Aerolineas Argentinas

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CHAPTER 77 - ENGINE INDICATING

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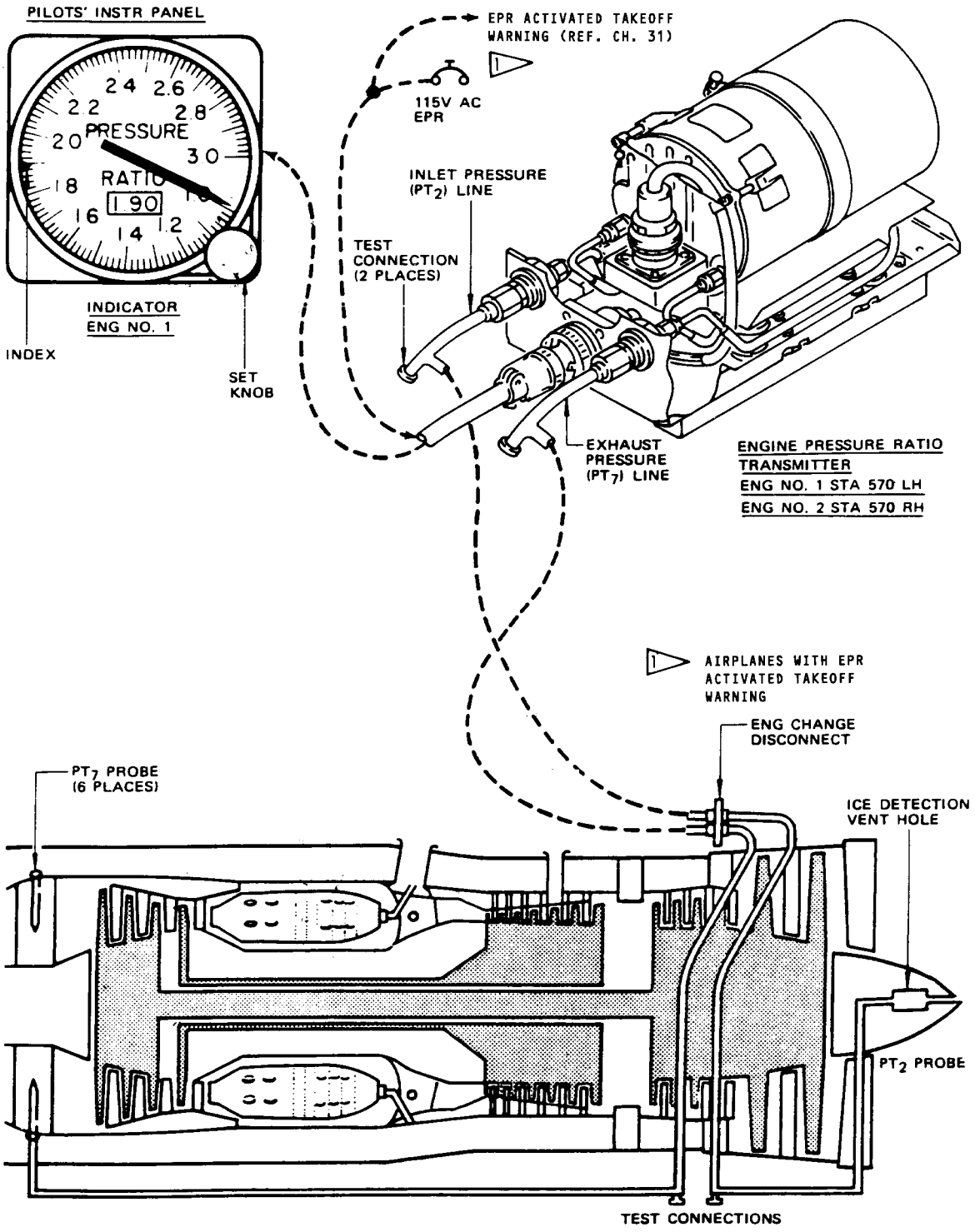
ENGINE INDICATING - DESCRIPTION

1. General
   A. The engine indicating systems described in this chapter include the engine pressure ratio (EPR) indicating system, a tachometer system to measure the speed of the low pressure compressor (N1) and high pressure compressor (N2), an exhaust gas temperature (EGT) indicating system, and an airborne vibration monitoring system.
   B. Each system provides a reading of engine operating conditions on indicators located on the center instrument panel. This information enables the monitoring of engine output and maintaining a selected flight performance.

ENGINE PRESSURE RATIO INDICATING SYSTEM - DESCRIPTION AND OPERATION

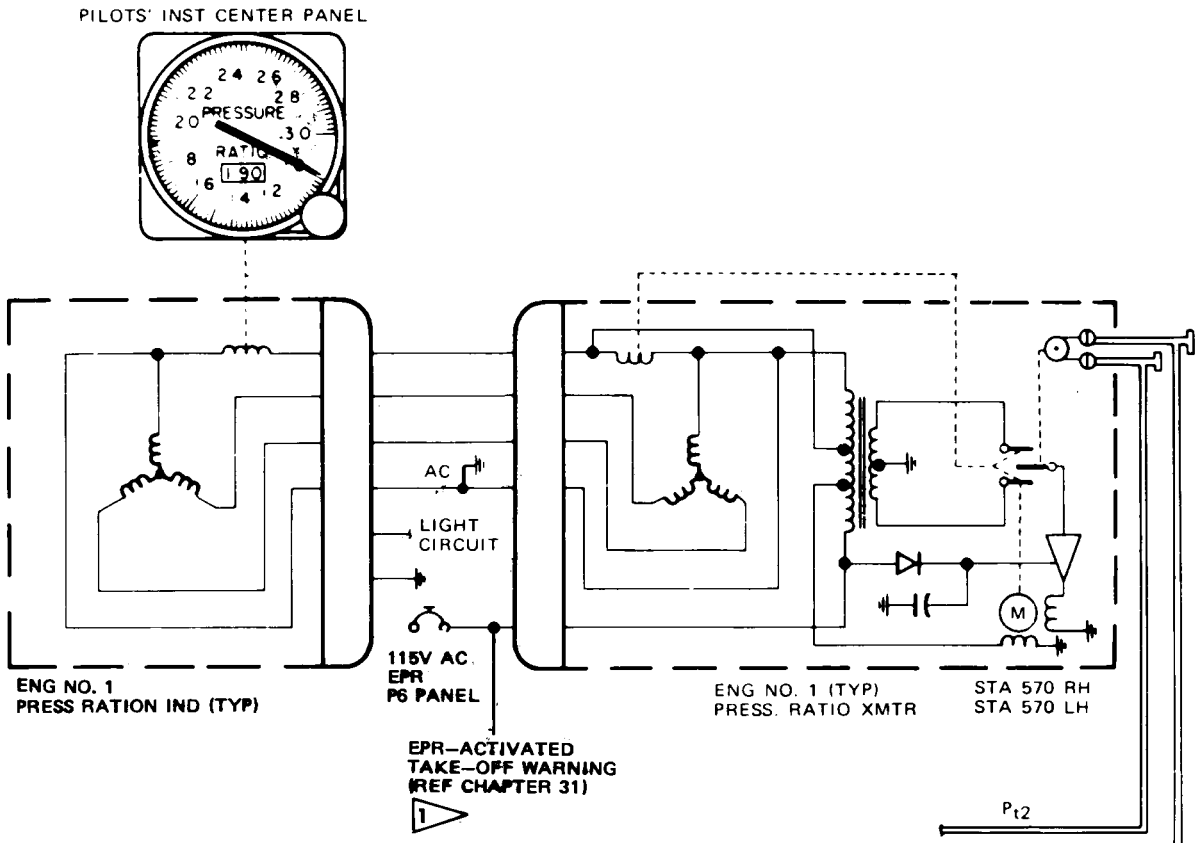
1. General
   A. The engine pressure ratio (EPR) indicating system shows the engine power output and is used for setting engine thrust and for monitoring engine performance. The EPR indicating system consists of one inlet pressure (Pt2) sensing probe, six exhaust pressure (Pt7) sensing probes, an engine pressure ratio transmitter and a pressure ratio indicator for each engine.
   B. The engine inlet and exhaust pressures, sensed by the pressure sensing probes, are transmitted to the pressure ratio transmitter. The transmitter converts the exhaust and inlet pressures into a ratio, provides output signals proportional to the EPR and transmits the signals to the EPR indicator located in the flight compartment. The indicator transforms the electrical input signals into the indicator pointer shaft rotation to show the engine pressure ratio. A test receptacle, used to attach a master indicator, is included in the circuit to provide a means of adjusting and checking the system (Fig. 1). On airplanes incorporating EPR-activated takeoff warning system, refer to Chapter 31, Instruments, for a description.
2. Inlet Pressure Sensing Probe
   A. The engine inlet pressure (Pt2) is sensed by a probe similar to a pitot tube. This probe is mounted through the center of the nose dome with the open end of the tube facing the inlet air stream. The vent hole in the probe functions as the probe ice detector by decreasing engine inlet pressure (increasing EPR) when icing occurs. The probe is anti-iced by the engine anti-ice system.
3. Exhaust Pressure Sensing Probe
   A. Each engine has six exhaust (discharge, Pt7) pressure sensing probes projected into the stream of turbine exhaust gases. The probes are connected to a common manifold for obtaining an average pressure of the exhaust gases. Exterior connection to the manifold is made at a single point through the fan discharge outer duct at approximately the seven o'clock position (Fig. 1).
4. Engine Pressure Ratio Transmitter
   A. The engine pressure ratio transmitter converts the exhaust pressure (Pt7) and the inlet pressure (Pt2) into a ratio, and generates three-phase electrical signals corresponding to pressure changes in the engine. It consists of two bellows (multicell diaphragms), a sensing mechanism, an amplifier, a motor-gear train, and a synchro transmitter. The engine pressure ratio transmitters are located at STA 570 on the right and left side of the airplane in the air conditioning bay.



Engine Pressure Ratio Indicating System
Figure 1

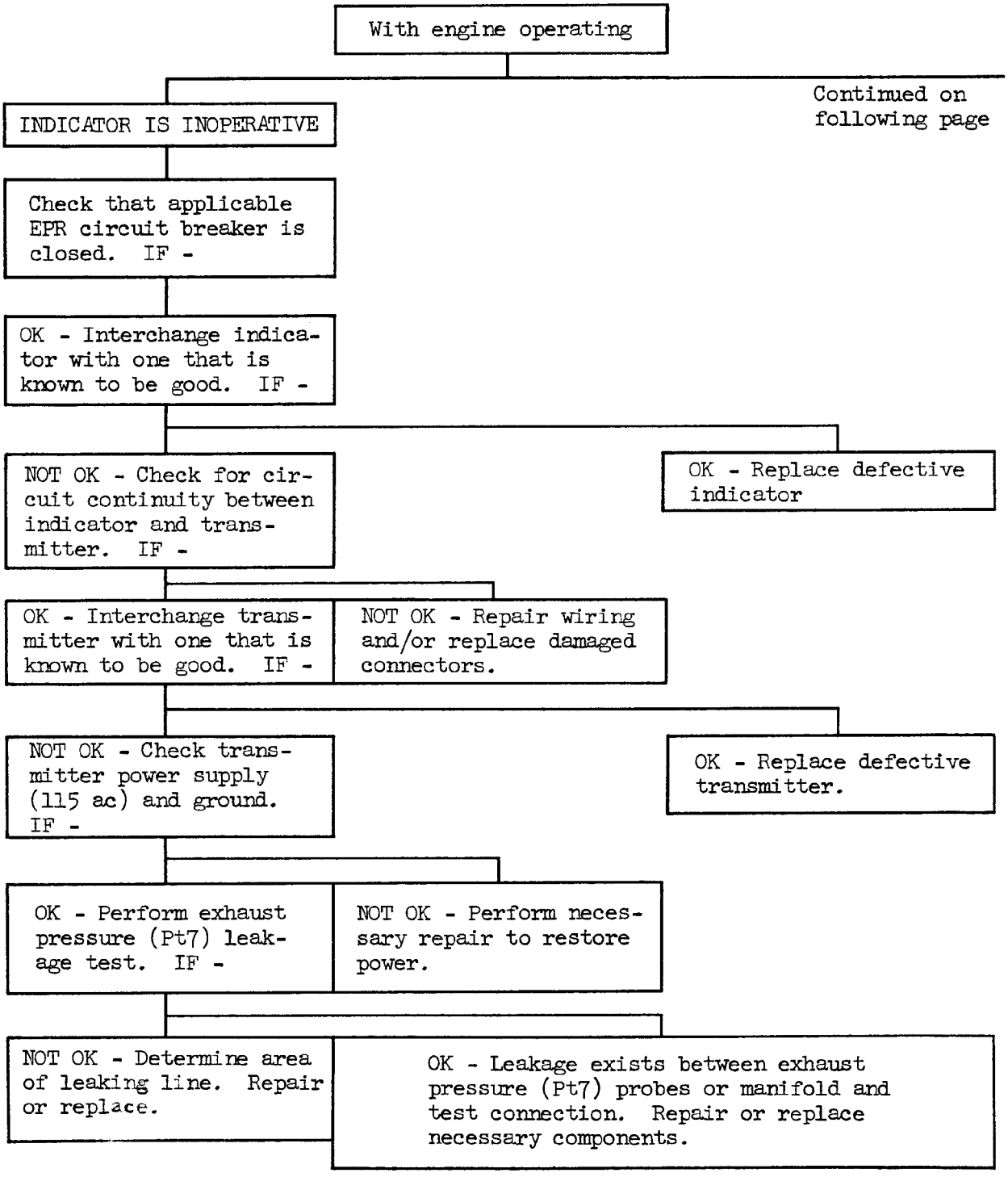
B. The engine exhaust and inlet pressures are applied to the bellows assembly of the transmitter. A change in either of these pressures cause differential bellows movement. The bellows movement affects the sensing mechanism which, with the aid of the amplifier and the motor-gear train, causes the (synchro transmitter) rotor to rotate and generate three-phase electrical signals.

5. Engine Pressure Ratio Indicator
   A. The engine pressure ratio indicator provides a visual indication of the engine exhaust and inlet pressure ratio (Pt7/Pt2). It consists of a synchro receiver and a graduated dial face. There is one indicator for each engine. The indicators are located on the center instrument panel.
   B. The engine pressure ratio indicator transforms electrical three-phase input signals into indicator pointer shaft rotation, to show performance of the engine.
6. Operation
   A. The system operates on ac power. (See figure 2.)
   B. The engine exhaust and inlet pressures are sensed by the pressure sensing probes. These pressures act on the bellows assembly of the pressure ratio transmitter, causing differential bellows movement whenever either of the pressures change. The relative bellows movement effects the sensing mechanism of the EPR transmitter which, with the aid of the amplifier and motor-gear train, cause the synchro transmitter rotor to rotate and generate three-phase electrical signals. The generated electrical signals are transmitted to a respective pressure ratio indicator over a three-wire system. The indicator converts the electrical signals into the pointer shaft rotation or indicator pointer movement corresponding to the pressure change in the engine. (See figure 2.)



1 AIRPLANES INCORPORATING EPR–ACTIVATED TAKEOFF WARNING

Engine Pressure Ratio Indicating System Schematic
Figure 2



Engine Pressure Ratio Indicating System - Troubleshooting
Figure 101 (Sheet 1)

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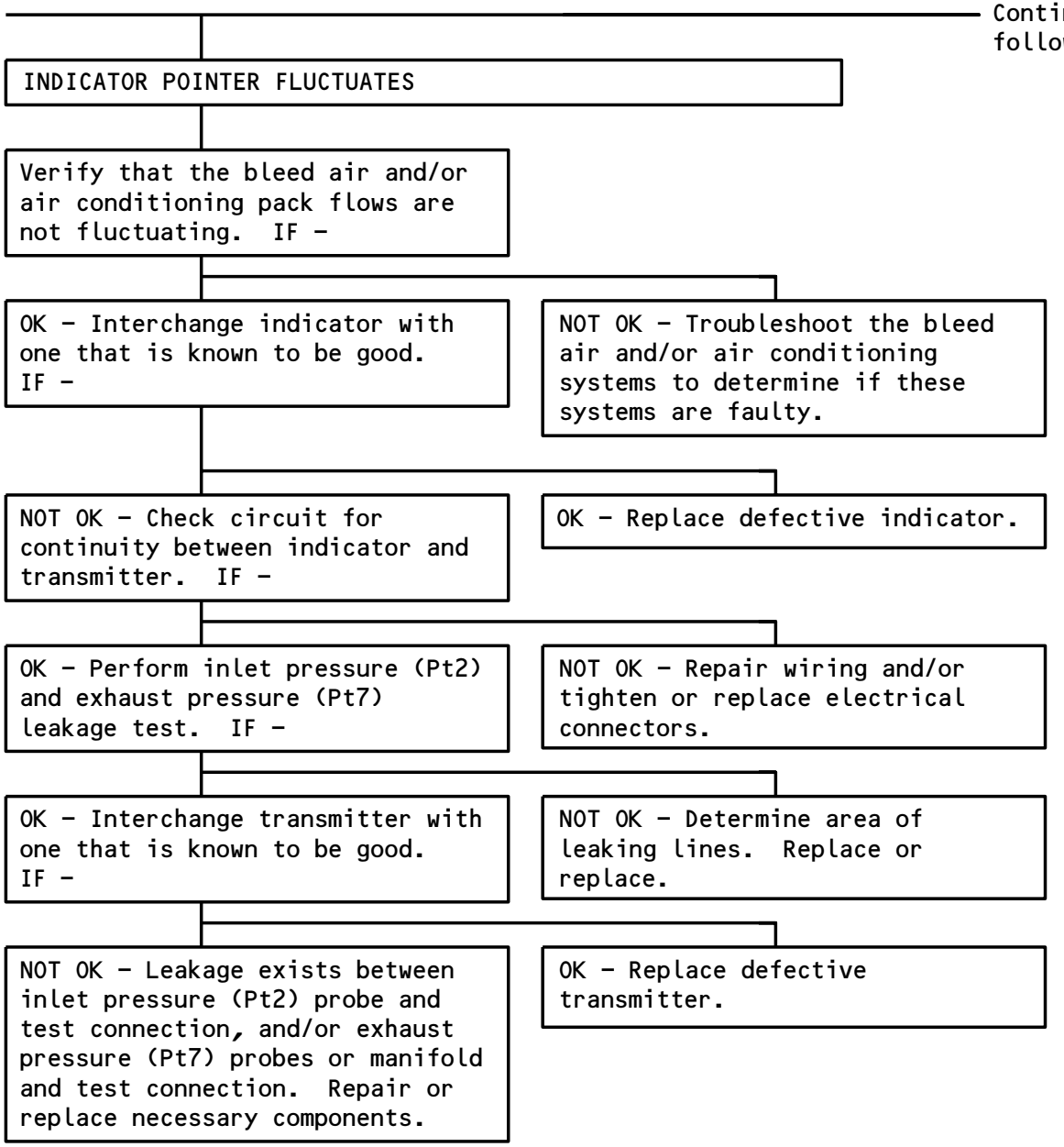
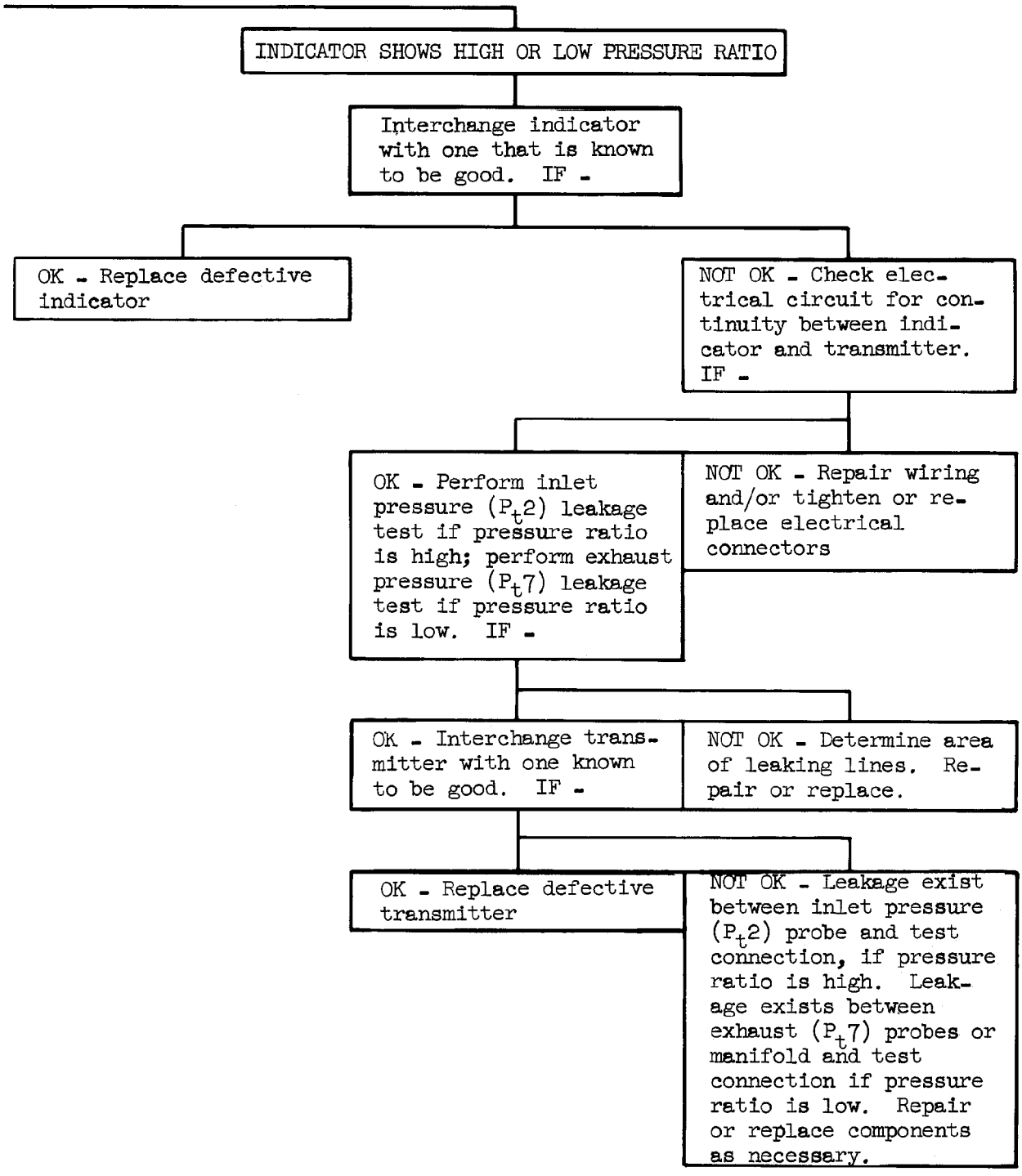


Engine Pressure Ratio Indicating System – Troubleshooting
Figure 101 (Sheet 2)



Engine Pressure Ratio Indicating System - Troubleshooting
Figure 101 (Sheet 3)

ENGINE PRESSURE RATIO INDICATING SYSTEM - ADJUSTMENT/TEST

1. Engine Pressure Ratio Indicating System Test (Preferred Procedure)
   A. General
      (1) Testing the engine pressure ratio (EPR) indicating system consists of two phases. The transmitter inlet (Pt2) and exhaust (Pt7) pressure lines are tested for leakage, and an operational test on the entire system is performed. The components included in this systems test are the pressure ratio transmitter, indicator, and the inlet and exhaust pressure lines.

         NOTE: The order of the two test phases should not be reversed. If systems operational test is performed prior to the leakage test, erroneous results may be obtained because of possible leaking lines or transmitter.

      (2) Testing the engine pressure ratio indicating system will not include the inlet pressure sensing probe and its connecting line through nose dome because of the difficulties in closing the vent hole in the nose dome for the testing purposes. Also, the exhaust pressure probes and manifold will not be included in the test due to the difficulties involved in obtaining access. Therefore, it should be kept in mind, that if the first phase of the test does not reveal any leakage, and the second phase indicates faulty systems operation, the cause may be assumed to be in the areas mentioned above.
      (3) Refer to step 2 for an alternate EPR test procedure.
   B. Equipment and Materials
      (1) An air pressure source with two individually regulated outlets, the pressure of which can be accurately set at pressures between 25.00 and 100.00 inches of mercury absolute. All pressures are to be monitored by pressure gages with an accuracy of ±0.5%. Shutoff valves must be provided on the source side of all gages (Fig. 501).
      (2) Gage - Pressure, Model C, 0-50 or 0-100 inch HgA, 0.1% Full Scale, Hiese
      (3) Shutoff Valve (4), A311 - 1/8" ID, Dwyer Instr.
      (4) T-Fitting (4), A343-1 - 1/8" ID, Dwyer Instr.
      (5) Fitting (2), A339 - 1/8" ID, Dwyer Instr.
      (6) Tubing 30 feet, A225 - 1/8" ID, Dwyer Instr.
      (7) Wheatstone Bridge, Shallcross 638-R, Shalltronix
   C. Prepare for Test
      (1) Obtain access to inlet pressure line coupler by removing nose dome on engine(s) to be tested (AMM Chapter 71, Power Plant).
         (a) On engines with a Pt2 pressure inlet test "TEE", seat the Pt2 pressure line coupler pressure tight.

(2) Observe the following precautions for maintenance in engine exhaust section.
  (a) Pull applicable engine START circuit breaker on circuit breaker panel P6-2, and placard circuit breaker with DO NOT CLOSE.
  (b) Placard thrust reverser controls with DO NOT OPERATE.

    WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR IF THRUST REVERSER IS OPERATED.

  (c) Open ENGINE-1 and ENGINE-2 EPR circuit breakers on circuit breaker panel P6.
(3) Obtain access to exhaust pressure line connection on engine(s) by opening cowl panel on engine(s) (AMM Chapter 71, Power Plant).
(4) Disconnect exhaust pressure line from exhaust pressure manifold outlet elbow on engine(s) (Fig. 501).

D. Test Engine Pressure Ratio Indicating System

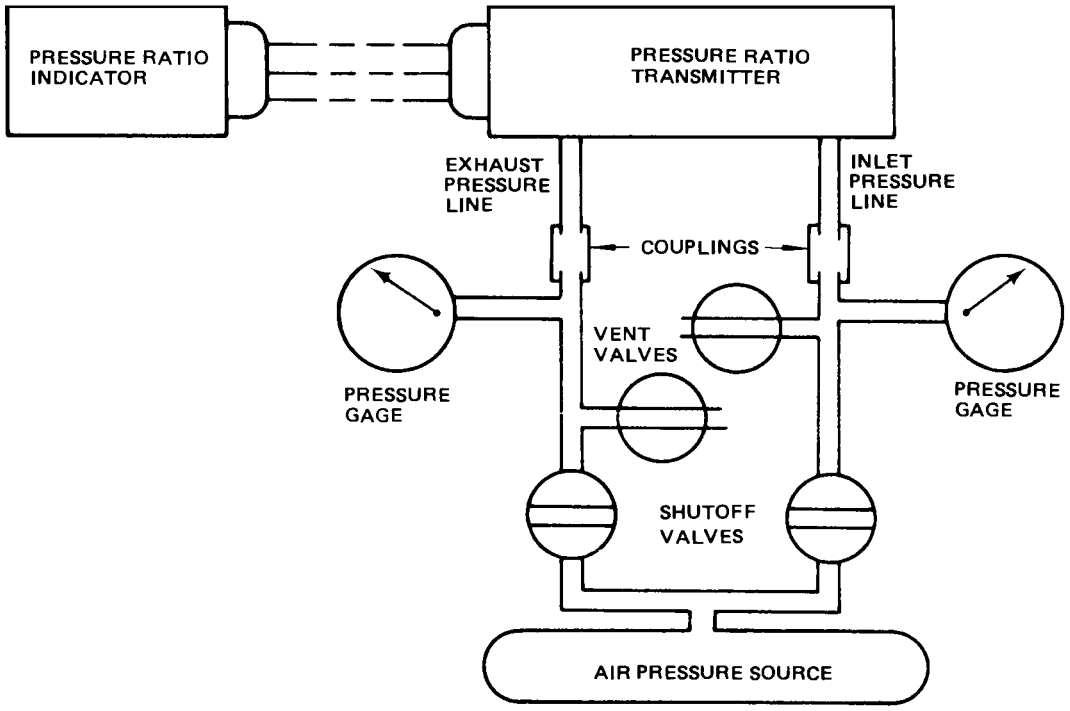
CAUTION: DO NOT EXCEED 42 INCHES OF MERCURY ABSOLUTE (20.63 PSIA) ON INLET PRESSURE LINE, OR 80 INCHES OF MERCURY ABSOLUTE ON EXHAUST PRESSURE LINE WHILE LINES ARE CONNECTED TO TRANSMITTER. MAXIMUM PRESSURE DIFFERENTIAL SHALL NOT EXCEED 51 INCHES OF MERCURY (25.05 PSIA) DURING THESE TESTS TO PREVENT PERMANENT DAMAGE TO THE TRANSMITTER.

(1) Test Inlet Pressure Line Leakage
  (a) Connect test hose from test apparatus to inlet pressure line test "Tee", located on lower front flange or on some airplanes to inlet line coupler, located on engine front accessory drive housing (Fig. 501). Do not connect test hose to exhaust pressure line at this time.

    NOTE: It is suggested that test hose adapter (to mate with inlet pressure line coupler) be made from a spare inlet pressure (Pt2) nose dome assembly.

  (b) Slowly apply pressure of 42 inches of mercury absolute (20.63 psia) to inlet pressure line, then close valve to pressure source.

    NOTE: Absolute pressure is the sum of gage pressure and barometric pressure. For example, if barometric pressure is 30.1 inches of mercury (14.79 psia), gage pressure required is 42 minus 30.1 or 11.9 inches of mercury (5.85 psia).



Engine Pressure Ratio Indicating System Test Connections
Figure 501 (Sheet 1)

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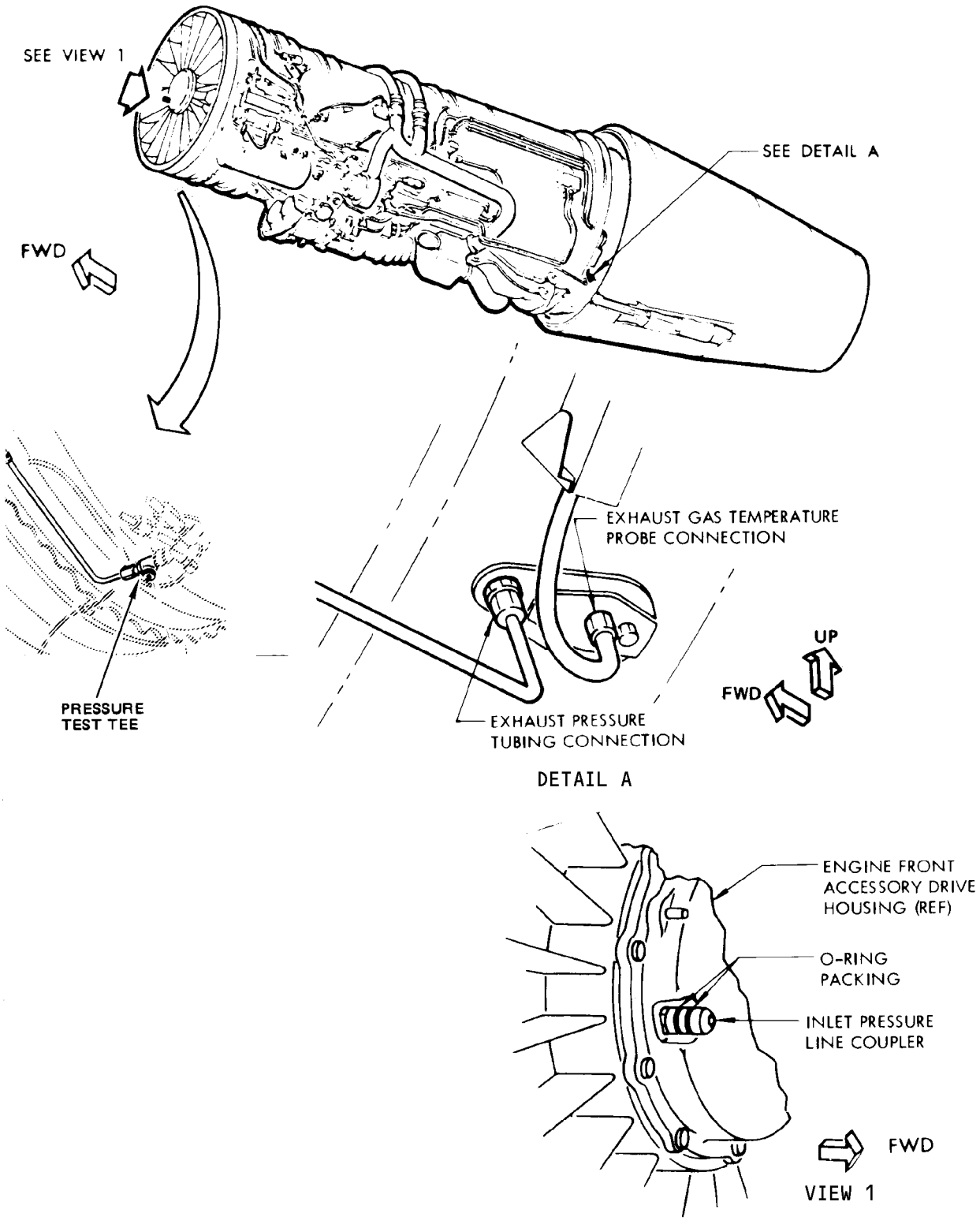


Engine Pressure Ratio Indicating System Test Connections
Figure 501 (Sheet 2)

(c) Check that pressure leakage does not exceed 0.25 inch of mercury during a 5-minute period.
(d) Relieve pressure slowly through test apparatus vent valve.

(2) Test Exhaust Pressure Line Leakage
(a) With inlet pressure test line still connected, connect test hose from test apparatus to exhaust pressure line.
(b) Slowly apply pressure of 32 inches of mercury absolute (15.71 psia) to inlet pressure line.
(c) Slowly apply pressure of 70 inches of mercury absolute (34.38 psia) to exhaust pressure line, then close valve to pressure source.
(d) Check that pressure leakage does not exceed 0.25 inch of mercury in exhaust pressure line during a 5-minute period.
(e) Reduce pressure in both lines through test apparatus vent valves.

CAUTION: REDUCE EXHAUST LINE PRESSURE BELOW 50 INCHES OF MERCURY ABSOLUTE (24.56 PSIA) BEFORE REDUCING INLET PRESSURE TO PREVENT DAMAGE TO TRANSMITTER.

(3) Test System Operation
(a) Connect electrical power to airplane.

NOTE: An engine pressure ratio indicator reading above 1.00 with engines shut down or no pressure applied to system does not necessarily mean that system is inaccurate or that a component needs replacement. Frictional losses may cause sticking of pointer, and an adjustment/test should be made before changing system components.

(b) Close applicable engine EPR AND OIL QUANTITY circuit breaker on circuit breaker panel (P6).

CAUTION: ALLOW SYSTEM TO WARM UP FOR 2 MINUTES BEFORE CONDUCTING TEST TO PREVENT DAMAGE TO PRESSURE RATIO TRANSMITTER.

(c) Apply pressure to inlet and exhaust pressure lines per Table I to obtain 1.50 on the pressure ratio indicator.

Table I				
ENGINE INLET PRESSURE		ENGINE EXHAUST PRESSURE		PRESSURE RATIO INDICATIONS
In. Hg Abs	PSIA	In. Hg Abs	PSIA	Pt7/Pt2
31.00*	15.23	68.2*	33.50	2.20 ±0.015**
31.00*	15.23	46.5*	22.84	1.5 ±0.015**
*	Correct for barometric pressure			
**	The tolerances exclude test equipment accuracy. Test equipment tolerance should be determined and considered cumulative to the test tolerance.			
***	± 0.005 for airplanes with digital readout EPR indicator and improved Honeywell EPR transmitter.			

(d) Open applicable EPR circuit breaker. Engine pressure ratio indicator reading should not change.
(e) With circuit breaker open, increase exhaust line pressure to 68.20 inches of mercury absolute (33.5 psia). Engine pressure ratio indicator reading should not change.
(f) Close applicable EPR circuit breaker. Pressure ratio indicator should read 2.20.
(g) Engine pressure ratio indicator should read both values within tolerances shown in Table I after tapping lightly.

CAUTION: DO NOT TAP INDICATOR GLASS HARD OR USE RINGS, SCREWDRIVER HANDLES, OR SIMILAR RIGID OBJECTS FOR TAPPING. BROKEN OR SCRATCHED GLASS MAY RESULT.

NOTE: An engine pressure ratio indicator above 1.00 with the engines shut down or no pressure applied to system is due to the lower mechanical stops in the transmitter which prevent the unit from going below 1.00. In some units due to tolerances in the gear train and location of the mechanical stop, the transmitter is incapable of transmitting a signal of 1.0 to the indicator.

(h) Relieve test pressures and remove test pressure lines.

CAUTION: REDUCE EXHAUST LINE PRESSURE BELOW 50 INCHES OF MERCURY ABSOLUTE (24.56 PSIA) BEFORE REDUCING INLET PRESSURE TO PREVENT TRANSMITTER DAMAGE.

(i) If other engine pressure ratio system is to be tested repeat steps C and D.

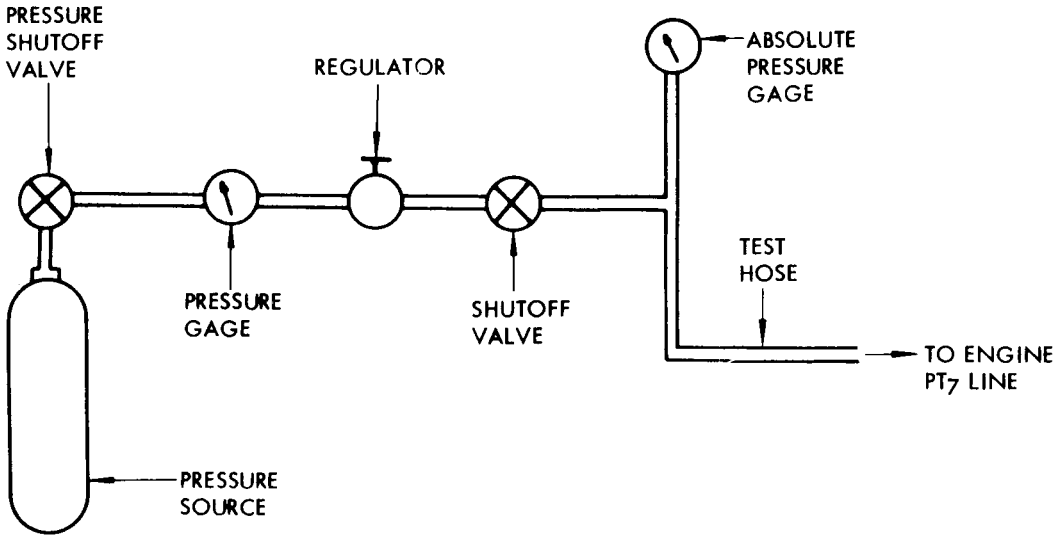
E. Return Airplane to Normal Configuration
(1) Reconnect exhaust pressure line to exhaust pressure manifold outlet elbow.
(2) Close engine cowl panel(s).
(3) Check inlet pressure nose dome(s) for visual damage.
(4) Install nose dome(s) (AMM 71-11-51).
(5) Determine whether there is any further need for electrical power on airplane; if not, remove power.

2. Engine Pressure Ratio Indicating System Test (Alternate Procedure)
A. General
(1) The following test procedure will apply during an Engine Pressure Ratio Indicating system accuracy check.
B. Equipment and Materials
(1) A regulated air pressure source
(2) Absolute pressure gage
(3) Test hose
(4) Shutoff valve (Fig. 501)
C. Prepare for Test
(1) Pull applicable engine START circuit breaker on circuit breaker panel P6-2, and placard circuit breaker with DO NOT CLOSE.
(2) Placard thrust reverser controls with DO NOT OPERATE.

WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR THRUST REVERSER IS OPERATED.

(3) Open ENGINE-1 and ENGINE-2 EPR circuit breakers on circuit breaker panel P6.
(4) Open cowl panels (AMM Chapter 71).
D. Test Engine Pressure Ratio Indicating System (Fig. 501)
(1) Disconnect PT7 line at the 6 o'clock position of the turbine exhaust case (Fig. 501).
(2) Attach test line to engine PT7 line.
(3) Obtain barometric pressure from absolute pressure gage and note.
(4) Check that regulator valve is backed off and that valve to test line is open.
(5) Open shutoff valve on air source.
(6) Gradually increase regulator setting until absolute pressure gage reads 1.5 times barometric pressure.

(7) Close valve.
(8) Note pressure reading on absolute gage. A drop in pressure indicates line leakage. Correct as necessary to obtain zero leakage.
(9) With 1.5 times barometric pressure trapped in system, the EPR indicator must read 1.50 ±0.015.
(10) Increase pressure with regulator until 2.20 times barometric is registered on absolute gage. Check that EPR indicator now reads 2.20 ±0.015.
(11) If either check point is out of limits, install a serviceable indicator to determine whether transmitter or indicator is at fault.
(12) Replace the faulty unit and recheck as per steps 9 and 10.
(13) Disconnect engine PT7 line from test unit and reconnect line to 6 o'clock fitting of turbine exhaust case.
(14) Close engine cowl panels.

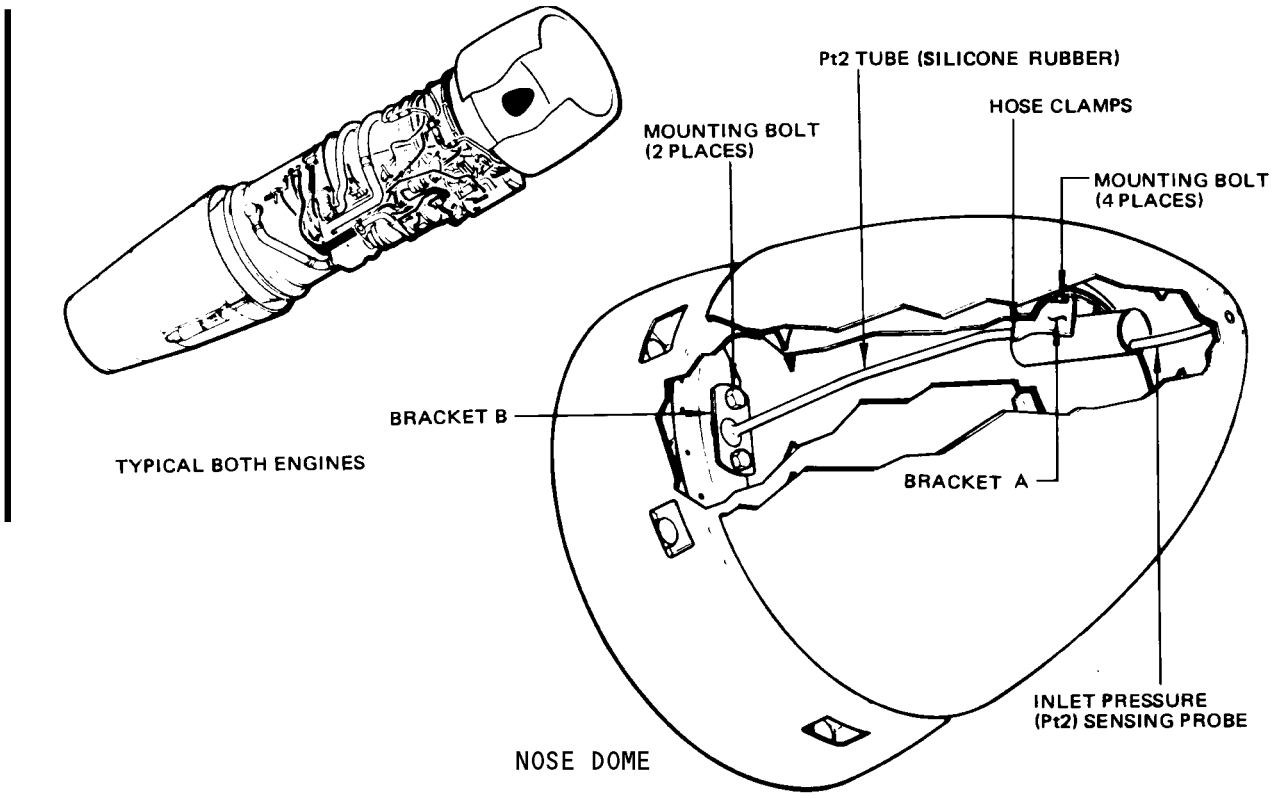


ALTERNATE PROCEDURE

Engine Pressure Ratio Indicating System Test Connections
Figure 501 (Sheet 3)

INLET PRESSURE SENSING PROBE - REMOVAL/INSTALLATION

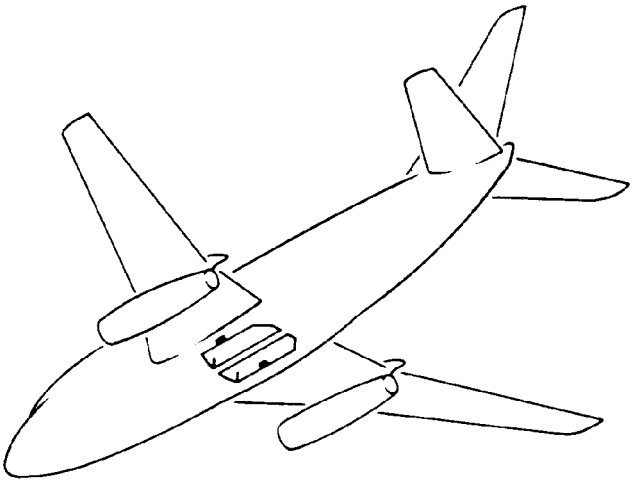
1. General
   A. The engine inlet pressure (Pt2) sensing probe is assembled to the engine nose dome and is removed and installed with the dome.
2. Remove Engine Inlet Pressure Sensing Probe
   A. Remove engine nose dome (Ref Chapter 71).
   B. Remove mounting bolts from brackets A and B (Fig. 401).
   C. Lift out inlet pressure sensing probe.
3. Install Engine Inlet Pressure Sensing Probe
   A. Check the tubes of the inlet pressure sensing probe for foreign material and remove if present.
   B. Place probe inside the nose dome.
   C. Install mounting bolts (Fig. 401).
   D. Install engine nose dome (Ref Chapter 71).

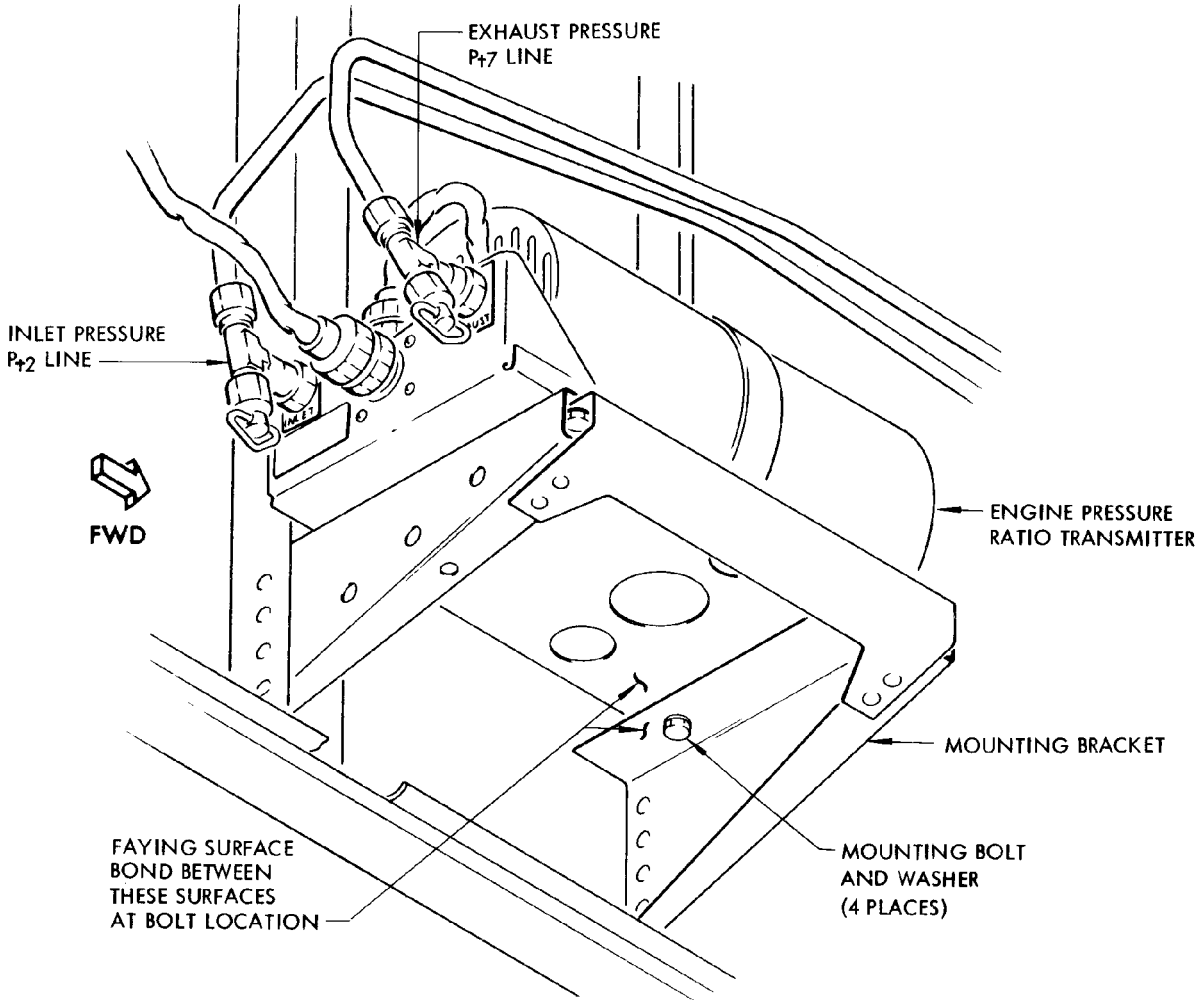


Inlet Pressure Sensing Probe Installation
Figure 401

ENGINE PRESSURE RATIO TRANSMITTER - REMOVAL/INSTALLATION

1. Equipment and Materials
   A. Cleaning Solvent - General Purpose, Varsol No. 1, Esso Standard Oil Co., 15 West 51st Street, New York 19, New York
   B. Abrasive Cloth - Aluminum Oxide, Closed Coat, 180 grit or finer, Federal Specification P-C-451
2. Remove Engine Pressure Ratio Transmitter (Fig. 401)
   A. Pull applicable ENGINE PRESS RATIO circuit breaker on circuit breaker panel P6.
   B. Obtain access to pressure ratio transmitter in air conditioning bay.
      (1) For engine No. 1 transmitter, open access panel to left side of air conditioning bay.
      (2) For engine No. 2 transmitter, open access panel to right side of air conditioning bay.
   C. Disconnect electrical connector from pressure ratio transmitter.
   D. Disconnect inlet (Pt2) and exhaust (Pt7) pressure lines from pressure ratio transmitter.
   E. Remove mounting bolts with washers and lift transmitter off mounting bracket.
3. Install Engine Pressure Ratio Transmitter (Fig. 401)
   A. Prepare faying surfaces on transmitter and airplane structure for faying surface bond.
      (1) Clean upper surface of mounting bracket around transmitter mounting holes with abrasive cloth to remove primer.
      (2) Wash faying surfaces on mounting bracket and transmitter mounting bracket with cleaning solvent. Scrub as necessary to remove visible contamination. Dry immediately with lint-free cloth.
   B. Place transmitter in position on mounting bracket.
   C. Install mounting bolts with washers (Fig. 401).
   D. Connect inlet (Pt2) and exhaust (Pt7) pressure lines to transmitter.
   E. Perform Engine Pressure Ratio Indicating System test (Ref. AMM 77-11-0).
   F. Connect electrical connector to transmitter.
   G. Close access panel.
   H. Close applicable ENGINE PRESS RATIO circuit breaker.





TYPICAL INSTALLATION FOR RIGHT AND LEFT SIDES

Engine Pressure Ratio Transmitter Installation
Figure 401

ENGINE EXHAUST PRESSURE PROBE AND MANIFOLD - INSPECTION/CHECK

1. General
   A. Engine compartment cleanliness is important because the extensive mass airflow tends to draw foreign objects into the engine. Thoroughly clean the entire engine compartment with a vacuum cleaner after completion of any work. Keep the compartment and the annular duct free of dirt, oil and grease, and remove all unused parts, such as nuts, washers, and pieces of lockwire. Immediately cover all apertures resulting from the disconnection of tubing or parts. Use external caps on all tube openings, not internal plugs.
   B. Carefully check the engine exhaust gas pressure probes and manifold without dismantling to ensure that all connections are tight and free from leaks and that lines, and tubing are secure.
   C. Check engine exhaust (discharge) pressure probe for burned or broken probe and for security of probe and attached line.

      NOTE: If one of the Pt7 manifold tubes has a crack or a leak, you can disconnect and remove that tube. The Pt7 probe fitting (on both ends of the removed manifold tube) must be sealed off with a stainless steel cap and safety wired. This procedure is limited to one Pt7 manifold tube and must be used for temporary engine operation only. Test the engine and do a check for the correct EPR limits. Replace the defective Pt7 manifold tube with a new or repaired tube as soon as possible.

2. Engine Exhaust Pressure Probe and Manifold Check
   A. Prepare Engine Exhaust Pressure Probe and Manifold for Leakage Check
      (1) Check that thrust reverser is in forward thrust position to permit entrance into engine exhaust section.
      (2) Observe the following precautions for maintenance in engine exhaust section:
         (a) Pull (open) applicable engine START IGNITION circuit breaker on circuit breaker panel P6-2, and placard the circuit breaker with DO NOT CLOSE.
         (b) Placard thrust reverser controls with DO NOT OPERATE.

            WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR IF THRUST REVERSER IS OPERATED.

      (3) Enter engine exhaust section.
      (4) Tape all exhaust pressure (Pt7) probe inlet ports.

         NOTE: Forward row of probes are exhaust pressure probes. Rear row of probes are EGT probes.

(5) Obtain access to exhaust pressure line connection on engine by opening left cowl panel. Refer to Chapter 71, Power Plant.
(6) Disconnect exhaust pressure line from exhaust pressure manifold outlet elbow. For location, refer to 77-11-0, figure 501.
(7) Connect air hose to exhaust pressure manifold outlet elbow.

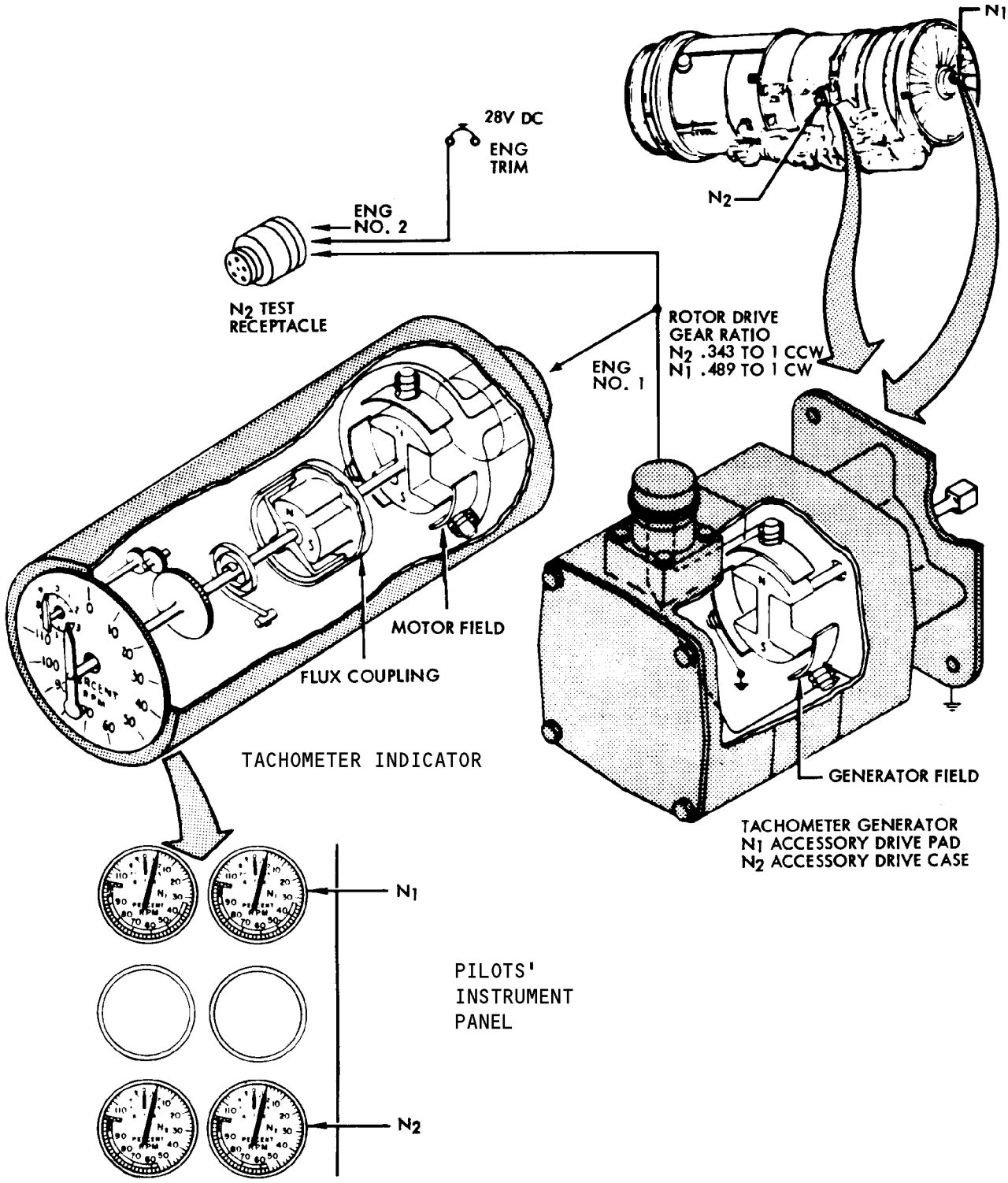
B. Check Engine Exhaust Pressure Probe and Manifold for Leakage
(1) Pressurize manifold to 20 psi and listen for leakage within fan air duct. If leakage is detected, make repairs with assistance of local P&WA representative.
(2) Relieve test pressure in manifold.
(3) Disconnect air hose from manifold outlet elbow.
(4) Reconnect exhaust pressure line.

C. Restore Airplane to Normal Configuration
(1) Remove tape from exhaust pressure probes.
(2) Close engine cowl panel.
(3) Remove placards in control cabin.

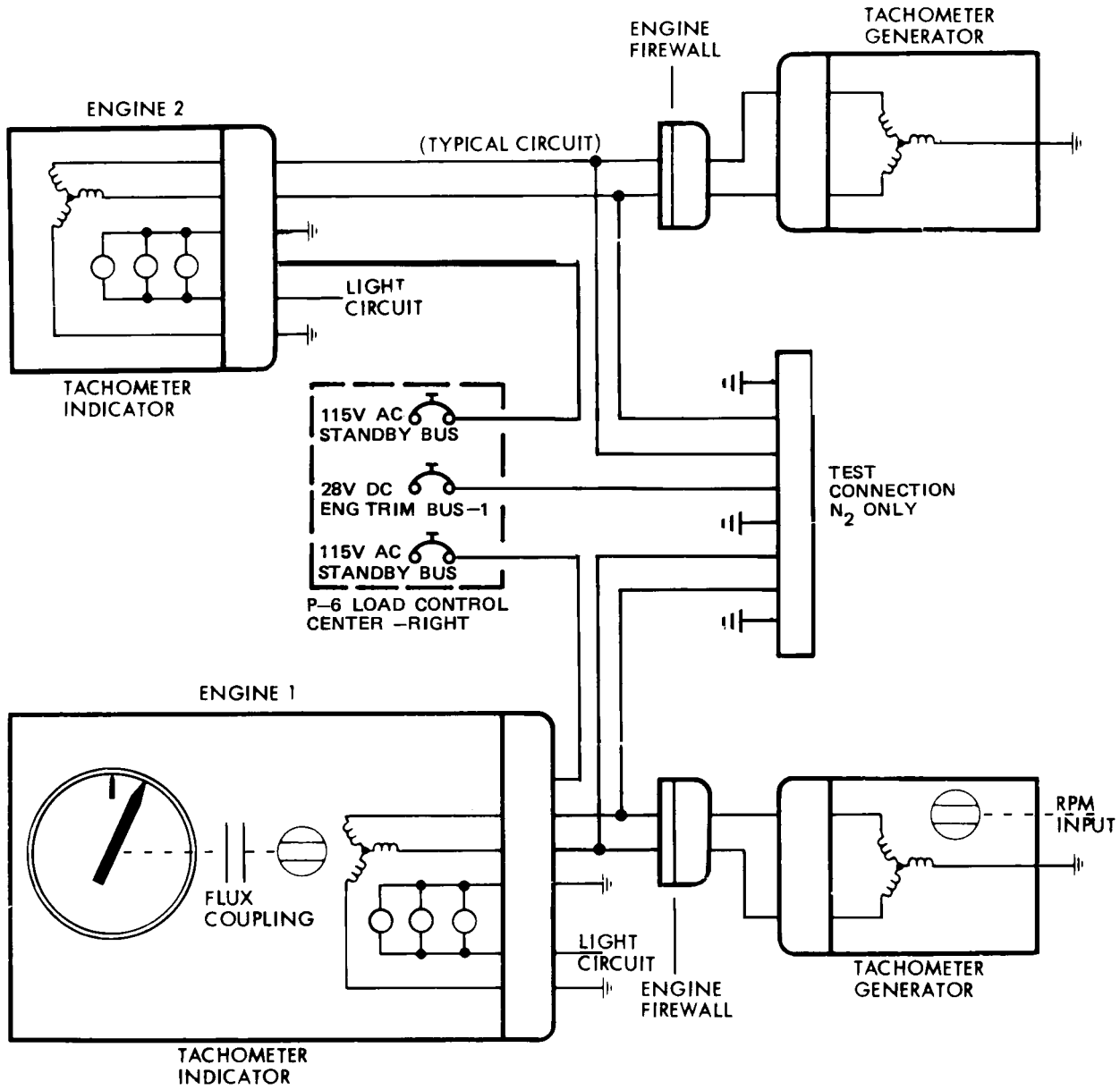
ENGINE TACHOMETER SYSTEM - DESCRIPTION AND OPERATION

1. General
   A. The engine tachometer system measures the rotary speed of an engine low pressure or high-pressure compressor rotor and provides visual speed indication to the pilots for monitoring engine performance. The engine tachometer system consists of two generator units (N1 and N2) on each engine and corresponding tachometer indicators on the center instrument panel. The N1 tachometer indicator shows the speed of rotation of the low-pressure compressor. The N2 tachometer indicator shows the speed of rotation of the high-pressure compressor. (Fig. 1)
   B. The tachometer generators, driven by the compressor rotors through reduction gearing, generates alternating electrical signals. The electrical signals, received from the generators, energize corresponding indicators, which in turn show their respective compressor speeds in percent. A test receptacle, used to attach a master indicator, is included in the circuit to provide a means of checking the system.
2. Engine Tachometer Generator
   A. The tachometer generator is a mechanism, which transforms the rotational input energy into equivalent electrical energy. It consists of a three-phase stator winding, end shields, and a permanent magnet rotor assembly, all contained in a sealed case. The tachometer generator is used to sense a compressor rotor speed and generate corresponding alternating electrical signals for the tachometer indicator operation. The N1 tachometer generator is located on the front accessory drive, and the N2 tachometer generator is on the aft right side of the accessory drive gearbox. (Fig. 1) Two types of tachometer generators are currently in use. One is a "Bearing" Type 2CM9 Tachometer Generator (approx. 3.62 inches in length) and the other is a "Bearingless" Type 2CM15 Tachometer Generator (approx. 2.12 inches in length) The "bearing" type tachometer generator consists of a three-phase stator winding, end shields, and a permanent magnet rotor mounted on bearings, all contained in a sealed case. It is used in both the N1 and N2 positions. The "bearingless" type tachometer generator is installed in the N1 and N2 positions and consists of a stator housing and a separate permanent magnet rotor assembly. At installation, (done only in the engine shop) the rotor assembly is mechanically attached into the square engine driven spline.
   B. Each tachometer generator is driven by its respective compressor rotor through a reduction gearing. The generator drive shaft turns the rotor assembly inside the stator coils, thus generating alternating electrical signals. The frequency of the generator output signals is a function of the engine compressor rpm.

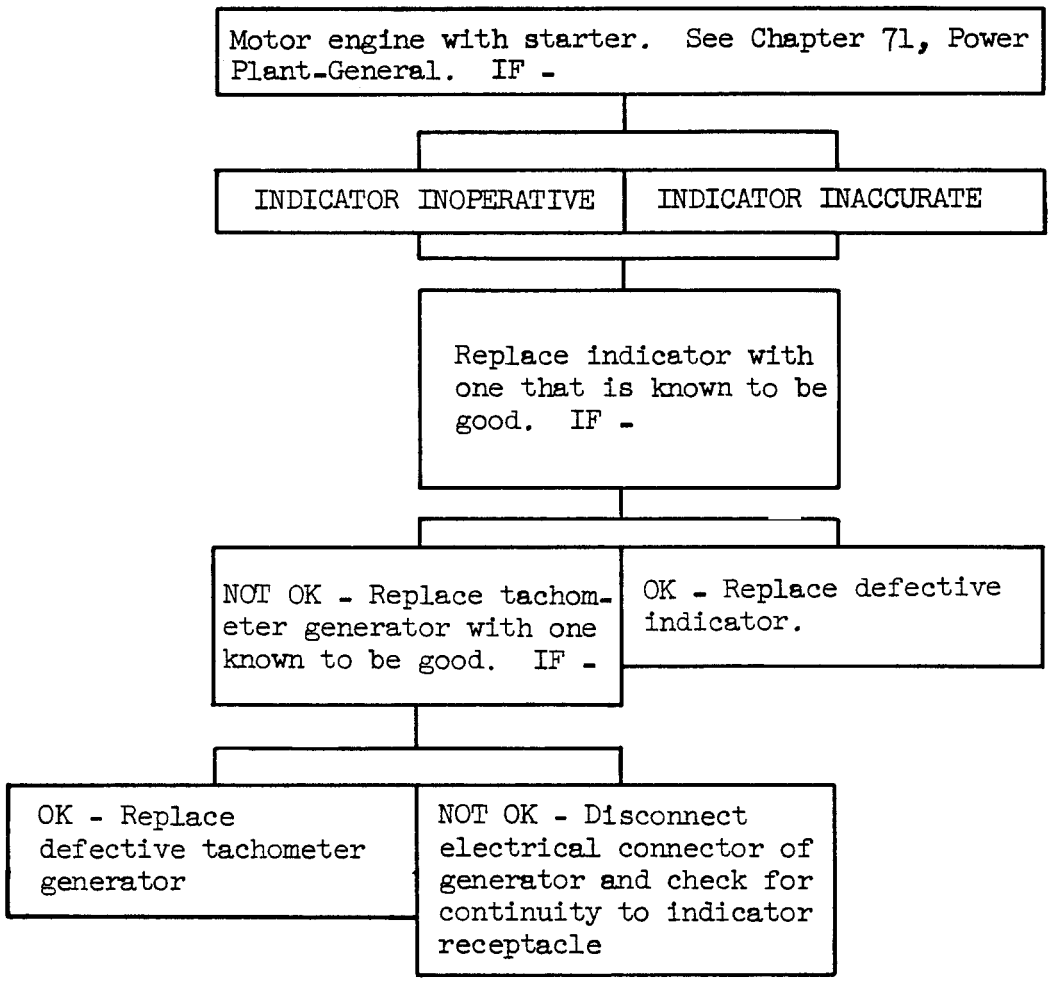
3. Engine Tachometer Indicator
   A. The tachometer indicator shows compressor rotor speeds. It consists of a three-phase synchro motor, a rotating drag assembly, a calibrated clock spring, all hermetically sealed in a case, and a round dial with a subdial. Each engine tachometer indicator shows its respective engine rotor speed as a percentage. The round indicator dial is graduated for readings between zero and 110 percent rpm, while the small subdial is graduated in ten divisions for each 10 percent change in speed. There are four tachometer indicators, two for N1 and two for N2 compressor rotors, mounted in two rows on the center instrument panel.
   B. The alternating electrical signals from the respective tachometer generator are fed into a tachometer indicator, which cause the drive shaft of the indicator synchro motor to rotate. The synchro motor drives the magnetic drag assembly or flux coupling which, in turn, restrained by a clock-type spring, moves the indicator pointers to a dial position corresponding to the compressor rotor speed.
4. Operation
   A. The engine tachometer system operates on self generated electrical power. The airplanes electrical power is required only for the integral lighting of the tachometer indicators (Fig. 2).
   B. Each tachometer generator (N1 and N2) is driven by its respective compressor rotor through reduction gearing. The generator drive shaft turns the rotor assembly inside the stator coils, thus generating alternating electrical signals. These signals are transmitted to the corresponding tachometer indicator synchro motor by a two-wire system, while the third phase is completed to ground. The alternating electrical signals cause the drive shaft of the indicator synchro motor to rotate. This rotation, through a flux coupling, tends to rotate the indicator pointer, which is restrained by a spring. The speed of the synchro motor determines the degree to which the indicator pointer is rotated, and corresponds to the related compressor rotor speed. The round indicator dial is graduated for readings between zero and 110 percent compressor rpm. The small subdial is graduated in ten divisions for each 10 percent change in speed. A master indicator(s) may be attached to the test receptacle(s), mounted in the control cabin, to provide a means of checking the system.



Engine Tachometer System
Figure 1



Engine Tachometer System Schematic
Figure 2



Engine Tachometer System - Troubleshooting
Figure 101

ENGINE TACHOMETER SYSTEM - ADJUSTMENT/TEST

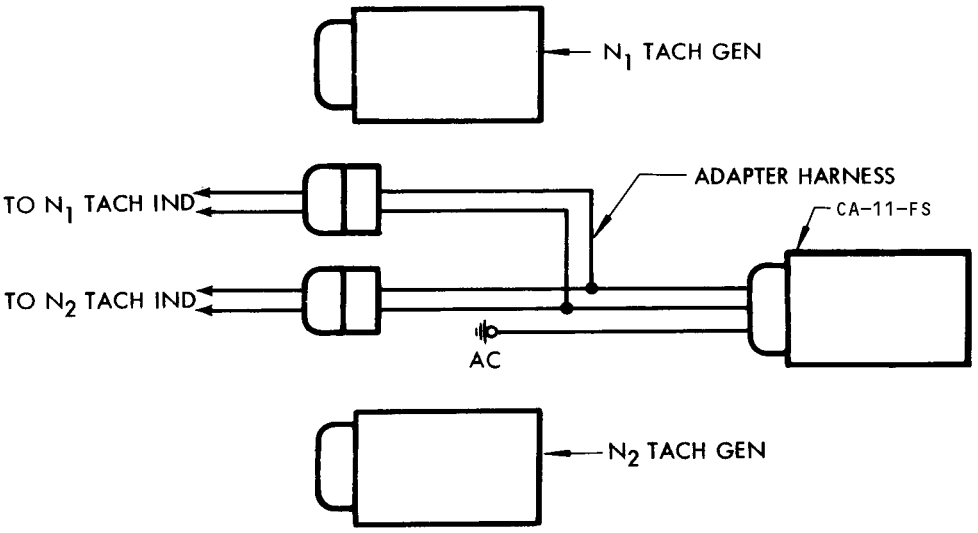
1. Engine Tachometer System Test
   A. General
      (1) The engine tachometer system is tested with the engines shut down. N1 and N2 tachometer generators are disconnected and a standard test generator is connected in their place. The test consists of driving a standard test generator at predetermined speeds while obtaining readings on N1 and N2 tachometer indicators.
   B. Equipment and Materials
      (1) Tachometer Tester - CA-11FS
      (2) Electrical motor for driving test generator at specified speeds
      (3) Adapter Harness F80228-15 - Adapter cable provided from G77001-4 test box, or manufacture locally for CA-11FS (Fig. 501)
   C. Test Engine Tachometer System
      (1) Obtain access to N1 tachometer generator by removing engine nose dome, and N2 tachometer generator by opening right engine cowl panel (AMM Chapter 71, Power Plant).
      (2) Disconnect N1 and N2 tachometer generators and connect standard test generator in their place using adapter harness. Connect adapter harness grounding lug to one tachometer generator-mounting stud (Fig. 501).
      (3) With standard test generator set to values listed in Table I, both indicators (N1 and N2) on pilots' engine instrument panel shall read the following percentage rpm within tolerances noted.

TABLE I

CA-11FS rpm	Indicator % rpm	Tolerances % RPM
0	0	± 0.50
840	20	± 0.50
2520	60	± 0.50
4200	100	± 0.50

NOTE: Tap indicators lightly before reading. Cover glass on each indicator must be tight and free of cracks. Indicator pointers must operate smoothly over scale.

(4) Disconnect test generator adapter harness and reconnect N1 and N2 tachometer generators.
(5) Install engine nose dome and close right engine cowl panel.



NOTE: MAKE ADAPTER HARNESS LOCALLY USING MATING CONNECTORS TO THOSE USED ON THE AIRPLANE. REFER TO ELECTRICAL WIRING DIAGRAMS.

Adapter Harness and Test Connections
Figure 501

ENGINE TACHOMETER GENERATOR - REMOVAL/INSTALLATION

1. Remove Engine Tachometer Generator
   A. Obtain access to N1 tachometer generator by removing engine nose dome (AMM 71-11-51/401).
   B. Obtain access to N2 tachometer generator by opening right cowl panel (AMM 71-11-11/401).
   C. Cut lockwire and disconnect electrical connector from tachometer generator (Fig. 401).
   D. Remove attaching nuts and washers fastening tachometer generator to drive.
   E. For N1 tachometer generator, remove ground wire terminal from generator mounting stud.
   F. For N1 tachometer generator, remove nose dome interference bracket, if installed.
   G. Remove generator (bearing type) or stator (bearingless type) from studs and discard old gasket.
   H. If generator is the bearingless type, proceed as follows:

      NOTE: In the following step, remember that it is a left-hand thread. Turn CW to loosen.

      (1) Loosen rotor assembly using a 9/16-inch, hex, box wrench, approximately three turns clockwise.
      (2) Lightly tap the end of the rotor assembly with a brass or plastic hammer to release the tapered threaded shaft.
      (3) Remove rotor assembly by hand.

          NOTE: If rotor assembly cannot be removed by hand, repeat steps (1) and (2) until it can be removed.

                If a tool is necessary to remove the rotor assembly, grip only on the large diameter of the collar. Pulling on the rotor will tend to tighten the assembly.

2. Install Engine Tachometer Generator
   A. Equipment and Materials
      (1) Grease - MIL-G-81322 (AMM 20-30-21/201)

B. Lightly hand-coat splines of tachometer generator drive shaft with grease.

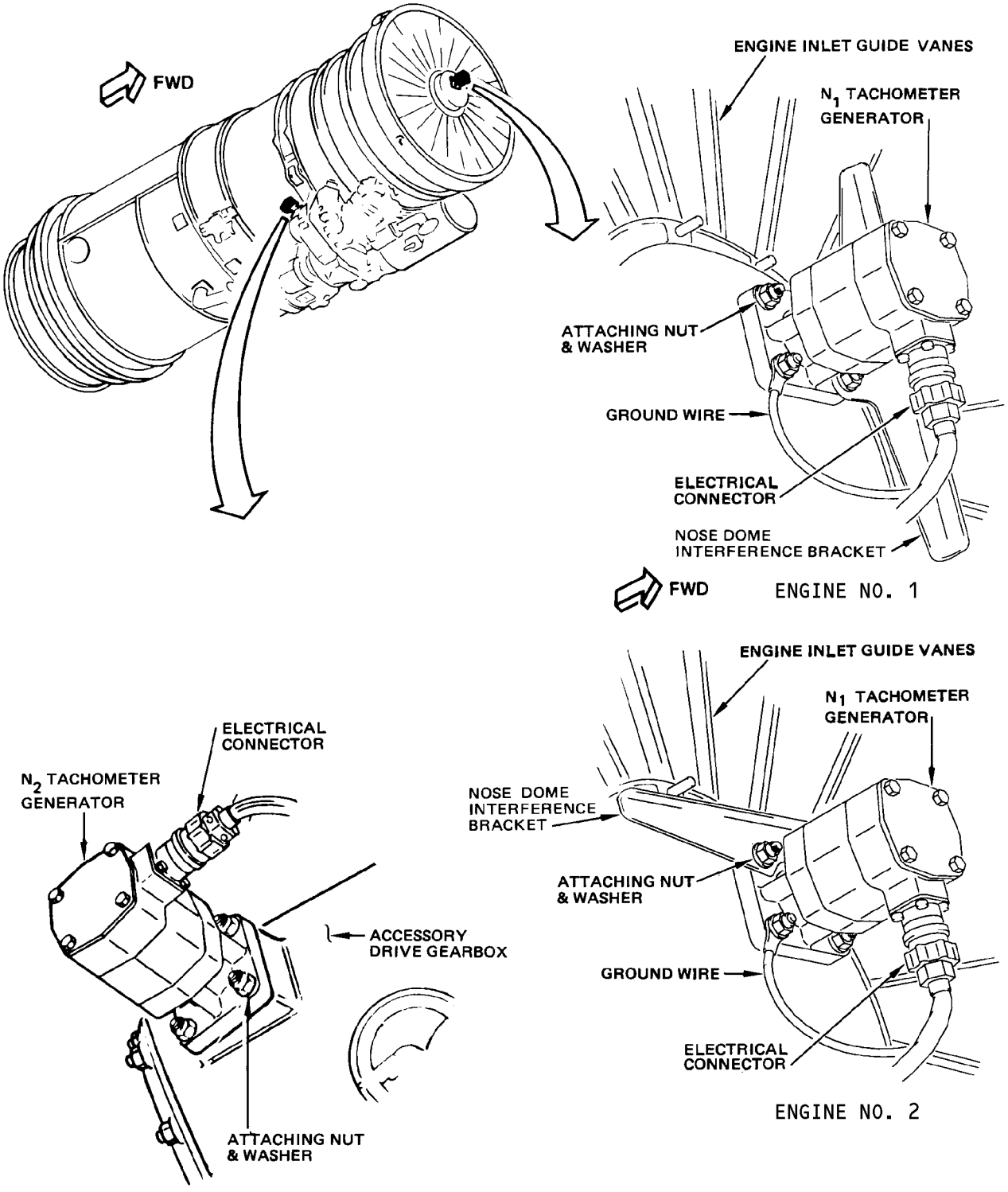
C. If generator is the bearingless type, proceed as follows (Fig. 402):

CAUTION: DO NOT REASSEMBLE COLLAR TO ROTOR BEFORE CLEANING AND LUBRICATING. WITHOUT LUBRICATION THE ROTOR HUB DIAMETER AND ITS MATING COLLAR COUNTERBORE MAY TEND TO SEIZE. AN ATTEMPT TO SEPARATE MAY CAUSE GALLING OR SCORES.

(1) Wash tapering threaded shaft, collar and rotor in clear gas.
(2) Rinse, drain and wipe or air-dry, being careful to wipe clean all mating surfaces of the three parts, including the separated surfaces of the square taper.
(3) Visually examine the parts for freedom from contamination, pick up, scores, and burrs, which would interfere with reassembly and alignment.
(4) Apply FELPRO C5A compound on only the mating surfaces of rotor hub diameter and the collar counterbore.
(5) Slide tapered shaft, threaded end, through the hole in the expandable collar.
(6) Slide rotor hub diameter into shaft counterbore, seating securely.
(7) Thread rotor on tapered shaft thread counterclockwise (left-hand thread) and hand-tighten only.
(8) Inspect square hole in engine power takeoff shaft where rotor assembly is to be inserted. Using a GO-NO GO gauge, GE P/N A2333 (or its equivalent), insert gauge to check size. If NO GO end enters or the square hole appears to be worn or damaged, do not install the rotor assembly.
(9) Clean square hole of shaft to remove oil, dirt or contamination. Wipe or blow dry. Make sure that flats on split square of the collar are clean and dry.

NOTE: In the next step, it is left-hand thread to tighten.

(10) Hand-tighten tapered shaft thread through collar into the thread on rotor.

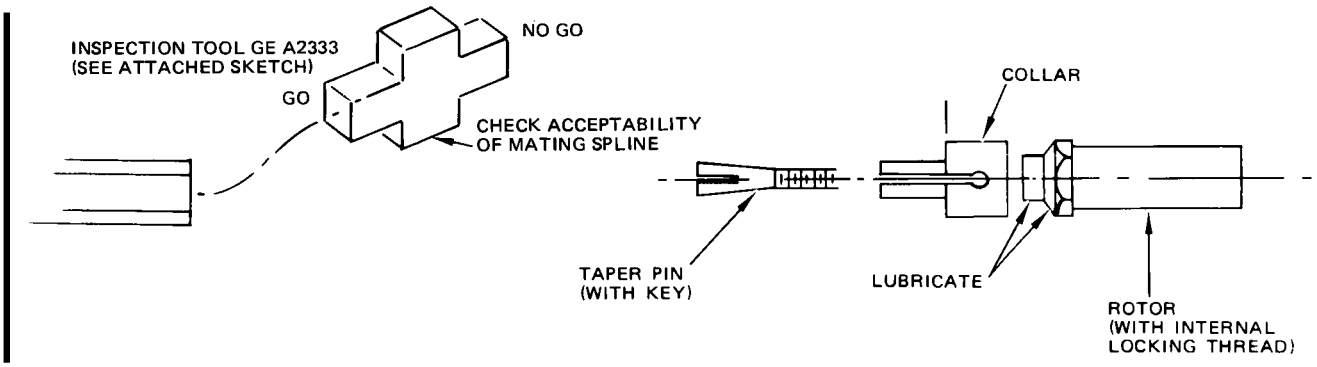


Engine Tachometer Generator Installation
Figure 401

(11) Push square shaft of rotor assembly into engine shaft square hole seating collar shoulder against end of engine shaft. Tap end of rotor lightly with a brass or plastic hammer to assure it is seated properly.
(12) Use a 9/16-inch hex deep socket torque wrench to secure rotor in shaft to 40 ±4 pound/inches.

NOTE: Before performing the next steps, visually examine to determine that the rotor appears properly aligned.

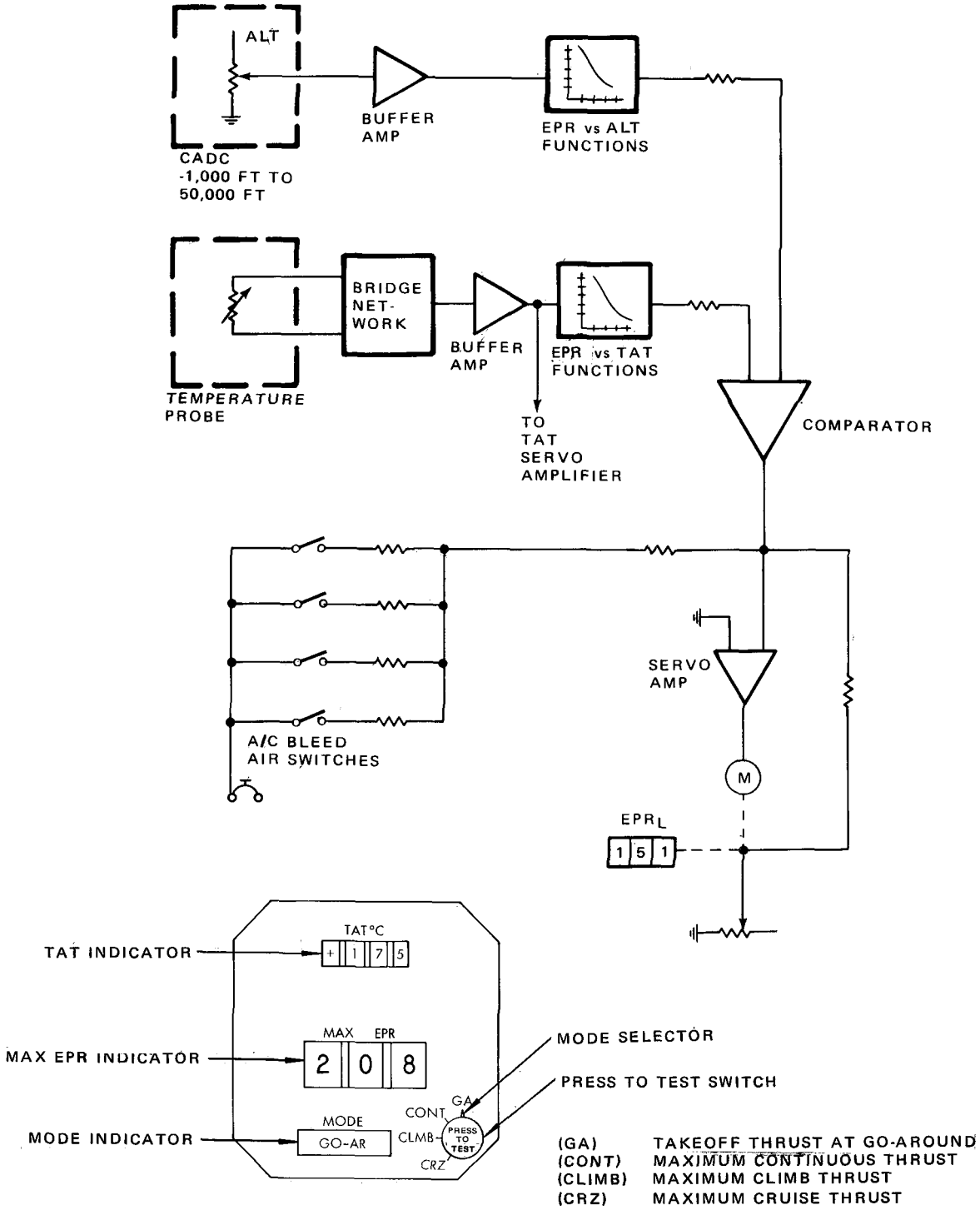
D. Place new gasket on mounting pad.
E. If generator is the bearing type, carefully align the drive shaft and place the generator on the mounting pad. If generator is the bearingless type, place the stator assy over the rotor assembly and pad mounting studs and gasket.
F. Place ground wire terminal on applicable generator mounting stud (Fig. 401).
G. For N1 tachometer generator, install nose dome interference bracket if previously installed.
H. Install washers and nuts attaching generator to engine.
I. Attach electrical connector to tachometer generator, and lockwire.
J. Replace nose dome if N1 tachometer generator is installed. Close cowl panel if N2 tachometer generator is installed.
K. Check the tachometer generator for proper operation during next engine run.



Rotor Assembly
Figure 402

TOTAL AIR TEMPERATURE - ENGINE PRESSURE RATIO LIMIT INDICATING SYSTEM - DESCRIPTION AND OPERATION

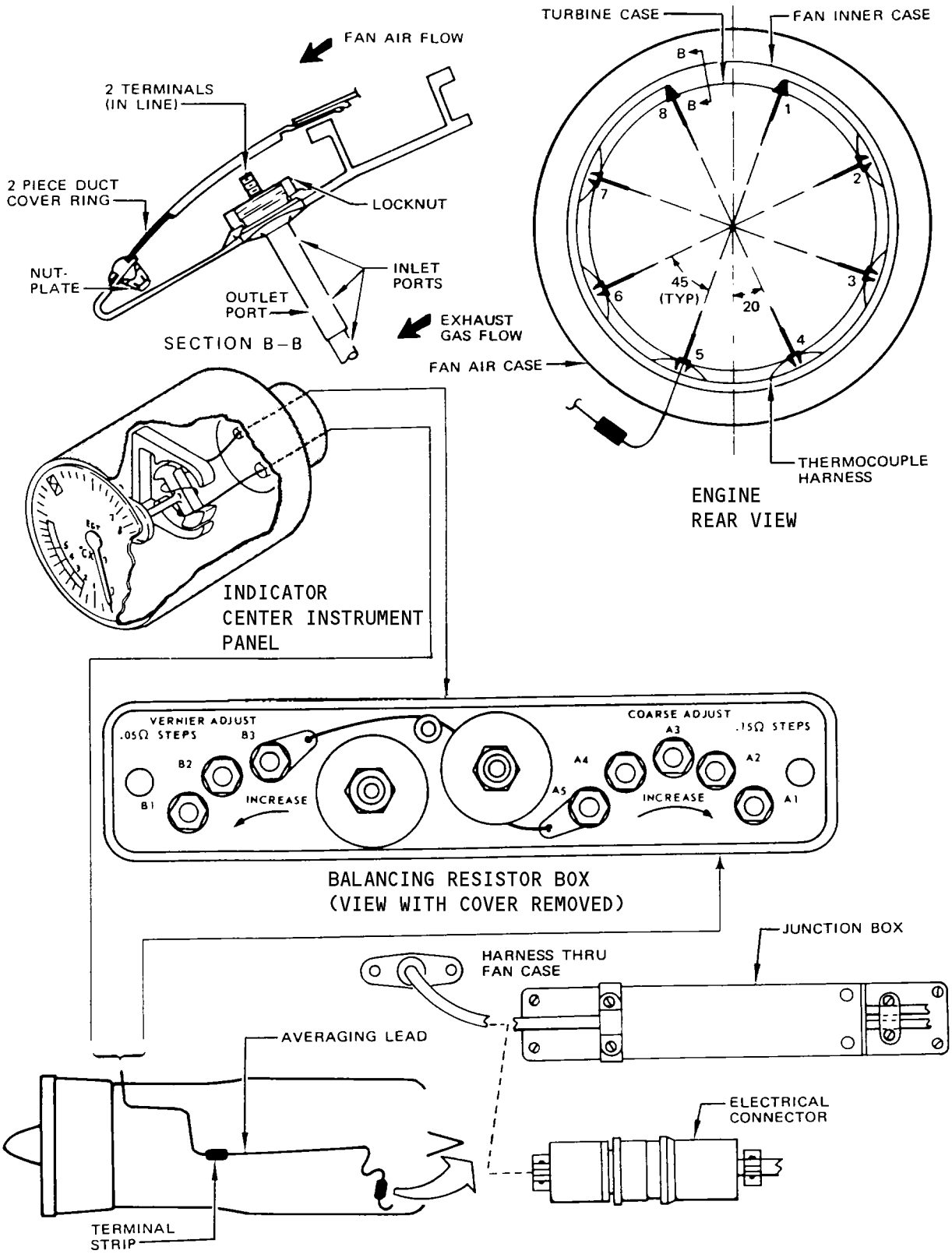
1. General
   A. The Total Air Temperature - Engine Pressure Ratio Limit System (TAT/EPRL) is a computer-indicator on the first officer's panel which monitors the temperature and pressure environment of an airplane to accurately display total air temperature (TAT) and maximum allowable engine pressure ratio (EPRL). (See figure 1.)
   B. The computer-indicator displays a digital readout of maximum allowable engine pressure ratio (EPRL) and air temperature (TAT) resulting from two input signals. One signal represents the total air temperature environment of the aircraft and furnishes input for EPRL calculations. The other signal input from the Central Air Data Computer, represents the pressure environment which is calculated with the temperature signal input to display maximum EPR. A built-in failure monitor system will detect malfunctions and flag the affected TAT and/or EPRL readout display. A mode select switch is provided to select the proper combination of inflight thrust setting curves, one of the curves determines maximum EPR for temperature and another determines maximum EPR for altitude. The computer-indicator automatically selects the lower value of the two and displays the lower value as maximum EPR.
   C. A PUSH-TO-TEST switch on the indicator front injects the equivalent of a 5-degree centigrade TAT input signal and a 1000 feet pressure altitude input signal into the computer-indicator. TAT readout will display +5 (±0.5) degrees C. EPR readout will display 2.029 in GA, 1.940 in CONT, 1.940 in CLIMB, and 1.848 in CRZ mode ± 0.005.
   D. The maximum engine pressure ratio (EPRL) is a target to be used during flight and should not be confused with engine pressure ratio (EPR) which is defined as the ratio of the total pressure at the engine exit to the total pressure at the engine inlet. Any maintenance performed on the TAT-EPRL computer-indicator should be per the manufacturers manuals.



Total Air Temperature - Engine Pressure Ratio Limit System
Figure 1

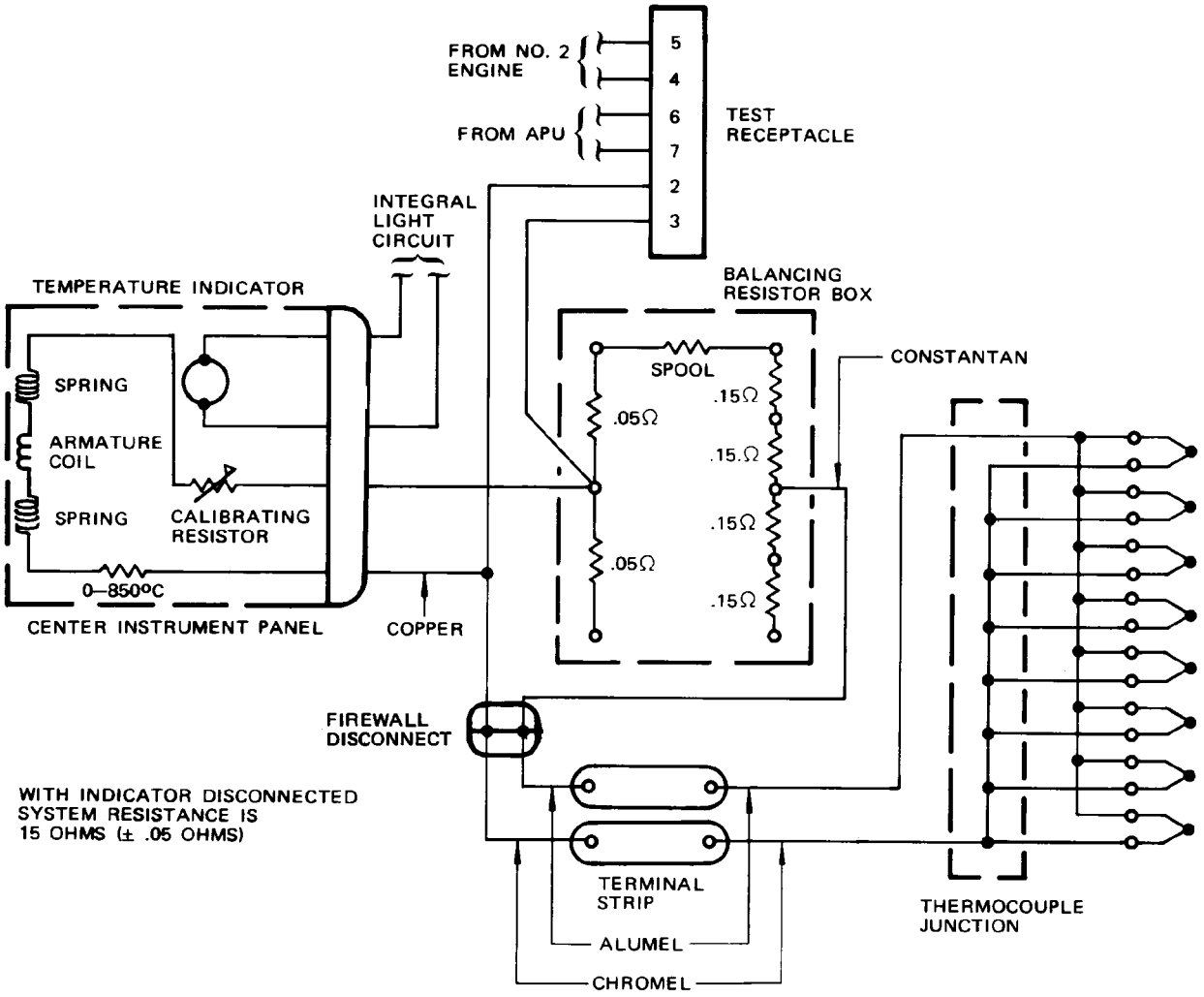
EXHAUST GAS TEMPERATURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. General
   A. The exhaust gas temperature (EGT) indicating system measures the engine exhaust gas temperature and displays the temperature value on indicators in the control cabin. The system, for each engine, consists of eight temperature sensing probes, a harness and lead, one balancing resistor, and a temperature indicator (Fig. 1). Copper and constantan wires are used in the low temperature zone of the engine; chromel and alumel wires are used where higher temperatures are encountered.
   B. Engine exhaust gas temperature is sensed by the thermocouple elements. The heat of the exhaust gases causes the thermocouple to generate dc electrical signals, which actuate the meter movement of the exhaust gas temperature indicator. The balancing resistor is included in the circuit to provide a means of adjusting the system.
2. Exhaust Gas Temperature Thermocouple Probe
   A. The thermocouple probe is a temperature-sensing device that senses the temperature of the engine exhaust gases. It consists of two stud terminals, a head, and a thermocouple measuring junction and leads enclosed in a cylindrical shield (Fig. 1). The thermocouple junction leads and terminals are made of chromel and alumel material. The alumel terminal (-) has a larger diameter stud than the chromel terminal (+). The correct orientation of the probe with respect to an engine is obtained with an index slot in the probe.
   B. Eight probes are mounted on the turbine exhaust section fan discharge inner duct of each engine and project into the engine exhaust gas path. The probes are connected in parallel to obtain the average value of the exhaust gas temperatures sensed by the eight probes.
3. Exhaust Gas Temperature Thermocouple Balancing Resistor
   A. The exhaust gas temperature thermocouple-balancing resistor permits adjustment of circuit resistance. The resistor consists of a spool of No. 24 constantan wire, coarse adjustment terminals and vernier adjustment terminals. Since primary adjustment of the resistance is made by cutting off lengths of the wire, a spare resistance spool is included for each engine system. The thermocouple resistors are located in a box in the P6 panel area and are connected into the constantan lead of the circuit.
4. Exhaust Gas Temperature Indicator
   A. The exhaust gas temperature indicator is a specially built, sensitive millivoltmeter with a dial, graduated in degrees centigrade, housed in a hermetically sealed case. Two indicators, one for each engine, are mounted on the center instrument panel. Two terminals, marked plus (+) and minus (-), on the back of the indicator connect the meter unit to the thermocouple circuit. The instrument dial indicates a temperature range from 0° to 850°C, with normal and dangerous operating temperatures marked in a color code.

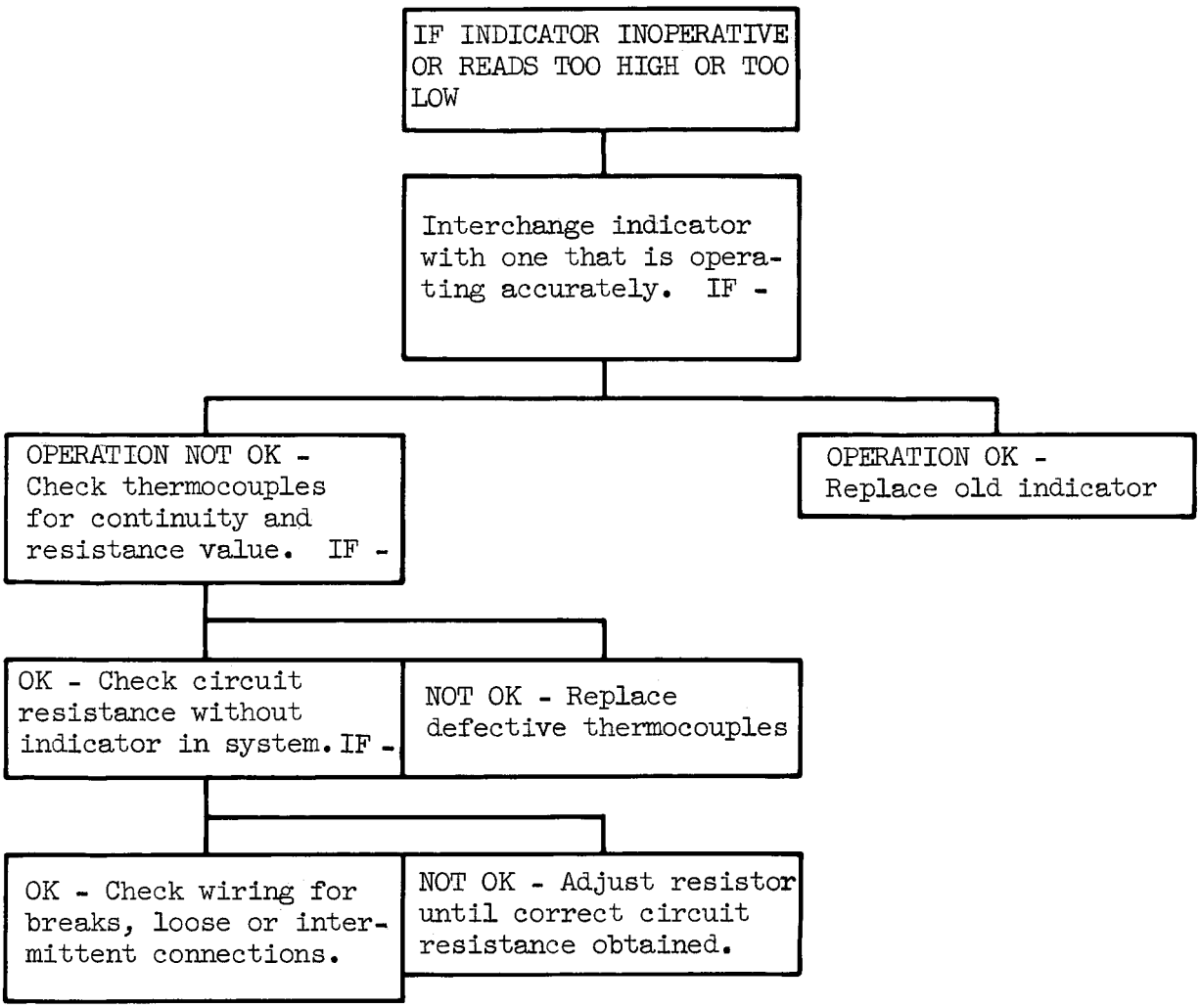


Exhaust Gas Temperature Indicating System
Figure 1

5. Exhaust Gas Temperature Thermocouple Harness and Lead
   A. The thermocouple harness is a flexible electrical conduit mounted on the circumference of the engine exhaust fan discharge inner duct. A two-wire thermocouple lead from the harness is routed forward to an electrical terminal strip on the fan discharge diffuser outer duct. The harness is connected to the lead with a nine pin electrical plug or junction box, located on the engine exhaust section fan discharge outer duct at approximately, the 7 o'clock position.
6. Operation
   A. Each engine exhaust gas indicating system consists of eight thermocouple probes connected in parallel to an indicator and operate on self-generated power. The airplane power is used only for integral lighting of the indicators (Fig. 2).
   B. The difference in temperatures between the hot junction at the thermocouple probes and the cold junction at the indicator causes electrical signals to be generated in the thermocouple circuit. These electrical signals are proportional to the temperature difference between the two junctions and are measured by the indicator. Since the generated signals correspond only to the temperature difference, correction due to control cabin ambient temperature variation must be made to this measured temperature difference to obtain the actual temperature of the exhaust gases; the indicator does this correction automatically. The control cabin temperature where the indicator is located, is reasonably constant; however, small temperature changes in the indicator are compensated with a bimetal (thermostatic) spring, connected to the indicator control mechanism. The indicated exhaust gas temperature is therefore, an accurate indication irrespective of prevailing ambient temperatures.
   C. The thermocouple probes are connected in parallel to obtain the average temperature of the exhaust gases. Another advantage of the parallel connection is that if a probe burns out or is damaged, thermocouple circuit is not disrupted.



Exhaust Gas Temperature Indicating System Circuit
Figure 2



Exhaust Gas Temperature Indicating System (Millivolt) - Troubleshooting
Figure 101

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - ADJUSTMENT/TEST

1. General
   A. The exhaust gas temperature (EGT) indicating system is tested using a Wheatstone Bridge. Tests include measurements of circuit resistance and insulation.
   B. Two operational tests are provided which may be used optionally to establish confidence of exhaust gas temperature indicating system. Neither test provides sufficient accuracy for system calibration, and is to be used only to indicate whether system operation is or is not satisfactory. Confidence test No. 1 is preferred if conditions allow.
2. Equipment and Materials
   A. Wheatstone Bridge capable of measuring resistance to ± 0.01 ohm at 15 ohms
   B. Low voltage ohmmeter capable of measuring resistance of 100,000 ohms. Meter should utilize less than 40 volts (dc) and should have accuracy of 5%

      NOTE: Low-powered digital meters may give a misleading indication when attempting to measure extremely high or infinite resistances. Analog meters operate at higher voltages and are preferred to digital meters.

   C. Low value load resistance variable to within ± 0.05 ohms
   D. DC power source variable from 0 to 50 millivolts
   E. DC millivolt meter capable of measuring to ± 0.01 millivolt
   F. Portable container of ice or accurate thermometer

3. Test Exhaust Gas Temperature Indicating System Resistance
   A. Disconnect plug from exhaust gas temperature indicator on engine instrument panel.
   B. Connect Wheatstone Bridge to sockets in plug and measure circuit resistance. Resistance reading should be as shown:

SYSTEM RESISTANCE (OHMS)*[1]	AMBIENT TEMPERATURE	
15.00 ±0.05	20° ±5°C	68° ±9°F
14.97 ±0.05	10° ±5°C	50° ±9°F
14.94 ±0.05	0° ±5°C	32° ±9°F
*[1] System resistance may be calculated for other ambient temperatures by extrapolating from the above values by using 0.03 ohms/10°C change.		

NOTE: If resistance is not within tolerance, check circuit for loose, corroded or shorted connections and defective thermocouples. Dissimilar materials at connections (nuts, screws, washers, and etc.) can cause incorrect circuit resistance. The following information should be kept in mind in checking this system:

On the engine the thermocouple leads are alumel and chromel in the high temperature region to the firewall disconnect. The alumel lead is magnetic and negative and color-coded green. The chromel lead is nonmagnetic and positive and color-coded white.

The leads from the firewall disconnect to the EGT indicator are copper and constantan. The copper is positive and color-coded red. The constantan is negative and color coded yellow.

   C. Adjust resistor spool to bring circuit resistance within specified limits, if required (AMM 77-21-11).
   D. Remove Wheatstone Bridge and reconnect plug to indicator.

4. Test Insulation Resistance
   A. Check thermocouple leads, from indicator to engine terminal strip, for short to ground.
      (1) Disconnect plug from exhaust gas temperature indicator on engine instrument panel.
      (2) Open left engine cowl panel (AMM Chapter 71).
      (3) Disconnect indicator leads (Chromel - white and Alumel - green) from terminal strip (Fig. 501).
      (4) Connect one side of ohmmeter to one of the leads and the other side of ohmmeter to ground.
      (5) Check lead for short to ground. The resistance shall not be less than 100,000 ohms.
      (6) Repeat steps (4) and (5) for the other lead.
      (7) Remove ohmmeter and connect leads to terminal strip.
      (8) Connect plug to the indicator.

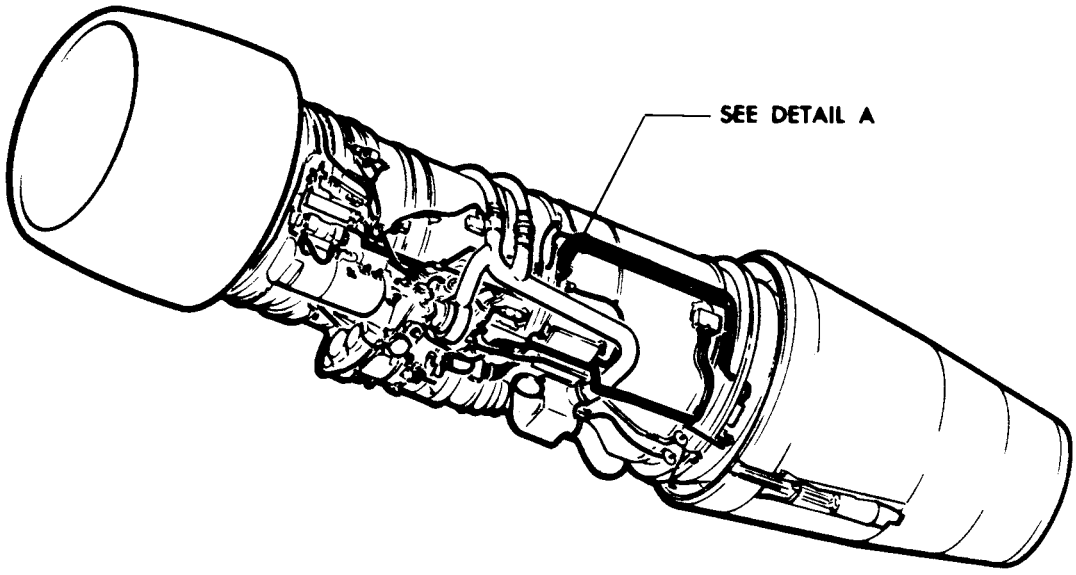
B. Check thermocouple harness and leads for shorts to ground.
   (1) Disconnect harness leads from the engine terminal strip (Fig. 501).
   (2) Connect one side of ohmmeter to one of the harness leads and the other side of ohmmeter to ground.
   (3) Check the thermocouple harness and lead for shorts to ground. Resistance shall not be less than 50,000 ohms.
   (4) Remove ohmmeter and reconnect harness leads to the engine terminal strip.
   (5) Close engine cowl panels.

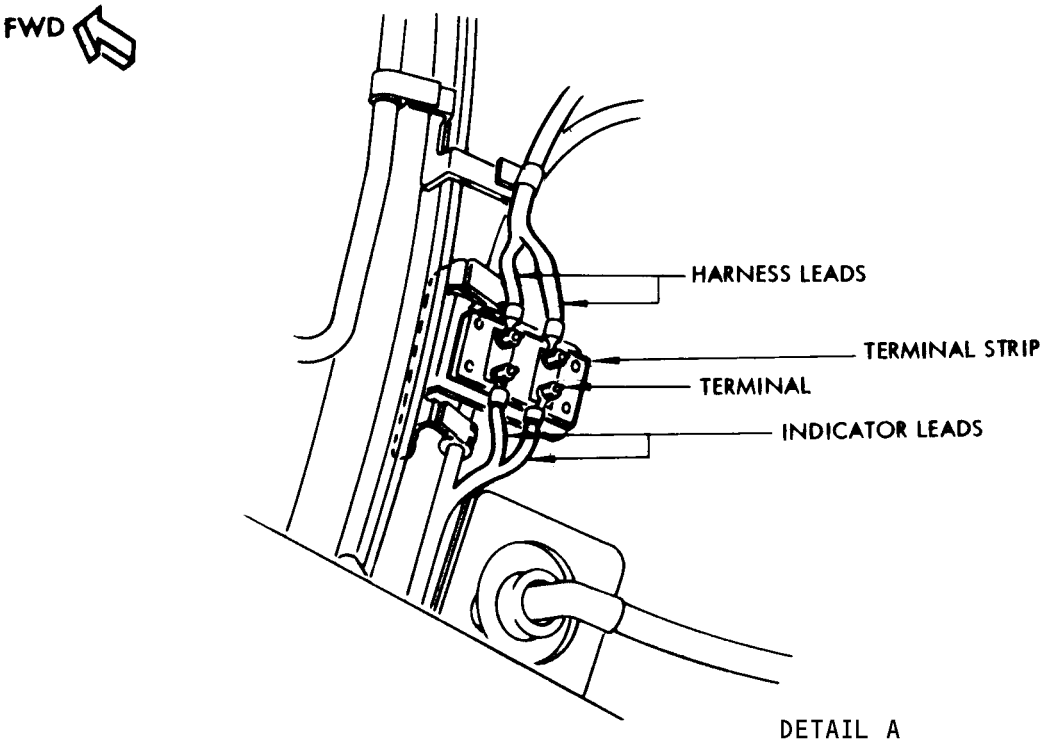
5. Operational Test No. 1 (Preferred)
   A. Open left side cowl panel (AMM Chapter 71).
   B. Disconnect indicator leads (Chromel - white and Alumel - green) from terminal strip (Fig. 501).
   C. Connect Wheatstone Bridge to harness leads and measure circuit resistance (Fig. 502).
   D. Take second reading with test leads reversed and obtain average resistance of opposite polarity readings.
   E. Adjust load resistance to average measured resistance.
   F. Make test connections to indicator leads (Fig. 502). Immerse test connections in ice bath.
   G. Apply voltages and observe indicator readings. Lightly tap front of indicator before taking reading.

      NOTE: A pointer movement greater than 25°C when tapping would be caused by defective indicator.

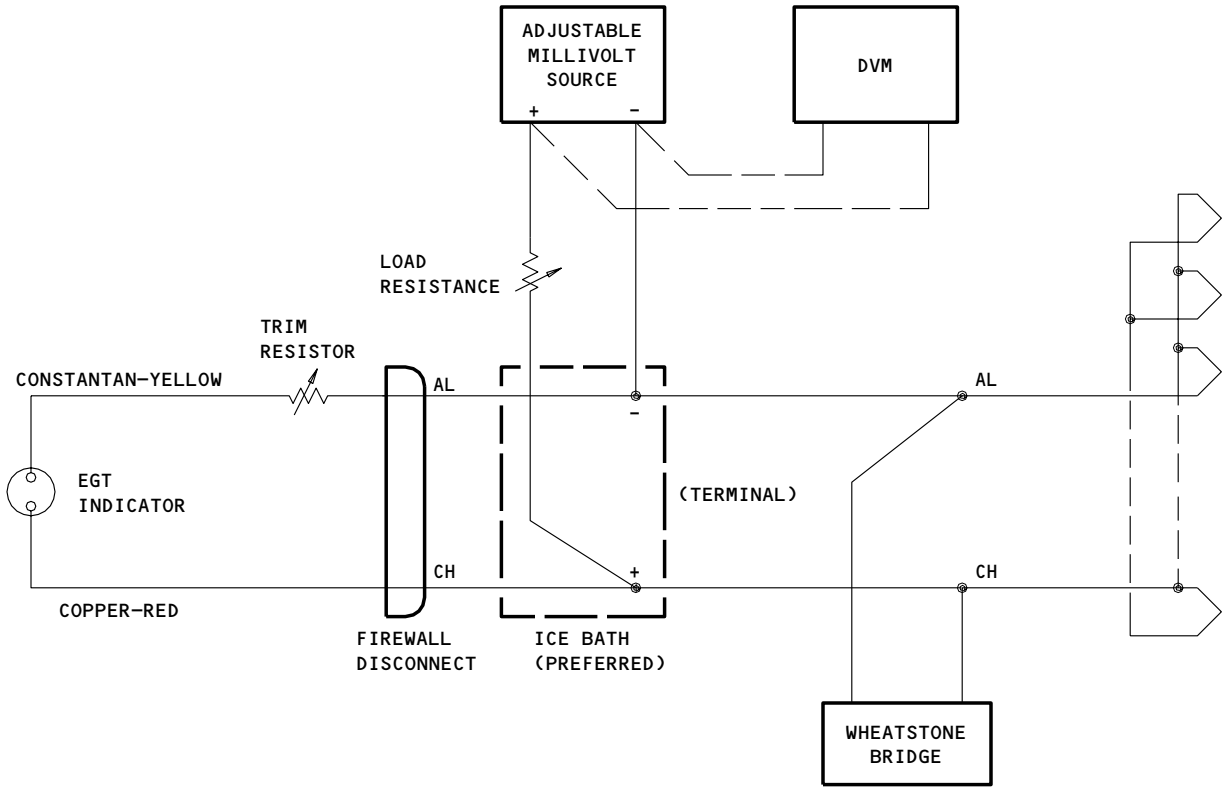
6. Operational Test No. 2 (Optional)
   A. Perform steps 5.A. thru 5.E.
   B. Make test connections to indicator leads (Fig. 502).
   C. Monitor ambient temperature at test connections.
   D. Apply voltages and observe indicator reading in Fig. 502 as adjusted for ambient temperature (Table 501).
   E. Lightly tap front of indicator before taking reading.

      NOTE: A pointer movement greater than 25°C when tapping would be caused by defective indicator.





Exhaust Gas Temperature Indicating System Terminal Strip
Figure 501



MILLIVOLTS-TO-INDICATED TEMPERATURE COMPARISONS

MILLIVOLT INPUT (± 0.02mv)	6.13	10.15	18.50	*[1]	27.03	31.23	35.35
INDICATOR READING °C	150	250	450	*[2]	650	750	850
INDICATOR READING TOLERANCE (± °C)	30	20	10	5	10	20	30

*[1] APPLIED VOLTAGE AT ENGINE TEMPERATURE LIMIT: 23.62 MILLIVOLTS FOR JT8D-7; 24.05 MILLIVOLTS FOR JT8D-7A, -9; 24.48 MILLIVOLTS FOR JT8D-7B, -9A; 24.69 MILLIVOLTS FOR JT8D-11; 26.18 MILLIVOLTS FOR JT8D-15; AND 27.45 MILLIVOLTS FOR JT8D-17.

*[2] ENGINE TEMPERATURE LIMIT: 570°C FOR JT8D-7, 580°C FOR JT8D-7A, -9; 590°C FOR JT8D-7B, -9A; 595°C FOR JT8D-11; 630°C FOR JT8D-15; AND 660°C FOR JT8D-17.

Exhaust Gas Temperature Indicating System Operational Test Requirements
Figure 502

REFERENCE TEMP	Table 501 TEST POINTS °C							
°C	0	150	250	450	550	650	750	850
0	0.00	6.13	10.15	18.50	22.77	27.03	31.25	35.35
15	-0.60	5.53	9.55	17.90	22.17	26.43	30.63	34.75
16	-0.64	5.49	9.51	17.86	22.13	26.39	30.59	34.71
17	-0.68	5.45	9.47	17.82	22.09	26.35	30.55	34.67
18	-0.72	5.41	9.43	17.78	22.05	26.31	30.51	34.63
19	-0.76	5.37	9.39	17.74	22.01	26.27	30.47	34.59
20	-0.80	5.33	9.36	17.70	21.97	26.23	30.43	34.55
21	-0.84	5.29	9.31	17.66	21.93	26.19	30.39	34.51
22	-0.88	5.25	9.27	17.62	21.89	26.15	30.35	34.47
23	-0.92	5.21	9.23	17.53	21.85	26.11	30.31	34.43
24	-0.96	5.17	9.19	17.54	21.81	26.07	30.27	34.39
25	-1.00	5.13	9.15	17.50	21.77	26.03	30.23	34.35
26	-1.04	5.09	9.11	17.46	21.73	25.99	30.19	34.31
27	-1.08	5.05	9.07	17.42	21.69	25.95	30.15	34.27
28	-1.12	5.01	9.03	17.38	21.65	25.91	30.11	34.23
29	-1.16	4.97	8.99	17.34	21.61	25.87	30.07	34.19
30	-1.20	4.93	8.95	17.30	21.57	25.83	30.03	34.15
31	-1.24	4.89	8.91	17.26	21.53	25.79	29.99	34.11
32	-1.28	4.85	8.87	17.22	21.49	25.75	29.95	34.07
33	-1.32	4.81	8.83	17.18	21.45	25.71	29.91	34.03
34	-1.36	4.77	8.79	17.14	21.41	25.67	29.87	33.99
35	-1.40	4.72	8.74	17.10	21.36	25.62	29.82	33.94
36	-1.45	4.68	8.70	17.05	21.32	25.58	29.78	33.90
37	-1.49	4.64	8.66	17.01	21.28	25.54	29.74	33.86
38	-1.53	4.60	8.62	16.97	21.24	25.50	29.70	33.82
39	-1.57	4.56	8.58	16.93	21.20	25.46	29.66	33.78
40	-1.61	4.52	8.54	16.89	21.16	25.42	29.62	33.74

NOTE: Millivolt-to-indicated temperature comparisons compensated for ambient conditions.

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - INSPECTION/CHECK

1. Exhaust Gas Temperature Indicating System Check
   A. General
      (1) Engine compartment cleanliness is important because the extensive mass air flow tends to draw foreign objects into the engine. Thoroughly clean the entire engine compartment with a vacuum cleaner after completion of any work. Keep the compartment and the annular duct free of dirt, oil and grease, and remove all unused parts, such as nuts, washers, and pieces of lockwire. Immediately cover al1 apertures resulting from the disconnection of parts. Use external caps on all openings, not internal plugs.
      (2) Carefully check the exhaust gas temperature indicating system without dismantling to ensure that all connections are tight and that lines are secure.
   B. Check Thermocouple Probes and Harness
      (1) Check for burned, broken or deformed probes.
      (2) Check for chafed or broken wiring.
      (3) Check continuity and insulation resistance of harness.

EXHAUST GAS TEMPERATURE THERMOCOUPLE BALANCING RESISTOR - ADJUSTMENT/TEST

1. Exhaust Gas Temperature Thermocouple Balancing Resistor - Adjustment
   A. General
      (1) The exhaust gas temperature circuit resistance is adjusted by moving constantan lead terminals from post to post on the coarse and vernier adjustments. The resistance increment between two coarse adjustment terminals is 0.15 ohm and between two vernier adjustment terminals is 0.05 ohm. External circuit resistance, excluding the indicator, should be 15.00 ohms nominal (measured at 20 ±5°C). Total circuit resistance, including the indicator should be 48 ohms (there is no resistance check of this).
      (2) To decrease the circuit resistance beyond coarse and vernier adjustment range, the resistor spool wire is shortened. To increase the circuit resistance beyond the coarse and vernier adjustment range, the spare, or a new, resistance spool is adjusted.
   B. Equipment
      (1) Wheatstone Bridge capable of measuring resistance to ± 0.01 ohms at 15 ohms.
   C. Prepare for Adjustment
      (1) Disconnect plug to exhaust gas temperature indicator on pilot's instrument panel for engine being tested. Connect Wheatstone Bridge between sockets 1 and 2 of indicator plug.
      (2) Remove side panel directly under right No. 3 window. Remove resistor cover from R202 (Eng 1) or R203 (Eng 2).

         NOTE: If the resistance of the circuit can be adjusted to the values shown in Table 501 using the coarse (0.15 ohms per post) and vernier (0.05 ohms per post) adjustment perform step D.(1). If the circuit resistance can not be corrected by using the coarse and vernier adjustment, perform step D.(2) to increase or step D.(3) to decrease the resistance to the value shown in Table 501.

Table 501
SYSTEMS RESISTANCE

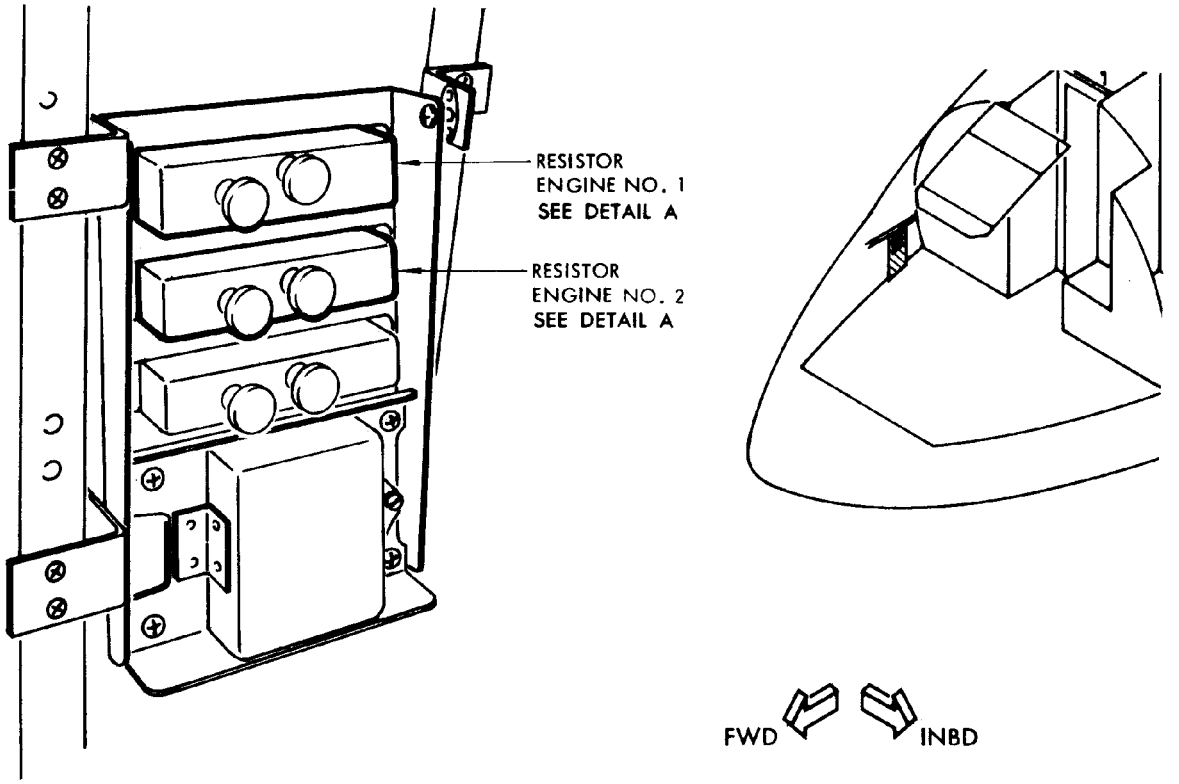
SYSTEMS RESISTANCE (OHMS)	AMBIENT TEMPERATURE	
15.00 ±0.05	20° ±5°C	68° ±9°F
14.97 ±0.05	10° ±5°C	50° ±9°F
14.94 ±0.05	0° ±5°C	32° ±9°F

   D. Adjust balance resistor.
      (1) Reposition airplane leads from one coarse and/or vernier adjustment terminal to another until circuit resistance in figure 501 is obtained.

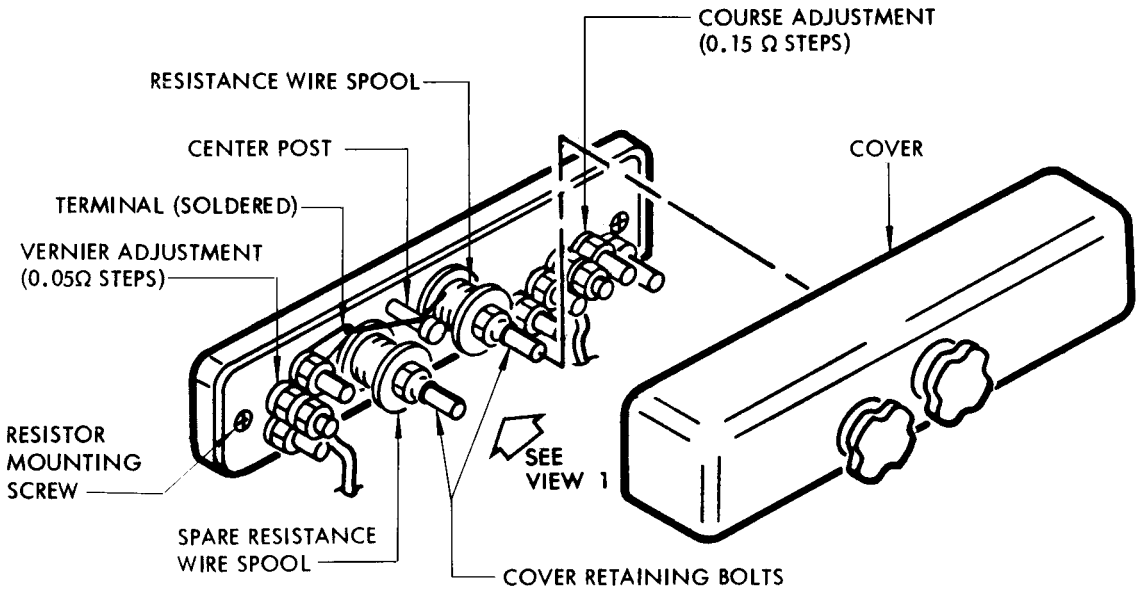
(2) Adjust resistor spool to increase circuit resistance.
  (a) Connect one airplane lead to coarse adjustment terminal A3 and other airplane lead to vernier adjustment terminal B2.
  (b) Disconnect resistance spool wire ends from terminals B3 and A5 with a soldering iron (Fig. 501).
  (c) Replace used spool if replacement is available; if not, use spare spool for adjustment.
  (d) Carefully scrape insulation from end of resistance wire emerging from center of new or spare spool and solder wire to terminal A5.
  (e) Unwind several turns of resistance wire and clip end to terminal B3 with an alligator type clip.

    NOTE: Be sure clip penetrates resistance wire insulation to make a good electrical contact.

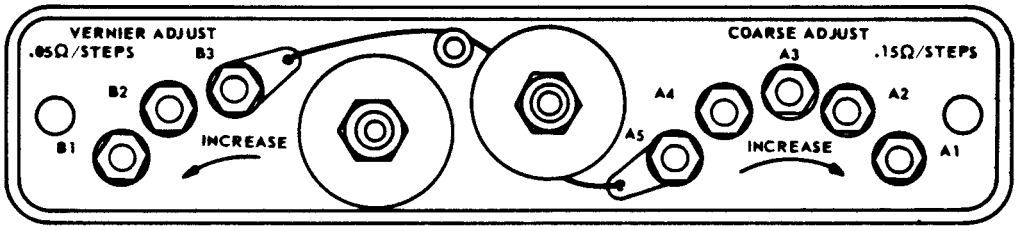
  (f) Check circuit resistance with Wheatstone Bridge. Resistance should be greater than that shown in figure 501.
  (g) On the basis of approximately 0.7 ohms per foot (.058 ohms per inch) of wire, unclip wire from terminal B3 and unwind approximate amount needed to give correct resistance.
  (h) Clip wire to terminal B3 and check resistance.
  (i) Check resistance at points along wire until resistance value shown in figure 501 is obtained.
  (j) Cut wire at this point and carefully scrape insulation from end of wire.
  (k) Wind excess wire back on spool and once around center post, leaving sufficient length of wire to reach terminal B3 for soldering.
  (l) Solder end of wire to terminal B3.
  (m) Recheck circuit resistance. If slight adjustment is necessary, reposition lead terminals on coarse and fine terminal posts to obtain the proper resistance reading per figure 501.
(3) Adjust resistor spool to decrease circuit resistance.
  (a) Disconnect resistance spool wire from terminal B3 with a soldering iron (Fig. 501).



Exhaust Gas Temperature Thermocouple Resistor Adjustment
Figure 501 (Sheet 1)



DETAIL A



VIEW 1

Exhaust Gas Temperature Thermocouple Resistor Adjustment
Figure 501 (Sheet 2)

(b) Unwind resistance wire from center post. On the basis of approximately 0.7 ohms per foot (.058 ohms per inch) unwind approximate amount of wire necessary to give correct resistance.

(c) Connect wire near the end to terminal B3 with an alligator type clip.

(d) Repeat steps (2)(h) through (2)(m).

E. Restore system to normal configuration.

(1) Disconnect Wheatstone Bridge from indicator plug. Reconnect plug to indicator receptacle.

(2) Replace resistor cover and side panel.

EXHAUST GAS TEMPERATURE THERMOCOUPLE PROBE - REMOVAL/INSTALLATION

1. Equipment
   A. Wrench, Thermocouple Spannernut - PWA-12437 (Pratt & Whitney Aircraft, East Hartford, Conn.)
2. Prepare to Remove Thermocouple Probe

   A. Observe the following precautions for maintenance in engine exhaust section.
      (1) Pull applicable engine START IGNITION circuit breaker on circuit breaker panel P6-2, and placard the circuit breaker with DO NOT CLOSE.
      (2) Placard thrust reverser controls with DO NOT OPERATE.

      WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR IF THRUST REVERSER IS OPERATED.

3. Remove Thermocouple Probe
   A. Enter engine exhaust section.
   B. Remove screws retaining fan exhaust inner rear case. Slide it to rear (Ref Chapter 72).
   C. Disconnect alumel and chromel leads from thermocouple probe.
   D. Cut lockwire and remove spannernut securing thermocouple probe to turbine rear inner case using wrench.

      NOTE: It may be necessary to remove harness supporting clips from turbine rear inner case for locknut removal.

   E. Push thermocouple probe through turbine rear inner case into turbine discharge passage, then remove probe through rear of engine.
4. Install Thermocouple Probe
   A. Install thermocouple probe into turbine rear inner case, aligning lug in case with slot in probe.
   B. Using PWA33449 wrench, secure thermocouple probe with locknut.
   C. Tighten locknut to 450-500 inch pounds and install lockwire.

D. Attach alumel and chromel leads to thermocouple probe and tighten nuts to torque value specified in 72-00 R/I, P&WA JT8D Maintenance Manual.

CAUTION: TORQUE REQUIREMENTS FOR LOCKNUTS ON THERMOCOUPLE LEAD STUDS SHALL BE OBSERVED. OVER TORQUING IF LOCKNUTS CAN RESULT IN STUD LOOSENING OR BREAKAGE.

NOTE: For engines incorporating SB 1957, proper installation of Terminal Nuts (PN 558987 and 558988) requires that cylindrical grooved portion of nut must lead the way onto stud.

E. Slide fan exhaust inner rear case into position and secure with 12 screws and washers.
F. Exit engine exhaust section.
G. Remove DO NOT OPERATE placard from thrust reverser controls.
H. Remove DO NOT CLOSE placard from applicable engine START circuit breaker and close circuit breaker on panel P6-2.

EXHAUST GAS TEMPERATURE THERMOCOUPLE PROBE - INSPECTION/CHECK

1. Exhaust Gas Temperature Thermocouple Probe Check
   A. Check Exhaust Gas Temperature Thermocouple Probe Visually

      NOTE: For EGT thermocouple probe access information, refer to Exhaust Gas Temperature Thermocouple Probe - Removal/Installation.

      (1) Check all surfaces of thermocouple for nicks, cracks, bending or evidence of heat erosion.
      (2) Check probe for straightness. Allowable deformation is 1/8 inch for small OD (lower end) of the probe.

         NOTE: Minor nicks in shield are not cause for rejection. Cracks at any location are cause for rejection. Do not attempt to repair minor bends in shield.

      (3) Check exhaust and inlet port openings for carbon buildup. If necessary, remove carbon with a straight piece of steel wire.
      (4) Check probe for looseness.
      (5) Check the terminal for looseness or thread damage. Deformation of 0.025 inch is allowable if terminals are not loose and thermocouple is electrically sound. Do not attempt to straighten or repair bent posts.
      (6) On thermocouples, after abrasive blasting, check area for loss of stud insulation.

   B. Check Exhaust Gas Temperature Thermocouple Probe Electrically

      NOTE: Before performing any of following checks, be sure that thermocouple has been satisfactorily cleaned according to instructions in Exhaust Gas Temperature Thermocouple Probe - Cleaning/Painting.

      (1) Equipment and Materials
         (a) Soldering iron or hot air gun with at least 500 watt capacity
         (b) Sensitive ohmmeter or Wheatstone Bridge
         (c) Low voltage ohmmeter capable of measuring resistance of 10,000 ohms. Meter should utilize less than 40 volts (dc) and should have an accuracy of five percent.
         (d) Temperature-controlled oven
         (e) Pyropotentiometer

(2) Check Thermocouple Integrity

NOTE: For EGT thermocouple probe access information, refer to Exhaust Gas Temperature Thermocouple Probe - Removal/Installation

(a) Place a hot soldering iron in contact with one of thermocouple probes.

WARNING: HEAT GUNS, SOLDERING GUNS AND SOLDERING IRONS ARE NOT EXPLOSION-PROOF. DO NOT USE WHERE FUEL OR FUEL VAPOR IS PRESENT (REF MM 20-10-21, MAINTENANCE PRACTICES).

(b) On engine instrument panel, observe indicator pointer for a temperature rise indication, thereby proving continuity.

NOTE: Thermocouples are located approximately at center of the probes. Soldering iron should, therefore, be placed on probe at the center to assure adequate heat transfer to give an indication.

(c) Allow sufficient period of time to elapse for indicator pointer to show a decrease in reading, then repeat the process with successive thermocouple probes until all of them have been checked.

NOTE: This is not intended as an adjustment check of thermocouple. If results of this check indicate a discontinuity, check probe as indicated in par. 2.C.

(3) Check Continuity and Resistance

NOTE: For EGT thermocouple probe access information, refer to Exhaust Gas Temperature Thermocouple Probe - Removal/Installation.

(a) Disconnect leads from EGT probe.
(b) Using sensitive ohmmeter or Wheatstone Bridge, check continuity and internal resistance of each thermocouple. Internal resistance of thermocouple should not exceed 0.120 ohms slow response 0.200 ohms fast response.

NOTE: Test leads must be securely attached to thermocouple studs. For most accurate reading, secure leads with thermocouple nuts.

(c) Using low voltage ohmmeter, check insulation resistance between each thermocouple probe terminal and body of probe for minimum of 25 seconds. Resistance shall be at least 50,000 ohms.

WARNING: TO REDUCE POSSIBILITY OF IGNITING FUEL, DO NOT USE A MEGGER OR OTHER HIGH VOLTAGE OHMMETER.

(4) Perform Functional Check

(a) Perform a functional check of thermocouple probe if continuity and resistance check indicates suspicion of trouble.

(b) Remove thermocouple probe from engine. Refer to Exhaust Gas Temperature Thermocouple Probe - Removal/Installation.

(c) Functional check consists of subjecting thermocouple probe to actual temperature variations and checking response voltages. A temperature-controlled oven will provide temperature elevation, and a pyropotentiometer will give thermocouple readings directly in degrees of temperature. Thermocouple response within 4°C (7°F) of laboratory standard accuracy at 500°C (932°F) is regarded as acceptable.

(d) If thermocouple calibration is desired, heat soak thermocouple probe to be tested together with one of predetermined accuracy in same oven and identical physical environment for at least one hour at 600°C (1112°F). A comparison between readings of test probe and standard may then be made.

(e) Install probe in engine.

EXHAUST GAS TEMPERATURE THERMOCOUPLE PROBE - CLEANING/PAINTING

1. Exhaust Gas Temperature Thermocouple Probe Cleaning
   A. General
      (1) Since operating temperatures to which EGT thermocouple probes are subjected are high, carbon deposits and dirt accumulation normally experienced at cooler locations will not present a cleaning problem. Perform any minor cleaning operations which may be necessary, exercising caution to prevent mechanical damage.

          NOTE: Carbon coating on thermocouple probe head reduces thermocouple resistance. Before checking resistance value, remove this coating, by using piston engine spark plug cleaning equipment containing AC Cleaning Compound, Type 2. Care shall be taken not to subject parts to excessive grit blasting.

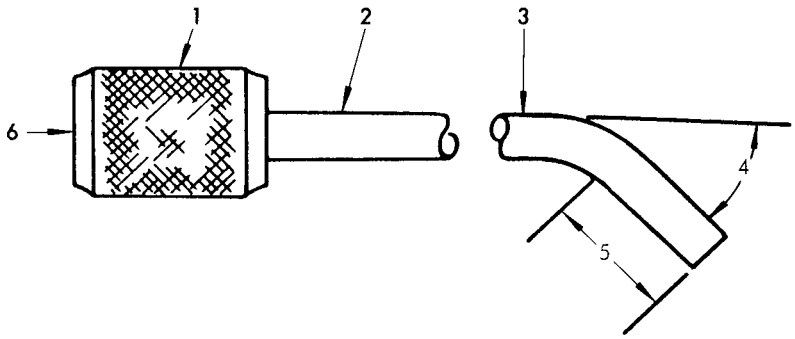
          CAUTION: INSULATION MATERIAL USED WITHIN THERMOCOUPLE PROBE WILL READILY ABSORB LIQUIDS. SINCE OPERATION OF THERMOCOUPLE MAY BE ADVERSELY AFFECTED BY PRESENCE OF LIQUIDS IN INSULATION, IT IS IMPORTANT THAT LIQUID SOLVENTS NOT BE USED IN ANY WAY WHICH WOULD PERMIT THEIR ENTRY INTO SHIELD.

   B. Clean Thermocouple Internally
      (1) Insert small nozzle into probe exhaust holes and remove carbon around thermocouple leads by air blasting.
      (2) Direct air blast at approximately 100 psig through nozzle.
      (3) Suggested nozzle may be fabricated from stainless steel tubing in accordance with dimensions shown in figure 701.

          NOTE: Carbon removal will aid in increasing insulation resistance of thermocouple.

   C. Clean Thermocouple by Grit Blasting
      (1) Carbon deposits which sometimes form on the head and terminals reduce thermocouple resistance. This coating may be removed by inserting the head only (not the probe) into a standard spark plug cleaning unit containing AC Cleaning Compound, Type 2.

          CAUTION: SUBJECT THE THERMOCOUPLE PROBE HEAD TO BLASTING ONLY LONG ENOUGH TO REMOVE THE CARBON COATING FROM TERMINALS AND FROM THE AREA AROUND THEIR BASES.



1. STANDARD CONNECTOR
2. 0.04 INCH ID TO 0.058 INCH OD TUBE
3. 0.250
4. 45 DEGREES
5. 0.200 INCH
6. 100 PSIG AIR PRESSURE APPLIED HERE

Thermocouple Probe Cleaner
Figure 701

EXHAUST GAS TEMPERATURE HARNESS AND LEAD - REMOVAL/INSTALLATION

1. Remove EGT Harness and Leads
   A. Obtain access to EGT circuit connector by opening left cowl panel. EGT circuit connector is located approximately, at the 7 o'clock position on fan exhaust outer case.

      NOTE: Some engines have junction boxes in place of connectors.

   B. Disconnect EGT circuit connector. On engine equipped with a junction box, remove output leads.
   C. Remove four nuts and screws securing connector receptacle or junction box to bracket.
   D. Remove two bolts securing EGT harness fitting to fan exhaust outer case.
   E. Check that thrust reverser is in forward thrust position to permit entrance into engine exhaust section.
   F. Observe the following precautions for maintenance in engine exhaust section.
      (1) Pull applicable engine ignition circuit breaker on circuit breaker panel P6, and placard the circuit breaker with DO NOT CLOSE.
      (2) Placard thrust reverser controls with DO NOT OPERATE.

         WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR IF THRUST REVERSER IS OPERATED.

   G. Enter engine exhaust section.
   H. Remove 12 screws retaining fan exhaust inner rear case. Slide it to rear. Refer to Fan Discharge Section, Chapter 72.
   I. Disconnect alumel and chromel leads from thermocouple probes.

      CAUTION: DO NOT BEND OR TWIST THERMOCOUPLE PROBE TERMINALS, AS TERMINALS MAY LOOSEN IN SUPPORTING INSULATION, AND THERMOCOUPLE FUSED JUNCTION MAY BREAK.

   J. Remove 15 screws securing EGT harness to turbine rear inner case.

K. Pull receptacle or junction box through fan exhaust outer case, and remove harness through rear of engine.

CAUTION: IN ALL HANDLING AND STORAGE, EGT HARNESS AND LEADS SHOULD BE HUNG ON RACK OR LAID ON CLEAN TABLE FREE OF OIL AND MATERIAL WITH WHICH IT MAY BECOME ENTANGLED. SEVERE REPEATED FLEXING AND HARD BENDING OR TWISTING WILL BREAK OR FRAY EXPOSED INSULATION. IF HUNG ON A RACK, CARE MUST BE TAKEN NOT TO INTRODUCE ANY SMALL RADIUS BENDS IN ANY PART OF ASSEMBLY. IT IS DESIRABLE TO HANG EGT HARNESS AND LEADS ON A RACK WHICH IS SIMILAR TO A SEGMENT OF A CIRCLE HAVING APPROXIMATELY THE SAME DIAMETER AS THE ENGINE CASINGS.

2. Install EGT Harness and Leads

A. Install harness through rear of engine and pull electrical connector receptacle or junction box through fan exhaust outer case.
B. Secure harness to turbine inner rear case using 15 screws.
C. Connect alumel and chromel leads to thermocouple probes.

CAUTION: DO NOT BEND OR TWIST THERMOCOUPLE PROBE TERMINALS AS TERMINALS MAY LOOSEN IN SUPPORTING INSULATION, AND THERMOCOUPLE FUSED JUNCTION MAY BREAK.

D. Slide fan exhaust inner rear case into position and secure it with 12 screws.
E. Install two bolts securing harness fitting to fan exhaust outer case.
F. Secure receptacle or junction box to bracket using four screws and nuts.
G. Reconnect electrical connector. On engine equipped with a junction box, attach leads to terminals at output end of junction box and tighten nuts to 18–22 lb–in for chromel lead and 20–25 lb–in (35–40 lb–in on engines with boost circuit system) for alumel lead. If bus bar has been removed, install over lugs, secure with nuts (18–22 lb–in for alumel lugs and 15–18 lb–in for chromel lugs), and install cover.
H. Close engine left cowl panel.
I. Remove placards in control cabin and close applicable engine ignition circuit breaker.

EXHAUST GAS TEMPERATURE HARNESS AND LEAD - ADJUSTMENT/TEST

1. Exhaust Gas Temperature Harness And Lead Test
   A. General
      (1) The exhaust gas temperature harness and lead is checked for evidence of mechanical damage to stainless steel braid, glass fiber sleeving, teflon coating (if so provided), and terminals. Check for rupture or severe fraying, and for broken conductor strands at any terminal.
      (2) Check mounting clips for deterioration of cushioning material. Replace defective clips.
      (3) The harness and lead is tested for continuity, insulation resistance and shorts with an ohmmeter. The validity of electrical checks made in the field may depend upon limitations inherent in the common ohmmeter. This instrument is not dependable for determining the exact wire resistances of the EGT harness and leads. However, it may be used to detect gross failures such as open or intermittent circuits and metal-to-metal short circuits. Also, approximate insulation resistance can be checked if certain precautions are observed. The ohmmeter used in the following test must be of good quality and in good condition; i.e. free from "stickiness" of the meter needle, with pin-jacks firm, test leads sound, and dry cells in condition to permit full scale deflection for all positions of the range switch.
   B. Equipment and Materials
      (1) Sensitive Ohmmeter
      (2) Low voltage ohmmeter capable of measuring resistance of 50,000 ohms. Meter should utilize less than 40 volts (dc) and should have accuracy of 5 percent.
   C. Prepare for Test
      (1) Check that thrust reverser is in forward thrust position to permit entrance into engine exhaust section.
      (2) Observe the following precautions for maintenance in engine exhaust section.
         (a) Pull applicable engine ignition circuit breaker on circuit breaker panel P6-2, and placard the circuit breaker with DO-NOT-CLOSE.
         (b) Placard thrust reverser controls with DO-NOT-OPERATE.

             WARNING: SERIOUS INJURY CAN OCCUR IF ENGINE IS STARTED AND/OR IF THRUST REVERSER IS OPERATED.

      (3) Enter engine exhaust section.
      (4) Remove 12 screws retaining duct cover ring to fan discharge turbine exhaust inner rear duct. Slide duct cover ring to the rear. Refer to Fan Discharge Ducts and Cases, Chapter 72.

(5) Obtain access to EGT circuit connector or junction box and terminal strip by opening left cowl panel. EGT circuit connector or junction box is located at approximately the 7 o'clock position on the engine, and the terminal strip at approximately the 9 o'clock position.
(6) Disconnect electrical connector. On engine equipped with a junction box, remove output leads, cover and bus bar.
(7) Disconnect harness lead terminals from terminal strip.

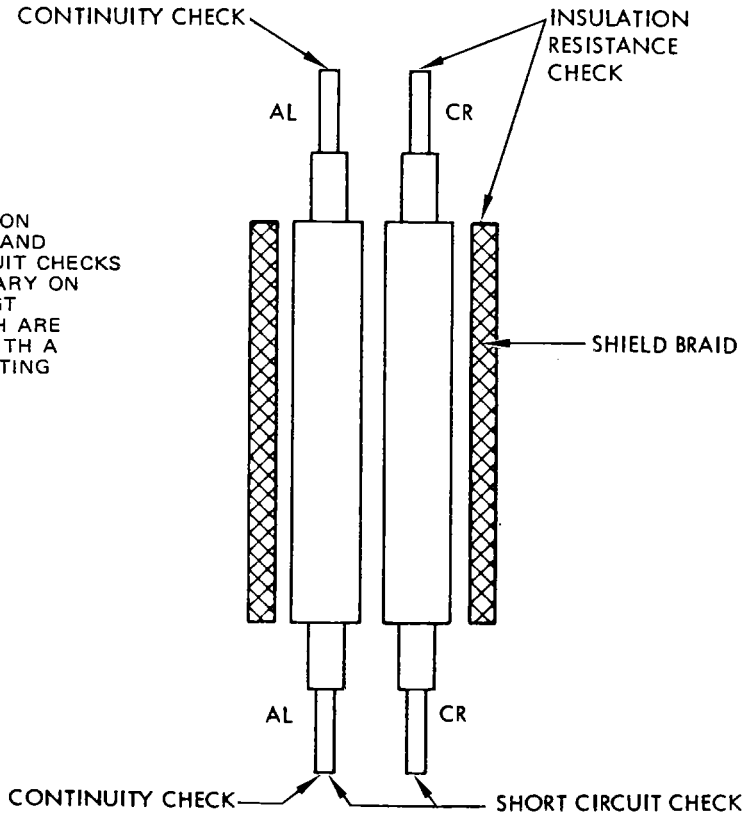
D. Test Exhaust Gas Temperature Harness and Lead
(1) Test harness and lead for continuity.
(a) Set ohmmeter switch to range with center scale value of approximately 10 ohms.
(b) Check continuity of harness lead between EGT circuit plug and terminal strip. On engine equipped with a junction box, perform continuity check on single wire leads only.
1) Connect one ohmmeter terminal to pin I on EGT circuit plug and other ohmmeter terminal to alumel terminal (green lead) on terminal strip

NOTE: It may be necessary to use a long piece of wire (8 to 10 feet) to conduct these continuity checks.

2) Flex EGT harness lead gently where possible and observe ohmmeter needle. If needle fluctuates or does not show an indication, continuity does not exist. Replace EGT harness lead.

NOTE: Broken wires which come in contact intermittently due to flexing will cause needle to fluctuate. False intermittent indications will result if ohmmeter terminals are not in firm contact with clean terminals, or if ohmmeter terminals or leads are defective.

3) Connect one ohmmeter terminal to pins A through H successively on EGT circuit plug and other ohmmeter terminal to chromel terminal (white lead) on terminal strip.
4) Flex EGT harness lead gently where possible and observe ohmmeter needle. If needle fluctuates or does not show an indication, continuity does not exist. Replace EGT harness lead.



NOTE: NO INSULATION RESISTANCE AND SHORT CIRCUIT CHECKS ARE NECESSARY ON TWO-WIRE EGT LEADS WHICH ARE PROVIDED WITH A TEFLON COATING

EGT LEADS WITH SHEILD BRAID

Test Schematic
Figure 501

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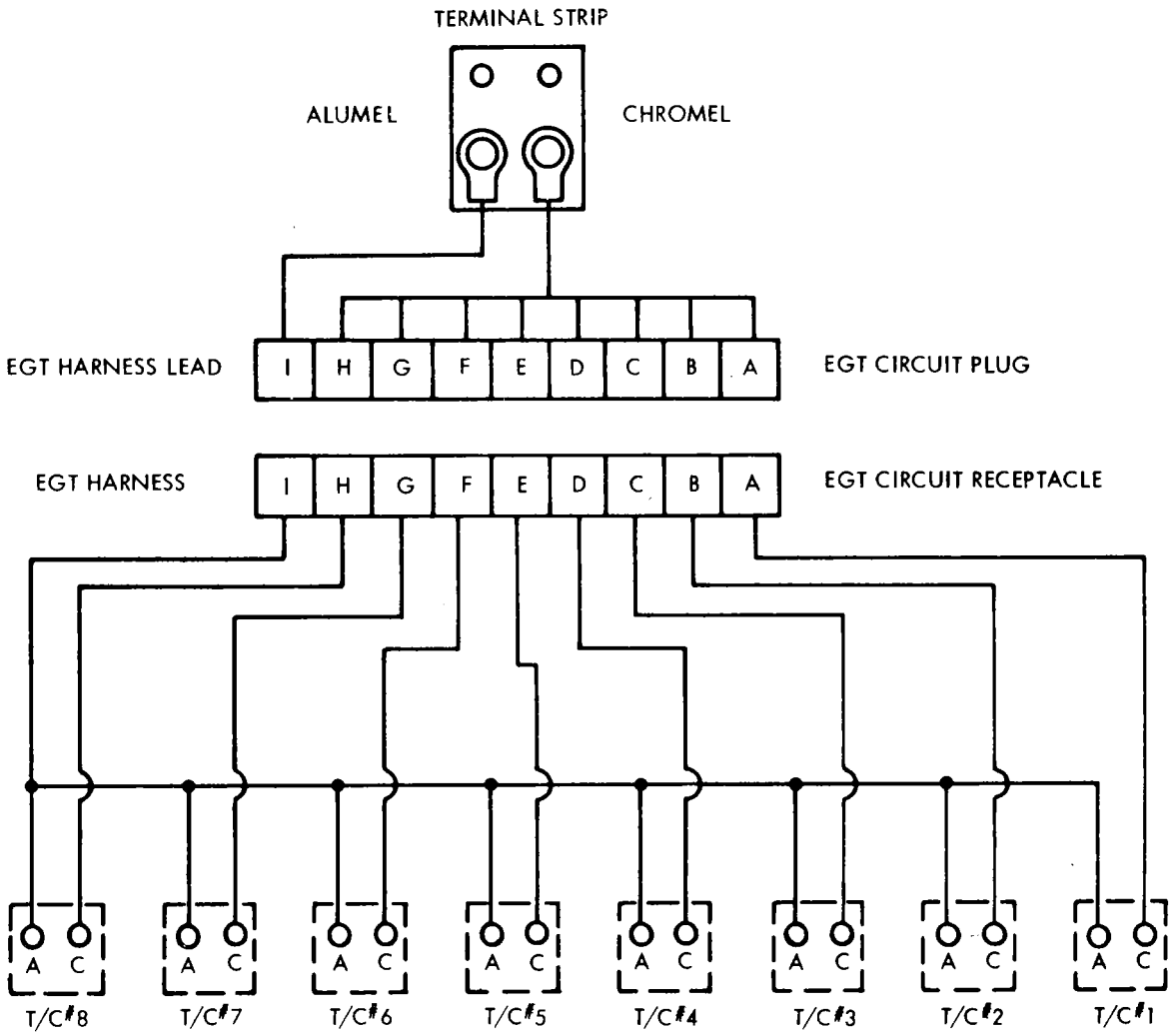

ENGINES WITH EGT ELECTRICAL CONNECTOR

EGT Harness and Lead Schematic
Figure 502 (Sheet 1)

EGT PROBE NO.	INDIVIDUAL PROBE CIRCUIT	
	RECEPTACLE PINS	JUNCTION BOX TERMINALS
1	A& 1	1 & AL
2	B & 1	2 & AL
3	C & 1	3 & AL
4	D & 1	4 & AL
5	E & 1	5 & AL
6	F & 1	6 & AL
7	G & 1	7 & AL
8	H & 1	8 & AL

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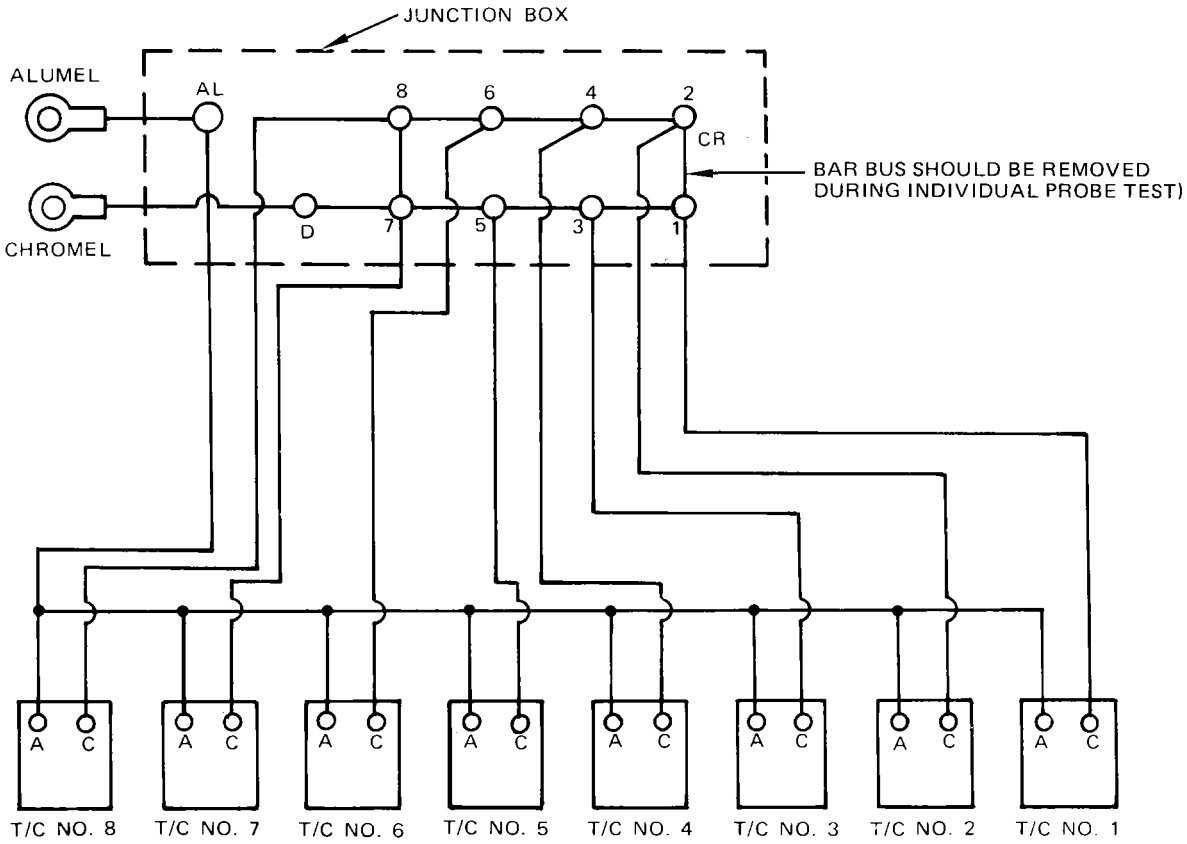


ENGINES WITH EGT JUNCTION BOX

EGT Harness and Lead Schematic
Figure 502 (Sheet 2)

449657

(2) Test harness continuity at EGT circuit connector receptacle or junction box.
   (a) On engine with EGT electrical connector, connect one ohmmeter (sensitive) terminal to pin I and other ohmmeter terminal to pins A through H successively.
   On engine equipped with a junction box, connect one ohmmeter terminal to AL terminal and other ohmmeter terminal to terminals 1 through 8 of junction box successively (bus bar removed) (Fig. 502 and 503).
   On engines with boost circuit at junction box, remove terminal connector at terminals 1 and 6. Connect ohmmeter terminals to terminals 1 and 6. Connect one ohmmeter terminal to AL terminal and one ohmmeter terminal to terminals 2, 3, 4, 5, 7, and 8 of junction box successively.
   (b) Flex EGT harness lead gently where possible while performing continuity checks and observe ohmmeter needle. If needle fluctuates or does not show an indication, continuity does not exist.
   (c) If continuity does not exist through any one EGT probe, check for continuity across corresponding probe terminals (Fig. 503).
      1) If continuity exists, replace EGT harness.
      2) If continuity does not exist, replace EGT probe(s).

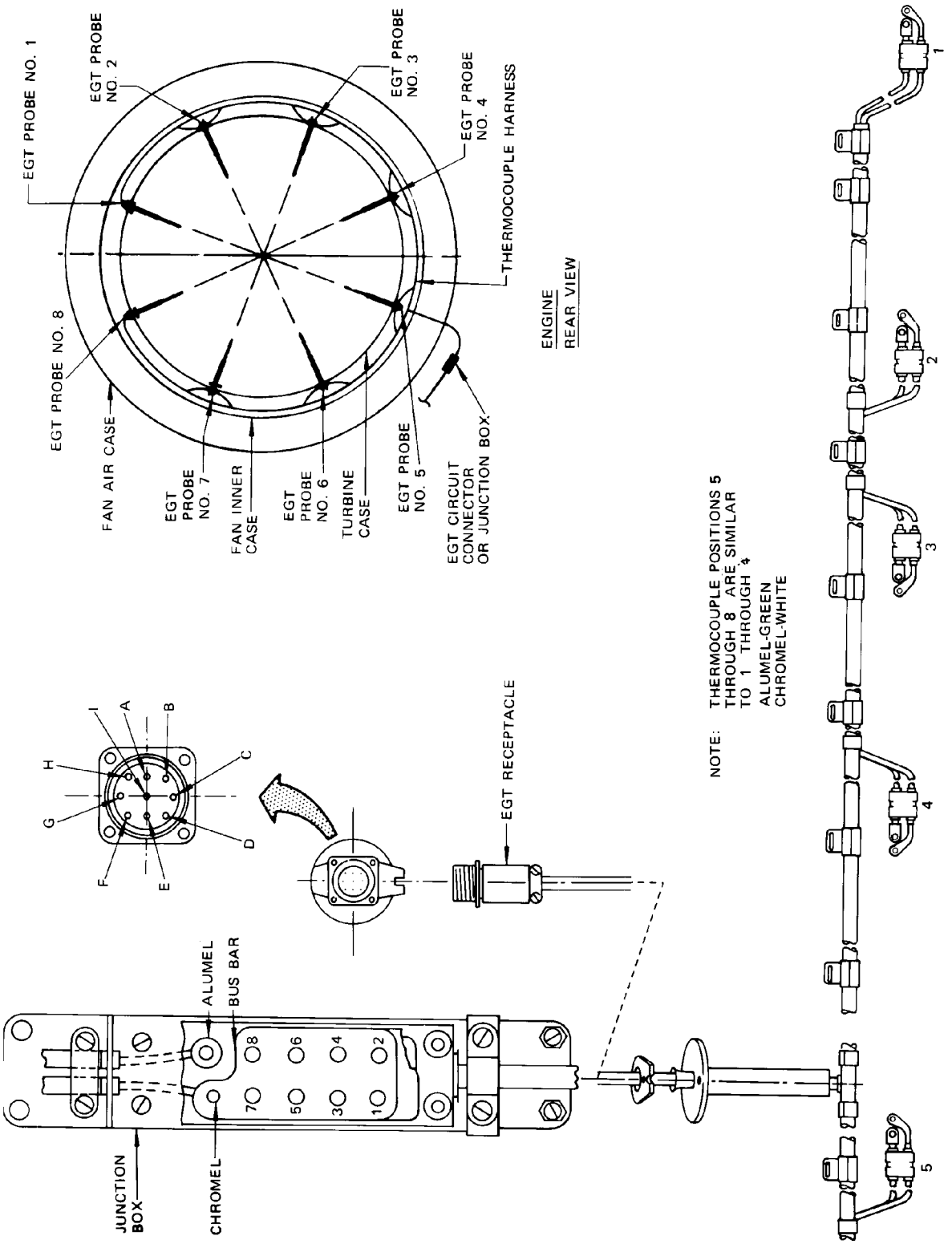
(3) Test insulation resistance between conductors and ground.

WARNING: TO REDUCE POSSIBILITY OF IGNITING FUEL, DO NOT USE A MEGGER OR OTHER HIGH VOLTAGE OHMMETER.

   (a) Ensure that the thermocouple cable and leads are properly installed and connected.

NOTE: Insulation resistance values slightly below the limits set forth below will not result in a defective EGT system. It does, however, clearly indicate that the insulation is deteriorating and will result in eventual shorts or deficient EGT readings. Therefore, EGT system components with insulation resistance readings below the limits set forth require attention to restore the insulation resistance to acceptable values and prevent further deterioration and EGT system failure.

   (b) Check proper operation of ohmmeter (low voltage) by touching test terminals together and noting needle deflection to read zero ohms.
   (c) Place one ohmmeter probe in contact with harness steel wire braid and other ohmmeter probe to terminals A through H or terminals 1 through 8 on junction box (bus bar removed).



Exhaust Gas Temperature Harness Layout
Figure 503

(d) Read ohmmeter. If resistance recorded is below 50,000 ohms, proceed as follows: If ful1-scale deflection (zero ohms) is recorded and no terminals are in accidental contact, replace harness; if large (but not ful1-scale) deflection is recorded, the presence of carbon or excessive moisture may be indicated. Carbon yields a fairly steady reading. Moisture tends to produce readings which waver or drift after 5 to 50 seconds.

NOTE: False drift may be due to variations in applied voltage. To check for false drift, place ohmmeter terminals in contact with each other for 10 seconds. The readings must not wander from ful1-scale deflection (0 ohms).

(e) Check harness lead resistance between each conductor and wire braid at terminal strip.

NOTE: No insulation resistance check is necessary on harness leads provided with a teflon coating.

(f) Repeat step (d).

(g) If presence of moisture is indicated, remove harness and lead, and bake at 200 to 250°F (93 to 121)°C for 1 hour and recheck. A substantial increase in readings indicates that moisture was cause of original low values.

(h) Install and connect harness and lead; and again measure insulation resistance between conductors and ground. It must be at least 50,000 ohms.

(4) Check circuit for shorts and insulation resistance between conductors.

NOTE: No short circuit check is necessary on harness leads provided with a teflon coating.

(a) Disconnect one lead from each EGT thermocouple probe.

CAUTION: DO NOT BEND OR TWIST THERMOCOUPLE PROBE TERMINALS, TERMINALS MAY LOOSEN IN SUPPORTING INSULATION, AND THERMOCOUPLE FUSED JUNCTION MAY BREAK.

(b) Set ohmmeter (sensitive) switch to range with center scale value of approximately 10 ohms.

(c) Check each individual probe circuit in harness for short circuits at EGT circuit connector receptacle. Refer to figures 501 and 502.
1) Flex harness gently and observe instrument needle. If any deflection results (unless caused by accidental contact of harness terminals at EGT probes), replace harness.

(d) Check harness lead for short circuits at terminal strip.
1) Flex harness lead gently and observe needle. If any deflection results, replace lead.

(e) Check proper operation of ohmmeter (low voltage) by touching test terminals together and noting needle deflection to read zero ohms.

WARNING: TO RESCUE POSSIBILITY OF IGNITING FUEL, DO NOT USE A MEGGER OR OTHER HIGH VOLTAGE OHMMETER.

(f) Check resistance of insulation between conductors by placing one ohmmeter terminal in contact with EGT connector receptacle pin I and other ohmmeter terminal in contact successively with pins A through H. If resistance is below 50,000 ohms, replace harness.

(g) Check resistance of insulation between harness lead conductors at terminal strip. If resistance is below 50,000 ohms, replace harness lead.

(h) Connect leads to EGT probe terminals.

CAUTION: DO NOT BEND OR TWIST THERMOCOUPLE PROBE TERMINALS AS TERMINALS MAY LOOSEN IN SUPPORTING INSULATION, AND THERMOCOUPLE FUSED JUNCTION MAY BREAK.

(5) Return airplane to normal configuration.

(a) Slide duct cover ring into the fan discharge turbine exhaust inner rear duct and secure with 12 screws.

(b) Connect harness lead to terminal strip.

(c) Connect EGT circuit connector. On engine equipped with a junction box, connect output leads; install bus bar, secure with nuts and install cover.

(d) Close engine left cowl panel.

(e) Remove placards in control cabin and close applicable engine circuit breakers.

EXHAUST GAS TEMPERATURE HARNESS AND LEAD - CLEANING/PAINTING

1. EGT Harness and Lead Cleaning
   A. Equipment and Materials
      (1) Solvent - Trichlorethylene
   B. Clean Harness and Lead
      (1) Clean external surfaces by wiping with cloth slightly dampened with trichlorethylene solvent.
      (2) If necessary, clean all terminal contact surfaces, using a stainless steel brush or stainless steel pad without soap.

          CAUTION: NO FOREIGN MATERIAL SHALL BE LEFT ON TERMINALS.

EXHAUST GAS TEMPERATURE INDICATOR - REMOVAL/INSTALLATION

1. Remove Exhaust Gas Temperature Indicator
   A. Open applicable circuit breakers pertaining to indicator being removed.

      WARNING: TAG AND SAFETY THE CIRCUIT BREAKERS.

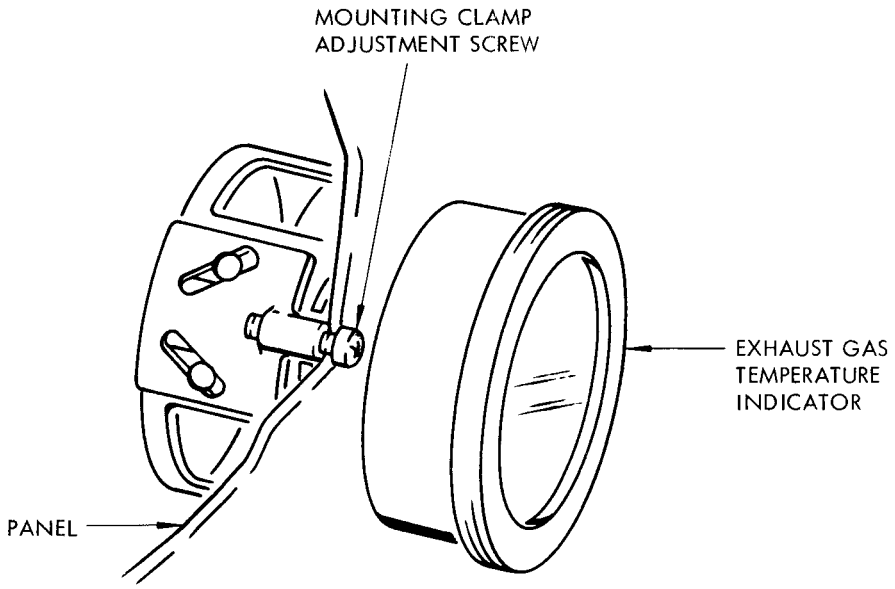
   B. Record position of indicator (such as 9 o'clock position) with respect to rest of panel to facilitate installation.
   C. Loosen indicator mounting clamp adjustment screw. (See figure 401.)
   D. Remove indicator by pulling straight out of panel clamp.
   E. Disconnect terminals or electrical connector from indicator.

      NOTE: Tag wires to identify if terminals are used.

2. Prepare for Installation

   NOTE: If indicator is being replaced with a new indicator it will be necessary to prepare for installation in accordance with steps A. and B.

   A. Remove shorting strap from new indicator.
   B. Install shorting strap between alumel and chromel terminals on old removed indicator.
   C. Make certain applicable circuit breakers pertaining to indicator to be removed are open and tagged.
3. Install Exhaust Gas Temperature Indicator
   A. Connect terminals or electrical connector to indicator.
   B. Insert indicator into panel.
   C. Align indicator so that 9 o'clock position is as recorded in paragraph 1.B.
   D. Tighten mounting clamp adjustment screw.
   E. Close circuit breakers and remove safety tags.



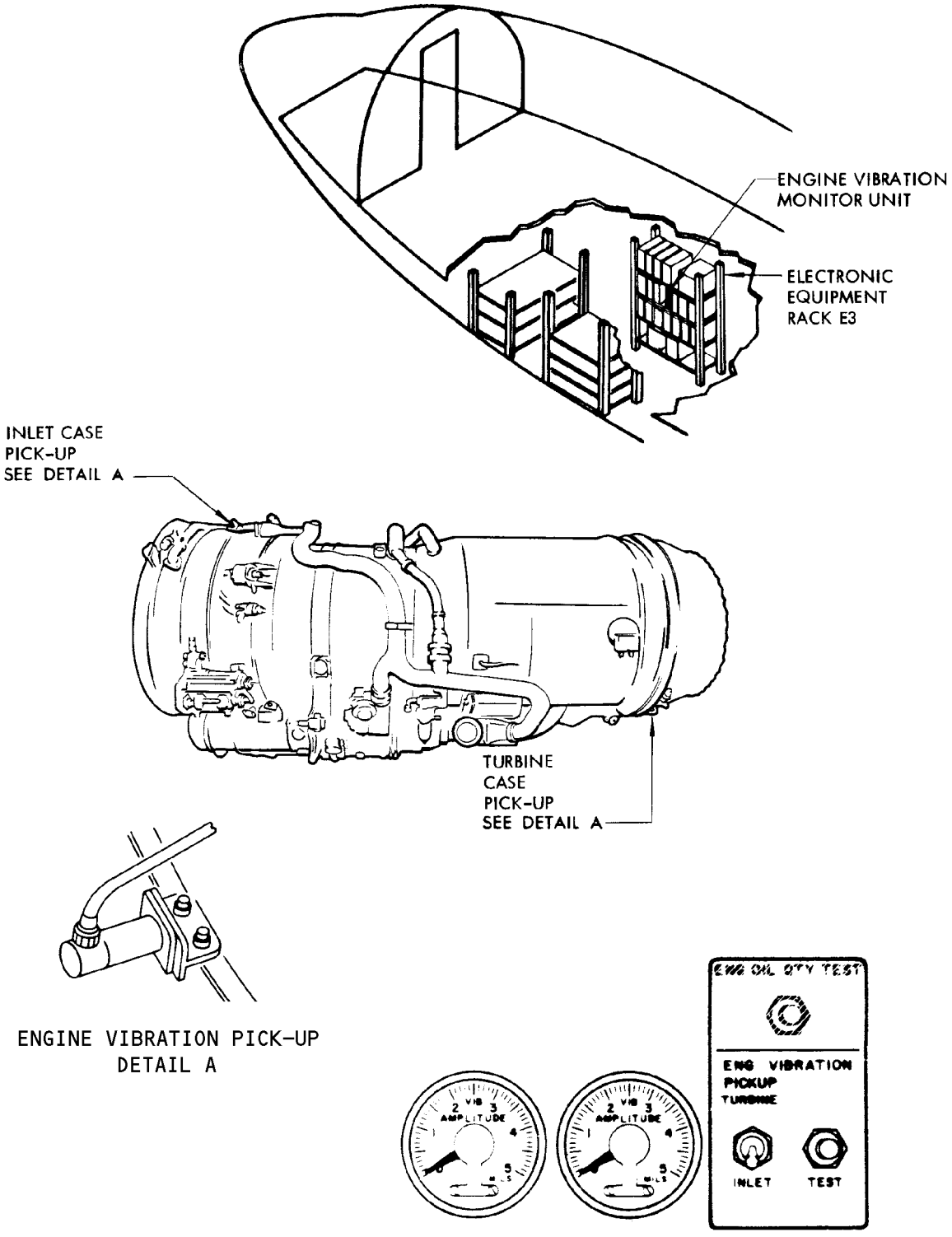
Exhaust Gas Temperature Indicator Installation
Figure 401

AIRBORNE VIBRATION MONITORING SYSTEM (CONSOLIDATED) - DESCRIPTION AND OPERATION

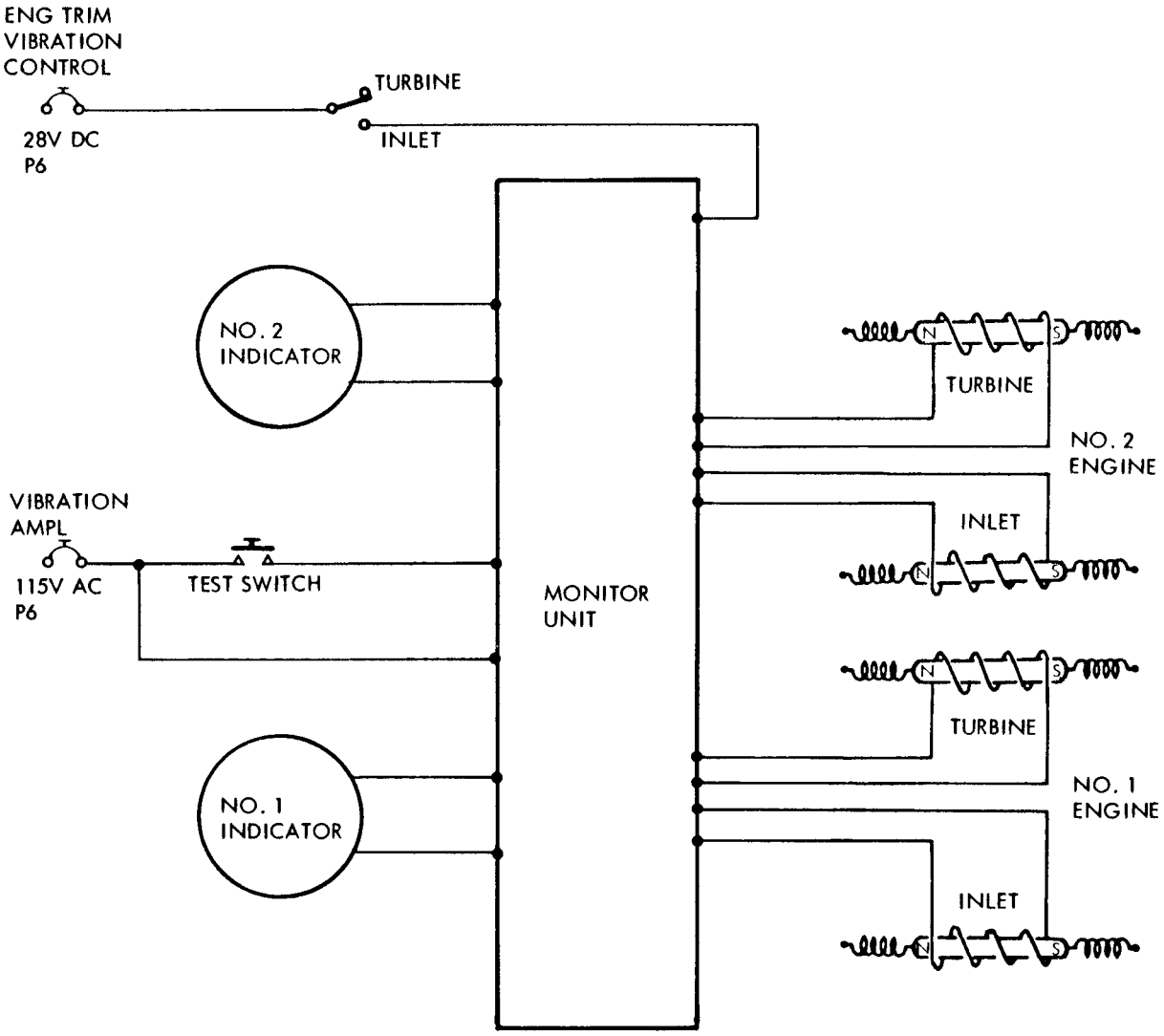
1. General
   A. The airborne vibration monitoring system measures the amount of engine vibration, and shows the engine vibration level on indicators at the center instrument panel. If any vibration increase is stabilized for over 30 seconds, it may be an indication of engine malfunction. Instantaneous warning of the malfunction permits corrective measures before extensive damage occurs.
   B. The system basically consists of two vibration pickups and one indicator for each engine, and a monitor unit, a pickup selector switch and a test switch for the two engine system.
   C. Vibration pickups generate alternating electrical signals proportional to the amount of engine vibration, and transmit the signals to the monitor unit. The monitor unit amplifies and rectifies the alternating electrical signals to pulsating dc signals, which operate the corresponding vibration indicators on the center instrument panel. A pickup selector switch is used to select the signals from either the engine inlet pickups or turbine section pickups of the two engines simultaneously. The test switch checks circuit continuity of the two engine airborne vibration monitoring system.
2. Engine Vibration Pickup
   A. The engine vibration pickup is a transmitter used to convert mechanical energy of vibration to alternating electrical signals of proportional magnitude. Each pickup is enclosed in a hermetically sealed case. A stabilized, permanent magnet is suspended on springs inside a coil. The coil is attached to the cylindrical case of the pickup which, in turn, is mounted on the engine. There are two pickups for each engine; one is located approximately at the 11 o'clock position on the front flange of the engine inlet case, while the other is on the turbine case forward flange at approximately the 6 o'clock position.
   B. As the engine vibrates, the case and coil move with the engine, but the magnet being suspended tends to remain at rest. The relative motion between the magnet and the coil generates alternating electrical signals in the coil, which appear as the pickup output.
3. Engine Vibration Monitor Unit
   A. The engine vibration monitor unit receives signals from the engine-mounted vibration pickups and transmits the amplified signals to the indicators. The monitor unit consists of two electronic channels. Each channel contains a signal integrator, signal amplifier, and a sensitive relay. The monitor unit with its power supply is located on the electrical equipment shelf (E3) in the electronic equipment compartment.

B. The monitor unit channels integrate input signals, filter out undesired frequencies, and amplify and rectify alternating signals to pulsating dc signals. The dc signals, transmitted through sensitive relays, appear as the output signals of the monitor unit.

4. Engine Vibration Indicator
   A. A vibration indicator shows the vibration level of an engine. It is a permanent magnet, temperature compensated dc microammeter, contained in a hermetically sealed case. The round dial face is graduated in mils (thousandths of an inch) of engine vibratory displacement (amplitude of vibration). There are two indicators, one for each engine, mounted on the center instrument panel.
5. Operation
   A. The monitor unit and test switch utilizes ac power, however, dc power is used for integral instrument lighting.
   B. With engines running, the airborne vibration monitoring system is energized by closing the applicable circuit breakers. The vibration pickups generate alternating electrical signals proportional to the amount of engine vibration due to the relative movement of a permanent magnet and a coil in each pickup. The generated electrical signals are the input received by the monitor unit. The monitor unit integrates the input signals, filters out undesired frequencies of vibration, and amplifies and rectifies the alternating signals to pulsating dc signals. The dc signals are transmitted through sensitive relays to the corresponding vibration indicators. The indicators transform the pulsating dc signals into the pointer movements on the indicator dials. Engine vibration readings can be obtained from either the engine inlet pickups or the turbine section pickups of the two engines simultaneously by properly positioning the pickup selector switch. The accepted vibration level at any selected engine rpm will vary between engines. If at any time an indicator shows engine vibration increasing above the normal level, the test switch should be used to determine if the system is functioning properly before corrective or compensating action is taken.



Airborne Vibration Monitoring System Component Location
Figure 1

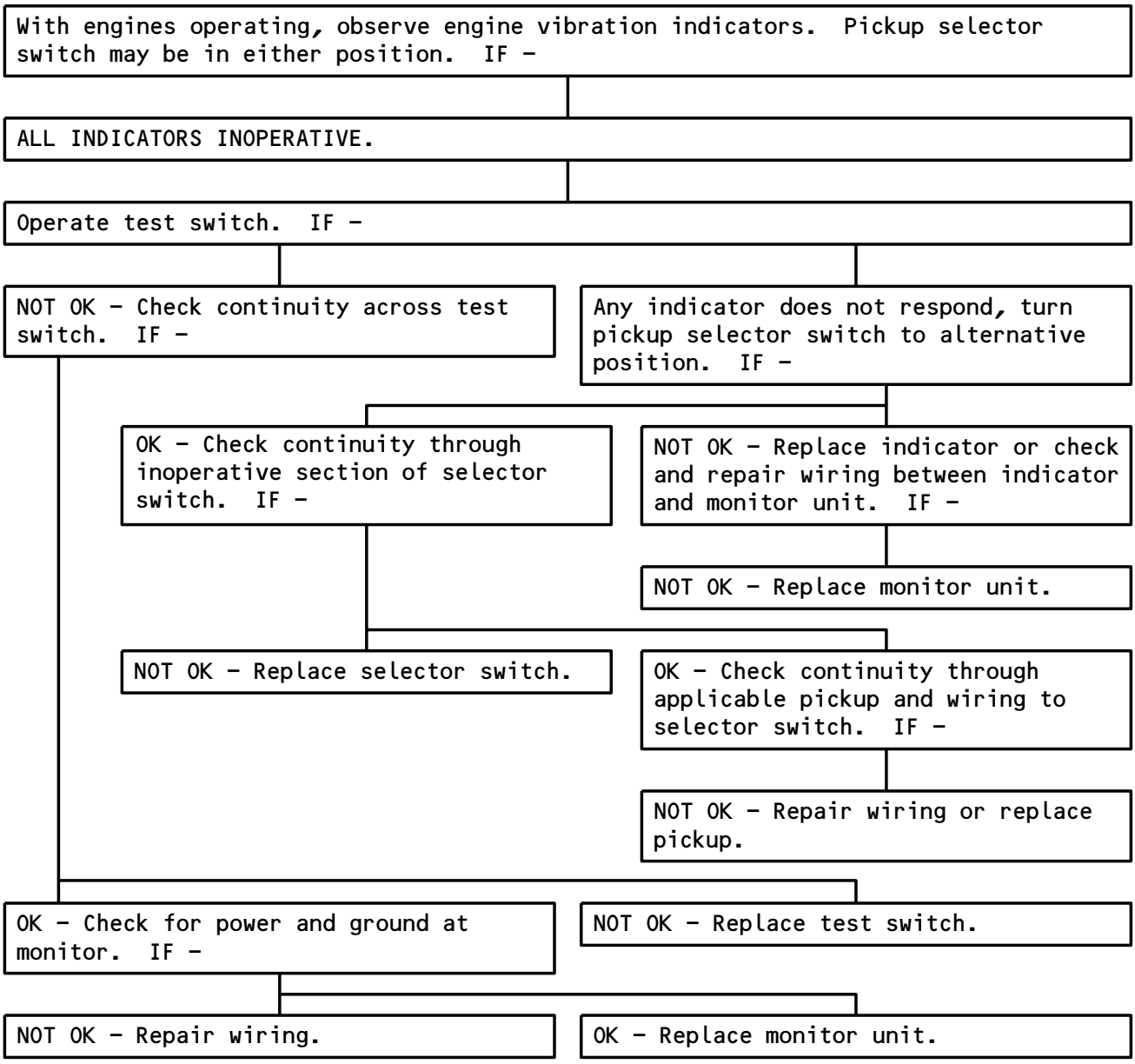


Airborne Vibration Monitoring System Schematic
Figure 2

AIRBORNE VIBRATION MONITORING SYSTEM - TROUBLE SHOOTING

EFFECTIVITY

AR LV-JMW thru LV-JMZ,LV-JND thru LV-JNE,LV-JTD,LV-JTO,LV-LEB
BL G-DFUB,G-BMON,N4529,N4530
BU ALL EXCEPT LN-SUA,LN-SUJ,LN-SUQ,LN-SUU thru LN-SUZ
HV ALL EXCEPT PH-TVX
NZ ZK-NAC,ZK-NAD,ZK-NAE,ZK-NAJ,ZK-NAM,ZK-NAP and ZK-NAQ
WA 261,262



Airborne Vibration Monitoring System - Troubleshooting
Figure 101

AIRBORNE VIBRATION MONITORING SYSTEM (CONSOLIDATED) - ADJUSTMENT/TEST

1. Airborne Vibration Monitoring System Operation Test
   A. Test Airborne Vibration Monitoring System Operation with Engines Shut Down
      (1) Prepare Airborne Vibration Monitoring System for Test.
         (a) Provide electrical power.
         (b) Open ENGINE VIB AMP and ENGINE TRIM and VIB CONT circuit breakers on circuit breaker panel P6.
         (c) Place ENG VIBRATION PICKUP selector switch in TURBINE position.
      (2) Test Airborne Vibration Monitoring System Indicator
         (a) Observe vibration indicators to establish that each indicator pointer is within one needle width of the zero position. Replace indicator(s) if not within limits.
         (b) Close ENGINE VIB AMP and ENGINE TRIM AND VIB CONT circuit breakers. This operation may cause a slight fluctuation and up-scale movement of indicator pointers. The final indicator pointer position should be within one needle width of zero.
         (c) Push TEST switch and observe that pointers read between 3.5 and 4.5 mils. Check that both indicators read within 0.5 mil of each other.
         (d) Release TEST switch.
         (e) Place ENG VIBRATION PICKUP selector switch in INLET position.
         (f) Repeat steps (c) and (d).
      (3) Restore Airplane to Normal Configuration
         (a) If no longer required, remove electrical power from airplane.
   B. Test Airborne Vibration Monitoring System Operation with Engines Operating
      (1) Prepare Airborne Vibration Monitoring System for Test
         (a) Start engines in accordance with Chapter 71, Power Plant.
         (b) Run engines at idle.
         (c) Close ENGINE VIB AMP circuit breaker on circuit breaker panel P6-2.
      (2) Test Airborne Vibration Monitoring System Operation
         (a) Place ENG VIBRATION PICKUP selector switch to INLET position.
         (b) Slowly advance engine thrust lever to maximum thrust position, observing corresponding engine vibration indicators.

            NOTE: Engine thrust lever movement from idle to maximum thrust position should take at least 60 seconds.

         (c) Engine vibration indicator pointers should move a minimum of half a pointer width during operation.

(d) Record maximum engine vibration reading and corresponding engine N2 percent rpm in log book.

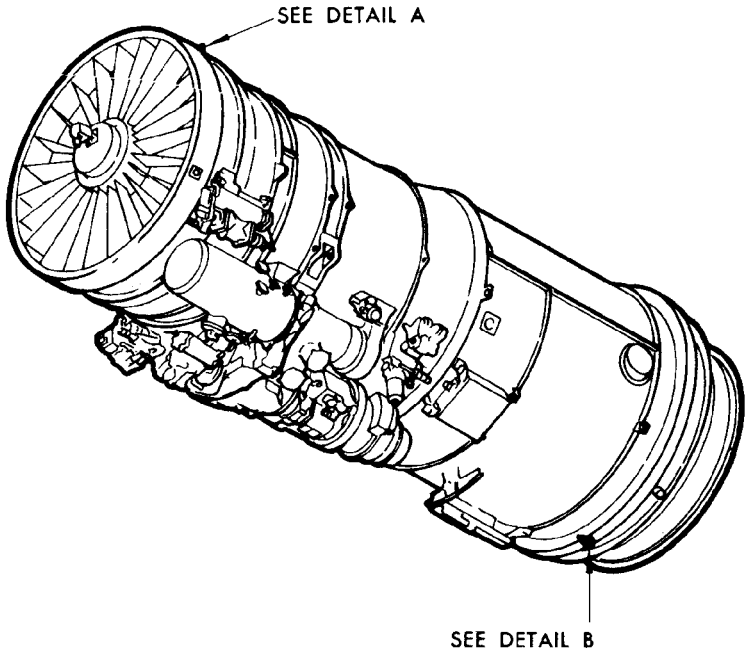
NOTE: This test is not intended for establishing any vibration limits of engine, but to find out if system is functioning properly. However, obtained data can be used as guide in establishing reference point on indicator for normal engine vibration, usually done during first few flights after engine change.

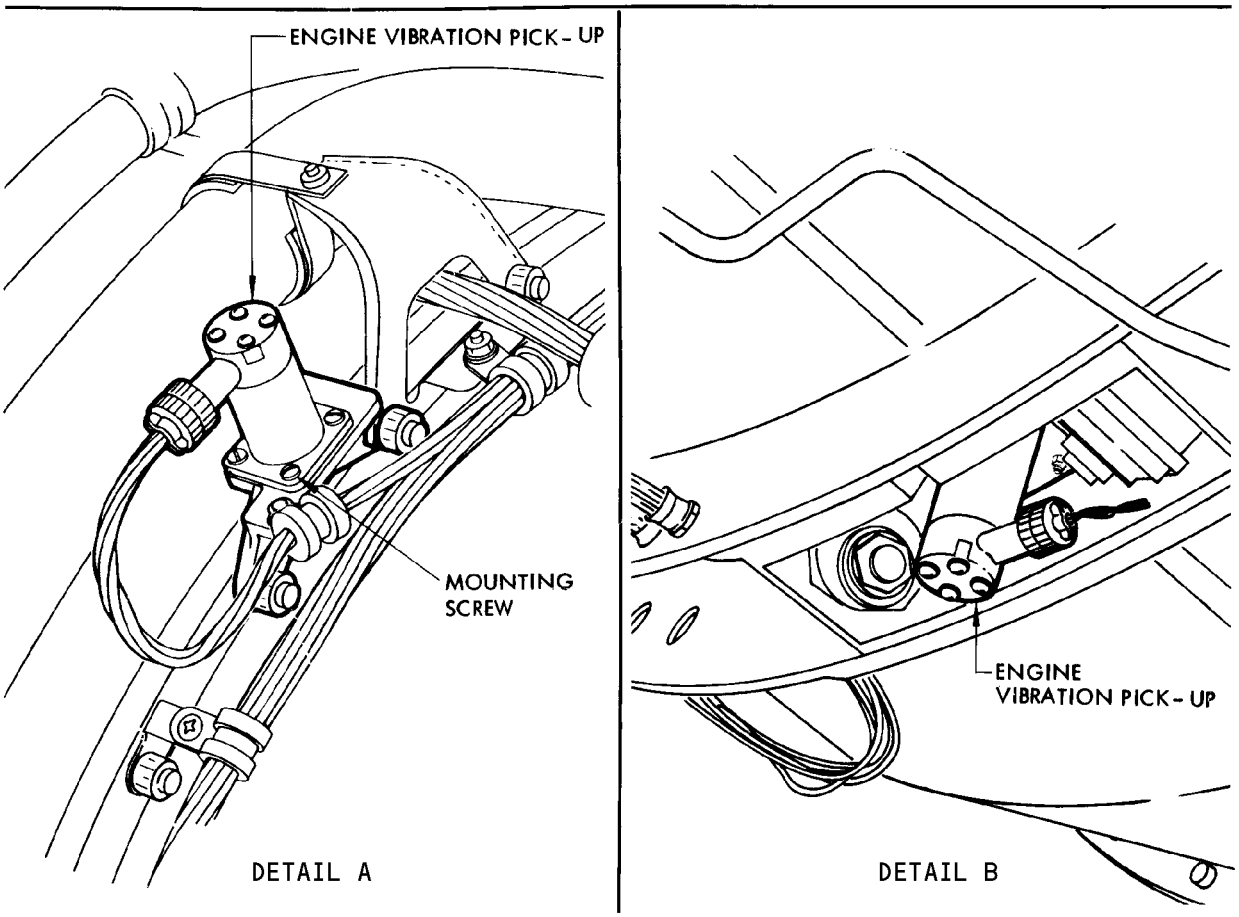
(e) Move engine thrust lever to idle position.
(f) Place ENG VIBRATION PICKUP selector switch to TURBINE position.
(g) Repeat steps (b) through (e).

(3) Restore Airplane to Normal Configuration
(a) Shut down engines in accordance with Chapter 71, Power Plant.
(b) Remove electrical power.

ENGINE VIBRATION PICKUP - REMOVAL/INSTALLATION

1. Remove Inlet Section Vibration Pickup
   A. Obtain access to inlet vibration pickup by opening applicable cowl panel (Ref Chapter 71, Engine Cowling).
   B. Disconnect electrical plug from vibration pickup. See Fig. 401, Detail A, for inlet section vibration pickup. See Fig. 401, Detail B, for turbine section vibration pickup.
   C. Cut and remove lockwire.
   D. Remove mounting screws and lift vibration pickup free of bracket.
2. Install Vibration Pickup
   A. Place vibration pickup on bracket, align holes, install mounting screws, and lockwire (Fig. 401).
   B. Connect electrical plug to vibration pickup.
   C. Close applicable cowl panels.
   D. Test Vibration System Operation (Engines Running) with pickup selector switch in first INLET then TURBINE position (Ref 77-32-0).





Engine Vibration Pickup Installation
Figure 401