AN 01-45HFA-1

PRELIMINARY

PILOT'S HANDBOOK

for

NAVY MODEL

F7U-1

AIRPLANES

This handbook is applicable to Bu No 124422 with J34-WE-42 engines installation.

PRELIMINARY COPY

This publication has not been revised by the Bureau of Aeronautics.

APPENDIX I OF THIS PUBLICATION SHALL NOT BE CARRIED IN AIRCRAFT ON COMBAT MISSIONS OR WHEN THERE IS A REASONABLE CHANCE OF ITS FALLING INTO THE HANDS OF THE ENEMY.

15 October 1952

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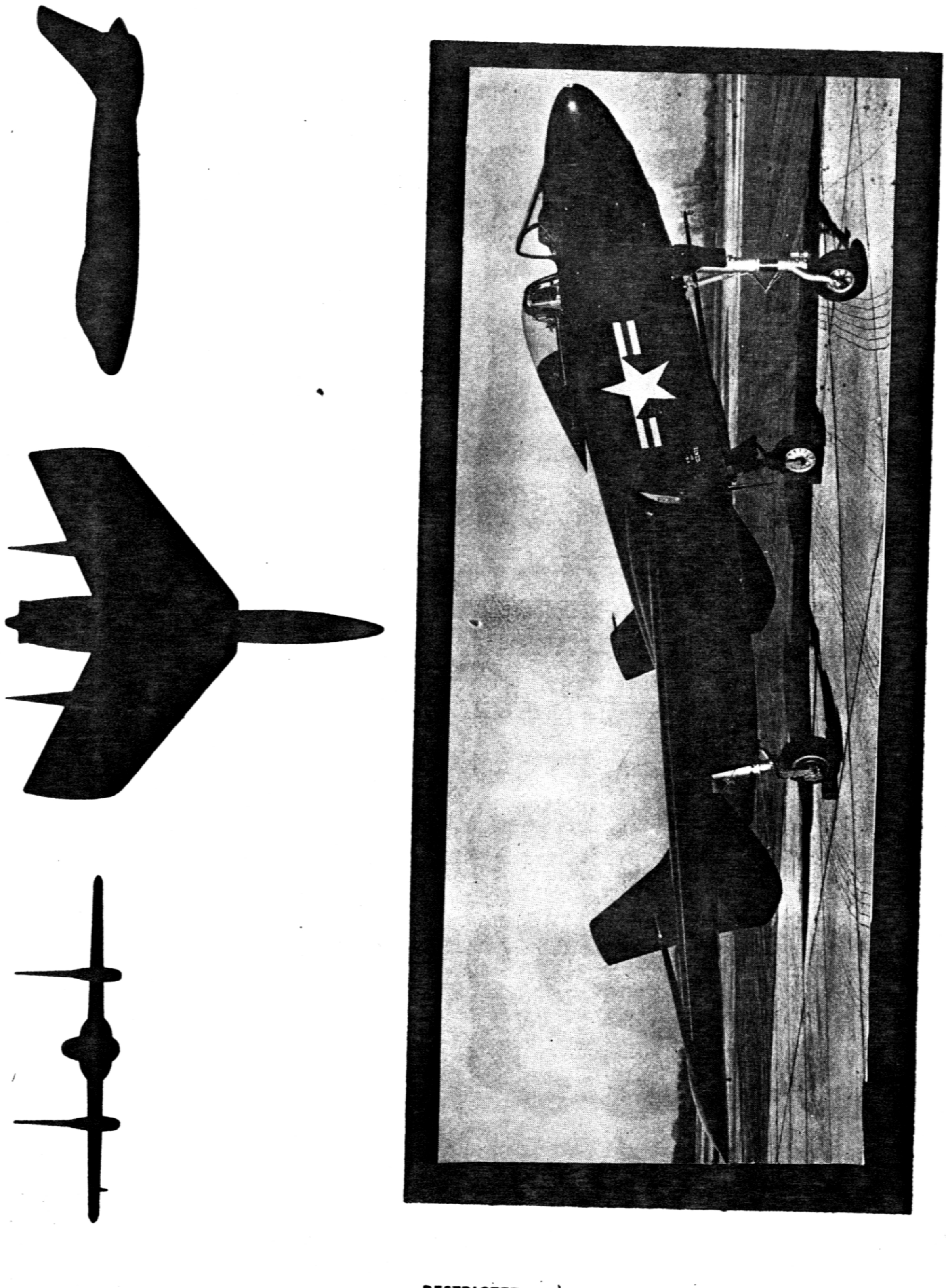

Figure 1–1. Model F7U-1 Airplane

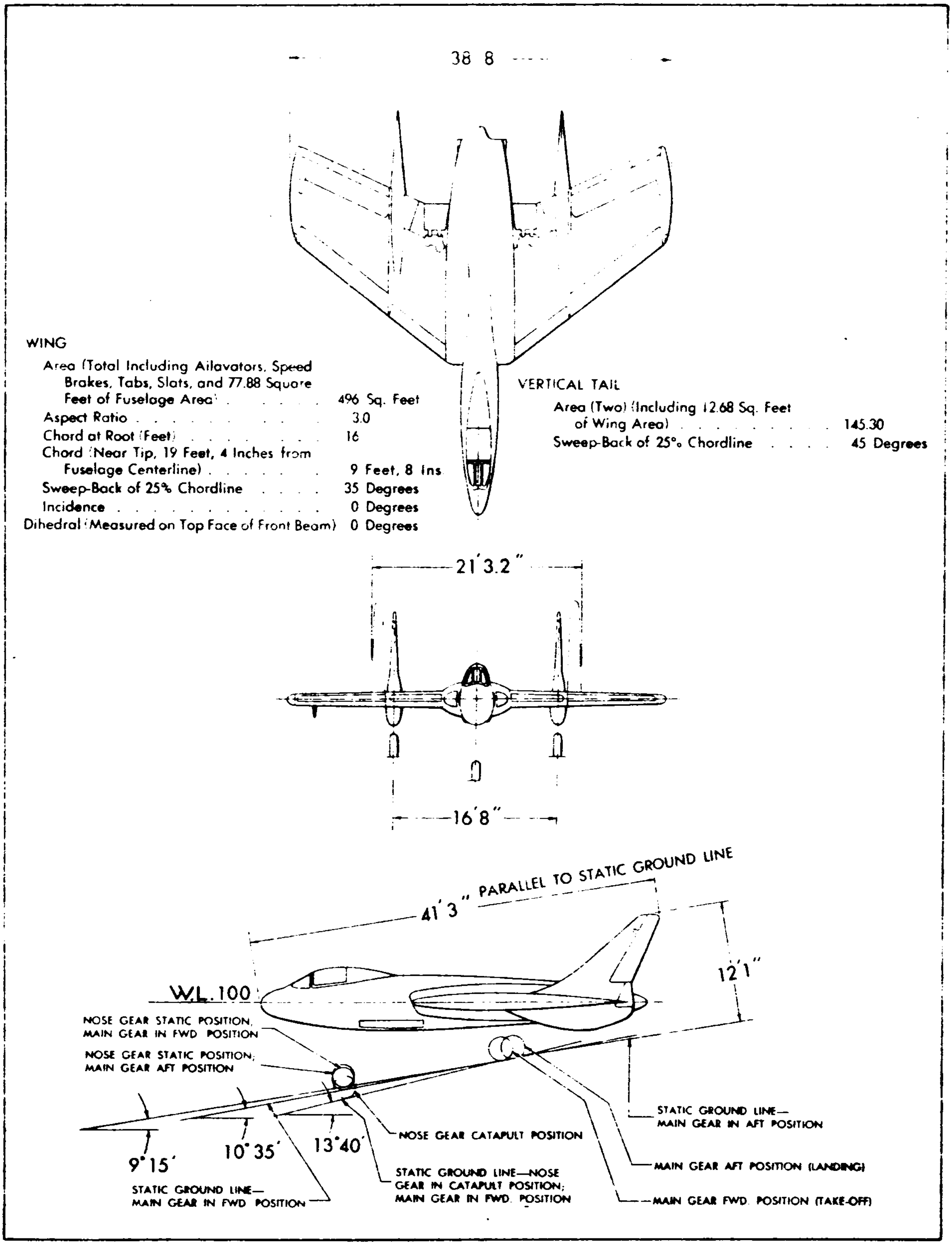

Figure 1–2. General Dimensions

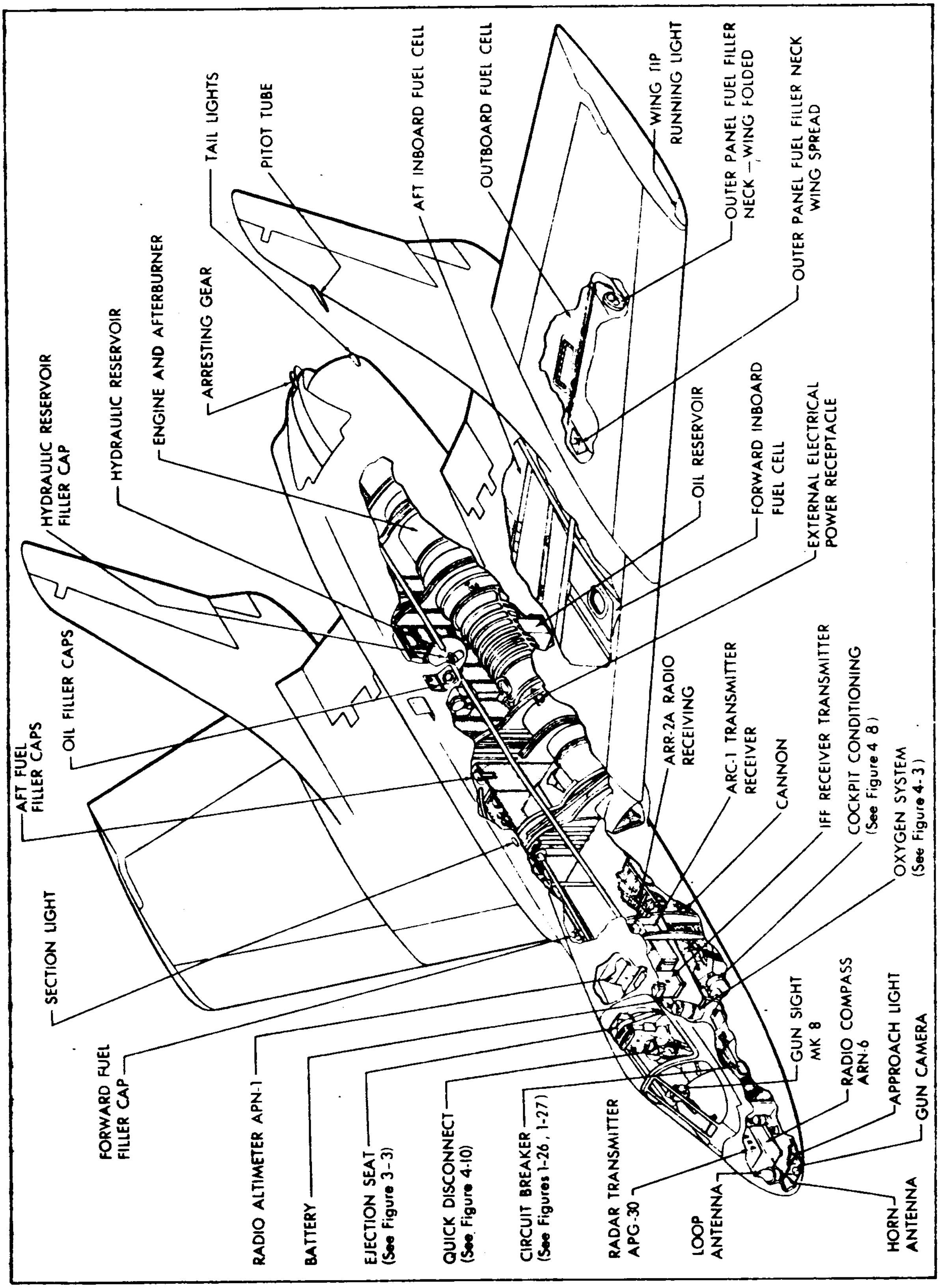

Figure 1–3. General Arrangements

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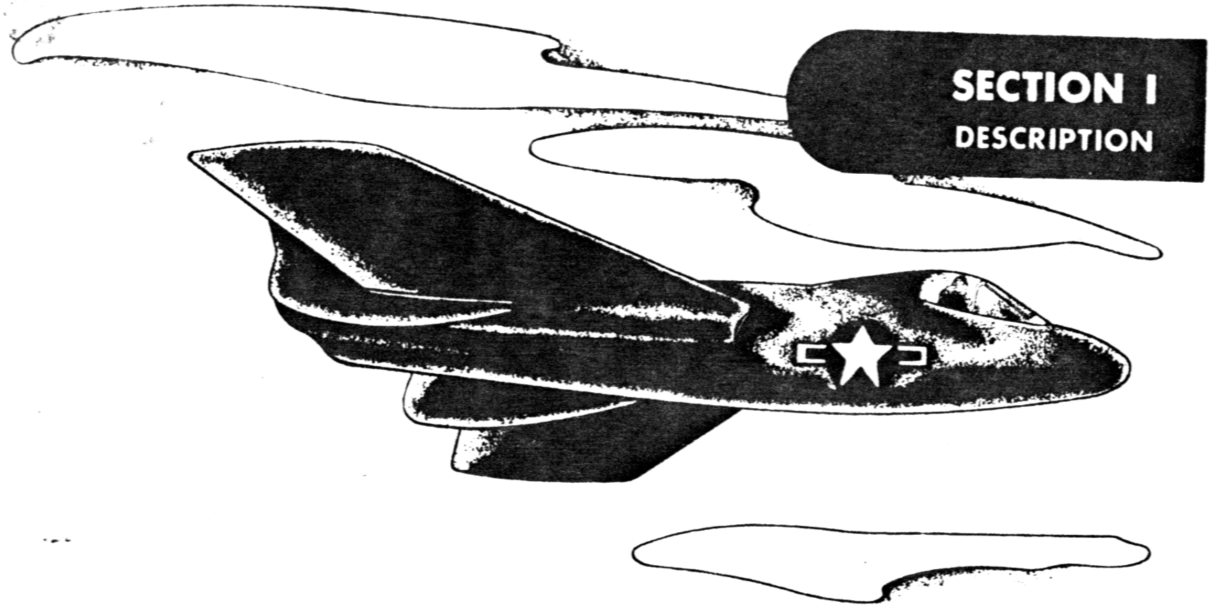
SECTION I
DESCRIPTION



1–1. THE AIRPLANE.

1–2. The Chance Vought F7U-1 airplane is a low-aspect-ratio, swept-back-wing fighter. Twin vertical stabilizers and rudders are mounted at the outboard edges of the wing center section, and conventional elevator and aileron control surfaces are combined in the ailavators to provide both longitudinal and lateral control. The airplane is designed for carrier-based or land-based fighter operations and is powered by two Westinghouse J34-WE 42 axial-flow turbo-jet engines with afterburners. The armament consists of four 20-mm M-3 automatic guns with 200 rounds of ammunition provided for each gun.

1–3. In addition to the swept-back wing and elimination of the empennage, the airplane incorporates several new developments designed to overcome limitations imposed on present fighter aircraft. These developments are an irreversible hydraulic boost and artificial feel system for ailavator control, controllable full span slats on the leading edge of the wing, and a cockpit air-conditioning and pressurizing system.

1–4. The take-off gross weight of the airplane is approximately 23,900 pounds with full fuel load; the combat gross weight is approximately 21,350 pounds with 60 percent fuel remaining. (These weights are based on the use of Spec. MIL-F-5624 Fuel. For the computation of the gross weight conditions of each airplane, refer to the Handbook of Weight and Balance Data, AN 01-1B-40.)

1–5. FLIGHT CONTROLS.

1–6. GENERAL. The flight controls in the airplane consist of control systems for the operation of the ailavators, rudders, wing slats, and speed brakes. Because of the high performance characteristics of the airplane, the unconventional nature of the controls, and the expected high control surface moments, the ailavator installation incorporates an irreversible hydraulic boost system. When the pilot moves the stick, he actuates hydraulic valves which move the ailavators as dictated by the amount of stick displacement. Since this boost system is irreversible (i.e., no aerodynamic force from the control surface is felt by the pilot), simulated feel systems are provided for both lateral and longitudinal control. However, the ailavators are equipped with tabs for trim and balance for emergency and boost-off operation. An emergency auxiliary aileron hydraulic boost system is also provided to give boosted aileron control when the airplane is being flown on manual control (boost off). A pitch damping installation for artificially increasing the damping in pitch of the airplane by moving the ailavators by means of the boost system in a direction to oppose any pitching oscillations is also incorporated in the airplane. The rudder control installation is a reversible type (a mechanical system), similar to that installed in other aircraft except that there are no rudder trim tabs; trim for directional control is provided by the adjustment of a trimmer located at the trailing edge of the left-hand fin stub. In addition, an automatically operated yaw damper is provided to dampen the dynamic yawing oscillations induced aerodynamically or by the pilot. The yaw damper tab is located at the trailing edge of the right-hand fin stub and is identical in appearance to the directional trimmer. The wing slats and speed brakes are hydraulically operated.

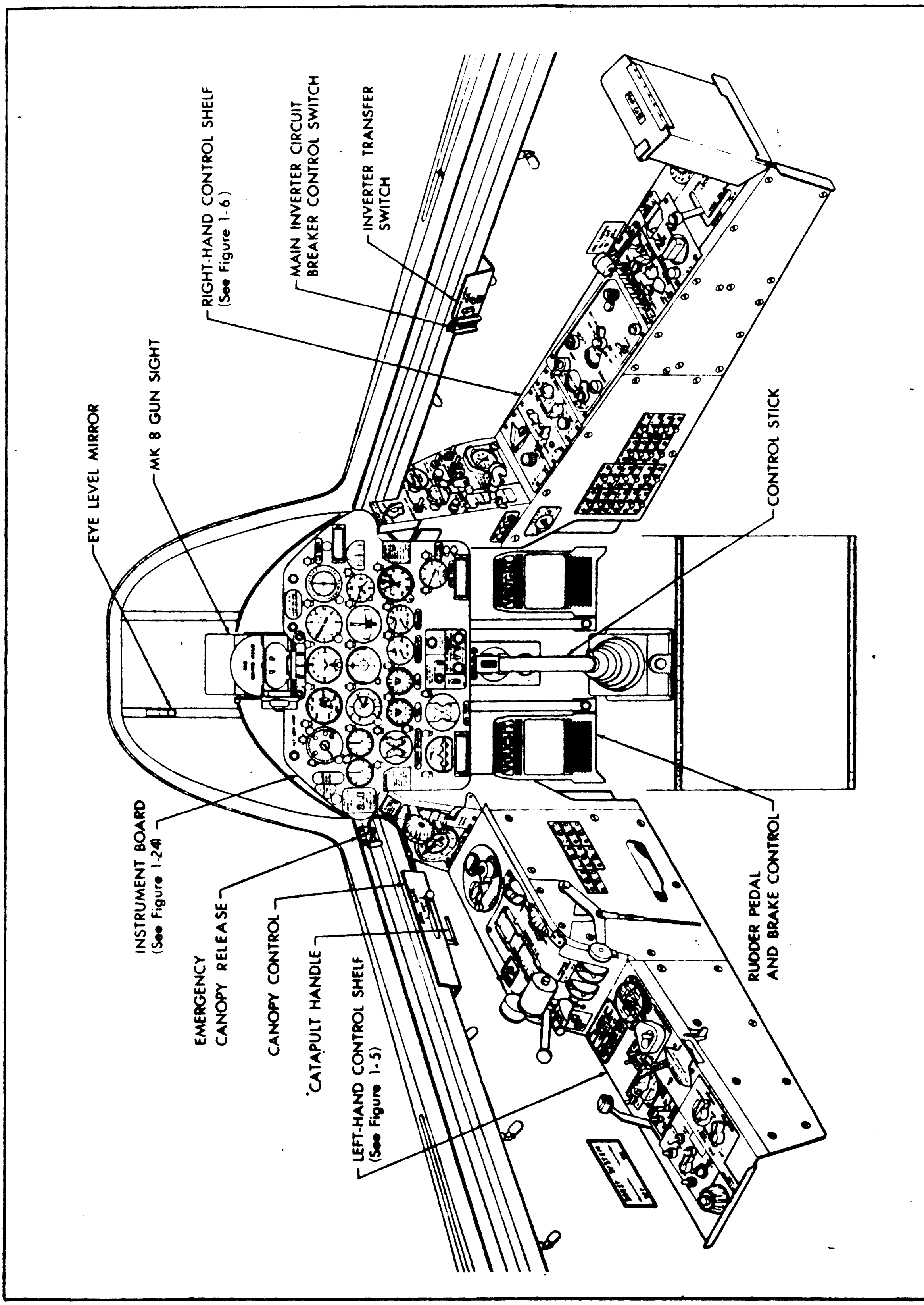


Figure 1-4. Cockpit — Looking Forward

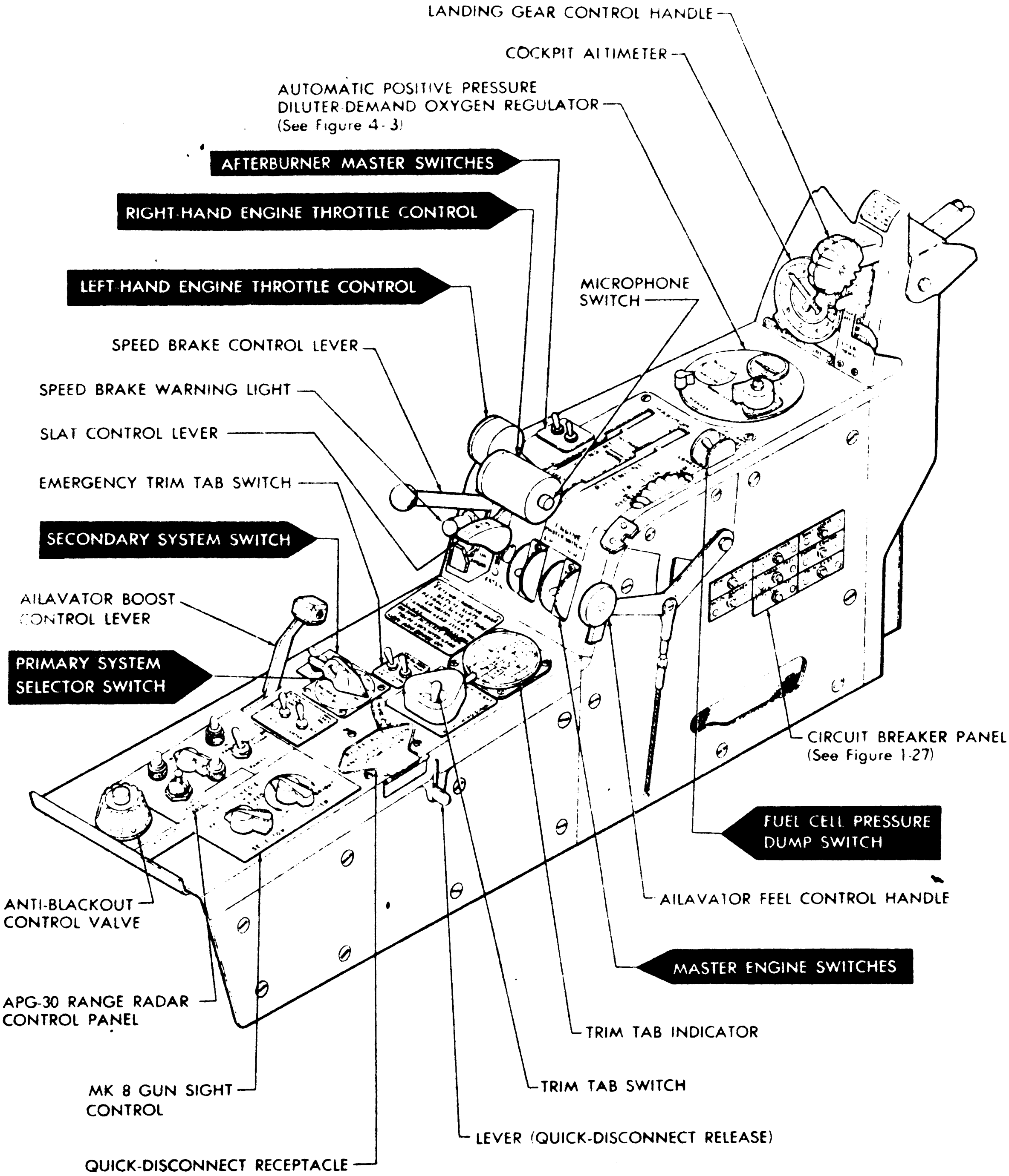


Figure 1-5. Cockpit — Left-Hand Side

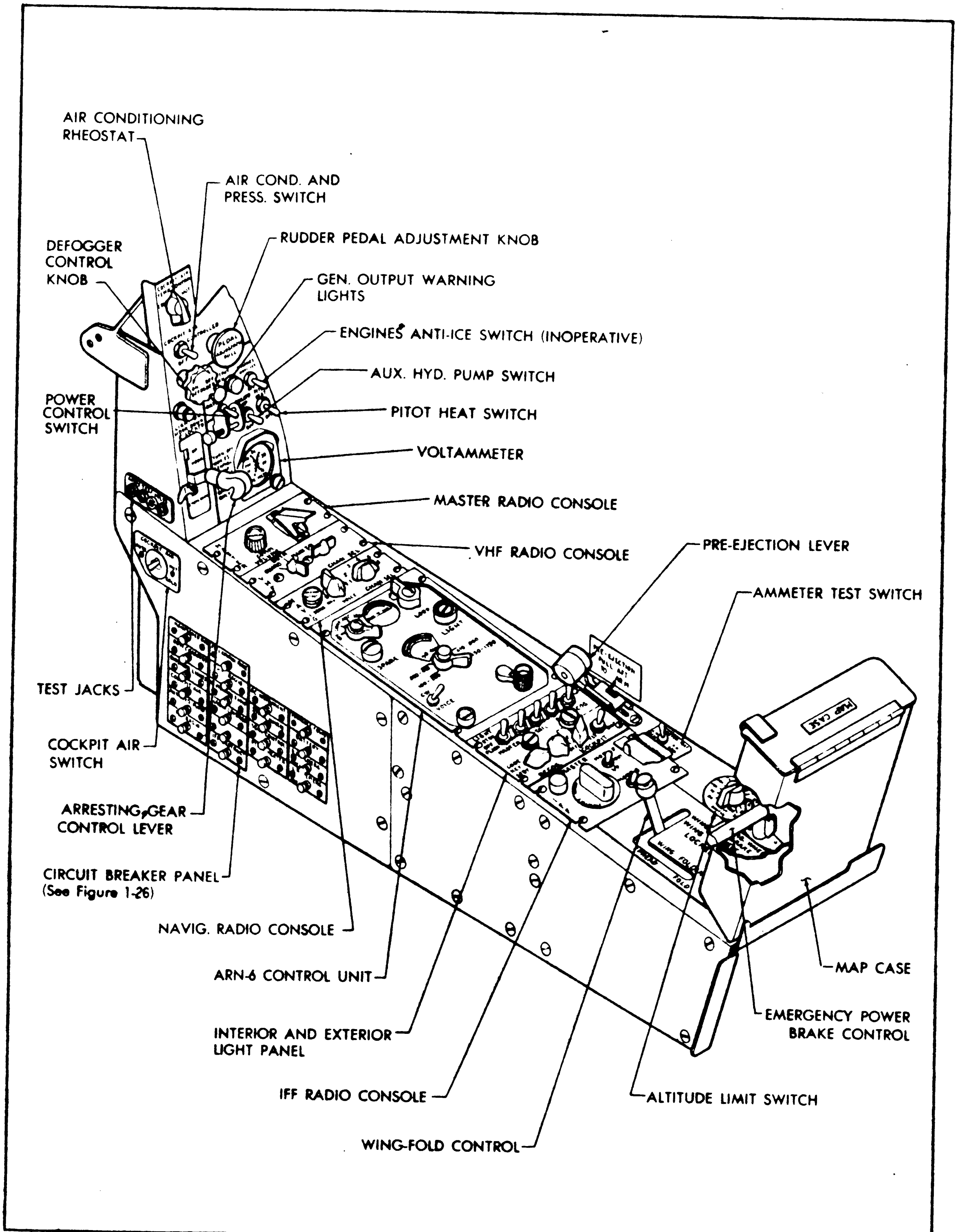


Figure 1–6. Cockpit – Right-Hand Side

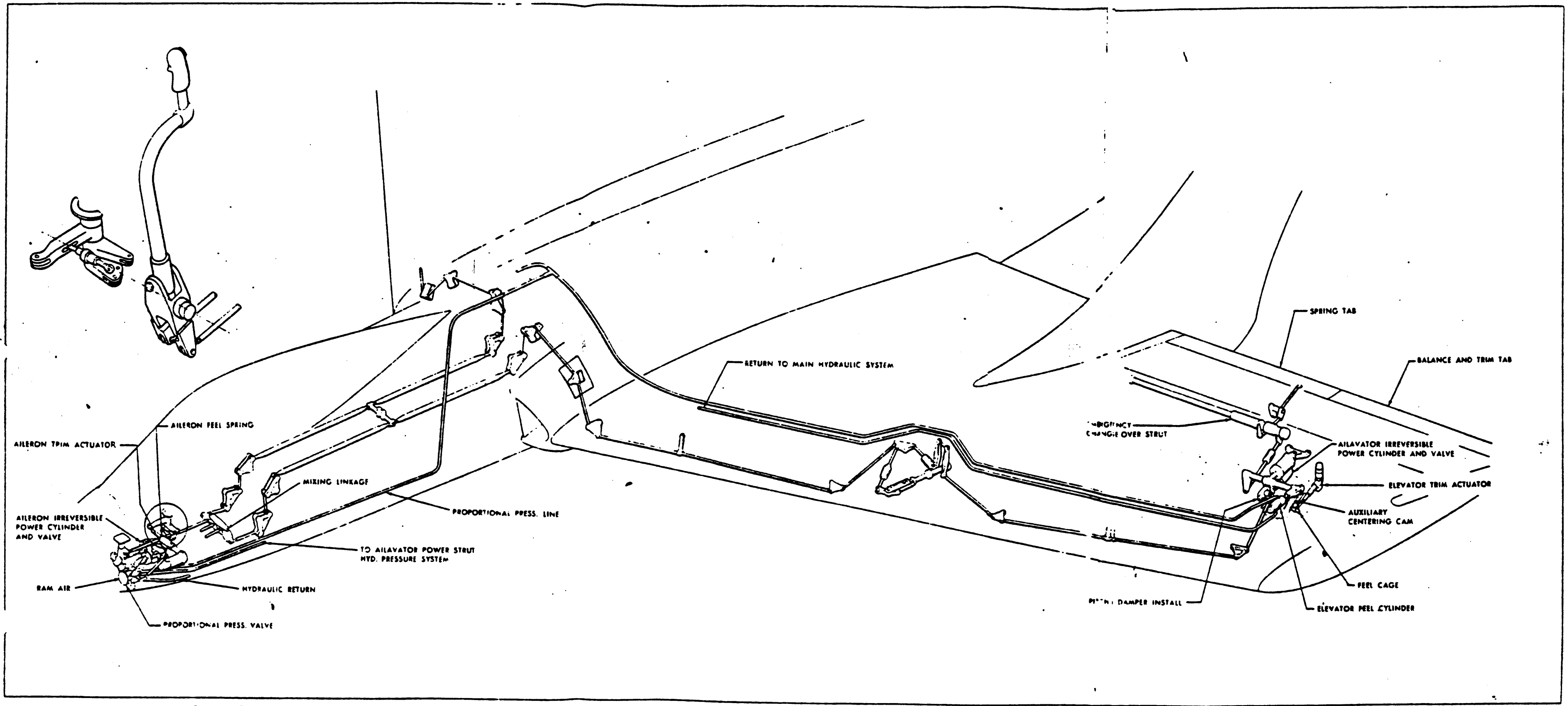


Figure 1-7. Ailavator Feel System

1-7. AILAVATORS. *(See figures 1-7 and 1-9.)* The ailavator control surfaces, located on the trailing edge of the wing outer panels, serve as both elevators and ailerons, either as a direct function of either control or as a combination of both. Movement of the control stick laterally will cause the ailavators to move asymmetrically to each other, as would be the case in the conventional aileron control installation. Movement of the control stick for elevator action will cause the ailavators to move symmetrically for longitudinal control. (Refer to paragraph 1-9.)

WARNING

When ailerons have been deflected, always return the stick to neutral by hand, i.e., do not deflect the stick to any aileron position and release. The action of the aileron centering spring will return the stick to neutral with enough speed and force to cause the stick to vibrate about the neutral position and seriously damage the boost system.

1-8. With the ailavator boost control lever in the normal "ON" position, movement of the control stick actuates an ailavator power cylinder and valve unit in each wing outer panel to deflect the ailavators hydraulically. *Elevator* stick force is simulated by a feel system which utilizes ram air to impose loads on the control stick, varying as a function of surface displacement and dynamic air pressure, as in an airplane with a mechanical control system. As the airspeed increases, a hydraulic valve that is sensitive to dynamic pressure allows the hydraulic pressure to build up in the feel system so that a greater stick force is required to move the stick a given displacement from its trim position. To give satisfactory maneuvering stability, the ram air bleed is automatically controlled as a function of Mach number to permit a reasonably constant stick force per "g" over the entire operable speed range. *Aileron* feel is simulated by an aileron centering spring which provides the same force for a given lateral stick deflection, regardless of airspeed. This is necessary as the artificial forces required for longitudinal feel are too large for desired lateral stick forces. A small power cylinder and servo valve unit is incorporated as an auxiliary boost for aileron control to overcome the artificial forces transmitted to the stick from the elevator feel units. Elevator and aileron trim actuators are provided to change the neutral position of the control stick as required for trimming either the elevator or aileron feel system. The actuators are operated during boosted flight by means of the longitudinal trim switch on the control stick and the trim tab switch on the left-hand control shelf. (Refer to paragraph 1-12.)

1-9. Each ailavator has an outboard trim tab and an

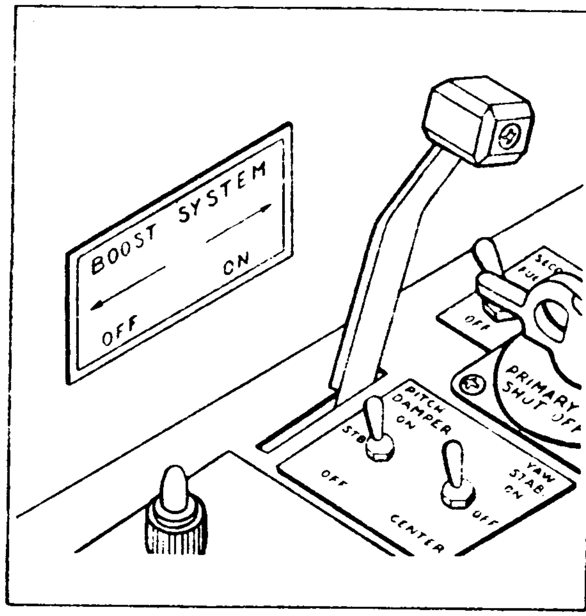


Figure 1-8. Ailavator Boost Control

inboard spring tab. The trim tab functions as a balance tab whenever the ailavator is moved from the neutral position. In normal boost "ON" flight the spring tab is locked in the neutral position. When the boost fails or is turned off manually, the spring tab is automatically unlocked and elevator control is then obtained through a straight mechanical spring tab control system. Aileron control is obtained through a mechanical system with emergency auxiliary aileron hydraulic boost. Longitudinal or lateral trim with the boost "OFF" is obtained with the trim tab. When the boost system fails or is turned "OFF," the forces exerted by the simulated elevator feel units on the control system are reduced to a negligible quantity.

1-10. RUDDERS. The rudder control installation is a reversible type similar to that installed in other airplanes. The rudder and brake pedals are supported on a horizontal tubular slide which rides along longitudinal tracks to provide fore and aft adjustment of the pedals. A rudder pedal adjustment knob is located on the right-hand control shelf. Pulling this knob releases the pedals and allows them to be moved fore and aft. In place of rudder trim tabs, trim for directional control of the airplane is accomplished by the adjustment of a trimmer located at the trailing edge of the left-hand fin stub below the rudder. The trimmer is adjusted by means of the trim tab switch on the left-hand control shelf.

1-11. AILAVATOR TRIM CONTROL. *(See figure 1-9.)* With the ailavator boost "ON" and the landing gear "DOWN," the ailavator trim tabs are automatically deflected to full nose-up position as a precaution against hydraulic boost failure during take-off or landing. Twenty seconds after the landing gear has been retracted, a time delay relay switches the trim tabs from automatic to manual control, and the trim tabs are returned to their centered position. Ailavator trim control with the gear up is accomplished in the following manner: *Longitudinal* trim control of the airplane is achieved during normal boosted or unboosted flight by means of the longitudinal trim switch on the control stick. Operation of this switch during boosted flight trims the ailavator feel system only. In unboosted flight, effected either by placing the ailavator boost control lever in "OFF" or by an ailavator hydraulic boost failure, the electrical circuits for longitudinal trim are automatically changed over to operate the ailavator trim tabs through the trim tab actuators. The two emergency trim tab switches, located outboard of the trim tab indicator, provide a means of actuating the ailavator trim tabs during unboosted flight or boosted flight with the landing gear retracted. These switches may be used to trim the airplane as required prior to shutting off the ailavator boost system, to reduce the hinge moments to zero so that no abrupt stick force change will occur when changing over from a boost system to a straight mechanical system. If both ailavator hydraulic boost and emergency aileron hydraulic boost are inoperative, the two emergency trim tab switches may be used to position the trim tab actuators to obtain desired trim control. *Lateral* trim control of the airplane is achieved during normal boosted or unboosted flight by means of the lateral trim switch on the left-hand control shelf. This switch actuates a rotary actuator below the control stick which positions the aileron feel spring strut, giving lateral control stick trim.

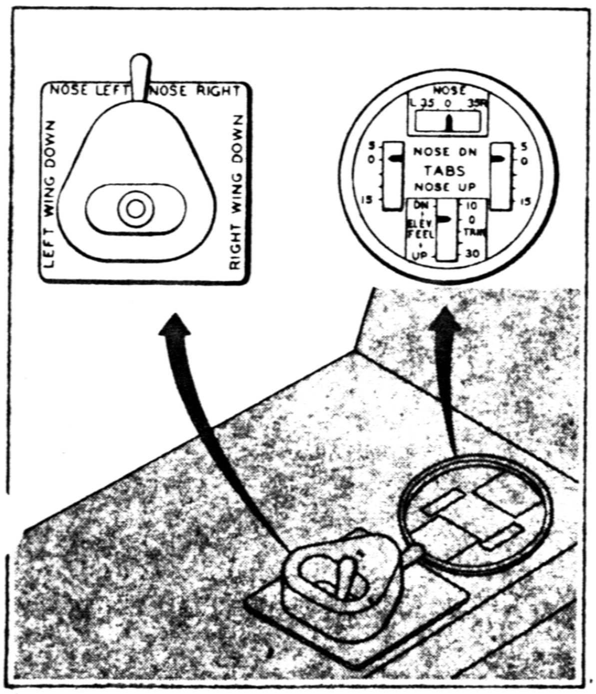


Figure 1-9. Rudder and Ailavator Trim Tab Control

WARNING

With ailavator boost "ON" and landing gear "DOWN," do not actuate emergency trim tab switches; with ailavator boost "OFF," do not actuate longitudinal trim switch and emergency trim tab switches simultaneously.

1-12. DIRECTIONAL TRIM CONTROL. *(See figure 1-9.)* Trim for directional control of the airplane is accomplished by means of the trim tab switch on the left-hand control shelf. Movement of the forward toggle on this switch to the "NOSE LEFT" or "NOSE RIGHT" position actuates the trimmer located at the trailing edge of the left-hand fin stub.

1-13. TRIM TAB INDICATOR. *(See figure 1-9.)* The trim tab indicator, located on the left-hand control shelf, indicates the settings for directional trim, for longitudinal feel trim for both ailavators and for each ailavator trim tab. There is no indication of lateral trim except lateral stick position. Trim travel ranges from 18 degrees 30 minutes nose-up to 5 degrees nose-down. Elevator simulated feel trim travel (boost on) is 25 degrees nose-up to 7 degrees nose-down.

1-14. YAW DAMPER CONTROL. *(See figure 1-10.)* The yaw damper installation is an automatically operated system to dampen any dynamic yawing oscillations encountered at any speeds. A centering switch for pilot control is located on the aft portion of the left-hand control shelf. When the switch is in "AUTOMATIC," the rate gyro is in control. When the switch is in "CENTER," the gyro is cut out of the circuit and the surface is driven to a preset position. The yaw damper tab is located at the trailing edge of the right-hand fin stub below the rudder. The principal component of the yaw damper system is the rate gyro, which is located in the nose wheel compartment and consists principally of a gyro and a potentiometer. The gyro measures the yawing velocity of the airplane and transmits a signal at variable voltage through the calibrator box to the servo power amplifier. The voltage is increased in the power amplifier, in proportion to the yawing velocity of the airplane, and is transmitted to the servo motor which actuates a hydraulic control valve. This results in movement of the hydraulic actuating cylinder and consequent deflection of the yaw tab in a direction to oppose the yawing velocity of the airplane.

1-15. PITCH DAMPER CONTROL. *(See figure 1-11.)* The pitch damper system automatically damps pitching accelerations of the airplane. The system accomplishes this by moving the ailavators, through the boost system, in a direction which opposes pitching oscillations. The pitch damper incorporates a circuit which differentiates between steady-state pitching velocities, such as are encountered in steady banked turns, etc., and oscillatory motions of the airplane.

Damping is provided only against oscillatory motions and against rapid entries into turns or pull-outs where large pitching accelerations are encountered. The system consists essentially of a pitch rate gyro, a pressure control unit, an amplifier, and the pitch damper actuator which positions the ailavator boost valve, and thus the ailavator, in accordance with the pitch rate gyro signals. The pressure control unit automatically controls the degree of ailavator deflection employed at any given altitude to oppose each degree per second of pitching acceleration. The pitch damper is limited in control to the equivalent of ± 2 degrees of ailavator deflection.

1–16. OPERATION. The cockpit control for the pitch damper is a three-position toggle switch, located on the left-hand control shelf. The toggle switch positions are: "OFF," "STAND-BY," and "ON." With the toggle switch in "OFF," no electrical power is supplied to the pitch damper and the pitch damper is locked in neutral by the engagement of a gear tooth so that there is a continuous linkage between the control stick and the boost valve. With the toggle switch in "STAND-BY," electrical power is supplied to the gyro, amplifier, and other components of the pitch damper circuit, but the pitch damper actuator does not receive pitch rate signals from the gyro and is still locked in neutral. With the toggle switch in "ON," the mechanical lock is released, and the pitch damper actuator functions by positioning the ailavator in accordance with the signals from the pitch rate gyro. The linkage between the stick and boost valve remains mechanical but by releasing the locking mechanism the actuator is permitted to reposition the boost valve and subsequently reposition the ailavator.

1–17. If it is desired to turn the pitch damper on, set toggle switch in "STAND-BY" position at least 2 minutes prior to use of pitch damper. At end of 2-minute interval, set toggle switch in "ON" position.

1–18. To turn the pitch damper off, place toggle switch in "OFF" position. If the pitch damper is to be turned off temporarily, the toggle switch may be left in "STAND-BY" position.

1–19. WING SLATS. *(See figure 1–5.)* The controllable full span wing slats are provided to increase the maximum lift coefficient for low landing speed, decrease the take-off run, and improve the low-speed handling characteristics of the airplane. The wing slats are the 2-position type, hydraulically operated and manually controlled by means of the slat control lever on the left-hand control shelf. Displacement of the control lever from the normal "RETRACT" to the "EXTEND" position results in an initial movement of the wing slats full forward, then down to the extended and locked position. The time required for normal extension and retraction of the wing slats is approximately 5 seconds. The position is shown on the wheel and slats position indicator on the instrument panel.

WARNING

Extend landing gear before extending slats. Retract slats before retracting landing gear. Landing gear restriction: 175 knots maximum. Slats restriction: 150 knots maximum. At speeds above 150 knots, with landing gear up and slats extended, the longitudinal stability becomes neutral to negative, depending upon the speed. Adequate stability exists at 150 knots but pilots are warned to observe this restriction meticulously.

1–20. SPEED BRAKES. *(See figure 1–5.)* Wing and fuselage speed brakes are provided on the airplane. The wing speed brakes are the split-flap type which, in the closed position, form the trailing edge of the wing center section. The fuselage speed brakes are the flap-type which in the closed position form a smooth fuselage contour beneath the main air ducts. Normally, the wing speed brakes operate on the 3,300-psi hydraulic system, and the fuselage speed brakes operate on the 1,500-psi system. The control lever for speed brake operation is located on the left-hand control shelf, and has "CLOSE," "OPEN," and "EMERGENCY" positions. An indicator light beside the control lever is illuminated when the speed brakes are open. If an electrical failure occurs while the speed brakes are hydraulically opened, the fuselage speed brake solenoid selector valve is automatically placed in the closed position, thereby allowing the fuselage speed brakes to close; the wing speed brakes remain open. Refer to paragraph 3–47 for emergency operating instructions.

1–21. SURFACE CONTROL LOCK. *(See figure 1–12.)* The surface control lock for the airplane is a tubular assembly which interlocks the control stick and the rudder pedals. The lower end of the control lock is inserted between the rudder pedals, fitting into the left rudder and brake pedal support tube. A spring-loaded plunger is then depressed to allow the control lock to engage the right rudder and brake pedal support tube. The control lock is finally secured to the control stick, at a point above the relief tube attachment, by means of two spring-loaded yoke and latch assemblies. The horizontal tube, which spans the lower end of the control lock, serves as a footblock to warn the pilot that the control surfaces are locked.

1–22. POWER PLANT.

1–22A. The airplane is powered by two Westinghouse J34-WE-42 turbojet engine quick-change units with afterburners (figure 1-14). Either engine may be operated alone, with or without afterburner operation, or both may be operated simultaneously. Each engine is equipped with a primary fuel control, an emergency fuel control, and automatic two-position exhaust nozzle eyelids. The emergency fuel control automatically

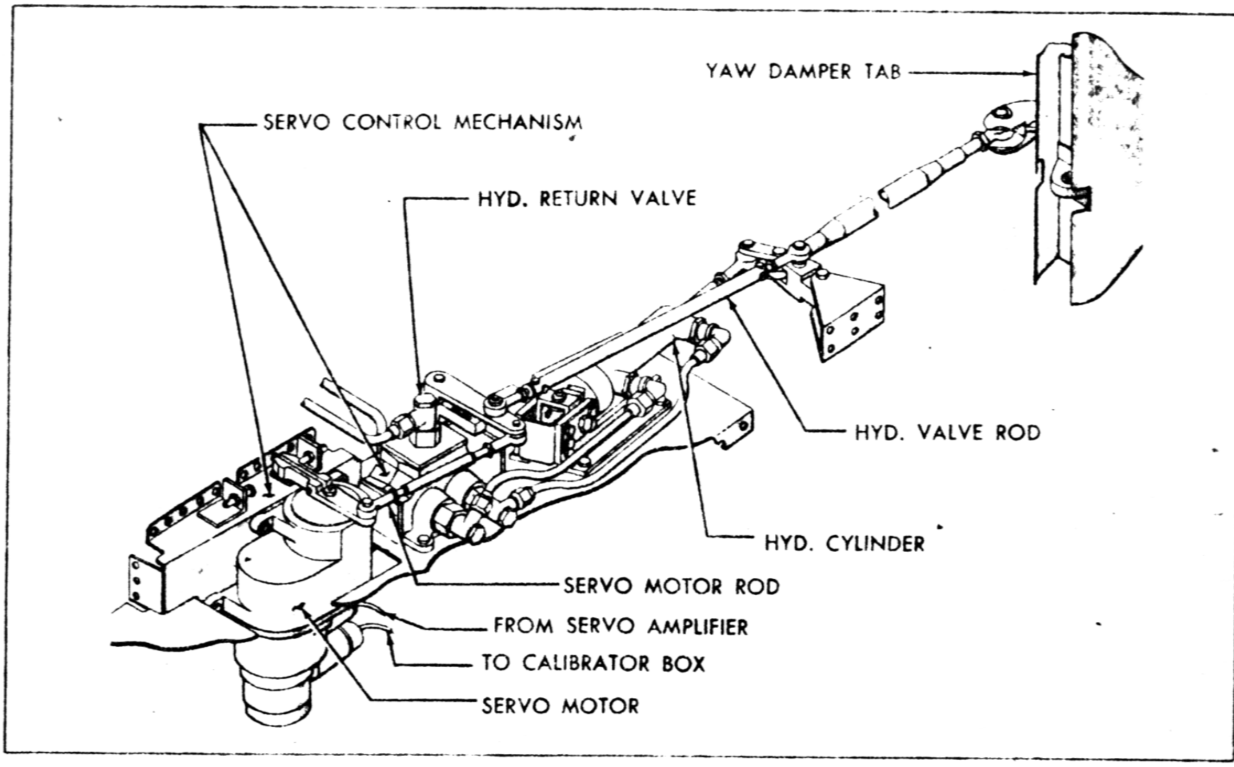


Figure 1–10. Yaw Damper Control

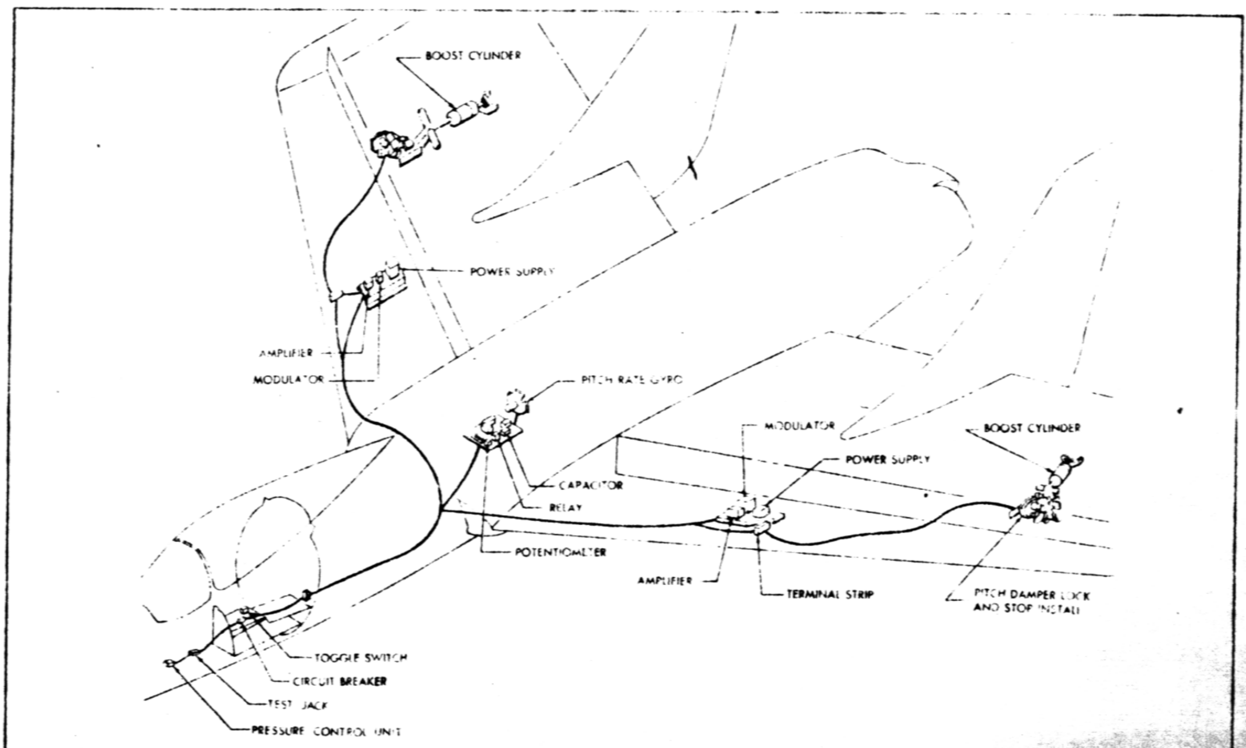


Figure 1–11. Pitch Damper Control

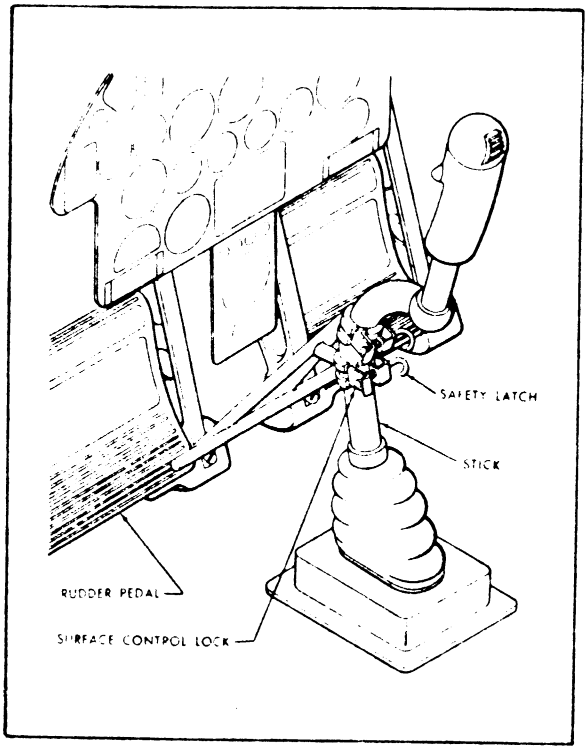


Figure 1-12. Surface Control Lock

becomes operative upon failure of the primary fuel control; however, the emergency fuel control may be pilot-selected (paragraph 1-35). Atmospheric air is supplied to the engines and afterburners through wing root and fuselage main air ducts. The engine accessory sections are cooled by air, tapped from the main air ducts, which exits through engine access door gills. Afterburner cooling is accomplished through tail cone gills, positive pressure doors, negative pressure doors, and engine access door gills. Power plant instruments are provided to indicate oil temperature, oil pressure, turbine exhaust temperature, engine and afterburner compartment temperature, fuel pressure, fuel quantity, and percent rpm. Indicator lights are provided for fuel transfer emergency fuel control, eyelid position indicator, and fire warning. Refer to paragraph 2-14 for engine starting procedure and to paragraph 2-19 for afterburner starting procedure.

1-23. POWER PLANT CONTROLS.

1-23A. GENERAL. The power plant controls for each engine consist of a throttle control lever, an engine master switch, an afterburner master switch, an emergency fuel control switch, and four throttle-actuated microswitches. A primary fuel selector switch (paragraph 1-38) directs fuel to either or both engines.

1-24. THROTTLE. The throttle control levers, mounted in a quadrant on the left-hand control shelf, regulate the engine primary and emergency fuel controls. The engine fuel controls regulate fuel flow to the right- and left-hand engines to maintain approximately constant engine rpm corresponding to the selected throttle setting. The seven labeled throttle settings are as follows: "OFF," "CRANK," "EMERG IGNITE," "IDLE," "NORMAL," "MILITARY," and "MAXIMUM." A friction adjustment knob on the throttle quadrant is moved forward to increase throttle friction and aft to decrease friction. The right-hand engine throttle is equipped with a microphone button and ranging throttle grip.

1-25. Microswitches within the throttle quadrant are actuated by the throttles and are used as follows: the microswitch at the "OFF" position is used in conjunction with the engine master switch for opening and closing the air duct doors; the microswitch at the "CRANK" position initiates the starting cycle; and the microswitch at the "EMERG IGNITE" position is used for starting the engine. A throttle-actuated microswitch for afterburner operation is located in the left-hand control shelf and is used to start the afterburner when the afterburner master switch is in the "ON" position and the throttle is advanced to the "MAXIMUM" position.

1-26. STARTER AND IGNITION SYSTEM. To start the engines, an external power source is used for the airplane accessories and for the starter circuit. The starting cycle for either engine is initiated when the throttle control lever is in the "OFF" position, the engine master switch is in the "ON" position, the main duct door is open, the primary fuel selector switch is turned to the "RIGHT ON" or "LEFT ON" position, and the throttle control lever is moved to the "CRANK" position. When contacted by the throttle

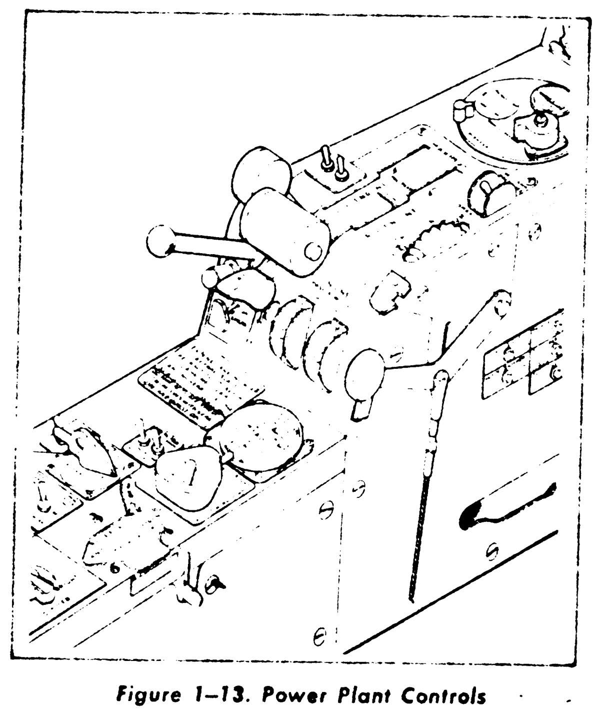
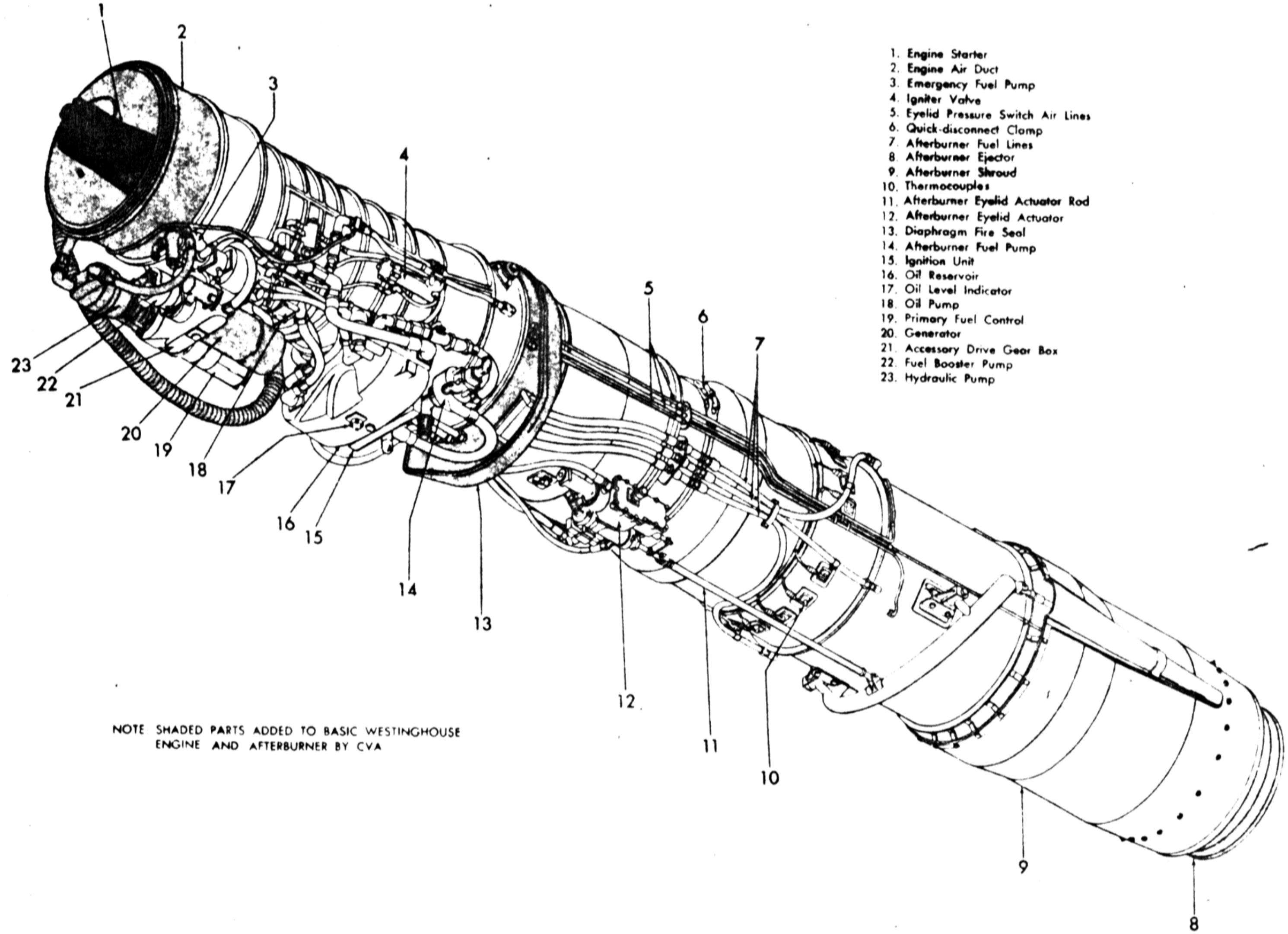


Figure 1-13. Power Plant Controls



1. Engine Starter
2. Engine Air Duct
3. Emergency Fuel Pump
4. Igniter Valve
5. Eyelid Pressure Switch Air Lines
6. Quick-disconnect Clamp
7. Afterburner Fuel Lines
8. Afterburner Ejector
9. Afterburner Shroud
10. Thermocouples
11. Afterburner Eyelid Actuator Rod
12. Afterburner Eyelid Actuator
13. Diaphragm Fire Seal
14. Afterburner Fuel Pump
15. Ignition Unit
16. Oil Reservoir
17. Oil Level Indicator
18. Oil Pump
19. Primary Fuel Control
20. Generator
21. Accessory Drive Gear Box
22. Fuel Booster Pump
23. Hydraulic Pump

NOTE SHADED PARTS ADDED TO BASIC WESTINGHOUSE ENGINE AND AFTERBURNER BY CVA

Figure 1–14. Turbo-Jet Engine and Afterburner

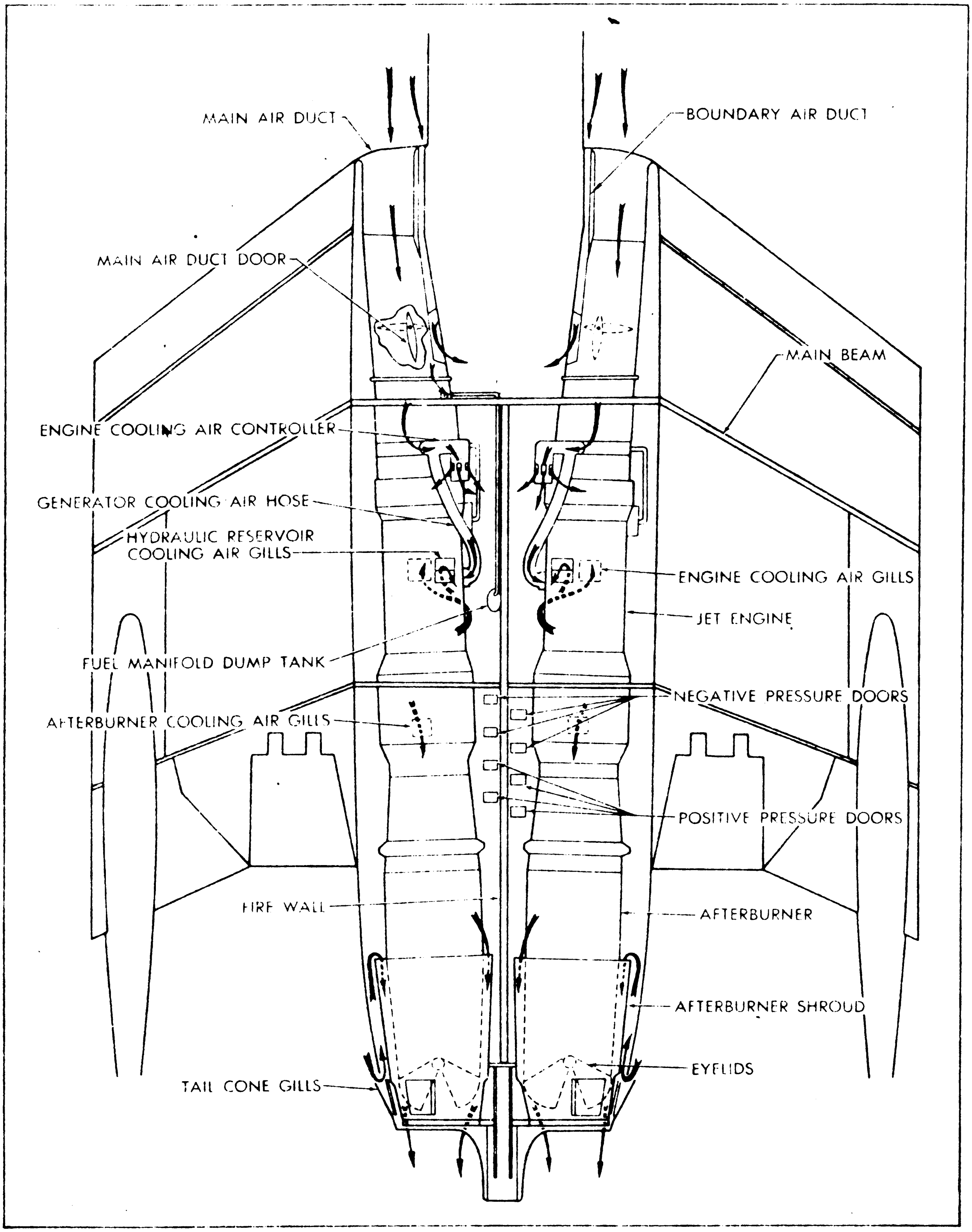
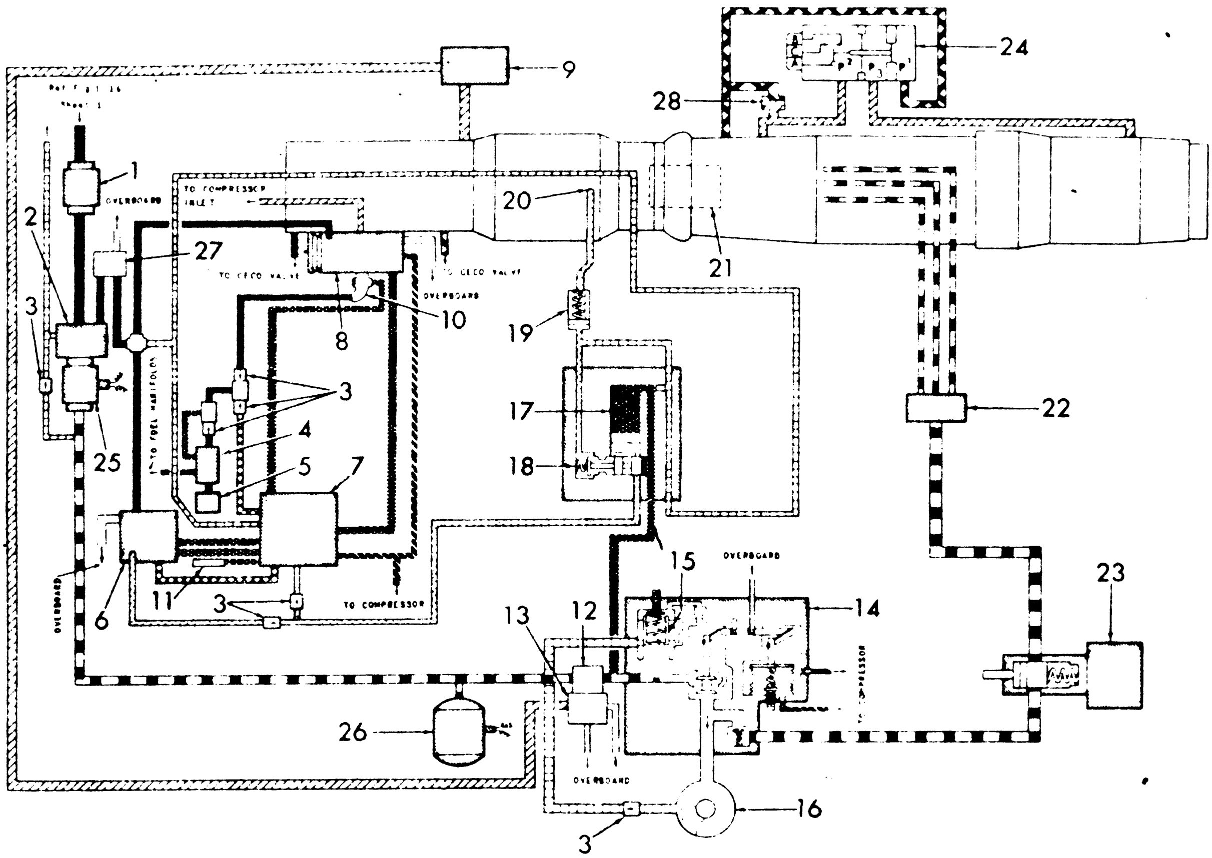


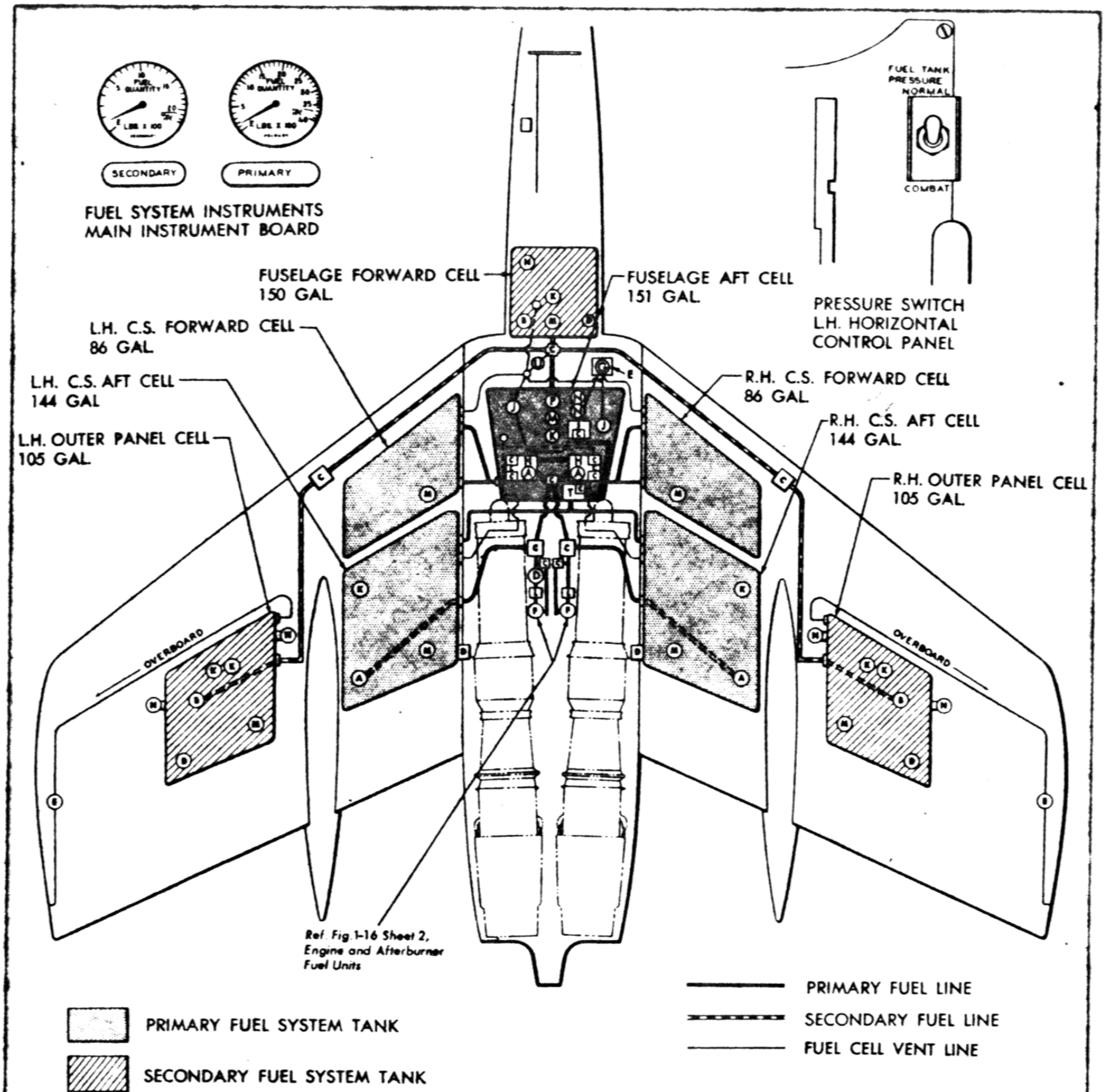
Figure 1–15. Air Induction System



FUEL SUPPLY
AFTERBURNER FUEL
OVERBOARD DRAIN
HOT STREAK FUEL
NO FLOW PRESSURE LINE
STATIC PRESSURE
INLET TOTAL PRESSURE
EMERGENCY FUEL
BY-PASS FUEL
OUTLET TOTAL PRESSURE

1. Fuel Shut off Valve
2. Fuel Strainer
3. Check Valve
4. Dump Valve
5. Dump Tank
6. Emergency Fuel Pump
7. Emergency Fuel Control
8. Primary Fuel Control
9. Air Shut off Valve
10. Fuel Shut off Valve
11. Pressure Switch
12. Afterburner Fuel Pump
13. Air Turbine
14. Ceco Valve
15. Ceco By pass Valve
16. Fuel By pass Valve
17. Accumulator Valve
18. Igniter Valve
19. Positive Shut off Check Valve
20. Hot Streak Injector
21. Nozzle Actuator
22. Fuel Manifold
23. Solenoid Fuel Shut off Valve
24. Eyelid Pressure Switch
25. Afterburner Shut off Valve
26. Meletron Pressure Switch
27. Fuel Boost Pump
28. Restrictor

Figure 1–16 (Sheet 2 of 2 Sheets). Fuel System Diagram



A. Submerged Boost Pump
B. Submerged Transfer Pump
C. Check Valve
D. Defueling Valve
E. Vent Valve
F. Strainer—Fuel
G. Overboard
H. Submerged Boost Pump Housings
J. Cell Vent Connection
K. Fuel Quantity Transmitter
L. Shut-Off Valve
M. Vacuum Relief Valve
N. Filler Cap
P. Float Valve
S. Check Valves and Standpipe
T. Fuel Cell Tee
U. Transfer Fuel Flow Indicator

FUEL CELL QUANTITY

Primary System	611 Gal
Secondary System	360 Gal
Total	971 Gal

Figure 1–16 (Sheet 1 of 2 Sheets). Fuel System Diagram

control lever, the "CRANK" microswitch energizes the starter circuit. Moving the throttle to "EMERG IGNITE" contacts a microswitch which energizes the ignition circuit. When the engine accelerates to above starting speed, an undercurrent relay disengages the starter. The starter and ignition system permits either engine to be started independently of the other and is not involved in sustaining engine operation.

1-27. AFTERBURNER CONTROLS. The pilot-operated controls for the afterburners are the afterburner master switches and the throttle-actuated afterburner microswitches. With the engines operating, the afterburners are started by placing the afterburner master switches in the "ON" position, waiting 20 to 30 seconds for the afterburner fuel control amplifier to warm up, and advancing the throttles to "MAXIMUM." Two amber indicator lights on the instrument panel burn when the afterburner eyelids are closed. Two adjacent green lights burn when the eyelids open after afterburner operation is initiated.

1-28. FUEL SYSTEM.

1-29. GENERAL. *(See figure 1-16.)* The fuel system consists of primary and secondary fuel systems, and contains provisions for an external fuel system. Fuel is supplied for the operation of the engines and afterburners in such proportions that excessive center-of-gravity movement during flight is prevented. The fuel system is designed so that all fuel is available to either engine and its afterburner, and so that either engine may be operated without the afterburner. The fuel system operates automatically once switches are set, but secondary fuel transfer may be pilot-selected. For information on fuel system management, refer to paragraph 2-10.

WARNING

If primary fuel has been utilized during an extended ground run-up with fuel in the secondary system and the secondary fuel switch in "OFF," the fuselage forward fuel cell and the primary fuel system should be refueled prior to take-off.

TOTAL FUEL CAPACITY

Fuel Cell System	Capacity U. S. Gal.	Type of Fuel: MIL-F-5572-1 (Pounds)	MIL-F-5624 (Pounds)
Primary	611	3666	3972
Secondary	360	2160	2340
Total	971	5826	6312

1-30. PRIMARY SYSTEM. The primary fuel system consists of five fuel cells as follows: a fuselage aft cell, two center section forward cells, and two center section aft cells. Also in the primary fuel system are submerged boost pumps, defueling valves, check valves, a primary control timer, vacuum relief valves, a standpipe within the fuselage aft cell, and venting provisions. The total capacity of the primary fuel system is 611 U. S. gallons.

1-31. An electric motor-driven primary timer causes the submerged boost pumps in the fuselage aft cell to run for timed intervals on low and high speed alternately with the submerged boost pumps in the two center section aft cells. Higher pressure produced by running the submerged boost pumps on high speed closes the check valves against fuel flow from the submerged boost pumps running on low speed, permitting fuel to be metered only from the fuel cells whose submerged boost pumps are running on high speed. When the primary fuel cells are full to half full, the fuselage aft cell submerged boost pumps run on low speed and the center section aft cell submerged boost pumps run on high speed for 13.3 seconds. At the completion of this cycle, the fuselage aft cell submerged boost pumps run on high speed and the right- and left-hand center section aft cell submerged boost pumps run on low speed for 6.7 seconds. These alternate cycles are continuous until the primary system is half full. The ratio of fuel fed from the fuselage aft cell and the right- and left-hand center section forward cells to the right- and left-hand center section aft cells is approximately 1 to 2. When the five primary cells are half full, a signal from the fuel quantity low-level control reverses the timing ratio, causing the fuselage aft cell submerged boost pumps to run on high speed and the right- and left-hand center section aft cell submerged boost pumps to run on low speed for 13.3 seconds. At the completion of this cycle, the fuselage aft cell submerged boost pumps run on low speed and the right- and left-hand center section submerged boost pumps run on high speed for 6.7 seconds. These timed cycles continue until the five primary fuel cells are empty. All primary fuel cells empty at approximately the same time. During the timed cycles, fuel is gravity-fed from the two center forward cells to the fuselage aft cell. The ratio of fuel fed from the fuselage aft cell and the right- and left-hand center section forward cells to the right- and left-hand center section aft cells is approximately 2 to 1. Should an electrical failure occur, or if there is a submerged boost pump failure, fuel is gravity-fed to the engines. Transfer fuel is not available when there is an electrical failure.

1-32. SECONDARY SYSTEM. The secondary fuel system consists of three fuel cells, a fuselage forward cell and two outer panel cells. The secondary fuel system also includes a secondary control timer, a float valve, submerged transfer pumps, defueling valves, vacuum relief valves, check valves, and venting provisions. The total capacity of the secondary fuel system is 360 U. S. gallons.

1-33. As fuel is used from the primary system, the supply is replenished from the secondary system when the secondary fuel system switch is "ON." This transferred fuel goes directly to the fuselage aft cell and then to the left- and right-hand center section forward cells. This transferred fuel is also directed to the left- and right-hand center section aft cells by gravity flow lines. A float valve in the fuselage aft cell stops transferred fuel flow when the primary system is full.

1-34. An electric motor-driven secondary control timer causes each of the outer panel cell submerged transfer pumps and the fuselage forward cell submerged transfer pump to operate at intervals as follows: For all engine power settings through "MILITARY" the timer cycles each pump from "OFF" to "LOW BOOST," each outer panel transfer pump for 30 seconds, and the fuselage forward cell transfer pump for 43 seconds. During combat power settings ("MAXIMUM") the timer is by-passed automatically and all three secondary transfer pumps operate on "LOW BOOST." The electrical wiring to the outer panel transfer pumps has resistance installed to reduce the individual fuel output of the pumps to approximately three-fourths of the output of the fuselage forward cell transfer pump when all pumps are operating simultaneously. This is done to aid proper airplane center-of-gravity control. Fuel from the three secondary system cells is utilized so that all secondary fuel cells empty at approximately the same time. A cockpit "NO FUEL TRANSFER" light burns intermittently when one or two secondary fuel cells become empty, and burns steadily when all secondary cells are empty. (Refer to paragraph 2-10 for information on fuel management.)

1-35. EMERGENCY FUEL CONTROL. If there is an engine primary fuel pump failure, the emergency fuel control automatically becomes operative, regulating fuel quantity supplied to the engine and maintaining constant engine rpm consistent with the throttle control lever setting. If there is a primary fuel governor failure, as indicated by fluctuation in turbine-out temperature or engine rpm, the emergency fuel control must be pilot-selected by placing the emergency fuel control switches in "SELECT EMERG." For additional information, refer to paragraph 3-18.

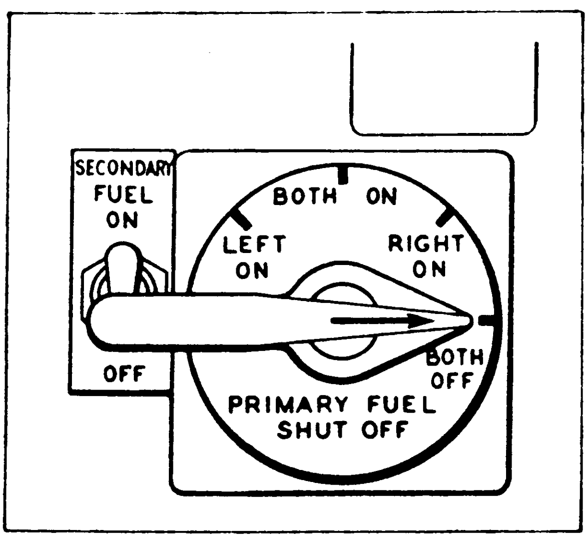


Figure 1-17. Fuel Selector Switches

WARNING

When the emergency fuel control is operative, engine speed should be kept above 56 percent rpm to prevent engine flame-out. Manual changes to emergency fuel control should not be made below 76 percent rpm. These rpm restrictions apply at all altitudes and airspeeds. Avoid prolonged operation at 68 to 76 percent rpm on both primary and emergency fuel controls.

1-36. EXTERNAL SYSTEM. Provisions are incorporated for the possible future installation of external auxiliary fuel tanks.

1-37. FUEL CELLS. Five fuel cells included in the primary fuel system have a total capacity of 611 U. S. gallons as follows: fuselage aft cell, 151 gallons; each center section aft cell, 144 gallons; each center section forward cell, 86 gallons. Three fuel cells included in the secondary fuel system have a total capacity of 360 U. S. gallons as follows: fuselage forward cell, 150 gallons; each outer panel cell, 105 gallons.

1-38. PRIMARY FUEL SELECTOR SWITCH. *(See figure 1-17.)* The primary fuel selector switch, located on the left-hand control shelf, has four positions: "LEFT ON," "RIGHT ON," "BOTH ON," and "BOTH OFF." When the switch is in "BOTH ON," fuel is delivered to both engines. When the switch is placed in either "LEFT ON" or "RIGHT ON," fuel is delivered to the selected engine only. This prevents delivery of fuel to the engine not in operation. The primary fuel selector switch is operative only when the power control switch is on, or when external power is connected. Placing the primary fuel selector switch in "BOTH OFF" (at the end of a flight) sets the right- and left-hand engine fuel shut-off valves in "OFF"; it also automatically sets the secondary fuel switch in "ON."

Note

When the primary fuel selector switch is moved, make certain that it is notched in the desired position.

1-39. SECONDARY FUEL SWITCH. The secondary fuel transfer switch is located immediately outboard of the primary fuel selector switch. In the "ON" position, fuel is transferred to the primary system from the secondary system. In the "OFF" position the secondary fuel switch is used to stop operation of the secondary fuel system submerged transfer pumps, when the secondary fuel system is empty, and to turn out the NO FUEL TRANSFER light.

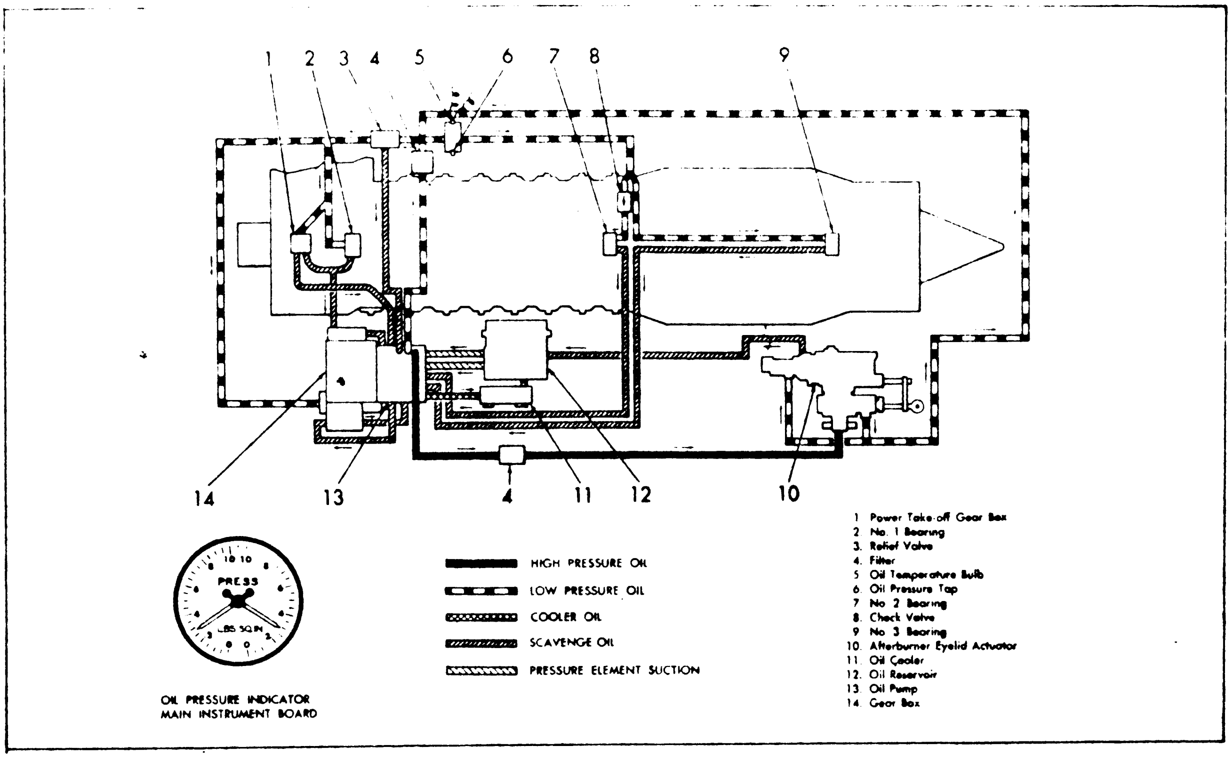


Figure 1-18. Oil System Diagram

1-40. FUEL CELL PRESSURE RELEASE. A manual fuel cell pressure release switch is located on the left-hand control shelf. Fuel cell pressure is dumped by moving the switch from "NORMAL" to "COMBAT."

1-41. DELETED.

1-42. OIL SYSTEM.

1-43. GENERAL. *(See figure 1-18.)* An independent oil system is part of each engine. The return positive pressure circulating oil system provides lubrication for the rotating parts of the engines and their accessory drives. It also supplies oil to the afterburner eyelid actuators for the operation of the exhaust nozzle eyelids. An oil pressure transmitter and an oil temperature bulb are incorporated in the system to transmit oil pressures and temperatures to cockpit indicators. There are no pilot-operated controls for the oil system. (Oil specification MIL-O-6081, Grade 1010.)

1-44. OIL RESERVOIRS. The oil reservoirs which are integral with each engine have a capacity of 2 U. S. gallons per reservoir. Oil level indicators are located on the bottom of each reservoir. The reservoirs are filled through two filler necks which are accessible through the oil filler neck access doors at fuselage station 264.

1-45. NORMAL COURSE OF OIL. With the engine operating, oil is drawn from its reservoir through separate connections to either the main or auxiliary pressure element of the pump. From the pump, the oil passes through a filter to a cross fitting. From the cross fitting, oil is distributed to a pressure relief valve, to the exhaust nozzle eyelid actuator, and through a check valve to the No. 2 and No. 3 bearings. From the relief valve, oil passes through a strut of the No. 1 bearing support to supply oil to that bearing and the power take-off gearbox. The accessory gearbox is supplied by part of the flow to the No. 1 bearing. The high pressure element of the pump takes oil from the discharge line of the main and auxiliary pump elements and discharges it into a line connected to the exhaust nozzle actuator. This line is protected by a relief valve in the pump which will by-pass oil if the discharge becomes excessive. Part of the oil is discharged from the exhaust nozzle actuator through a line to the tee connection supplying the No. 2 and No. 3 bearings. The remaining oil is bled back to the reservoir. The pump scavenges oil from the front and rear of the accessory gearbox, No. 1, 2, and 3 bearings, and the power take-off gearbox. The oil discharged from the scavenge elements is passed through the cooler to the reservoir.

1-46. LANDING GEAR CONTROLS.

1-47. NORMAL CONTROL. The control lever for the hydraulically operated landing gear is located on the forward inclined section of the left-hand control shelf. The control lever is tire-shaped for ready identification. It is made of clear plastic material and glows red whenever the landing gear is not in the locked position indicated by the position of the control lever.

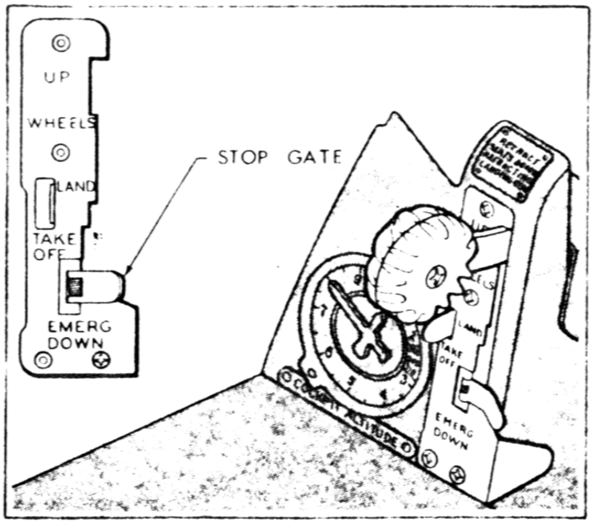


Figure 1–19. Landing Gear Control

Landing gear positions ("UP and LOCKED," "DOWN and LOCKED") are indicated on the wheel and slat position indicator. The four positions of the landing gear control handle are "UP," "LAND," "TAKE-OFF," and "EMERGENCY DOWN." The position of the main landing gear is different for take-off and landing conditions, the gear being approximately 20 inches farther aft for landing. The landing gear can be placed in "TAKE-OFF" when the airplane is on the ground, but cannot be moved from "TAKE-OFF" to "LANDING." Before the control lever can be moved from "TAKE-OFF" to "EMERGENCY DOWN," the stop-gate must be displaced. It is not advisable to move the landing gear to "TAKE-OFF" when taxiing the airplane. When the airplane is on the ground, positive mechanical downlocks prevent the landing gear from being retracted by inadvertent operation of the control lever. Normal operation of the landing gear is restricted to speeds below 175 knots. Extend landing gear before extending slats, and retract slats before retracting landing gear.

1–48. EMERGENCY CONTROLS. A compressed air bottle system is provided for emergency extension of the landing gear and is operated from the same control lever that is used for normal gear operation. The system is actuated by placing the control lever in "EMERGENCY DOWN," which releases air pressure in the air bottle. A stop-gate at the base of the control slot must be displaced prior to moving the control lever to "EMERGENCY DOWN." The air bottle is charged to 1,800 psi. Emergency operation of the landing gear is restricted to speeds below 175 knots.

1–49. **BRAKES.** The airplane is equipped with self-adjusting "puck-type" brakes. As the brakes wear, the pucks maintain a constant clearance from the brake shoe. A combination master cylinder and power boost hydraulic system controls the braking action. A master cylinder is provided for each brake, resulting in two independent systems controllable from the brake pedals on the rudder pedals. When the system is functioning normally, pressure from the hydraulic system assists each master cylinder in applying brake pressure. In the event of a hydraulic failure, the braking power of the master cylinders is reduced, and more pedal pressure is required. In an emergency, the brakes may be operated by a compressed air system. The control handle is located on the aft portion of the right-hand control shelf. The compressed air utilized for the main wheel brakes is from the arresting gear air bottle. Refer to paragraph 3–38 for information on emergency operation of the brakes.

1–50. ARRESTING GEAR AND BARRIER GUARD.

1–51. GENERAL. A folding jointed arresting hook is installed in the upper tail cone of the fuselage. The hook is extended by a hydraulic cylinder which actuates a gear rack to rotate the upper shank of the arresting gear and unfold the hook aft and downward. A dashpot on the actuating cylinder applies a downward force on the arresting hook to hold the hook on the deck and aids in absorbing cable shock. A hold-down cylinder and dashpot keep the arresting gear latched in the down position, and the cylinder, dashpot, and an accumulator damp vertical oscillation of the hook after the cable is contacted. When the hook is extended, it is at an angle of 45 degrees below the centerline of the airplane and is capable of lateral deflections of 20 degrees to either side of the centerline. A compressed air system is provided for emergency operation of the arresting gear. A retractable barrier guard is mounted on the fuselage forward of the windshield. It is installed so that it is flush with the skin contour when retracted. Operation of the arresting gear (extension or retraction) is restricted to 175 knots.

1–52. ARRESTING GEAR AND BARRIER GUARD CONTROLS. The arresting gear and barrier guard

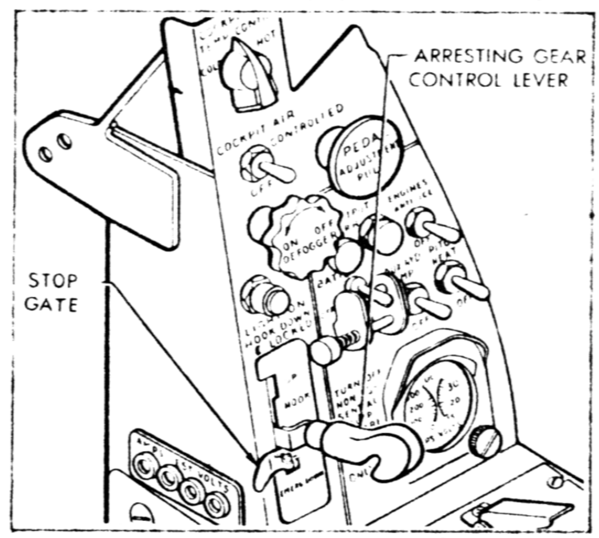


Figure 1–20. Arresting Gear and Barrier Guard Control

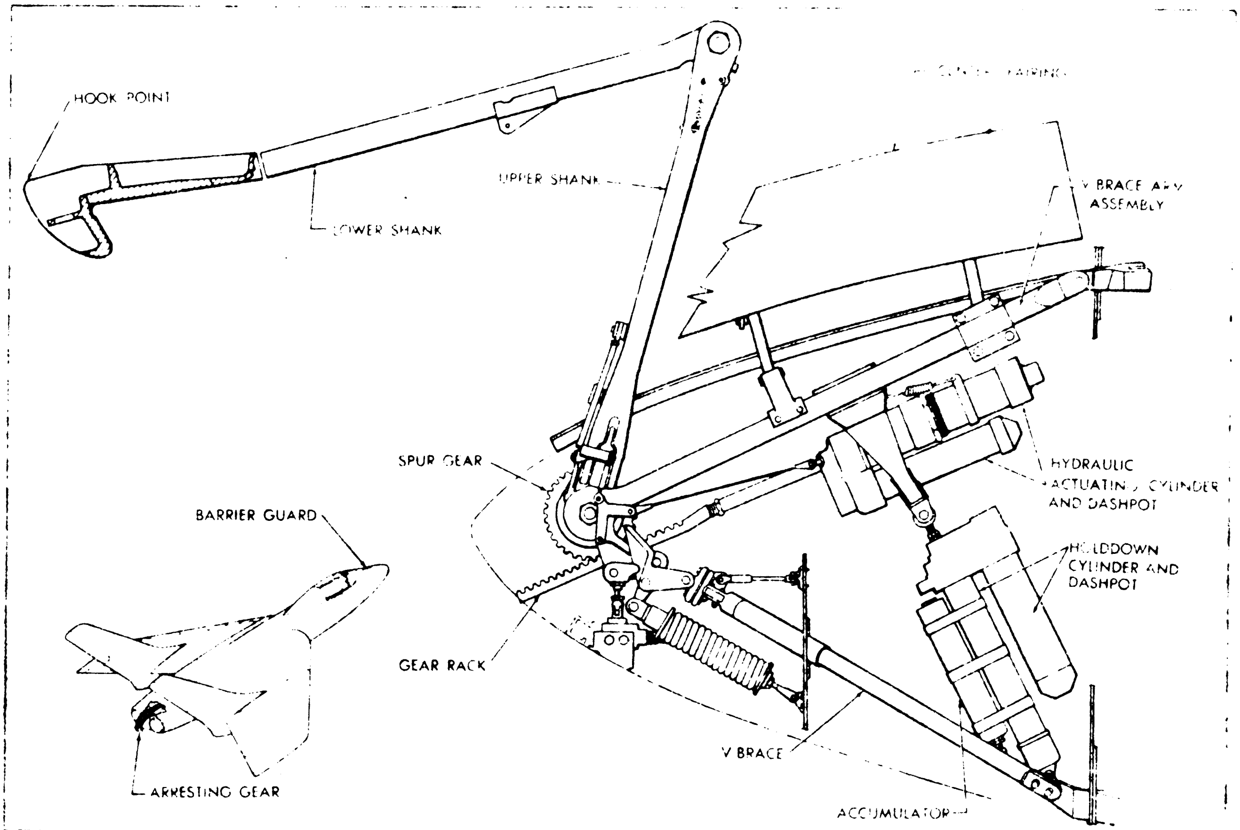


Figure 1-21. Arresting Gear and Barrier Guard

controls are operated by a hook-shaped lever on the right-hand inclined control panel. The lever is attached to a Teleflex cable which leads aft to the hydraulic selector valve. The lever may be placed in any one of three positions: "UP," "DOWN," and "EMERGENCY DOWN." When the handle is moved from "UP" to "DOWN," the barrier guard control cable is pulled, releasing the barrier guard latch and allowing the mast to extend to the erect position. Retraction of the barrier guard is accomplished hydraulically when the arresting gear is retracted. The arresting gear control handle must be in the "UP" position in order to retract the barrier guard. An indicator light above the control handle burns when the arresting gear is down and locked.

WARNING

Before extending the arresting hook and barrier guard, always make certain that all personnel are clear of the upper nose cone and aft fuselage.

1-53. EMERGENCY OPERATION. To operate the arresting gear emergency air system, displace the stop-gate and move the arresting gear lever to "EMERGENCY DOWN." (Refer to paragraph 3-44.)

1-54. WING-FOLD AND LOCKING SYSTEM.

1-55. GENERAL. *(See figure 1-6.)* The control handle, located on the aft portion of the right-hand control shelf, has three positions: "FOLD," "SPREAD," and "WING HINGE PIN LOCKED." A warning flag in the center section wing will be in the extended position until the wing hinge is locked. When the wing-fold control is moved forward from the "FOLD" position to the "SPREAD" position, the folding cylinder retracts, spreading the wings. When the control handle is moved to the "WING HINGE PIN LOCKED" position, the mechanical lock in the pin actuating cylinder is engaged, preventing inadvertent folding of the wings. To fold the wings, the handle is moved to the "SPREAD" position, disengaging the hinge pin lock. The handle is then moved aft to the "FOLD" position, extending the wing-fold cylinder and folding the wings.

WARNING

Do not fold wings with boost "OFF" unless ailavators are battened.

1-56. HYDRAULIC SYSTEM.

1-57. HYDRAULIC OIL. Specification MIL-O-5606 (red fluid).

1-58. GENERAL. *(See figure 1-22.)* The hydraulic system in the airplane is supplied with power by two engine-driven pumps. Two system pressures are available: (1) the 3,300-psi system which supplies power for the operation of the wing-fold, wing speed brakes, and the ailavator boost systems; (2) the 1,500-psi system which supplies power for the operation of the slats, landing gear, nose wheel oleo extension, power brakes, canopy, fuselage speed brakes, arresting gear, barrier guard (retraction), gun chargers, and the yaw-rate damping systems. An emergency auxiliary aileron boost system operates on a pressure of 1,500-psi when there is a hydraulic failure in the ailavator boost hydraulic circuit and the airplane is being flown on manual control. The pressure necessary for the operation of the emergency auxiliary aileron boost is supplied by a separate hydraulic pump which begins operation automatically when the ailavator boost is off or a hydraulic failure occurs in the ailavator boost system. The complete hydraulic system, including the reservoir, holds 18.5 gallons of hydraulic fluid. The fluid is drawn from the reservoir by the two engine-driven pumps and fed into the master manifold at 3,300 psi. Pressure reducing valves reduce the pressure to 1,500 psi for the lower pressure systems. These valves are by-passed by the pressure lines to the wing-fold, wing speed brakes and ailavator boost systems. The hydraulic pressure gage is located on the main instrument panel and will read 3,300 psi when the system is functioning properly. The hydraulic system is provided with a flow regulating valve. The purpose of this valve is to prevent any subsystem from robbing the boost system of the fluid necessary to operate satisfactorily, particularly during the landing or take-off sequence when several of the subsystems may be operated in quick succession.

1-59. An auxiliary hydraulic pump is installed and may be used, in the event of hydraulic failure, for operation of any subsystem. The effectiveness of the auxiliary hydraulic pump depends upon the nature of the hydraulic failure. The auxiliary hydraulic pump switch is located on the inclined panel of the right-hand control shelf. A microswitch in the radio compartment permits operation of the pump for closing or opening the canopy from outside the cockpit.

Note

The ailavator boost control handle must be in the "OFF" position when the auxiliary hydraulic pump is used.

1-60. Five subsystems may be operated in an emergency by compressed air. These systems are: the landing gear (paragraph 3-34), the main wheel brakes (paragraph 3-37), the arresting gear (paragraph 3-42), the wing and fuselage speed brakes (paragraph 3-45), and the canopy (paragraph 3-39). The canopy may also be operated manually in an emergency (paragraph 1-83). The brakes are still operative in the event of hydraulic failure (paragraphs 1-49 and 3-38).

1-61. Two warning lights on the instrument panel will indicate a failure of one or both of the engine-driven hydraulic pumps. The lights come on when pump output pressure is reduced to 850 (±50) psi. If ailavator boost pressure drops to 875 psi, because of low engine rpm during single-engine operation or some other cause, utility system shut-off valves will operate, shutting off all hydraulic subsystems except the wing-fold, the main wheel brakes, and the gun charger circuits. If the boost pressure builds up again, the shut-off valves will open, making pressure available to the subsystems.

1-62. HYDRAULIC RESERVOIR. The reservoir consists essentially of a hemispherical aluminum alloy tank with a weighted flexible suction hose which tends to stay immersed in the fluid during maneuvers and inverted flight. The tank is mounted between and above the engines. The total volume of the reservoir is approximately 8.4 gallons. Accessibility to the filler neck and the sight gage is obtained through a door in the top of the fuselage. The reservoir is pressurized at 10 to 12 psi above atmospheric pressure through a line from the compressor section of the engine. A pressure reducing valve and a check relief valve prevent excessive pressures from building up in the reservoir.

1-63. ELECTRICAL SYSTEM.

1-64. GENERAL. The electrical system is a direct-current 28-volt 1-wire system. The negative side of the circuit is carried through the electrically bonded structure of the airplane. Electric power is provided by any one of three sources: a 24-volt 11-ampere-hour battery; two 30-volt 200-ampere-hour generators; or an outside source through the external power receptacle. Voltage regulators maintain constant generator voltage regardless of electrical loads. Differential-type reverse current cut-out relays connect the generators to the electrical system when generator voltage exceeds that of the battery by a given amount, and they disconnect the generators from the system at a reverse current of 15 to 25 amperes flowing from the battery. Thus the battery is kept from feeding power to the generators and running them as motors. All circuits are protected by thermal-type push-pull circuit breakers, automatic-reset circuit breakers, or fuses.

1-65. Two inverters provide power for the equipment and instruments requiring a-c power. Under normal conditions, all a-c power loads will be carried by the main inverter (E-1737-1) located in the nose cone. In the event of a main inverter failure, the stand-by inverter (E-1617-1), located in the center section wing, will automatically take over the a-c power load with the exception of AN/APG-30, AN/APX-6, yaw-rate, and pitch damper operation. The main inverter circuit breaker control switch, located on the right-hand

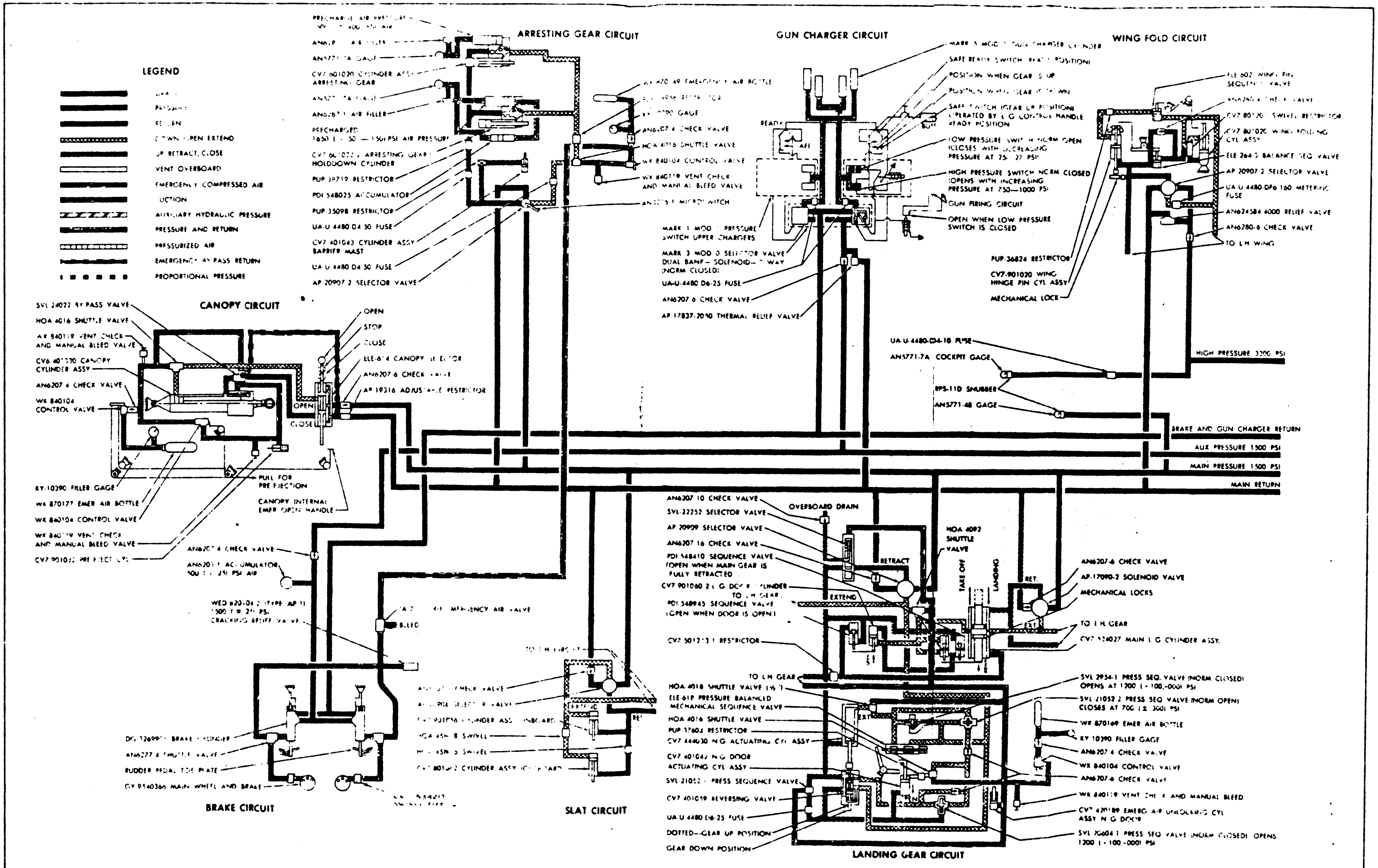


Figure 1-22 (Sheet 1 of 2). Hydraulic System

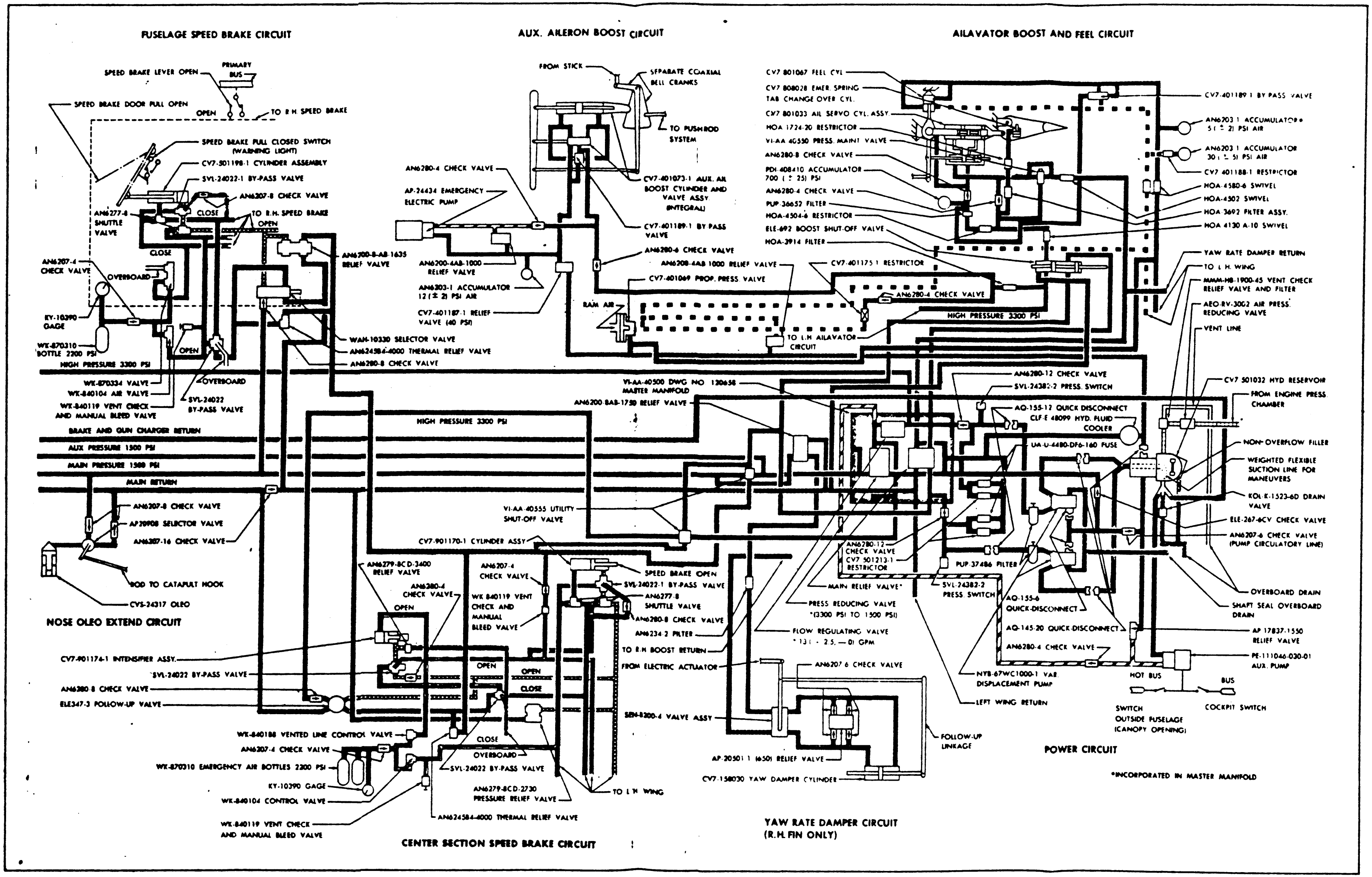


Figure 1-22 (Sheet 2 of 2). Hydraulic System

longeron, has two positions, "RESET" and "TRIP." This switch must be in "RESET" and the adjacent (INVERTER TRANSFER) switch in "MAIN" if main inverter operation is required. A three-position switch (INVERTER TRANSFER), normally guarded in the "MAIN" position, and a warning light mounted on the right-hand longeron immediately aft of the main inverter circuit breaker control switch are provided: (1) to warn the pilot of stand-by inverter transfer by the lighting of the warning light; (2) to permit the pilot to turn off the warning light by setting the switch in the "STAND-BY" position; and (3) to permit the pilot to energize the main inverter circuit (provided no electrical failure in the main inverter circuit has occurred) if operation has been on stand-by inverter (see Note below). The lighting of the warning light does not necessarily indicate stand-by inverter operation; it indicates that stand-by inverter transfer has been made. The pilot should check the a-c instruments, such as the fuel quantity and or the gyro-horizon indicator, for proper operation. If the instruments are not operating, set the switch in "STAND-BY."

Note

To return to main inverter operation after use of stand-by inverter, place the RESET-TRIP switch in "RESET." Then operate the INVERTER TRANSFER switch from "STAND-BY" to "AUTO TRANS OFF" to "MAIN," pausing momentarily at "AUTO TRANS OFF." The warning light should go off when the main inverter takes over the a-c loads.

1–66. The power control switch, a voltammeter, and two generator warning lights are located on the inclined panel at the forward end of the right-hand control shelf. Should one generator fail, the remaining generator will provide electrical power for the normal operation of the electrical equipment. The electrical system is a 4-bus system which provides for automatic removal of nonessential electrical loads in event of failure of both generators in flight. Electrical loads have been divided among the four buses as follows:

(1) *Primary Bus.* This bus carries all items considered necessary for safety of flight and remains connected to the battery if the generators fail.

(2) *Secondary Bus.* This bus carries items considered secondary in importance (such as exterior lights, radio, gun charging, cockpit pressurizing and air-conditioning, and auxiliary hydraulic pump circuits) and is automatically disconnected from the battery upon failure of the generators when the landing gear control handle is in the "UP" position. The pilot may reconnect this bus to the battery in flight by placing the power control switch in the "BATTERY ONLY" position. When the landing gear control handle is in any position other than the "UP" position, the secondary bus remains connected to the battery, regardless of generator output.

(3) *Monitored Bus.* This bus carries nonessential items (such as radio altimeter, gun camera heat, and gunsight radar range control circuits) and is also automatically disconnected from the battery upon failure of the generators. There is no way in which this bus can be reconnected to the battery in flight.

(4) *Battery Bus.* This bus carries items (such as the IFF radio destructor and the auxiliary hydraulic pump microswitch for opening and closing the canopy from outside the airplane) which are always hot circuits and are not affected by the position of the power control switch.

1–67. EXTERNAL POWER RECEPTACLES. There are two external power receptacles which are accessible when the small spring-loaded doors located on the left- and right-hand engine access doors are opened. Two sources of external power are required: one for the left-hand power receptacle for engine starting only and one for the right-hand receptacle for ground operation of any electrical equipment other than the engine starters. The power control switch should be in the "OFF" position when external power sources are connected to the power receptacles to prevent draining the airplane battery. External power is necessary for starting the engines and should be used for ground operation of any electrical equipment whenever possible.

1–68. ELECTRICAL AND RADIO CONTROLS.

1–69. RIGHT-HAND CONTROL SHELF. *(See figure 1–6.)* The following electrical and radio controls are located on the right-hand control shelf:

(1) Voltammeter.
(2) Power Control Switch.
(3) Generator Warning Lights.
(4) Pitot Heat Switch.
(5) Circuit Breaker Panel.
(6) Auxiliary Hydraulic Pump Switch.
(7) Cockpit Air-Conditioning and Pressurizing Switches.
(8) Interior and Exterior Light Panel.
(9) Radio Control Panels.
(10) Radio Altimeter Altitude Limit Switch.
(11) Ammeter Test Switch.
(12) Engine Anti-Ice Switch (inoperative).

1–70. LEFT-HAND CONTROL SHELF. *(See figure 1–5.)* The following electrical controls and indicators are located on the left-hand control shelf:

(1) Fuel Cell Pressure Dump Switch.
(2) Engine Master Switches.
(3) Microphone Switch.
(4) Speed Brake Warning Light.
(5) Trim Tab Switches.
(6) Primary and Secondary Fuel System Selector Switches.
(7) Gun Sight Control Panel.
(8) AN/APG-30 Range Radar Control Panel.
(9) Quick-Disconnect Receptacle (connections for pilot's headset, microphone, and heated flying suit).

(10) Circuit Breaker Panel.
(11) Yaw Rate Control Switch.
(12) Pitch Damping Control Switch.
(13) Afterburner Master Switches.
(14) Throttle-actuated Engine and Afterburner Microswitches.

1-71. INSTRUMENT PANEL. *(See figure 1-24.)* The following electrical controls and electrically operated instruments are located on the main instrument panel:

(1) Master Gun Switch and Gun Selector Switches.
(2) Engine Fire Detector Lights and Test Switches.
(3) Radio Altimeter Indicator and Low Limit Warning Light.
(4) Gyro Horizon Indicator.
(5) Radio Compass Indicator.
(6) Tachometer Indicators.
(7) G-2 Compass Indicator.
(8) Turbine Exhaust Temperature Indicator.
(9) Fuel Pressure Indicator.
(10) Oil Pressure Indicator.
(11) Primary and Secondary Fuel Quantity Gages.
(12) Wheel and Slat Position Indicator.
(13) Oil Temperature Indicator.
(14) Gyro Horizon Indicator Warning Light and Control Switch.
(15) G-2 Compass Free Directional Gyro Control Switch.
(16) Fuel Transfer Warning Light.
(17) Emergency Fuel Control Warning Lights.
(18) Engine-driven Hydraulic Pump Warning Lights.
(19) Emergency Fuel Control Switches.
(20) Compartment Temperature Indicator and Switch.
(21) Eyelids Position Indicator Lights.

1-72. VOLTAMMETER. *(See figure 1-23.)* The voltammeter is located on the inclined panel at the forward end of the right-hand control shelf. The instrument indicates the voltage output of one (if only one generator is operating) or both generators and the amperage output of either the left or right generator. The ammeter test switch, located on the right-hand control shelf near the IFF radio control panel, is used to select the generator for which an amperage indication is desired. The voltammeter is connected to the electrical system on the battery side of the reverse current cut-out relays and will indicate generator voltage when engines are running and battery voltage when engines are shut-down. Voltmeter and ammeter test jacks are provided for checking the voltammeter against portable test instruments.

1-73. POWER CONTROL SWITCH. *(See figure 1-23.)* The power control switch, located on the inclined panel at the forward end of the right-hand control shelf, is a combination battery and generator switch. Normally when the switch is placed in the "BATTERY AND GEN" position, both generators and the battery are the source of electrical power; in the "OFF" position, the generators and the battery are disconnected from the electrical system; and in the "BAT ONLY" position, the generators are disconnected from the system and the battery alone is the source of electrical power. "BATTERY AND GEN" is the normal position for operation of all electrical and radio equipment. "BAT ONLY" is an emergency position. The switch is placed in this position in flight to prevent over-charging the battery in case of excessive voltage output from the generators; or in case of low voltage output as indicated by the generator warning lights, to connect the secondary bus to the battery if electrical equipment which derives its power from this bus is needed (paragraph 1-66). The spring-loaded pin on the power control switch serves as a guard and must be displaced before the switch can be placed at "BAT ONLY."

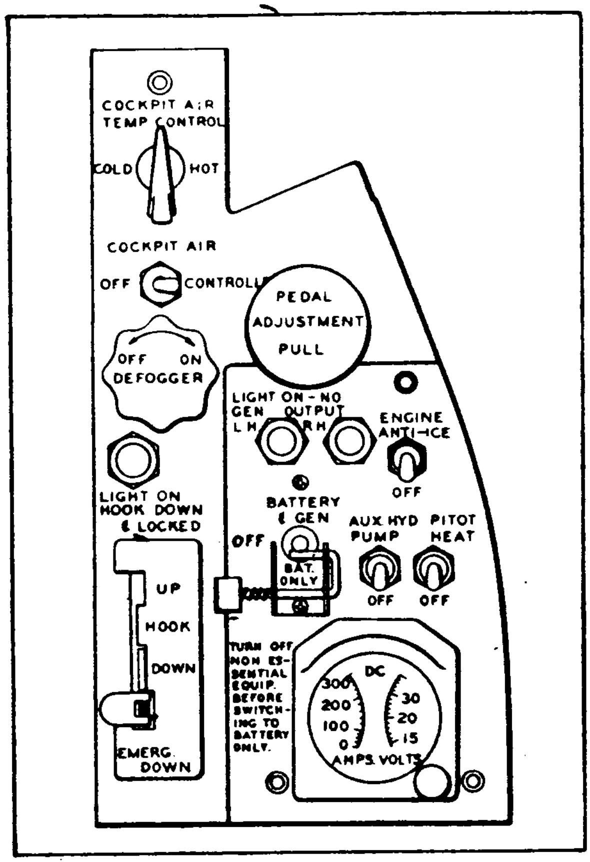


Figure 1-23. Right-Hand Vertical Panel

Note

When the power control switch is in the emergency "BAT ONLY" position, all circuits not absolutely essential should be turned off, either by means of the individual toggle switches or the push-pull circuit breakers, to conserve battery power.

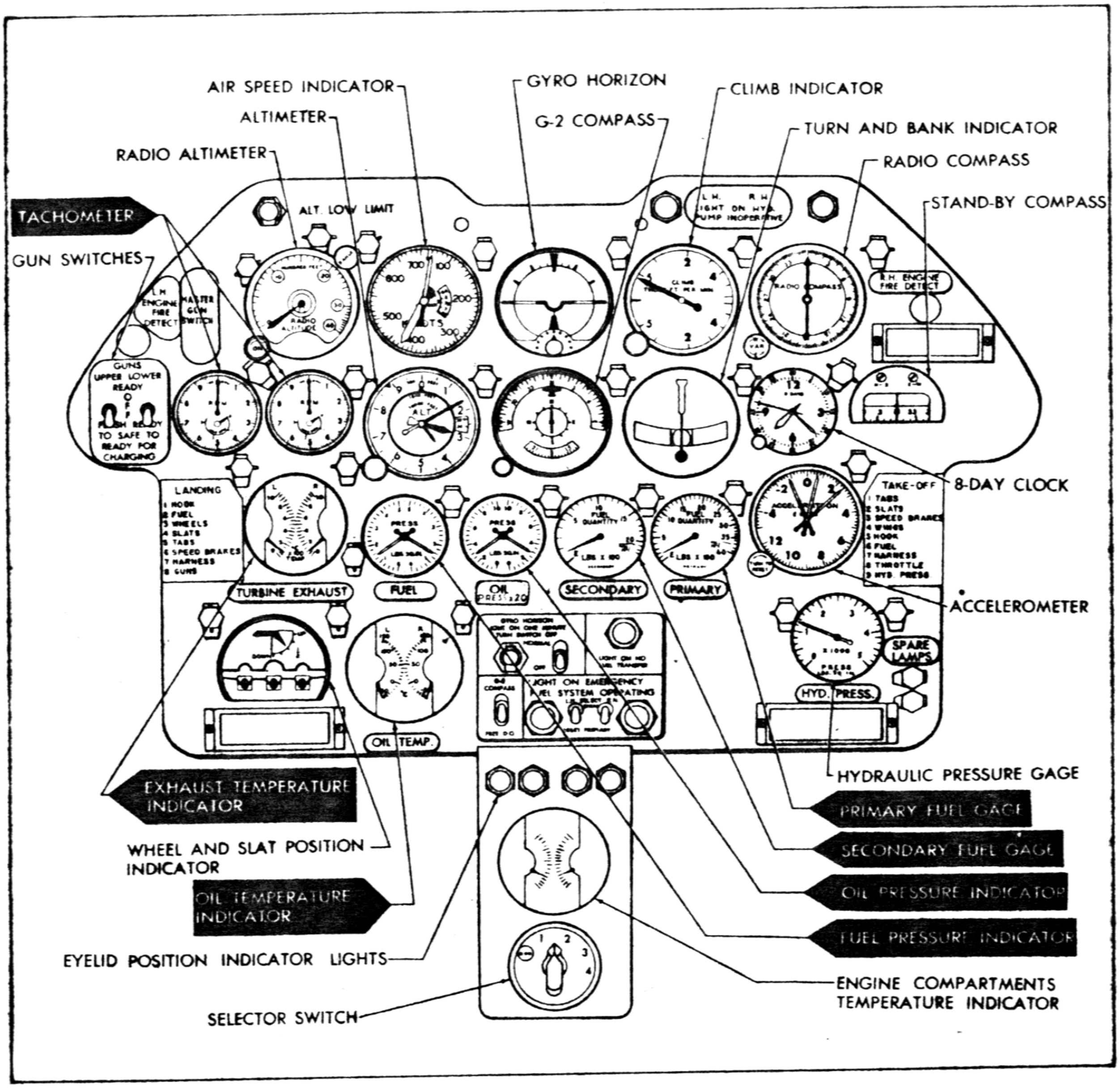


Figure 1-24. Instrument Panel

1-74. INVERTER SWITCHES. *(See figure 1-4.)* Two switches, mounted on the right-hand longeron, are provided for the operation and selection of the a-c inverters. The main inverter circuit breaker control switch is a 2-position toggle switch with "RESET" and "TRIP" positions. The normal position of this switch is "RESET" as this position will, when the inverter transfer switch is in "MAIN" or "AUTO TRANS OFF," energize the main inverter circuit. The "TRIP" position may be used for rendering the main inverter inoperative, thereby setting the stand-by inverter in operation. Regardless of the position of this switch, the stand-by inverter is always ready to take over the a-c power load (except when the inverter transfer switch is in "AUTO TRANS OFF") with the exception of AN/APG-30, AN/APX-6, yaw rate, and pitch damping operation. The inverter transfer switch has three positions, "MAIN," "AUTO TRANS OFF," and "STAND-BY." The switch is normally guarded in the "MAIN" position. The "STAND-BY" position is used to turn off the inverter transfer warning light, and it should be placed in this position if operation on stand-by inverter is continuous. This switch may be used for voluntary transfer back to the

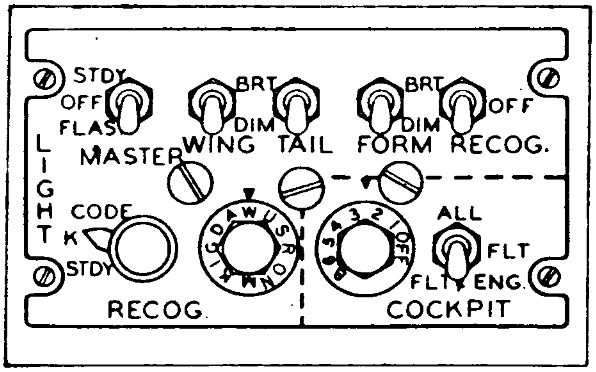


Figure 1-25. Interior and Exterior Lights Panel

main inverter (providing there has been no failure in the main inverter circuit) by first placing the RESET-TRIP switch in "RESET" and then operating from "STAND-BY," to "AUTO TRANS OFF," to "MAIN," pausing momentarily in "AUTO TRANS OFF."

1-75. PITOT HEAT SWITCH. *(See figure 1-23.)* The pitot heat switch is a 2-position toggle switch located on the inclined panel forward of the right-hand control shelf. When flying in freezing weather conditions, this switch should be turned "ON" to prevent icing of the pitot tube.

1-76. AUXILIARY HYDRAULIC PUMP SWITCH. *(See figure 1-23.)* The auxiliary hydraulic pump switch, located on the inclined panel forward of the right-hand control shelf, is a 2-position momentary toggle switch. When held in the "ON" position, this switch turns on the auxiliary hydraulic pump which may be used for ground checking the hydraulic system. (Refer to paragraph 1-59 for additional information on the use of the auxiliary hydraulic pump.)

Note

The ailavator boost control lever should be "OFF" when using the auxiliary hydraulic pump.

1-77. COCKPIT AIR-CONDITIONING AND PRESSURIZING SWITCHES. *(See figure 1-23.)* There are two cockpit air-conditioning and pressurizing switches and a temperature control rheostat. The air-conditioning and pressurizing switch on the inclined panel forward of the right-hand control shelf must be in the "CONTROLLED" position for the operation of the air-conditioning and pressurizing system. The cockpit air switch, located on the side of the right-hand control shelf, has four positions: "AUTOMATIC," "OFF," momentary "HOT," and momentary "COLD" for cockpit temperature control. The rheostat, located above the air-conditioning and pressurizing switch on the inclined panel, is used to adjust the cockpit temperature to a desired setting when the cockpit air switch is in the "AUTOMATIC" position. (Refer to paragraphs 4-48 through 4-56 for additional information on the operation of the cockpit air-conditioning and pressurizing system.)

1-78. EXTERIOR LIGHTS CONTROL PANEL. The exterior lights control panel is on the right-hand control shelf. It has controls for all exterior lights except the approach light which is operated automatically by the extension of the landing gear and arresting hook when the master switch is in the "STEADY" position. The control panel is equipped with a 3-position toggle switch which is the master switch. This switch has the following positions: "STEADY," "OFF," and "FLASH." There are four exterior light toggle switches for controlling the operation of "WING," "TAIL," "FORMATION," and "RECOGNITION" lights. Each of these four toggle switches has three positions: "BRT," "OFF," and "DIM." The recogni-

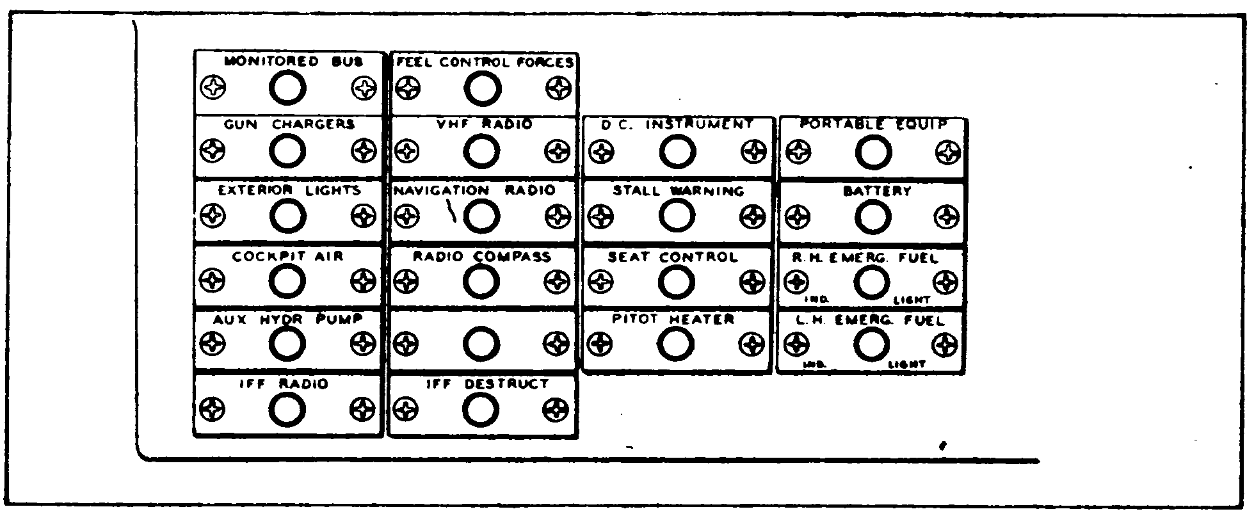


Figure 1-26. Right-Hand Circuit Breaker Panel

tion code switch, located aft of the master light switch, is a 3-position combination selector type switch and code key having the following positions: "STEADY," "KEY," and "CODE." When this switch is placed in the "KEY" position, the switch knob may be used as a coding key. A light on the control panel flashes the code as it is being keyed. A code selector switch is also provided for selecting the predetermined code.

1–79. INSTRUMENT AND COCKPIT LIGHTS CONTROL PANEL. *(See figure 1–25.)* The instrument and cockpit lights control panel, or the interior lights control panel, is on the right-hand control shelf. The interior lights are controlled by a 3-position toggle switch and a rheostat dimmer unit. The following positions may be selected by means of the toggle switch: "ALL," which illuminates all instrument and cockpit lights, "FLIGHT AND ENGINE," which illuminates only flight and engine instruments, and "FLIGHT," which illuminates only the flight instruments. The rheostat dimmer unit varies the brilliance from "OFF" to "BRIGHT." There are also individual switches on each cockpit light.

1–80. CIRCUIT BREAKER PANELS. The electrical circuits are protected by automatic-reset circuit breakers, push-pull type circuit breakers, or fuses. The majority of the push-pull type circuit breakers are located on the circuit breaker panels on the sides of the left- and right-hand control shelves for control by the pilot. The remainder of the push-pull type circuit breakers are located in the nose wheel well and the radio compartment and are not accessible in flight. For operation of a particular circuit, the circuit breaker button is pushed in. If an overload occurs in the circuit, the breaker becomes heated and thermal expansion causes the button to pop out and open the circuit. The circuit may be closed again by resetting the button. If the button continues to pop out, however, this indicates the overload on that circuit is permanent and the circuit should remain inoperative until it can be checked and the necessary repairs made.

1–81. MISCELLANEOUS CONTROLS.

1–82. CANOPY CONTROLS.

1–83. GENERAL. *(See figures 1–28 and 2–1.)* For normal operation the canopy is opened and closed hydraulically. For emergency operation there are two systems, a mechanical system and a compressed air system. From within the cockpit, normal (hydraulic) operation is controlled by a handle located on the forward left-hand side of the cockpit. Refer to paragraph 1–85 for information on hydraulic operation of the canopy from outside the cockpit. The emergency (compressed air) canopy control is a T-shaped handle located on the left-hand canopy track above the normal canopy control. The emergency mechanical (manual) operation from within the cockpit is controlled by a handle located on the left-hand side of the canopy forward former. For emergency opening of the canopy from the outside, a handle protrudes through the canopy fairing. Pulling of this handle will disconnect the canopy from the hydraulic strut, allowing the canopy to be moved aft manually. In the fully opened position, the left-hand forward roller engages a stop in the track. The stop will prevent the canopy from closing in the event of a hard landing. The stop is automatically released when the canopy is operated hydraulically, but must be released manually if the canopy is operated manually, the release handle being part of the stop in the left-hand track. (For emergency operation of the canopy, refer to paragraph 3–41.)

1–84. NORMAL CANOPY CONTROL. The canopy control handle is located on the left-hand side of the cockpit, just above the throttle quadrant. It has three positions: "OPEN," "STOP," and "CLOSE." To operate the canopy normally from within the cockpit, the control handle is moved to either "OPEN" or "CLOSE." The canopy is stopped in intermediate positions by placing the control handle in "STOP." With the control handle in "STOP," the canopy is hydraulically locked in position. With the canopy fully opened or closed and the control handle in the corresponding position, hydraulic pressure holds the canopy in place.

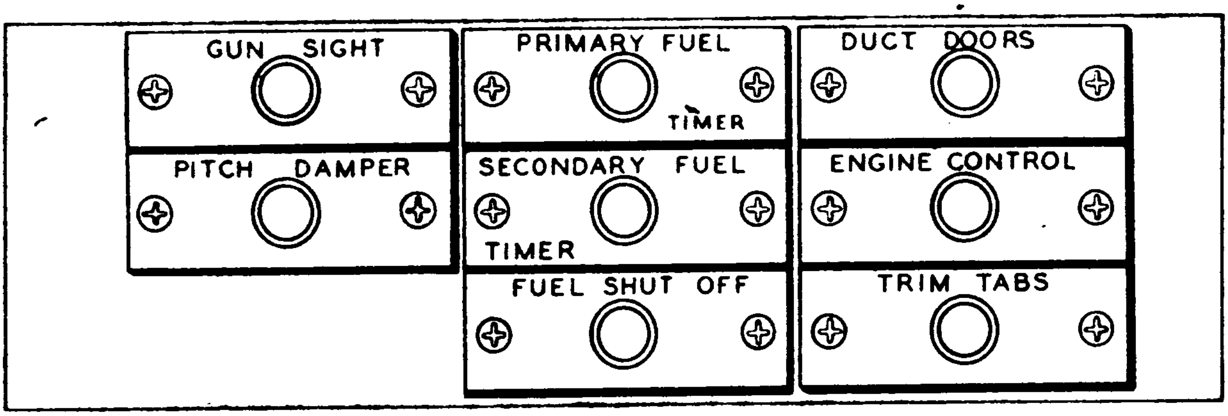


Figure 1–27. Left-Hand Circuit Breaker Panel

WARNING

If the pilot is above normal flight or gun sight position, as determined by the eye-level mirror (paragraph 1-97), it is mandatory that he lower himself to the proper position prior to operating the canopy.

Note

Normal operation of the canopy is restricted to 260 knots.

1-85. EXTERNAL CANOPY CONTROL. *(See figure 2-1.)* The canopy is opened hydraulically from the outside by means of the external release handle on the left side of the fuselage just below the canopy and the auxiliary hydraulic pump microswitch located in the radio compartment. When the external release handle is pulled out, the canopy control handle in the cockpit is moved into "OPEN." The canopy may then be opened by depressing the hydraulic pump microswitch until the desired open position is obtained. To close the canopy hydraulically from the outside, hydraulic pressure must be dissipated by moving the canopy control handle from "OPEN" to "CLOSE" until the hydraulic gage reads zero, and the control handle must be left in "CLOSE" when leaving the cockpit. The auxiliary hydraulic pump microswitch may then be operated to close the canopy.

WARNING

Under no conditions shall personnel outside the cockpit operate the canopy hydraulically until all personnel are clear of the canopy and tracks. Serious injury may result if this warning is not observed.

Note

The ailavator boost control handle must be in the "OFF" position before the canopy can be actuated by means of the auxiliary hydraulic pump.

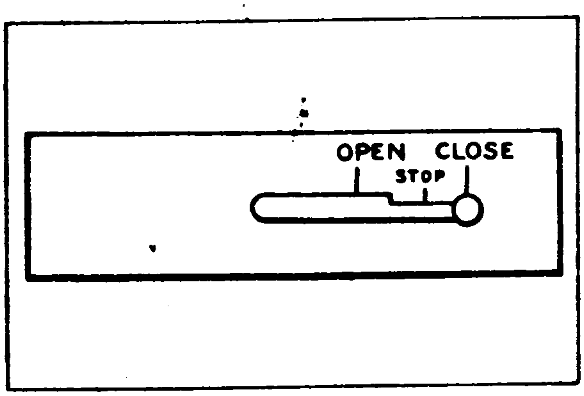


Figure 1-28. Canopy Control

1-86. MANUAL CANOPY CONTROL. The canopy may be opened manually from within the cockpit in an emergency by means of the internal release handles on the forward side of the canopy. The handle on the left-hand side of the canopy releases the canopy from the actuating cylinder to permit the canopy to be opened from within the cockpit. The strut disconnect handle, located on the aft end of the canopy, also disconnects the cylinder from the canopy, thus providing emergency access to the cockpit from outside the airplane.

1-87. EMERGENCY CANOPY CONTROL. A compressed air system is installed for opening the canopy in case of hydraulic system failure. Pulling of the T-shaped control handle on the left-hand track will release a charge of compressed air for emergency opening of the canopy. Access to the compressed air bottle is obtained by opening the nose cone door. The gage is in the radio compartment and should be checked by the pilot before flight to be sure the bottle is charged according to instructions on the name plate. The emergency system may be used at any speed.

Note

The canopy is jettisoned by operation of the seat pre-ejection lever (paragraphs 3-23 through 3-26.)

1-88. MISCELLANEOUS EQUIPMENT.

1-89. PILOT'S SEAT. *(See figure 3-3.)* An ejection-type pilot's seat is used in place of the conventional bucket seat. The ejection seat, which includes a bucket seat similar to the conventional type, is used in high speed aircraft so that the pilot may eject the seat and himself from the airplane in an emergency. For normal operation, the bucket seat and headrest ride in tracks mounted on the seat chassis. The seat has a vertical adjustment over a 7-inch range. The seat is adjusted by means of the 2-position ("UP" and "DOWN") momentary toggle switch mounted on the headrest adjusting lever, which is located on the lower right-hand side of the seat. The headrest is raised to its maximum height when the headrest adjusting lever is moved outboard and aft. This action disengages the detent pins from the telescopic tubes, permitting the spring-loaded headrest to assume the full up position. As long as the headrest adjusting lever is held in the aft position, the headrest remains stationary. This allows the pilot to adjust the height of the seat to the desired relative position of the headrest by raising or lowering the seat by means of the momentary toggle switch. With the headrest adjustment lever in the forward position, the detent pins become engaged in the telescopic tubes so that the pilot can raise or lower the seat and headrest as a unit to the desired height by using the momentary switch. A limit switch at the top of the headrest breaks the circuit to the seat actuators when the headrest is in the full up position and the headrest adjusting handle is in the forward position, thus protecting the actuators. If additional seat height is desired, the headrest adjusting handle must be moved aft to override the limit switch which also releases the detent pins in the headrest telescopic tubes. Refer to paragraphs 3-23 through 3-26 for information on emergency operation of the ejection seat.

1-90. SAFETY BELT. The safety belt is fastened over the pilot's lap by a quick-release buckle. The forward ends of the shoulder harness are also fastened to this buckle and are released with the safety belt when the quick-release buckle is opened. Either belt may be adjusted by using the adjustment buckles.

1-91. SHOULDER HARNESS INERTIA REEL. *(See figure 3-3.)* The shoulder harness passes from the quick-release buckle over the cross-bar on the headrest and behind the seat where it attaches to the inertia reel. In normal operation the locked and unlocked positions are controlled by a handle on the lower left-hand side of the seat. Press down and forward for the "LOCKED POSITION," and down and aft for the "UNLOCKED" position. With the handle in the "LOCKED" position, further extension of the shoulder harness is prevented. In the "UNLOCKED" position, the shoulder harness will extend further only if a relatively light pressure is exerted on the shoulder harness. The reel will lock automatically if the pilot is forced by inertia against the harness, as in the case of sudden deceleration of the airplane. The automatic locking occurs when the reel, suspended by two light springs, is forced by inertia against the gear teeth on the housing. The inertia reel also becomes locked automatically in an emergency when the seat pre-ejection lever is operated.

1-92. RELIEF TUBE. The relief tube installation consists of a horn, reservoir, and rubber tubing. The horn is stowed on the control column.

1-93. PILOT'S CATAPULT HANDGRIP. *(See figure 1-4.)* The pilot's catapult handgrip is located on the left-hand side panel at approximately fuselage station 41.45. When not in use, the handgrip folds flat against the side panel. To use the handgrip, pull inboard and hold in conjunction with the throttle control. This enables the pilot to hold the throttle steady during a catapult take-off.

1-94. MAP CASE. *(See figure 1-6.)* The map case is located at the aft end of the right-hand control shelf. The case is hinged at the lower end and may be tilted forward by lifting the cover which is hinged to the seat bulkhead.

1-95. CHECK-OFF LISTS. *(See figure 1-24.)* The check-off lists are provided on the main instrument panel. The landing list is located on the left-hand side and the take-off list on the right-hand side. The check-off lists are illuminated only when the interior lights selector switch is in the "ALL INTERIOR LIGHTS" position.

1-96. REAR-VIEW MIRRORS. Two rear-view mirrors are attached to the aft face of the forward canopy former. The mirrors have a demagnification factor of 2½ to 1 to provide a greater field of view. The mirrors may be adjusted to the desired position by loosening the two attaching bolts.

1-97. EYE-LEVEL MIRROR. *(See figure 1-4.)* To provide the pilot with a visible means of determining correct seat height, a mirror has been installed on the left-hand frame of the bullet-resistant glass. The horizontal centerline of the mirror is at waterline 131 (normal flight and gun sight position).

1-98. OPERATIONAL EQUIPMENT.

1-99. ARMAMENT. *(Refer to paragraph 4-1.)*

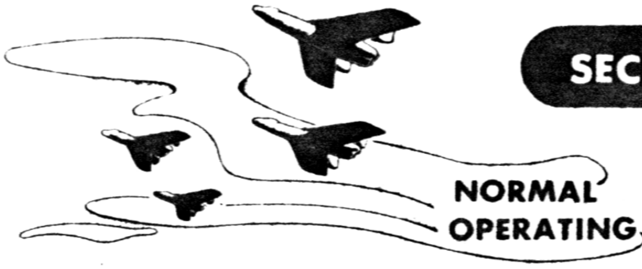
1-100. OXYGEN. *(Refer to paragraph 4-15.)*

1-101. RADIO COMMUNICATION, NAVIGATION, RANGE RADAR, AND IFF EQUIPMENT. *(Refer to paragraph 4-24.)*

1-102. AIR-CONDITIONING AND PRESSURIZING. *(Refer to paragraph 4-47.)*

1-103. ANTI-BLACKOUT EQUIPMENT. *(Refer to paragraph 4-58.)*

1-104. QUICK-DISCONNECT UNIT. *(Refer to paragraph 4-60.)*



SECTION II

NORMAL OPERATING INSTRUCTIONS

2-1. BEFORE ENTERING COCKPIT.

Flight Limitations

WARNING

Inverted flight is not recommended. No provision has been made in the fuel system for flow during inverted flight. Due to oil system limitations in the engine, inverted flight is limited to 30 seconds. The time limit for zero "g" is 10 seconds.

ITEM	OPERATION or CONDITION	RESTRICTION
Airplane	Spins and snap rolls	No intentional spins or snap rolls permitted
Airplane	Rolling	Refer to paragraph 2-47
Airplane	Symmetrical flight	With slats retracted, 6g to -1.5g for weight of 19,773 lb. With slats extended, +2g to 0g for weight of 22,000 lb.
Slats	Normal operation, retraction or extension	150 knots
Landing Gear	Normal operation, retraction or extension	175 knots
Landing Gear	Emergency operation	175 knots

Note

Extend gear before extending slats. (Refer to paragraph 2-43.)

ITEM	OPERATION or CONDITION	RESTRICTION
Canopy	Normal operation	260 knots
	Emergency operation	No speed restriction
Speed Brakes		No speed restriction
Arresting Hook	Extension or retraction	175 knots
Ailerons		Refer to paragraph 2-47
Ailavator Boost	Boost-off flight	Normal and accelerated stalls not recommended

Catapult take-offs and arrested landings are not permitted unless authorized by the Bureau of Aeronautics.

THESE LIMITATIONS AND RESTRICTIONS ARE SUBJECT TO CHANGE, AND LATEST SERVICE DIRECTIVES AND ORDERS MUST BE CONSULTED.

2-2. INITIAL GROSS WEIGHT AND LOADING DATA CHECK. Check gross weight and center-of-gravity location for take-off and anticipated loading for landing. Loading data are furnished in "Handbook of Weight and Balance Data" AN 01-1B-40.

2-3. With the airplane loaded for take-off, the following center-of-gravity locations are recommended:

Gear down (take-off position), ammunition in: 16.2 percent MAC.

Gear down, ammunition out: 17.4 percent MAC.

The above recommendations apply for fuel loadings with both the *primary* and *secondary* fuel systems *full* or with the *primary* system *full* and *secondary* system *empty* and will result in satisfactory loading as the ammunition and fuel are expended.

CAUTION

The airplane is to be released for flight only with the *primary* and *secondary* fuel systems *full* or with the *primary* system *full* and the *secondary* system *empty*. Partial filling of either system will disturb the rate at which fuel flows from the fuel cells and will adversely affect the balance of the airplane.

2-4. AIRPLANE PREFLIGHT CHECK. Before entering the airplane, make certain it is ready for flight. Observe where it stands and whether or not there are any puddles of fuel, oil, or hydraulic fluid beneath it that indicate a possible leak in one of those systems. Then make the following preflight check:

a. Pitot tube cover removed.

b. Dust covers and screens removed from engine intake ducts and intake ducts free of loose objects.

c. All removable cowling and access doors fastened.

d. Check personally, or have checked by a reliable service crew member, that proper quantities of fuel, lubricating oil and hydraulic oil are aboard and that all tank caps are secure.

e. Check charges in emergency air bottles (landing gear, arresting gear, wing speed brakes, fuselage speed brakes, and canopy).

f. Control batten removed.

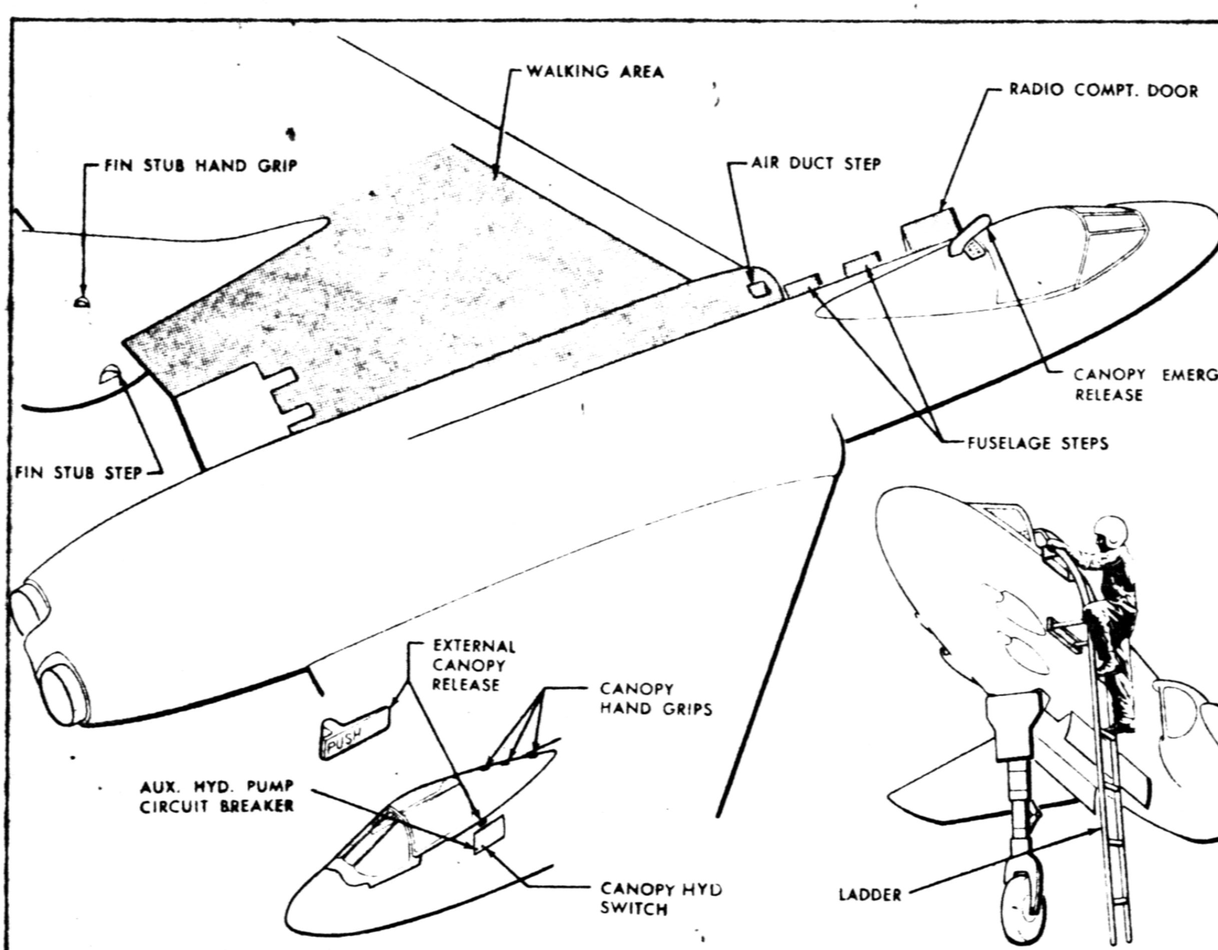


Figure 2-1. Entrance to Airplane

g. See that the airplane is parked where the jet blast will do no harm and where no loose objects can be sucked into the inlet air ducts.

h. Wheel chocks in place.

2-5. ENTRANCE TO CLOSED AIRPLANE. Entrance to a closed airplane is made from the left-hand side. The canopy may be opened hydraulically by actuating the external canopy release and then depressing the auxiliary hydraulic pump microswitch in the left-hand radio compartment. The switch must be held in until the desired opening of the canopy is obtained. If the canopy is opened, the pilot may enter the cockpit by using a collapsible ladder installed as shown in figure 2-1.

WARNING

Under no conditions shall personnel outside the cockpit operate the canopy hydraulically until all personnel are clear of the canopy and tracks. Serious injury may result if this warning is not observed.

2-6. ON ENTERING AIRPLANE.

Note

A pilot's check-off list is provided in the cockpit.

2-7. STANDARD CHECK FOR ALL FLIGHTS. Jet engines require no warm-up, but fuel consumption is high at all times. The following check should, therefore, be made before starting the engine:

a. Adjust rudder pedals and seat height.

b. Adjust safety belt and shoulder harness. After adjustment, harness can be unlocked to facilitate movement in cockpit.

c. Check controls for freedom and direction.

d. Primary fuel selector switch—"BOTH OFF."

e. Throttles—"OFF" position.

f. Armament switches—"SAFE." Master armament switch—"OFF."

g. Power control switch—"OFF."

h. External power sources connected (starter and airplane).

i. Test operation of gun sight.

j. Check security of attachment of quick-disconnect adapter to receptacle on left-hand control shelf.

k. Test operation of oxygen system.

l. Check altimeter.

m. Inverter circuit breaker control switch — "RESET."

n. Uncage gyro instruments.

o. Check 8-day clock.

p. Check fuel quantity gages.

q. Arresting hook — "UP."

r. Check radio operation.

s. Check fire detection lights.

t. Wing fold — control handle in "WING HINGE PIN LOCKED," and warning flag retracted.

2-8. NIGHT FLIGHT CHECK LIST. In addition to the standard check, before night flights light switches on the interior and exterior lights control panel should be checked as follows:

a. Check cockpit and instrument panel lights with the selector toggle switch. Check rheostat.

b. Check formation, section, wing, and tail running lights.

Note

When operating in combat areas, the exterior lights to be used in flight can be selected before take-off, and turned on with the "MASTER EXTERIOR LIGHT SWITCH" when needed.

2-9. FUEL SYSTEM.

2-10. MANAGEMENT. *(See figure 1-16.)* Under normal conditions, the fuel system starts to operate when an engine master switch is turned on and the primary selector switch is turned to the "RIGHT ON," "BOTH ON," or "LEFT ON" position. The secondary system switch is automatically placed in the "ON" position when the primary selector switch is turned to the "OFF" position. During starts, ground runs, take-offs, flights, and landings, the selection of secondary fuel is at the pilot's discretion; however, it is desirable to use secondary fuel as early as possible (see Warning in paragraph 1-29). When the secondary system switch is in the "ON" position, fuel is transferred from the secondary system into the primary system. When the secondary fuel system is empty, the NO FUEL TRANSFER light comes on, and the primary fuel system automatically becomes operative. The light may be turned off by placing the secondary fuel selector switch "OFF." This position will also stop the operation of the secondary fuel system submerged transfer pumps. Intermittent burning of the NO FUEL TRANSFER light may indicate failure of a submerged transfer pump and failure of an electric motor-driven timer. Some intermittent burning may be expected when the transfer fuel cells are nearly empty, as the transfer cells are not likely to empty at exactly the same time. The pilot should check the secondary fuel quantity gage when the NO FUEL TRANSFER light comes on. If the gage indicates a small amount of secondary fuel remaining and the airplane is in a climbing or diving attitude, it should be brought to a level flight attitude in order to check actual fuel quantity. When the light burns steadily, the secondary system switch should be placed in "OFF." If the gage indicates a substantial amount of secondary fuel remaining, and the above circumstances occur, the secondary system switch should be placed in the "OFF" position. The fuel system automatically supplies fuel from the primary cells and secondary cells for the operation of engines and afterburners, in such proportions that excessive center-of-gravity movement during flight is prevented. No fuel system provisions are incorporated for inverted flight.

2-11. FUEL TANK SELECTION. Fuel tank selection is limited to selection of secondary fuel transfer only.

2-12. FUEL CELL PRESSURIZING. Potential high altitude boiling of fuel and resultant fuel loss are minimized by pressurizing the fuel cells. An automatic check relief valve in the vent lines remains open under 18,000 feet, and closed above, so that the cells pressurize themselves as the fuel vaporizes. The valve releases at a pressure of 2½ psi.

2-13. FUEL CELL PRESSURE RELEASE. The fuel cell pressure release switch is located on the left-hand control shelf immediately forward of the throttle friction control. It is a 2-position toggle switch, the positions being "NORMAL" and "COMBAT." When the switch is placed in "COMBAT," the tanks are vented to the atmosphere, minimizing the damage which might occur to the self-sealing cells under gunfire.

2-14. STARTING ENGINES.

WARNING

Prior to starting engines be sure that the brakes are set and or that the wheels are chocked, that the air duct covers are removed, and that, prior to flight operation, the air duct screens are removed. All personnel are to be clear of the intake ducts and jet exhaust.

2-15. PROCEDURE. The following procedure may be used for either right or left engine starting.

Note

No attempt should be made to start the engines on the ground at temperatures below −20 F without preheating the engine oil.

a. Throttle — "OFF."

b. Power control switch — "OFF."

c. External power connected (starter and airplane).

d. Inverter circuit breaker control switch — "RESET."

Note

The inverter circuit breaker control switch must be placed in "RESET" immediately after connecting external power. If external power has been connected and the switch has not been placed in "RESET" immediately, the stand-by transfer warning light will be lit. To switch over to the main inverter the pilot must first set the inverter circuit breaker control switch in "RESET," and then cycle the guarded transfer switch from "MAIN" to "STAND-BY" to "MAIN," pausing momentarily at the center position "AUTO TRANS OFF." If the warning light remains on after cycling the guarded transfer switch, a wait of approximately 30 seconds must be made to allow the thermal element to cool prior to cycling the switch again.

e. Engine master switch for engine to be started — "ON."

f. Primary fuel selector switch for engine to be started — "RIGHT ON," or "LEFT ON" position.

g. Move throttle control lever to "CRANK" and hold until tachometer indicates engine acceleration of 8 to 12 percent rpm.

Note

Once the "CRANK" microswitch is closed, the starter continues to crank until the engine starts. With proper initial throttle setting, the engine reaches full cranking speed (8 to 12 percent rpm) in approximately 15 seconds. After combustion occurs and the engine accelerates above cranking speed, a drop in required amperage for starter operation actuates an undercurrent relay and disengages the starter.

h. Move throttle control lever to "EMERG IGNITE," then allow lever to move to its approximate "IDLE" position (40 percent rpm).

Note

When the "EMERG IGNITE" microswitch is closed by placing the throttle control lever in "EMERG IGNITE," the ignition circuit for the engine to be started is energized and remains energized for approximately 30 seconds. Upon contacting the "EMERG IGNITE" microswitch, the throttle control lever may be moved to "IDLE." Engine start is indicated by a rise in turbine-out temperature.

i. When engine reaches 36 to 40 percent rpm, as indicated by tachometer, place power control switch in "BATTERY & GEN" position.

j. With engine idling at 36 to 40 percent rpm, a spot check of instrument readings should be made.

(See figure A-5 for maximum engine operation.) The following are typical instrument readings to be expected. (These readings are preliminary data.)

	IDLE	NORMAL	MILITARY
RPM: Primary control	36-40%	94-95%	100-101%
Emergency control	None	94-95%	97-98%
Oil temperature (stabilized)	10°C-50°C	20°C-65°C	10°C-100°C
Turbine-out temperature	Less than 650 C	Refer to engine log book	Refer to engine log book
Fuel manifold pressure	20-40 psi	200-300 psi	250-350 psi
Oil pressure (stabilized)	Above 20 psi	90-130 psi	90-130 psi

Note

If turbine-out temperature exceeds 960 C in the first 5 seconds of a start or 850 C for the balance of acceleration time to "IDLE" rpm shut down the engine. During engine acceleration from idle to 100 percent rpm, the maximum turbine-out temperature should be less than 850 C for the first 5 seconds and less than 760 C for the balance of acceleration time.

2-16. If the starting cycle has been carried through with proper technique and engine fails to start, a second attempt may be made, after investigating cause of failure to start, by observing the following procedure:

Note

It may take approximately 30 seconds of engine cranking after the "CRANK" microswitch is actuated before an engine start. After a total of five consecutive starting attempts, or a total cranking time of 2½ minutes, a wait of 10 minutes is recommended to allow the starter to cool before attempting another start.

a. Throttle—"OFF."

b. Engine master switch—"OFF."

c. Allow starter to stop cranking. After starter stops, starting procedure given in paragraph 2-15 may be attempted. (See note preceding step a above.)

2-17. FALSE START. When the throttle control lever is placed in "OFF" after a false start or during a normal shutdown, the fuel dump valve opens and drains the fuel in the nozzle rings into the manifold dump tank. The manifold dump tank must be drained in accordance with instructions given on the decalcomania on the dump tank. If repeated false starts occur, the dump valve may be stuck open, draining fuel into the dump tank, and starving the fuel nozzles, or the malfunctioning may be in the ignition system.

2-18. FLAMING START. A flaming start is the result of a rich fuel mixture burning aft of the turbine. If a flaming start occurs, the throttle control lever may be advanced and an attempt made to secure normal engine operation. If it becomes necessary to shut down the engine, the fuel selector switch should be placed in "OFF," the throttle should be left in an advanced position, and the engine should be allowed to stop because of lack of fuel. Carbon dioxide may be injected into the intake ducts after the engine rotor has slowed to approximately 6 percent rpm. Above 6 percent rpm, carbon dioxide has little effect upon the burning unless prohibitively large quantities are used.

2-19. AFTERBURNER STARTING.

2-20. PROCEDURE. The following procedure may be used for starting either the left- or right-hand afterburner.

a. With engine operating, place afterburner master switch "ON."

b. Allow 20 to 30 seconds for afterburner fuel control amplifier to warm up.

c. Throttle - "MAXIMUM."

Note

Both afterburners may be started simultaneously.

2-21. FALSE START. If an afterburner false start is experienced, retarding the throttle control lever to "MILITARY" automatically opens the control shelf microswitch which closes the afterburner solenoid fuel shut-off valve, stops the air turbine fuel pump, and switches the submerged fuel booster pumps to low speed. For information on the afterburner starting cycle, refer to paragraph 2-20.

2-22. ELECTRICAL CHECK WITH ENGINES RUNNING. After the engines are running properly, make the following check of the electrical system:

a. Power control switch—"BATTERY AND GEN."

b. Disconnect external power (starter and airplane.)

c. With engines operating above 48 percent rpm and with generator warning lights out, place power control switch in "BAT ONLY" position. If generator warning lights come on, reverse current cut-out is operating normally.

d. Place power control switch in "BATTERY AND GEN" position and check voltage output of generators. Voltage should be between 27.5 and 28.5 volts.

2-23. HYDRAULIC CHECK. The following visual and functional check of the hydraulic system should be made with engines running.

a. Check hydraulic pressure gage on instrument panel. Normal reading should be between 2,500 and 3,000 psi.

b. Slats in "EXTEND" and "RETRACT."

c. Speed brakes in full "OPEN" and "CLOSE."

d. Check ailavator boost by placing boost control—"ON" and displacing stick. Stick displacement should be relatively easy as compared to stick displacement with boost "OFF."

e. Cycle canopy.

2-24. Hydraulic system pressure will fluctuate and then stabilize within a few psi of the normal reading as the individual subsystems are actuated. After the actuation of the last subsystem, pressure should be given a few minutes to stabilize, then checked to see that it is constant.

2-25. RADIO CHECK. Test radio operation according to instructions given in paragraphs 4-25 through 4-46.

2-26. TAXIING INSTRUCTIONS.

Note

Visibility on the ground is excellent so that normally there should be no need for S-turn taxiing, and consequent playing of the jet blast over a wide angle to the rear. Speed should be maintained in short-radius turns as it is difficult to start moving with the nose wheel turned sharply.

a. Cut taxi time to a minimum as ground fuel consumption is relatively high.

b. Steering of airplane while taxiing depends upon adept use of brakes, as there is no propeller blast on rudder surfaces. Let airplane roll free when possible and use brakes sparingly to avoid overheating.

d. Keep electrical load at a minimum to prevent battery discharge.

2-27. TAKE-OFF.

2-28. CHECK PRIOR TO TAKE-OFF. The following should be checked prior to take-off:

a. Shoulder harness and safety belt secure and "LOCKED."

b. Canopy open.

c. Primary fuel selector switch—"BOTH ON."

d. Secondary fuel switch—"ON."

e. Rudder trimmer—neutral.

f. Aileron trim — neutral.

g. Wing slats—"EXTEND."

h. Speed brakes—"CLOSE."

i. Ailavator control boost—"ON."

j. Gun switches—"SAFE."

k. Arresting hook—"UP."

l. Power control switch—"BATTERY AND GEN."

m. Landing gear—"TAKE-OFF."

2-29. TAKE-OFF. At the end of the runway, turn into the take-off position. Allow the airplane to roll ahead a few feet to align the nose wheel. If the afterburners are to be used, hold the brakes, place the afterburner master switches in the "ON" position, allow 20 to 30 seconds for the afterburner fuel control amplifier to warm up and push the throttles into the "MAXIMUM" position. As soon as satisfactory engine operation is noted (fuel and oil pressure, turbine-out and oil temperatures within limits), release the brakes and start the take-off run.

Note

If afterburners fail to start after several seconds, the throttle must be retarded to the "MILITARY" position and then advanced again to the "MAXIMUM" position for another try. This procedure resets the automatic starting cycle.

2-30. MINIMUM RUN TAKE-OFF. The best procedure for a minimum run take-off is to extend the slats and use maximum power.

2-31. CATAPULT TAKE-OFF. The best procedure for a catapult take-off is to extend the slats and the nose wheel oleo (refer to Note below) and use maximum power.

Note

For a catapult take-off, the nose wheel oleo is hydraulically extended when the catapult hook is pulled to the down position.

2-32. ENGINE FAILURE DURING TAKE-OFF. Refer to paragraph 3-7 for the procedure to be followed if the engine fails during take-off.

2-33. AFTER TAKE-OFF. After take-off, perform the following operations:

a. Retract slats.

b. Retract landing gear.

c. Close canopy.

WARNING

Always retract the slats before the landing gear is retracted. If the landing gear is retracted first, the airspeed will build up so fast that slat restrictions may be exceeded. Refer to placard on the left-hand control shelf.

2-34. CLIMB.

2-35. For climb and level flight of airplane and for engine operation, refer to the Take-off, Climb, and Landing Chart, the Flight Operation Instruction Chart, and the Power Plant Chart in Appendix I.

2-36. DURING FLIGHT.

2-37. MILITARY POWER. The limits for military power are 100 percent (+1, -0 percent) rpm. Refer to engine log book for turbine-out temperature limits while operating at military power. Operation at military power is limited to 30 minutes.

Note

A close check of both afterburner and military power time must be kept by the pilot at all times. This is mandatory and required for engine overhaul and inspection purposes.

2-38. NORMAL RATED POWER. The upper operating limit for normal rated power is 94 to 95 percent rpm. All operation above 90 percent limit turbine-out temperature (refer to engine log book) will be logged as military power.

2-39. WEIGHT CHANGE EFFECTS. See the Flight Operations Instructions Chart in Appendix I for the effect of changes in gross weight on cruising, and paragraph 2-50 for the effects of changes in gross weight on stalling speed.

2-40. STABILITY. In all loading conditions, the stability of the airplane is satisfactory. The condition of lowest stability, however, will be found when ammunition has been expended, the airplane is at its lowest gross weight, the slats are extended, and the airspeed is at the speed restricting use of the slats. Extending the slats decreases the stability of the airplane, but extending the landing gear increases the stability; the landing gear should, therefore, be extended prior to, and whenever the slats are to be used.

Note

A placard on the left-hand control shelf reads as follows:

EXTEND LANDING GEAR BEFORE SLATS

RETRACT SLATS BEFORE LANDING GEAR

LANDING GEAR 175 KNOTS MAX

SLATS 150 KNOTS MAX

These instructions must be followed at all times.

2-41. If malfunctioning of the fuel transfer system occurs, the center-of-gravity travel may be adversely affected. A frequent check of the transfer (secondary) fuel gage should be made and intermittent flashing of the fuel transfer warning light should be noted. The transfer system should be turned off if abnormal operation is indicated. To prevent excessive rearward travel of the center of gravity, ammunition should not be expended.

2-42. In the clean condition, a positive static margin will exist with the center of gravity in the most aft position possible if the transfer fuel system is malfunctioning. Longitudinal control of the airplane will appear sensitive in this condition and may be improved by reducing speed as much as possible.

2-43. In the landing condition strict observance of the maximum speed for slat operation and landing gear-slat operation sequence will prevent any difficulty with longitudinal control if an aft center-of-gravity condition exists because of transfer system malfunctioning. Refer to paragraph 2-1, and to the Note in paragraph 2-40.

2-44. MACH EFFECT ON TRIM. The only significant Mach number effects that have been noted in flights up to a Mach number of 0.96 were a gradual increase in rearward stick position with an increasing pull force for trim at 1 g at Mach numbers above 0.88, and a larger stick displacement and pull force for recovery than are required at lower Mach numbers. Throughout the high Mach number region in which this airplane has been flown, no adverse compressibility effects such as buffeting, wing dropping, or lateral-directional oscillations were encountered.

2-45. CRUISING. Consult the Flight Operation Instruction Chart, figure A-7.

2-46. MANEUVERS.

2-47. The restriction upon the use of ailerons in rolling maneuvers because of vertical tail loads is as follows: Full lateral stick throw is permitted in combination with 4.5g to 0g up to speeds of 550 knots EAS or Mach number 0.9, whichever is lower.

Half lateral stick throw is permitted in combination with 4.5g to 1.0g at all speeds. Abrupt aileron reversals should not be performed.

2-48. STALLS.

2-49. GENERAL. The stalling characteristics of the airplane are good. In the landing condition, there will be no actual stall break. The airplane will "mush" in a nose-high attitude. In a clean condition stall, there is a slight nose-right yaw and then a nose-down pitch at the stall. Because there is not enough stall warning in the form of aerodynamic buffet, a stick shaker has been installed to warn the pilot of the approach to a stall. The stick shaker is not presently operative.

CAUTION

Pilots should become thoroughly familiar with the stall characteristics of this airplane, in both the clean and landing conditions. This familiarization should include stalls in both straight and level flight and in turns of various banks in the clean condition as well as stalls in the landing condition using various power settings while simulating approach and landing conditions.

2-50. STALLING SPEEDS. The approximate indicated stalling speeds, in knots, for take-off, combat, and landing loading conditions are given in the following table.

Loading Condition	Weight (Pounds)	Power	Condition	Stalling Speed (Knots)
Take-off[1]	23,900	"OFF" (Idle)	Landing	113
			Clean	127
		"ON" (Normal)	Landing	108
			Clean	123
Combat[2]	21,350	"OFF" (Idle)	Landing	107
			Clean	119
		"ON" (Normal)	Landing	101
			Clean	114
Landing[3]	18,600	"OFF" (Idle)	Landing	99
			Clean	109
		"ON" (Normal)	Landing	92
			Clean	105

[1]Take-off gross weight.
[2]Take-off gross weight less 40% fuel.
[3]Take-off gross weight less 75% fuel; ammunition expended.

2-51. SPINS.

WARNING

No intentional spinning of the airplane is permitted.

2-52. SPIN CHARACTERISTICS. The airplane spins slowly in a steep nose-down attitude with an approximate rotation rate of one turn every six seconds. The spins are oscillatory in nature and are accompanied by heavy buffet. The airplane hesitates in the spin every one-half to one full turn. The altitude loss per turn is approximately 1,500 feet.

2-53. SPIN RECOVERY. The following spin recovery technique is based on flight tests. The rudder should be reversed from full with the spin to neutral or full against the spin and approximately one-half turn later the stick should be moved forward, but maintained laterally neutral. Approximately 5000 feet of altitude is lost in recovering a wing level attitude

2-54. INVERTED SPIN RECOVERY. If an inverted spin should occur, the rudder should be reversed briskly to full against the spin. As the rotation stops, the controls should be neutral, to prevent entry into a normal spin.

2-55. ACROBATICS.

2-55A. No acrobatics shall be performed.

2-56. DIVES.

2-57. DIVE CHECK LIST.

a. Slats—Retracted.

b. Landing Gear—"UP."

c. Speed Brakes—As desired.

d. Canopy—Closed.

Note

The cockpit canopy should be closed before entering high speed dives as it is not designed for such speeds in the open position. With the canopy open, the airplane is restricted to speeds below 260 knots.

2-58. APPROACH AND LANDING.

2-59. CHECK LIST. The following should be checked prior to landing:

a. Landing Gear—Down and locked in "LAND" position.

b. Slats—Extended.

c. Boost—"ON."

d. Speed Brakes—Closed.

e. Shoulder Harness—Locked.

f. Canopy—"OPEN."

g. Armament Switches—"SAFE." Master armament switch—"OFF."

h. Carrier landing only, arresting hook—"DOWN."

WARNING

Do not open canopy unless properly seated.

2-60. CROSS-WIND LANDING. Use the conventional methods of correcting for cross-wind when landing. Once the ground is contacted, the nose gear will tend to cause the airplane to roll straight.

2-61. LANDING RUN. After contact of the main gear, continue to hold the nose gear off the ground until the airplane has slowed to the point where the pressure on the control column becomes heavy, then ease the nose wheel to the ground. In the aft or landing position of the two-position gear, the airplane will tend to pitch forward onto the nose gear when the main gear contacts the ground.

2-62. MINIMUM RUN LANDING. Put the nose gear on the runway as soon as the main gear contacts the ground, and then apply brakes. Care should be taken to avoid overheating the brakes. Use of speed brakes is left to pilot's discretion.

2-63. WAVE-OFF. The ability of most jet-propelled aircraft to take a wave-off is inferior to that of reciprocating engine fighters. Therefore, the decision to take a wave-off in jet-propelled aircraft should be made as soon as possible. However, by using the afterburners, the airplane can take an excellent wave-off. The landing gear must be left down until the slats are retracted or the airspeed restriction on the slats will be exceeded. (Refer to Note in paragraph 2-40.)

2-64. STOPPING ENGINES. The following procedure is recommended for stopping the engines:

a. When using MIL-F-5624 fuel increase engine rpm to 65% rpm for 10 to 30 seconds

b. Rapidly close throttles to "OFF" position.

c. Allow engines to come to rest. Place primary fuel selector switch in "BOTH OFF" position.

Note

It is important that the fuel selector switch be turned off before the power control switch. The fuel selector switch is electrically operated and will not close the fuel shut-off valves unless there is electrical power to the selector switch.

d. Master engine switches—"OFF."

Note

To close the air duct doors, the master engine switch must be "OFF" and the throttle held in "OFF" for approximately 1 minute. The power control switch must be in either "BATTERY AND GEN" or "BAT ONLY."

e. Gun switches—"OFF."

f. Light and radio switches—"OFF."

g. Power control switch—"OFF."

2-65. If burning continues in the combustion chamber after the engine has been shut off, push the throttle outboard, reinitiating the starting cycle and blowing out the fire. This is done without advancing the throttle. An external source of power is required for this operation. As an alternate, but less desirable method, the ground crew should direct carbon dioxide into the engine inlet ducts.

2-66. BEFORE LEAVING COCKPIT.

2-67. Before leaving the cockpit make sure that all switches have been turned off, and have the surface control lock installed. Place oxygen regulator air valve knob in "100% OXYGEN" position to prevent entrance of dust into regulator.

Note

If the wings are to be folded, the warning given in paragraph 1-55 must be observed.

2-68. MOORING.

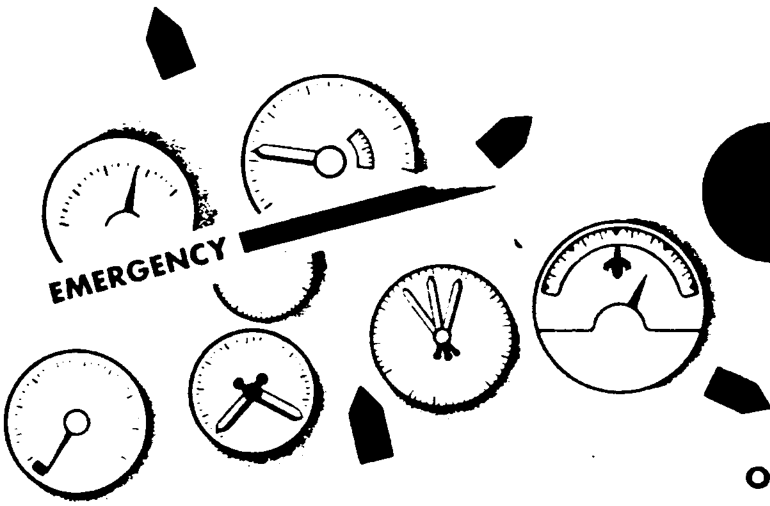
2-69. TIE-DOWN. The airplane is provided with tie-down fittings on the nose gear and on the main gear. In the event of unfavorable weather conditions involving high wind velocities, heavy precipitation, or dust, or if the airplane is to remain parked for a considerable length of time, observe the following in addition to the usual tie-down procedure:

a. Place chocks fore and aft of all wheels.

b. Install intake duct dust covers.

c. Install pitot tube cover.

d. Close canopy.



SECTION III

OPERATING INSTRUCTIONS

3-1. FIRE.

3-2. GENERAL. *(See figure 3-1.)* There are 12 fire detector thermoswitches mounted on the firewall and around the outside of the engines and afterburners. These thermoswitches are connected to the two fire detector warning lights on the instrument panel, one light for the left-hand engine and afterburner compartments, the other one for the right-hand engine and afterburner compartments. Local excessive temperatures cause a thermoswitch to close, resulting in burning of a warning light. There are two push-type switches mounted on the instrument panel for testing the circuit through the fire detector system. These switches only test the circuits and they do not check the operation of the thermoswitches, since a thermal change is required for such a check.

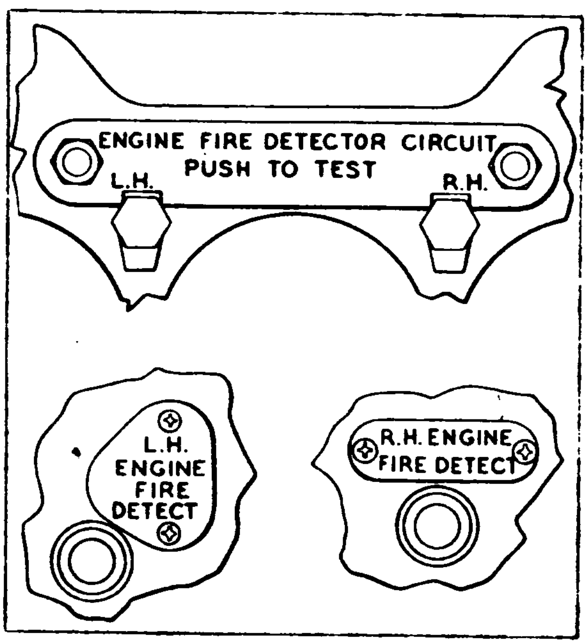


Figure 3-1. Fire Detection

3-2A. ENGINE AND AFTERBURNER COMPARTMENT TEMPERATURE-INDICATING SYSTEM. *(See figure 1-24.)* The engine and afterburner compartment temperature-indicating system enables the pilot to verify warning signals given by the fire detector warning lights (paragraph 3-2) and to detect possible false warnings. The indicator is located on the instrument panel and is electrically connected to a selector switch and thermocouples in the engine and afterburner compartments. When the selector switch is in the "1" position, the two pointers on the indicator register temperatures in the right- and the left-hand afterburner compartments. Temperatures in the two engine compartments are indicated when the selector switch is placed in the "2" position. Switch positions "3" and "4" are inoperative. If the temperature rises above 280°C in an afterburner compartment or 125°C in an engine compartment, the pilot should reduce the power setting of the affected engine to an intermediate range. If the temperature then drops, the condition may be due to an exhaust gas leak. If the temperature does not drop, a fire may exist in the overheated compartment. Refer to paragraphs 3-3 through 3-5 for procedures to be followed if fire is detected in one or both engine sections.

3-2B. If one or more fire warning lights should burn, check validity of warning as follows:

a. To check temperature in either afterburner compartment turn compartment temperature selector switch to "1." Temperatures should not exceed 280°C.

b. To check either engine compartment, turn selector switch to "2." Temperatures should not exceed 125°C.

c. If temperatures exceeding limits in steps a and b

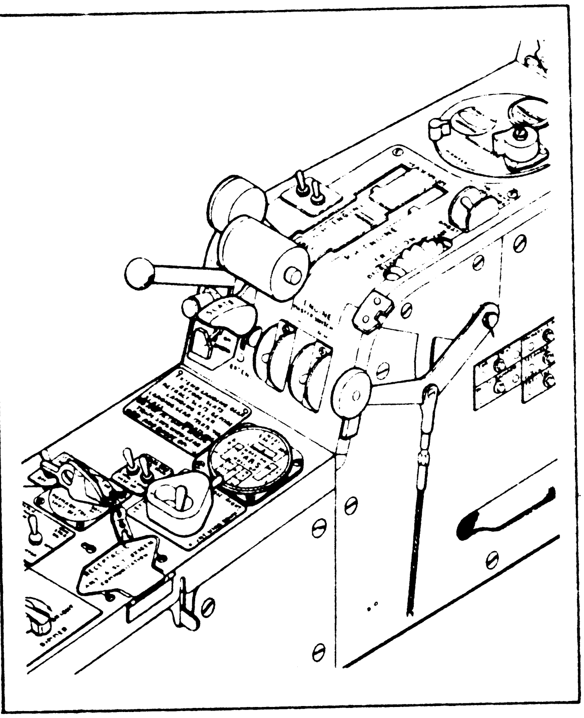


Figure 3-2. Power Plant Controls

are encountered, reduce power to an intermediate level. If temperature drops, overheated condition is due to exhaust gas leakage.

d. If overheated condition persists, fire is a possibility.

3-3. If a fire is detected in the engine section before take-off, the following procedure is recommended:

a. Throttles—"OFF."
b. Fuel selector switch—"BOTH OFF."
c. Engine master switches—"OFF."
d. Power control switch—"OFF."
e. Abandon airplane.

3-4. If a fire is detected in one engine section when in flight, the following procedure is recommended:

a. Throttle (for burning engine only)—"OFF."
b. Fuel selector switch—"RIGHT ON" or "LEFT ON" only (turn off fuel to burning engine).
c. Engine master switch—"OFF" (switch for burning engine only).
d. Power control switch—"BATTERY AND GEN."
e. If fire does not go out, abandon airplane.

3-5. If fire is detected in both engine sections, abandon airplane.

3-6. ENGINE FAILURE.

3-7. ENGINE FAILURE DURING TAKE-OFF.

a. If an engine should fail during take-off *before leaving the ground*, proceed as follows:

(1) Use brakes as required.
(2) Throttle for "dead" engine—"OFF."
(3) Engine master switch for "dead" engine—"OFF."
(4) Throttle for operating engine—"IDLE."

CAUTION

Do not "cut" throttle for the operating engine as this will result in the loss of hydraulic pressure to the main wheel power brakes. Emergency (air) wheel brakes may be used if a loss of hydraulic pressure occurs.

(5) Fuel selector switch—"LEFT ON" or "RIGHT ON" to feed fuel to operating engine only.

b. If after leaving the ground an engine should fail *before altitude is attained*, and there is insufficient airspeed for level flight, proceed as follows:

(1) Retract landing gear.
(2) Retract slats.
(3) Move throttle for "dead" engine to "OFF."
(4) Turn fuel selector switch to either "LEFT ON" or "RIGHT ON" so that fuel is supplied to operative engine only.
(5) Turn dead" engine master switch to "OFF."
(6) If sufficient airspeed can be attained, a one-engine landing may be attempted. (Refer to paragraph 3-8.)

3-8. ENGINE FAILURE DURING FLIGHT. Engine failure during flight will be indicated by a loss of power and retarding of engine rpm.

a. If *one* engine should fail during flight the following procedure is recommended:

(1) Attempt an air start (paragraph 3-10).
(2) If "dead" engine does not start, move throttle for "dead" engine to "OFF" position.
(3) Place fuel selector switch in "LEFT ON" or "RIGHT ON" position to feed fuel to operating engine only.
(4) Turn engine master switch for "dead" engine to "OFF" position.
(5) If conditions are favorable, attempt return to base at optimum conditions for single-engine operation. See figures A-1, A-2, and A-3, and A-3A.
(6) If conditions are not favorable for a single-engine landing, prepare to abandon airplane. (Refer to paragraph 3-20.)

b. If *both engines* should fail during flight the following procedure is recommended:

(1) Attempt an air start (paragraph 3-11).
(2) If only one engine starts, follow the procedure outlined in step a of this paragraph.
(3) If neither engine starts, a dead stick landing may be attempted providing flight conditions warrant such an attempt; if not, prepare to abandon the airplane. (Refer to paragraphs 3-20 through 3-26.)

3-9. AIR STARTING ENGINES.

3-10. AIR STARTING ONE ENGINE. This procedure is recommended for air starting one engine while the other engine is operating. With one engine operating, it may then be assumed that the following conditions exist: Power control switch is in the "BATTERY AND GEN" position, engine master switch for inoperative engine is in the "OFF" position, throttle for inoperative engine is in the "OFF" position, and the fuel selector switch is in either the "RIGHT ON" on the "LEFT ON" position depending upon which engine is in operation. To air start the non-operating engine, proceed as follows:

a. Maintain airspeed necessary to obtain 15 to 17 percent rpm (approximately 170 knots).

b. Place fuel selector switch in "BOTH ON" position.

c. Turn master engine switch for "dead" engine to "ON" position.

d. Move throttle, for engine being started, to "EMERG IGNITE" position.

3-11. AIR STARTING BOTH ENGINES. To air start with both engines "dead," it is necessary to start one engine at a time. Before attempting to start one of the dead engines (it is assumed that the right-hand engine will be started first) the engine controls must be in the following positions (see Note, paragraph 3-10):

a. Power control switch—"BATTERY AND GEN."

b. Both throttles—"OFF."

c. Engine master switch for left-hand engine—"OFF."

d. Engine master switch for right-hand engine—"ON."

e. Fuel selector switch—"RIGHT ON."

3-12. With the engine controls in the positions described in paragraph 3-11, maintain an airspeed necessary to obtain 15 to 17 percent engine rpm (approximately 170 knots), and move the throttle for the right-hand engine to "EMERG IGNITE" position. If the right-hand engine does not start, cut the right-hand engine controls and start the left-hand engine. When one engine is operating, the other one may be air-started by following the procedure given in paragraph 3-10.

3-13 THROUGH 3-16 DELETED.

3-17. EXCESSIVE OPERATING TEMPERATURES. If oil temperature or turbine-out temperature exceeds the maximum operating limits, reduce the engine rpm as required. (Refer to power plant chart, figure A-5.)

3-18. RUNAWAY TURBINE. The allowable engine overspeed is 101 percent rpm. Failure of the primary fuel control governor may cause the turbine to develop excessive speed. If this condition should occur, observe the following procedure:

a. Retard throttle for overspeeding engine.

b. Place emergency fuel control switch in "SELECT EMERG" position for overspeeding engine.

Note

Placing the emergency fuel control switch in "SELECT EMERG" (a momentary position) will set the selected engine emergency fuel control in operation. Emergency fuel control operation is indicated by a slight drop in fuel pressure and burning of cockpit warning light.

c. If overspeeding is checked, place the emergency fuel control switch in "RESET PRIMARY" and advance throttle if desired.

Note

Placing the emergency fuel control switch in "RESET PRIMARY" (a momentary position) will cut out the emergency fuel control and cut in the primary fuel control.

d. If excessive overspeed is still apparent after placing the emergency fuel control switch in "RESET PRIMARY," place switch in "SELECT EMERG."

3-19. EMERGENCY AFTERBURNER OPERATION. It is possible to operate the afterburners with the emergency fuel control operating, but it is not recommended because of a possible resulting loss of engine rpm control by the emergency fuel system.

3-20. BAIL-OUT.

3-21. In most cases, it is considered desirable to roll the airplane over on its back if possible and drop away from it. This decision, however, should be left to the pilot's discretion. If the decision to bail out is made the following procedure shall be observed:

a. Reduce airspeed as much as possible.

b. Disconnect radio and oxygen equipment.

CAUTION

Before jumping at altitude, turn oxygen regulator air valve to 100 percent oxygen and inhale as much oxygen as possible.

c. Unfasten safety belt and harness.

d. Open canopy by pulling T-shaped handle.

e. Raise seat to maximum height.

f. Abandon airplane.

3-22. EJECTION SEAT.

3-23. GENERAL. An ejection-type pilot's seat is used in place of the conventional bucket seat. The ejection seat, which includes a bucket seat similar to the conventional type, is installed in high-speed aircraft to enable the pilot to eject the seat and himself from the airplane in case of an emergency at high speeds, or when normal bail-out procedure seems inadvisable. (For normal operation of the ejection seat, refer to paragraph 1-89.)

3-24. SEQUENCE OF OPERATIONS. The following sequence of operations is accomplished when the pre-ejection control lever is operated.

1. Lowering of pilot's seat by automatic actuation of a switch in right-hand control shelf. Actuation of this switch will set seat actuator control box in the emergency down position.

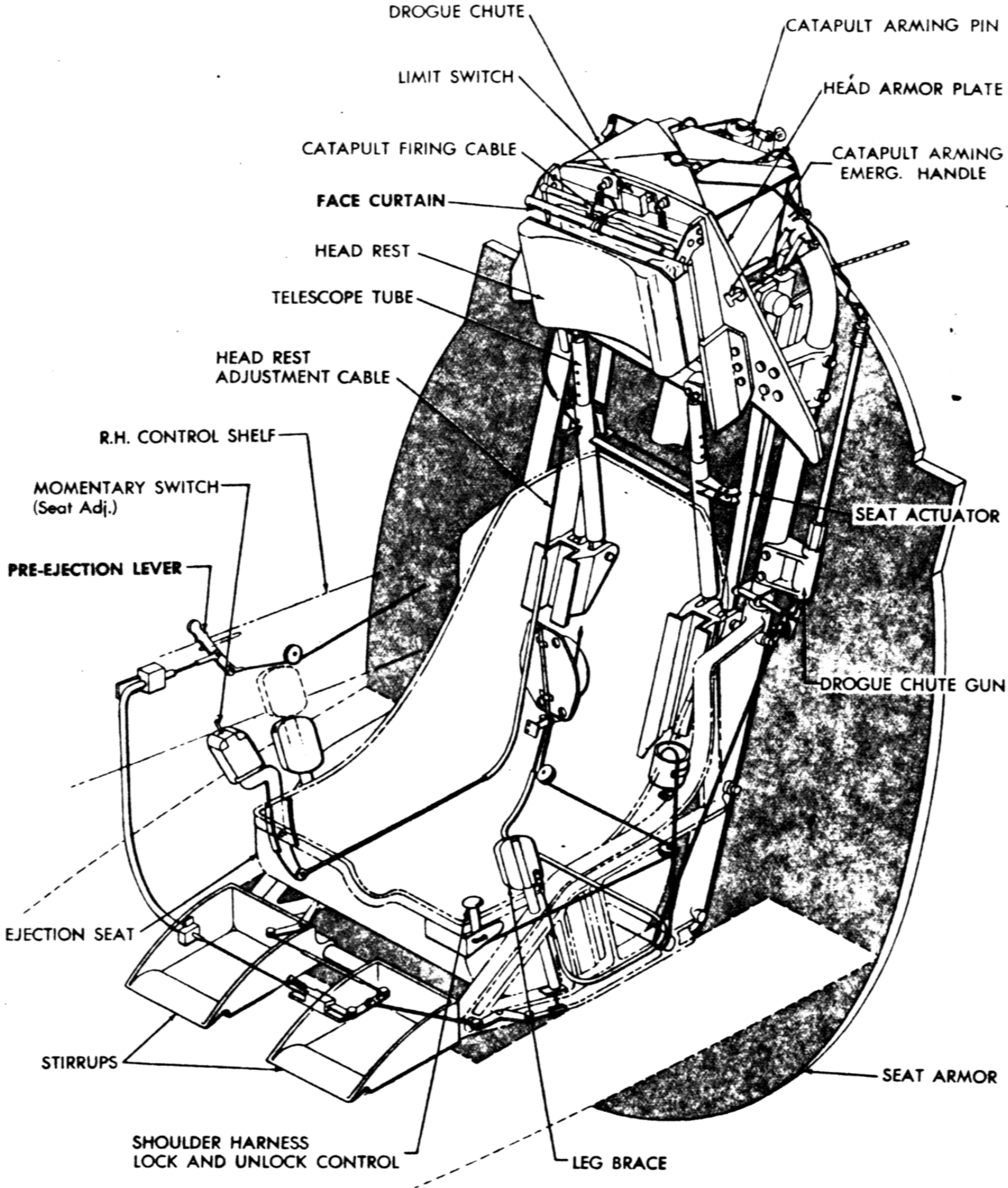


Figure 3–3. Ejection Seat

2. Extension of leg braces to keep pilot's knees within limits during ejection.
3. Locking of shoulder harness.
4. Decompression of pressurized cockpit by actuation of pressure dump valve.
5. Removal of canopy by actuation of canopy compressed air system.
6. Arming of the seat catapult by removal of the arming pin.

3-25. EMERGENCY OPERATION. When the decision to use the ejection seat is made, the pilot shall perform the following operations.

a. Reduce airspeed if possible.
b. Place feet in seat stirrups.

Note

If the canopy fails to go off after the pre-ejection lever is pulled, and consequently the seat catapult is not armed, the pilot may arm the seat catapult by pulling the T-shaped handle on the left-hand side of the headrest armor. Steps d, e, and f of this paragraph should then be followed.

c. Lift safety latch on pre-ejection lever and pull lever aft.
d. Assume an erect sitting position with head pressed against headrest.
e. Activate the bail-out oxygen equipment.
f. Reach overhead with palm aft, grasp face curtain and pull forward and down, keeping elbows close to body. This action will fire the seat catapult.

3-26. AFTER FIRING. After firing, the drogue chute is automatically fired to stabilize the seat. When the seat has decelerated sufficiently, the pilot should release himself from the seat and use his own parachute for descent.

WARNING

To avoid effects of anoxia and cold when escape is accomplished at high altitudes, it is imperative that the pilot fall free to a safe altitude before opening his parachute.

3-27. FORCED LANDINGS.

3-28. Unless a safe approach can be made to an airport runway, the landing gear should always be retracted.

3-29. DITCHING AND BELLY LANDINGS.

3-30. Proceed as follows when the airplane is to be ditched or when a belly landing is advisable:

a. Shoulder harness and safety helt "LOCKED."
b. Canopy fully open.
c. Landing gear—"UP." Slats—"RETRACT."
d. Engine master switches—"OFF."
e. Primary fuel selector switch "OFF."
f. Power control switch—"OFF." Throttles—"OFF."
g. Touch down as easily as possible at minimum speed. Leave airplane immediately.

3-31. GENERATOR SYSTEM FAILURE.

3-32. HIGH VOLTAGE (OVER 30.0 VOLTS). In the event of excessive voltage output (over 30.0 volts), the following steps should be taken:

a. Place power control switch in "BATT ONLY."
b. Turn off all equipment nonessential for existing flight conditions.

Note

When operating in "BAT ONLY" for comparatively long periods of time, or if battery is in a weakened condition indicated by inefficient functioning of electrical equipment, move the power control switch to "BATTERY AND GEN" for short periods to recharge the battery.

3-33. LOW VOLTAGE (BELOW 26.0 VOLTS). If the output of one generator drops below the generator cut-out setting, it will automatically be cut out of the circuit to avoid draining the battery. Satisfactory operation should be obtained from the operative generator; therefore the power control switch may be left in "BATTERY AND GEN." However, if both generator systems fail, place the power control switch in "BAT ONLY" and turn off all equipment nonessential for existing flight conditions.

3-34. EMERGENCY LANDING GEAR SYSTEM.

3-35. DESCRIPTION. The landing gear may be extended by means of the compressed air emergency system when the hydraulic system malfunctions. The compressed air bottle is located in the nose wheel compartment and it is charged to 1,800 psi.

3-36. OPERATION. For emergency extension of the landing gear, observe the following procedure:

a. Reduce airspeed as much as possible (175 knots).
b. Place landing gear control lever in "EMERGENCY DOWN." The stop-gate must be displaced before the control handle will travel to this position.

3-37. EMERGENCY POWER BRAKE SYSTEM.

3-38. DESCRIPTION. The main wheel power brakes may be operated by compressed air, taken from the compressed air bottle in the emergency arresting gear system. A handle located on the aft portion of the right-hand control shelf is normally held in "OFF." When the handle is rotated from "OFF" to "ON," compressed air is directed to the main wheel brakes. The pilot may then release the spring-loaded handle, which will return to the "HOLD" position, still holding the air at the brakes. To release the brakes, the pilot may return the handle to "OFF," bleeding the air from the brakes. Air may again be directed to the brakes by returning the handle to "ON."

3-39. EMERGENCY CANOPY SYSTEM.

3-40. DESCRIPTION. The canopy may be opened by means of a compressed air system. The compressed air bottle is located on the forward side of bulkhead 16 in the nose cone. The bottle is charged to 1,800 psi. The compressed air system is operated by pulling a T-shaped handle on the left-hand canopy track. In an emergency, the canopy may be opened manually by using the internal release handle on the left-hand and the stationary handle on the right-hand side of the canopy forward former.

3-41. EMERGENCY OPERATION. For emergency operation of the canopy, proceed as follows:

a. Pull T-shaped handle.

b. If canopy fails to open, simultaneously pull aft on internal release handle and stationary handle.

3-42. EMERGENCY ARRESTING GEAR SYSTEM.

3-43. DESCRIPTION. The arresting gear may be extended by means of a compressed air system. The compressed air bottle is located in the nose wheel well. The bottle is charged to 1,800 psi.

3-44. EMERGENCY OPERATION. To extend the arresting gear in an emergency, proceed as follows:

a. Displace safety latch on arresting gear control panel.

b. Move arresting gear control lever to "EMERGENCY DOWN."

3-45. EMERGENCY SPEED BRAKE SYSTEM.

3-46. DESCRIPTION. Both the wing and the fuselage speed brakes may be operated by compressed air. There are two separate air systems for the speed brakes but both are controlled by the same control lever.

3-47. When the control level is placed in "EMERGENCY," air for opening the speed brakes is released as follows: air for the wing speed brakes flows to an intensifier, and high pressure hydraulic fluid is then passed from the intensifier to the wing speed brake actuating cylinders; and air for the fuselage speed brakes flows directly to the fuselage speed brake actuating cylinders. When the control lever is returned to an internal stop position, air for closing the speed brakes is directed as follows: air from the wing speed brake bottles goes directly to the actuating cylinders via the "close" ports, forcing the hydraulic fluid overboard; and air from the fuselage speed brake bottle goes directly to the actuating cylinders via the "close" ports, forcing the air in the opposite side overboard. The speed brakes may be operated through one cycle, from closed to open to closed, after which neither speed brake may be operated.

Note

If the speed brakes have been opened hydraulically and an electrical failure occurs, allowing the fuselage speed brakes to close (refer to paragraph 1-20), the fuselage speed brakes may be operated, if desired, by following the procedure given in paragraph 3-47.

3-48. AILAVATOR BOOST FAILURE.

3-49. If the ailavator boost sytem fails, the change-over to manual control is automatic. Loss of ailavator boost is indicated by heavier stick forces. In this change-over, a lever on the change-over strut will actuate a microswitch which sets the emergency aileron boost hydraulic pump into operation. This will give the pilot hydraulic boosted emergency aileron control only; elevator control is strictly manual. If the flight condition at the time of a boost failure results in excessive stick forces, the speed brakes should be used to reduce airplane speed as quickly as possible. Refer to paragraph 3-47 for emergency speed brake operation.

INSERT A, Page 44A

3-52. EMERGENCY EQUIPMENT.

3-53. The pilot's seat is bucket-shaped to accommodate a standard Navy seat-type parachute and a Pararaft kit(Model PK-1).

3-54. OXYGEN.

3-55. If excessive carbon monoxide or other noxious or irritating gas is present, the air valve knob should be switched to the "100% OXYGEN" position regardless of altitude. If symptoms suggestive of anoxia occur, the safety pressure knob should be operated. If for any reason the regulator becomes inoperative in flight, the oxygen bail-out equipment should be activated and descent should be made to below 10,000 feet.

3-56. IFF DESTRUCTOR.

3-57. Destruction of the AN APX-6 apparatus is accomplished manually by operating the DESTRUCT switch located on the IFF control panel on the right-hand control shelf. To destroy the receiver, raise the red guard cover, breaking the safety wire, and throw the DESTRUCT switch to "ON." Automatic destruction is accomplished through the impact switch.

3-58. IFF EMERGENCY SIGNAL.

3-59. To transmit automatic distress signals, press the red dial stop and rotate the MASTER selector on the IFF control panel to the "EMERGENCY" position. The IFF control panel is located on the right-hand control shelf.

3-60. ARMAMENT.

3-61. RUNAWAY GUNS. If the trigger switch should stick, resulting in uncontrolled automatic firing, turn the master armament switch "OFF" and use it as a trigger switch. To stop a runaway gun, move the SAFE-READY switch to "SAFE."

Insert A, page 44.

CAUTION

Flight at speeds in excess of a Mach number of 0.85 at altitudes below 3,000 feet should be attempted only with extreme caution in view of the severely restricted longitudinal control available in the event of a hydraulic boost failure under these conditions. If a power control system failure should occur at speeds in excess of a Mach number of 0.85, the pilot should immediately attempt to reduce his speed by use of speed brakes and engine rpm reduction. The initial excessive stick forces can be trimmed out by nose-up ailavator trim tab actuation; but the amount of trim tab employed should be reduced as the speed is reduced to avoid an inadvertent pitch-up of the airplane resulting from the retention of an excessive amount of nose-up trim tab at reduced speeds.

Insert A, page 44 (cont'd)

3-50. SIMULATED ELEVATOR FEEL FAILURE.

3-51. Simulated elevator feel failure results in extremely light stick forces during maneuvers to the extent that a definite possibility of overcontrol by the pilot exists. Continued overcontrol during attempts to compensate for an initial error of overcontrol may result in rapid, erratic, pilot-induced longitudinal oscillations of the airplane. Control of the airplane will be less difficult if the pitch damper is "ON." At low speeds, the airplane may be flown safely by avoiding rapid stick motions. As airspeed is increased, control of the airplane becomes more difficult. The speed brakes should not be used during boost-on flight without simulated elevator feel; the pilot may overcontrol when compensating for the trim changes accompanying the rapid reduction of airspeed, and pilot-induced longitudinal oscillation may be initiated. If pilot-induced oscillation is encountered at high speeds, release the control stick and allow the oscillation to damp out. If the oscillations continue, place the ailavator boost control lever in the "OFF" position. With the boost system turned off and the airplane being flown on manual control, elevator stick forces will increase, but aileron stick forces will be helped by the emergency aileron hydraulic boost. Refer to paragraph 3-49 for information on flight at high Mach numbers without ailavator hydraulic boost.

Insert A, page 44 (contd)

3-51A. To provide adequate elevator control power for landing flare-out, especially in rough air, the ailavator boost control lever should be placed in "ON" before landing. If ailavator boost power is not available, or if the pilot prefers to make the landing on manual control, a preliminary check of minimum trim speed for zero longitudinal stick force (with slats and landing gear extended) should be made at a safe altitude. During this check the pilot should familiarize himself with the boost-off longitudinal control limitations which will be encountered when landing. If the minimum trim speed is low enough to indicate sufficient available longitudinal control for the anticipated approach and landing airspeeds, a manual control landing may be made.

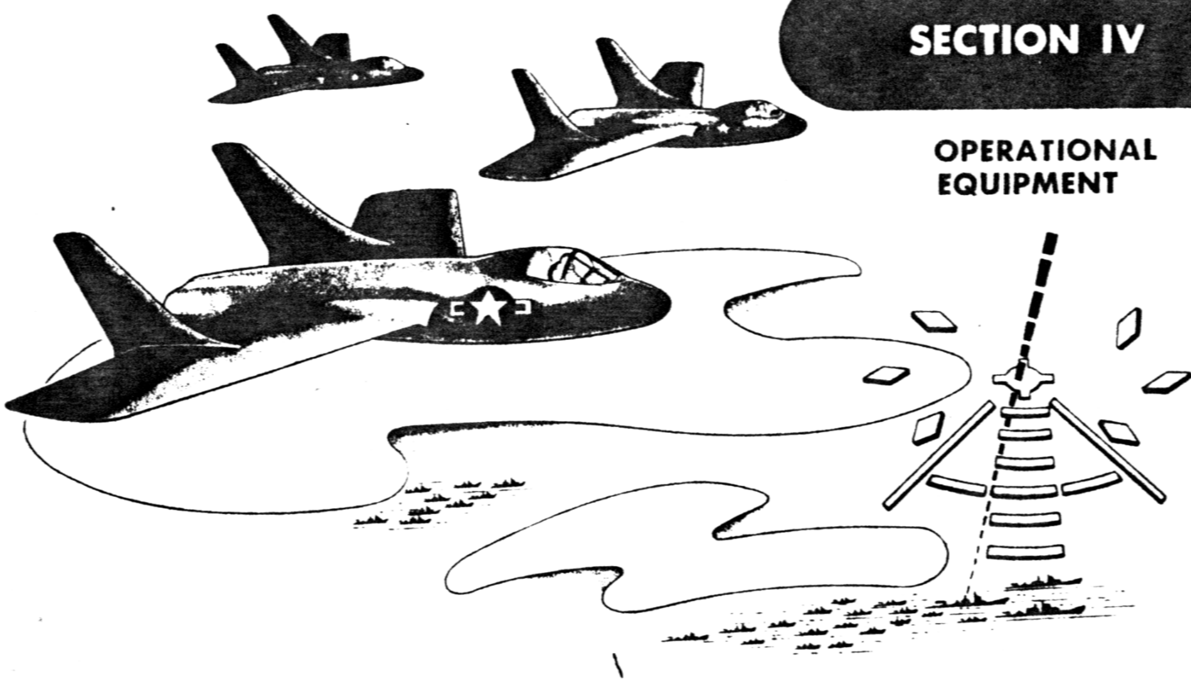
CAUTION

Take care to avoid stalling the airplane during this check.

3-51B. Sticking of the proportional pressure valve in its low-speed position will result in partial loss of simulated elevator feel, and boost-on flight above 300 knots will be prohibitively difficult. If the valve becomes unstuck and suddenly assumes its proper position for the existing flight condition, an abrupt nose-down trim change will occur. Less than five pounds of stick

Insert A, page 44 (contd)

force is required to oppose this trim change. The unstuck valve will in most cases operate normally for the balance of the flight, and no corrective action by the pilot will be necessary. Malfunction of the Mach programming system, incorporated in the simulated elevator feel system, will not alone produce the possibility of pilot-induced longitudinal oscillations. Mach programming system malfunction may result in abnormally heavy stick forces during maneuvers at high Mach number or indicated airspeed. These excessive stick forces may be reduced by placing the ailavator feel control handle on the left-hand control shelf in the "DECREASE" position. If the stick forces remain excessive, use the speed brakes as desired to reduce the airspeed until stick forces are satisfactory for continued boost-on flight.



SECTION IV

OPERATIONAL EQUIPMENT

4–1. ARMAMENT.

4–2. GENERAL. The gunnery system consists of four M3 (T-31) 20-mm guns which are hydraulically charged and electrically fired. Eight ammunition boxes, providing a total of 800 rounds, are located at the rear of the nose gear compartment and are accessible when the nose gear compartment doors are open. The two right-hand outboard ammunition boxes feed the upper left gun; the two left-hand outboard boxes feed the upper right gun; the two right-hand inboard boxes feed the lower right gun; and the two left-hand inboard boxes feed the lower left gun. The hydraulic cylinder mounted on the inboard side of each gun charges the gun prior to firing and is operated by the two SAFE-READY switches on the instrument panel. After the initial hydraulic charge, the gun mechanism is electrically operated by depressing the trigger on the forward side of the pilot's control stick. Also included in the gunnery system is the armament control system (ACS) AERO-5A. The major components of the armament control system AERO-5A are: (1) the MK 6 Mod 0 aircraft fire control system (AFCS); (2) the servo, radar range AERO-1A; (3) the controller, gun sight AERO-2C; (4) the ranging, throttle grip control on the right-hand engine throttle for manual operation of the gun sight; (5) the AN/APG-30 automatic range only (ARO) radar; and (6) flexible mechanical cable to connect the controller, gun sight AERO-2C to the MK 8 Mod 0 sight unit of the MK 6 Mod 0 AFCS. The sight unit selector and dimmer switches are mounted on the aft portion of the left-hand control shelf. An AN-N-6A gun camera, mounted in the lower part of the nose cone, is operated by the gun trigger switch. The gun camera may be tested by operating a test switch in the nose cone. A T-2 electric gun heater attached to the underside of each gun receiver body prevents the gun oil from congealing at freezing temperatures. A thermoswitch automatically closes the gun heater circuit and starts the heaters operating when the temperature drops below 4.4°C (40°F).

4–3. GUNNERY SYSTEM SWITCHES. The gunnery switches are located in the upper left-hand corner of the instrument panel and consist of the master gun switch and the upper and lower gun SAFE-READY switches. A gun trigger switch is located on the forward side of the pilot's control stick. A separate switch panel, located on the left-hand control shelf, is provided for the gun sight. The master gun switch must be "ON" before normal operation of the guns, gun sight, or gun camera is possible. It is also necessary to have the SAFE-READY switches in the "READY" position to fire the guns. The gun sight and camera may be operated when the SAFE-READY switches are in the "OFF" and "SAFE" position. The guns are charged by means of the SAFE-READY switches only; there is no charging button and the guns can be charged with the master gun switch in the "OFF" position. The SAFE-READY switches permit simultaneous firing of all guns, or firing of only the upper or lower guns. Three armament safety devices are automatically actuated by the landing gear control handle. With the landing gear control handle in the "LAND" or "TAKE-OFF" position, a relay opens the complete armament circuit and renders it inoperative. When the landing gear control handle is returned to the "UP" position (after take-off), the master gun switch will have to be reset to the "ON" position before the guns can be fired.

4-4. GUN CHARGING. To charge and fire the guns, the switches should be operated as follows:

Note

It is assumed that all gunnery switches are "OFF," that there is hydraulic system pressure, that there is electrical power available, and, if the gun charging and firing is to be a ground operation, that the armament safety disabling switch has been depressed.

a. To charge guns, flash SAFE-READY switches from "READY" to "SAFE" to "READY." It is not necessary to have master gun switch in the "ON" position for this operation.

b. To fire guns, they must first be charged and master gun switch placed in the "ON" position. Depress trigger switch on forward side of control stick.

c. After firing, guns must be safetied. Place master gun switch in "OFF" position and both SAFE-READY switches in "SAFE" position. When SAFE-READY switches are in "SAFE" position, hydraulic gun charger pistons move aft within the cylinders and remain in that position, holding the breechblocks and prohibiting them from forward travel.

4-5. ARMAMENT CONTROL SYSTEM. The MK 6 Mod 0 aircraft fire control system incorporates the MK 8 sight unit, a gyroscopic lead computing gun sight. The gun sight is operated automatically in range by the AN/APG-30 radar set or manually by the throttle ranging control grip. The radar set control C-637/APG-30 and the gun sight switch are located on the rear of the left-hand control shelf. A mirror is installed on the left-hand side of the windshield to reflect the pilot's eye and provides him with a visible means of determining gun sight eye-level position. The pilot must allow for gravity drop in tracking. The necessity of smooth ranging and/or smooth tracking cannot be overemphasized. When tracking is erratic, new target rates are generated so fast that the proper lead cannot be generated. (For information about manual gun sight range control, refer to paragraph 4-7; for information about radar set AN/APG 30, refer to paragraph 4-8.)

4-6. GUN SIGHT. The MK 8 gyroscopic lead-computing gun sight unit, located at the front of the cockpit, is supported on a mount bolted to the cockpit cowling. The gun sight is held in position by a disk-

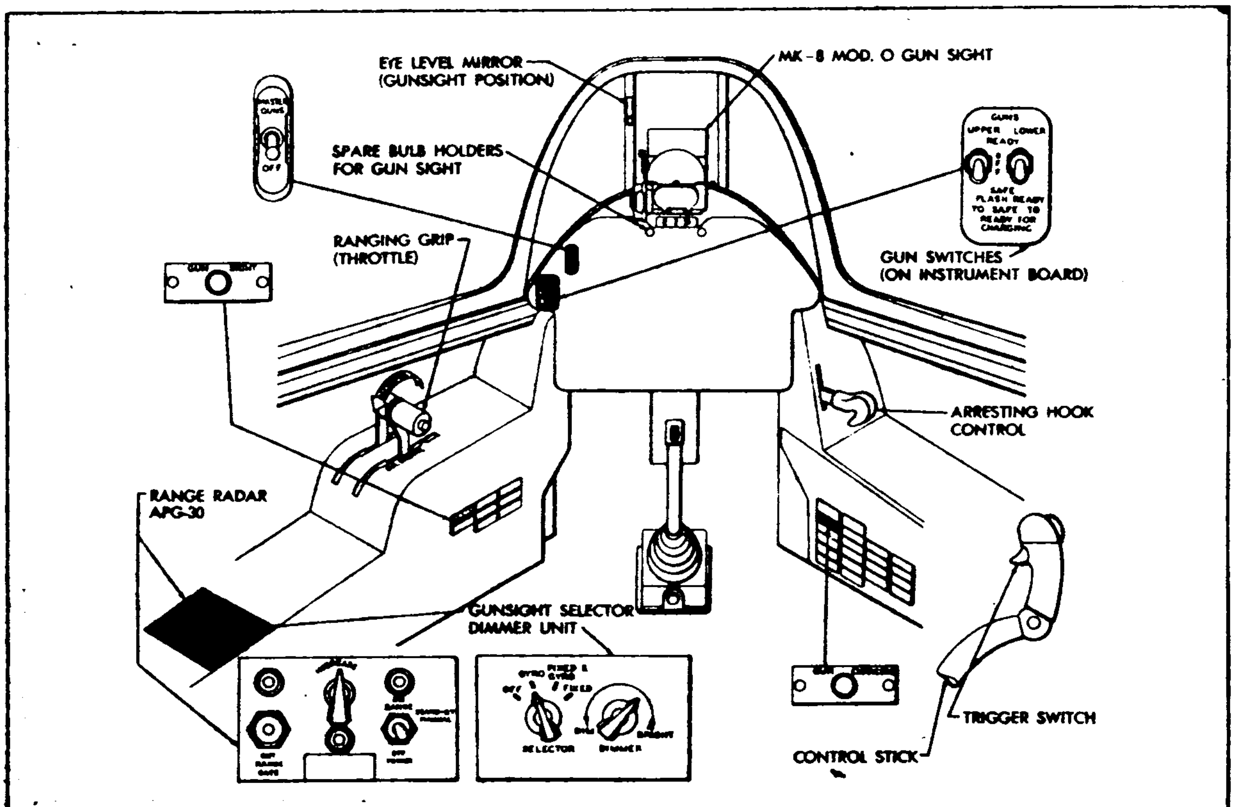


Figure 4-1. Armament Provisions (Cockpit)

shaped fitting bolted to the bottom of the sight, which fits into a spherical mounting clamp. The clamp holds the gun sight securely when the clamp locking bolt is tightened. The mounting clamp can be loosened to permit limited rotation of the gun sight in any direction when a boresight adjustment is required. A bracket is incorporated for a recording camera. The gun sight computes the lead which must be allowed for the relative motion and range of a target and is designed to compute for ranges varying from 600 to 2,400 feet. Allowance for gravity drop must be estimated by the pilot. The pilot views the target through a glass reflector, in which are reflected the images of two reticle patterns projected to infinity by two independent sighting systems, contained in the gun sight housing. The fixed reticle image viewed by the pilot's left eye consists of a cross, a 45-degree radial line extending from the cross into each of the lower quadrants, and arcs of circles from 10 to 70 mils radii in increments of 10 mils below the cross. If desired, the entire pattern for the fixed sight, except the cross, may be blacked out by pushing down the fixed reticle masking lever located on the upper left-hand side of the sight head. The fixed image remains stationary and establishes a line of sight which is boresighted with the guns. A movable or gyro reticle image viewed by the right eye makes apparent the angle of lead computed by the sight and provides a means of ranging. The gyro image consists of a center pip and a surrounding circle formed by six radially disposed diamond-shaped dots. For manual operation, proper deflection (movement) of the image to compensate for target range is accomplished by the rotation of the throttle ranging grip after the span indicator is set to correspond with a selected dimension of the target aircraft, usually its wingspan. Manual rotation of the range grip causes variations in the diameter size of the gyro image circle and also variations in electrical current supplied to the gyro rotor magnetic field. Variations in the magnetic field cause a deflection of the gyro mirror, and hence the image. For manual operation, the pilot operates the range grip as required to keep the target encircled by the inner tips of the reticle image dots. As the target is approached, it becomes larger to the eye, causing the pilot to rotate the grip so that the diameter of the image will be increased to keep the target framed within the circle. Automatic ranging operation of the gun sight is obtained when the AN/APG-30 radar set is locked on the desired target. After the span is properly set, the radar set controls the variations in the diameter of the gyro image circle to keep the target encircled. A light, mounted on the cowl to the right of the gun sight, goes out when the radar set is locked on a target. When the light is on, the radar is radiating but is not locked on a target. When under STAND-BY (MANUAL) operation, the ranging throttle grip, by hand rotation, controls the range setting of the MK 8 sight unit. When under RADAR operation, the ranging throttle grip is not used for ranging, but it is used for uncaging the gyro in the MK 8 sight unit. In this, when the radar is locked on to a target, the gyro may be uncaged by rotating the ranging throttle grip out of the detent to a position about half-way between the extremes of rotation of the throttle grip. This permits the gyro sight line to make its initial jump and settle down at as long a target range as is feasible. This results in smoother tracking, and is essential at high speeds and at attacks at large angles off the tail of the target aircraft. The gyro in the MK 8 sight unit, however, will be automatically uncaged whenever the radar is locked on to a target and the target is at a range of less than 2,400 feet, regardless of the setting of the ranging throttle grip. Before commencing an attack run, under both STAND-BY (MANUAL) and RADAR modes of operation, the ranging throttle grip should be placed in the detent position. Under STAND-BY (MANUAL) operation, the detent position of the ranging throttle grip corresponds to the high range end (2,400 feet) of the MK 8 sight unit. The opposite position or rotation of the ranging throttle grip corresponds to the low range end (600 feet) of the MK 8 sight unit. The angular rotation of the throttle grip produces a proportional change in range of the range setting of the MK 8 sight unit, when used with the AERO-2C gun sight controller. A gun sight selector-dimmer unit (paragraph 4–12) allows the pilot to select any one of four positions, "OFF," "GYRO," "FIXED & GYRO," and "FIXED." The light intensity of the images may be varied by a rheostat control located on the left-hand control shelf. The master gun switch must first be turned on to operate the sight. A rubber crash pad is located on the sighting head for protection of the pilot. Directly below the crash pad there is a sight lamp cover. The lamps are readily accessible, and should one fail in flight, the pilot can replace it with one of the two spare bulbs which are held in clips located just below the sight.

4–7. GUN SIGHT RANGE CONTROL—STAND-BY—MANUAL. The gun sight range control installation provides a means for the pilot to set target range data into the sight. Manual ranging control is accomplished when the pilot operates the ranging throttle grip with POWER switch of radar set control C-637/APG-30 in "STAND-BY — MANUAL" position. The gun sight manual ranging control becomes inoperative when radar set control C-637/APG-30 POWER switch is in "ON RADAR" position. The ranging grip is bolted to the right-hand throttle lever and consists of a cylindrical handle containing a potentiometer, a microphone switch, and the necessary electric leads. Full rotation of the grip causes the potentiometer wiper to traverse from one end of the potentiometer resistance winding to the other. It is rotated to keep the target framed within the gyro image circle. The grip is capable of 60 degrees of rotation to permit range adjustments varying from 600 to 2,400 feet. Decreasing range requires that the grip be turned aft or counterclockwise (as viewed from the inboard end). The rotation of the ranging throttle grip causes the rotation of the electrical wiper arm on the potentiometer inside the ranging throttle grip. The d-c voltage between this potentiometer wiper arm and the aircraft metal ground corresponds to a setting of the ranging throttle grip. The range setting into the MK 8 sight unit is changed by an electrical motor in the gun sight controller Aero-2C, which drives the MK 8 sight unit through a flexible cable, and also, inside of the controller, simultaneously the potentiometer wiper arm of the servo response potentiometer. The d-c voltage between the wiper arm of the servo response potentiometer and ground likewise corresponds to the setting of this potentiometer, and the range setting of the MK 8 sight unit. A sensitive polarized relay in the gun sight controller. AERO-2C detects the difference between these two d-c voltages, and through another relay drives the electric motor so as to reduce this difference to as small a value as practicable, thus changing the range input to the MK 8 sight unit to correspond to the setting of the ranging throttle grip. The rotation of the range input shaft to the MK 8 sight unit causes corresponding changes to the values of the electric current in the range coils associated with the gyroscopic lead computing sight. The strength of the magnetic field in these range coils controls the extent to which the gyro mirror will be displaced under a given rate of angular motion of the aircraft, this angular motion being the result of turning in a pursuit course attack upon a target aircraft. The movement of the gyro mirror causes the proper displacement of the optical image when the aircraft is flying along a pursuit course or curved attack. It is important that the attack be executed in a smooth manner, or otherwise the optical image will not have time enough to settle on a steady or slowly changing deflection. In operation, this lead computing gun sight provides a "disturbed" optical system (rather than a "director" system). A window in the adapter permits visual inspection to determine the position of the range numbers inscribed on the range drum. (Refer to paragraph 4-8 for information on ranging with radar set AN/APG-30.

4-8. GUN SIGHT RANGE CONTROL — AUTOMATIC.

Note

A-C power required for the operation of the AN/APG-30 equipment must come from the main inverter, therefore, the AN/APG-30 equipment cannot be operated if the stand-by inverter is in operation.

The AN/APG-30 radar set provides continuous and accurate radar ranging information to the optical fire control system. This equipment is designed only for automatic ranging control, and while it relieves the pilot of this one function, the target must be tracked in azimuth and elevation. The automatic features of this system allow the pilot to concentrate on flying the airplane and tracking the target in azimuth and elevation. The radar set control C-637/APG-30 is located on the aft end of the left-hand control shelf. The 3-position toggle switch, on the forward side of the control panel, is used for controlling the system. With the toggle switch in the "ON-RADAR" position, ranging is entirely automatic. Manual ranging may be accomplished with the throttle ranging grip by placing the automatic range control toggle switch in the "STAND-BY MANUAL" position. The radar performs its functions of automatic search in range, tracking *in range* and delivering range information to the gun sight system only after the antenna has been trained on the target. Since the relationship between the guns and radar antenna is fixed, radar range information will be immediately available when the target is framed and the radar is locked on the target. Delivery of range information to the range servo continues as long as the on target light remains off (red light on left-hand control shelf). When there is more than one target close to the radar line-of-sight, the desired target may be selected by operating the "RANGE GATE OUT" switch and noting the change in reticle separation. This will only apply when the reticle diameter can be observed to change with range. In the RADAR mode of operation, the radar supplies a d-c voltage that is proportional to range whenever the radar is locked on to a target. (This voltage is 5 volts plus 20 volts per 3,000 feet of range). When the radar is not locked on to a target, an artificial range equivalent to approximately 2,400 feet (21 volts) is supplied for the purpose of causing the range input to the MK 8 sight unit to be at its maximum range end. This d-c range voltage from the radar is supplied as one of the inputs to the servo, radar range AERO-1A, along with a corresponding voltage from the servo response potentiometer located in the gun sight controller AERO-2C. The difference between these two d-c voltage inputs is amplified in the servo, radar range AERO-1A and is used to control the sensitive polarized relay located inside the gun sight controller AERO-2C, controlling the direction of rotation of the electric motor in the controller in such a direction that this voltage difference is reduced to a small value. The same mechanical drive from this motor controls the setting of the servo response potentiometer and the setting of the range input shaft to the MK 8 shaft unit.

4-9. EMERGENCY OPERATION. In case of failure of the gun sight controller AERO-2C, and if replacements are not available, the MK 6 Mod 0 aircraft fire control system may be used by setting (on the ground/carrier) the setting of the range dial on the MK 8 sight unit to a selected value (1,200 to 1,500 feet, as determined by squadron commanders), and firing at the target aircraft as the range passes through this region. The stadiametric span-setting handle must be set for proper wing span, as in the STAND-BY (MANUAL) mode of operation.

4-10. The radar system is adjusted for operation and controlled during flight by the pilot as follows:

a. Place POWER switch in "STAND-BY MANUAL" position and check to see that light is on (amber light). In this position the radar is held in readiness, but is not radiating. While the radar equipment is held in readiness, the optical-mechanical range system may be used.

b. Turn on fire control equipment; refer to paragraph 4-3.

c. Place POWER switch in "ON-RADAR" position prior to contact with target. Associated indicator light (green) should go on. On-target light (red) should also go on. The RANGE MAX control is used to adjust the maximum range of the gate sweep. The proper setting of this control will vary with the altitude of the aircraft and should be adjusted so that the range gates do not lock on ground reflections. (Refer to paragraph 4-7 for information about the manual gun sight range control.)

Note

If possible, the equipment should be allowed to "warm-up" in "STAND-BY—MANUAL" position for 15 minutes prior to its use. However, a 3-minute "warm-up" period is sufficient if necessary.

4-11. If it is desired to operate the AN/APG-30 radar set without a 15-minute warm-up, the POWER switch may be placed directly in "ON-RADAR." However, a 3-minute delay period is required to secure complete radar operation. In an emergency, the time delay circuit may be by-passed by switching the POWER switch from "ON-RADAR" to "STAND-BY MANUAL." Then the POWER switch should be switched to "OFF" and back to "STAND-BY MANUAL" as rapidly as possible. The POWER switch should then be placed in "ON-RADAR."

Note

After the POWER switch has been placed in "ON RADAR," the system should be transmitting. If it is not, repeat the above procedure. The above procedure may also be used if the equipment appears to be malfunctioning after the normal 3-minute time delay.

4-12. GUN SIGHT SELECTOR-DIMMER UNIT. A gun sight selector switch and dimmer switch are located on the aft end of the left-hand control shelf. When the master gun switch is turned to the "ON" position, electric current is transmitted to the gun sight selector-dimmer unit. The gun sight dimmer is a rheostat which varies the light intensity of the images. It is recommended that the intensity of the image be at a maximum when facing into the sun. The 4-position gun sight selector switch permits the pilot to turn off either the fixed or gyro image or have both on together. When the switch is in the "OFF" position, both reticle images are out. In the "FIXED" position, only the fixed image appears. When the switch is in the "FIXED & GYRO" position, both images are on, and the angle set up between the gyro pip and the fixed cross forms the angle between the line of sight and the bore axis of the guns, thus indicating the size of the lead angle. In the "GYRO" position, only the gyro image is visible. This provision is made for pilots who prefer to use only the gyro image when tracking.

4-13. TESTING FIRE CONTROL SYSTEM.

4-14. To ground test the MK 6, Mod 0, fire control system, observe the following procedure:

a. Power control switch—"OFF."

b. Master gun switch—"ON."

c. Landing gear control handle—"LAND."

d. Attach external source of electric power, and check to make sure master gun switch is automatically thrown to "OFF" (this may take approximately 30 seconds). The master gun switch being thrown to "OFF" indicates that the armament safety limit switches are operating properly.

e. With power control switch "OFF" and external electric power connected, push armament disabling safety switch (in the nose wheel well) and then turn master gun switch "ON."

f. Place gun sight selector switch in "FIXED" position. Only fixed reticle image should be visible. Move reticle masking lever up and down to determine whether it blacks out area below fixed cross. Check masking lever for freedom of travel.

g. Move selector switch to "FIXED & GYRO" position. Both reticle images should be visible. Determine whether images are properly aligned.

h. Place selector switch in "GYRO" position. Only gyro image should be visible.

i. Move selector switch back to "FIXED & GYRO" position. Rotate gun sight dimmer to ascertain whether it varies light intensity of images.

j. Check for image parallax. Examine one image at a time, moving the eye from side to side over the width of the lens opening. There should be no apparent shift of the reticle image with respect to the target as the eye is moved. If the image shifts or moves more than 3 mils in any direction, the lens is out of focus and the sighting head should be replaced.

k. Operate throttle ranging grip. The gyro image (pips) diameter should decrease as the grip is rotated clockwise (as viewed from the inboard end), and increase as the grip is rotated counterclockwise.

l. Place throttle ranging grip in extreme aft (counterclockwise as viewed from inboard end) position and look through window on sight gear adapter. The range drum should be positioned so that the numeral "6" is adjacent to the index mark. Rotate grip to extreme forward (clockwise) position. The range drum should be positioned so that the numeral "24" is aligned with the index mark.

m. Check movement of span-setting handle over span dial. Movement should be free throughout entire range. With handle at the extreme left-hand (high) end of the scale, turn range drum to minimum range (600 feet). The handle should not move as the drum is turned. If the handle moves, there is not sufficient friction between the handle and crash pad plate. Pressing against the crash pad to bend the plate slightly will usually remedy this condition.

n. Open gun sight lamp cover and examine lamps. If they show signs of blackening, replace them. Make certain that two new spare bulbs are installed in the stowage clips.

o. Check color of silica gel in cell at back of the sight. Dry silica gel should be bright blue.

4–15. OXYGEN SYSTEM.

4–16. GENERAL. *(See figures 4–2 and 4–3.)* The oxygen system consists of an oxygen cylinder, a cylinder recharging installation, and an automatic positive-pressure diluter-demand oxygen regulator with a built-in cylinder pressure gage and oxygen flow indicator. An adapter assembly, to which the pilot makes his oxygen mask connections for both normal and bail-out oxygen, is attached to a quick-disconnect receptacle on the left-hand control shelf. Oxygen from the high-pressure oxygen cylinder, located behind the seat bulkhead, is directed through suitable tubing to the automatic positive-pressure diluter-demand regulator and then to the receptacle and adapter assembly. In an emergency seat ejection, the adapter assembly will automatically be disconnected from the quick-disconnect receptacle and the pilot's normal oxygen supply will be interrupted. The pilot's bail-out oxygen cylinder (government-furnished and -installed) will furnish the pilot oxygen only after the bail-out cylinder ring has been pulled. The ring may be pulled, at the pilot's discretion, either before or after ejection. All oxygen tubes are color-coded with ½-inch bands of light green.

4–17. AUTOMATIC POSITIVE-PRESSURE DILUTER-DEMAND OXYGEN REGULATOR. *(See figure 4–4.)* The automatic positive-pressure diluter-demand oxygen regulator is located on the forward portion of the left-hand control shelf. All controls for operating the regulator are mounted on its face. Under normal conditions the air valve knob should be set in the "NORMAL OXYGEN" position. This provides the pilot with an air-oxygen mixture upon demand, that is, only upon inhalation. The exact ratio of air to oxygen depends upon altitude. (At altitudes above 28,000 to 32,000 feet pure oxygen is automatically supplied through the demand system.) If excessive carbon monoxide or other noxious or irritating gas is present, the air valve knob should be switched to the "100% OXYGEN" position regardless of altitude. This setting will provide pure oxygen through the demand system. If symptoms suggestive of anoxia occur, the

OXYGEN CONSUMPTION TABLE

APPROXIMATE HOURS OF OXYGEN — ONE MAN — AIR VALVE "NORMAL OXYGEN"

CYLINDER PRESSURE	ALTITUDE IN FEET							
	5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000
1800	7.5	9.0	8.5	6.9	4.1	3.1	4.2	4.2
1500	6.0	7.5	6.7	5.5	3.2	2.4	3.3	3.3
1200	4.5	5.4	5.1	4.1	2.4	1.8	2.5	2.5
900	3.0	3.6	3.4	2.7	1.6	1.2	1.6	1.6
600	1.5	1.8	1.7	1.3	0.8	0.6	0.8	0.8
300	Descend Below 10,000 Feet							

One 514 Cubic Inch Cylinder—Automatic Positive-Pressure Diluter-Demand Regulator

Figure 4–2. Oxygen Consumption Table

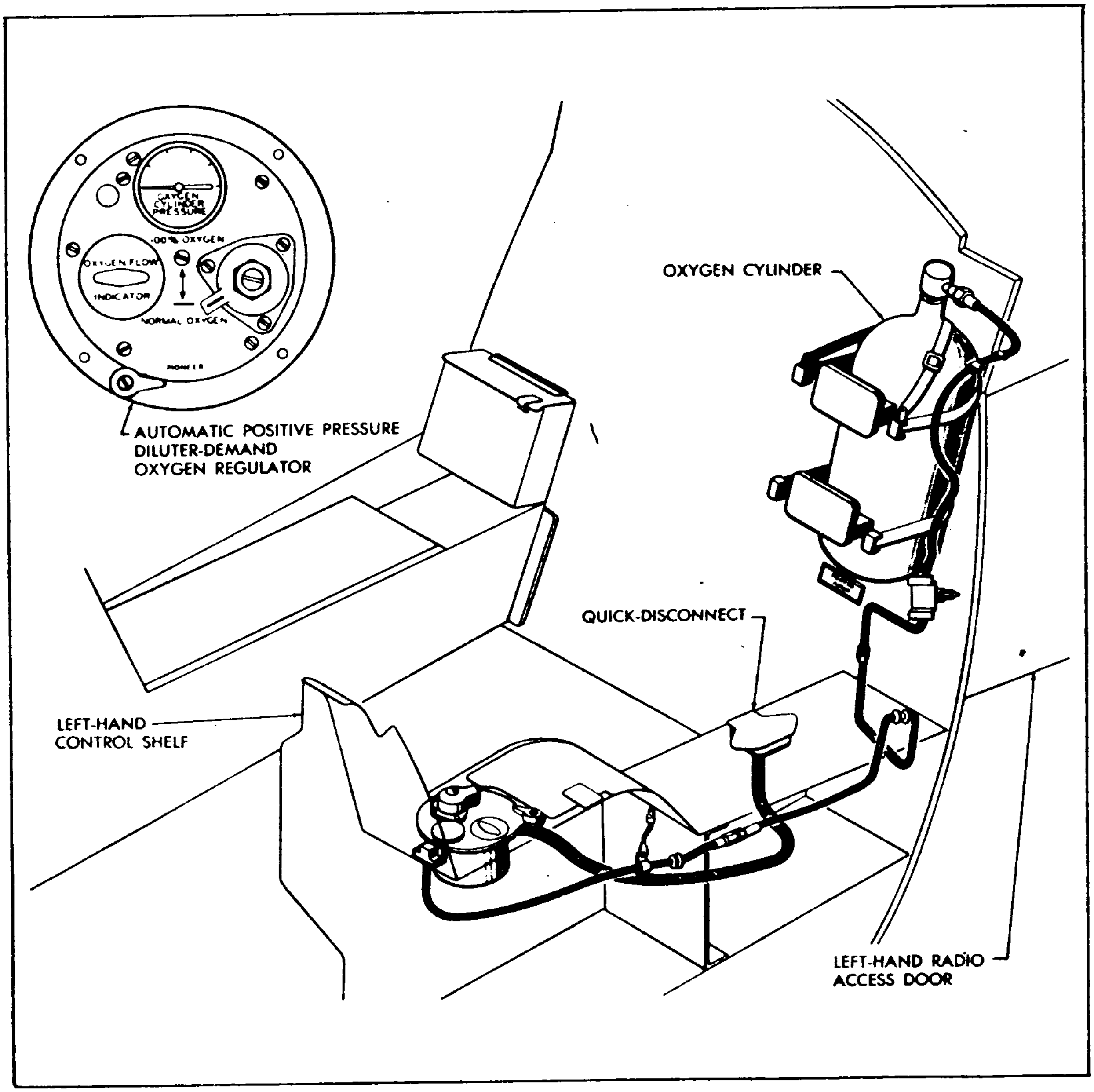


Figure 4-3. Oxygen System

safety knob should be operated. This will deliver oxygen to the mask at a pressure of 1¾ (±¼) inches of water, permitting a small pressure to build up inside the mask and will prevent inboard leakage at the mask. The safety knob may be used at any altitude at which anoxia is suspected; however, it should not be used routinely since the use of the safety pressure knob at low altitudes reduces the effectiveness of the air diluter and causes increased oxygen consumption. At equivalent cabin pressures above 35,000 feet, oxygen as required is automatically delivered to the mask and operation of the safety pressure knob is unnecessary and may be uncomfortable. If for any reason the regulator becomes inoperative in flight, the oxygen bail-out equipment should be activated and the pilot should descend below 10,000 feet. With a tight mask and with the regulator supplying 100 percent oxygen, the maximum ceiling is approximately 43,000 feet. The pressure gage on the regulator indicates oxygen cylinder pressure at all times. The cylinder pressure should not be exhausted below 300 psi except in an emergency.

4-18. OXYGEN FLOW INDICATOR. A shutter-type oxygen flow indicator on the regulator blinks rapidly when the regulator is functioning properly and pro-

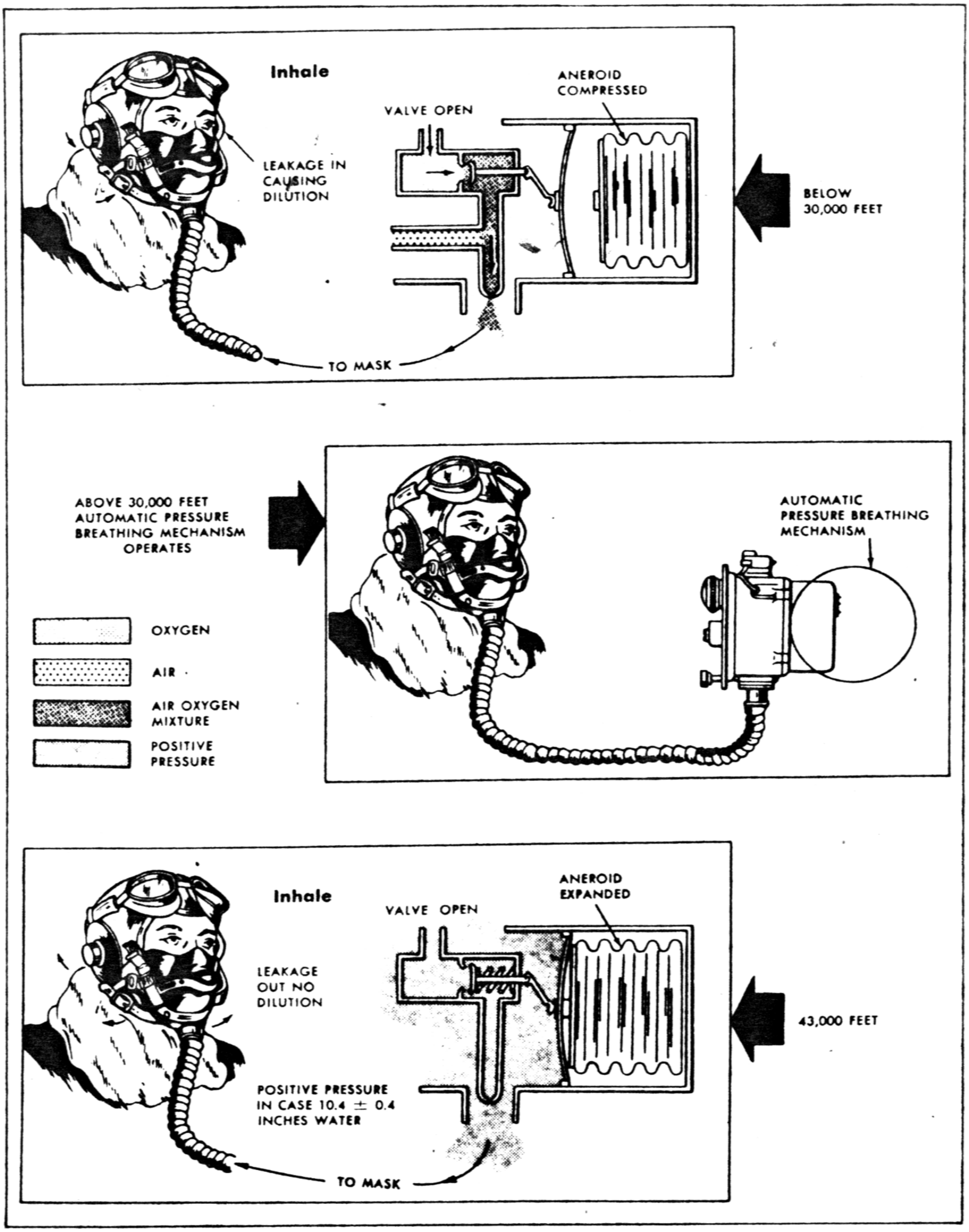


Figure 4–4. Oxygen Regulator

viding the pilot with undiluted oxygen or air-oxygen mixture.

4–19. OXYGEN SYSTEM PRESSURE GAGE. A pressure gage incorporated into the face of the regulator indicates oxygen system pressure.

4–20. BREATHING TUBE. The standard breathing tube extends into the cockpit in conjunction with the quick-disconnect apparatus at the aft end of the left-hand control shelf.

4–21. OXYGEN MASK. It is recommended that a pressure breathing type mask, such as type A-13, be used with the automatic positive-pressure diluter-demand regulator. A leak-proof fit of the mask around the face is essential to insure the proper supply of oxygen at high altitudes.

4–22. PREFLIGHT CHECK PROCEDURE. The following check should be made prior to each flight in which oxygen is to be, or is likely to be, used:

a. Oxygen system pressure gage should read 1,800 psi if cylinder is fully charged. If the cylinder pressure has decreased by more than 50 pounds in 24 hours, the leakage is excessive and the system should be submitted to a "Ground Crew Test" prior to use.

Note

An increase of 3.5 psi for each degree (Fahrenheit) that the temperature rises above 70°F, and a decrease of 3.5 for each degree that the temperature drops below 70°F are to be allowed for temperature changes.

b. Put on mask. Check fit by placing thumb over disconnect at end of mask tube and inhaling lightly. If mask is leak-proof, it will adhere tightly to the face and inhalation will be resisted. If mask leaks, tighten mask suspension straps and/or adjust the nose wire. DO NOT USE A MASK THAT LEAKS.

c. Connect mask to oxygen system tube.

d. Breathe several times with the regulator valve in the "NORMAL OXYGEN" and "100% OXYGEN" positions in turn, to check regulator operation, and observe oxygen flow indicator for "blink," verifying positive flow of oxygen.

Note

Since oxygen flow at sea level is negligible when the regulator is in the "NORMAL OXYGEN" position, the flow meter may not operate on the ground when the regulator handle is in that position. In this case, turn the air valve to "100% OXYGEN" position and test again. The air valve should be turned to "NORMAL OXYGEN" after the check.

CAUTION

Do not exhaust cylinder supply below 300 psi except in case of emergency.

4–23. OPERATING INSTRUCTIONS.

a. Use oxygen constantly during day flights when the airplane altitude exceeds 10,000 feet, during night flights when the airplane altitude exceeds 5,000 feet, when on combat missions, and when on training missions simulating combat.

b. Check the pressure gage. (The pressure gage should read approximately 1,800 psi for a fully charged cylinder.)

c. Set the air valve to "NORMAL OXYGEN" for normal flight conditions. Only when the presence of carbon monoxide or other noxious gases is suspected should the air valve be set to "100% OXYGEN."

d. Put on oxygen mask, fully engage disconnect coupling, and attach clip to shoulder harness sufficiently high on the chest to permit unimpeded movement of the head.

e. Check mask fit periodically by squeezing mask tube and inhaling lightly. If there is no leakage, mask will adhere tightly to the face and definite resistance to inhalation will be encountered. If mask leakage is indicated, tighten mask suspension.

f. Breathe normally. Make frequent checks of the following:

(1) Cylinder pressure gage for amount of oxygen remaining.

(2) Oxygen flow indicator for flow of oxygen through the regulator.

(3) Mask fit by squeezing tube and inhaling.

g. Do not exhaust supply cylinder below 300 psi except in case of an emergency.

Note

The safety pressure knob may be used at any altitude at which anoxia is suspected; however, it should not be used routinely since the use of the safety pressure knob at low altitudes reduces the effectiveness of the air diluter and causes increased oxygen consumption. If for any reason the regulator becomes inoperative in flight, the oxygen bail-out equipment should be activated and the pilot should descend below 10,000 feet.

4–24. COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

Table 1. Communication and Associated Electronic Equipment

Type	Designation	Use	Figure Reference	Remarks
VHF	AN/ARC-1	Two-way voice communication.	4-5	Frequency range 100 to 156 megacycles.
Navigation Radio	AN/ARR-2A	Navigation receiving	4-5	Frequency range 234 to 258 megacycles.
IFF	AN/APX-6	Identification	4-5	
Radio Compass	AN/ARN-6	1. Homing compass 2. Position finding 3. Receiver 4. Direction finder	4-5	Frequency range 100 to 1,750 kilocycles.
Radio Altimeter	AN/APN-1	Measures absolute altitude	4-7	Frequency range 420 to 460 megacycles.
Radar Range Equipment	AN/APG-30	Automatic ranging	4-6	

4–25. OPERATION OF RADIO EQUIPMENT.

4–26. UPON ENTERING COCKPIT. The radio control panels on the right-hand control shelf provide remote control of the electronic equipment except for microphone operation, radio compass indicator, radio altimeter, and radar range control. The radar control panel is located on the aft end of the left-hand control shelf. The radio compass indicator and radio altimeter are located on the instrument panel. The microphone switch and manual ranging control are integral components of the right-hand engine throttle control. The master radio switch must be on to operate the VHF (AN/ARC-1), navigation radio (AN/ARR-2A), and radio compass (AN/ARN-6) equipment. All radio gear requires a 1-minute warm-up period except the radar range equipment which normally requires a 15-minute warm-up period.

4–27. VHF VOICE COMMUNICATION. The VHF (AN/ARC-1) radio equipment provides 2-way voice communication between aircraft and ground stations on any of the nine prearranged main-channel communication frequencies or on a guard-channel frequency. Incoming signals are received at all times except during transmission. The change from the receiving to the transmitting condition is made simply by operating the microphone push button on the right-hand engine throttle control. An AT-145/B/A antenna on the underside of the right-hand wing outer panel is used jointly by this unit and the AN/ARR-2A equipment.

Note

For an actual operating test of the equipment, it is necessary that signals be present on the channels to be operated. In the absence of signals, the squelch circuit reduces the receiver output to zero so that it is impractical to gage receiver performance.

4–28. VHF RECEPTION.

a. Set power switch on master control panel to "ON" position, GUARD-MAIN switch to "BOTH" position, and CHAN-SEL switch to desired main channel. The equipment will be ready for reception of incoming signals on guard channel and selected main channel after vacuum tubes reach operating temperature.

b. To increase selectivity of signal while equipment is operating on main channel and monitoring guard channel ("BOTH" position of switch), turn switch to either "GUARD" or "MAIN T/R" position, depending upon incoming signal.

c. Control volume by use of COMM VOLUME knob on master control panel.

4–29. VHF TRANSMISSION. Communication transmission with the VHF equipment is controlled by the same operations as receiving and may be accomplished by simply depressing the microphone button on the throttle control handle. When the GUARD MAIN switch is in the "MAIN T/R" or "BOTH" positions, transmission takes place on the selected channel (i.e., 1, 2, 3, etc.). When the switch is in the "GUARD" position, transmission takes place on the guard channel.

WARNING

These instructions are subject to local limitations regarding radio silence.

4–30. NAVIGATION RECEPTION. The navigation receiver (R-4A/ARR-2) is a remotely controlled superheterodyne receiver used for navigation operations. It receives either voice or telegraph signals on any one of six modulated-frequency channels. When used for navigation, a beat frequency oscillator produces an audible beat note, and when used for reception of voice modulation, the beat note oscillator is cut out.

4–31. NAVIGATION RECEPTION — OPERATION.

a. Turn master radio switch "ON."

b. Set CHAN-SEL switch to assigned channel number.

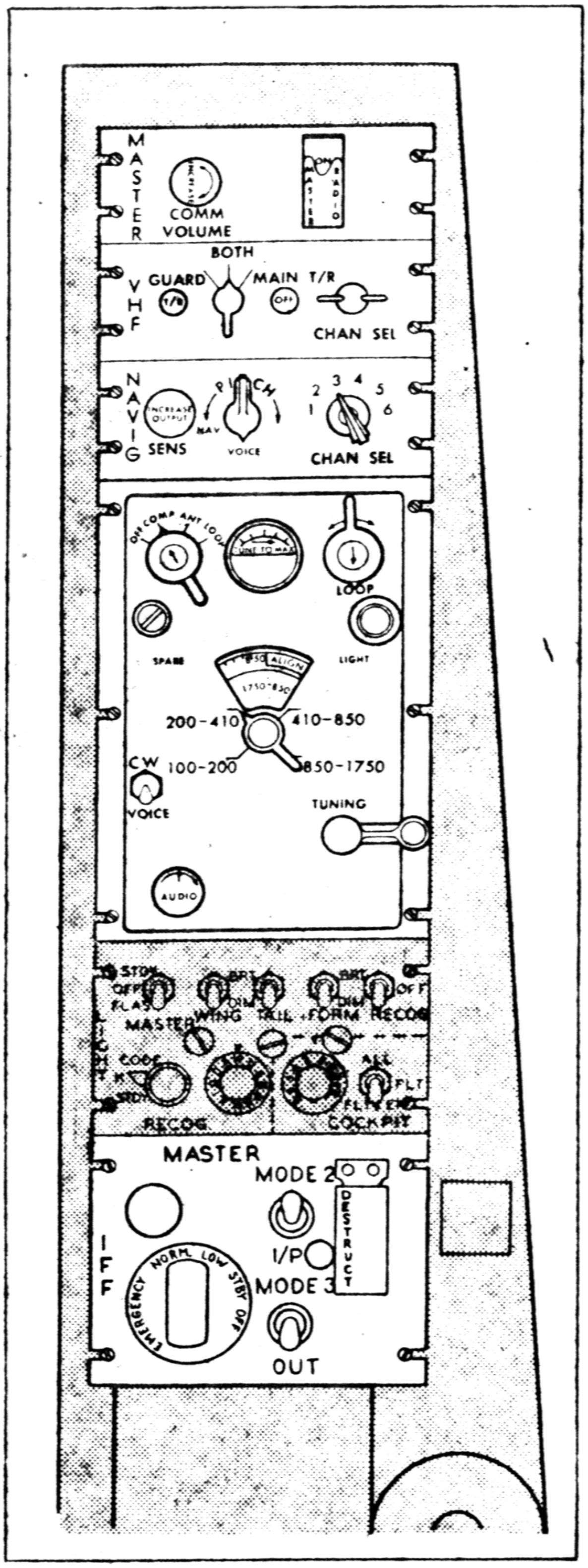


Figure 4-5. Radio Console

c. Set NAV-VOICE control to "NAV." The "VOICE" setting is not used for navigating. If "VOICE" is to be used, special instructions are given before take-off.

d. Increase volume by turning SENS control slowly clockwise to obtain a usable signal.

e. Adjust PITCH control for clear tone and re-adjust SENS control for audible signal.

Note

Minimum volume is essential for accurate interpretation of navigation signals. Loud signals can be inaccurate.

4-32. RADIO COMPASS (AN/ARN-6). The radio compass equipment is designed to guide the aircraft to a transmitting station at its destination or to take bearings on transmitting stations as an aid to navigaion. The radio compass indicator continuously indicates the direction of the transmitting station with respect to the aircraft heading. While the equipment is being used as a radio compass, the pilot can also hear the station signals and thus obtain weather reports or other flight information. In addition, it may be used as a radio communication receiver. The control panel is located on the right-hand control shelf, and the indicator is located on the instrument panel. The radio compass can be used to perform the following major functions: homing compass operation, position finder using automatic and aural-null methods, and receiver operation using "ANT." or "LOOP."

4-33. RADIO COMPASS—HOMING OPERATION. To use the radio compass unit for homing operation, use the following procedure:

a. Turn function switch (OFF-COMP-ANT-LOOP switch) to "COMP" position.

b. Rotate band switch to select frequency range in which operation is desired.

c. Turn TUNING crank to desired station frequency and tune for maximum swing of tuning meter. Place CW-VOICE switch in "CW" position for greater tuning accuracy and return switch to "VOICE" position after tuning.

d. Adjust AUDIO (volume) control for desired headset level.

e. Listen for station identification to be sure that correct station is being received.

f. Turn VAR knob on indicator located on instrument panel until azimuth zero is at index.

g. Indicator pointer will now show bearing of station relative to aircraft heading. For aircraft homing, aircraft must be turned so that indicator pointer is at zero and station is directly ahead. Correction must be made for crosswinds as described in the Handbook of Maintenance Instructions for AN/ARN-6 equipment (AN 16-30ARN6-3).

4–34. AUTOMATIC POSITION-FINDING OPERATION. Use the following procedure to take automatic bearings for a radio fix.

a. Select three stations whose geographical locations are approximately equally spaced about the airplane, tune them in, identify each, and log their dial readings.

b. Adjust VAR knob on indicator until its bearing scale at index is same as true magnetic heading of airplane.

c. Set function switch to "COMP."

d. Tune in selected stations one after another in rapid succession while flying a steady level heading and record bearing of each as indicated by "tail" of indicator pointer.

e. Recorded bearings will be station-to-airplane bearings from north and may be plotted to obtain a position triangle.

4–35. AURAL-NULL POSITION-FINDING OPERATION. Use the following procedure to obtain aural-null bearings for a radio fix:

a. Select three stations to be used and set indicator bearing scale as described in paragraph 4–34.

b. Set function switch to "LOOP."

c. Tune in desired station, rotating loop, if necessary, by means of the LOOP L-R switch for maximum signal. Direction and speed of loop rotation are controlled by direction and amount of LOOP L-R switch rotation, respectively.

d. Use LOOP L-R switch as directed in step c to rotate loop for minimum headset volume and record bearing shown by indicator pointer. Definition of null may be obtained by using "CW" operation and by turning AUDIO control fully clockwise and locating null by either listening for minimum audio signal or noting a counterclockwise dip of tuning meter pointer.

e. Position finding in "LOOP" operation is subject to a 180-degree error since there are two null points in a 360-degree rotation of the loop. This error is overcome by keeping aware of the general geographical location and by selecting stations located well to either side of the course.

4–36. RECEIVER OPERATION WITH NONDIRECTIONAL ANTENNA. Use the following procedure for receiver operation using nondirectional antenna:

a. Turn function switch to "ANT."

b. Turn band switch to desired frequency range.

c. Throw CW VOICE switch to "CW" for reception of unmodulated signals or to "VOICE" for reception of modulated signals.

d. Tune in desired station with TUNING crank.

e. Adjust AUDIO control for desired headset volume.

4–37. RECEIVER OPERATION WITH LOOP ANTENNA. The procedure for receiver operation with the loop antenna is the same as the procedure described in paragraph 4–36 except that the function switch is set on "LOOP" and the loop must be adjusted for maximum signal using the LOOP L-R switch. Readjustments of loop may be necessary, especially if the flight course is not straight.

Note

Cone-of-silence indications of radio ranges are not always reliable while receiving on "LOOP."

4–38. IFF EQUIPMENT. The Radar Identification Set AN/APX-6 is an airborne transpondor and is one of several equipments which may be operated together to provide a system of electronic identification and recognition. The purposes of the AN/APX-6 IFF equipment are: (1) to identify the airplane in which it is installed as friendly when correctly challenged by an interrogator-responsor associated with friendly shore, shipboard, and airborne radars and (2) to permit surface tracking and control of aircraft in which it is installed. Functionally, the AN/APX-6 IFF equipment receives challenges, which are initiated by an interrogator-responsor, and transmits replies back to the interrogator-responsor where the replies are displayed, along with the associated radar targets, on the radar indicators. When a radar target is accompanied by a proper IFF reply, as transmitted by the AN/APX-6 IFF equipment, that target is considered friendly.

4–39. IFF EQUIPMENT—OPERATION. *(See figure 4–5.)* All controls required for operation of the AN/APX-6 IFF equipment are located on the C-544/APX-6 Radar Set Control. This unit is located on the right-hand control shelf and operation is as follows:

Note

A-C power required for the operation of the AN/APX-6 equipment must come from the main inverter, therefore, the AN/APX-6 equipment cannot be operated if the stand-by inverter is in operation.

(1) To turn equipment on, rotate MASTER selector to "NORM."

(2) To indicate emergency or distress, press red dial stop and rotate MASTER selector to "EMERGENCY."

(3) To maintain equipment ready for instant use but inoperative, rotate MASTER selector to "STDBY."

(4) The detent position labeled "LOW" on the MASTER selector should not be used except upon proper authorization.

(5) The switches labeled "MODE 2" and "MODE 3" should be set to their "OUT" positions unless otherwise directed by proper authority.

(6) To explode destructors within equipment, raise switch guard labeled "DESTRUCT" and raise switch handle to "ON" position.

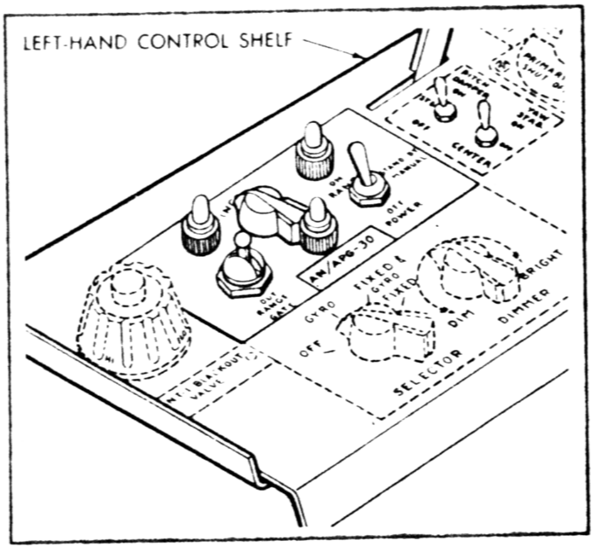


Figure 4–6. AN/APG-30 Control Panel

WARNING

Do not fire destructors unless the AN/APX-6 IFF equipment is in danger of falling into enemy hands. When in doubt about the security of the area you are *forced* to land in, fire the destructors.

(7) To secure equipment, rotate MASTER selector to "OFF."

(8) If destructors were fired during flight, notify your Commanding Officer.

4–40. RADAR RANGE EQUIPMENT. The radar range equipment, AN/APG-30, automatically provides continuous and accurate radar range information to the optical fire control system in the airplane. Every second the radar makes three searches through the range from 150 to 3,000 yards. The search is made with a beam whose half-power points are found within an 18-degree cone. Upon encountering a target in a search, the radar automatically locks and thereafter tracks the target *in range* at a maximum tracking rate of 1,000 knots per hour. The pilot is automatically warned that the radar is locked on and tracking a target by a red warning light on the control panel on the left-hand control shelf. As soon as the radar is locked, the target range voltage is automatically fed into the computer through the computer servo system.

Note

A-C power required for the operation of the AN/APG-30 equipment must come from the main inverter, therefore, the AN/APG-30 equipment cannot be operated if the stand-by inverter is in operation.

4–41. RADAR RANGE — OPERATION. This system operates on the pulse transmission, reflection, and detection radar principle. These pulses of r-f energy are transmitted from the transmitter-receiver unit through a waveguide directional coupler to a cone-shaped horn antenna. The target echoes are received by the antenna that transmits the pulses and the detected return signal is fed to the range unit. This unit makes use of double range gates that will automatically lock on and track the target *in range*. The pilot is informed by a glowing light that the range to the target is being continuously fed to his gun sight. The range unit computes the range, transforms it into d-c voltage, which varies linearly with the time interval between transmission and reception, and supplies it to the range servo. This unit converts the high-impedance d-c radar range voltage to another voltage with the proper characteristics to drive the gun sight controller, which in turn drives the mechanical output cable to position the range shaft of the lead-computing gun sight at a setting corresponding to the target range. The pilot can control the operation of the system through the control unit mounted on the left-hand side of the cockpit. (Additional information about the AN/APG-30 equipment is given in paragraph 4–8.)

4–42. RADIO ALTIMETER (AN/APN-1). The radio altimeter is used to provide direct measurement of "absolute altitude" (terrain clearance) during flight. The equipment provides altitude within two ranges: a low range from 0 to 400 feet and a high range from 400 to 4,000 feet. The altitude indicator reading will

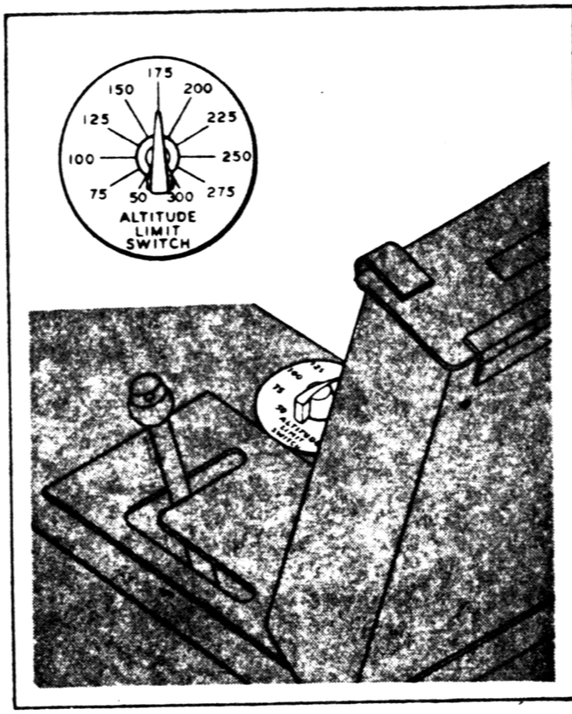


Figure 4–7. Radio Altimeter Limit Switch

normally fluctuate with changes in terrain clearance when flying over rough or obstructed terrain, or through bumpy air. At drop-out altitudes, that is, altitudes considerably above the upper limits of either range of the altimeter, the altitude indicator pointer may be expected to fall back from its full stop position.

4-43. RADIO ALTIMETER—OPERATION. Use the following procedure for operating the AN APN-1 radio altimeter:

a. Set RANGE switch on indicator located on instrument panel to required range. When on ground or in flight at an altitude below 400 feet, always use low range (0 to 400 feet). When in flight at an altitude above 400 feet, use high range (400 to 4,000 feet).

WARNING

The high range is not calibrated for and must not be used at altitudes below 400 feet. Under conditions of poor visibility, always use the low range when flying at altitudes below 600 feet.

b. Set altitude limit switch, located on right-hand control shelf, for desired preset altitude (altitude of reference for limit indicator). The red light, located on the instrument panel, is the altitude limit indicator signal. This light indicates flight below the control range corresponding to the preset altitude determined by the altitude limit switch setting, thereby relieving the pilot of constant attention to the altitude indicator scale. The setting of the altitude limit switch may be changed at any time to a new preset altitude.

c. Power control switch —"BATTERY AND GENERATOR."

d. Power switch on indicator clockwise to "ON" position.

e. After allowing an interval of approximately one minute for tubes to heat, pointer of indicator will have moved from its sub-zero stop position to some other position, indicating that equipment is operating.

CAUTION

When the airplane is on the ground, the indicator pointer may not indicate zero reading for this condition.

f. To stop the equipment, turn the power switch counterclockwise to "OFF" position.

4-44. PILOT'S RADIO AND RADAR CHECK LIST.

4-45. BEFORE TAKE-OFF. The pilot shall make the following radio equipment check before take-off.

a. Check with line crew to make sure that a complete destructor circuit test has been made for IFF equipment.

b. Connect quick-disconnect headphone cord to receptacle on left-hand control shelf.

c. Set power control switch—"BATTERY AND GEN."

d. Set main inverter circuit breaker control switch —"RESET."

e. Set inverter transfer switch—"MAIN."

f. Master radio switch—"ON."

g. Set up VHF receiver controls and adjust COMM-VOLUME knob on master panel.

h. Set up NAVIG controls.

i. Set up radio compass controls.

j. Set up IFF controls.

k. Set up radio altimeter controls.

l. If local security regulations permit, select desired transmitter channel and make test transmission with base station on VHF.

m. Turn radar range power switch to "ON" and check for illumination of green and amber lights on control panel. Turn power switch "OFF."

Note

If the flight is to be a combat mission, the radar range equipment must be submitted to a ground crew check prior to take-off.

4-46. AFTER LANDING. The following check should be made after landing.

a. Turn radio master switch "OFF."

b. Turn master control on IFF panel "OFF."

c. Turn radar range power switch "OFF."

d. Turn power control switch "OFF."

4-47. AIR-CONDITIONING AND PRESSURIZING.

4-48. GENERAL. The high-altitude performance of this airplane and the potentially extreme temperature changes imposed on the cockpit from various combinations of air friction and ambient air temperatures demand an air-conditioning and pressurizing system for the safety and increased efficiency of the pilot.

4-49. The main components of the system are: a refrigeration unit assembly with an air-driven turbine, an automatic cabin pressure regulator, a dump safety valve, an electrical thermostat system, and an emergency fresh air door. Hot air for the pressurizing and air-conditioning system is taken from the two jet engine compressor sections, and cooled as necessary in the refrigeration unit, from which it enters the cockpit area through three inlet ports. The normal air exhaust from the cabin is through the pressure regulator. Switches for controlling the pressurizing and air-conditioning equipment are located on the right-hand control shelf. The main components of the electrical system are: a cabin thermostat, a supply air anticipator, a control box, and the control switches. Emergency fresh air is obtained by opening the door located in the lower aft portion of the right-hand side of the wind-

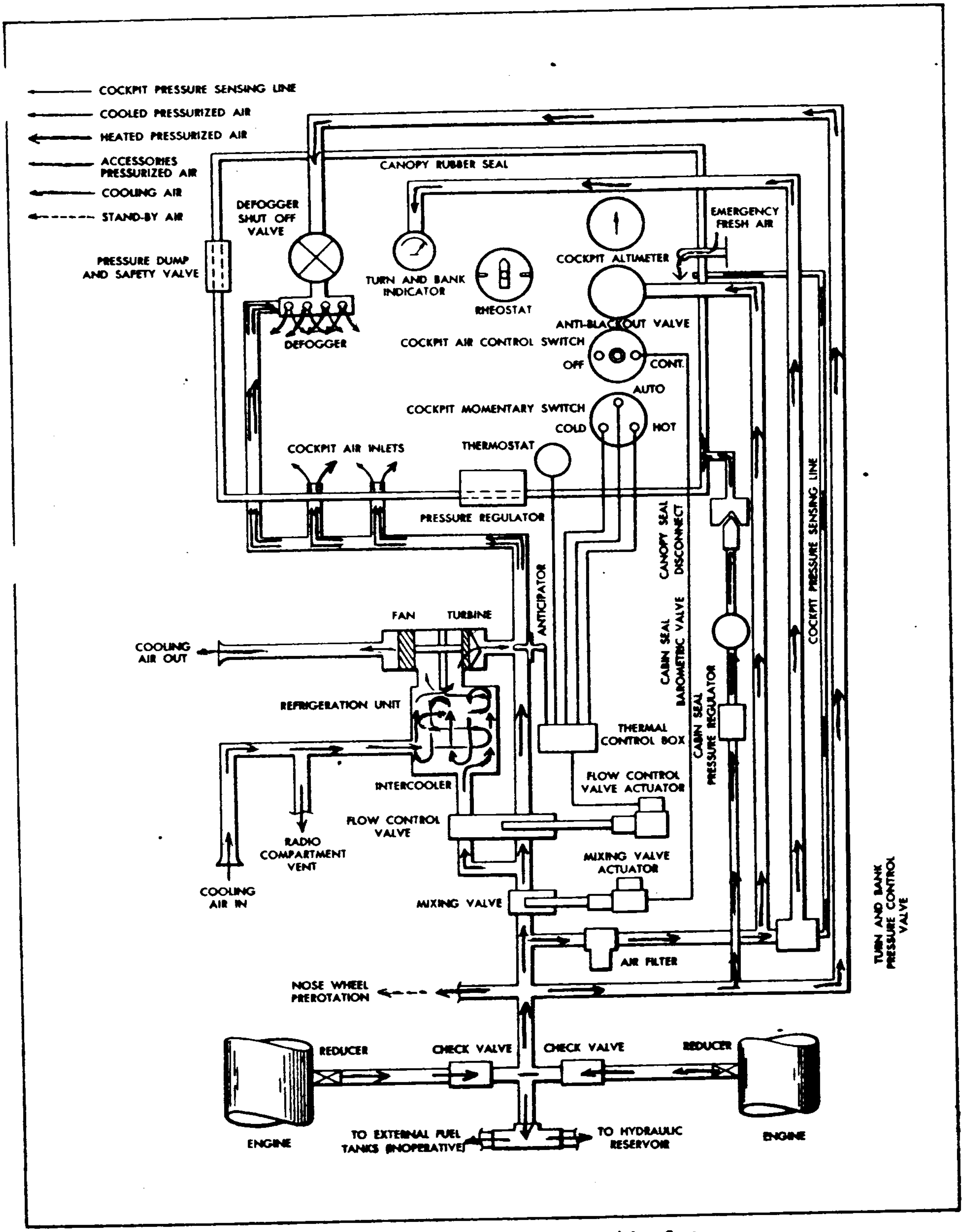


Figure 4-8. Air-Conditioning and Pressurizing System

shield when the air-conditioning switch is in the "OFF" position.

Note

Except when selecting emergency fresh air, this door shall be tightly closed to avoid leakage.

4–50. The system provides for cockpit pressurization as follows: Up to 10,000 feet cabin altitude, there is no pressurization. At cabin altitudes above 10,000 feet, the cabin altitude pressure is maintained at the 10,000-foot airplane altitude value until the airplane reaches 18,000 feet, at which time a 2.75-psi pressure differential between cabin altitude and airplane altitude is reached. From 18,000 feet to 38,000 feet, the 2.75-psi pressure differential is maintained, and above 38,000 feet the pressure differential is reduced to within safe limits under conditions of explosive decompression.

4–51. COCKPIT TEMPERATURE CONTROL. To obtain normal cockpit temperature (70 F), operate the system control switches as follows:

a. Place air-conditioning switch "ON."

b. Place COCKPIT AIR TEMP CONTROL rheostat in neutral (control knob in vertical position).

c. Place cockpit air momentary override switch in "AUTO." The above switch settings will, through the anticipator and the thermostat, automatically seek the normal cockpit temperature of 70 F at all times except for short periods at extreme operating conditions.

Note

When taking off in rain or on a slushy runway, the air-conditioning switch should be in the "OFF" position to prevent fogging in the cockpit.

4–52. If it is desirable to have the cockpit temperature above or below 70 F, the COCKPIT AIR TEMP CONTROL rheostat may be turned either counterclockwise for "COLD," or clockwise for "HOT" position. If the "HOT" position is selected and still more heat is desired, it may be obtained by setting and holding the COCKPIT AIR momentary override switch in the "HOT" position and returning to "OFF" when desired heat is obtained. This will override the anticipator and the thermostat. No automatic temperature control is provided with the COCKPIT AIR momentary switch in the "OFF" position. Changes in altitude, power, and/or airspeed will cause large and rapid changes in supply air temperature. It is therefore recommended that manual control be used only when necessary in steady level flight. A fresh air intake door is installed to provide additional fresh air according to the needs of the pilot. By rotating the cup, located on the right-hand side of the windshield at station 42.5, a scoop is projected into the air stream and fresh air is scooped into the cockpit.

Note

When high ambient humidity and temperature exist, fog or snow may enter the cockpit from the air-conditioning system. To aid in dispersing fog, the rheostat may be adjusted to "HOT."

4–53. COCKPIT PRESSURE. A pressure regulator, which is vented to outside atmospheric pressure through a hole in the floor on which it is mounted, maintains a pressure differential between the inside and the outside of the cockpit by controlling the rate of discharge from the cockpit. The regulator controls cabin pressures at altitudes above 10,000 feet. Below 10,000 feet there is no pressurization. At altitudes ranging between 10,000 feet and 18,000 feet, the 10,000-foot airplane altitude value is maintained. At altitudes between 18,000 feet and 38,000 feet, a 2.75-psi pressure differential is maintained, and above 38,000 feet, the pressure differential is reduced to within safe limits under conditions of explosive decompression.

4–54. A pressure dump and safety valve is provided for automatically dumping the cockpit pressure when the pre-ejection seat control handle is operated; for relieving the cockpit pressure automatically if the pressure exceeds a differential of 3.0 (±.03) psi; and for relieving a negative cockpit pressure with respect to atmosphere. If the pressure regulator does not relieve the cockpit pressure, the safety valve will relieve the pressure when a differential of 3.0 (±.03) psi is attained. If a negative cockpit pressure exists with respect to atmosphere, as in a steep dive, the safety valve will allow air to flow into the cockpit when the pressure differential exceeds 1 (±1) inch of water. The valve is installed through the seat bulkhead on the left-hand side of the cockpit.

4–55. The canopy is sealed automatically at altitudes above 10,000 feet through inflation of a hollow rubber seal. Air from the engine compressor sections is used for sealing the canopy. Air pressure to the seal is controlled automatically through a pressure control valve, check valve, and a barometric valve. A spring-loaded fitting on the right-hand side of the canopy mates with a socket fitting when the canopy is closed. When the airplane is below 10,000 feet, the barometric valve is closed, thereby shutting off the air passage to the cabin seal. The bellows within the valve expands at altitudes above 10,000 feet and closes off the by-pass; this allows air to pass into the cabin seal. The check valve delays the sudden loss of pressure through the intake line in the event of engine failure or use of low engine power at high altitude.

4–56. A defogger installation is used to diffuse hot air, bled from the engine compressors, over the entire flat portion of the windshield. A small amount of conditioned air enters the cabin from the defogger except when hot air defogging is utilized. Condensation may be prevented from forming on the inside of the windshield by proper use of the defogging in-

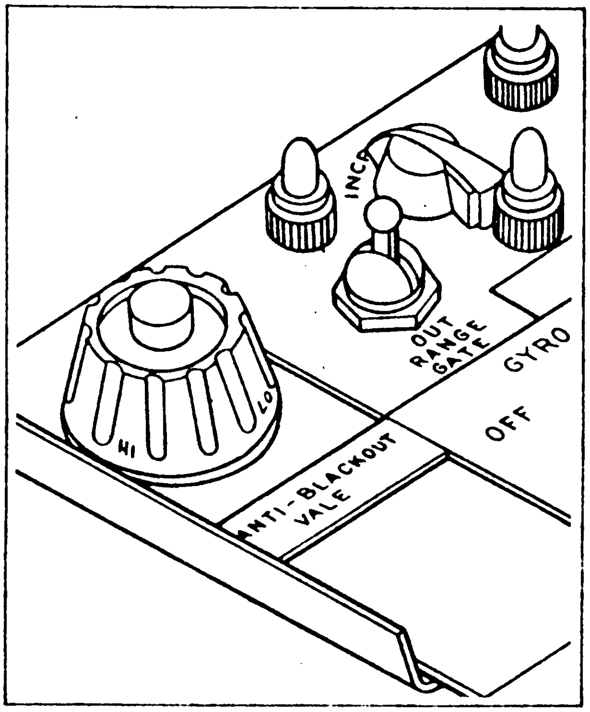


Figure 4–9. Anti-Blackout Valve

stallation. The defogger installation is controlled by the pilot by means of the defogger control knob located on the inclined panel of the right-hand control shelf.

Note

If fogging conditions are anticipated, the defogging system should be turned on at the earliest opportunity. Unless the system is in operation *before* actual fogging conditions are encountered, considerable time may be lost in raising the temperature of the windshield surface to clear it.

4–57. ANTI-BLACKOUT SYSTEM.

4–58. GENERAL. The anti-blackout suit system is installed for the purpose of inflating the pilot's coverall-type anti-blackout suit. Air pressure inflates the bladders in the suit around the calves, thighs, and abdomen of the pilot. The expanding bladders pull the suit tightly around the veins, causing the circulation in the lower part of the body to slow down and thus maintain a regular flow of blood to the head. The system is operated by pressure from the engine compressor line which is passed through an air filter and regulated by the anti-blackout control valve. There is a short length of tubing from the anti-blackout valve to the ejection seat quick-disconnect receptacle located on the aft end of the left-hand control shelf. (Paragraph 4–61 provides complete information on the quick-disconnect receptacle.) An accelerometer located on the instrument panel records the number of g's attained by the airplane. It is used by the pilot for reference in connection with the anti-blackout suit, but has no direct connection with the anti-blackout system.

4–59. ANTI-BLACKOUT VALVE. The anti-blackout control valve (Type JP-9V) is located on the aft end of the left-hand control shelf. When the top of the valve is adjusted to the "LO" setting, the valve governs the supply of pressure to the anti-blackout suit at 1.0 psi per g, starting at 1.75 g's. When turned to the "HI" setting, the valve governs the pressure at 1.4 psi per g, starting at 1.75 g's. The output in either case remains constant in spite of the variations in input pressure, and once the valve is set the operation is completely automatic. The valve is equipped with a push button for manual testing. This permits the pilot to pressurize the anti-blackout suit temporarily during flight or ground test.

4–60. QUICK-DISCONNECT UNIT.

4–61. The airplane is provided with a quick-disconnect unit to allow a complete break of the pilot's microphone, headset, heated flying suit, anti-blackout suit, and the main oxygen line from the airplane. (This break is accomplished when the pilot ejects the seat.) The main components of the quick-disconnect unit are a receptacle assembly, mounted on the left-hand control shelf of the airplane, and an adapter assembly with a connector assembly at its lower end. This connector assembly is released when the seat is ejected. A disconnect assembly is attached to the upper end of the adapter assembly—the lower half is part of the adapter assembly end, and the upper half is clipped to the pilot's flying suit. For a complete installation, the upper half is inserted into the lower half and then the pilot inserts his lines for anti-blackout, heated flying suit, microphone, and headset. The main oxygen connection is made by inserting the hose end of the mask into the upper half of the disconnect. The pilot's bail-out oxygen line is also inserted into this disconnect. The electrical connections from the adapter assembly are made when the connector at the lower end of the adapter is inserted into the receptacle mounted on the left-hand control shelf. (For complete information on the oxygen system, refer to paragraph 4-15; for complete information on the anti-blackout suit and valve, refer to paragraph 4–57.)

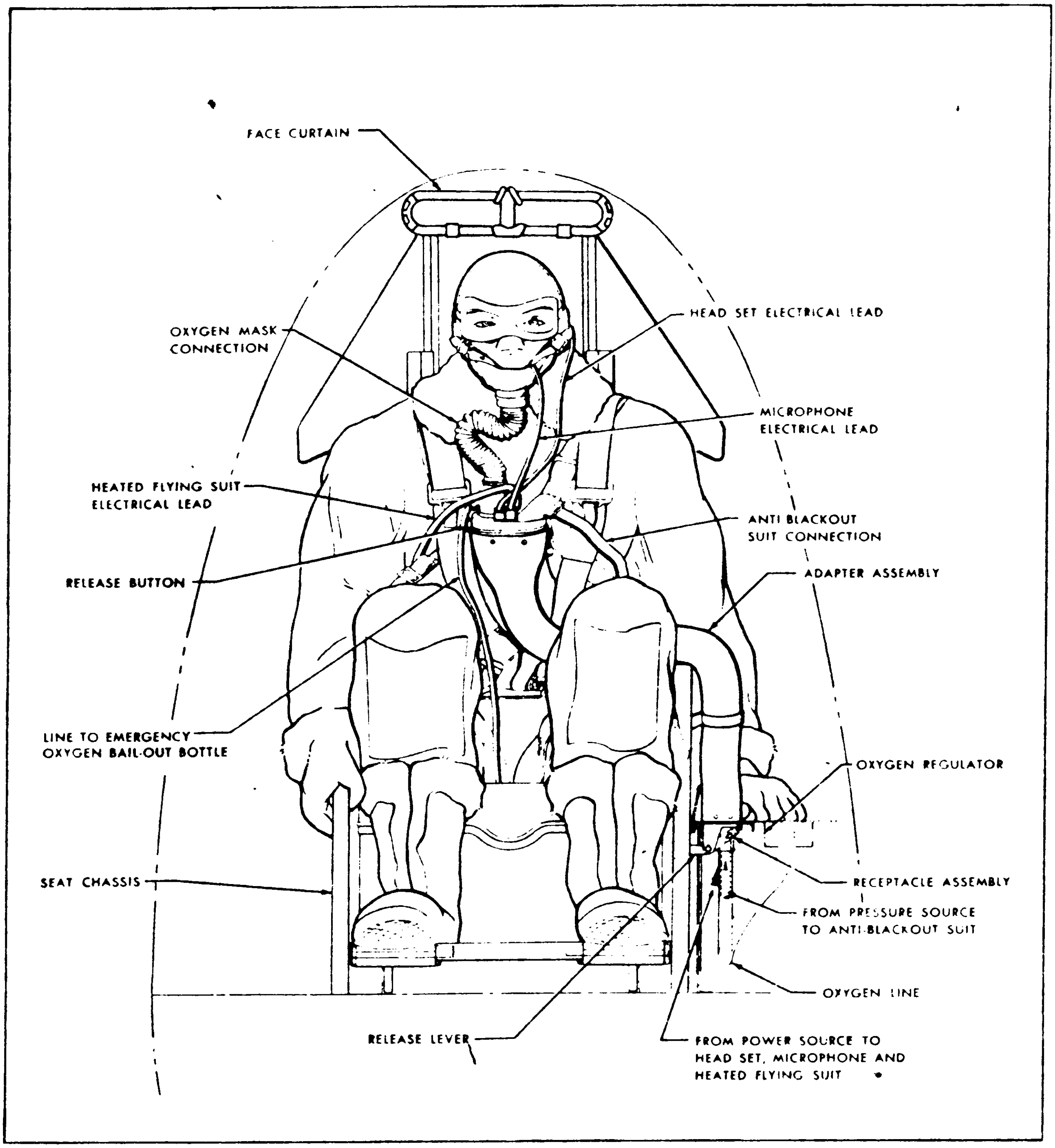
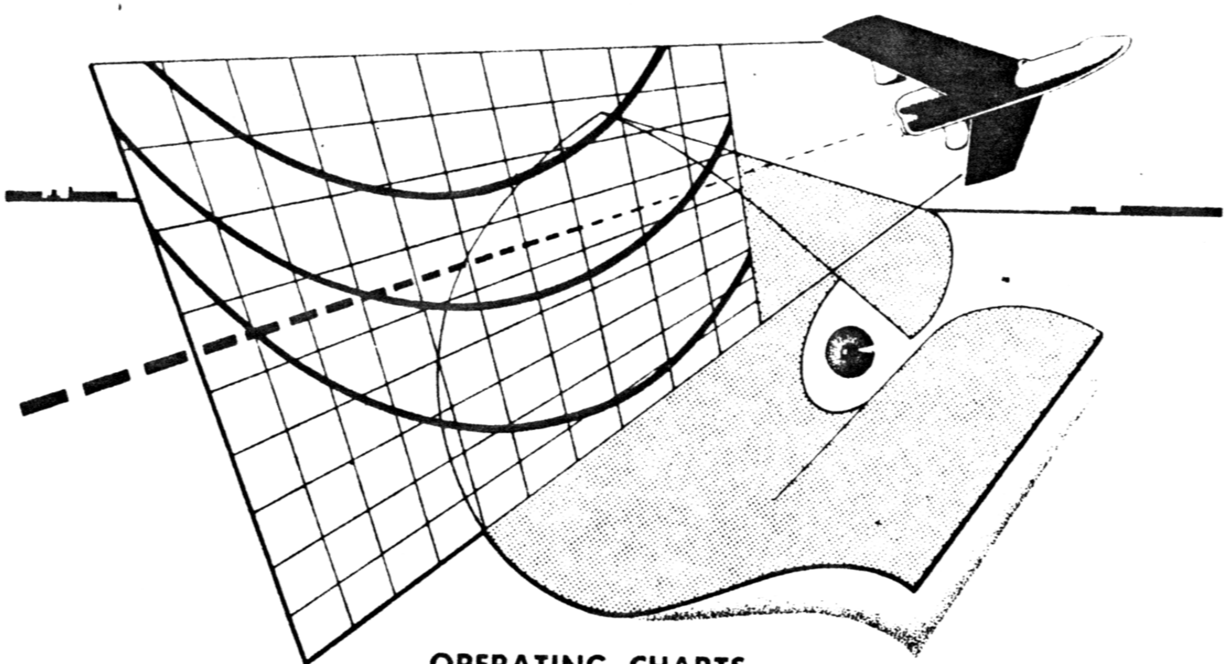


Figure 4–10. Pilot's Quick-Disconnect Unit

APPENDIX I



OPERATING CHARTS

INFORMATION WILL BE FURNISHED AT A LATER DATE

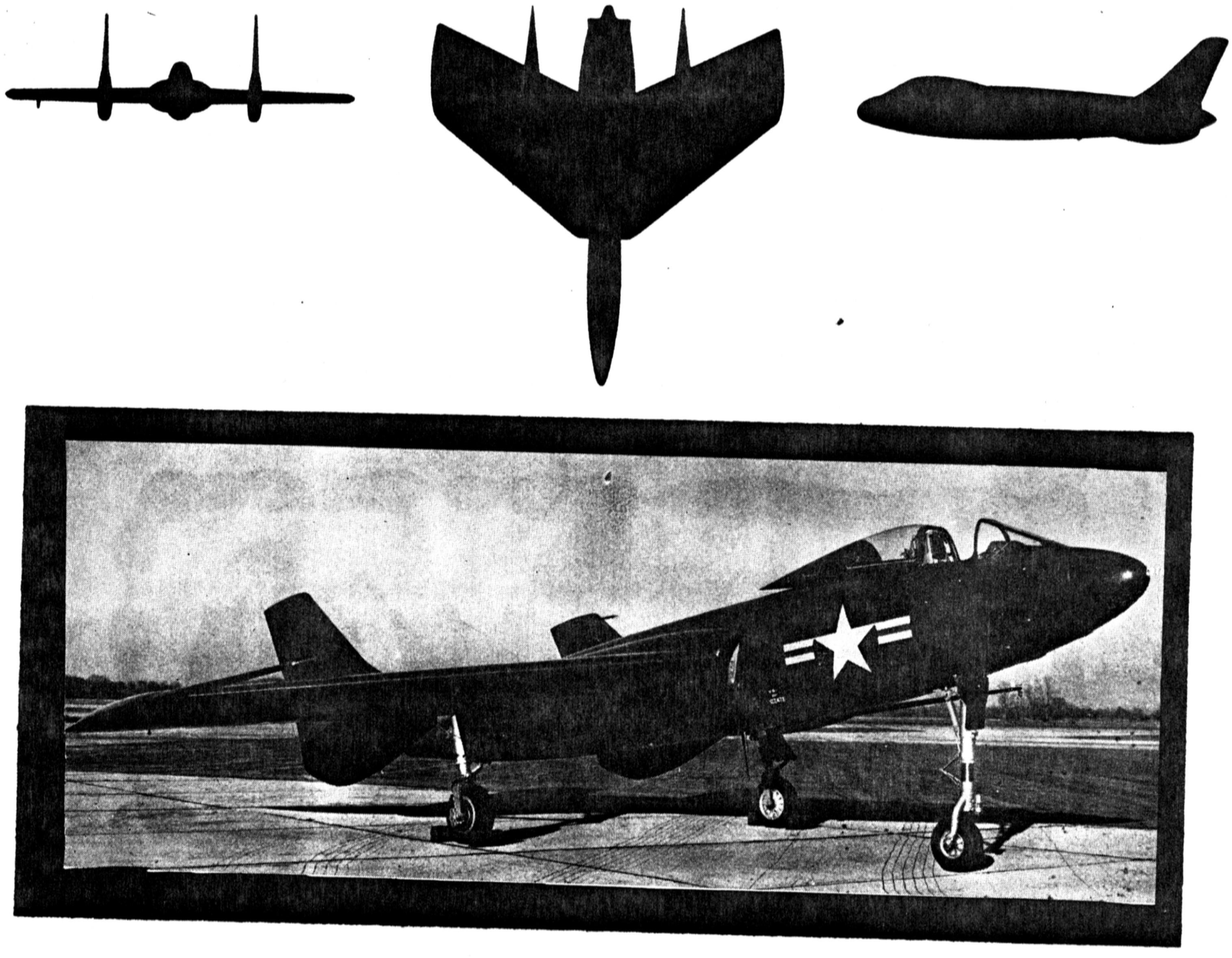


Figure 1-1. Model F7U-1 Airplane

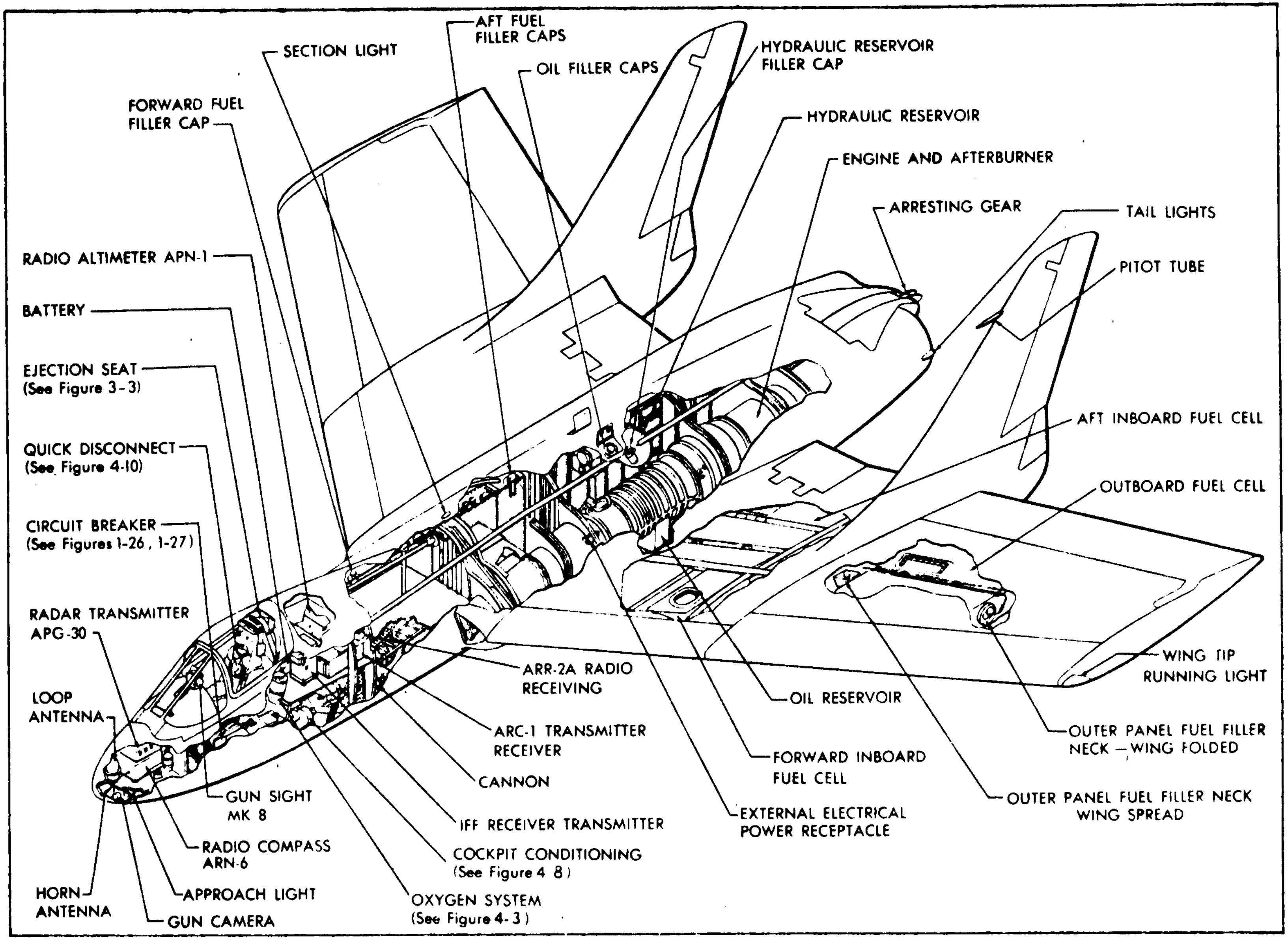


Figure 1–3. General Arrangements

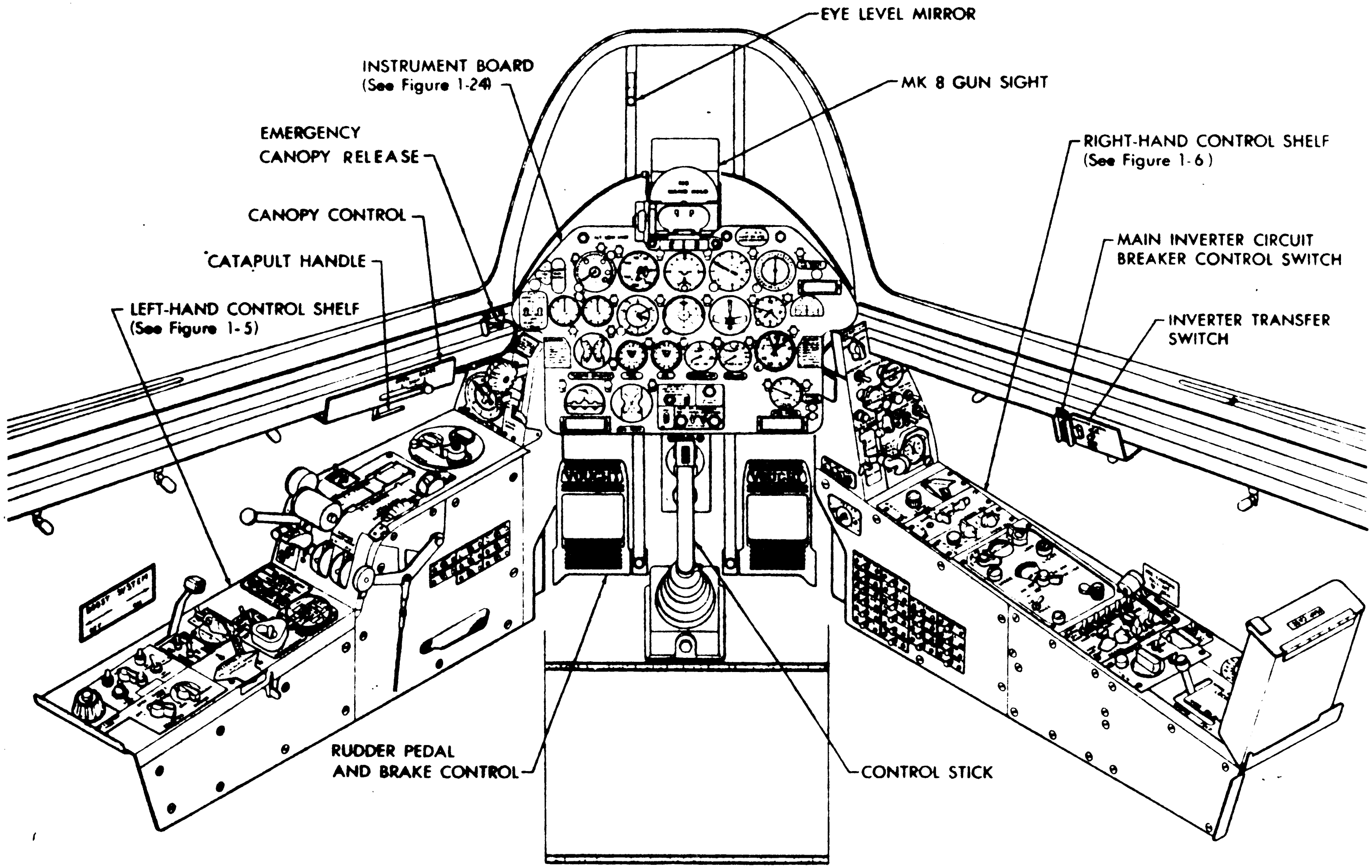


Figure 1–4. Cockpit — Looking Forward

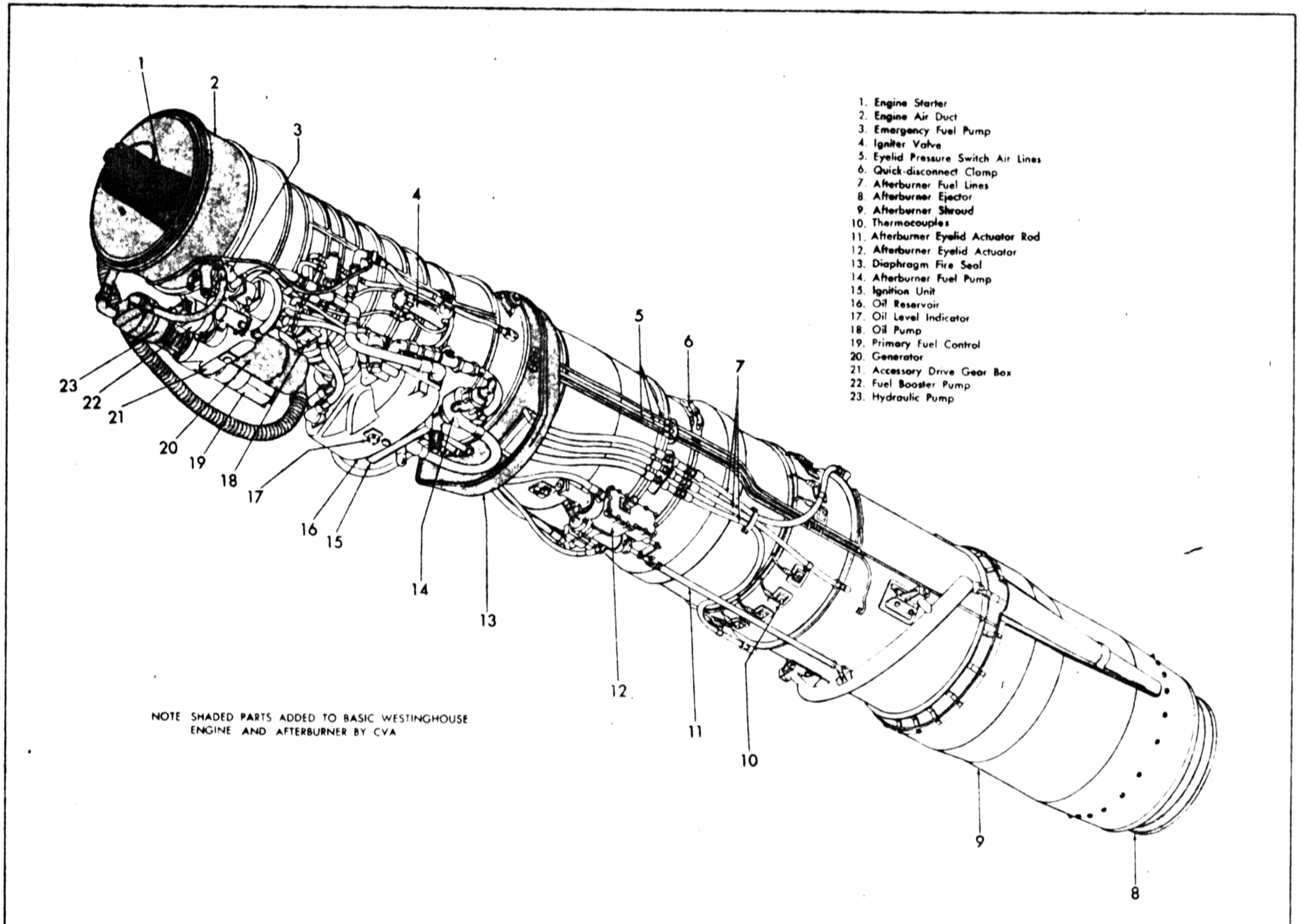


Figure 1–14. Turbo-Jet Engine and Afterburner