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PRELIMINARY PILOT'S HANDBOOK FLIGHT OPERATING INSTRUCTIONS FOR USAF MODEL XF-88 AIRCRAFT

CONTRACT NO. W33-038-ac-14582

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PRELIMINARY

Pilot's Handbook

FLIGHT OPERATING INSTRUCTIONS

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FOR
USAF MODEL
XF-88
AIRCRAFT

SERIAL NOS. 46-525 46-526

MFG MODEL DESIGNATION 36

POWERED WITH TWO TURBO JET MODEL J-34-WE-22 ENGINES

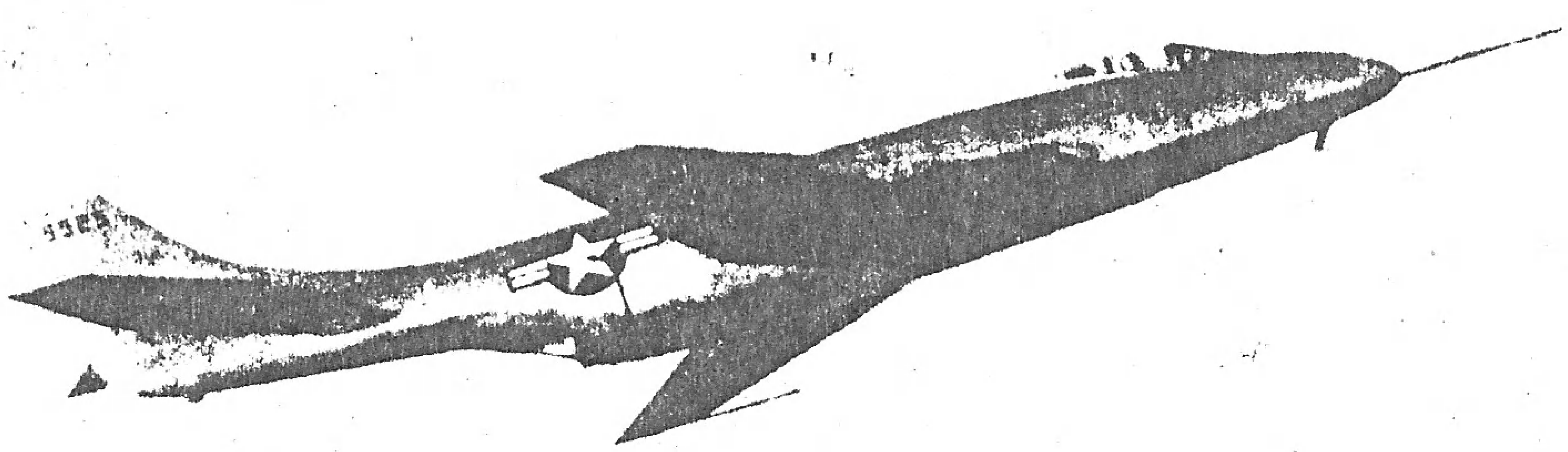
ENGINE MFG & MODEL DESIGNATION WESTINGHOUSE-24C

MANUFACTURED BY

McDONNELL AIRCRAFT CORP.

CONTRACT W33-038-AC-14582

SPECIFICATION S-148



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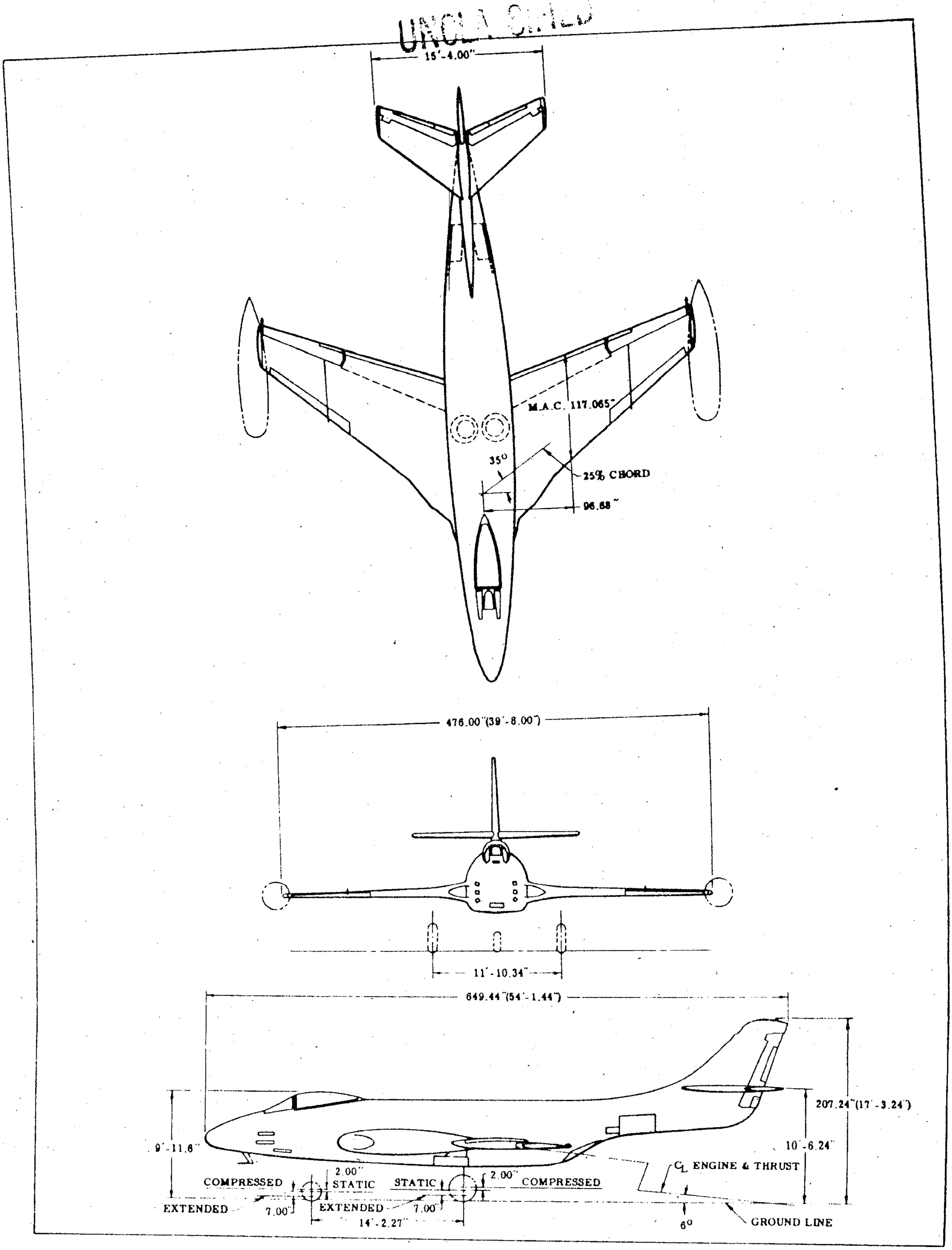

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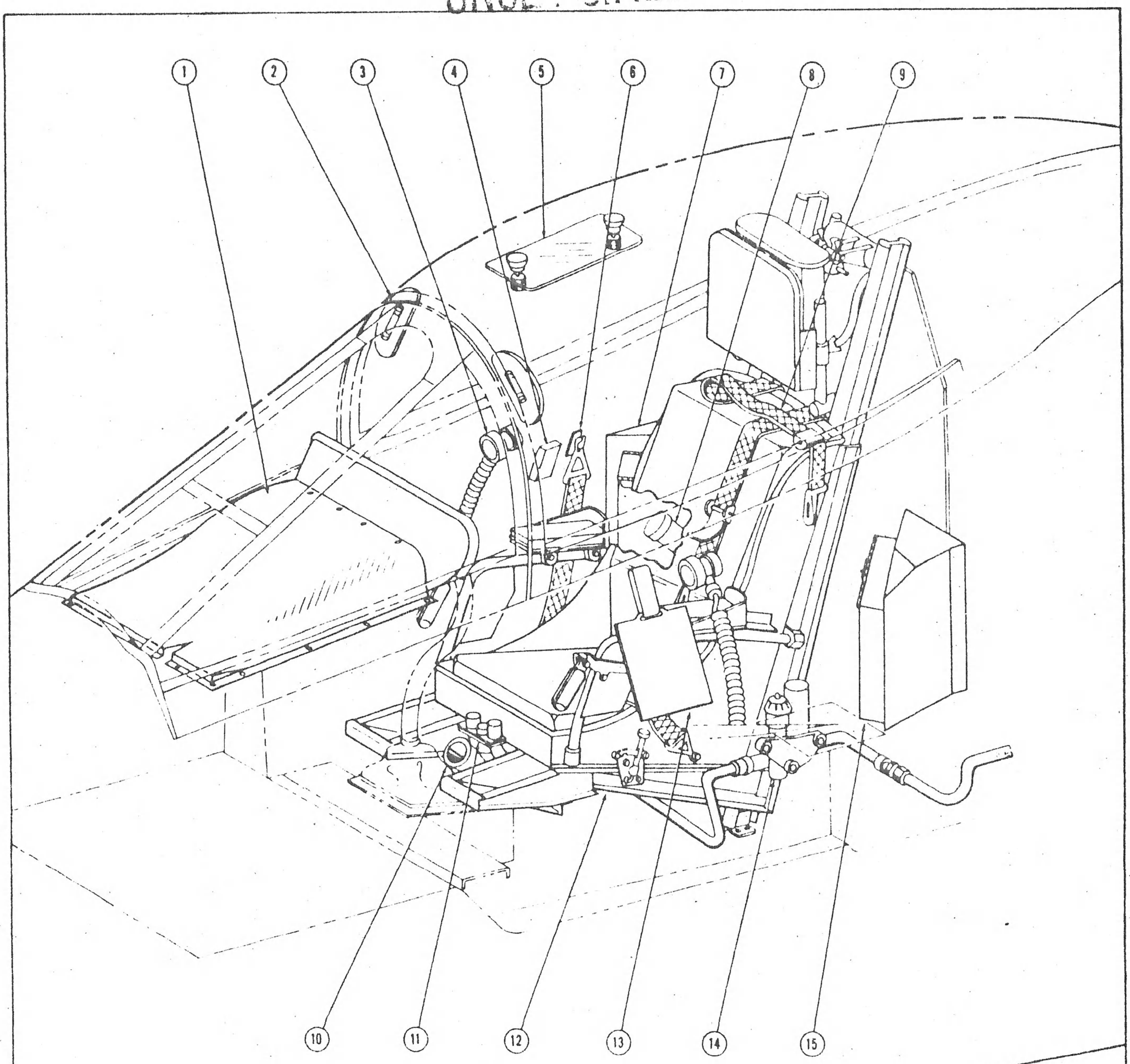

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Cockpit Equipment

SECTION I
DESCRIPTION

1-1. DESCRIPTION. The Model XF-88 is a single place, two engine, jet-propelled penetration fighter airplane. The airplane is powered by two Westinghouse, Model J-34, turbo-jet engines. The airplane in the normal gross weight fighter condition (approximately 18500 lbs.) is loaded with 734 gallons (4404 lbs.) of fuel, contained in three self-sealing interconnected fuselage tanks. The airplane in the overload gross weight condition (approximately 23100 lbs.) is loaded with 1434 gallons (8604 lbs.) of fuel, contained in the three fuselage tanks (734 gallons) and two jettisonable wing tip tanks (350 gallons each). The basic systems in the airplane are hydraulically operated. Six .20 mm forward firing guns are installed in the nose of the fuselage, 220 rounds of ammunition each. Provisions are made on the under surface of the wing for the alternate installation of two bomb racks for carrying general purpose bombs, chemical tanks, and fragmentation bombs; and the installation of eight five inch rockets. Principal dimensions are shown on Three View - XF-88.

1-2. PILOT EJECTION. The pilot ejection seat provides a safer means of escape from high speed jet aircraft than conventional 'bail-out' procedure. For specific seat ejection procedure, see Section III.

1-3. LANDING GEAR. A tricycle type, hydraulically actuated landing gear is provided. The main and nose gear shock struts are the conventional oleo pneumatic type. The main gear retracts inboard into the wing and fuselage and the nose gear retracts forward into the fuselage. The nose gear is steerable from the cockpit.

1-4. NOSE GEAR STEERING. The nose gear is steerable thru 15 degrees right-left by means of cables and hydraulic cylinders, actuated by the rudder pedals. The gear will caster when the 15 degrees are reached.

1-5. BRAKE SYSTEM. A hydraulically operated, single disc brake is provided on each main landing gear. The brakes are independently operated by toe pressure on the rudder pedals, thus providing differential braking. In the event of power failure of the main hydraulic system, the brake valves act as master cylinders and brake pressure is obtained by foot force alone.

1-6. PARKING BRAKE. A parking brake is provided. The control is a pull knob on the cockpit floor, forward of the control stick. This knob locks the rudder pedal brake control in any position to which the brake pedals are depressed.

1-7. POWER PLANT.

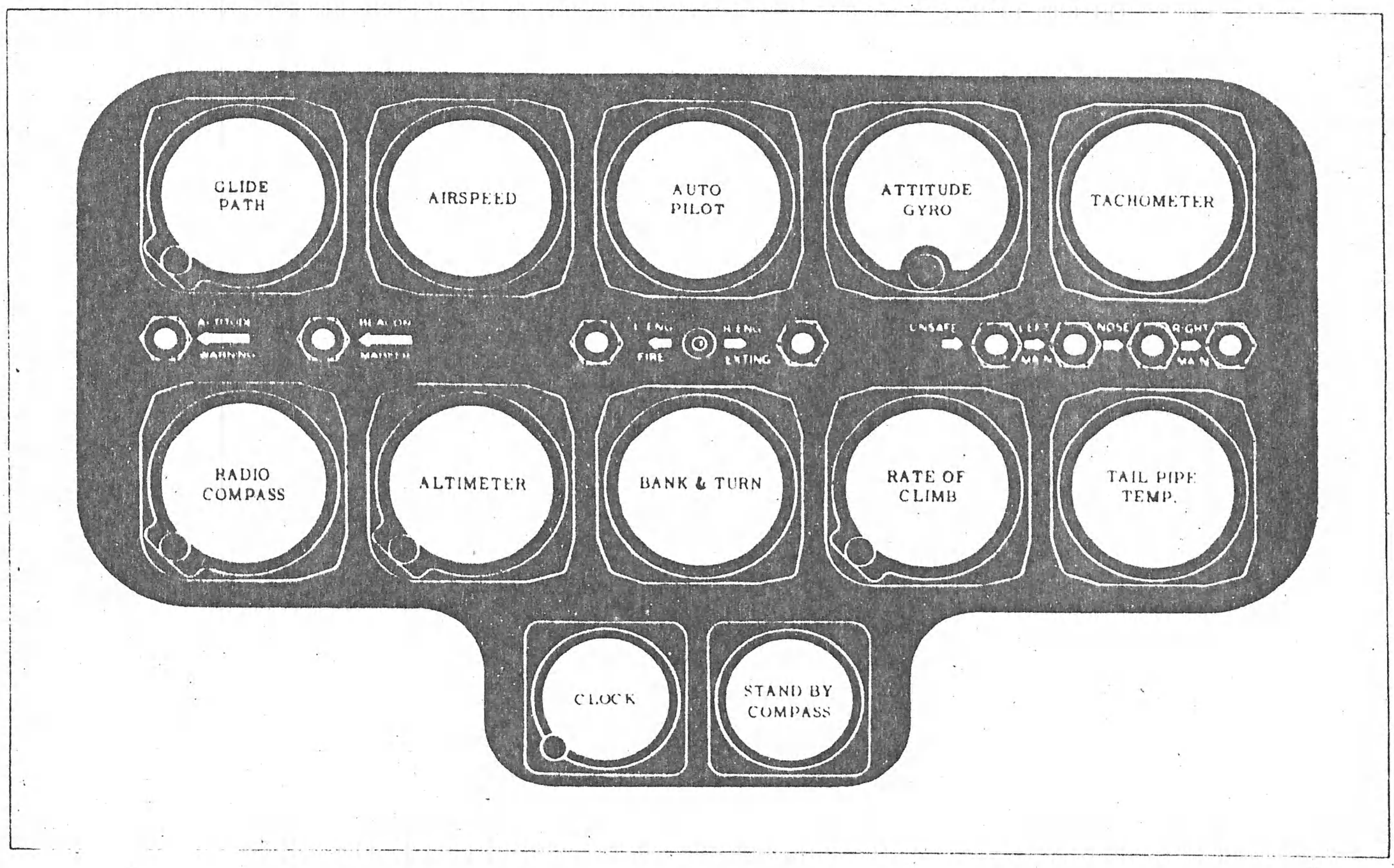


Figure 1-1. Instrument Panels

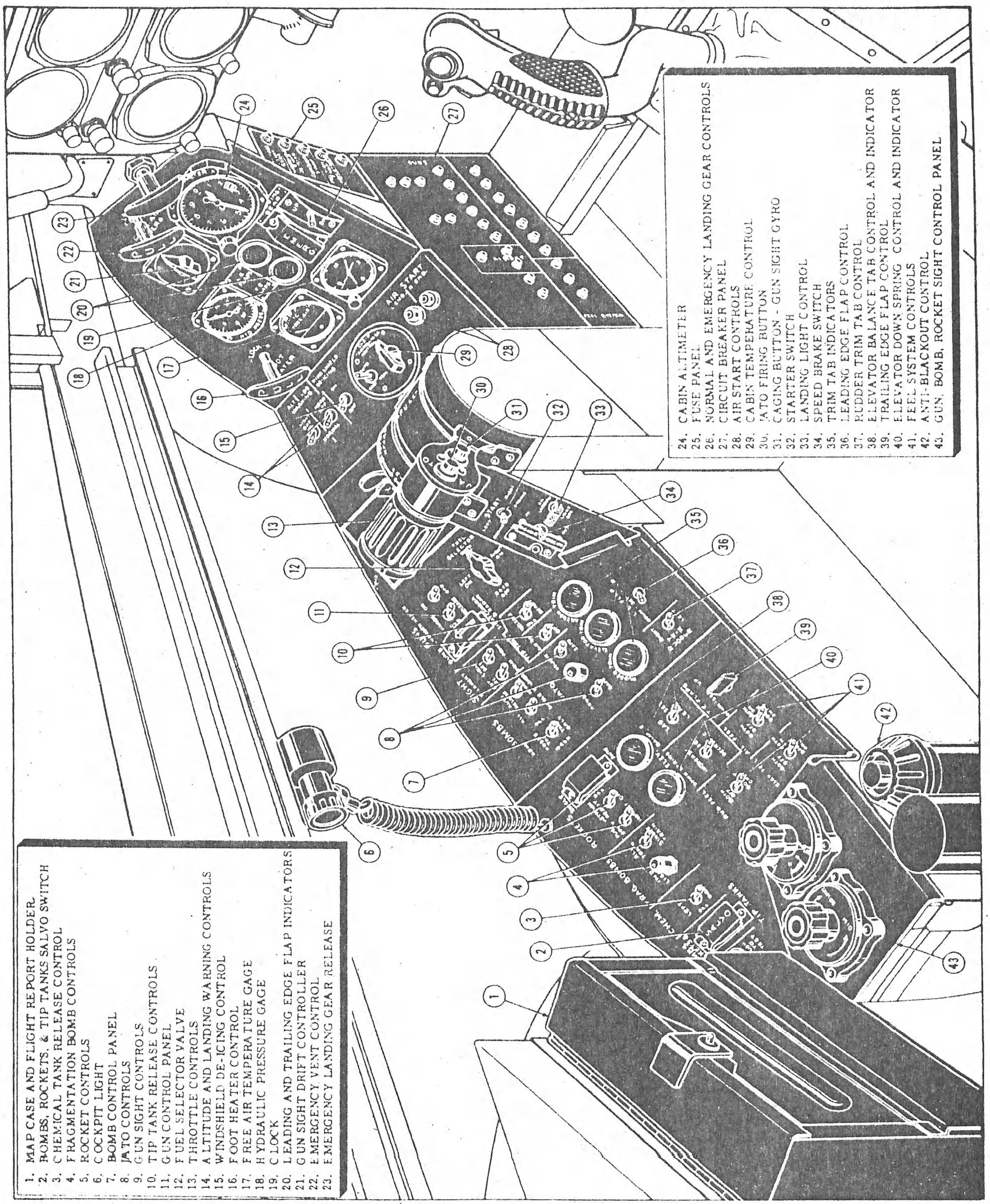


Figure 1-2. Cockpit Left Side

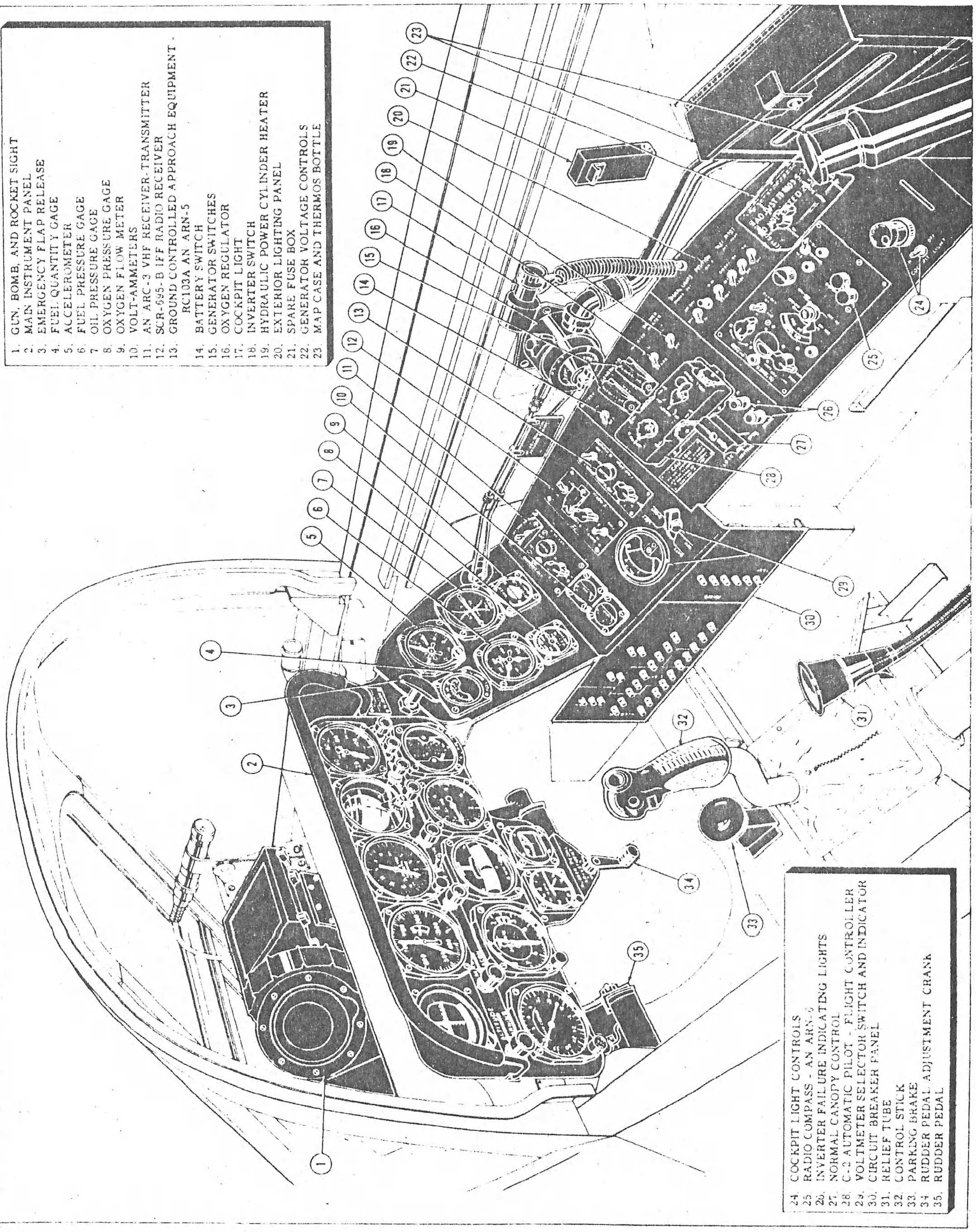


Figure 1-3. Cockpit Right Side

1-8. GENERAL. Two Westinghouse J-34-WE-22 turbojet engines are installed side by side in the lower section of the center fuselage separated by a vertical web. Air for combustion is supplied via an intake duct in the leading edge of each wing. A throttle control, air start switch and a starter switch constitute the power plant controls of each engine.

1-9. POWER PLANT CONTROLS.

1-10. THROTTLE CONTROL. The throttle control is conventional for governor controlled engines. The controls, one for each engine, are located adjacent to the pilot's seat. The throttles read 'OFF', 'IDLE' and 'FULL'. Advancing the throttle from 'OFF' to 'IDLE' automatically turns on the booster pumps in the fuel system. The governor maintains any desired engine rpm between the 'IDLE' and 'FULL' positions.

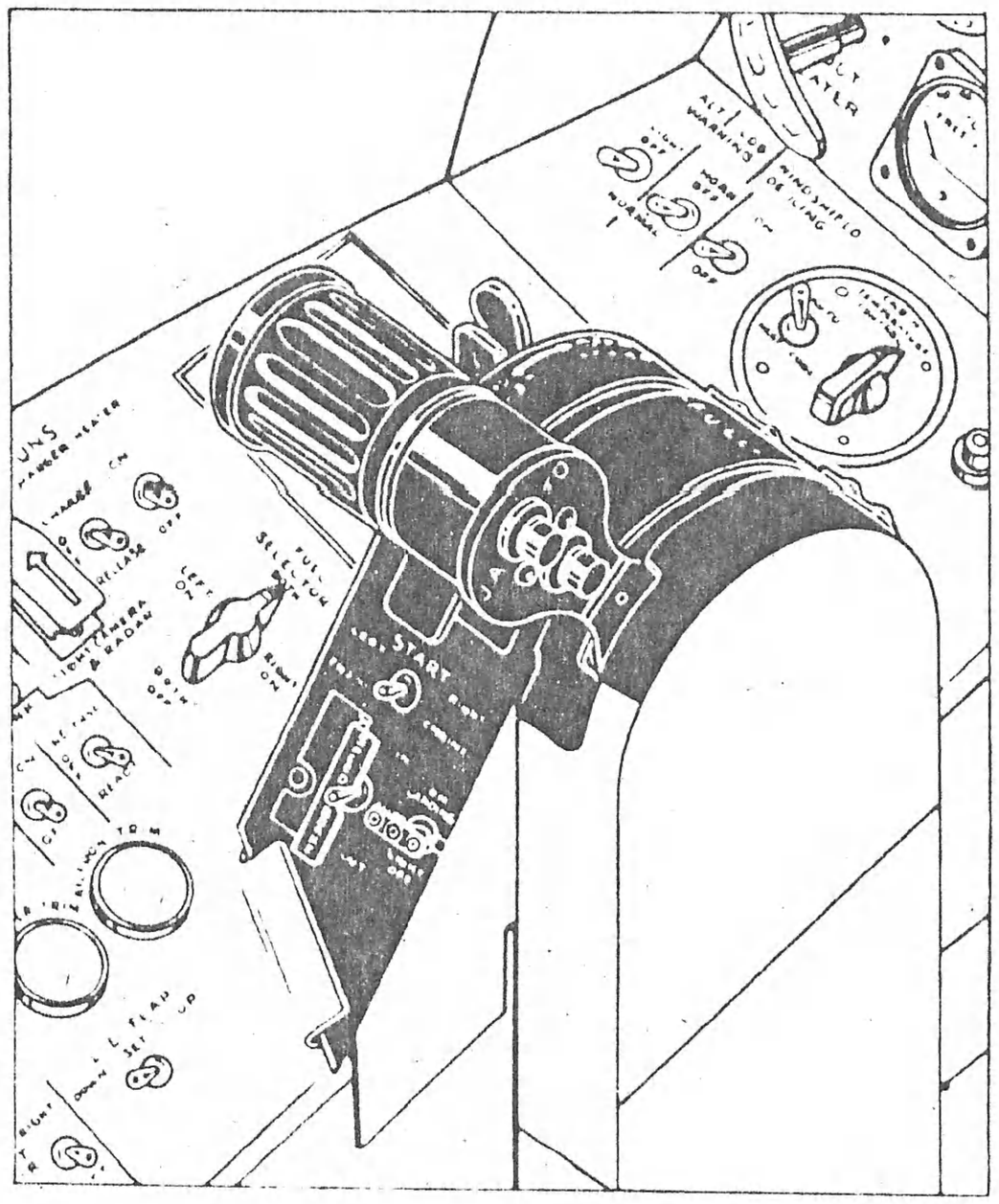


Figure 1-4. Throttle Controls

1-11. STARTING AND IGNITION. The engines are brought up to starting speed by energizing the electrical starter. The ignition system for each engine consists of two spark plugs and two ignition coils which are used for initial combustion. Thereafter combustion is self-supporting and the spark plugs cut out automatically. The starter switch is a momentary contact double-throw type toggle switch and is located on the left side of the cockpit directly below the throttle controls. Attempts to start the engines should not be made if ambient temperature is below -28.9°C (-20°F).

CAUTION

Do not energize starter switch for longer than 60 seconds at one time or the starter motor will be damaged.

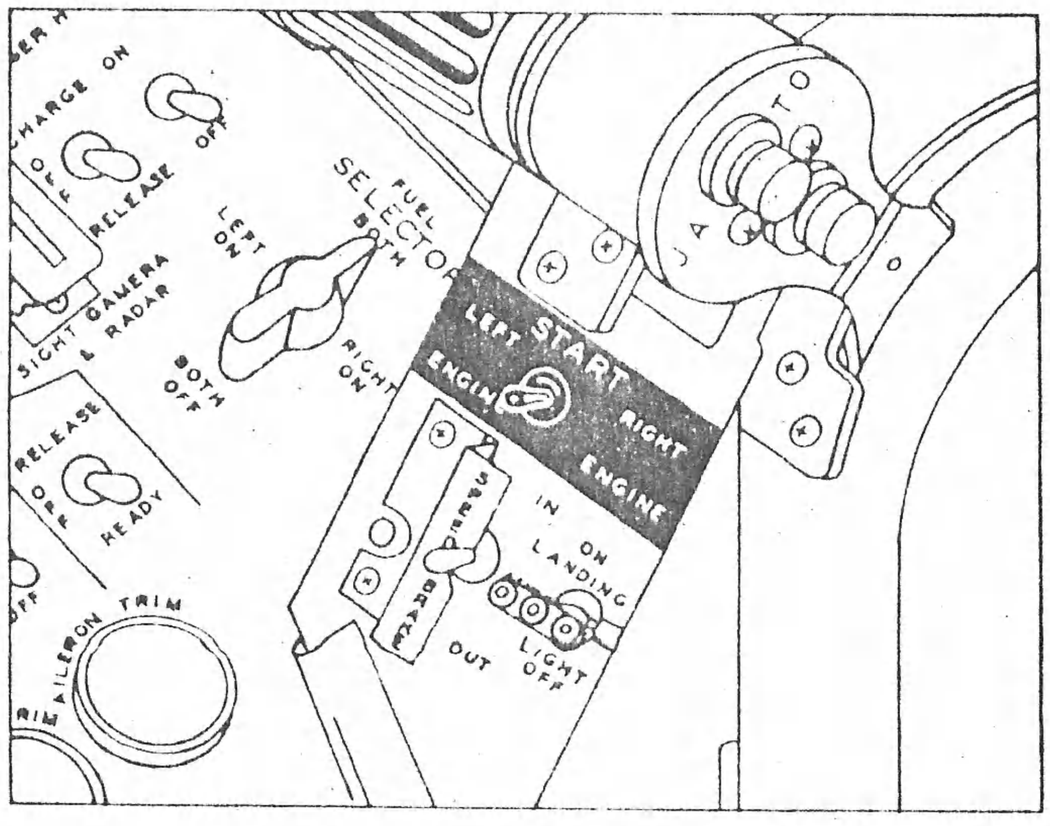


Figure 1-5. Starter Switch

1-12. AIR START SWITCHES. An air start switch which supplies power to the booster coil directly from the battery and operates independently of the starter switch is provided for each engine. This switch enables the engine to be started in flight by means of engine windmill rpm and a spark from the booster coil, with throttles open, without 'draining juice' from the battery for the starter motor. The switches are located aft of the throttle controls, and are designated 'L. ENG.' and 'R. ENG.' If the engine fails to start after energizing normal ground start switch for the maximum 60 seconds, the air start switch should be operated to stop the starter motor.

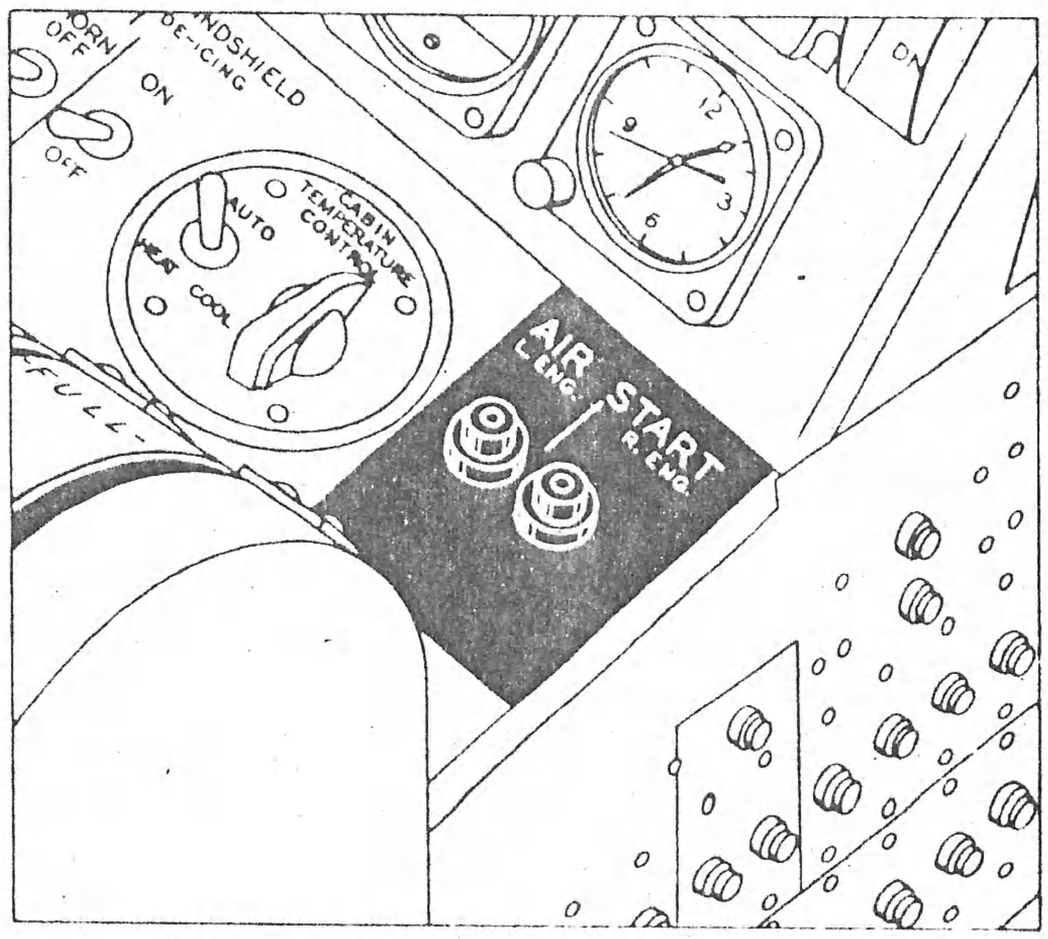


Figure 1-6. Air Start Switches

1-13. FLIGHT CONTROLS.

1-14. GENERAL. The ailerons and elevator are controlled in a conventional manner by the control stick. The rudder is conventionally controlled by the rudder pedals. A hydraulically operated power cylinder is provided for each movable surface control. The cylinders are controlled by valves directly connected to and actuated by the movement of the control stick and

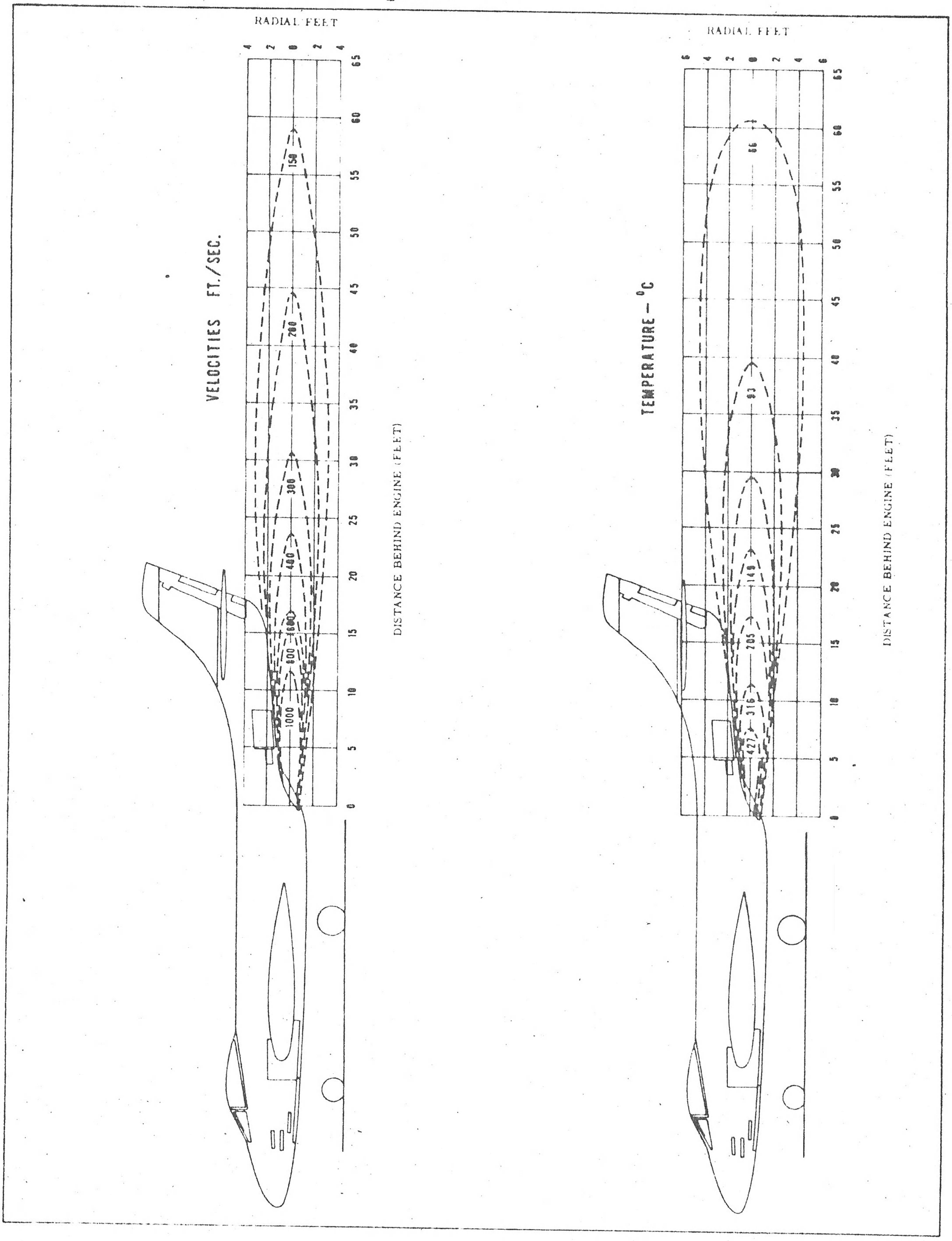


Figure 1-7. Jet Temperatures and Velocities

rudder pedals. Normally the control surfaces are power operated; however, the controls can also be operated without the aid of the power cylinders. The power operated control surfaces require a minimum of pilot effort; merely the effort required to position the valve in the power cylinder. This system is usually referred to as an irreversible power control system since no 'feed back' from the control system is introduced. In order to produce forces on these controls in relation to the amount of actual movement, an artificial 'feel' system is provided for each control system.

1-15. COCKPIT CONTROLS. Each 'feel' system is operated by means of individual three position toggle switches, located on the left-hand console below the elevator balance tab indicators. The switches also control the hydraulic power cylinders for each surface control. The switches have 'BOTH OFF', 'BOTH ON' and 'BOOST ONLY' positions. 'BOTH' refers to the combination of hydraulic power control and artificial 'feel', and 'BOOST' refers only to the hydraulic power system.

1-16. 'FEEL' SYSTEM.

1-17. GENERAL DESCRIPTION. Each 'feel' system mechanism consists of a bellows and linkage arrangement, which transmits dynamic air pressure loads to the pilot's controls. The bellows consists of two pressure chambers divided by a sealed diaphragm connected to the mechanical linkage to the pilot's controls. The static pressure in one chamber and total pressure in the other produces a pressure differential on the diaphragm equal to the dynamic air pressure. A 'feel' spring is installed in the rudder and aileron 'feel' system to supplement bellows loads at low speeds. A cockpit controlled down spring is installed in the elevator system to increase apparent stick free stability. Each 'feel' system linkage mechanism contains one link which is a linear actuator. The length of this actuator is controlled by the pilot, and the link is used to trim the 'feel' system. That is; with the pilot's control and the control surfaces in neutral position, the actuator link length is set so that the linkage is dead centered and no loads are imposed on the pilot's controls due to loads on the bellows diaphragm. The 'feel' for all the control systems can be trimmed in flight by deflecting the pilot's controls until the desired flight attitude is reached and then changing the length of the linear actuator until zero control force is obtained.

1-18. AILERON CONTROL SYSTEM.

1-19. BALANCE TABS. The aileron control system incorporates a ground adjustable balance tab on each aileron. The balance tab is adjustable from 0.3:1.00 to 1.00:1.00 lagging.

1-20. TRIM TAB. The left aileron only is equipped with a cockpit controlled trim tab discussed below.

1-21. AILERON 'FEEL' SYSTEM. The 'feel' trim actuator or adjustable link and the synchronous trim tab actuator are controlled by the four way slide switch on the control stick grip. By means of the synchronous relay interconnecting the two actuators, the ailerons can be trimmed for approximately zero hinge moment when the artificial 'feel' system is trimmed. The position of the aileron trim tab is shown by an indicator located on the left-hand console, aft of the throttle controls. The aileron stick force due to the 'feel' system diaphragm force increases rapidly with velocity; therefore, a 'feel' spring producing 20 pounds stick force at all speeds with full aileron deflection has been incorporated to reduce the amount of stick force variation. The aileron 'feel' system is designed to produce 30 pounds stick force at 400 mph IAS (337 knots) with full deflection' i.e., 20 pounds due to the 'feel' spring and 10 pounds due to the 'feel' system diaphragm force. The 'feel' spring aids in producing desirable low speed aileron stick force characteristics where the diaphragm force is very small. The 'feel' spring functions regardless of whether the 'feel' system is in operation or not.

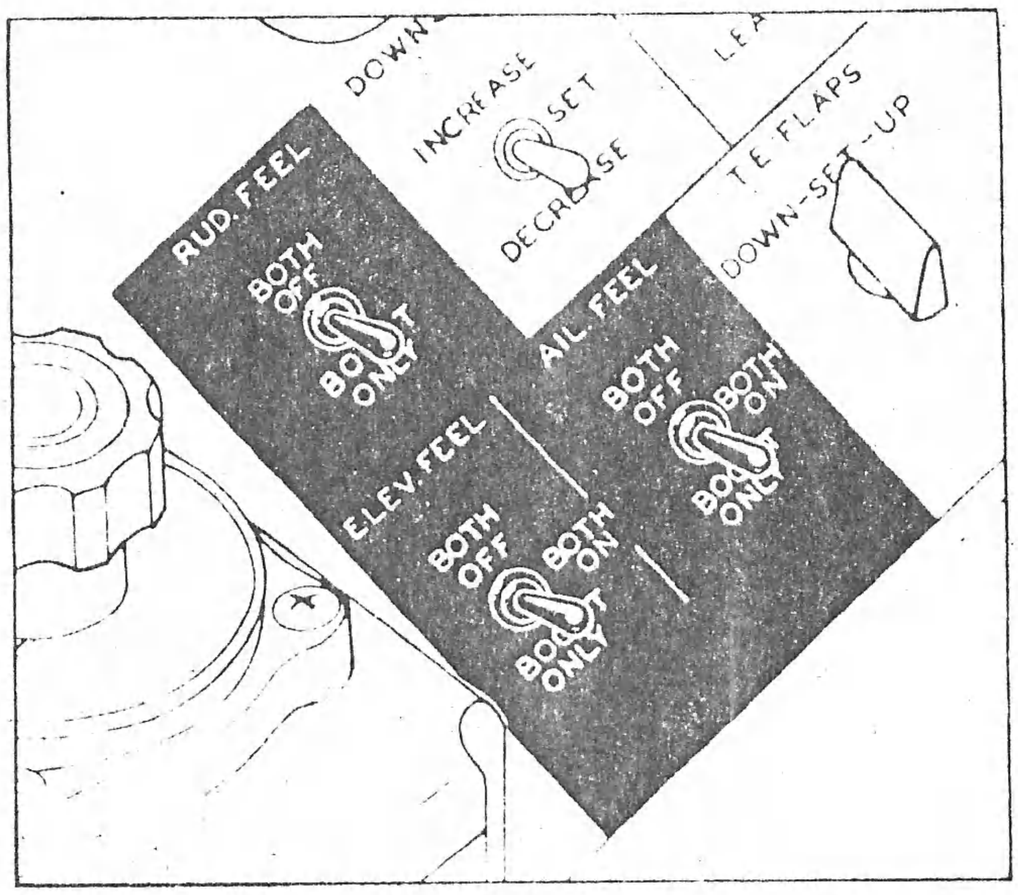


Figure 1-8. Feel System Controls

1-22. RUDDER CONTROL SYSTEM.

1-23. BALANCE TAB. The rudder control system incorporates a ground adjustable balance tab, adjustable from 0:1.00 to 0.70:1.00 lagging or leading.

1-24. TRIM TAB. A cockpit controlled trim tab is also provided on the rudder discussed below.

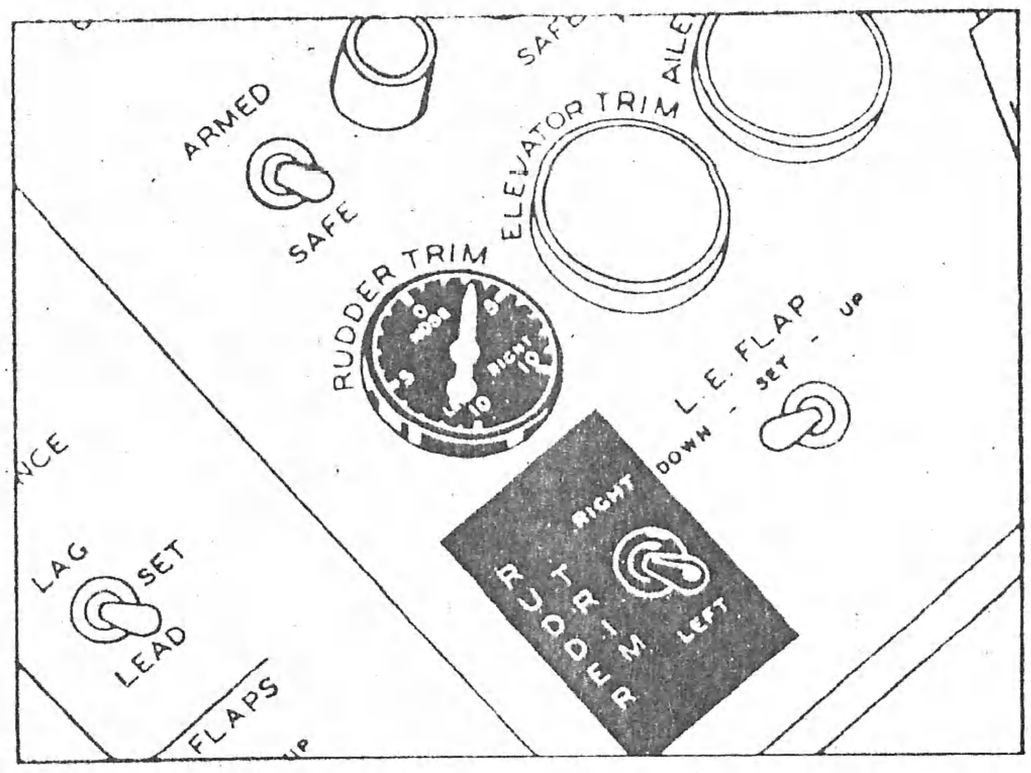


Figure 1-9. Rudder Trim Tab Control

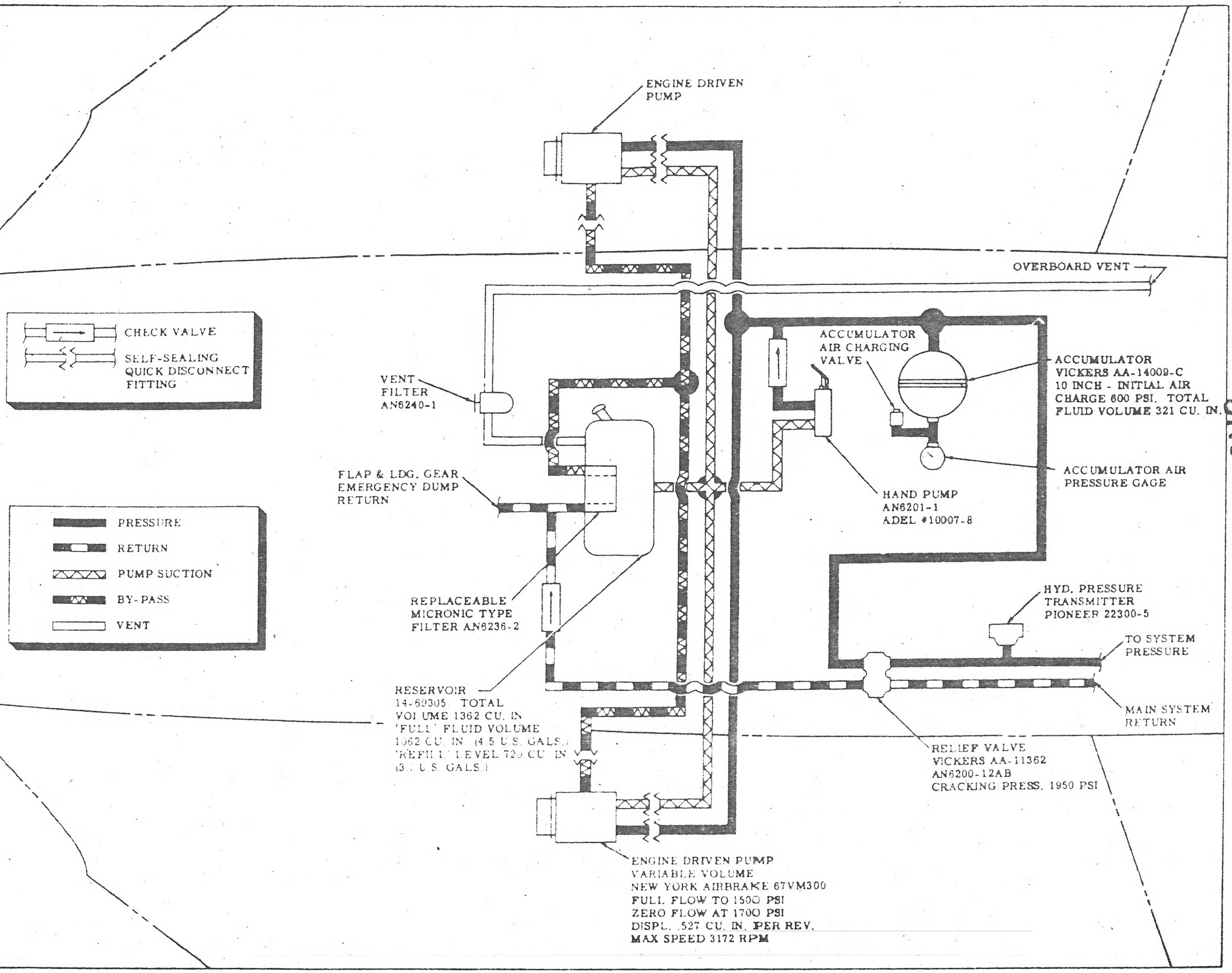


Figure 1-10. Hydraulic Power System Schematic

1-25. RUDDER 'FEEL' SYSTEM. The 'feel' trim actuator and the synchronous trim tab actuator are controlled by the toggle switch on the left-hand console, aft of the rudder controls. The switch reads for nose 'LEFT' and 'RIGHT' positions. By means of the synchronous relay interconnecting the two actuators, the rudder will be trimmed for approximately zero hinge moment when the artificial 'feel' system is trimmed. The position of the rudder trim tab is shown by an indicator on the left-hand console adjacent to the aileron trim tab indicator. At all speeds the centering spring produces 100 lbs. rudder pedal force at full rudder deflection. This spring is in the rudder control system whether or not the 'feel' system is in operation. The diaphragm in the 'feel' system bellows produces 300 lbs. pedal force at full deflection at 400 mph IAS (337 knots). The total pedal force at full deflection with 'feel' system in operation is 400 lbs. at 400 mph IAS (337 knots). The 'feel' spring aids in producing desirable low speed rudder pedal force characteristics when the diaphragm force is very small.

1-26. ELEVATOR CONTROL SYSTEM.

1-27. BALANCE TABS. The elevator control system incorporates a cockpit adjustable balance tab on each elevator, to be used in case of emergency to decrease pilot stick forces. The balance tab is adjustable from 0:1.00 to 0.65:1.00 lag. The balance tab ratio can be controlled by means of the toggle switch on the left-hand console above the trailing edge flap switch. The switch reads for 'LAG', 'LEAD', and 'SET', although the 'LEAD' position is not used. An indicator showing the balance tab ratio is located on the left-hand console above the trailing edge flap switch.

1-28. TRIM TABS. Each elevator is also equipped with a cockpit controlled trim tab, discussed below.

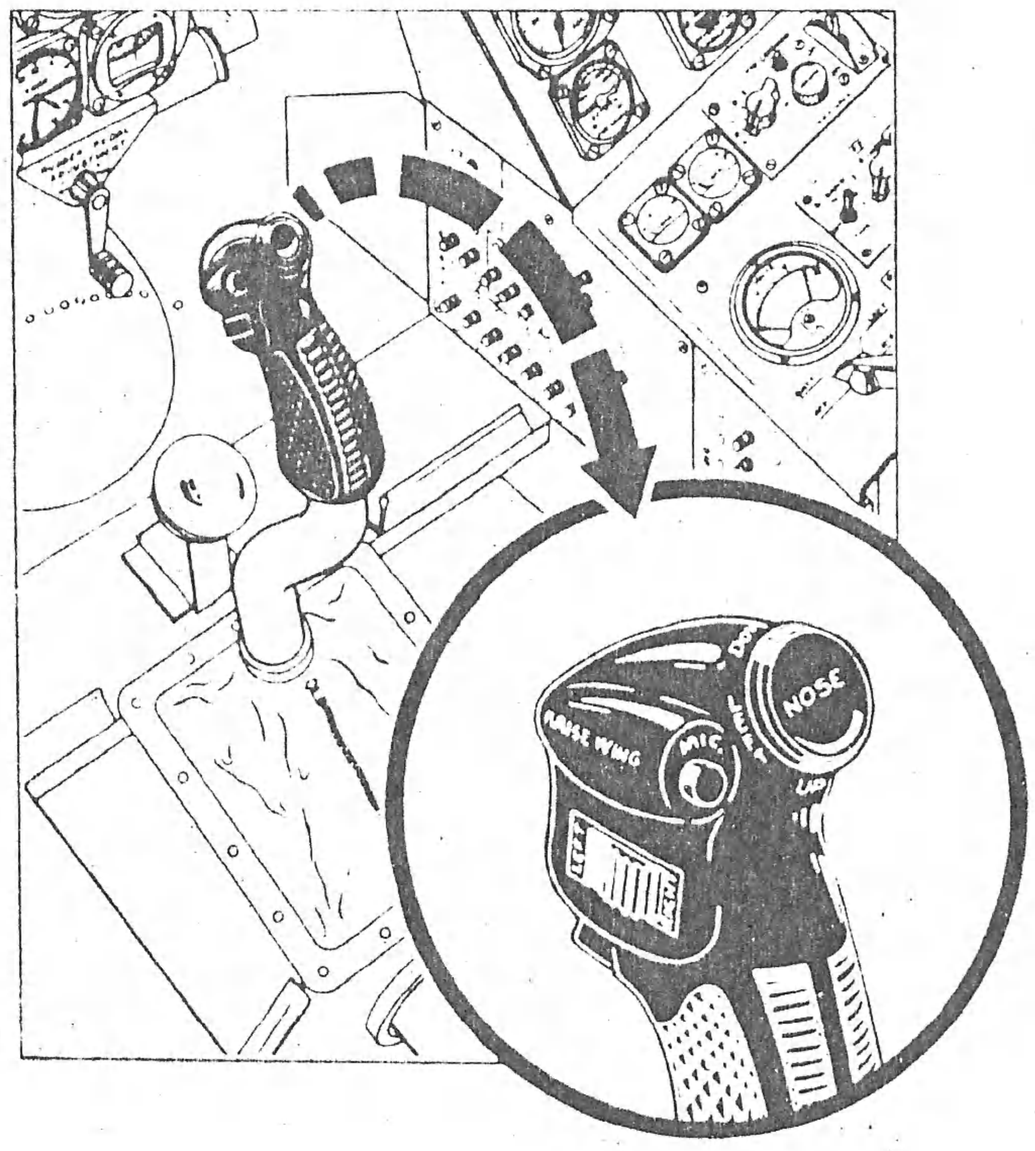


Figure 1-11. Aileron and Elevator Trim Tab Controls

1-29. ELEVATOR 'FEEL' SYSTEM. The 'feel' trim actuator and the trim tab actuator are controlled by separate cockpit controls. The 'feel' trim actuator switch is located on the left-hand console and the trim tab actuator is controlled by the slide switch on the control stick hand grip. When trimming the airplane, the elevator trim tab should be adjusted to give zero elevator hinge moment before the artificial 'feel' system is trimmed out. The position of the elevator trim tabs is shown by an indicator located on the left-hand console, between the rudder and aileron trim tab indicators. A hinge moment gage is also provided on the left-hand console immediately above the toggle switch control.

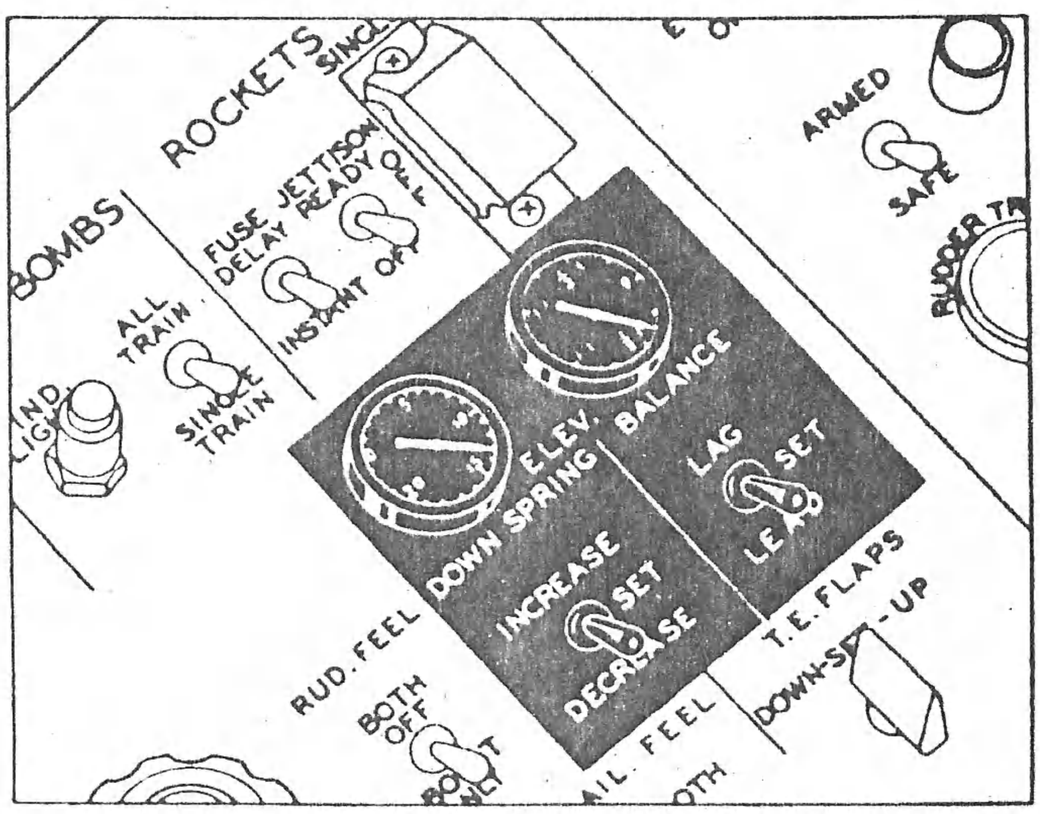


Figure 1-12. Elevator Down Spring and Balance Tab Controls

1-30. ELEVATOR DOWN SPRING. An electrically actuated down spring or bungee is provided in the elevator control system, between the 'feel' system and the power cylinder. The spring is designed to increase the free control stability of the 'feel' system in proportion to the amount of preload in the spring. This preload can be controlled by a toggle switch located adjacent to the balance tab switch. The switch has 'INCREASE', 'DECREASE', and 'SET' positions. The down spring is adjustable by means of this switch, from zero to 20 pounds stick force. An indicator which shows the down spring load is located on the left-hand console, immediately above the toggle switch.

CAUTION

While making any change in the setting of the artificial feel and power control systems during flight, special caution should be taken to maintain firm hold on the control stick.

1-31. EMERGENCY OPERATION OF 'FEEL' SYSTEM.

1-32. AILERON CONTROL SYSTEM. In case of hydraulic power system failure during flight, move the 'AIL. FEEL' switch to 'BOTH OFF', in order to eliminate the forces due to the artificial 'feel' system.

1-33. RUDDER CONTROL SYSTEM. In case of hydraulic power system failure during flight, move the

pressure to a hydraulic motor. The cockpit control for this valve is a three position momentary contact toggle switch, located aft of the leading edge flap switch on the left console. The switch has 'UP', 'DOWN', and 'SET' positions. The flaps may be operated to intermediate positions by holding the toggle switch to 'UP' or 'DOWN', until the desired flap setting is obtained. A trailing edge flap position indicator is located on the left-hand instrument panel.

CAUTION

Do not operate trailing edge flaps above 200 mph (176 knots) IAS.

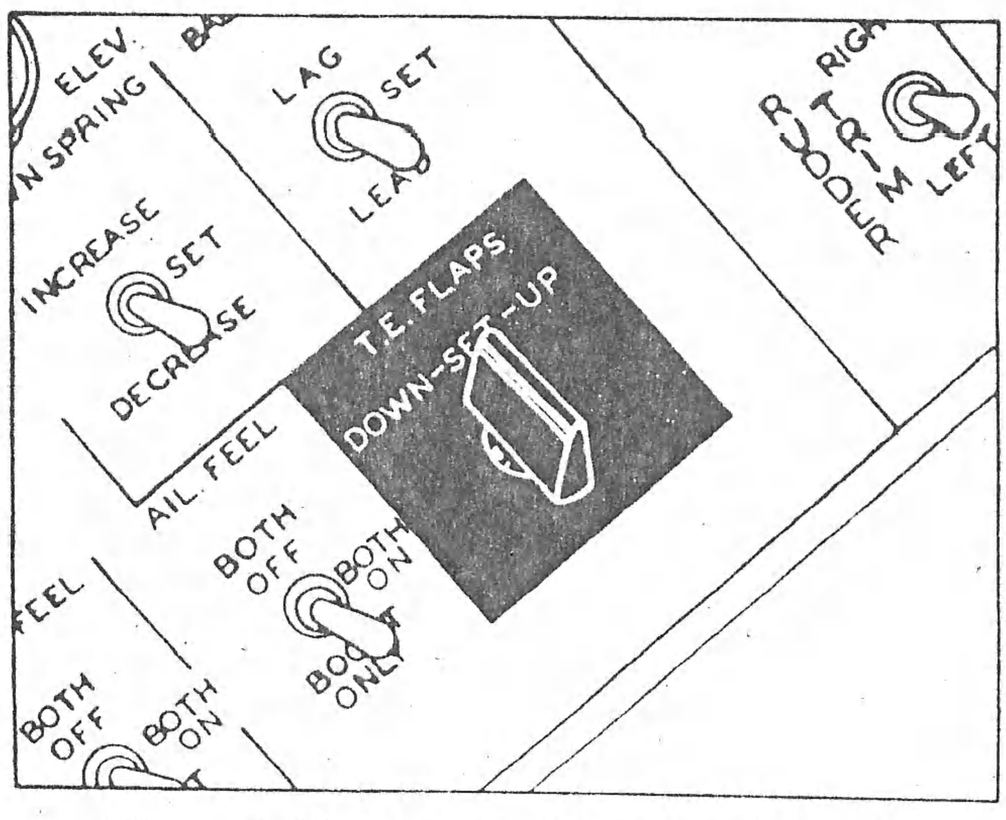


Figure 1-15. Trailing Edge Flap Control

1-46. FUEL SYSTEM. Fuel conforming to Specification AN-F-28, cheapest grade available, is contained in three self-sealing fuselage tanks, and two metal droppable tanks installed on the wing tips. The three main fuselage tanks are interconnected to function as one, and contain a total capacity of 734 gallons (4404 lbs.) of fuel. The wing tip tanks contain a total capacity of 700 gallons (4200 lbs.) of fuel. Manual selection of tanks is not required. Fuel to the engines flows from the center fuselage tank through two submerged booster pumps. Either pump has sufficient capacity to supply both engines operating at military power. The pumps operate when the throttle is opened to the 'IDLE' position, and supply pressurized fuel into a double check valve tee, acting as a system manifold. From this manifold fuel flows into one inlet of an electrically operated shut-off valve, remotely controlled from the cockpit. The fuel pump and governor are an integral unit. The governor maintains a constant engine rpm, and compensates for changes in altitude and atmospheric pressure. Fuel enters the engine manifold via an outlet from a dump valve at the engine and operated by fuel pump outlet pressure. From the engine manifold the fuel is injected into the combustion chamber by means of spray nozzles. In this chamber, the atomized fuel combines with compressed air and is ignited by spark plugs, two for each engine. After initial combustion, the spark plugs cut out. In case of failure or malfunctioning of the governor-fuel pump unit, an emergency fuel pump on the engine, and operating constantly, supplies fuel to the engine through the main governor. Upon closing the throttle, when shutting down an engine, the dump valve dumps overboard all fuel remaining in the engine manifold.

1-47. AUXILIARY FUEL SYSTEM. Fuel from the two tip tanks is automatically transferred to the forward and center fuselage tanks by means of pressurized air tapped from the engine compressor section. A limit switch in each tip tank system automatically opens an air valve in the air pressure line to the corresponding tip tank, immediately upon installation of the tank. The compressed air is regulated to a pressure of approximately five psi, and forces the fuel out of the tip tanks into float valves installed in the forward and center tanks. The float valve governs the flow of fuel into the fuselage tanks as required to keep the tanks filled constantly. The fuselage tanks remain filled until the fuel in the tip tanks is exhausted.

1-48. FUEL SYSTEM CONTROLS.

1-49. AIR PRESSURE SWITCH. A two position toggle switch is provided to shut off the air pressure after the fuel is exhausted from the tip tanks. The switch has 'AIR ON' and 'OFF' positions and is located on the left-hand console, adjacent to the tip tank jettison switch.

1-50. TANK JETTISON SWITCH. If tanks are jettisoned, the limit switches on the tank automatically shut off the air pressure when the jettison switch is actuated. This switch is a three position toggle switch, located on the left-hand console, adjacent to the air pressure switch. The positions are 'OFF', 'RELEASE', and 'JETTISON READY'. The latter is the position for salvo release actuated by the bomb button on the control stick hand grip.

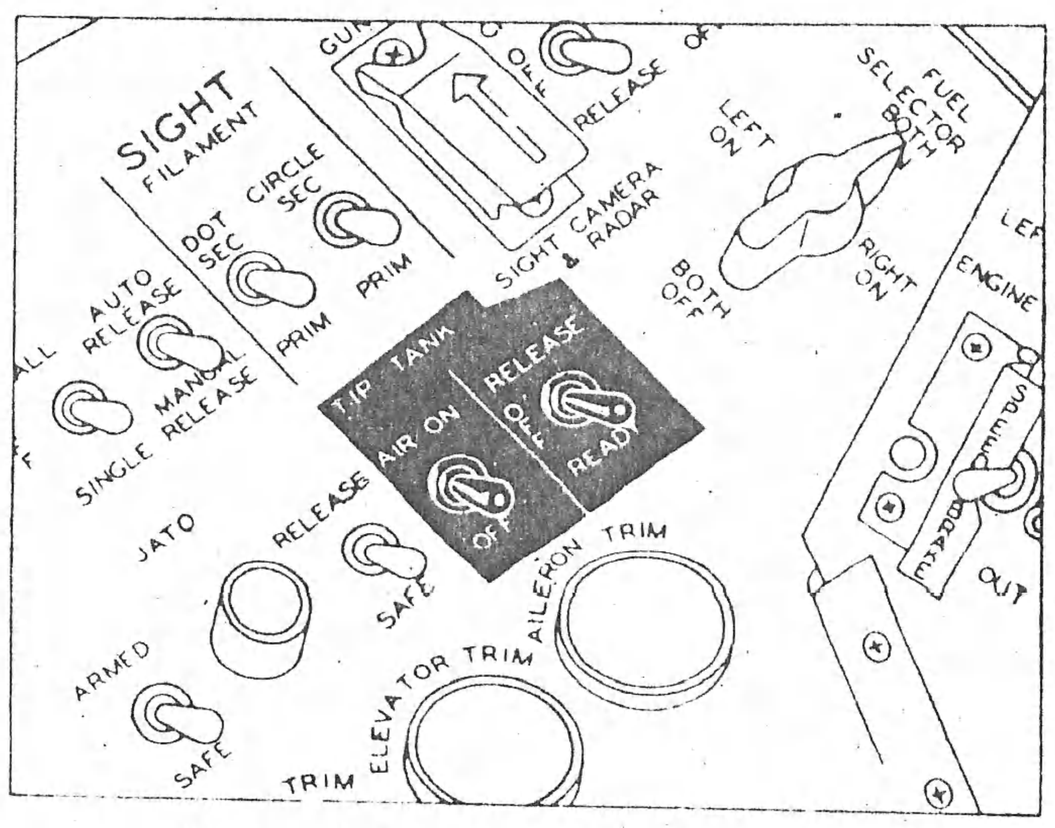


Figure 1-16. Tip Tank Controls

1-51. FUEL SELECTOR VALVE. An electrically operated fuel selector valve is installed. The cockpit control for this valve is a four position toggle switch, located on the left-hand console, outboard of the throttle controls, and can select 'BOTH ON', 'BOTH OFF', 'LEFT ON', and/or 'RIGHT ON' positions. The switch is normally in the 'BOTH ON' position, and is used in emergency to shut down the malfunctioning engine.

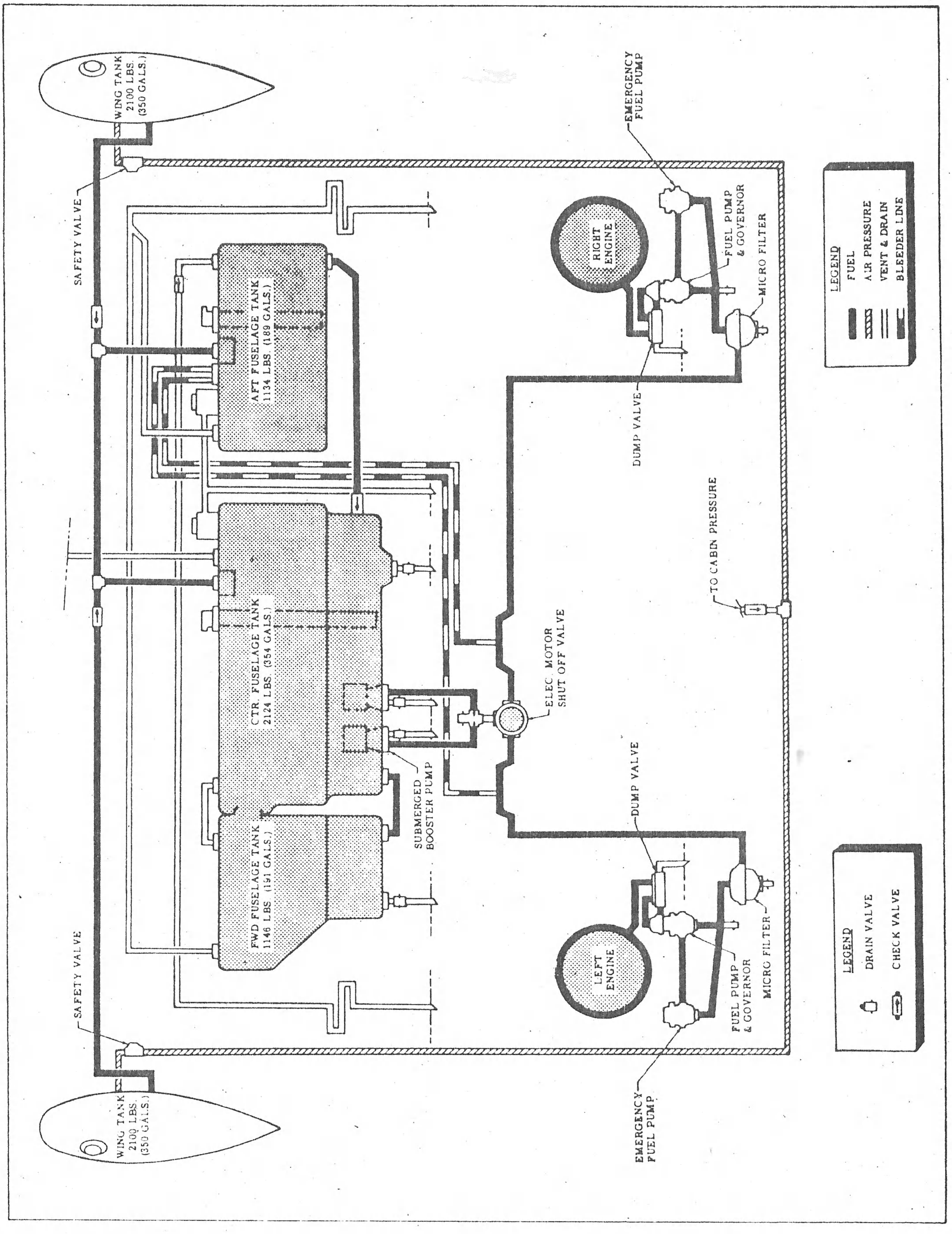


Figure 1-17. Fuel System Diagram

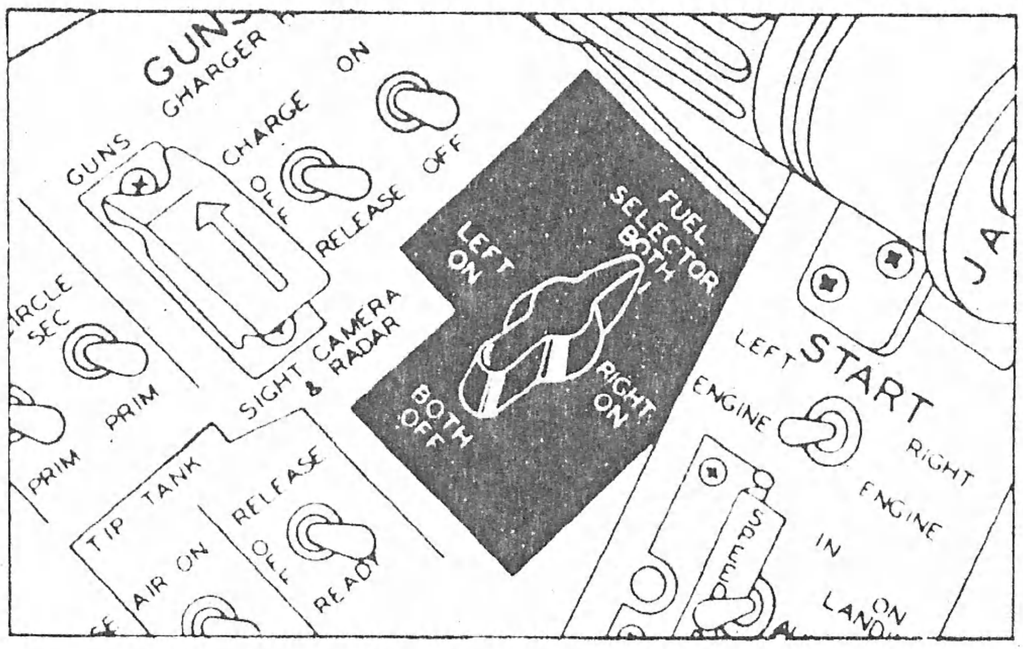


Figure 1-18. Fuel Selector Valve

1-52. FUEL LEVEL GAGE. An electronic type fuel level gage is installed on the right-hand console instrument panel, and indicates total fuel remaining in the main tanks. No indication is given of tip tank levels, however the gage will show full until the tip tanks are empty, due to the transfer system into the main tanks. The gage is calibrated in pounds of fuel.

1-53. FUEL PRESSURE GAGE. A magnesyn dual concentric type fuel pressure gage is located on the right-hand instrument panel, forward of the oxygen pressure gage, and is calibrated from 0-1000 pounds. Fuel pressure indications are obtained from the emergency fuel pump.

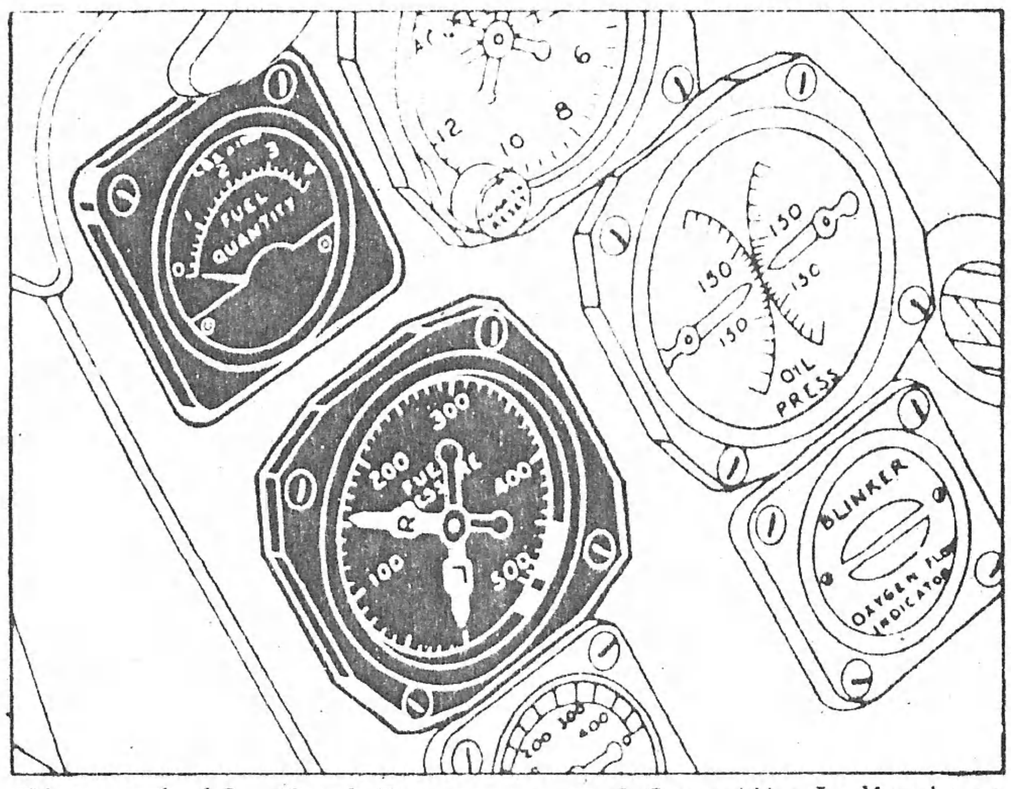


Figure 1-19. Fuel Pressure and Quantity Indicators

1-54. OIL SYSTEM. Oil conforming to Specification AN-O-9, Grade 1010 or 1015 is contained in two six

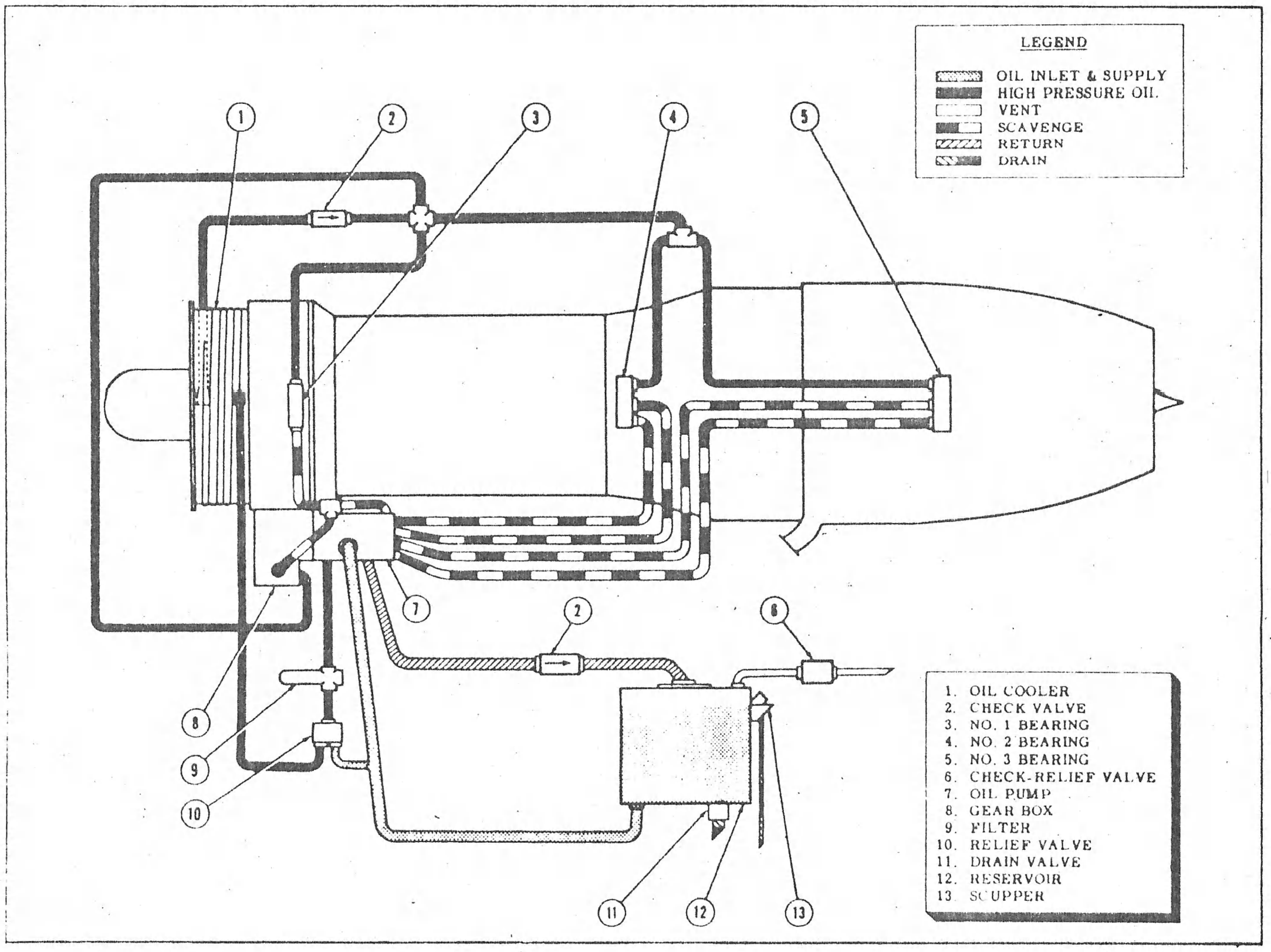


Figure 1-20. Oil System Diagram

gallon reservoirs located in the engine compartments. A four element pump provides both lubricating and scavenging and is mounted on the accessory drive of the engine. The lubricating element of the pump draws the oil from the reservoir and under pressure circulates it through the oil filter, the oil pressure relief valve, into the oil cooler and from there to the accessory gear box and main bearings. The other three elements scavenge the lubricated regions and return the oil to the reservoirs.

1-55. ELECTRICAL SYSTEM.

1-56. GENERAL. The airplane is equipped with a primary and secondary electrical system.

1-57. PRIMARY SYSTEM. The primary power supply is a 28 volt, dc system, consisting of one 24 volt, 34 ampere hour battery, and two 30 volt, 300 ampere hour engine driven generators. The primary system supplies power to the engine controls, armament equipment, automatic pilot, trim tab and control stick 'feel' system, rudder 'feel' system, pitot heater, radio equipment, the valve actuators for the hydraulic system, etc.

1-58. SECONDARY SYSTEM. The secondary electrical system is a 115 volt, ac system, with a power supply furnished by a 1500 VA inverter. In case of failure of the 'MAIN' inverter, the ac system is automatically switched over to the 'SPARE' inverter. The 'MAIN' inverter supplies power to operate the instrments, attitude gyro, gun sight, and windshield de-icer. The 'SPARE' inverter supplies power to operate the instruments and attitude gyro.

1-59. ELECTRICAL SYSTEM CONTROLS.

1-60. BATTERY AND GENERATOR SWITCHES. One battery and two generator switches are located on the right-hand console panel, outboard of the automatic pilot controls. Each switch has 'ON' and 'OFF' positions, and the generator switches are designated 'LEFT' and 'RIGHT'.

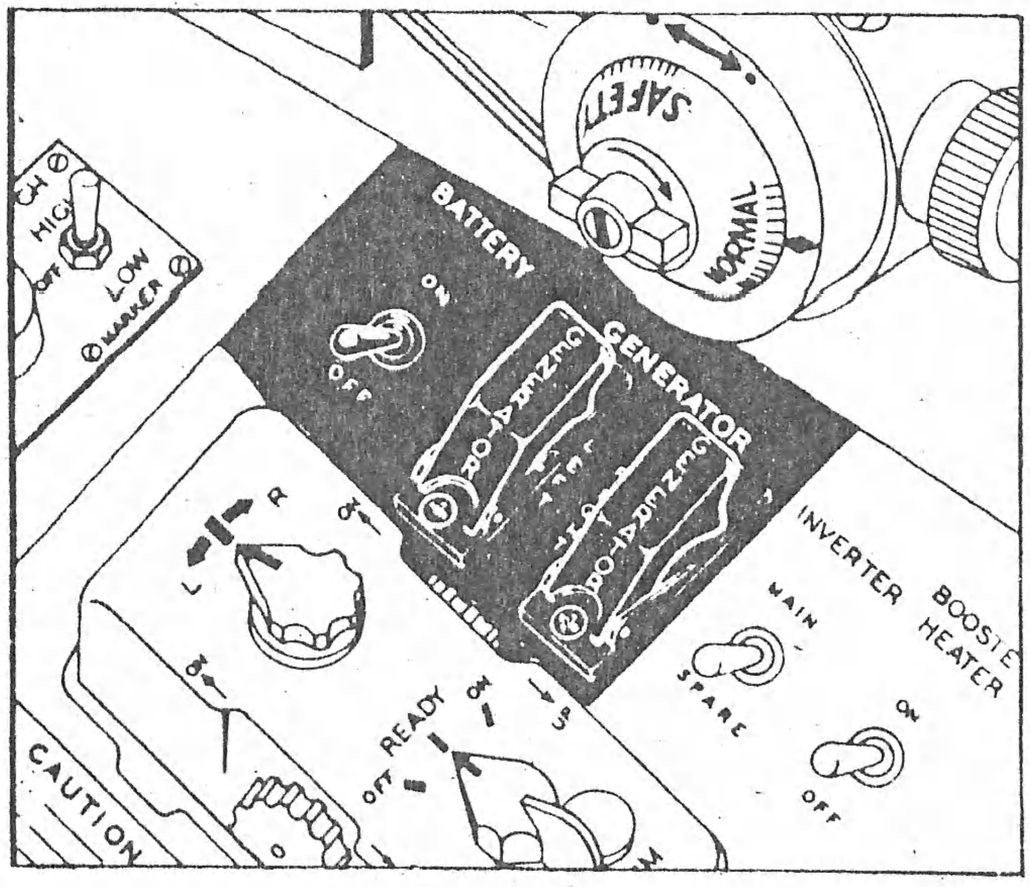


Figure 1-21. Battery and Generator Controls

1-61. INVERTER SWITCH. A toggle type inverter switch is located immediately aft of the generator switches. The switch has 'MAIN', 'OFF' and 'SPARE' positions.

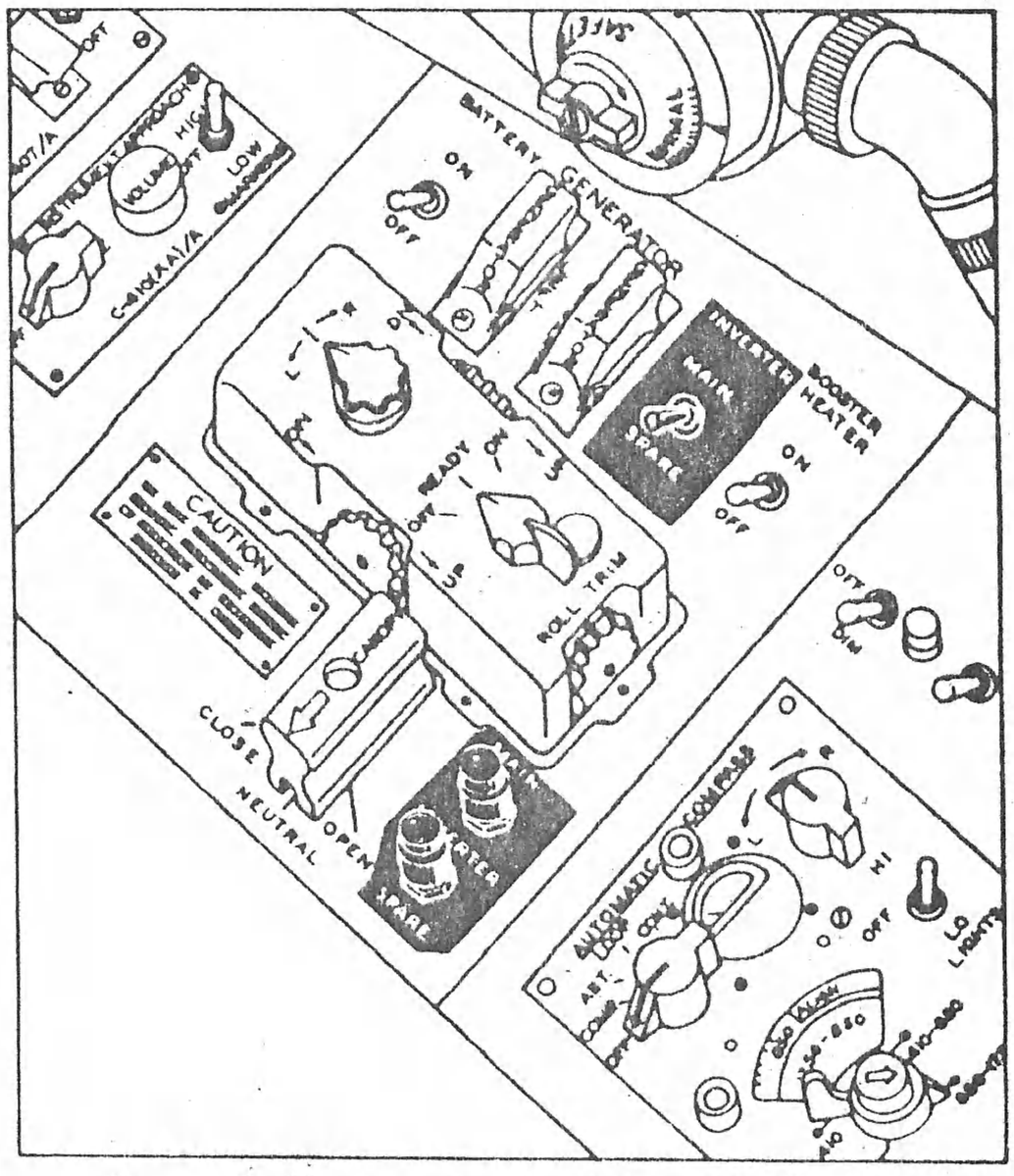


Figure 1-22. Inverter Switch and Indicators

1-62. INVERTER FAILURE INDICATING LIGHTS. Two warning lights which indicate failure of 'MAIN' or 'SPARE' inverters are located on the right-hand console aft of the canopy control. The upper light when on indicates 'MAIN INVERTER OUT', and the lower light indicates 'BOTH OUT'.

1-63. CIRCUIT BREAKERS. Circuit breakers are located in the forward part of the right and left-hand consoles.

1-64. ELECTRICAL CONTROLS FOR HYDRAULICALLY ACTUATED COMPONENTS.

1-65. LANDING GEAR CONTROL. The landing gear is controlled by an electrically operated hydraulic

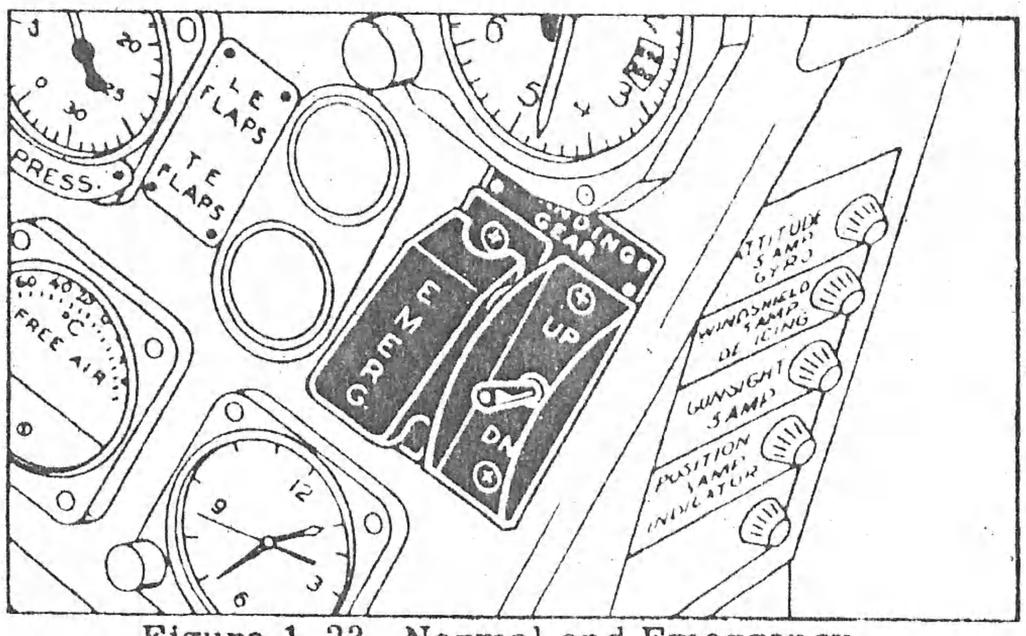


Figure 1-23. Normal and Emergency Landing Gear Controls

valve. The cockpit control for this valve is a toggle switch located on the left-hand instrument panel. The switch has 'UP' and 'DOWN' positions.

CAUTION

Allow the gear to complete cycle selected, prior to changing cycle, in order to prevent possible damage to the landing gear fairing doors.

1-66. GENERATOR VOLTAGE CONTROLS. A cockpit controlled adjustment rheostat for the generator voltage regulators is provided for each generator. The rheostats are located on the right-hand console, aft of the pitot heater switch, and have 'DECREASE AND INCREASE' positions. Generator output is checked by means of a voltmeter selector switch located on the forward right-hand console panel, immediately aft of the voltmeter. The switch has 'LEFT', 'RIGHT', 'BATT', and 'OFF' positions.

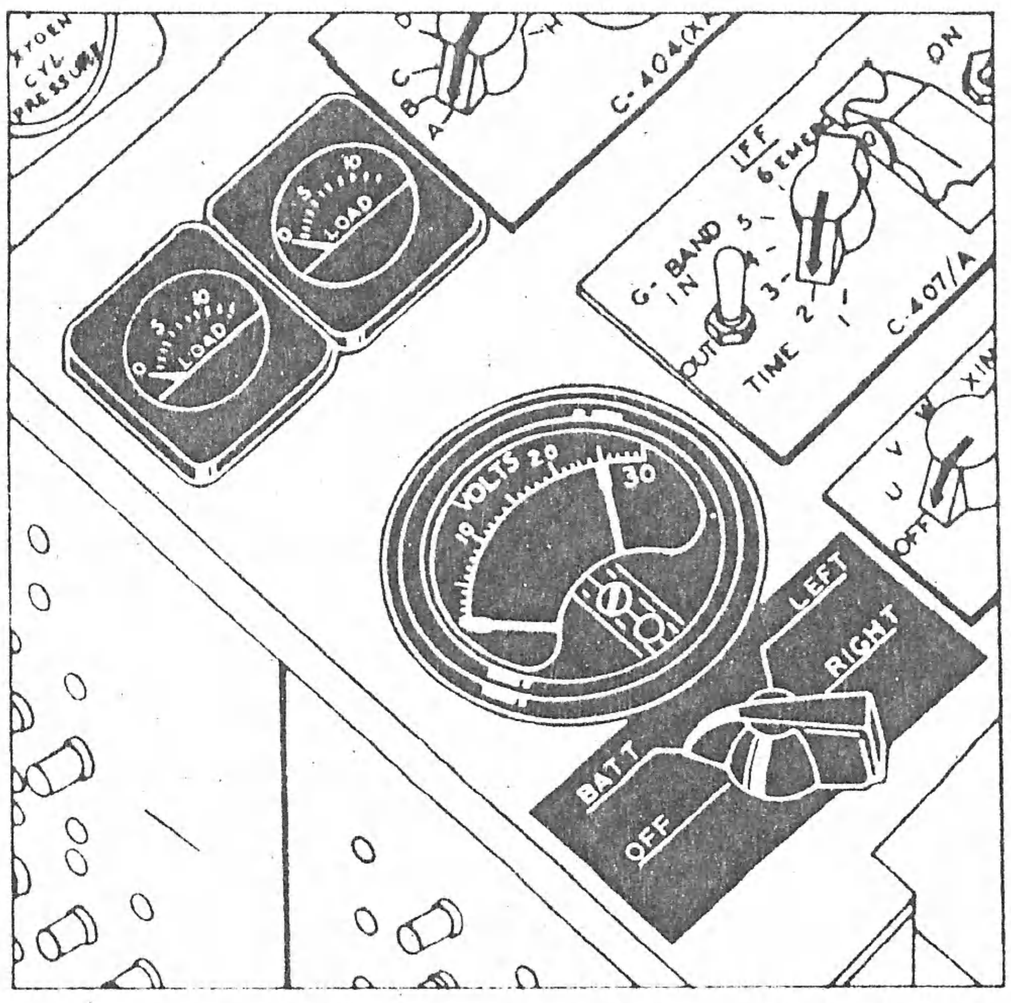


Figure 1-24. Generator Voltage Controls

1-67. INTERIOR LIGHTING.

1-68. INSTRUMENT PANEL LIGHTING. Instrument panel lighting is provided by two flexible fluorescent lights located on the left and right side of the cockpit, above the console panels. The lights provide a source of ultra-violet energy, used to illuminate the fluorescent markings on the instrument dials. The intensity of ultra-violet illumination is controlled by a rheostat integral with the light assembly. The rheostat has 'BRIGHT', 'DIM', and 'OFF' positions.

1-69. COCKPIT LIGHTING. A cockpit extension light assembly, located on the right-hand console, aft of the auto compass controls is provided. The light assembly provides a source of floodlighting or spotlighting for map reading and general cockpit illumination. A sliding shutter operated by the rotating head on the light assembly, controls the type of light desired. The shutter on the side of the head permits floodlighting, and a hole in the head of the assembly allows a direct spotlight source. The light is manually operated by means of an 'ON' and 'OFF' position toggle switch, mounted on the reel box, directly below the light assembly.

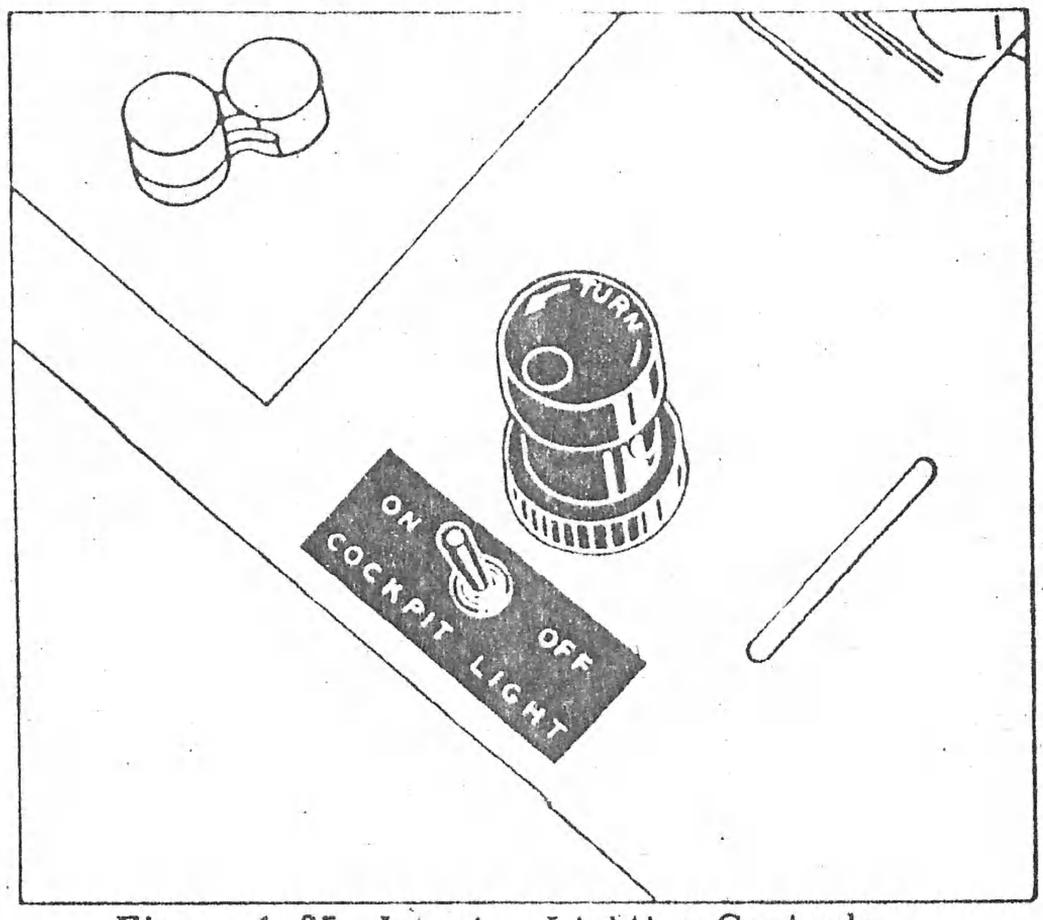


Figure 1-25. Interior Lighting Controls

1-70. EXTERIOR LIGHTING.

1-71. POSITION LIGHTS. There is a position light on each wing tip, and two on the tail of the airplane. The lights are controlled by two toggle switches located on the right-hand console, outboard of the auto compass controls. One switch has 'STEADY', and 'FLASH' positions, and the other has 'DIM', 'OFF', and 'BRIGHT' positions.

1-72. WING TIP TANK LIGHTS. When the wing tip tanks are installed, the position lights on the wing tips are covered. Therefore, a light is installed on each tip tank and is operated by the position light toggle switches.

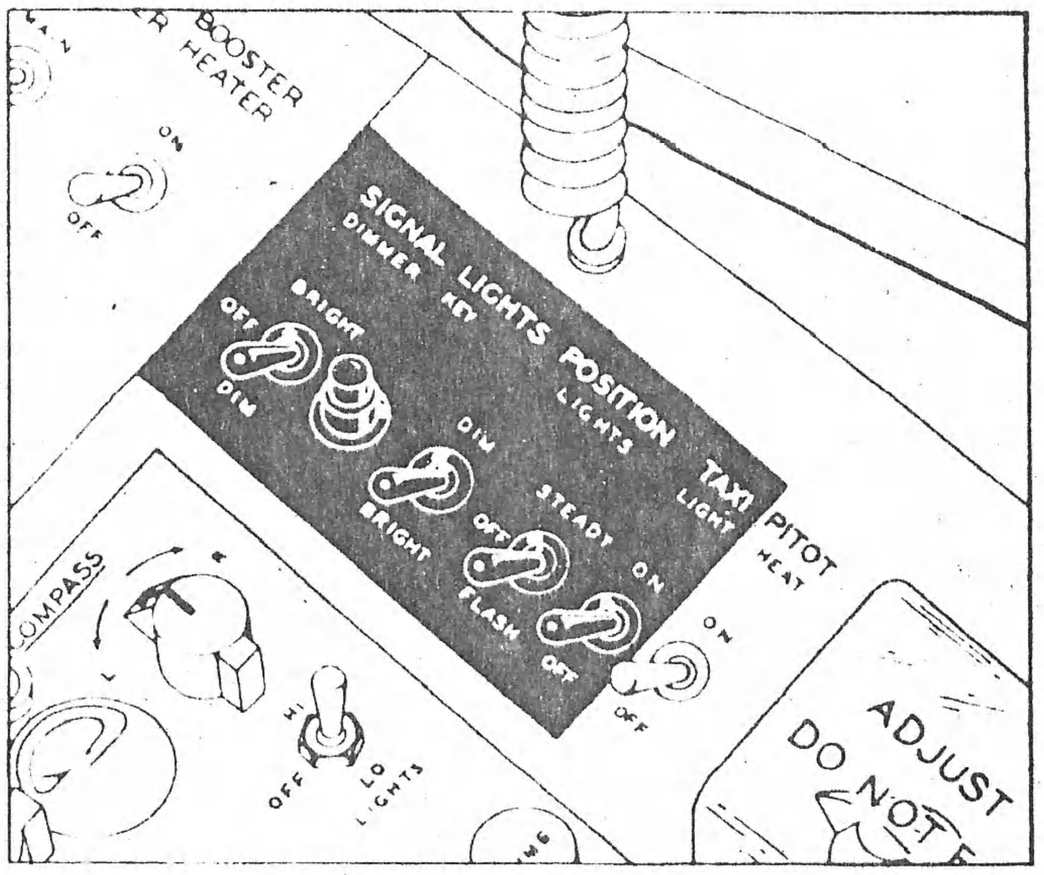


Figure 1-26. Exterior Lighting Controls

1-73. SIGNAL LIGHTS. A signal light, consisting of two lamps, is installed on the upper and lower surface of the fuselage. The lights are regulated to 'BRIGHT', 'OFF', and 'DIM' positions by means of a toggle switch on the right-hand console, forward of the position lights switches. A dimmer key is also provided adjacent to the toggle switch, and is used for signaling purposes. One of the two lamps in each light assembly burns constantly (switch on) while the other is operated by the dimmer key.

1-74. LANDING LIGHTS. A light is installed on each nose gear door, and extends simultaneously with the nose wheel. The lights are manually operated by means of an 'ON' and 'OFF' position toggle switch, located on the left-hand console, aft of the throttle controls.

1-75. TAXI LIGHT. The landing light on the right nose gear door is used as a taxi light toggle switch on the right-hand console, aft of the position light controls. The switch has 'ON' and 'OFF' positions.

1-76. PITOT HEATER SWITCH. A pitot heater circuit breaker type toggle switch is located on the right-hand console, aft of the taxi light switch. The switch has 'ON' and 'OFF' positions.

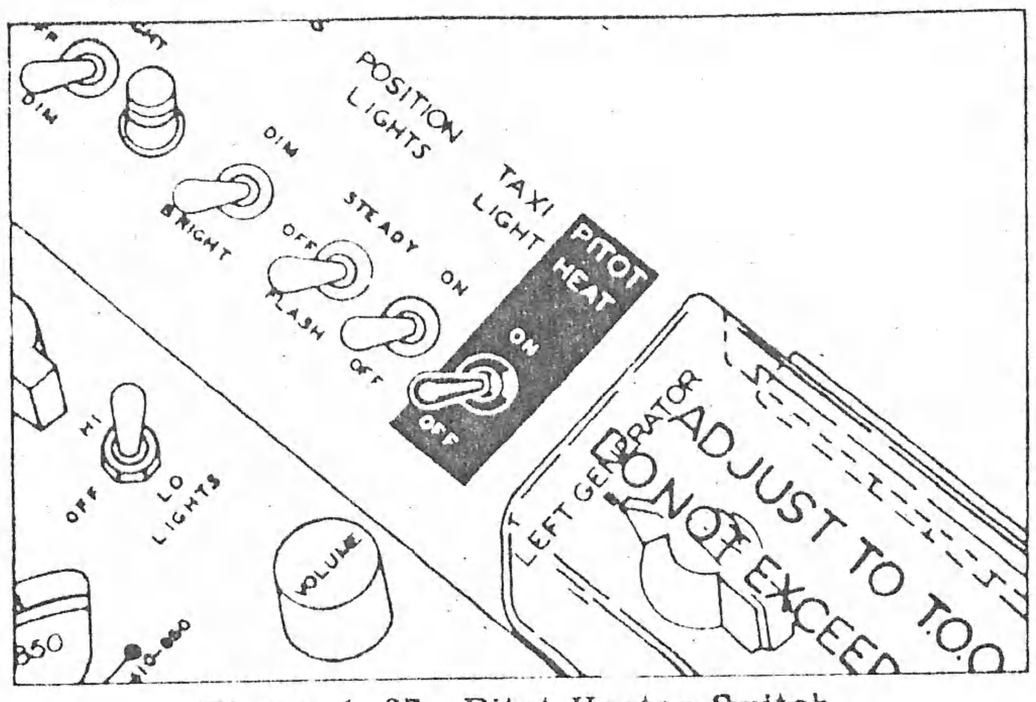


Figure 1-27. Pitot Heater Switch

1-77. WINDSHIELD DE-ICING SWITCH. A transparent electrically conductive coat is incorporated on the windshield and is used for de-icing purposes. The cockpit control for this feature is an 'ON' and 'OFF' circuit breaker type toggle switch located on the left-hand console, forward of the throttle and outboard of the cockpit ventilating controls.

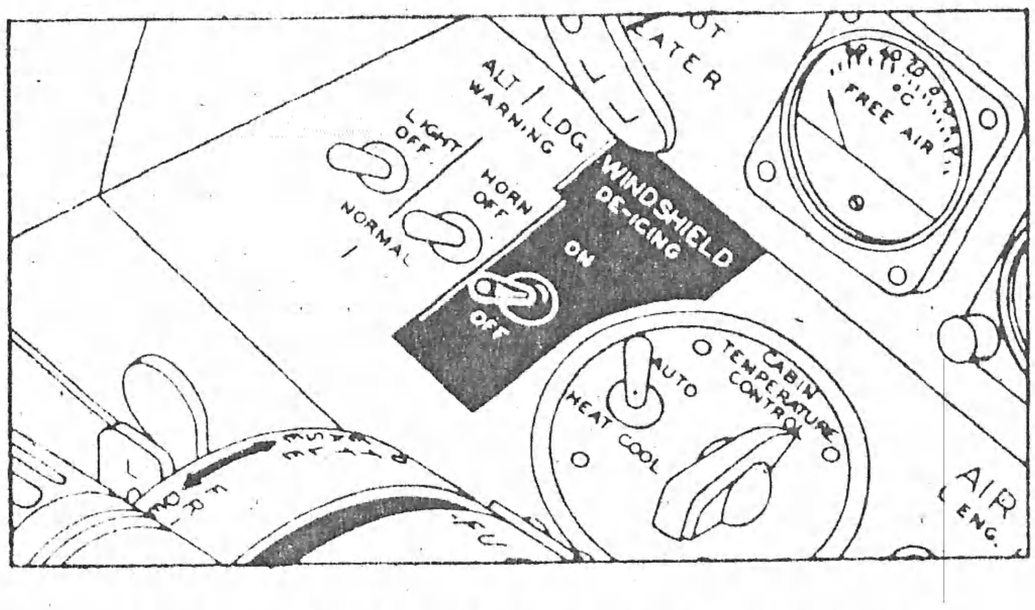


Figure 1-28. Windshield De-icing Switch

1-78. EMERGENCY LANDING GEAR CONTROLS.

1-79. EMERGENCY RETRACTION. A toggle switch adjacent to the normal landing gear control provides a means of retracting the landing gear while on the ground. The switch has an 'EMERG. UP' position. For specific instructions on raising gear while on ground see Section III.

1-80. EMERGENCY EXTENSION. See Section III.

1-81. ALTITUDE WARNING LIGHT. An altitude warning light is provided on the main instrument panel. The light warns the pilot when cabin altitude exceeds 40,000 feet, and cabin pressure conditions require adjustment of the oxygen regulator. A toggle switch located on the left-hand console, outboard of the cabin temperature controls, is provided to override the light circuit.

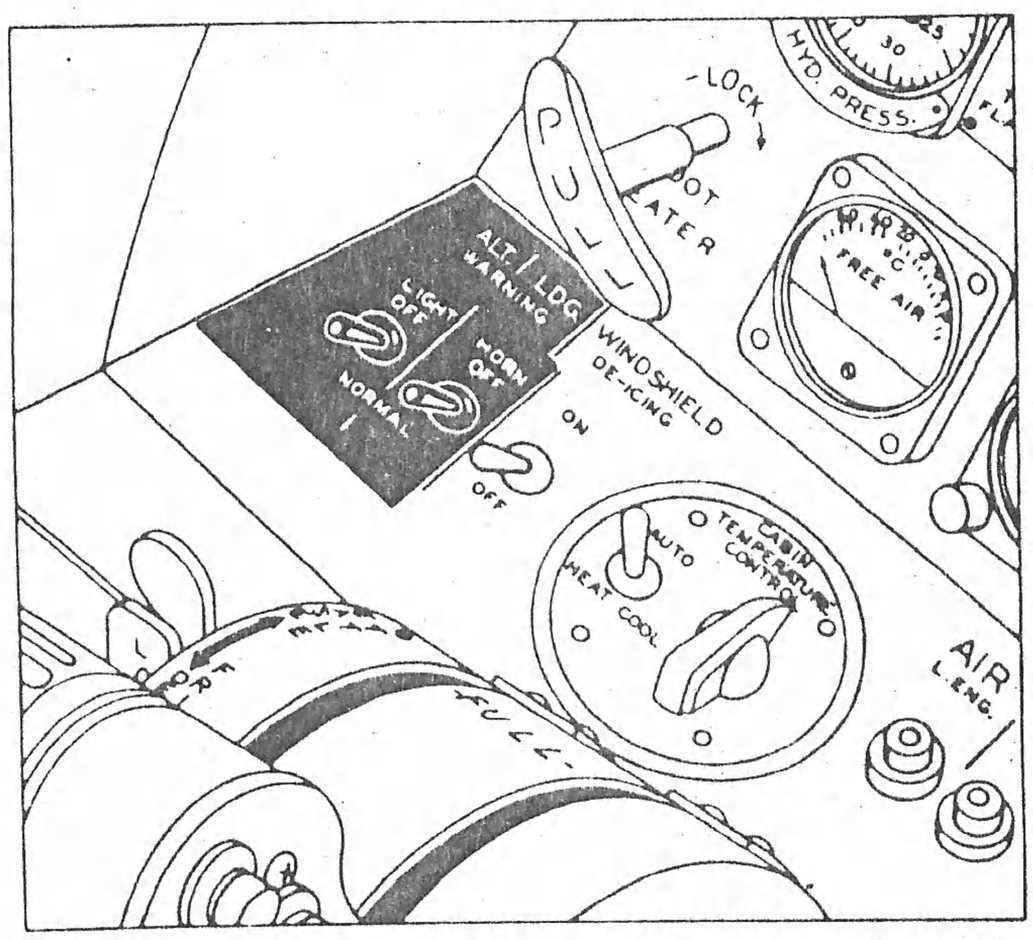


Figure 1-29. Altitude and Landing Warning Control

1-82. LANDING GEAR POSITION INDICATORS. Three green and one red light located on the main instrument panel, indicate the landing gear position. One middle

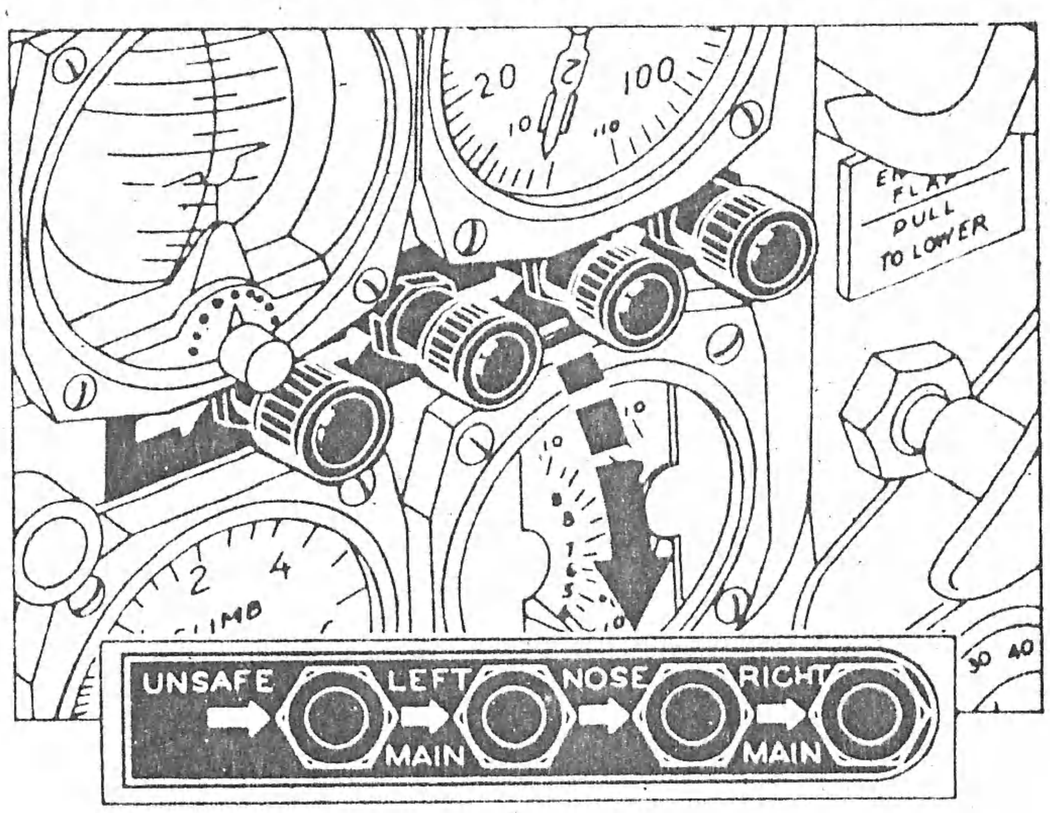


Figure 1-30. Landing Gear Warning Lights

green light represents the nose gear, and the adjacent green lights represent the main gear. The lights operate as follows;

a. All green lights 'ON' - red light 'OFF' - when both main and nose gear are locked down.
b. Any or all green lights 'OFF' - red light 'ON' - when either main or nose gear is unlocked.
c. All lights 'OFF' - when both main and nose gear are locked up.
d. All green lights 'OFF' - red light 'ON' - when both main and nose gear are locked 'UP' providing that throttle is retarded below minimum cruising rpm, and trailing edge flaps deflected at least 20 degrees.

1-83. LANDING GEAR WARNING HORN. In addition to the warning lights a landing gear warning horn is also provided. When the main and nose gear are not locked 'DOWN' and throttle retarded less than for minimum cruising rpm and trailing edge flaps deflected at least 20 degrees the warning horn will sound. The horn may be discontinued by means of the toggle switch located on the left-hand console, adjacent to the altitude warning toggle switch.

1-84. JATO UNITS. Provisions are made for the installation of two Jato units. Each unit supplies thrust augmentation of 1000 pounds. The units are mounted on the lower surface of the fuselage, on the forward access door directly below the engines.

1-85. JATO CONTROLS AND RELEASE. The Jato controls consist of an 'ARMED - SAFE' position toggle switch, located immediately aft of the Jato 'RELEASE - SAFE' toggle switch, on the left-hand console, aft of the throttle controls. With the aft toggle switch in the 'ARMED' position, the units are energized (fired) by means of a push button switch located on the engine throttle. When the switch is depressed, a light between the two toggle switches indicates that the circuit is energized. The units are released, after thrust is utilized, when the forward toggle switch is in the 'RELEASE' position.

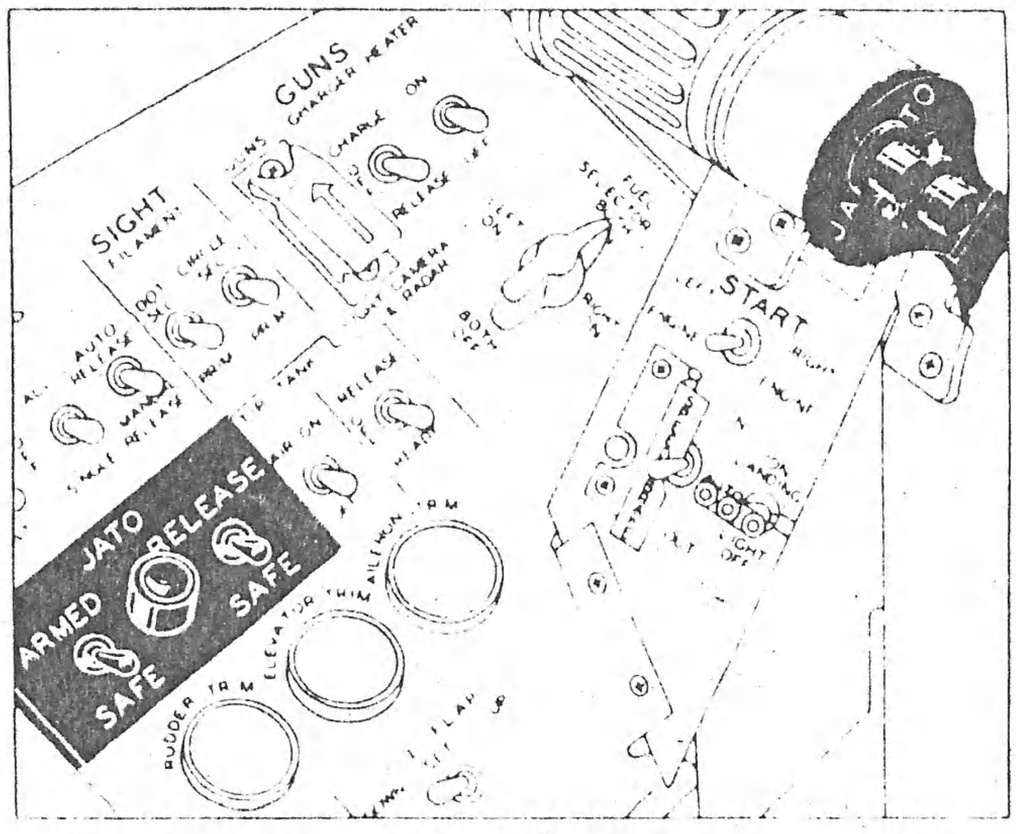


Figure 1-31. Jato Controls

1-86. NORMAL CANOPY OPERATION.

1-87. INTERIOR OPERATION. The canopy is hydraulically operated by means of a manual control knob in the cockpit. The control is located on the right-hand console, inboard of the auto pilot controls. An arrow on the control knob indicates direction of movement. The canopy is opened by turning the knob aft to the 'OPEN' position, and holding in this position. The canopy will continue to open until the knob is released and allowed to return to the 'NEUTRAL' position. This allows the canopy to lock in any desired position. The canopy is closed by turning the knob forward to the 'CLOSE' position, and holding in this position.

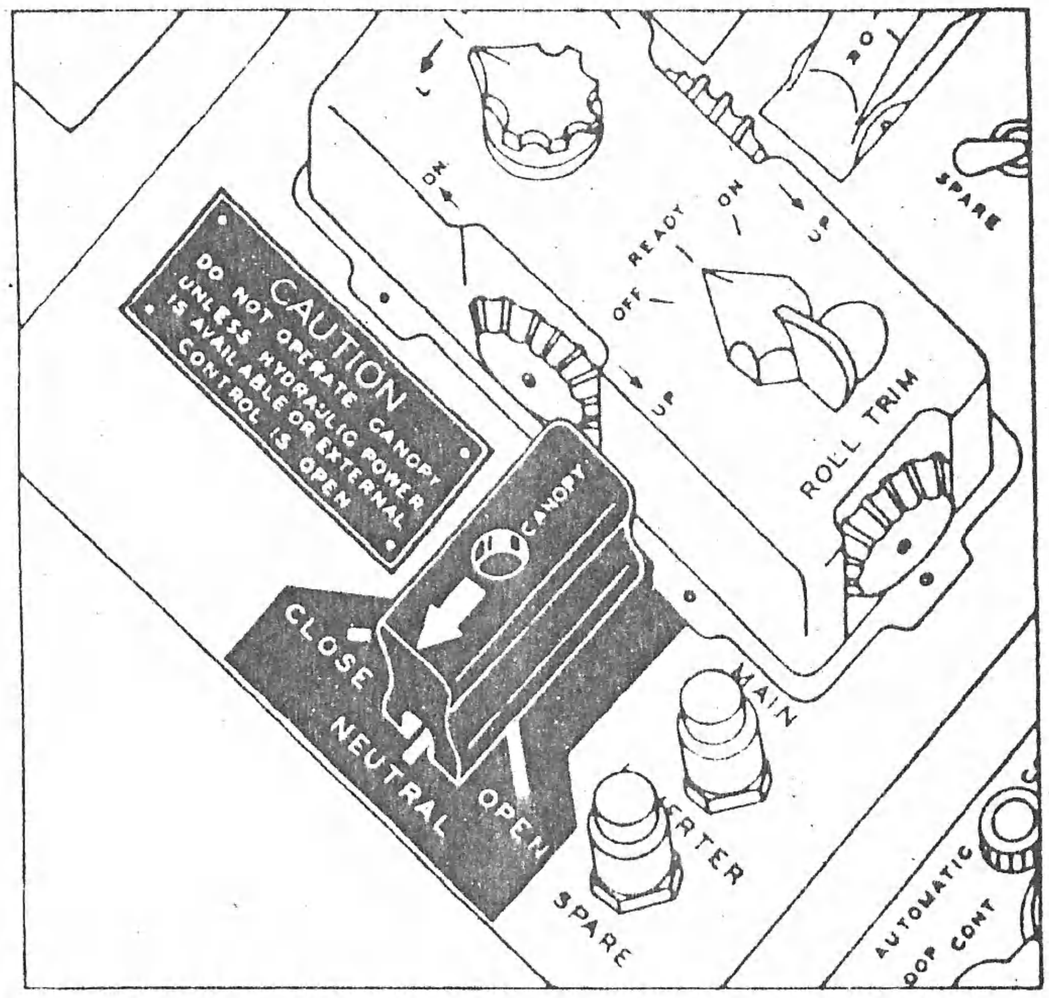


Figure 1-32. Normal Canopy Control - Interior

1-88. EXTERIOR OPERATION. The canopy is operated manually from outside the cockpit by means of a flush type handle located above and forward of the inlet air ducts in the wings. Pulling out the handle disengages the hydraulic motor by means of a cable and lever assembly. The flush type fastener is pushed to release the handle. The handle must be rotated completely aft (approx. 180°) in order to disengage the hydraulic motor. The canopy can then be pushed open manually. The hydraulic motor is re-engaged when the handle is pushed closed.

1-89. MISCELLANEOUS CONTROLS AND EQUIPMENT.

1-90. EJECTION SEAT. The airplane is equipped with an ejection type pilot's seat. The seat is manually adjusted five inches vertically by means of the adjustment handle on the lower right side of the seat. An armor plate headrest is provided and remains stationary as the seat is adjusted. The shoulder harness is attached to an inertia reel on the seat back, and is locked and released by means of the small handle on the lower left side of the seat.

1-91. RUDDER PEDAL ADJUSTMENT. The rudder pedals are adjustable fore and aft by means of the pedal

adjustment crank. This crank moves both pedals simultaneously and is located on the center line of the airplane, directly forward of the control stick. Turn in a clockwise direction for forward adjustment, counter-clockwise for aft.

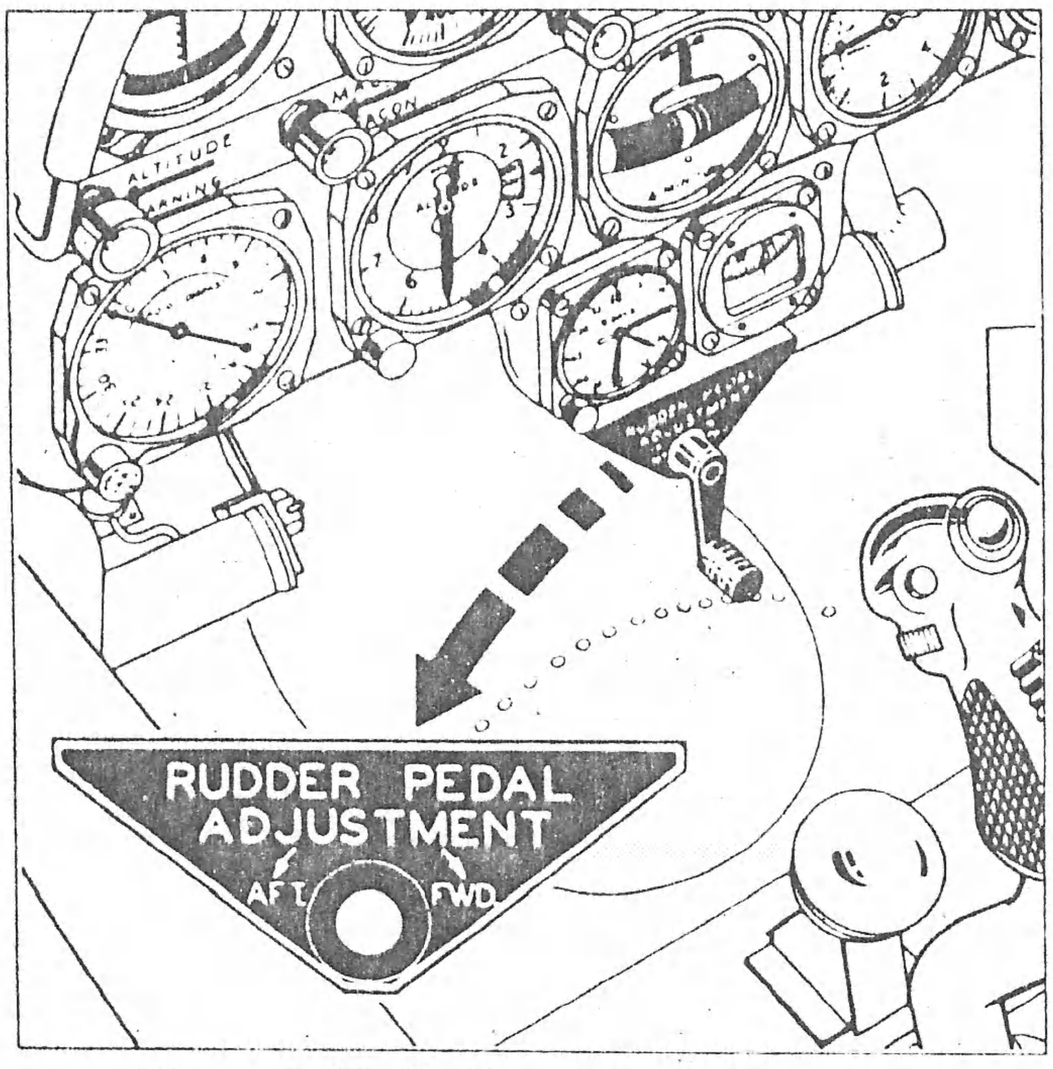


Figure 1-33. Rudder Pedal Adjustment

1-92. STABILIZING PARACHUTE. A stabilizing parachute is incorporated in the headrest. This parachute releases a pre-set timer upon seat ejection, which in turn, automatically opens the parachute.

1-93. EJECTION SEAT CONTROLS AND ATTACHMENTS.

1-94. FOOT STIRRUPS. Two foot stirrups are installed on the lower section of the seat, and are to be used for ejection only.

WARNING

Be absolutely certain that feet are securely placed as far aft as possible within the foot stirrups prior to operating the ejection controls.

1-95. CANOPY EMERGENCY JETTISON HANDLE. A red handle on the left side of the seat, above the shoulder harness release lever, jettisons the canopy. The canopy in turn pulls the catapult safety pin and allows the firing pin to fall into the cocked position.

1-96. SEAT JETTISON HANDLE. The red handle on the right side of the seat fires the catapult, thereby jettisoning the seat.

1-97. MAP, FLIGHT REPORT HOLDERS AND DATA CASE. Two map, flight report holder, and data cases are provided on each side of the cockpit, above the consoles.

1-98. REAR VIEW MIRRORS. Two rear vision mirrors are mounted on the forward frame of the sliding canopy enclosure.

1-99. PARACHUTE. Provisions are made for the use of a standard seat or back type parachute.

1-100. RELIEF TUBE. A spring loaded relief tube is provided on the under surface of the pilot's seat. The horn contains an integral control valve to prevent loss of pressure.

1-101. SUNSHADE. A sunshade on the inside of the canopy is provided. The shade is used to deflect glare away from the pilot's face, and is held in place by means of rubber suction cups.

1-102. SPARE FUSE BOX. A spare fuse container is installed on the right side of the cockpit wall aft of the oxygen regulator.

1-103. THERMOS BOTTLE. A one quart thermos bottle is provided and is mounted on the right map case.

1-104. ANTI-BLACKOUT SYSTEM. An anti-g connection for the anti-blackout system is located on the rear left-hand console panel. Compressed air for the system is tapped from each engine compressor section and piped to the regulator and outlet connections on the console panel. Automatic pressurization is controlled by the knurled knob on the pressure regulator; thereby inflating the suit according to g's pulled. Air is supplied manually by depressing button atop the adjustment knob.

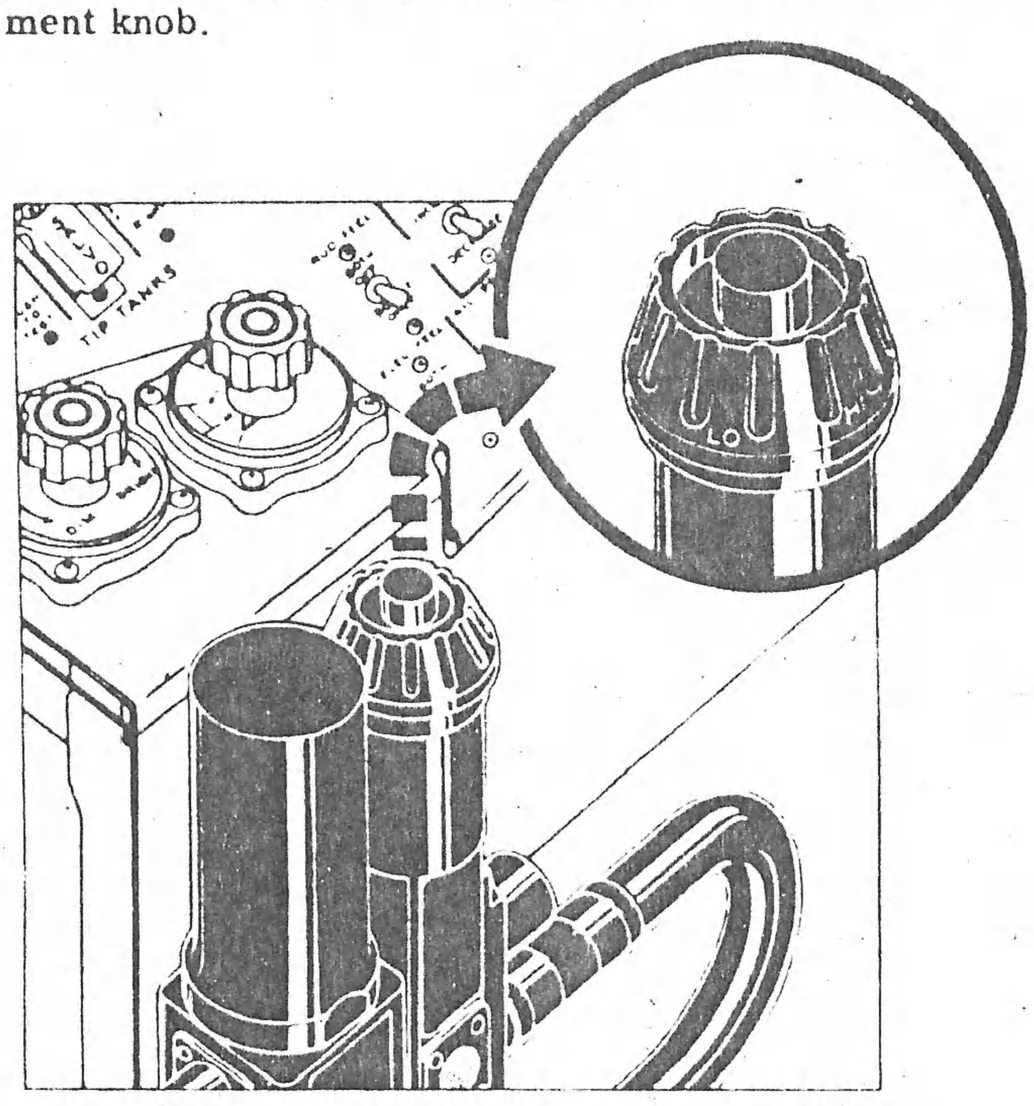


Figure 1-34. Anti-blackout Controls

1-105. SHOULDER STRAP RELEASE. The shoulder harness consists of two straps connected to the cable of an inertia type reel. The reel is attached to the aft side of the pilot's seat. The straps run upward behind

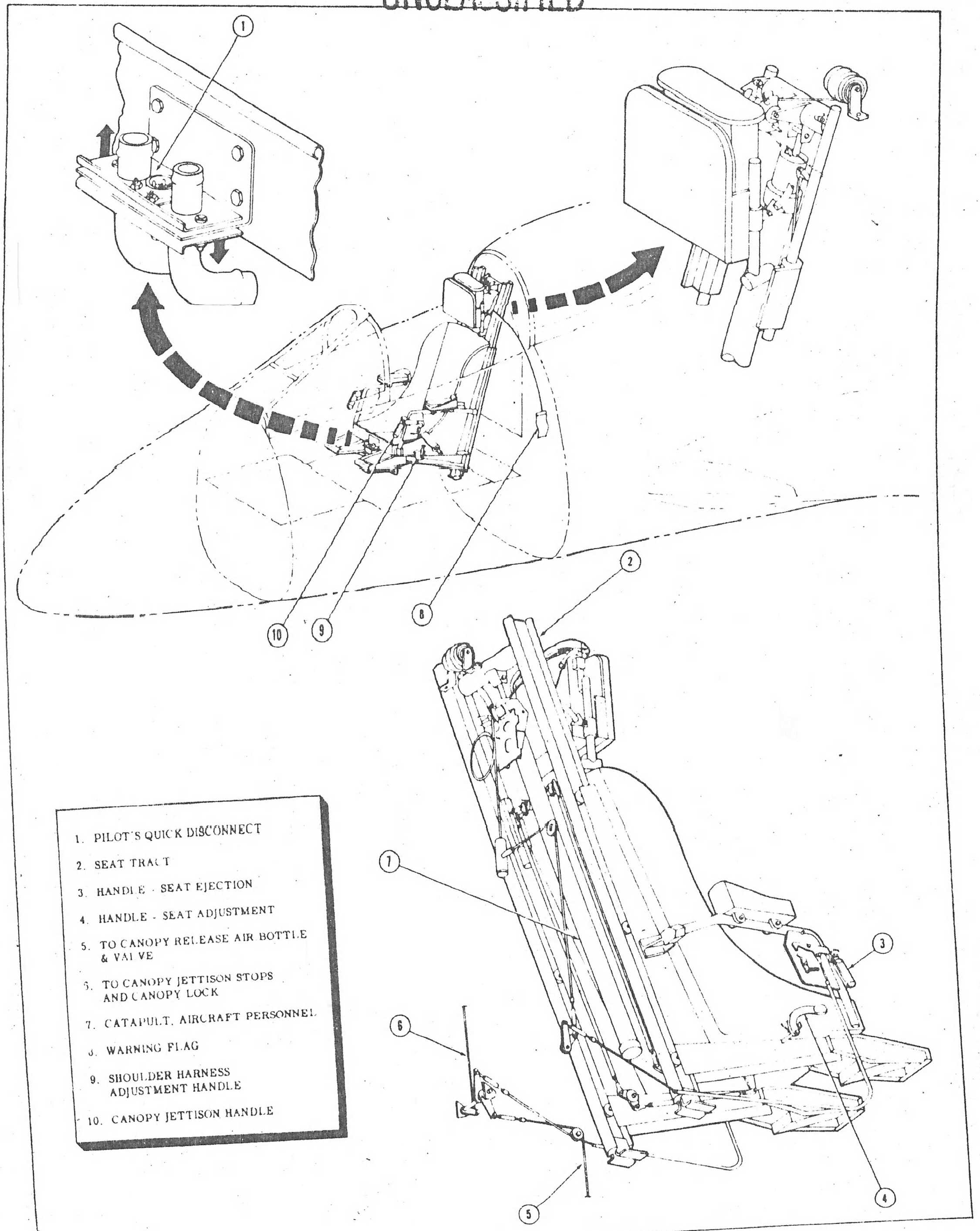


Figure 1-35. Pilot's Seat and Ejection Controls

the seat and over a guide tube attached to the seat. The free ends of the shoulder straps are equipped with loops which connect to the buckle of the lap belt. Release of the lap belt buckle also releases the shoulder straps. A manual control handle on the left side of the seat provides for locking or unlocking the inertia reel. In the 'UNLOCKED' position, the reel lets out cable, permitting the pilot to lean forward at will. As pilot leans back, the reel winds in cable and takes the slack out of shoulder straps. In the unlocked position, the reel will automatically lock when a decelerative force of two to three g is imposed. In the 'LOCKED' position, the reel takes in cable as pilot leans back holding pilot firmly against back of seat.

1-106. PILOT'S PERSONAL QUICK DISCONNECT. A personal quick disconnect panel is provided on the forward portion of the seat pan. The panel is composed of two tubes, one for the anti-g connection, and the other for the oxygen connection, and one electrical disconnect plug and socket for the radio microphone and earphones. The tubes are mounted on plates and are fastened together with spring clips. The tubes and plug on the lower plate are fastened to the seat, and the upper plate connection is broken when the pilot leaves the airplane.

PILOT'S NOTES

SECTION II
NORMAL OPERATING INSTRUCTIONS

NOTE THE FOLLOWING RESTRICTIONS:

OPERATING FLIGHT RESTRICTIONS

The maximum permissible limit speed (KNOTS-IAS) for various operations are as follows:

Lowering or Retracting Landing Gear	205 (235 mph)
Lowering Flaps	175 (200 mph)
Opening Canopy	217 (250 mph)
Opening Speed Brakes	Not Available
Closing Speed Brakes	Not Available
Structural Limits	Not Available
Aerodynamic Limits	Not Available

Note

All data contained in this handbook is calculated, and subject to change pending flight testing of airplane. Sufficient space has been provided after each paragraph in this section for pilot's notes on aircraft performance or operation.

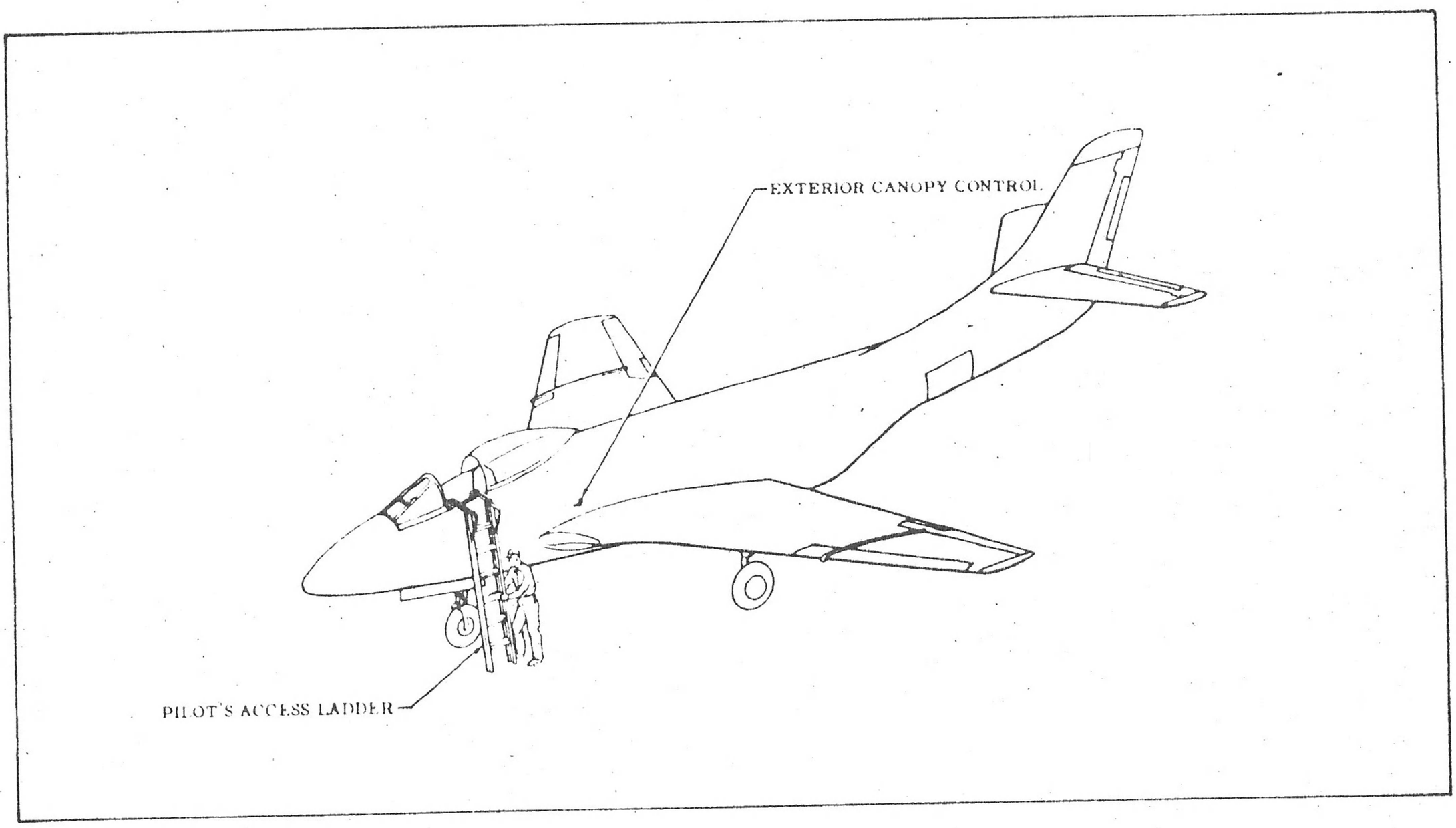


Figure 2-1. Cockpit Access

2-1. BEFORE ENTERING COCKPIT - CHECK FOLLOWING ITEMS.

a. Check gross weight and c.g. locations for take-off and anticipated loading for landing. Loading data are furnished in the Handbook of Weight and Balance Data AN01-1B-40.
b. Fuel and oil caps secured.
c. See that engine inlet air duct guards are installed and the airplane is parked where the jet blast will do no harm.

CAUTION

Ascertain that landing gear door safety switch in right main gear wheel well is in 'ON' position.

2-2. GAINING ENTRANCE TO COCKPIT. Enter the airplane as shown in Figure 2-1. .

2-3. ON ENTERING COCKPIT. Jet engines require very little warm-up, however, fuel consumption while idling is extremely high. Therefore, the following preparations for flight should be accomplished before starting the engines.

2-4. BEFORE ALL FLIGHTS.

Check List

a. ADJUST RUDDER PEDALS.
b. ADJUST SEAT HEIGHT.
c. ADJUST SEAT HARNESS AND RADIO GEAR FOR FLIGHT.
d. FEEL AND POWER CONTROLS TO 'BOTH ON'.
e. ASCERTAIN THAT OIL QUANTITY HAS BEEN CHECKED.
f. CHECK POSITION OF CANOPY CONTROL.
g. CHECK POSITION OF SEAT CONTROLS.
h. SET FLIGHT ALTIMETER TO CORRECT BAROMETRIC PRESSURE.
i. TEST OPERATE OXYGEN SYSTEM IF HIGH ALTITUDE FLIGHT IS ANTICIPATED.
j. CABIN PRESSURIZATION CONTROL 'AUTO'.
k. ALL ARMAMENT SWITCHES 'OFF'.
l. JATO CONTROLS 'SAFE'.

CAUTION

Do not 'ARM' Jato units until ready for take-off.

m. ELEVATOR DOWN SPRING 'SET'
n. BATTERY 'ON'
o. CHECK FUEL QUANTITY GAGE.
p. TEST OPERATE GUN SIGHT FOR ILLUMINATION.
q. BATTERY 'OFF'.

2-5. BEFORE NIGHT FLIGHTS.

a. BATTERY 'ON'.
b. OPERATE INSTRUMENT PANEL RHEOSTAT.
c. OPERATE COCKPIT LIGHT SWITCH.
d. OPERATE INDIVIDUAL EXTERIOR LIGHTS.
e. BATTERY 'OFF'.

2-6. FUEL SYSTEM MANAGEMENT.

CAUTION

Fuel consumption is greater for jet propelled aircraft than for conventional aircraft. Fuel consumption in flight can be as high as 19 gallons per minute when operating at military power. Therefore, observe fuel quantities closely.

2-7. SEQUENCE OF TANK SELECTION. The pilot has no control of fuel tank sequence as fuel flow is automatic when the throttle is past the 'OFF' position.

2-8. STARTING ENGINES. Head airplane into the wind for starting, if surface wind velocity is over 10 knots.

Note

An external power supply is required for starting the engines. Jet engines necessitate higher starting power for a longer period than conventional power plants.

2-9. GENERAL. A cold engine will normally 'light off' in approximately 15 seconds (11.4 - 12.2% rpm). Do not advance throttle such that turbine outlet temperature limits are exceeded. The characteristic sound of the engine while starting is a whine which increases in pitch with combustion. Listen carefully to each engine as an unusual delay in 'lighting off' may mean malfunctioning of the engine. If engine fails to start after 60 seconds, depress air start switch to stop starter motor. During the starting cycle, note the vibration of the engine. Engine bearing failure is usually indicated by excessive engine vibration at less than 40.6% rpm.

TACHOMETER PERCENTAGE (%) CONVERSION TABLE

ENGINE RPM	% TACH. RPM
12500	101.5
12300	100
12000	97.5
11000	89.5
10000	81.4
9000	73.2
8000	65
7000	56.9
6000	48.8
5000	40.6
4000	32.5
3000	24.4
2000	16.2

Note

The engine tachometers are calibrated in percentages of rpm, therefore refer to the preceding conversion table for equivalent engine rpm.

2-10. STARTING PROCEDURE.

a. Battery switch 'OFF'.

CAUTION

Battery switch must be 'OFF' when starting engines with external power, in order to prevent airplane battery drain.

b. Generator switch 'OFF'.
c. External power connected.
d. Throttle cracked from closed position.
e. Fuel on engine to be started.
f. Momentarily engage starter switch of selected engine.
g. Allow engine to reach at least 11.4% rpm and advance throttle slowly to 'IDLE'.

Note

Starter circuit will cut out if air start switch is operated.

h. After 'light off', retard throttle slightly momentarily. Then advance slowly to 'IDLE'.

Note

A hot start can be identified by 'rumbling' and/or 'torching' at the exhaust nozzle. If a hot start is indicated, retard throttle to hold acceleration to a minimum until engine reaches idling rpm. If turbine outlet temperature is still excessive when idling rpm is reached, advance throttle slowly to 65% rpm, and hold until temperature decreases.

i. If engine 'lights off' very late in cycle, immediately re-engage normal starter switch a second time so that the starter will assist the engine to accelerate. This procedure will prevent hot starts caused by late ignition. If 'light off' does not occur, check for presence of fuel in the combustion chamber and exhaust nozzle before attempting another start.
j. If engine fails to start, repeat above procedures, after making certain no abnormal condition exists.
k. Start second engine after first engine reaches idling rpm (32.5 - 40.6%). Fuel selector valve 'BOTH ON'.
l. Battery 'ON' after external power is disconnected.
m. Generators 'ON'. Advance throttles and note voltmeter readings. (Should be 28.5 volts at approximately 39% rpm)
n. Advance throttles to 65% rpm and check fuel pressure.
o. Increase to 101.5% rpm or turbine outlet limiting temperature.

POWER PLANT CHECKS

2-11. OIL PRESSURE CHECK.

32.5%	5-28 psi
65%	44-70 psi
101.5%	65-90 psi

2-12. TURBINE OUTLET CHECKS.

32.5%	538°C (1000°F)
65%	427-483°C (800-900°F)
101.5%	594°C (1100°F)

to limit red lined on indicator.

2-12. FUEL PRESSURE CHECK.

ENGINE RPM (%)	EMERG. PUMP FAILED MAIN PUMP OPERATING	(NORMALLY READ IN COCKPIT) BOTH PUMPS OPERATING NORMALLY	EMERGENCY PUMP OPERATING MAIN PUMP HAS FAILED
32.5	0-15 psi	45 psi	470 psi
40.6		49	478
48.8		52	505
62		60	535
65.8		65	545
75.4		75	550
85		85	565
89.5		90	565
96.4		95	568
97.5		100	575
101.5		108	575

CAUTION

Avoid making above test on gravel or loose dirt surface, because of possible damage to engines.

2-14. FAILURE OF ENGINE TO START. If the engine fails to start after the foregoing procedure, it is a definite indication of malfunctioning of the engine and the engine should be checked. Unsuccessful starting attempts may result in flooding the combustion chamber and tail pipe with fuel. The presence of this fuel will cause a flaming start, with resultant hot spots within the engine, and occasionally a jet of flame will be emitted from the engine's exhaust nozzle. This fuel must be drained prior to attempting a start a second time. The starter and ignition coils should be allowed to cool for at least 20 minutes after making two unsuccessful starting attempts.

2-15. WARM-UP AND GROUND TESTS. No extended warm-up is required for jet propulsion engines, as proper combustion and operation are not dependent on engine temperature. Also the oil system uses low viscosity oil that does not have to be warmed to give proper lubrication. To avoid confusing the 'warm-up' of conventional engines with that operation for jet engines, the operation is called engine 'run-up'. The only purpose of the 'run-up' is to afford an opportunity for checking the operation of the engine prior to take-off. A sufficient 'run-up' period is allowed if the ground test of the first engine is made as soon as the second engine has reached stable operating conditions. The second engine may be tested as soon as the first engine tests have been completed. Using this procedure the complete starting and ground tests of the engines can be accomplished in two minutes.

CAUTION

Do not prolong 'run-up'. Fuel consumption will cut seriously into actual flight time.

2-16. ENGINE RUN-UP. Since the generator reverse current cut outs close when the generator output reaches 28.5 volts, the engines will carry the electrical load if the rpm is maintained above approximately 39% rpm.

WARNING

The pilot should warn personnel wearing loose caps, gloves, etc., to beware of the inlet air duct opening. Serious personal injury and damage to the engine can result if sucked against the opening.

2-17. IDLING CHARACTERISTICS. The engine idling characteristics may vary daily, but should be kept between 32.5 - 40.6% rpm. However, the generator reverse current relays close only when the generator output reaches 28.5 volts (approximately 39% rpm); therefore during periods of prolonged idling, engine rpm must be maintained at this speed, at least, in order to prevent excessive drain on the battery power.

2-18. SCRAMBLE TAKE-OFF. For an emergency take-off eliminate engine run-up or ground testing but determine that the engines are up to speed and are operating smoothly. Take-off may be accomplished approximately one and a half minutes after starting the first engine.

2-19. TAXIING INSTRUCTIONS.

2-20. Vision from the cockpit is unimpaired.

2-21. Whenever possible, avoid taxiing over soft spots in the runway or over soft ground. The high pressure tires allow the airplane to become mired very easily.

2-22. It is much easier to make turns with a tricycle landing gear if the airplane is allowed to start rolling forward slightly before the turn is started.

2-23. On flat hard surfaces the airplane will roll forward with both engines idling.

2-24. TAKE-OFF.

Check List

a. SHOULDER HARNESS LOCKED.
b. LEADING EDGE FLAPS SET FOR 30° (FULL DOWN) AND TRAILING EDGE FLAPS SET FOR 30° (1/2 DOWN).
c. ALL SURFACE CONTROL POWER UNITS SET FOR 'BOTH ON'.
d. CONTROLS CHECKED FOR FULL MOVEMENT.
e. CANOPY 'CLOSE'.
f. TRIM TABS SET AT ZERO.

2-25. GENERAL.

2-26. TAB SETTINGS. There is very little trim change due to changes in power or to extension of landing gear or flaps.

2-27. FLAP SETTINGS. Flaps should be used on all take offs. For ordinary operations, a trailing edge flap setting of one-quarter (15°) to one-half (30°) down, and full down leading edge flaps should be used. The 30° setting allows a small increase in run over trailing edge flaps one-third down, but an improved rate of climb after take off. Take off with trailing edge flaps up will require an extremely long run and the initial rate of climb after take off will be poor.

2-28. TAKE-OFF TECHNIQUE.

2-29. NORMAL TAKE-OFF. Advance the throttles to military rpm (101.5%). If satisfactory engine operation is noted, release the brakes to allow the airplane to start rolling. At about 115 knots (130 mph) IAS bring the stick back in order to lift the nose off the ground and the airplane into the air. Retract the wheels as soon as the airplane is definitely airborne. Retard throttle to normal power (89.5%). Raise the trailing edge flaps at about 160 knots (184 mph) IAS. The leading edge flaps will raise automatically when approximately 165 knots (190 mph) is reached. Remain at low altitude until climbing speed of 356 knots (410 mph) IAS is attained before starting the climb.

2-30. MINIMUM RUN TAKE-OFF. Take-off with minimum ground run is accomplished with leading edge and trailing edge flaps full down. Start the run as for a normal take-off but pull the airplane off the ground at 115 knots (132 mph) IAS. Raise the landing gear as soon as airborne but do not raise the trailing edge flaps until 160 knots (184 mph) IAS has been attained.

2-31. OBSTACLE TAKE-OFF. Use one-half flap. Retract the wheels as soon as airborne, and climb the airplane at 190 knots (220 mph) IAS until the obstacle is cleared.

2-32. CLIMB AND LEVEL FLIGHT.

2-33. RATED POWER CLIMB AND LEVEL FLIGHT. Operate according to the Take-Off, Climb, and Landing Chart. A rated power climb consumes a larger amount of fuel before reaching the desired altitude. If the flight anticipated will require conservation and careful control of fuel, as much of the climb as possible should be made at military power.

2-34. SINGLE ENGINE CLIMB. When climbing with one engine, use military power if possible. This will conserve fuel in reaching the desired altitude.

2-35. GENERAL FLYING CHARACTERISTICS. This information will be furnished when available.

2-36. STABILITY. The airplane is stable under all conditions.

2-37. TRIM CHANGES. This information will be furnished when available.

2-38. CRUISING. Operate according to Flight Operation Instruction Chart.

2-39. BEST RANGE. Optimum range is obtained by flying on both engines at as high an altitude as possible.

2-40. MAXIMUM PERMISSIBLE SPEED AND ACCELERATIONS. This information will be furnished when available.

2-41. STEEP DIVES. The airplane is very clean and steep dives should not be made until familiarization with the rate of speed increases in dives and speeds attained has been obtained in shallow diving at safe altitudes.

2-42. GYRO-ATTITUDE INDICATOR. The attitude gyro indicator is an electrically operated non-tumbling instrument, and is on when the battery switch is on.

2-43. ENGINE SHUT-DOWN IN FLIGHT.

Check List

a. THROTTLE 'OFF'.
b. ALLOW ENGINE TO WINDMILL FOR SEVERAL MINUTES UNTIL THE TURBINE OUTLET TEMPERATURE IS LESS THAN 200°C (392°F).

CAUTION

Do not allow engines to windmill in air when temperature is less than -28.9°C (-28°F).

c. FUEL 'OFF' ON THIS ENGINE.
d. GENERATOR SWITCH 'OFF'.

2-44. ENGINE STARTING IN FLIGHT.

Check List

a. OBTAIN AIR SPEED BETWEEN 130-175 KNOTS (150-200 MPH) IAS.
b. FUEL 'ON' - BOTH ENGINES.
c. ADVANCE THROTTLE TO 'IDLE' POSITION.
d. HOLD AIR START SWITCH 'ON' UNTIL ENGINE LIGHTS OFF.
e. GENERATOR 'ON' WHEN ENGINE REACHES 5000 RPM. IF AN ATTEMPT TO START THE ENGINE IN FLIGHT IS UNSUCCESSFUL, TURN THE GENERATOR SWITCH 'OFF', CLOSE THE THROTTLE, TURN FUEL 'OFF', AND ALLOW ENGINE TO WINDMILL FOR SEVERAL MINUTES TO DISSIPATE EXCESS FUEL IN THE SYSTEM. TURN FUEL 'ON' AND ATTEMPT ANOTHER START.

2-45. MANEUVERS. This information will be furnished at a later date.

2-46. STALLS. This information will be furnished at a later date.

2-47. SPINS. This information will be furnished at a later date.

2-48. DIVES. This information will be furnished at a later date.

2-49. A warming up period is not required after completing the dive prior to opening the engines to military power. The engine speed does NOT increase appreciably in dives since the governor maintains constant engine speed. Engine speed will actually decrease if appreciable altitude is lost.

2-50. APPROACH AND LANDING. The airplane has a relatively flat approach angle in the landing configuration, throttles 'IDLE', but due to the high approach speeds, a high rate of descent is present. If a very low approach is made, careful power adjustment is required to maintain a safe approach speed.

Check List

a. SHOULDER HARNESS LOCKED.
b. EXTEND TRAILING EDGE FLAPS TO 50 DEGREES DOWN AT LESS THAN 160 KNOTS (184 MPH) IAS.
c. LANDING GEAR 'DOWN' AT LESS THAN 175 KNOTS (200 MPH) IAS.
d. ARMAMENT SWITCHES 'OFF'.

2-51. NORMAL APPROACH. Normal approach is accomplished with wheels and flaps fully down at approximately 125 knots (144 mph) IAS with a little power on 73.2% rpm). With this approach there will be an appreciable float after retarding throttles to 'IDLE', but a smooth landing can be made with the tail well down at approximately 115 knots (132 mph) IAS. In landing, fly the airplane to the ground with the tail down and hold the nose in the air as long as possible. If the stick is held fully back, the nose will rock over gently to the three-point attitude at about 65 knots (75 mph) IAS.

2-52. CROSS-WIND LANDING. Normal landing technique can be used in cross-wind landings. The tricycle landing gear will guarantee a straight roll after landing. Use nose gear steering, if necessary.

2-53. STOPPING ENGINES.

Check List

a. THROTTLES 'OFF'.
b. FUEL 'OFF' - BOTH ENGINES.
c. POWER CONTROL UNIT SWITCHES 'OFF'.
d. BATTERY AND GENERATOR SWITCHES 'OFF'.
e. LIGHTING SWITCHES 'OFF'.

2-54. It is recommended, when time permits, to shut down the engines individually, and the vibration of each engine be carefully noted below 40.6% rpm. The most marked indication of engine bearing failure occurs at about 16.2% rpm.

2-55. If residual burning occurs, (burning in the combustion chamber after stopping the engine) extinguish by pumping carbon dioxide into the inlet of the engine. If carbon dioxide extinguishers are not available immediately or engines have stopped, run the engine through a starting cycle with the fuel supply off.

2-56. AFTER LEAVING COCKPIT. If airplane is to be parked outside for any length of time, secure the airplane as per instructions contained in Erection and Maintenance Handbook.

SECTION III
EMERGENCY OPERATING INSTRUCTIONS

3-1. EMERGENCY RETRACTION OF LANDING GEAR.

a. Normal landing gear switch 'UP'.
b. 'EMERG.' switch 'UP'.

3-2. EMERGENCY EXTENSION OF LANDING GEAR. 'PULL OUT' emergency handle on forward vertical instrument panel and allow gear to free fall. Pulling the emergency release handle operates the main and nose landing gear emergency release mechanism, and an emergency dump valve through a cable and bellcrank system.

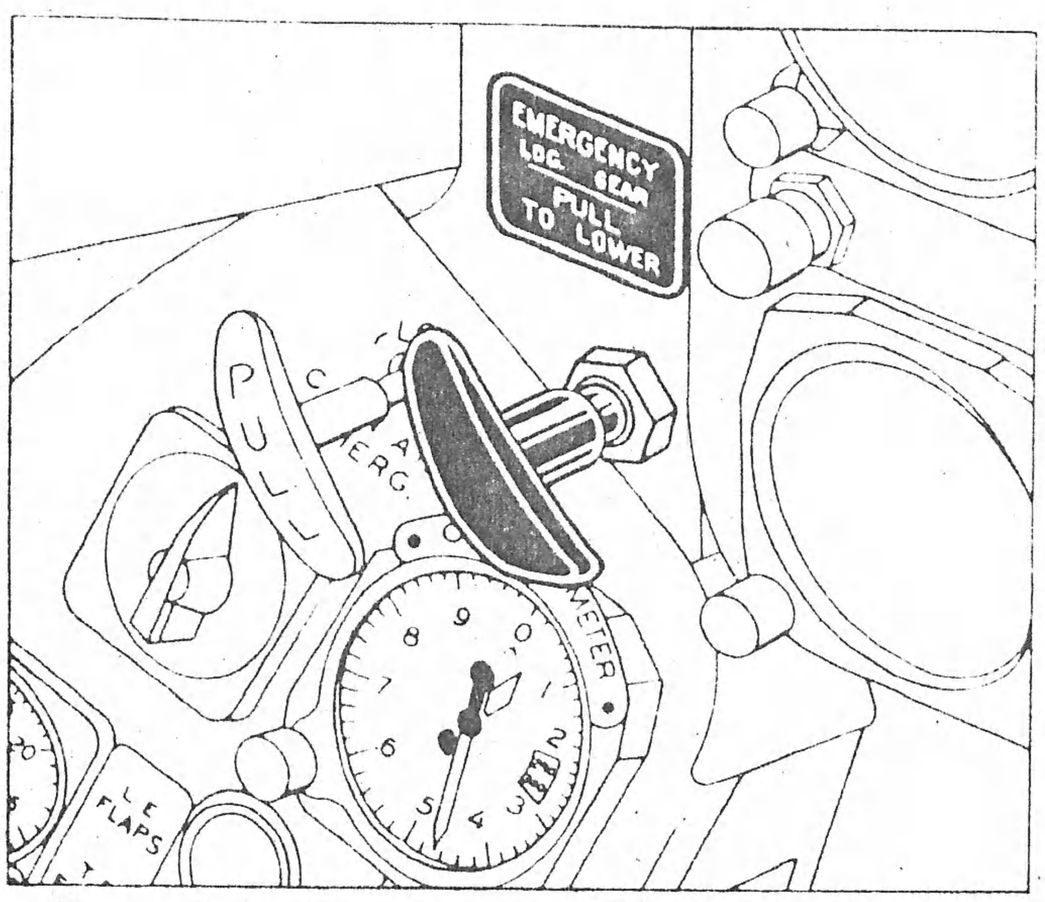


Figure 3-1. Emergency Landing Gear Release

3-3. FIRE DETECTION SYSTEM. A fire detector and warning system for the engine compartments is provided. The controls for testing the system consist of two 'PUSH TO TEST' warning lights located on the main instrument panel, and one fire detector test switch located on the left-hand console immediately aft of the salvo switch. The lights, one for each engine, are electrically connected to thermocouples in the corresponding engine compartment. In the event of fire in an engine compartment, the thermocouples in that compartment cause the corresponding warning light to glow. The test switch, when depressed, operates both lights and tests the complete circuit of both engine detector systems. If necessary, hold the switch in for ten seconds while testing.

CAUTION

Do not ignore a fire warning regardless of previous test indications. The test circuit may have been defective while testing, yet the actual operating circuit will function independently in case of fire.

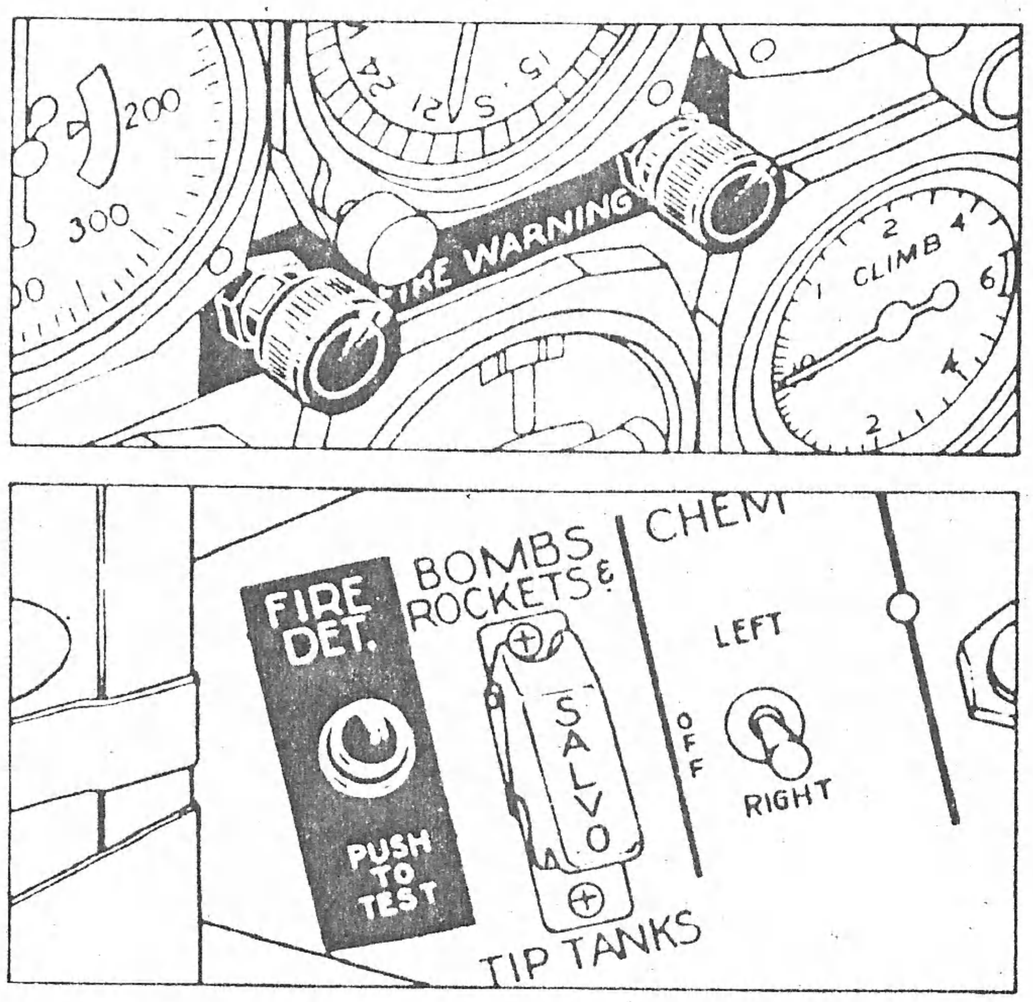


Figure 3-2. Fire Detection Controls

3-4. ENGINE FIRE IN FLIGHT.

a. Throttle 'OFF' - affected engine.
b. Fuel 'ON' - operating engine only.
c. Generator switch 'OFF' - affected engine.

Note

An increase in airplane speed will assist in extinguishing the flames.

3-5. ELECTRICAL FIRE.

a. Battery and generator switches 'OFF'.
b. Usually circuit causing fire will 'pop' circuit breaker. If circuit breaker cannot be reset, circuit is defective.

WARNING

Holding circuit breaker in manually may sustain the fire.

3-6. CANOPY JETTISON. The canopy is pneumatically jettisoned in an emergency by means of the manual jettison handle located on the left side of the pilot's seat. Pulling up the release handle actuates the valve on the air bottle which supplies compressed air to the canopy motor, and also rotates the canopy stop out of the path of the canopy rollers allowing the canopy to fly back freely.

3-7. OXYGEN SYSTEM OPERATION. If for any reason the supply of oxygen becomes inadequate because of restrictions or faulty dilution mechanism, clockwise rotation of the pressure breathing knob will open the valve, allowing a free flow of oxygen until sufficient pressure is built up to raise the diaphragm and close the valve. It must be remembered that any position of the knob other than 'NORMAL', causes the diluter mechanism to become inoperative, and allows 100 per cent oxygen to flow under pressure. Below 34,000 feet, this operation is uneconomical. The successful completion of a long, high altitude mission will depend on the economical use of the available oxygen supply.

3-8. EMERGENCY OPERATION OF 'FEEL' SYSTEM.

3-9. AILERON CONTROL SYSTEM. In case of hydraulic power system failure during flight, move the 'AIL. FEEL' switch to 'BOTH OFF', in order to eliminate the forces due to the artificial 'feel' system.

3-10. RUDDER CONTROL SYSTEM. In case of hydraulic power system failure during flight, move the 'RUD. FEEL' switch to 'BOTH OFF', in order to eliminate the forces due to the artificial 'feel' system.

3-11. ELEVATOR CONTROL SYSTEM. In case of hydraulic power system failure during flight, observe the following procedure:

a. Trim out elevator. If zero stick force is being held prior to hydraulic power system failure, the force on the stick after failure will be due entirely to the load on the elevator, and therefore may be trimmed out without reference to the trim tab indicator.

b. Reduce down spring load to zero, maintaining trim in the artificial 'feel' system.

c. Move 'ELEV. FEEL' switch to 'BOTH OFF', in order to eliminate the forces due to the artificial 'feel' system.

d. Increase balance tab ratio to maximum lagging (.65:1.00).

CAUTION

While making any change in the setting of the artificial feel and power control systems during flight, special caution should be taken to maintain firm hold on the cockpit controls.

3-12. FLAPS EMERGENCY OPERATION. In the event of hydraulic system power failure, the leading and trailing edge flaps may be extended by the use of the flap emergency system. Pulling the emergency flap control in the cockpit opens the valve on the emergency air bottle installed in the airplane. Compressed air, acting upon the shuttle valves, closes the normal flaps 'DOWN' lines and directs air pressure to the leading and trailing edge flap motors. As the shuttle valves open, compressed air, acting simultaneously upon the emergency dump valve, allows flap motor exhaust air and hydraulic fluid to return directly to the reservoir with a minimum of restriction. Once on the ground the flaps will have to be retracted hydraulically and the compressed air bottle recharged or replaced.

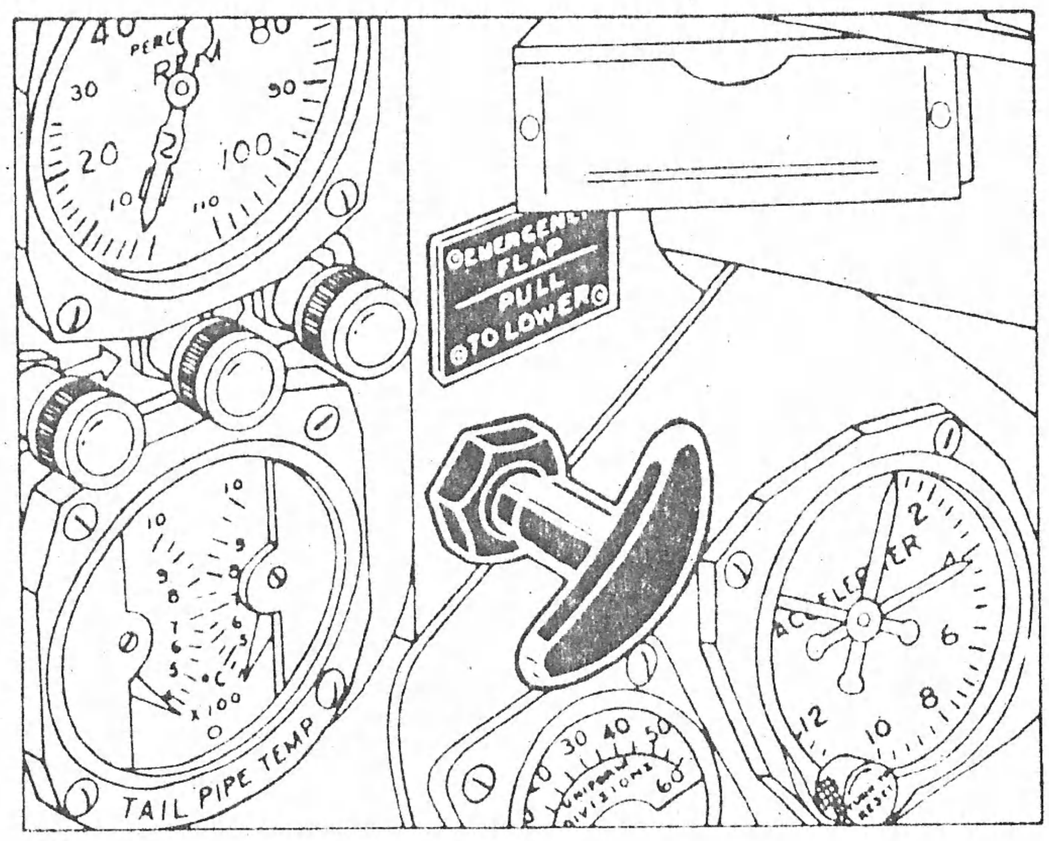


Figure 3-3. Emergency Flap Release

PILOT'S NOTES

SECTION IV
OPERATIONAL EQUIPMENT

4-1. OXYGEN SYSTEM.

4-2. GENERAL. The airplane is equipped with a low pressure demand type oxygen system. The components of the system are four oxygen cylinders, each having a capacity of 500 cubic inches, a type A-14 pressure demand regulator, a pressure indicator, a flow indicator, a filler valve, and low pressure check valves. The system operates at a working pressure of 400 psi.

4-3. PRESSURE DEMAND REGULATOR.

4-4. DESCRIPTION. The pressure demand regulator is designed for high altitude flying. The regulator is a diaphragm-operated flow valve which is opened by the suction of the inhalation phase of the breathing cycle, and closes automatically when the suction ceases. The regulator is fully automatic and provides the user with the proper amount of oxygen at all altitudes and under all conditions. The percentage of oxygen being delivered increases with increasing altitude, becoming 100 per cent at an altitude of approximately 34000 feet.

4-5. AUTOMATIC OPERATION. Each time the pilot inhales, a slight suction is applied to the regulator. This suction is sufficient to deflect a diaphragm which is connected to a valve, thus causing the valve to open and oxygen to flow. A few tenths of an inch of water suction is required to operate the regulator. When inhalation ceases and suction is no longer applied, a spring, plus oxygen pressure returns the diaphragm to its original position and the valve is closed. The regulator in addition to furnishing oxygen on demand, also mixes air with oxygen in varying quantities according to existing altitudes. At sea level air only is supplied. With increasing altitude a mixture of oxygen and air is supplied according to requirements. At approximately 34000 feet, 100 per cent oxygen is delivered to simulate low altitude air.

4-6. NORMAL CONTROLS. Two manual controls are also provided for use in special instances. One of these is the diluter control, and the other is the pressure breathing knob. The diluter control has 'NORMAL OXYGEN' and '100 PER CENT OXYGEN' positions. When the diluter handle is in the 'NORMAL OXYGEN' position, the regulator automatically mixes the required amount of oxygen with the inspired air to maintain adequate oxygen concentrations at all altitudes. When the auto-mix is in the '100 PER CENT OXYGEN' position, the air port is closed and no air is taken into the regulator, thereby delivering 100 per cent oxygen at all altitudes.

4-7. NORMAL OPERATING INSTRUCTIONS. Turn the diluter control to the 'NORMAL OXYGEN' position during flight. This is the normal operating condition of the regulator and provides against waste of oxygen at low altitudes even though the mask is in use. No adjustment or manual operation of valves is necessary at altitudes when oxygen is needed. Supply of suitable oxygen concentrations for all required respiratory rates is automatic.

4-8. PREFLIGHT INSPECTION. When flying is to be done at altitudes requiring oxygen supply, the oxygen equipment must be checked prior to each flight. Test for oxygen flow at ground level by placing the auto-mix lever in the '100 PER CENT OXYGEN' position. Open the trap door dust cover of the mask-to-regulator tubing, on the end opposite to that connected to the regulator, and exert a suction similar to that in breathing by placing the mouth on the opening. A good flow of oxygen should pass through the tubing with negligible resistance. With the dust cover held open, rotate the pressure breathing knob clockwise approximately 90 degrees. A steady flow of oxygen indicates satisfactory operation. With the diluter control in the '100 PER CENT OXYGEN' position and the pressure breathing knob at 'NORMAL', blow back into the mask-to-regulator tubing. An indication of a free passage through the regulator would indicate a damaged diaphragm or air metering system. If the breathing resistance through the instrument or the flow of oxygen with pressure breathing knob turned clockwise, or the blow-back test is not correct, replace the regulator. The tightness of the regulator may be judged by the fact that the oxygen supply pressure does or does not diminish during standby periods while the plane is not in operation. The test, however, is only possible if the connectors in the system are entirely free of leaks.

4-9. CABIN PRESSURIZATION. The airplane is equipped with an automatic cabin pressurization system, which utilizes compressed air from the engine compressor sections. Ducting from the engines is interconnected, permitting operation of the system with one engine shut-down. The air is distributed in the cockpit through a foot warmer and defogging ducts in the windshield and canopy. A cabin altimeter which indicates altitudes of cabin at all flight elevations is provided on the left-hand console. A standard flight altimeter is also provided, located on the forward instrument panel.

4-10. PRESSURIZATION SCHEDULE. The pressurization schedule is as follows:

a. Unpressurized cabin to 10000 ft.

b. Constant cabin altitude of 10000 ft. regardless of flight altitude, until 17900 ft. flight altitude is reached.

c. Cabin altitude increases as flight altitude increases from 17900 ft. to 38500 ft. flight altitude, i.e., when flight altitude = 30000 ft., cabin altitude = 18750 ft.

d. The pressure regulator in the system maintains a combat limit control from 38500 ft. flight altitude (24000 ft. cabin altitude) to the flight ceiling of the airplane, approximately 50000 ft. flight altitude (40000 ft. cabin altitude.)

1. PRESSURE GAGE
2. FLOW INDICATOR
3. PILOT'S QUICK DISCONNECT FITTING
4. REGULATOR
5. FILLER VALVE
6. CYLINDER (500 CU. IN. CAP)

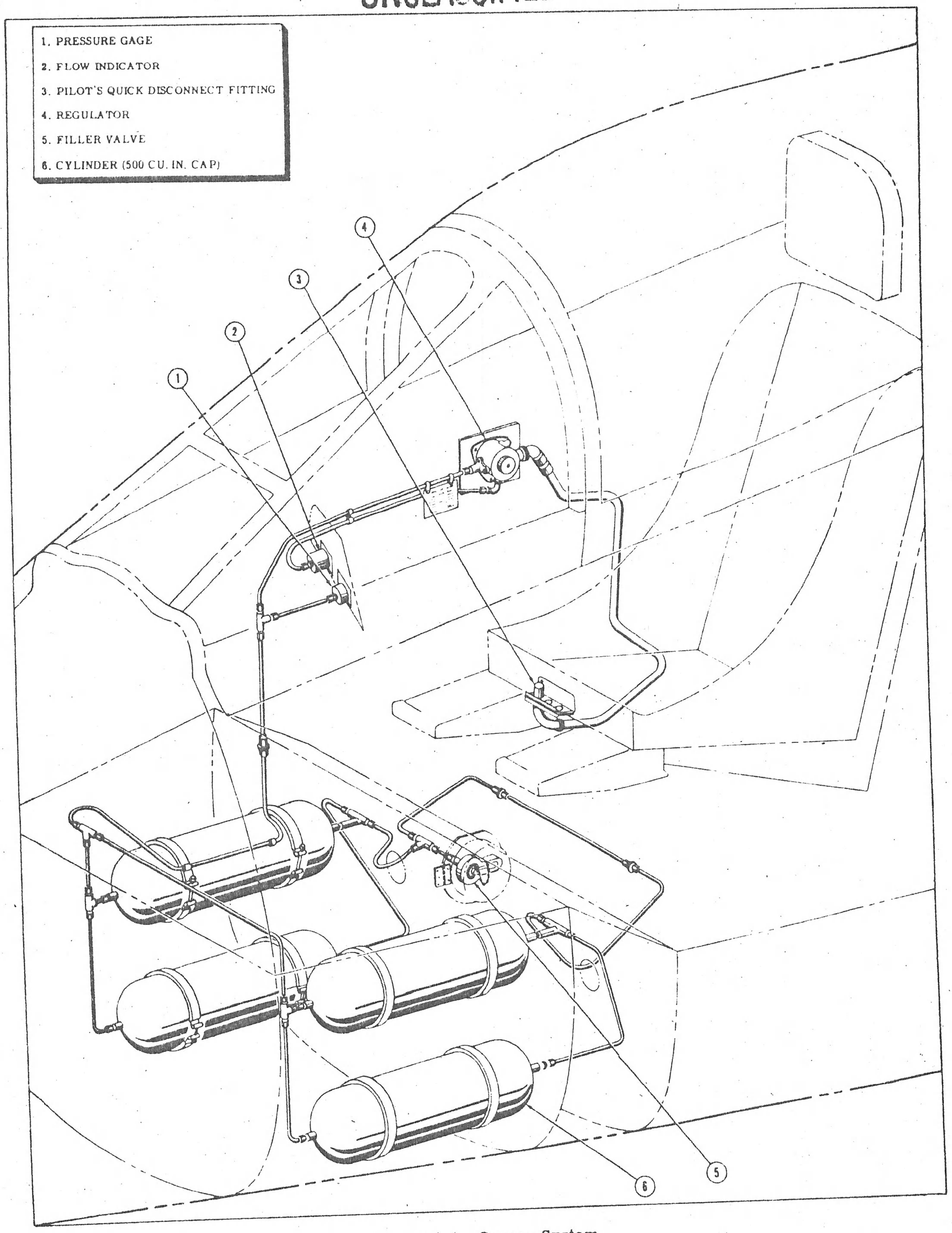


Figure 4-1. Oxygen System

4-11. AUTOMATIC PRESSURIZATION CONTROLS.

4-12. PRESSURE REGULATOR VALVE. A pressure regulator valve automatically regulates cabin pressure in accordance with the preceding pressurization schedule.

4-13. PRESSURE SAFETY VALVE. A cabin pressure safety valve which functions as a pressure relief, vacuum relief and dump valve is provided in the system.

a. As a pressure relief valve, it protects the cabin structure against excessive positive pressure differentials in the event of malfunctioning of the pressure regulator valve.

b. The vacuum relief function relieves the cabin from negative differential pressures encountered during high speed descent.

c. Cabin pressure can be relieved manually by means of the dump feature of the valve.

4-14. CABIN THERMOSTAT. The thermostat located in the cabin regulates cockpit temperature by controlling the flow of hot and cold air through the mixing valve.

4-15. MANUAL PRESSURIZATION CONTROLS. The manual controls for the normal operation of the pressurization system are located on the Cabin Temperature panel, left-hand console. The controls include the temperature control and a four way selector toggle switch.

4-16. OPERATION. Set the temperature control to the desired cabin temperature. The cabin thermostat maintains the desired temperature when the toggle switch is in the 'AUTO' position. The other positions of the switch are 'OFF' and two momentary contacts, which read 'HOT' and 'COLD'. When the switch is held in either 'HOT' or 'COLD' the thermostat control is overridden and maximum hot or cold air is available. The switch snaps to the 'OFF' position when released.

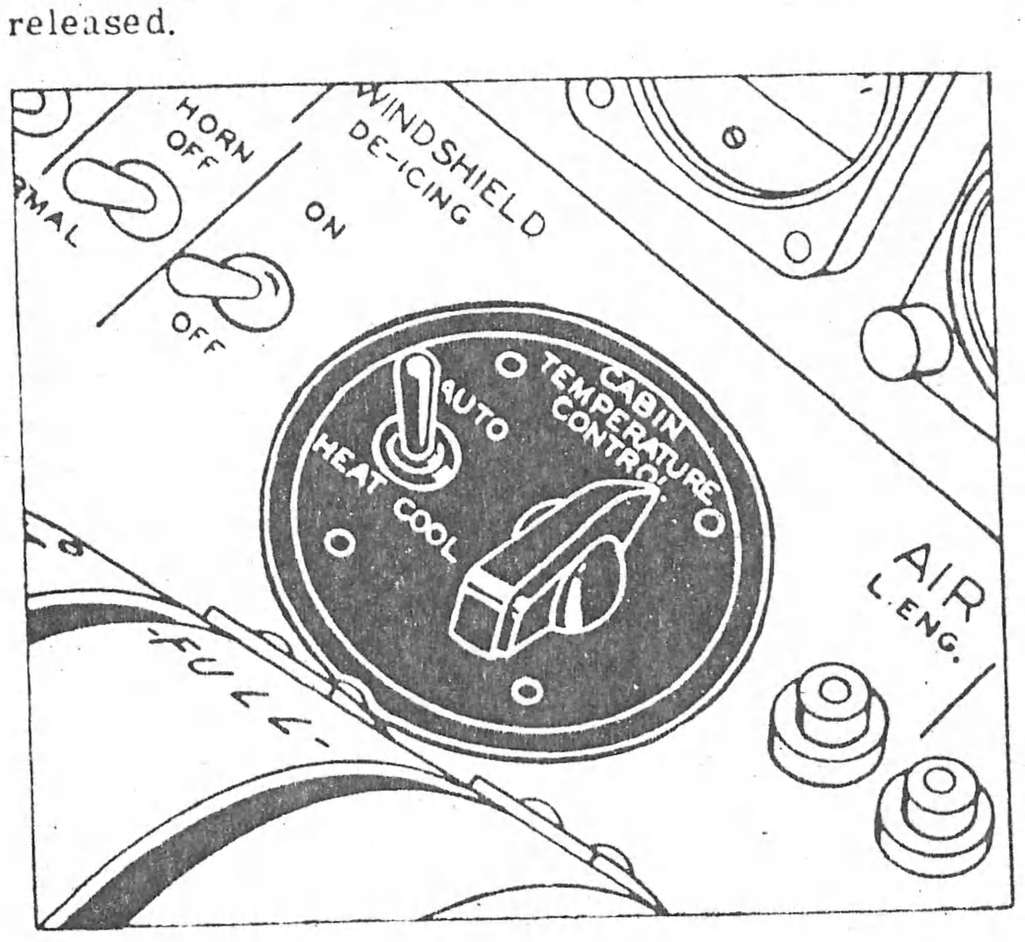


Figure 4-2. Cabin Temperature Controls

4-17. FOOT HEATER. A valve is installed in the cabin air supply line, and when opened hot air can be directed in the region of the pilot's feet. The valve is operated by means of the 'FOOT HEATER' handle, located on the left-hand instrument panel.

4-18. EMERGENCY VENT. In case of failure of the pressurization system, such as fire in the engine compartment, noxious fumes in the pressurization lines, etc., a means of selecting ram air ventilation is provided. This is accomplished by means of the 'EMERG. VENT' handle located on the left-hand instrument panel. Manual operation of this handle simultaneously opens the ram air ventilation port located forward of the windshield, opens the dump valve, and closes the pressurization shutoff valve.

4-19. MANUAL EMERGENCY SHUTOFF CONTROL. An 'ON - OFF' control is located on the right-hand aft console panel. This handle is provided to discontinue the heat and ventilation supply to the cockpit in case of malfunctioning of the electrically controlled shutoff valve.

4-20. AUTOMATIC PILOT. The Type C-2 Automatic Pilot consists of the following components:

a. Three Axes Gyro Control.
b. Turn and Pitch Controller.
c. Electric Servos.
d. Master Direction Indicator.
e. Remote Compass Transmitter.

4-21. THREE AXES GYRO CONTROL. The three axes gyro control contains a vertical gyro, a directional gyro, servo amplifiers, and directional slaving amplifiers. The vertical gyro provides the reference for automatic control of pitch and roll through corresponding electromagnetic pick-off. A separate amplifier channel is provided for each axis to properly phase and amplify the signal for operating the solenoid clutches in the servo. The directional gyro is provided with an electromagnetic pick-off for azimuth reference. A similar servo amplifier is provided for this axis. In addition, a slaving control amplifier and a gyro follow-up amplifier are provided that operate in conjunction with the directional gyro, the master direction indicator, and the remote compass transmitter to automatically orientate the directional pick-off so that the directional reference corresponds to a particular magnetic heading.

4-22. SERVOS. The servo contains a direct current motor which operates continuously through a gear train to a pair of solenoid operated friction clutches. The direction of rotation of the output drum depends upon which clutch is energized by the servo amplifier. The torque output of the servo is nearly proportional to the signal from the servo amplifier. In the double axis servo, the motor also drives an ac generator which supplies the power required to operate the gyro rotors and the amplifier circuits.

4-23. MASTER DIRECTION INDICATOR. The Master Direction Indicator contains the necessary electrical and mechanical mechanism to receive the remote

compass transmitter signal and orientate the directional gyro pick-off signal to the proper magnetic heading, in addition to operating an indicator that shows the magnetic heading of the aircraft.

4-24. FLIGHT CONTROLLER. The controller contains all the necessary controls for operation of the automatic pilot. It is provided with the engaging switch, aileron trim knob, elevator trim knob and coordinated turn control knob. In addition, the elevator signal follow-up is contained in this unit and operates in the 'READY' position of the pilot to maintain zero signal to the elevator channel.

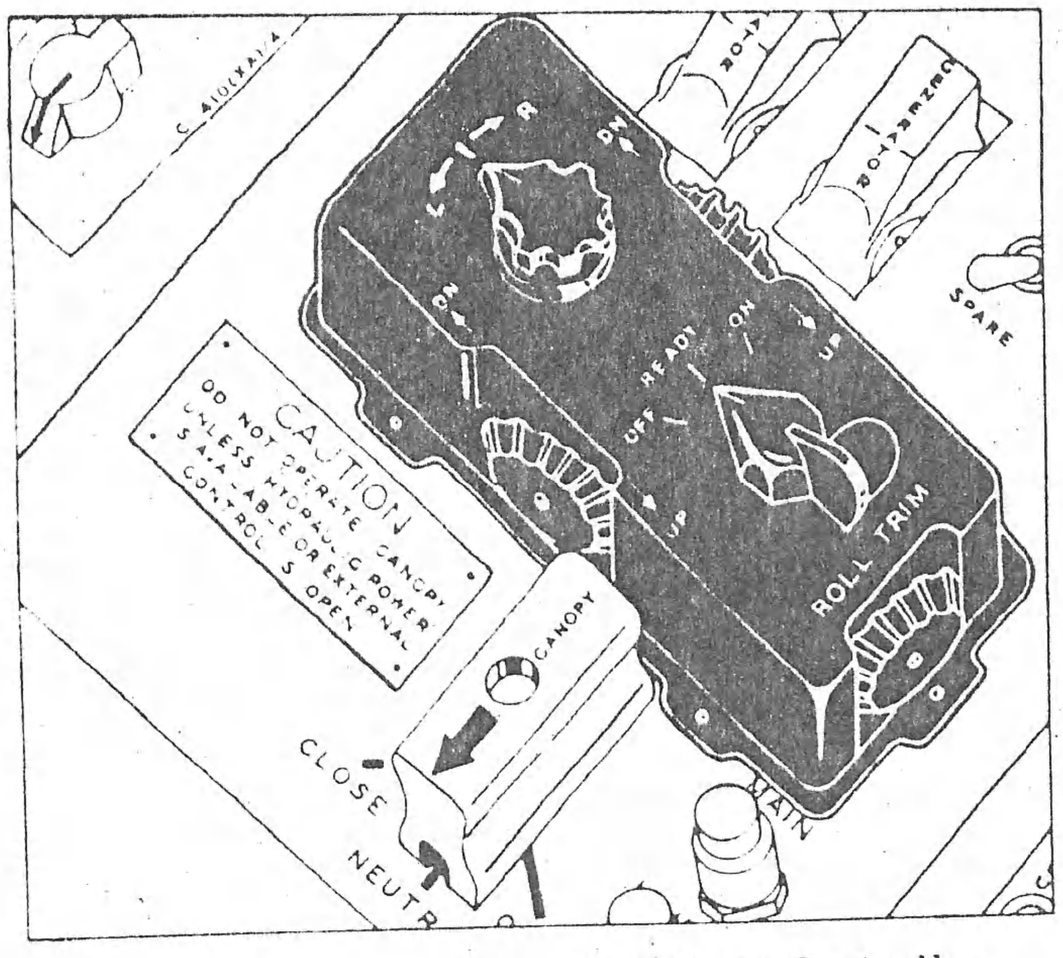


Figure 4-3. Automatic Pilot Flight Controller

4-25. AUTOMATIC FLIGHT CONTROL OPERATION. The operation of the Automatic Pilot equipment is accomplished entirely from the Flight Controller. When the 'CONTROL SWITCH' is moved from the 'OFF' to the 'READY' position, power is applied to the servo motor and amplifier. The gyros will start to operate and cause the Master Directional Indicator to align itself with the magnetic heading of the aircraft. After a time interval of 15 seconds, a time delay switch will close and release the vertical gyro snubber. After a two minute interval, another time delay switch will release an electromechanical lock located within the Flight Controller, which prior to this time has made it impossible to rotate the 'CONTROL SWITCH' to the 'ON' (engaged) position.

4-26. In order to prevent changing of the directional heading upon engaging, the Control Switch will also remain locked, provided the 'TURN' control is not in the detent (center) position.

4-27. After the two minute time interval, the Automatic Pilot will maintain itself in synchronization with the flight attitude and directional heading of the aircraft, so that when the 'CONTROL SWITCH' is moved to the 'ON' (engaged) position the change-over from manual to automatic flight control will be smooth.

4-28. In the event of power failure, the 'CONTROL SWITCH' will automatically return to the 'READY' (locked) position. It will not unlock again until power has been restored to the equipment and the two minute warm-up period has again elapsed. A mechanical lock, integral externally with the 'CONTROL SWITCH', locks the knob at the 'READY' position whenever it is turned in this direction from the 'ON' (engaged) position. The lock must be depressed before the knob can be turned to the 'OFF' position. This lock prevents accidental movement of the 'CONTROL SWITCH' from the 'ON' position directly to the 'OFF' position, which action would necessitate the usual waiting period of two minutes before the knob could again be turned to the 'ON' position.

4-29. FLIGHT CONTROLLER OPERATION.

4-30. CONTROLS. After the Automatic Pilot has been engaged, the pilot may control the aircraft through the use of the 'ROLL TRIM', 'PITCH TRIM', and 'TURN' controls on the Flight Controller. These controls are operated in the following manner.

a. ROLL. The 'ROLL TRIM' control allows for small displacements about the roll axis. Rotate the knob to the right for a right bank and to the left for a left bank.

b. PITCH. The 'PITCH TRIM' control allows the climb or dive angle of the aircraft to be varied. Rotate the control forward and away from the pilot ('DN' direction) to cause the airplane to dive, and to the rear toward the pilot ('UP' direction) to cause the airplane to climb. This control should be rotated slowly.

c. TURN. The 'TURN' control, when rotated to the left or right, will give well coordinated turns in the relative direction. The angle of bank is proportional to the angular displacement of the control from its detent (center) position. The control must be lifted before it can be turned, thus guarding against accidental movement.

4-31. In general the system functions as follows:

a. In the 'OFF' position of the automatic pilot, only the directional gyro and slaving system function to operate the master direction indicator. In the 'READY' position, the electric element in the servo amplifiers is warmed up and the pitch synchronizing system is energized. When the automatic pilot is engaged, the system will:

(1) Maintain the airplane on the magnetic heading on which it was engaged.
(2) Return the wings to level position if same were not level when engaged.
(3) Maintain pitch altitude of aircraft at time of engagement, providing the attitude is within plus or minus 25 degrees from level flight.

b. When the autopilot is engaged, the following maneuvers can be performed with the corresponding knobs on the controllers:

(1) Pitch trim plus or minus 25 degrees from level flight attitude.
(2) Aileron trim plus or minus 5 degrees from level flight attitude.
(3) Coordinated turns up to 45 degrees in bank.

The gyros are universally mounted to permit extreme maneuvers during manual flying without tumbling.

4-32. OPERATION OF RADIO, COMMUNICATION, AND NAVIGATION EQUIPMENT.

4-33. GENERAL. The airplane is furnished with an AN/ARC-3 Receiver-transmitter, SCR-695-B IFF Radio Equipment, RC-103 Localizer Receiver and AN/ARN-5 Glide Path Receiver constituting the blind flying glide control system, AN/ARN-6 Radio Compass Receiver, and AN/ARN-12 Marker Beacon Receiver.

4-34. AN/ARC-3 RECEIVER-TRANSMITTER.

4-35. GENERAL. Radio Set AN/ARC-3 is an airborne receiving and transmitting equipment designed to provide 'VOICE' and 'MCW' communication from plane to plane, or from plane to ground. Eight channels are provided, and complete remote-control operation of the equipment is accomplished by use of Control Box C-404/A. The equipment operates in a frequency range of 100 to 156 megacycles. Frequencies of this range are characterized by 'line of sight' distances. Average communicating distances are approximately 30 miles at an altitude of 1000 feet and 135 miles at 10000 feet. These distances may be increased or decreased, depending on atmospheric conditions.

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life and may be fatal if contacted by operating personnel. Use every precaution when working with this equipment.

4-36. OPERATION.

4-37. To Start the Equipment:

a. Battery switch 'ON'.
b. On 'VHF Command' panel: Toggle switch on right side of panel to 'ON' position.
c. Insert the headset plug in the 'Tel' jack on pilot's composite disconnect panel, bucket part of seat.
d. Insert the plug of the microphone in the 'MIC.' jack on quick disconnect panel.
e. Select any one of the eight channels available, designated 'A' through 'H'. This applies power to the equipment, which then automatically tunes to the frequency of the channel selected.
f. Allow 30 to 45 seconds for the tubes to reach normal operating temperature. During the latter portion of this period an audio tone will be heard in the headset. When this tone stops, the receiver and transmitter have been tuned to the selected channel and reception should then be possible.
g. Press the press-to-talk button on the control stick grip. Speech (side-tone) which modulates the transmitter should be audible in the headset. If none is heard, check to make sure that a crystal has been inserted for that channel of the transmitter.
h. Release the microphone switch button to restore receiver operation. The receiver will continuously monitor that channel selected, except during periods to transmission, at which time the receiver is shut off.
i. If necessary to adjust the level of the received signal, rotate the volume control on the control panel.
j. Use the 'D/F TONE' button on the control box as a key when 'MCW' operation of the equipment is desired. Maximum keying speed is limited to approximately 15 words per minute.
k. Select other operating frequencies by selecting the channel whose frequency corresponds to the one desired, the rotating channel selector.

Note

If either the receiver or transmitter have tuned incorrectly, select any other channel, and then select the desired channel again. Repeated mistuning indicates a defective crystal, incorrect setting of the thumbwheels, or a defect in the equipment.

4-38. To Stop the Equipment:

a. Toggle switch to 'OFF' position.

4-39. SCR-695-B - IFF RADIO EQUIPMENT.

4-40. GENERAL. Radio Set SCR-695-B is an airborne equipment which provides identification and can transmit an emergency or distress signal. This equipment operates at altitudes up to 50000 feet above sea level. The dependable operating range, under favorable operating conditions, is approximately 100 miles. This range, however is limited both by existing atmospheric conditions and by the terrain over which the operations take place.

4-41. OPERATION.

4-42. TO START THE EQUIPMENT.

Note

Before starting the equipment, make certain that the coding switch on the 'IFF' panel is in position '1' unless otherwise directed by the communications officer-in-charge.

a. Battery switch 'ON'.
b. Place the 'ON - OFF' toggle switch on 'IFF' panel to 'ON' position.

4-43. I-BAND OPERATION.

a. Set the six-position coding switch to position '1' unless otherwise directed by the communications officer-in-charge.
b. Invert a headset into the phone jack on pilot's quick disconnect panel and listen for the characteristic switching noise.

4-44. G-BAND OPERATION. Directions for the use of the 'G-BAND' switch will be given by the communi-

cations officer-in-charge.

4-45. 'DESTROY' SWITCH OPERATION. Directions for the use of the 'DESTROY' switch will be given by the communications officer-in-charge.

4-46. TO STOP THE EQUIPMENT.

a. Place the 'ON - OFF' toggle switch in the 'OFF' position.

4-47. BLIND FLYING GLIDE CONTROL SYSTEM.

4-48. GENERAL. Radio Receiving Equipment AN/ARN-5A is airborne equipment designed to give vertical guidance to the pilot during aircraft landing operations. This equipment is part of an instrument approach system which provides both lateral and vertical guidance. Lateral guidance is supplied by Radio Receiving Equipment RC-103A.

4-49. RC-103A LOCALIZER RECEIVER.

4-50. GENERAL. Localizer Receiver RC-103 is installed to receive signals transmitted by a localizer transmitter as an aid to instrument landing. The output of the RC-103 receiver is indicated by the vertical pointer of the instrument landing indicator located on the main instrument panel. In all instances the needle of the indicator will point to the color area over which the airplane is located. When an incoming plane is to the right of the runway or landing area, the receiving equipment will pick up the signal modulated at 150 cycles per second, and the indicator needle will swing to the left or 'BLUE AREA'. Thus with the plane coming into the transmitter, the pilot need merely 'Follow the Needle' to correct his horizontal position with respect to the runway. In flying away from the transmitter the reverse will be true. The audio signals in the headphones is of no material aid in landing the plane.

4-51. AN/ARN-5A RECEIVING EQUIPMENT. The R-89B/ARN-5A radio receiver is an ultra-high frequency glide-path receiver used to pick up signals from an associated glide-path transmitter located adjacent to the landing strip. A two cross-pointer indicator located on the main instrument panel provides visual indication of the position of the aircraft with relation to the glide path. The receiver operates at a frequency ranging from 332.6 to 335.0 megacycles. The operating frequency is changed by means of the frequency selector switch on the 'INSTRUMENT APPROACH' panel. The selector switch channels are designated 'U', 'V', 'W', 'X', 'Y' and 'Z'.

4-52. INDICATOR.

4-53. The horizontal needle on the indicator is actuated by the R-89B/ARN-5A receiver and provides vertical guidance during landing operations.

4-54. The vertical needle is actuated by the RC-103A receiver and provides lateral guidance.

4-55. OPERATION.

a. Approximately 15 minutes before the runway is approached, turn the frequency selector switch to the desired position to allow the receiver a chance to warm up. The frequency of the localizer transmitter must be known, either by communication with the ground or by consulting the radio facilities charts.

b. Adjust the volume to a comfortable hearing level by means of the 'VOLUME' knob.

4-56. RC-103A OPERATION. Observe the vertical pointer on the indicator. When the aircraft is coming into the transmitter on the front course, the vertical needle will point in the direction toward which heading of the airplane should be corrected. When the aircraft is directly in line with the runway, the vertical needle will be centered. A deviation of one fourth scale deflection to right or left of center is not too great for successful landing. When the vertical pointer is more than one fourth scale off center, corrections in the airplane direction of travel should be made very slowly so that the aircraft will not overshoot the localizer path.

a. After landing turn the frequency selector switch 'OFF'

4-57. R-89B/ARN-5A OPERATION. Operation of the R-89B/ARN-5A receiver is identical to that of the RC-103A receiver except that the horizontal needle must be observed.

4-58. GLIDE PATH. The glide path is an imaginary beam created by the combined operation of the vertical and lateral guidance transmitters, which runs from the landing spot on the field, at a specified angle up into the air as far as the radiated signals will reach. When the aircraft is headed toward the runway during a landing operation, the action of the horizontal needle is directional, that is, when the needle is above center, the aircraft must be flown up to regain the center of the glide path.

Note

If the associated glide-path transmitting equipment fails to send out signals or, if a failure of the glide-path receiver occurs the automatic alarm circuit in the receiver will cause the horizontal needle to deflect up and remain up, regardless of the aircraft position. If the power supply to the receiver fails, the horizontal needle will remain in the center of the meter face regardless of aircraft position.

The glide path may be used to determine distance from the landing area. At any given distance the altitude at which an 'ON COURSE' indication is observed is dependent upon the angle at which the glide-path is radiated from the transmitter.

4-59. AN/ARN-6 RADIO COMPASS RECEIVER.

FREQUENCY	
100-200 kilocycles	410-850 kilocycles
200-410 kilocycles	850-1750 kilocycles

4-60. GENERAL. The equipment will perform the following three major functions:

a. Homing compass operation.
b. Position finding using automatic and aural-null methods.
c. Receiver operation using 'ANT' or 'LOOP'.

4-61. HOMING COMPASS OPERATION-AN/ARN-6. To use as a homing compass perform the following operations:

a. Battery switch 'ON'.
b. Master switch 'ON'.
c. Function switch to 'COMP' position.
d. Rotate the band switch to the frequency band in which the operation is desired.
e. Turn the 'TUNING' crank to the desired station frequency and tune for maximum swing of the tuning meter. Greater accuracy in tuning may be obtained by placing the 'C.W. - VOICE' switch in the 'C.W.' position. A 900 cycle tone will be heard along with the station modulation. This will aid in accurate tuning. After tuning, return the 'C.W. - VOICE' switch to 'VOICE' to eliminate the 900 cycle tone.
f. Adjust 'AUDIO' control for desired headset level.
g. Listen for station identification to be sure that the correct station is being received.
h. Turn the 'VAR' knob on the indicator until the azimuth zero is at the index.
i. The indicator pointer will now show the bearing of the station relative to aircraft heading. For example, if the pointer is to the left of zero, the station is on our left. Turn your aircraft to the left until the pointer is at zero. If the aircraft heading is held at zero degrees on the radio compass indicator, you will ultimately fly over the radio station antenna. Cross winds, however, will cause the flight path to be a curved line. Direction of wind may be determined by noting any change in magnetic bearing while homing with the radio compass. An increasing magnetic bearing indicates a wing from the right while a decreasing magnetic bearing indicates a wind from the left. Compensate for wind drift by off-setting the aircraft heading until there is a minimum rate of change of the magnetic compass reading. The radio compass indicator now shows directly in degrees the relative aircraft to station heading necessary to correct for wind drift.

4-62. POSITION FINDING.

4-63. GENERAL. There are two methods of position finding, automatic and aural-null. Prior to the use of either method, the following steps should be taken in order to shorten the time required for a complete set of readings:

a. Select three stations whose geographical locations are spaced at approximately equal intervals about the aircraft.
b. Tune in the stations, identify them and log their dial readings.

4-64. AUTOMATIC METHOD. For operation as an automatic indicating position finder, perform the following operations:

a. Adjust 'VAR' knob on the indicator until its bearing scale at the index is the same as the true magnetic heading of the aircraft.
b. Function switch to 'COMP' position.
c. Tune in one of the selected stations, and record the bearing as indicated by the tail of the indicator pointer.
d. Repeat (c) for the other stations, in rapid succession while flying with a steady level heading.

Note

Because of the airplane's motion, the less time taken for observations, the greater the accuracy of the fix.

e. The recorded bearings will be the station to aircraft bearings from north. Project lines from the stations at the recorded bearings. The aircraft position will be within the vicinity of the small triangle made by the intersection of the projected lines.

4-65. AURAL-NULL METHOD. For operation as an aural-null position finder, perform the following operations:

a. Adjust the 'VAR' knob on the indicator until the bearing scale at the index is the same as the true magnetic heading of the aircraft.
b. Function switch to 'LOOP' position.
c. Tune in the desired station. To obtain good signal strength for station identification, it may be necessary to rotate the loop by means of the 'LOOP L-R' switch knob for maximum signal. Direction and speed of loop rotation are controlled by direction and amount of 'LOOP L-R' switch rotation, respectively.
d. Use the 'LOOP L-R' switch knob as in (c), and rotate loop for minimum headset volume. Record the bearing shown by the indicator pointer. Better definition of the null may be obtained by turning the 'AUDIO' control fully clockwise and locating the null by either listening for minimum audio signal or noting a counter-clockwise dip of the tuning meter pointer. The use of 'C.W.' operation also improves the definition of the null. To obtain 'C.W.' operation flip the 'C.W. - VOICE' switch to 'C.W.' position.
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 ambiguity is overcome by keeping aware of the general geographical location and selecting stations located well to the left and right of the course.

4-66. RECEIVER OPERATION.

4-67. ANTENNA RECEPTION.

a. Function switch to 'ANT' position.
b. Band switch to desired frequency band.
c. Flip 'C.W. - VOICE' switch to 'C.W.' position for aural reception of unmodulated signals.
d. Use the 'TUNING' crank and tune in the desired station.
e. Adjust 'AUDIO' control for desired headset volume.

Note

For best definition of radio range stations, adjust the 'AUDIO' control for the lowest usable headset volume and continue to reduce volume as the A-N signals increase in strength.

4-68. LOOP RECEPTION. If reception on 'ANT' is noisy due to precipitation static, commonly known as rain or snow static, better results may be obtained by operating in 'LOOP' position as follows:

a. Function switch to 'LOOP' position.
b. Band switch to desired frequency band.
c. If station is unmodulated, flip 'C.W. - VOICE' switch to 'C.W.' position.
d. Tune in desired station.
e. Rotate loop with the 'LOOP L-R' switch until maximum signal is obtained. If flight course is not straight, readjustments may be necessary.
f. Adjust 'AUDIO' control for desired headset volume.
g. For best definition of radio range A-N signals on 'LOOP', it is necessary to maintain the loop near the 90 or 270 degree position and adjust the 'AUDIO' control for lowest usable headset volume.

Note

Cone of silence indications are not always reliable while receiving on 'LOOP'. In some cases, an increase instead of a decrease in signal may be noted. This is the result of certain types of radio range transmitting antennas and the loop location on the aircraft.

4-69. SUMMARY OF PRECAUTIONS DURING OPERATION.

a. Select radio stations that provide stable bearings. Do not use a station for bearing unless it can be identified by headset signal on 'COMP' operation. High powered clear channel stations should be used when possible. Any interference from other stations will cause an error in bearing. Tune equipment accurately. Station identification must be checked, especially stations broadcasting network programs. Avoid taking bearings on synchronized stations except when near desired station. If station stops transmitting or fades, bearings may change to other stations of the same frequency, thus causing errors. This is especially true of code stations operating in a network.

b. Night effect or reflection of radio waves from the sky may be recognized by fluctuations in bearings. Night effect is worse at sunrise and sunset. The higher the frequency of operation, the greater the night effect. It may be present at distances over 20 miles when receiving 850 to 1750 kilocycle stations, however, with 100 to 450 kilocycle stations, reliable bearings above 200 miles can be taken even when night effect is present. The remedies for night effect are:

(1) Increase altitude, thereby increasing the signal strength of direct waves.
(2) Use stations operating at lower frequency.
(3) Take an average of the fluctuations.

c. Mountain effect is considered to be reflection of radio waves from mountain surfaces. It is known to exist around Salt Lake City and Pittsburgh. Do not rely fully on bearings taken in such areas.

d. For aural reception of A-N signals, operate equipment on 'ANT' or 'LOOP' instead of 'COMP', since the action of AVC in 'COMP' position will cause broad course indications. Always operate the equipment with 'AUDIO' control set at lowest usable headset volume and reduce it as the A-N signal strength increases. Cone of silence indications are not always reliable when operating the equipment on 'LOOP'. Use equipment on 'ANT' for cone of silence indication.

e. This equipment should provide compass bearings during conditions of moderate precipitation static which interrupt normal reception. When static becomes too severe, it will be necessary to operate on 'LOOP' position. In this position, satisfactory aural reception and aural-null direction finding will be possible most of the time.

f. Do not depend on two stations for a fix of locations, use at least three stations with bearings spaced at approximately equal intervals throughout 360 degrees for greatest accuracy.

g. While taking bearings, always keep aircraft on a steady level heading.

h. When homing or direction finding on 'LOOP' operation, there is a 180 degree ambiguity and station bearings may be 180 degrees from the null obtained. Use stations with good signal strength for sharply defined nulls. Width of null may be controlled by position of 'AUDIO' control. The tuning meter may be used as a visual null indicator.

4-70. AN/ARN-12 MARKER BEACON RECEIVER. This information will be furnished when available.

4-71. ARMAMENT.

4-72. GUNS. The airplane is armed with six 20 mm forward firing fixed guns, installed in the fuselage nose section. The guns are mounted in vertical staggered tiers of three on side of the fuselage. Provisions are made for 220 rounds of ammunition per gun, expended links and cases remaining in the fuselage. The guns are charged pneumatically and are discharged electrically. Armament controls are located on the left-hand console panel, aft of the throttle quadrant.

4-73. GUN CHARGING & FIRING CONTROLS. The gun charging mechanism is operated by a three position toggle switch located on the control panel. The switch has 'CHARGE', 'RELEASE', and 'OFF' positions. The guns are fired by means of the conventional type trigger switch incorporated on the control stick hand grip.

4-74. GUN CAMERA. A gun camera is installed in the fuselage nose section, and is actuated by the gun trigger switch on the control stick hand grip.

4-75. GUN HEATERS. The gun heaters are electrically operated by means of a toggle switch on the armament control panel. The switch has 'ON' and 'OFF' positions.

Note

Information concerning the installation and

operation of guns, bombs, rockets, and gun sight will be furnished at a later date.

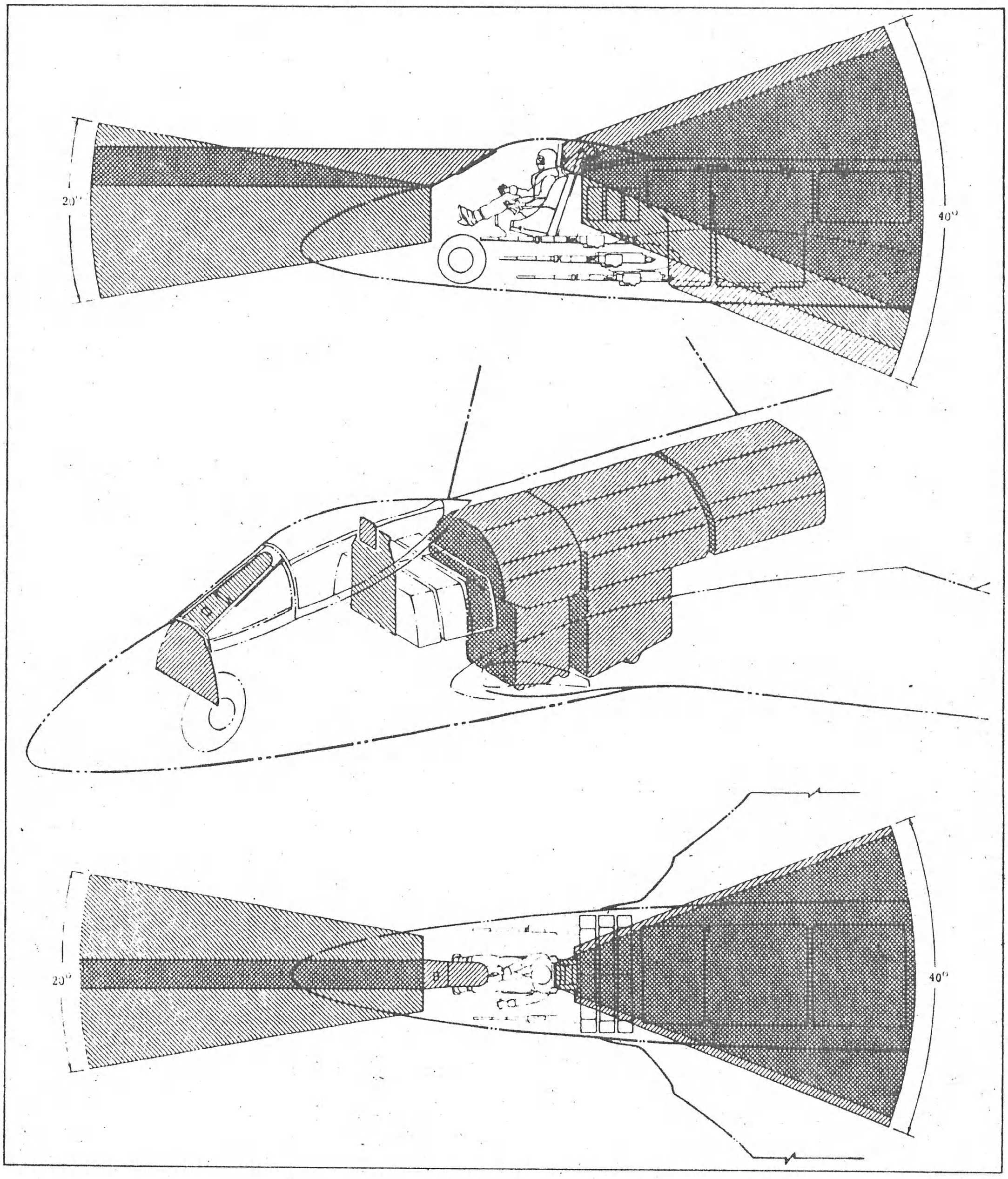
4-76. OPERATING DATA. The Operations Charts, Airspeed Calibration Chart, Instrument Marking Diagram and the Ferrying Chart will be supplied when available.

AIR SPEED INSTALLATION CORRECTION TABLE

To be filled out by the pilot when information is available.

PILOT'S NOTES

APPENDIX A



Angles of Armor Protection