D636 and D1086 can be cross connected with other connectors in the vicinity (WDM 24-10-01, 24-10-02).

D. Connect electrical connectors to the module.

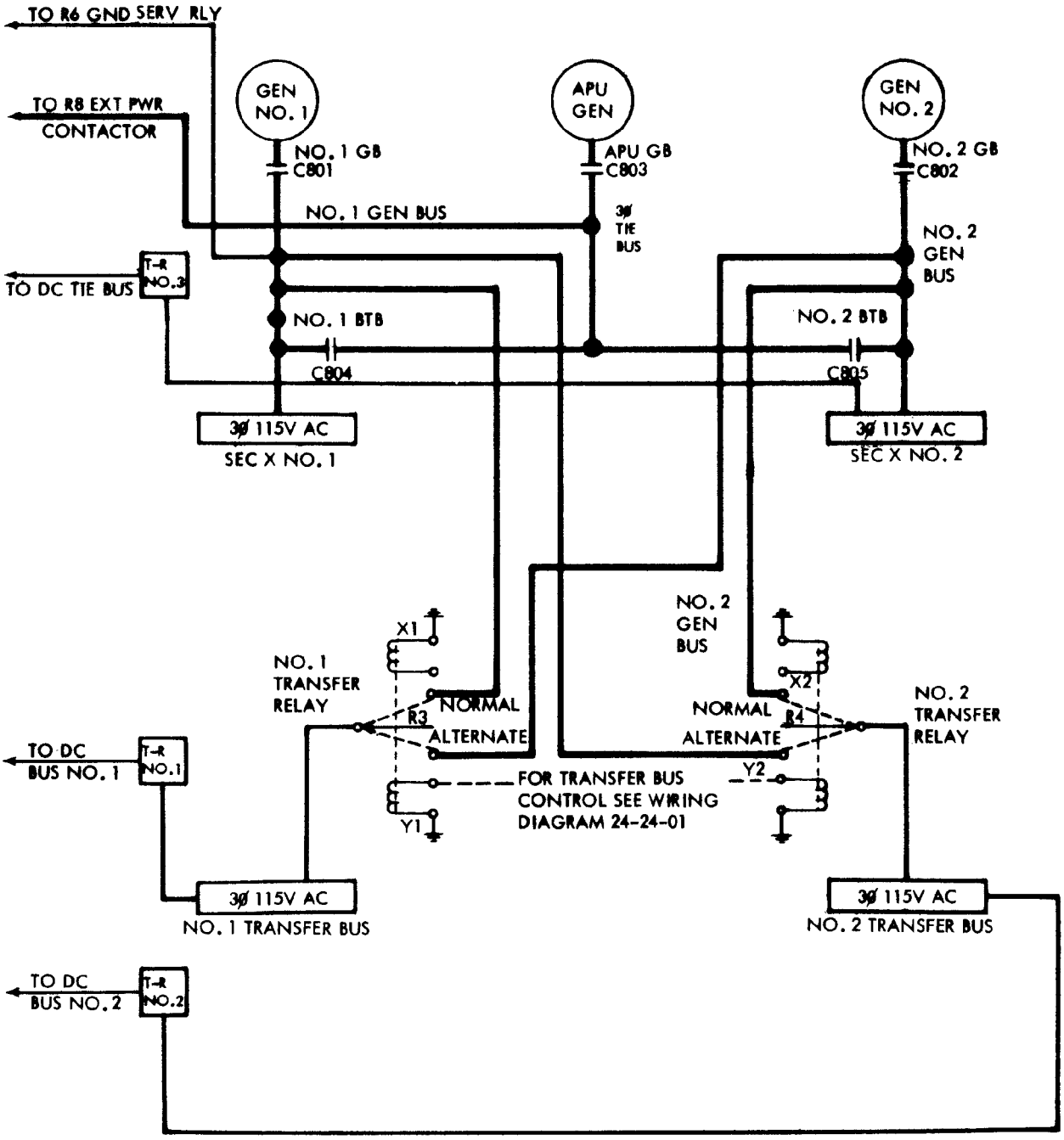
CAUTION: CARE MUST BE TAKEN TO ENSURE NO DAMAGE OCCURS TO ELECTRICAL CABLES AT REAR OF MODULE.

E. Place module into position in the overhead panel bay.
F. Tighten quarter turn fasteners on module.

4. Installation Test
   A. Disconnect the Generator Constant Speed Drive to simulate failure (Ref 24-11-11/401).
   B. Perform the Adjustment Test for the Standby Power System (Ref 24-54-0/501).
5. Restore aircraft to normal configuration
   A. Remove electrical power if no longer required (Ref 24-22-0/201).

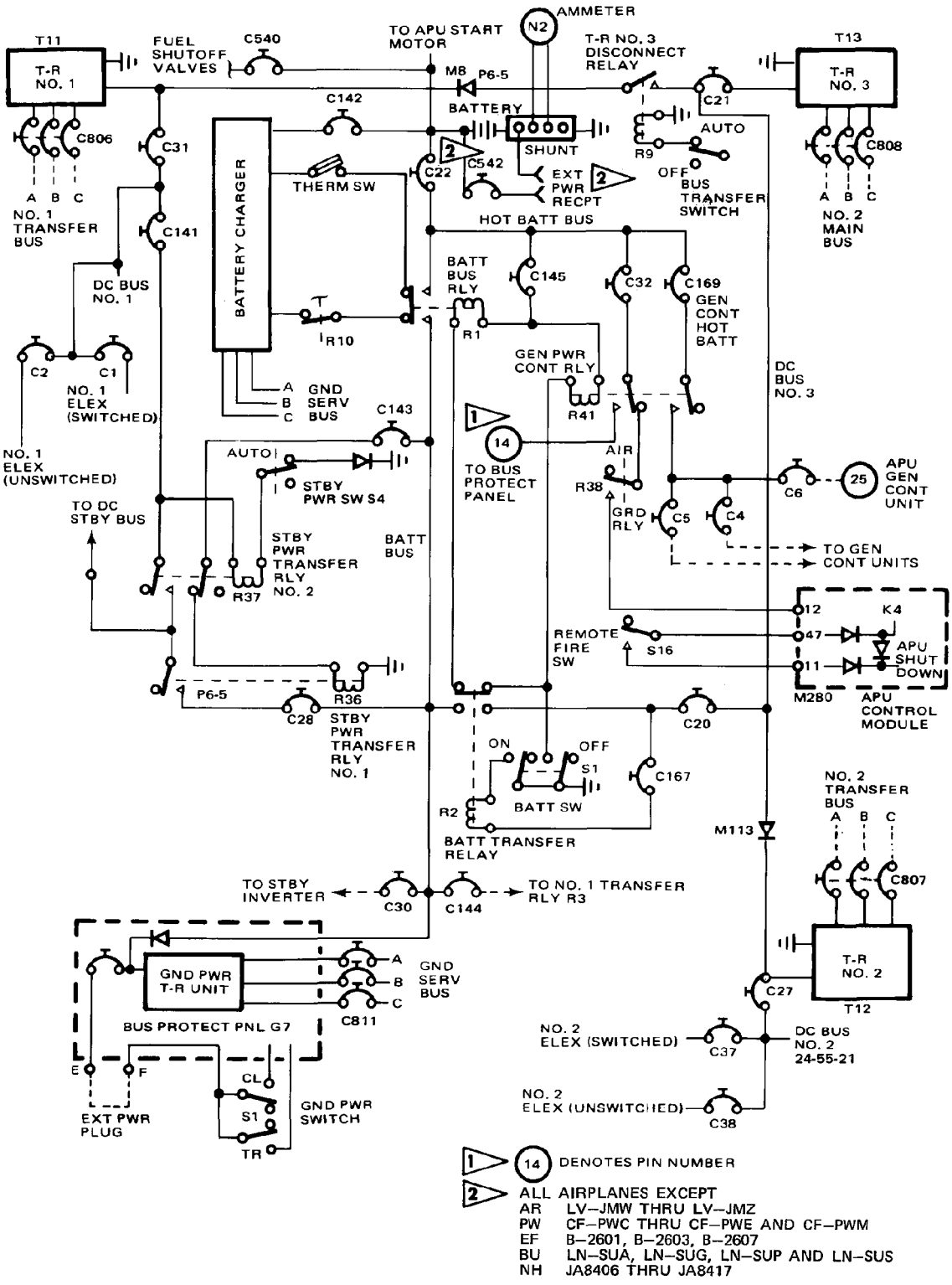
DC POWER DISTRIBUTION - DESCRIPTION AND OPERATION

1. General
   A. That portion of the 115-volt ac power on the airplane which is converted to 28 volts dc is used mostly for control purposes and is distributed from the main load control center panels P6-1, P6-4, P18-1, and P18-2. Conversion or rectification is made through five transformer-rectifier units. T-R units No. 1, 2 and 3 are the unregulated silicone type located on shelf E3-1 in the electronic compartment (Fig. 1). Diodes M8 and M113 between the dc tie bus and dc buses No. 1 and 2 prevent current being fed from T-R units No. 1 and 2 to the output side of T-R unit No. 3 (Fig. 2).
   B. The 28-volt dc external power bus is fed by a fourth T-R unit within the bus protection panel (Fig. 3), and connects to the dc pin E in the external power receptacle. The external power plug contains a jumper which connects pin E to F, completing the circuit to the ground power switch (S1). The bus protection panel T-R provides about 5 amperes dc at 28 volts for ground service use thereby eliminating the need for a separate T-R unit for this purpose, and permits operation of contactors and relays without having a battery on the airplane. The fifth T-R unit, designed specifically for charging the airplane storage battery, is located on E3-1 shelf in the lower forward section (Fig. 3). The battery charger is a limited pulse-type unit capable of supplying 25 amperes continuously. Like the other four T-R units, the charger uses 3-phase 400-Hz input power.
2. DC Power Buses
   A. The dc system supplies power to the following load buses: dc buses No. 1 and 2, the battery bus and hot battery bus, the dc standby bus, the dc electronics buses No. 1 and 2, and the dc external power bus. DC power buses No. 1 and 2 dc buses are isolated from each other preventing a fault on one from affecting the operation of the other. T-R No. 1 and 2 provides dc power for No. 1 and 2 main buses, respectively (Fig. 2). T-R No. 3 is connected in parallel with T-R 1 and 2. A blocking diode in each connecting branch permits only unilateral current flow. In the event either/or both T-R No. 1 and 2 fail, T-R No. 3 provides dc power to the main dc buses.
   B. The battery bus receives power normally from T-R No. 3. When T-R No. 3 is not operating, the battery bus is connected to the hot battery bus. During normal operation, the dc standby bus is supplied power by the No. 1 dc bus (Fig. 2). Should a complete power failure occur, dc bus No. 1 is de-energized, the standby power transfer relay (R37) relaxes, the battery is automatically connected to the battery bus and the dc standby bus. The sequence for this operation is; the battery switch is in the ON position, the battery transfer relay (R2) relaxes when dc bus No. 3 goes dead, the battery bus relay (R1) closes and energizes the battery bus and the standby power transfer relay No. 1 (R36) closes.



dc Power Distribution - Power Source Bus Diagram
Figure 1

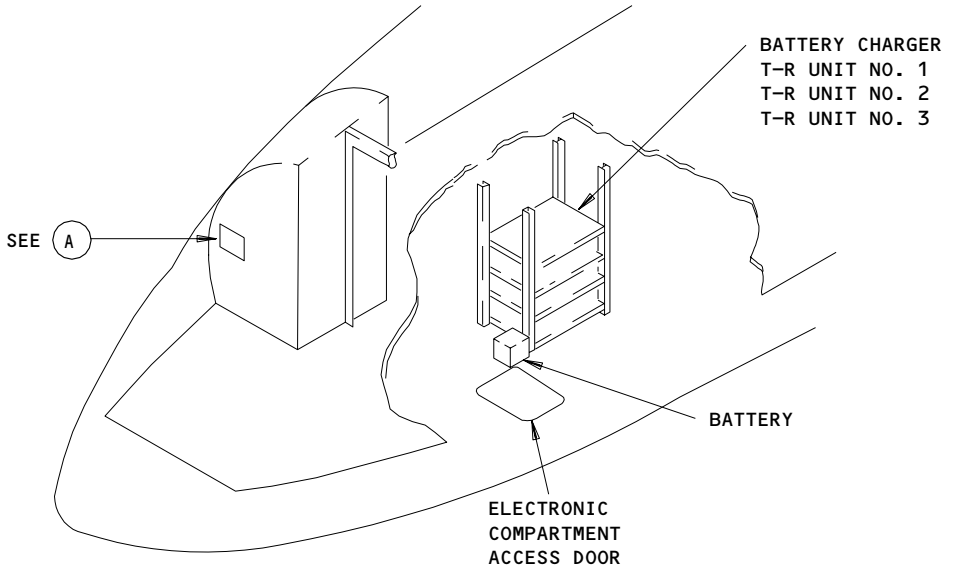
C. The radio and other electronic equipment dc power is distributed from isolated bus connected to dc bus No. 1 and 2. Protection is provided with thermal circuit breakers. Circuit breakers C27 and C31 separate dc bus No. 1 and 2 respectively from the system and therefore, isolate the electronic load busses (Fig. 2). Equipment subject to control by the flight crew is connected to the bus, which are energized only when the No. 1 or 2 master electronic switches (S17 and S18) are in the ON position. This distinction is indicated by showing one branch of the bus as "switched" and the other as "unswitched" (Fig. 2).

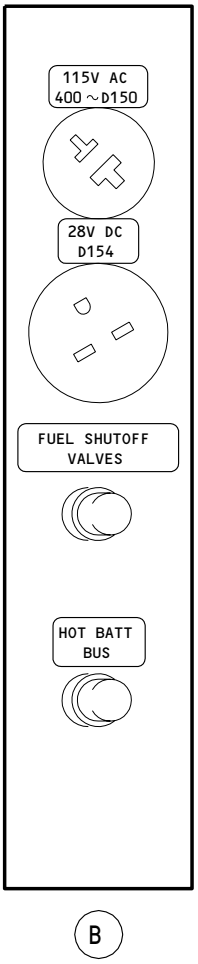


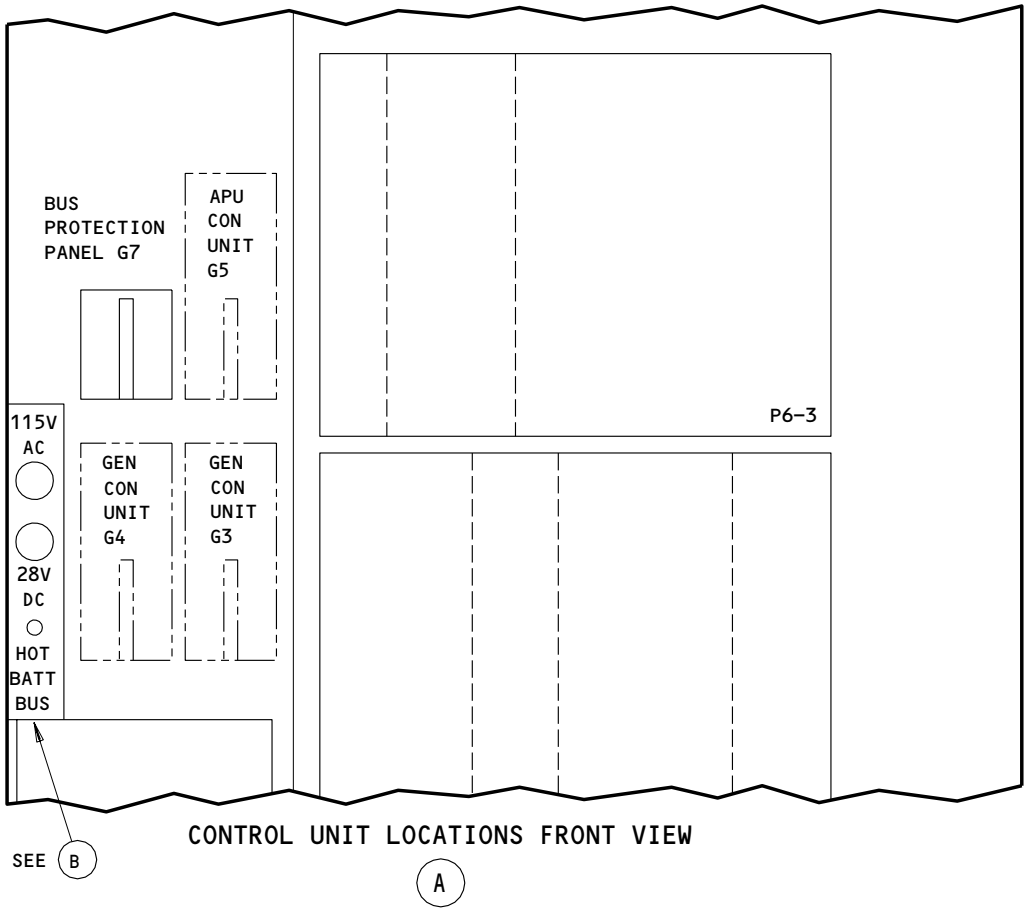
dc Power Distribution
Figure 2 (Sheet 1)

CIRCUIT BREAKER NUMBER	NOMENCLATURE	LOCATION
C1	NO. 1 ELEX BUS SWITCHED	P6
C2	NO. 1 ELEX BUS SWITCHED	P6
C4	NO. 1 GEN DC CONTR	P6-4
C5	NO. 2 GEN DC CONTR	P6-4
C6	APU GEN DC CONTR	P6-4
C20	BATT BUS ALT SUPPLY	P6-5
C21	NO. 1 ALT DC SUPPLY	P6-5
C22	HOT BATT BUS	P6-6
C27	NO. 2 ALT DC SUPPLY	P6-5
C28	STANDBY POWER - BATT	P6-5
C30	INVERTER POWER	P6-5
C31	NO. 1 DC BUS	P6
C32	FUELING & E.P. CONTROL	P6-5
C37	NO. 2 ELEX BUS SWITCHED	P6
C38	NO. 2 ELEX BUS UNSWITCHED	P6
C141	DC STANDBY POWER - TR	P6-5
C142	BATT CHARGER	P6-5
C143	INVERTER CONTROL	P6-5
C144	NO. 1 TRANSFER BUS IND LT	P6-5
C145	BATT BUS CONTROL (HOT BATT)	P6-5
C167	BATT TRANSFER CONTR	P6-5
C169	GENERATOR CONTROL	P6-5
C540	FUEL SHUTOFF VALVES	P6-6

dc Power Distribution
Figure 2 (Sheet 2)







CONTROL UNIT LOCATIONS FRONT VIEW

A

dc Power Distribution Component Location
Figure 3