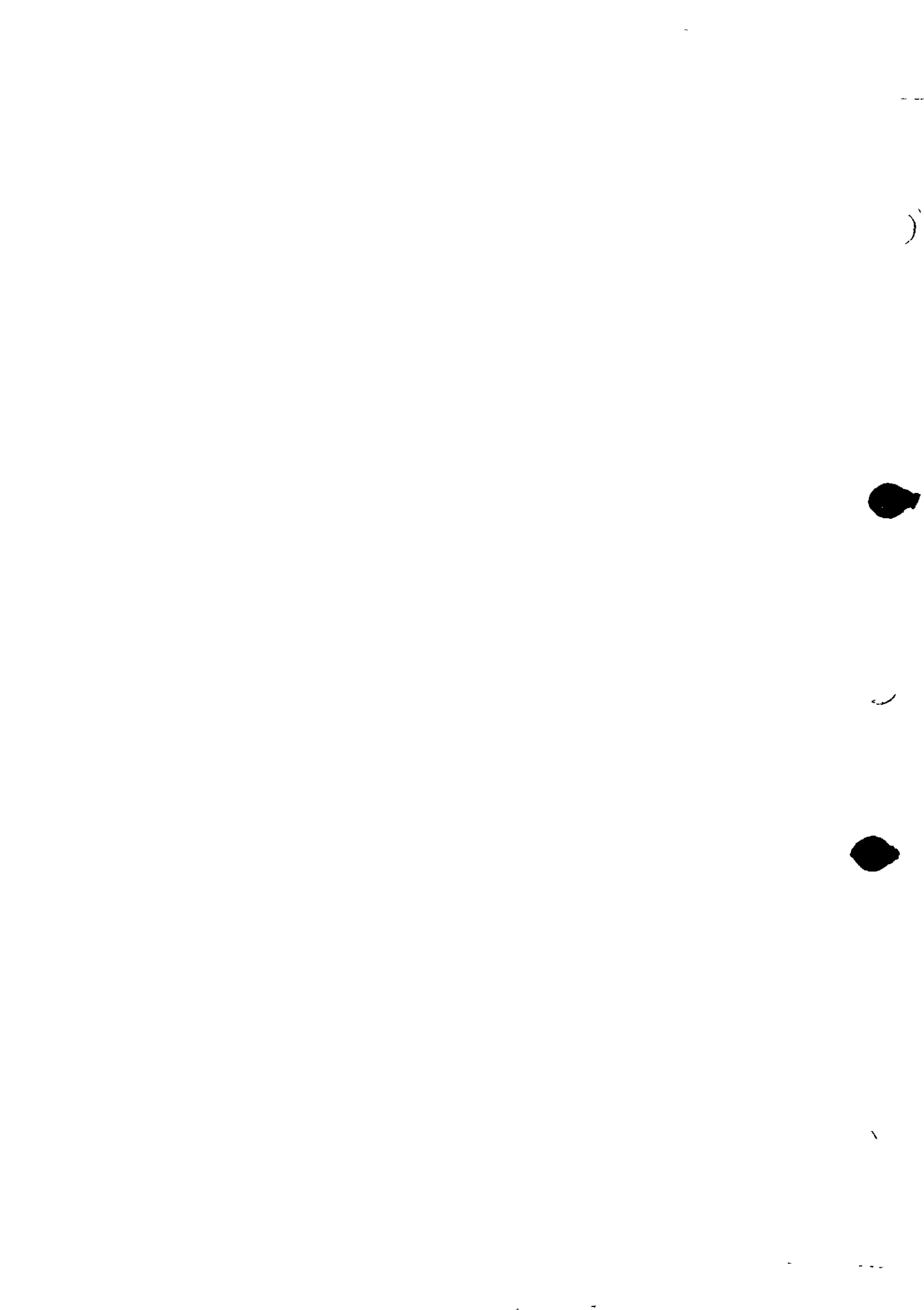


CHAPTER

74



BOEING 707

MAINTENANCE MANUAL

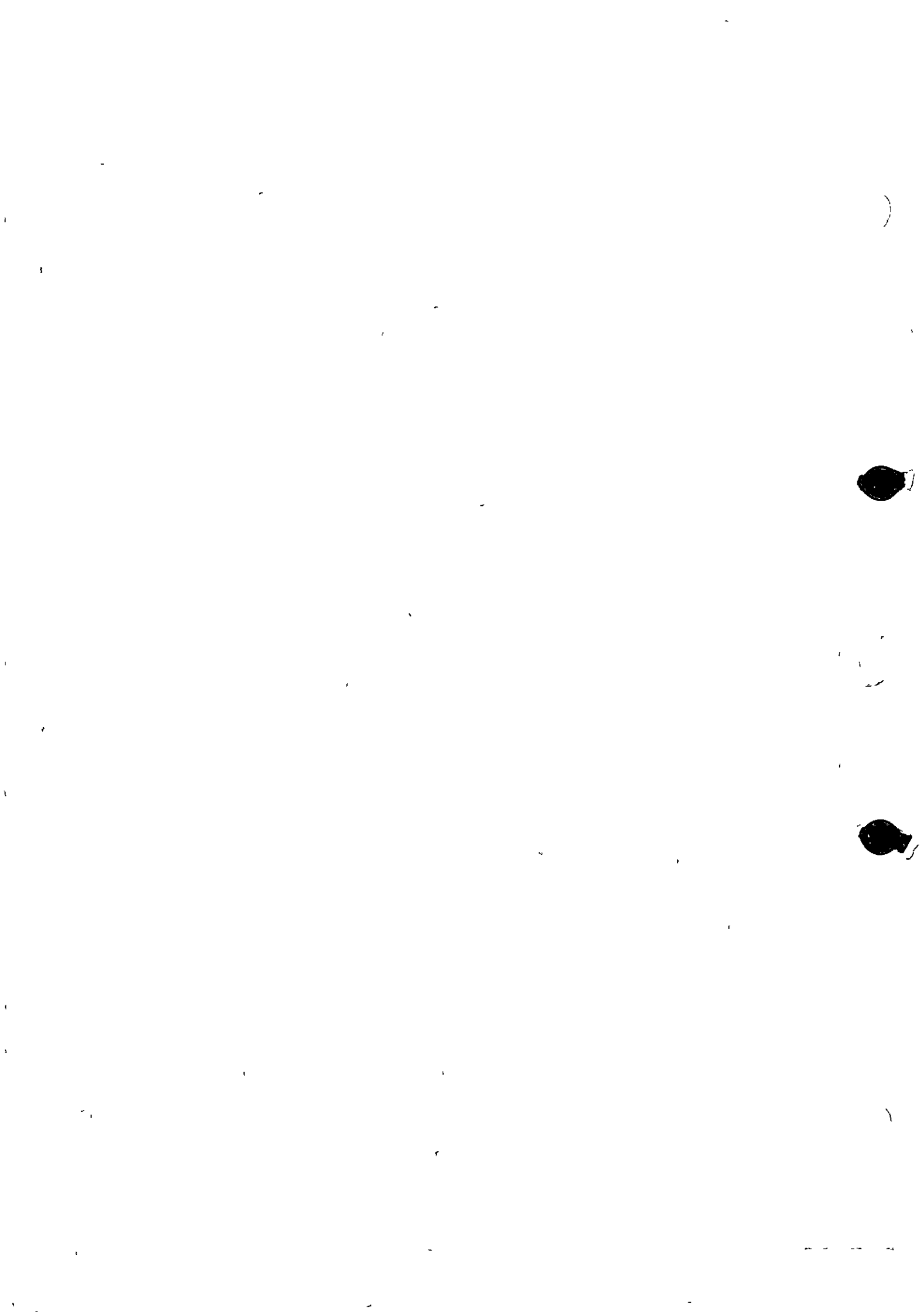
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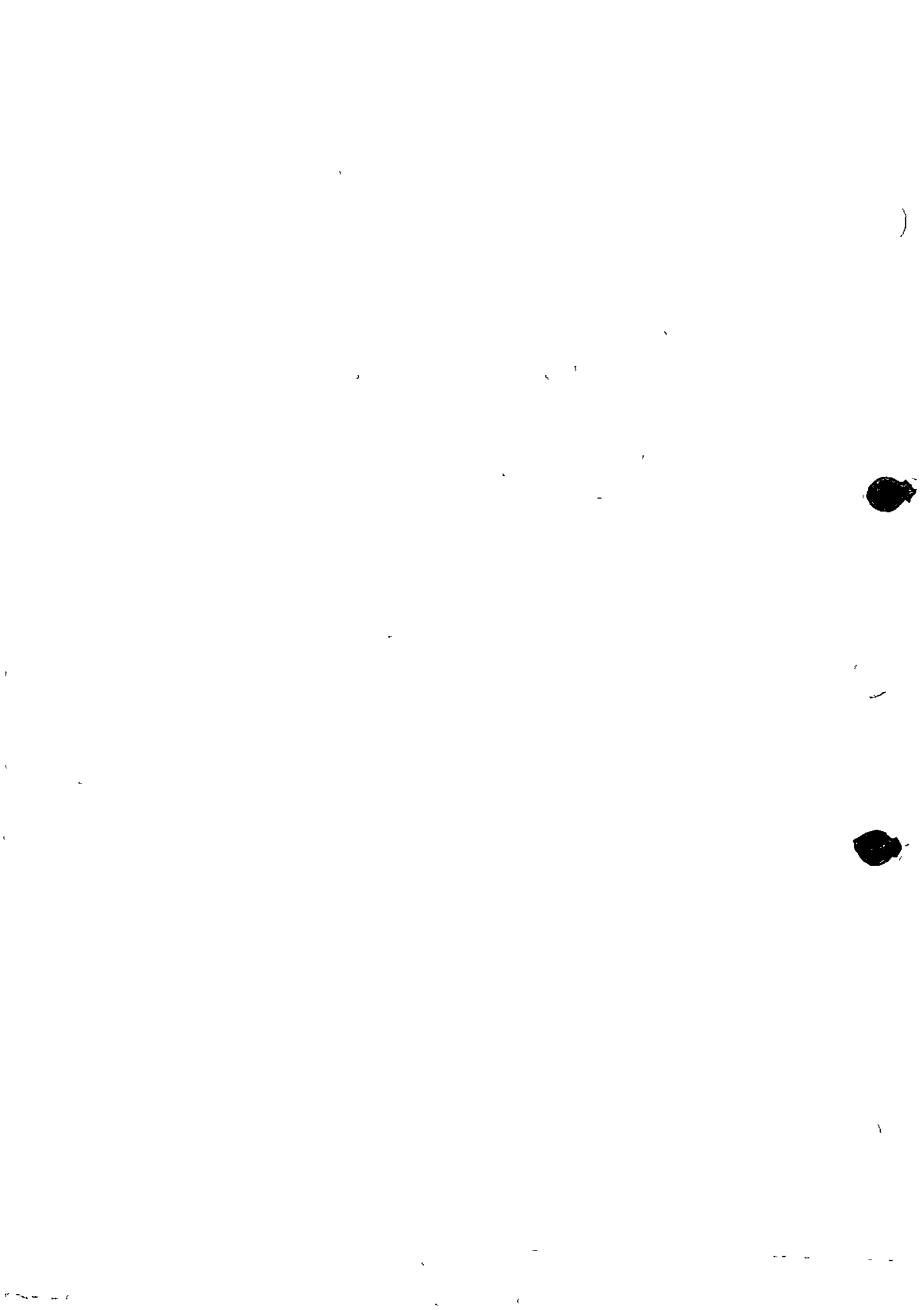
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CHAPTER 74

IGNITION

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IGNITION SYSTEM - DESCRIPTION AND OPERATION

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1. General

- A. The ignition system converts 28 volt dc power into high voltage pulsating current, which produces a high energy spark at spark igniters to initiate fuel combustion in the engine. The system is a high energy capacitor type, generating a sufficiently hot spark for engine starts at high altitudes and under wet conditions.

WARNING: OPEN IGNITION SYSTEM CIRCUIT BREAKERS AT LEAST 3 MINUTES BEFORE MAKING DISCONNECTIONS. AFTER DISCONNECTING ANY LEAD, ASSURE DISCHARGE OF CAPACITORS BY IMMEDIATELY SHORTING TERMINAL TO GROUND. THE CURRENTS INVOLVED IN THE IGNITION SYSTEM CAN BE FATAL.

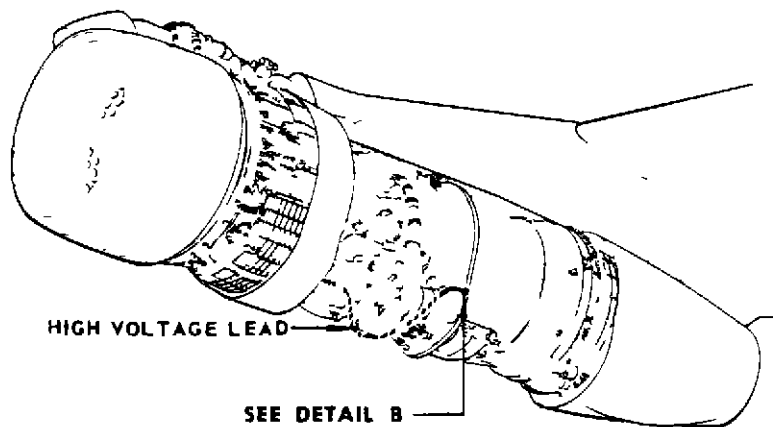
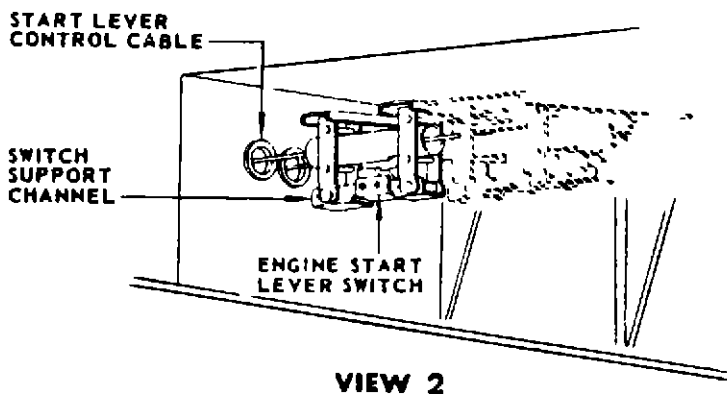
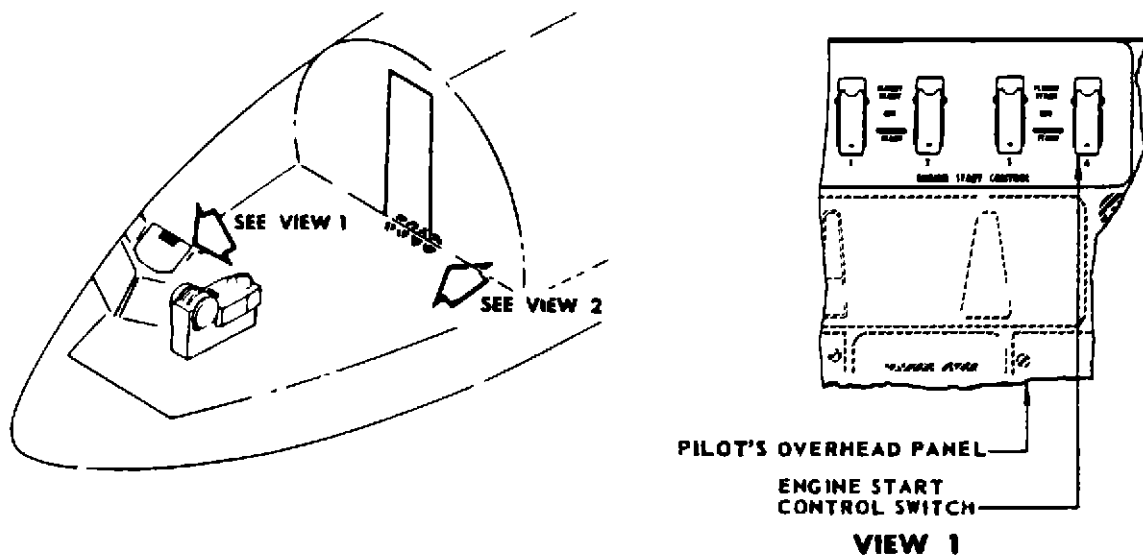
- B. Ignition for each engine is accomplished by two identical circuits, each consisting of an exciter unit and a spark igniter. (See figure 1.) Successful starts may be made with one circuit inoperative.
- C. Control of the ignition system is provided by two switches for each engine. These are the engine start control switches (view 1, figure 1) on the overhead panel and the cam-operated engine start lever switches in the lower nose compartment. (See view 2, figure 1.) Each engine start lever switch is cable operated by a start lever on the control stand.

2. Engine Ignition Exciter Units

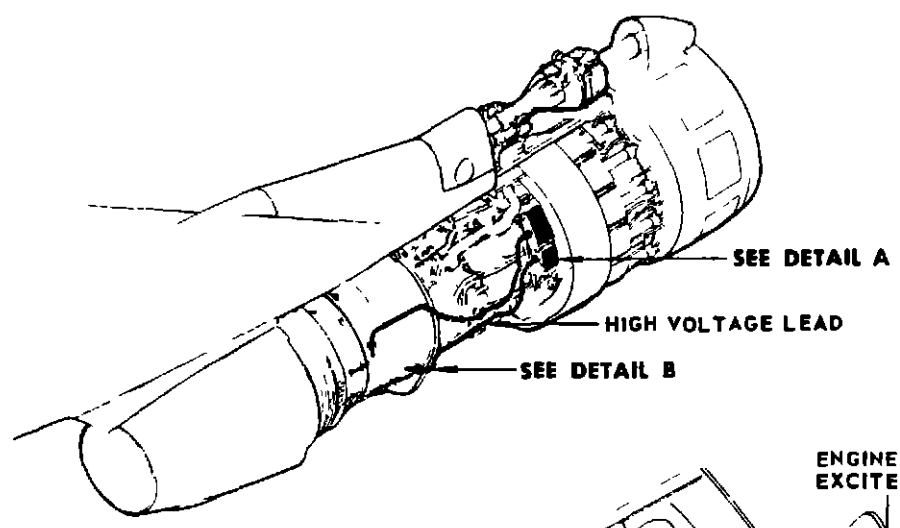
- A. Each exciter unit includes an input radio noise filter, one vibrator, one vibrator transformer, a rectifier, and a triggering transformer. On airplanes SABENA OO-SJM and on, SAA ZS-SAG and on, an additional radio noise filter for each exciter unit is provided at the wing leading edge area. The exciter unit is housed in a hermetically-sealed metal container, providing protection against weather and the possibility of flashover at altitude. Both exciter units (detail A, figure 1) are mounted on the right side of the N1 compressor case.

3. Spark Igniters

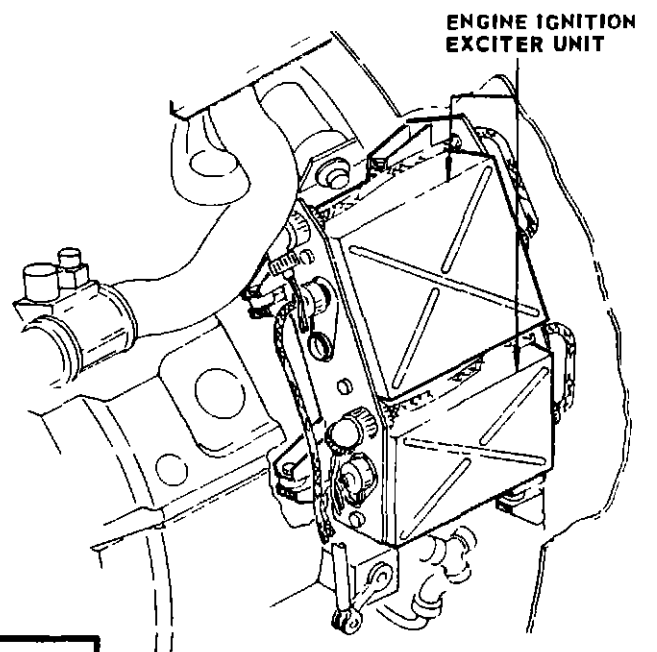
- A. The spark igniters initiate combustion in the wettest fuel area during engine starting. The flame propagates to the remaining combustion chambers through interconnected flame tubes. The principal parts of the spark igniter are a two piece outer shell, a center electrode and a ceramic insulator. The spark that jumps across the annular nonadjustable gap between the shell and the center electrode is of sufficient intensity to vaporize wet fuel and break down carbon deposits. The spark igniters (detail B, figure 1) are installed in combustion chambers No. 4 and 5.



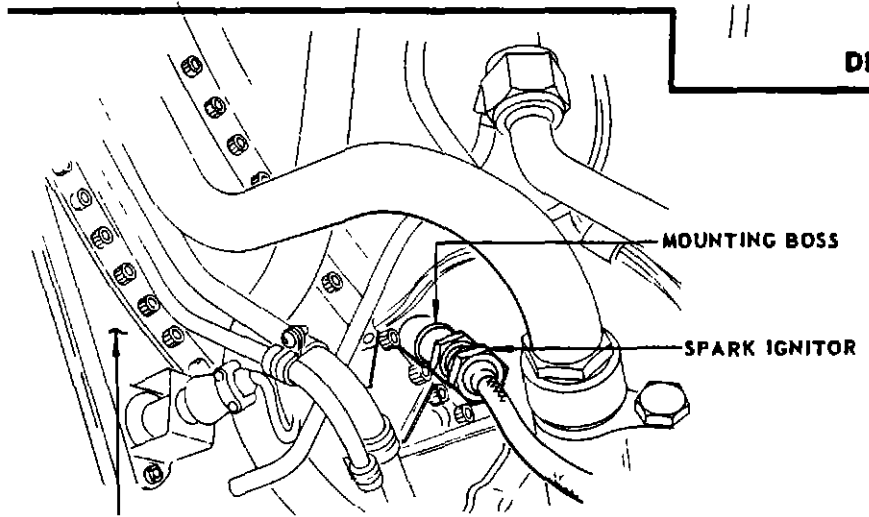
**LEFT SIDE
TYPICAL ALL FOUR ENGINES**



TYPICAL ALL FOUR ENGINES



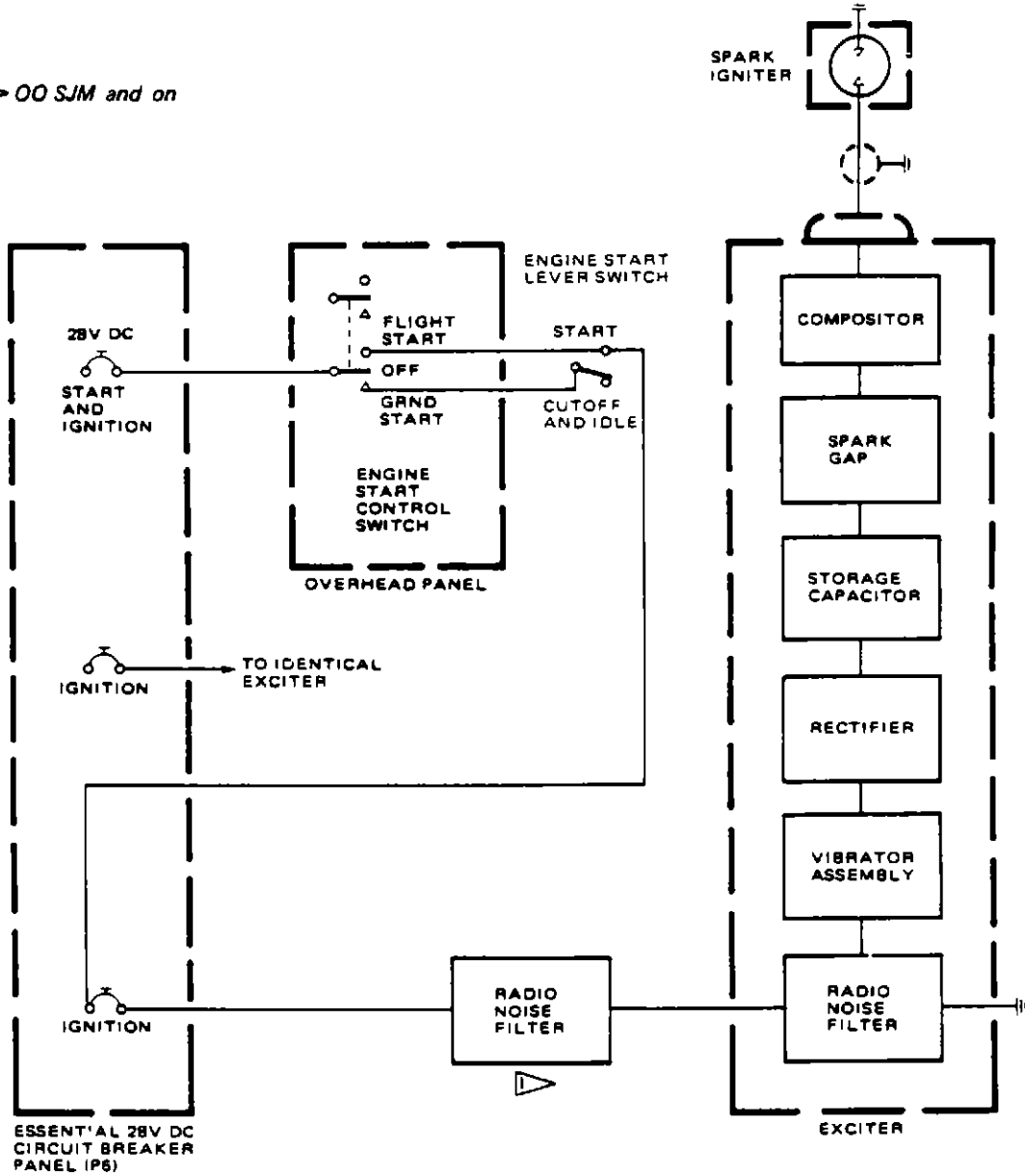
DETAIL A



ENGINE FIREWALL

DETAIL B

▷ 00 SJM and on



TYPICAL ALL FOUR ENGINES

4. High Voltage Leads

- A. Two high voltage leads connect the exciter units to the spark igniters. The leads consist of a single wire cable encased in braided conduit with insulated, threaded connectors at both ends. The leads and connectors are shielded to prevent radio interference.

5. Start Lever Switch

- A. The start lever switches control the application of ignition for ground starting. Each start lever switch assembly (figure 201, 74-2-1) consists of a cam guide tube, a cam, a switch actuator, a start lever switch and a support bracket assembly. The cam is attached to the start lever control cable and passes through each start lever switch assembly. As the cable is actuated by the start lever on the captain's control stand, the cam depresses a follower on the switch actuator arm causing the switch to open or close. The switch is rigged to close when the start lever is ahead of the cutoff detent and open when the start lever is aft of the idle detent. See adjustment/test, 74-2-1. There are four start lever switch assemblies, one for each engine, located in the lower nose compartment.

6. Operation

- A. The ignition system is energized for ground starting when the circuit breakers on the essential 28 volt circuit breaker panel are closed, the engine start control switch is in GROUND START and the start lever is in the START detent. The system is also energized when the circuit breakers are closed and the engine start control switch is in FLIGHT START, irrespective of the position of the start lever. The ignition system may be operated continuously for periods up to 10 minutes.
- B. When the ignition system is energized, 28 volt dc power is fed through a radio noise filter to a vibrator in the exciter unit. On airplanes 00-SJM and on, 28 volt dc power is fed through an additional radio noise filter before being fed to the exciter unit. Pulsating current from the vibrator is fed through a transformer where the voltage is raised to about 2000 volts and is then fed through a gas charged rectifier tube to storage capacitors. When the storage capacitors become fully charged, an air gap breaks down and allows a surge of current to pass through the primary coil of a high voltage transformer. The secondary of this transformer delivers a voltage to the spark igniters of a value sufficient to break down the igniter air gap and allow the discharge of a high energy spark.
- C. The ignition system is used in conjunction with the engine starting system for ground starts and with engine windmilling for flight starts.



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IGNITION SYSTEM - TROUBLE SHOOTING

WARNING· THE CURRENTS INVOLVED IN THE IGNITION SYSTEM CAN BE FATAL. BE SURE POWER IS REMOVED FROM SYSTEM AT LEAST 3 MINUTES BEFORE DISASSEMBLY OF ANY CONNECTORS. ON DETACHING ANY LEAD ASSURE COMPLETE DISCHARGE OF CAPACITORS BY IMMEDIATELY SHORTING TERMINAL TO GROUND.

1. General

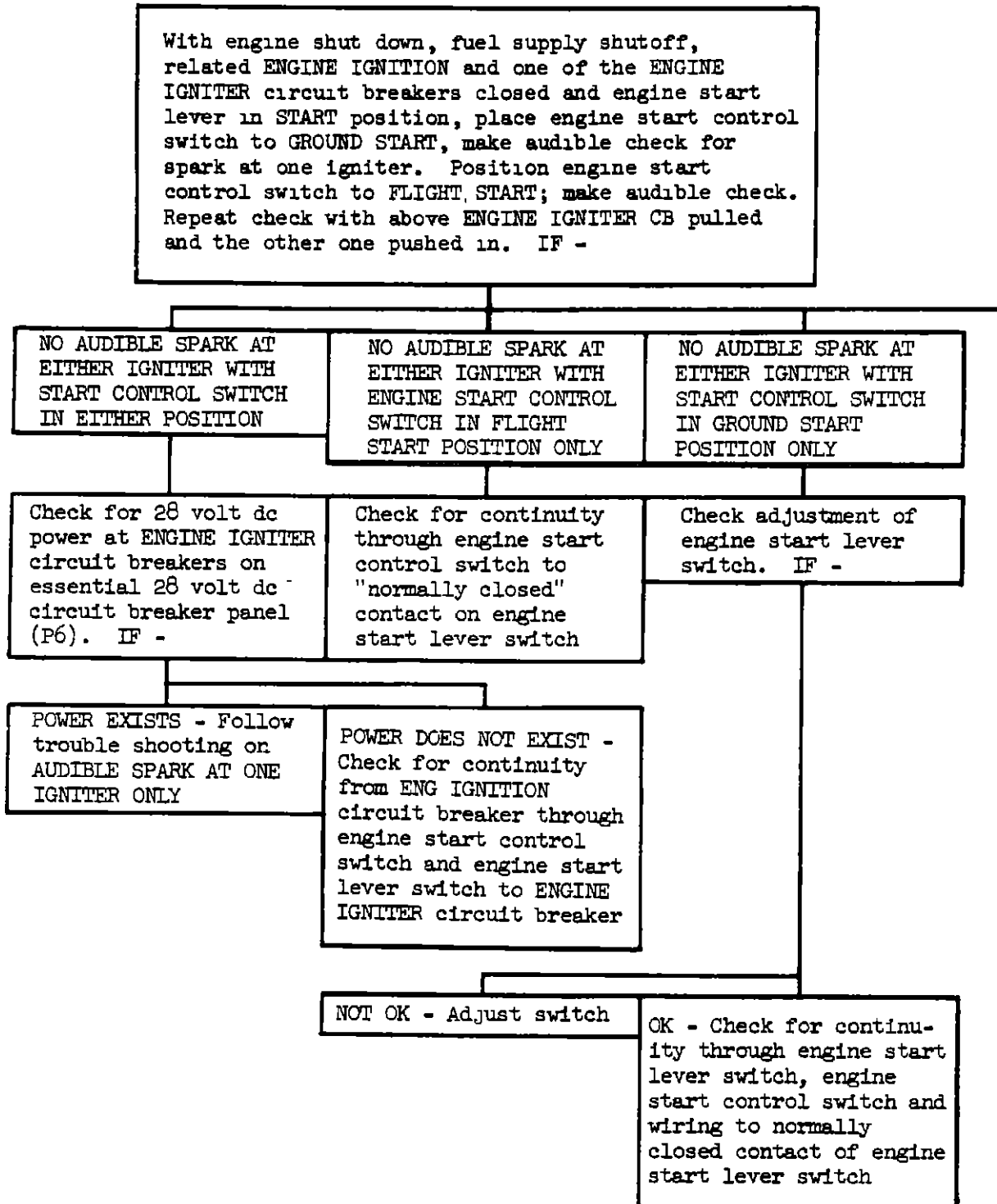
- A. The high energy spark developed by the ignition system is easily audible. Therefore, it is best to begin trouble shooting by making an audible check of the spark igniters. If no spark is heard at either igniter, check that the proper circuit breakers are closed and then proceed according to the trouble shooting charts.

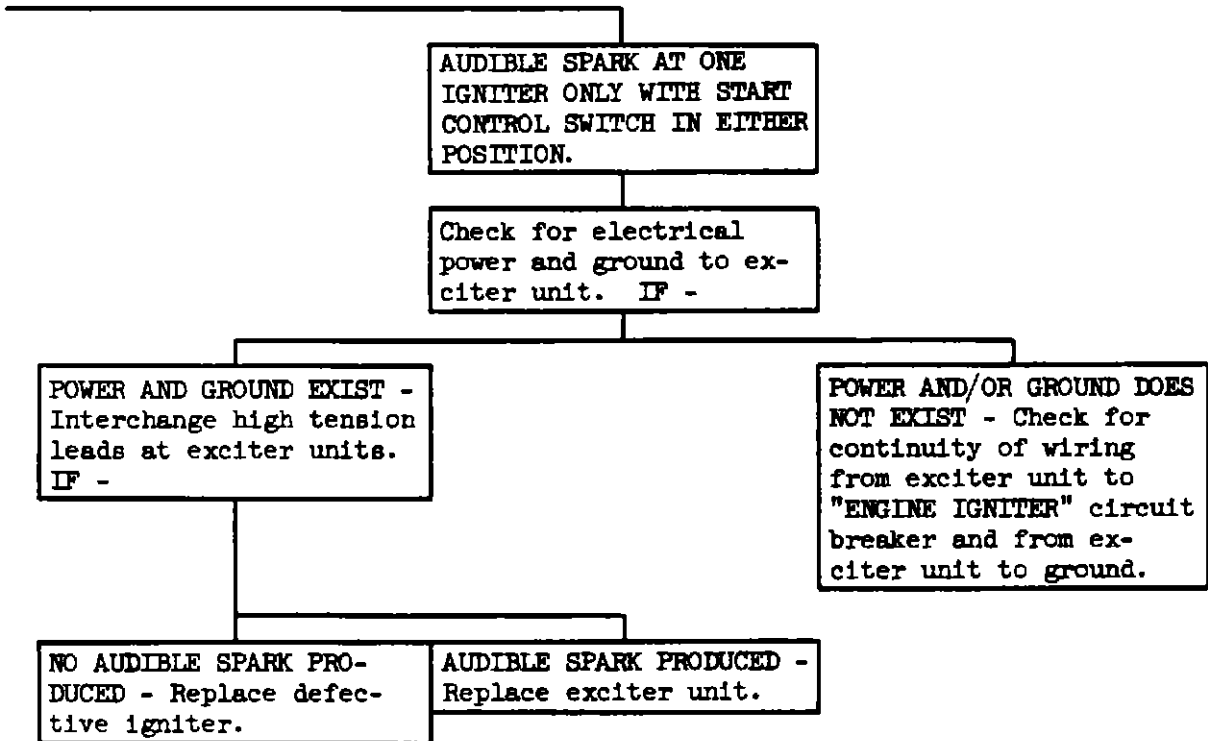
WARNING· IT IS IMPERATIVE THAT THE THRUST REVERSERS DOORS ARE IN THE FORWARD THRUST POSITION WHEN PERFORMING THE ABOVE CHECK. REFER TO CHAPTER 78, "EXHAUST," FOR FURTHER INFORMATION.

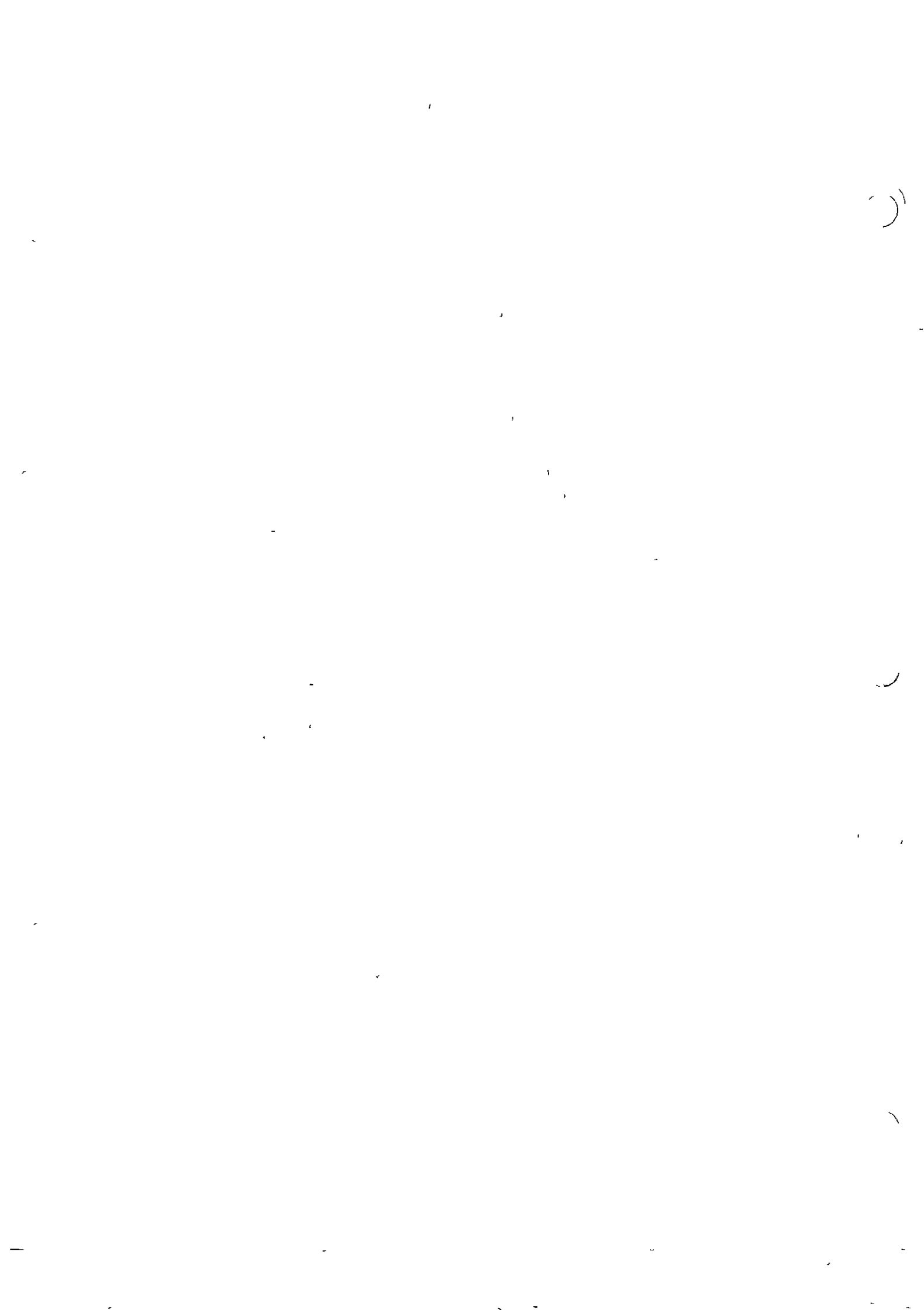
CAUTION DO NOT ENERGIZE IGNITION SYSTEM UNLESS IGNITER IS CONNECTED TO EXCITER UNIT. TO DO SO MAY DAMAGE TRANSFORMER IN EXCITER UNIT.

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2. Ignition System Trouble Shooting Chart









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IGNITION SYSTEM - ADJUSTMENT/PLUG

1. General

- A. Test the ignition system by checking for audible sparking sound.
- (1) The test will consist of checking for individual spark igniter operation (one spark igniter firing).
 - (2) The test applies to any engine. Ensure sequence is applied to the engine being tested.

2. Test Ignition System (Fig. 501, 502)

WARNING CHECK OF IGNITION SYSTEM MUST NOT BE PERFORMED WHEN AIRPLANE IS IN HANGER, NEAR BUILDINGS AND/OR OTHER AIRPLANES, OR DURING AIRPLANE FUELING. ENSURE THAT NO PERSONNEL ARE IN OR NEAR ENGINE INLET AND EXHAUST OF APPLICABLE ENGINE DURING IGNITER PLUG CHECK.

IGNITION VOLTAGE IS DEADLY. DO NOT TOUCH IGNITER PLUGS OR LIVE PORTION OF IGNITION EXCITER OR LEADS DURING OPERATION.

CAUTION. PRIOR TO PERFORMING IGNITER PLUG CHECK, DRY MOTOR ENGINE TO REMOVE UNBURNED FUEL, (REF. 71-5-0 A/T) UNBURNED FUEL COULD RESULT IN ENGINE INTERNAL OR EXHAUST FIRE. DO NOT PERFORM IGNITER PLUG CHECK IF N2 IS ROTATING. WITH N2 ROTATION, FUEL ENTRY INTO COMBUSTION CHAMBER IS POSSIBLE WHEN START LEVER IS ADVANCED TO IDLE AND INADVERTENT LIGHTUP DURING IGNITER CHECK COULD RESULT.

- A. Provide dc electrical power.
- B. Open FUEL SHUTOFF (FUEL VALVES) and PRESS SELECTOR & LNG START (AIR VALVES) circuit breakers for applicable engine located on circuit breaker panel P6 (Fig. 501).
- C. Open left circuit breaker for applicable engine located on circuit breaker panel P6 (Fig. 501).
- D. Close right circuit breaker for applicable engine located on circuit breaker panel P6 (Fig. 501).
- E. Position applicable ENGINE START CONTROL switch on overhead panel to GROUND START position.

NOTE: Verify by audio check that neither spark igniter is firing.

- F. Lift applicable ENGINE START lever from CUTOFF to IDLE position (Fig. 502).

NOTE: Verify by audio check that spark igniter is firing (one spark igniter firing - LOWER spark igniter).

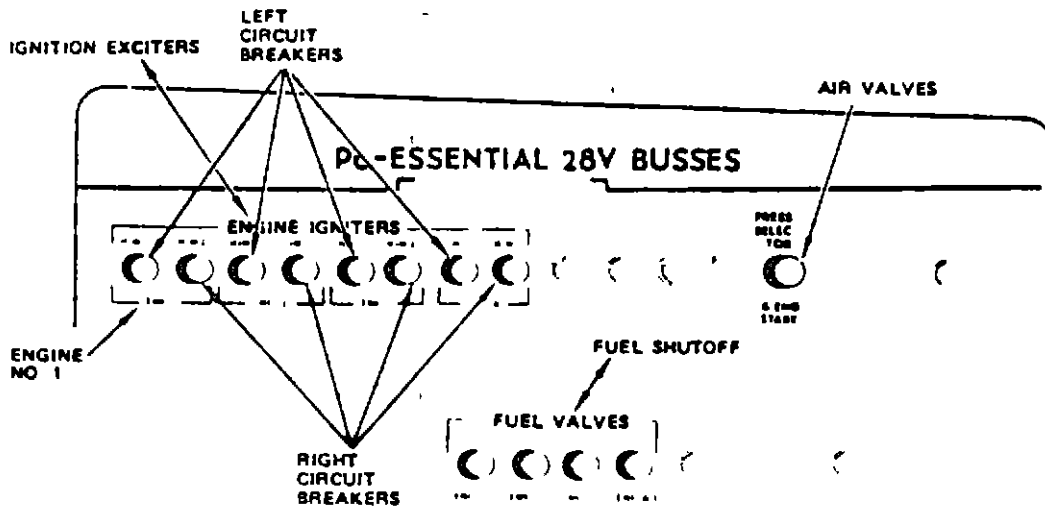
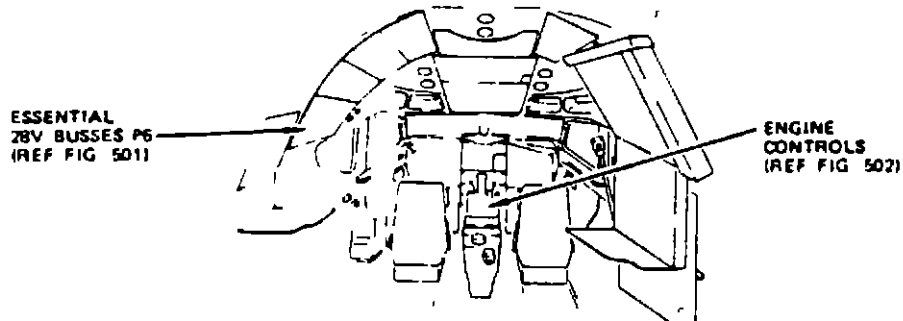
- G. Open right circuit breaker for applicable engine located on circuit breaker panel P6 (Fig. 501).

NOTE: Verify by audio check that neither spark igniter is firing.

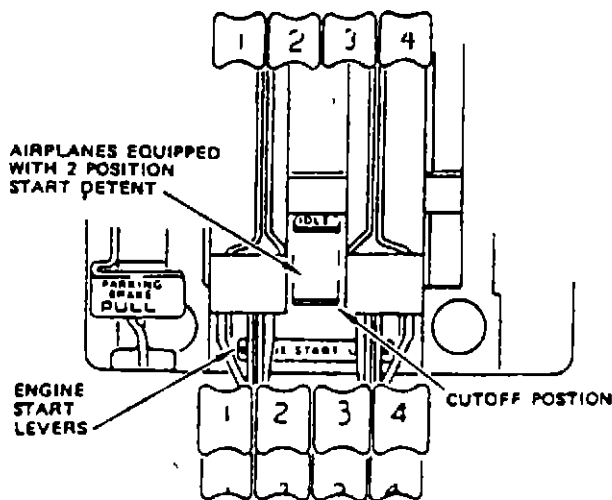
- H. Close left circuit breaker for applicable engine located on circuit breaker panel P6 (Fig. 501).

NOTE. Verify by audio check that igniter plug is firing (one spark igniter firing - UPPLR spark igniter).

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P6 Circuit Breaker Position
Figure 501



Engine Start Lever Position
Figure 502

ENGINE START LEVER SWITCHES - MAINTENANCE PRACTICES

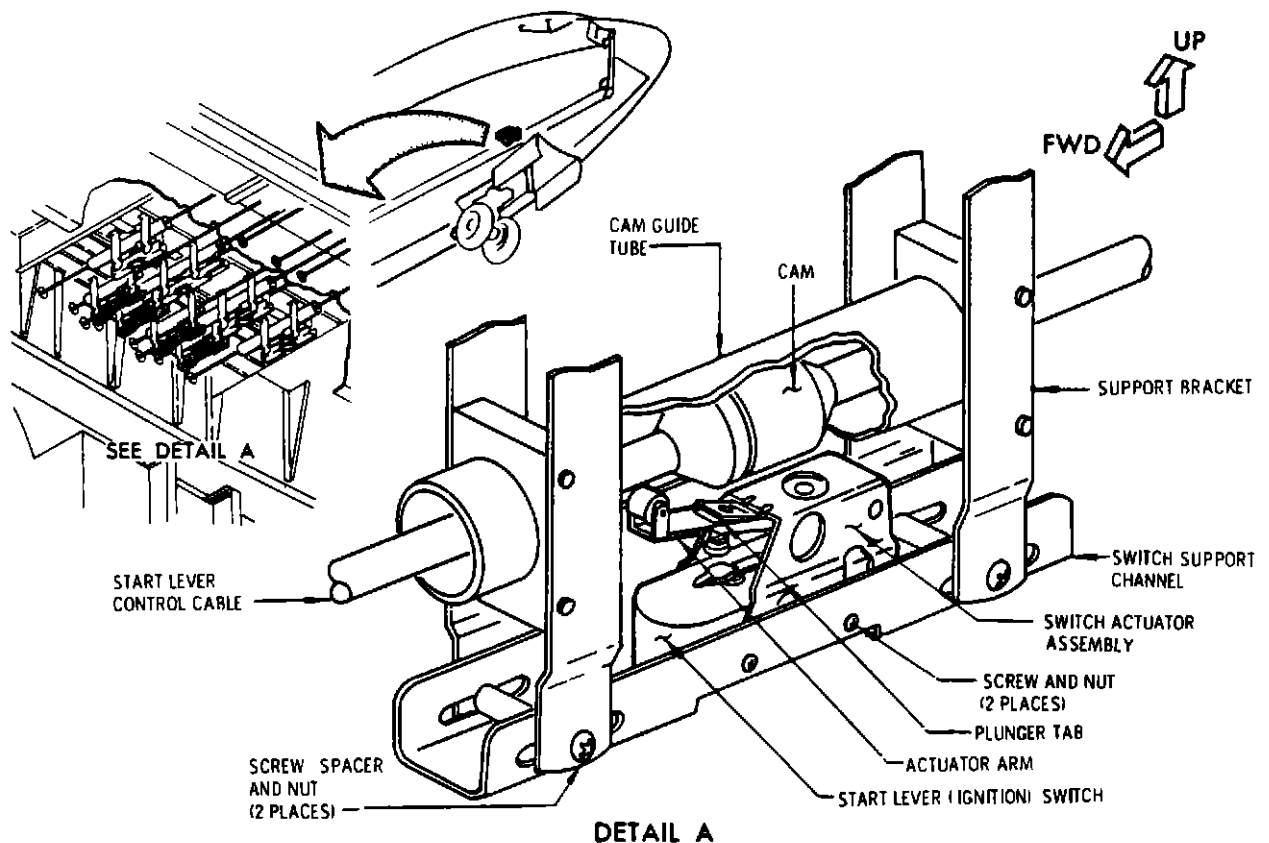
1. Removal/Installation Engine Start Lever Switches

A. Remove Engine Start Lever Switches (See figure 201.)

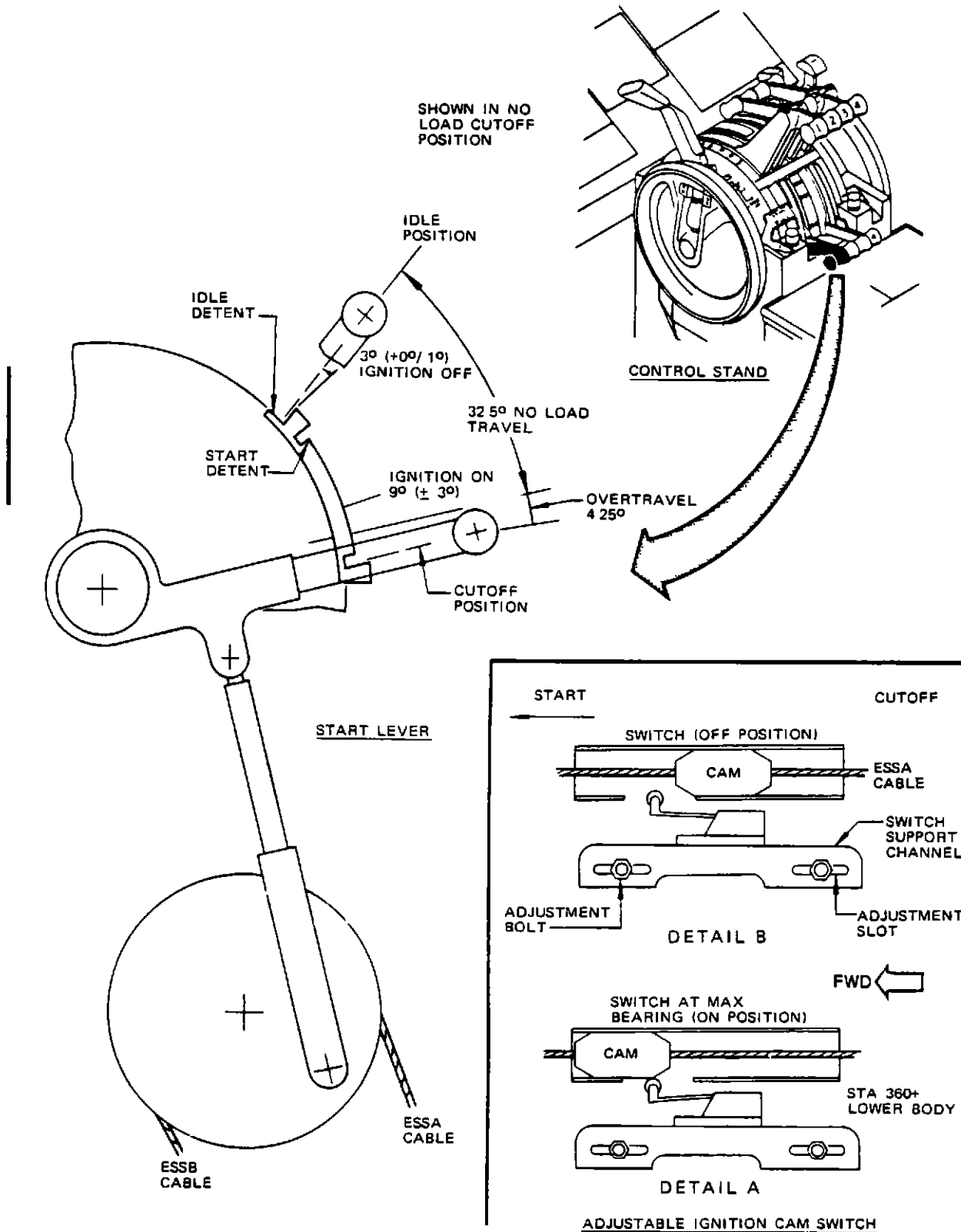
- (1) Open all "ENG IGNITION" circuit breakers on essential 28 volt DC circuit breaker panel (P6).
- (2) Disconnect switch electrical connections
- (3) Support switch and switch actuator and remove switch mounting screws.
- (4) Remove switch and switch actuator.

B Install Engine Start Lever Switches (See figure 201.)

- (1) Position switch and actuator in support channel and install mounting screws.
- (2) Connect electrical wiring.
- (3) Adjust switch See "Adjust Engine Start Lever Switches."



DETAIL A



Engine Start Lever Switch Adjustment
 Figure 202



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2. Adjustment/Test Engine Start Lever Switch

NOTE: Start levers must be properly rigged prior to switch adjustments to ensure synchronization of fuel and ignition system operations. See Chapter 76 for rigging procedures.

A. Adjust Engine Start Lever Switch (See figure 202.)

- (1) Loosen fore and aft adjustment screws.

NOTE: A special tool with Phillips offset head is required to loosen switch adjustment screws. (See figure 203.)

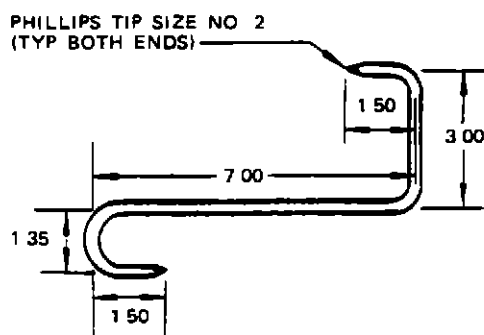
- (2) Place start lever in START detent.

- (3) Adjust switch to maximum bearing on switch actuating cam. (See detail A.)

NOTE: Switch must be actuated when engine start lever is approximately $9 (\pm 3)$ degrees forward of cutoff position, equivalent to $0.63 (\pm 0.21)$ inch cable travel and deactuated at $3 (+0/-1)$ degrees aft of idle detent (equivalent to $0.21 (+0.00/-0.07)$ inch cable travel.) The plunger tab (figure 201) of the actuator may be bent up a maximum of 7 degrees for additional adjustment.

CAUTION: DO NOT BEND ACTUATOR ARM TO ADJUST SWITCH.

- (4) Tighten adjustment screws.
- (5) Slowly return start lever to cutoff position. (See detail B for relative cam switch position.)



MATERIAL 250 DIA 4130 STEEL
HT 180 000-200 000 PSI

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ENGINE IGNITION EXCITER UNIT - MAINTENANCE PRACTICES

WARNING: THE CURRENTS INVOLVED IN THE IGNITION SYSTEM CAN BE FATAL. BE SURE POWER IS REMOVED FROM SYSTEM AT LEAST 3 MINUTES BEFORE DISASSEMBLY OF ANY CONNECTORS. ON DETACHING ANY LEAD INSURE COMPLETE DISCHARGE BY IMMEDIATELY SHORTING TERMINAL TO GROUND.

1. Removal/Installation Engine Ignition Exciter Units

A. General

- (1) Tag or note location of all brackets and clips to insure the installation in proper place.

B. Remove Engine Ignition Exciter Unit (See figure 201.)

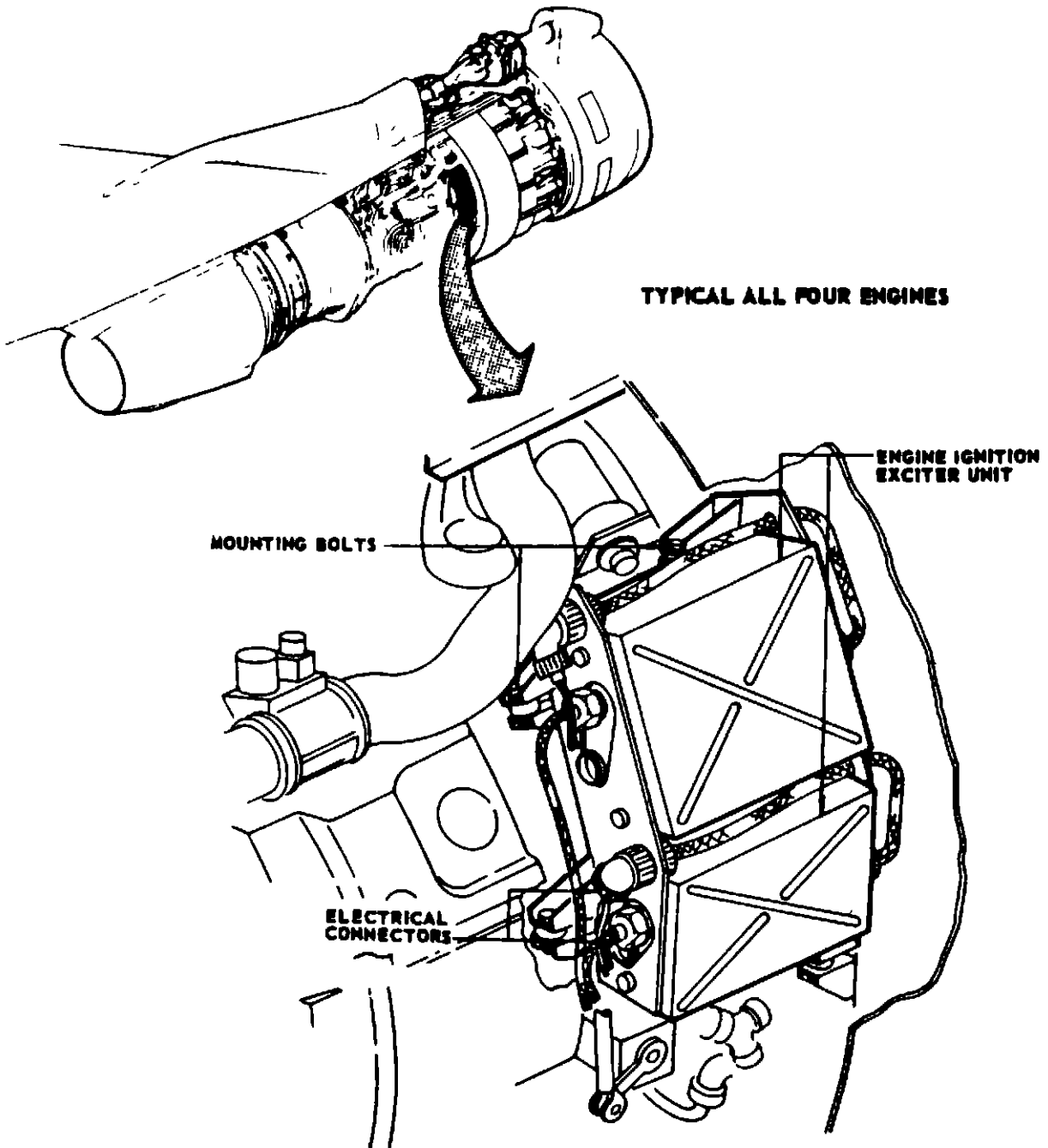
- (1) Detach all electrical leads from the rear of the exciter units.
- (2) Remove four bolts and lock nuts securing the exciter units assembly to its vibration isolators, lift off the assembly.
- (3) Separate the two exciters from their mount brackets by removing eight bolts and the forward electrical leads.

NOTE: Ignition exciters are sealed units. Do not break the seal.

C. Install Engine Ignition Exciter Unit (See figure 201.)

- (1) Check leads for fraying and loose connections. Examine receptacles for foreign material and clean as required.
- (2) Secure the two exciters to their mount brackets with eight bolts and lockwire.
- (3) Install forward electrical leads removed in step 3 above, and lockwire.
- (4) Mount the exciter assembly on its four vibration isolators with four bolts and lock nuts.
- (5) Attach all remaining electrical leads to their respective connectors. Torque cigarette-type high voltage leads to a torque of 140 to 160 inch-pounds. Tighten and lockwire all other connectors.

CAUTION: DO NOT ENERGIZE IGNITION CIRCUIT UNLESS SPARK IGNITER IS CONNECTED TO EXCITER UNIT. TO DO SO MAY DAMAGE TRANSFORMER IN EXCITER UNIT.



2. Remove Spark Igniters (See figure 401.)

A Remove electrical connector and install protective cap.

CAUTION: DO NOT TWIST LEAD DIFFICULTY IN REMOVAL MAY BE CAUSED BY ADHESION OF THE SILICONE WASHER ON THE ELECTRICAL CONNECTOR TO THE CERAMIC BARREL OF THE IGNITER. WASHER SHOULD BE REPLACED BY A LATER TYPE WASHER INCORPORATING A TEFLON COATING SHOULD FORCE HAVE BEEN APPLIED DURING REMOVING, CHECK CONDITION OF INSULATOR BENEATH WASHER AND REPLACE LEAD ACCORDINGLY.

B Remove spark igniter and heat shield. Cap lead end and wrap in protective paper.

3. Install Spark Igniters (See figure 401.)

A Coat igniter threads with BG Mica Lube A-768 Anti-Seize Compound.

B With the heat shield, install spark igniter in mounting boss and torque to 300 to 360 pound-inches.

CAUTION: THIS MUST BE DONE WITH CARE TO PRECLUDE THE POSSIBILITY OF DISLODGING THE NO 4 AND/OR NO 5 COMBUSTION CHAMBERS, CAUSING SUBSEQUENT DAMAGE. IF DIFFICULTY IS ENCOUNTERED INSTALLING SPARK IGNITERS, CHECK DIFFUSER CASE THREADS IF NECESSARY, CHASE THREADS USING PWA-8597 TAP

C Apply molybdenum disulfide powder on the spark igniter lead coupling. Install connector and torque to 140 to 160 pound-inches, taking care not to twist the lead.

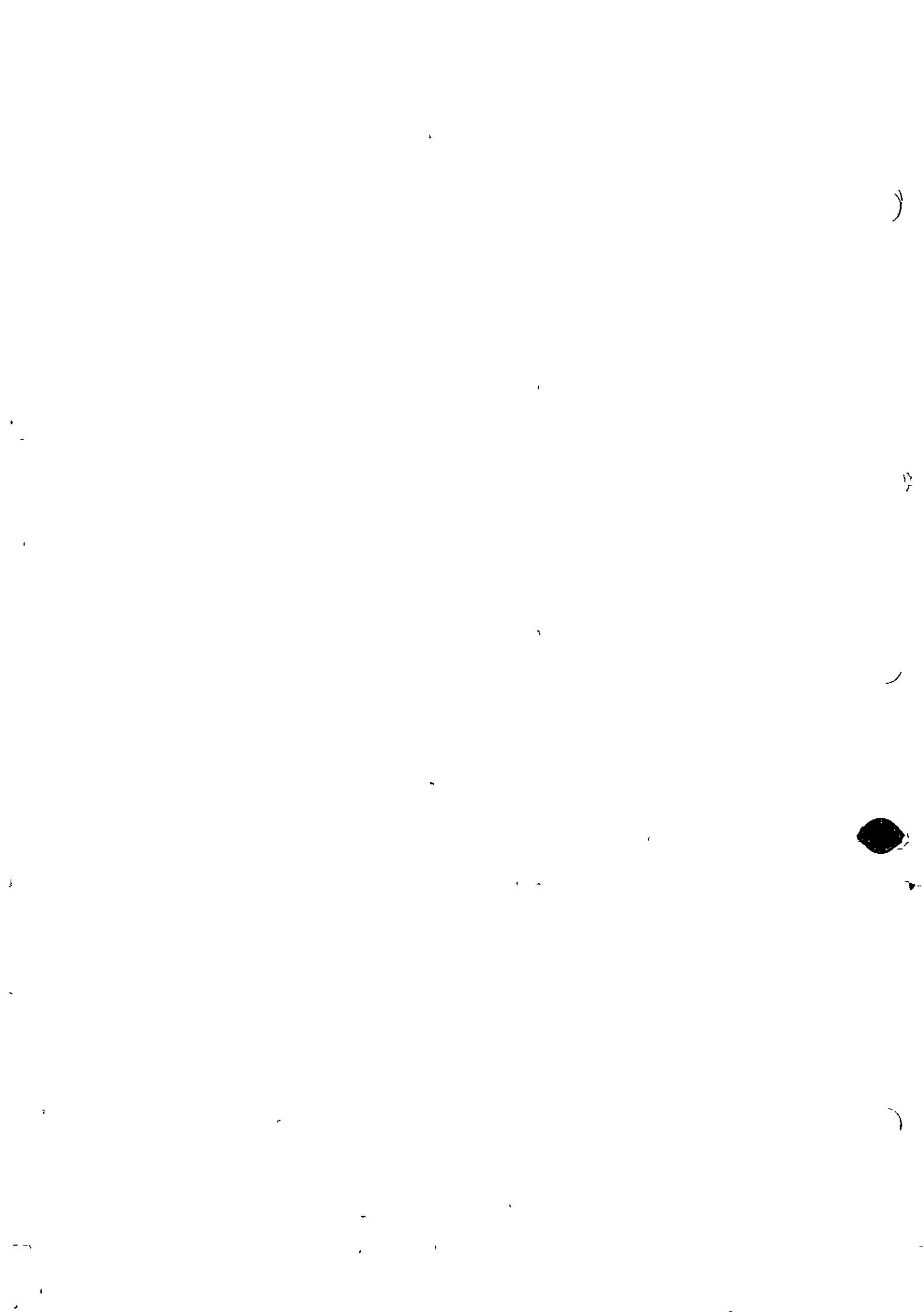
CAUTION DO NOT TWIST HIGH VOLTAGE LEADS WHEN TURNING LEAD NUTS

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SPARK IGNITER - ADJUSTMENT/TEST

1. Test Spark Igniter

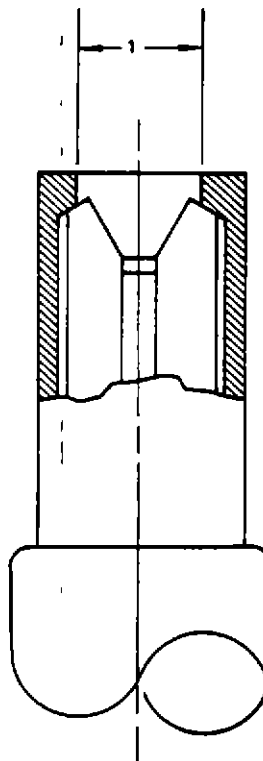
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SPARK IGNITERS - INSPECTION/CHECK

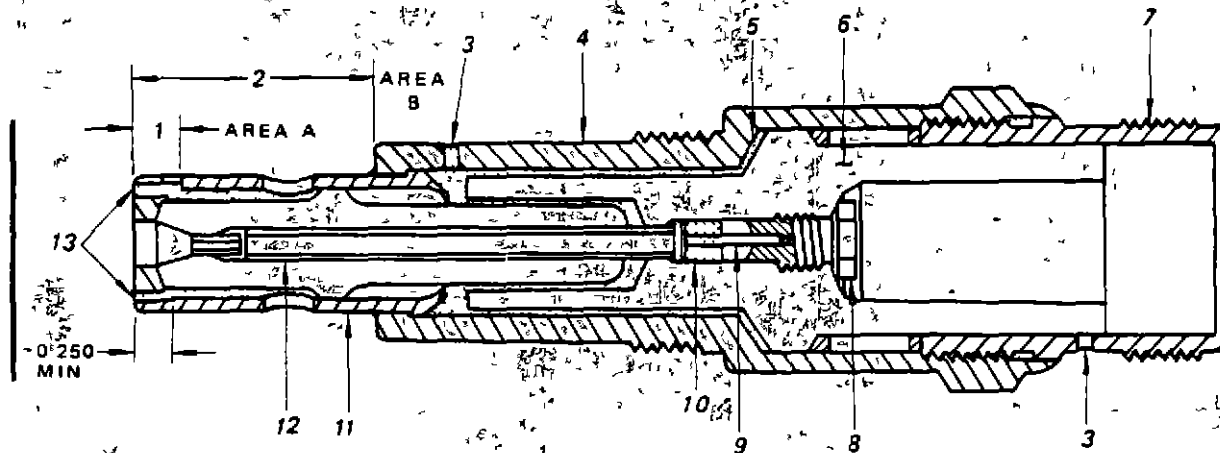
1. Spark Igniter Inspection

- A. Visually examine the connector threads and shell threads of spark igniter. If damaged, chase threads using a 1.000-20NS-3A die for connector threads and a 0.9375-16NS die for shell threads.
- B. Examine ceramic for cracks on either end of igniter. Any cracks in ceramic are cause for rejection of spark igniter. Internal ceramic breaks or cracks are detected by shaking igniter and listening for rattle.
- C. Maximum outer shell ID erosion is a physical limit to prevent possible loss of ceramic and ingestion by turbine.
- D. Examine spark igniters in areas shown in accordance with figures 601 and 602 for abrasion. Reject igniters not meeting required abrasion wear limits shown in referenced figures.



0.0312 ID MAXIMUM OUTER SHELL EROSION

P&WA 74-6-1, PAGE 601, Dec 15/68



- 1 AREA A EXPOSURE OF ONE AIR COOLING PASSAGE OR 0.030 WEAR DEPTH
- 2 AREA B - 0.030 MAXIMUM WEAR DEPTH
- 3 DRAIN HOLE
- 4 UPPER SHELL
- 5 GASKET
- 6 INSULATOR
- 7 COUPLING THREAD

- 8 TERMINAL SCREW
- 9 SEALING WIRE
- 10 CEMENT
- 11 LOWER SHELL
- 12 CENTER ELECTRODE
- 13 AIR COOLING HOLES
0.250 INCH MIN
DEPTH

PMA 74-6-1, PAGE 602, Dec 15/68

Spark Igniter and Abrasion Wear Limits
Figure 602

SPARK IGNITERS - CLEANING/PAINTING

1. Clean Spark Igniter

- A Degrease spark igniter, using methyl ethyl ketone solvent.
- B Clean outer shell of spark igniter, using wire brush.
- C. Using methyl ethyl ketone solvent and nonmetallic brush, remove deposits from external surface of firing end of spark igniter. It is not necessary to restore ceramic to cleanliness of new ceramic surface.

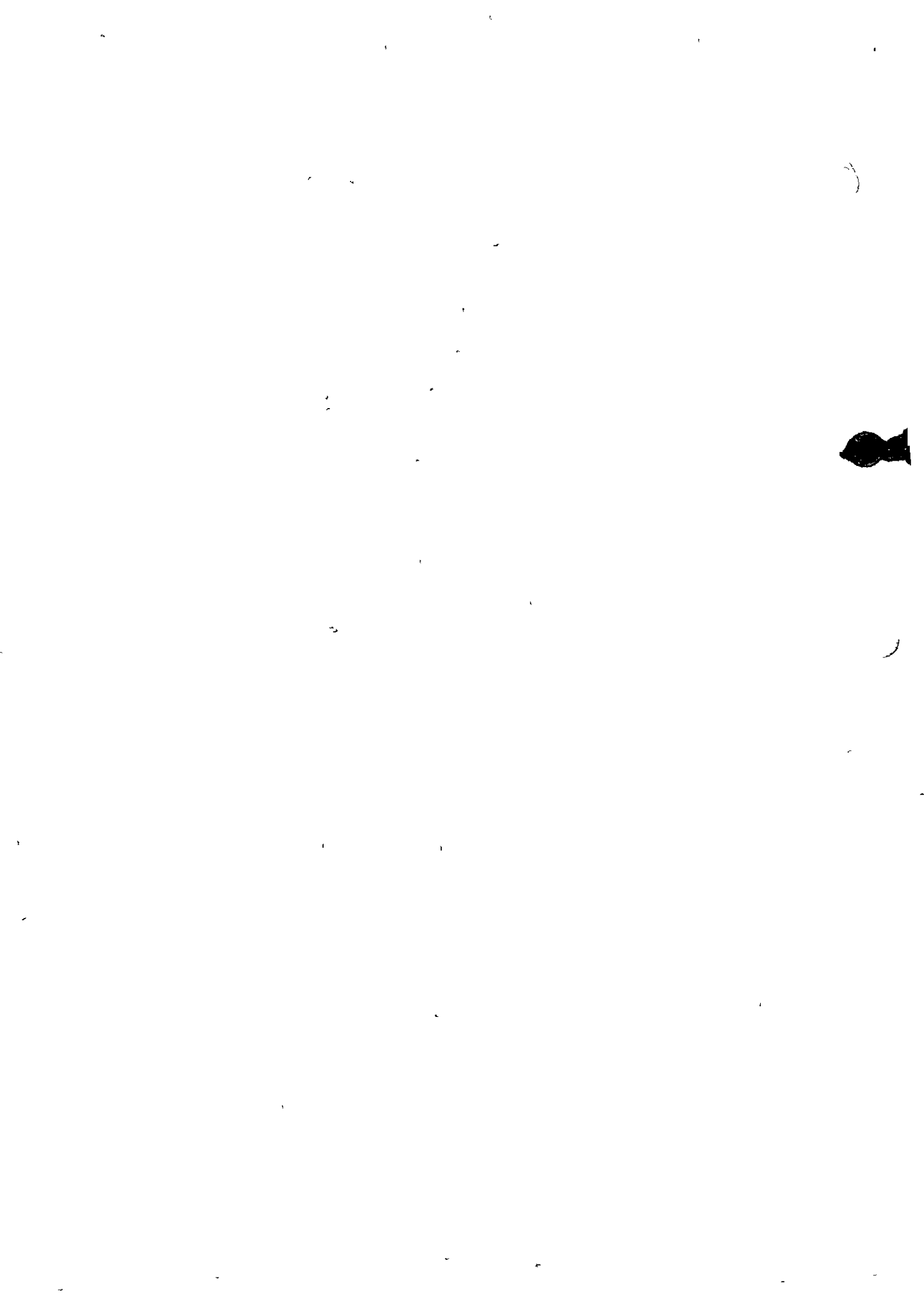
NOTE: Cleaning of recessed center electrode cavity is recommended only to extent ceramic is visible to allow inspection for cracks.

- D. Clean ceramic barrel on connector end of igniter with a soft swab dampened in a cleaning solvent conforming to AMS 3160 or equivalent.

NOTE Do not use abrasive blasting on the ceramic barrel as this will remove glaze.

- E Remove all traces of solvent from spark igniter using air blast.

CAUTION MAKE SURE CONDENSATION DRAIN HOLES AND COOLING AIR HOLES ARE FREE FROM FOREIGN PARTICLES BLOCKAGE OF DRAIN HOLES COULD CAUSE CERAMIC CRACKING OR IGNITER SHORTING CLOGGED COOLING AIR HOLES WILL REDUCE EFFECT OF COOLING.



HIGH VOLTAGE LEADS - REMOVAL/INSTALLATION1. General

- A. The high voltage leads connect the exciter units to the spark igniters. Access to the leads is gained by opening the engine right side cowl panel.

WARNING: OPEN IGNITION SYSTEM CIRCUIT BREAKERS AT LEAST 3 MINUTES BEFORE DISASSEMBLY OF CONNECTORS. ON DETACHING LEAD ENSURE COMPLETE DISCHARGE BY IMMEDIATELY SHORTING TERMINAL TO GROUND. THE CURRENTS INVOLVED IN THE IGNITION SYSTEM CAN BE FATAL.

CAUTION: DO NOT ENERGIZE IGNITION CIRCUIT UNLESS SPARK IGNITER IS CONNECTED TO EXCITER UNIT. TO DO SO MAY DAMAGE TRANSFORMER IN EXCITER UNIT.

2. Equipment and Materials

- A. Powdered molybdenum disulfide - Molykote Type Z (Alpha Molykote Corp., Stamford, Conn.)

3. Remove High Voltage Leads (See figure 401.)

- A. Open ignition system circuit breakers at P6 circuit breaker panel.
B. Open engine right side cowl panel.
C. Unfasten nuts securing high voltage leads to exciter units and spark igniters. Upon detaching lead, immediately short terminal to ground.

CAUTION: DO NOT TWIST HIGH VOLTAGE LEADS WHEN TURNING NUTS.

- D. Remove high voltage leads from engine.

NOTE: Visually examine grommets installed in terminals of all high tension connectors whenever coupling nuts are disconnected. Replace grommets if there is any indication or suspicion of damage.

4. Install High Voltage Leads (See figure 401.)

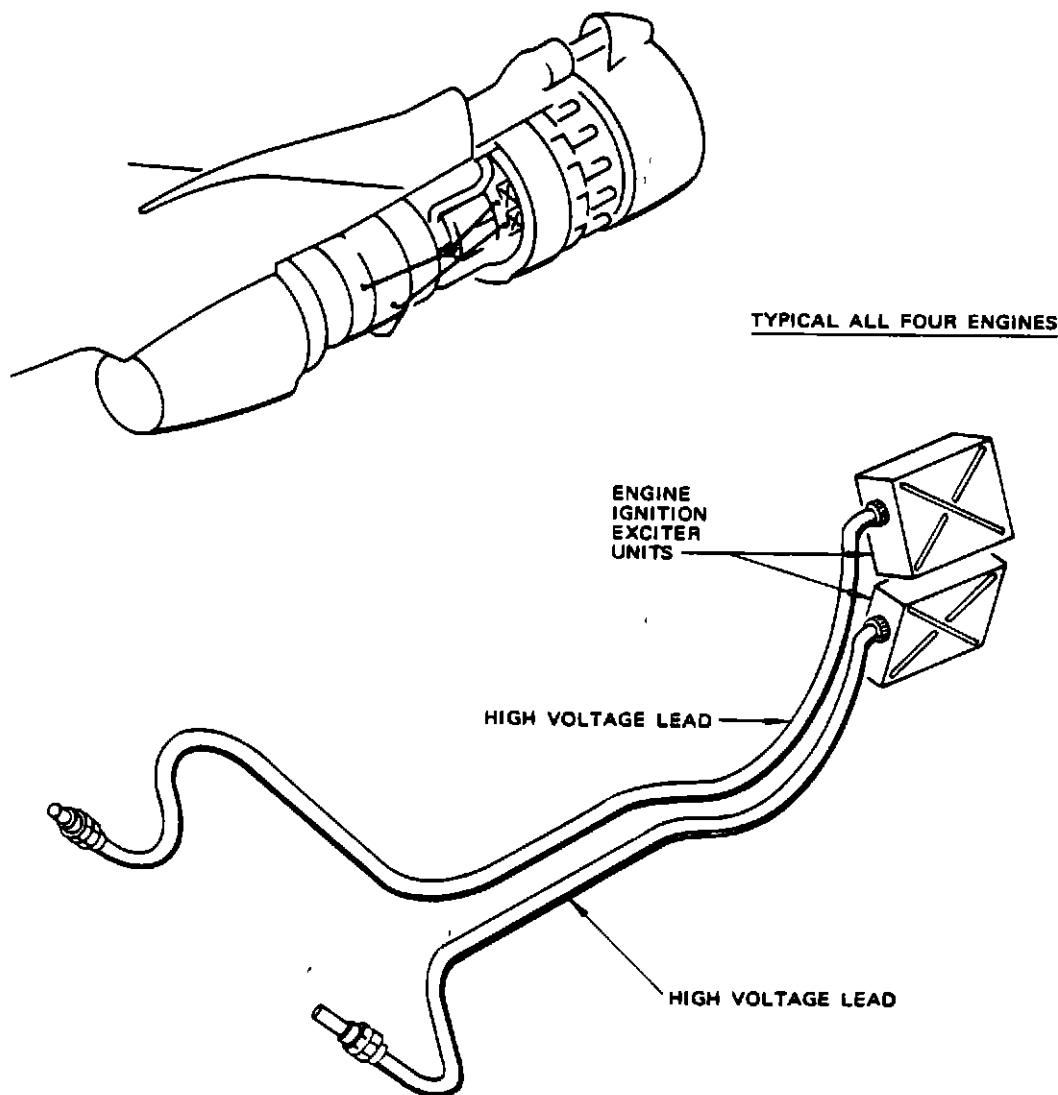
NOTE: Apply molybdenum disulfide powder on the spark igniter lead coupling nuts. The powder is to be applied to both nuts of the lead at initial assembly and each time the nut is disengaged from its mating part. The powder may be deposited on either the OD or ID thread. Since it is a dielectric material, the hazard of inducing electrical leakage is not involved.

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- A. Install high voltage leads to exciter units and spark igniters and tighten nuts to torque of 140 to 160 pound-inches. Secure lead to engine with clips. Tighten screws and nuts on clips to torque of 20 to 30 pound-inches.

CAUTION: DO NOT TWIST HIGH VOLTAGE LEADS WHEN TURNING LEAD NUTS.

- B. Close engine right side cowl panel.
C. Close ignition system circuit breakers at P6 circuit breaker panel.



High Voltage Leads Installation
Figure 401

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5. Left Igniter High Voltage Lead Replacement. (Alternate Procedure)

- A. Disconnect existing failed lead at both ends. Keep lead in place and store couplings.
- B. Install a high voltage lead P/N 40535 (Used on JT4A engine) as follows :
 - (1) Connect the 90° coupling to the exciter.
 - (2) Route the lead up first, then to the rear through the right engine mount links, to the diffuser case forward flange. At last, along this flange and engine left side to the gearbox and the igniter.
 - (3) Provide good clamping on engine cases and gearbox.
 - (4) Follow also instructions under paragraph 4.
 - (5) Perform audible check per 74-2-0, TROUBLE SHOOTING.