REPORT NO. 8758

Super Constellation

Model 1049 Series

CREW OPERATING MANUAL

LOCKHEED AIRCRAFT CORPORATION
BURBANK, CALIFORNIA

LOCKHEED REPORT 8758

crew operating manual

lockheed

MODEL 1049 C

Super Constellation

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LOG OF REVISIONS

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foreword

This manual has been prepared for the information and guidance of the flight crews of Lockheed Model 1049C Super Constellation Aircraft. Essential information has been organized for quick reference into seven sections as follows:

SECTION I — DESCRIPTION

Describes the aircraft systems and controls that are required to fly the aircraft. All emergency and miscellaneous equipment which is not auxiliary equipment is also discussed.

SECTION II — NORMAL OPERATING PROCEDURES

Details operating procedures for the aircraft and its systems for any routine, medium altitude flight under normal conditions.

SECTION III — EMERGENCY OPERATING PROCEDURES

Outlines basic emergency procedures and the use of emergency systems and facilities described in Section I.

SECTION IV — DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

Describes and explains the normal and emergency operation of auxiliary systems and equipment not described in Section I.

SECTION V — OPERATING LIMITATIONS

Sets forth operating limitations and restrictions of the aircraft, engines, and the various systems.

SECTION VI — SYSTEMS OPERATION

Outlines special operating procedures necessary in various unusual circumstances, situations, and conditions. Optimum operating procedures under varying circumstances are also presented.

SECTION VII — TROUBLE SHOOTING

Tabulates common indications of trouble, probable causes, and corrective action.

Cruise control, performance information, weight and balance data, and maintenance instructions are not included in this manual, but are published in separate reports. These reports are identified as follows:

SUBJECT	LOCKHEED REPORT NO.
Cruise Control	
Performance—CAA Flight Manual	9153* 9154†
Weight and Balance	8098§
Maintenance Instructions Manual	8681

*LAC Serial Numbers 4501 through 4509.

†LAC Serial Numbers 4510 through 4519.

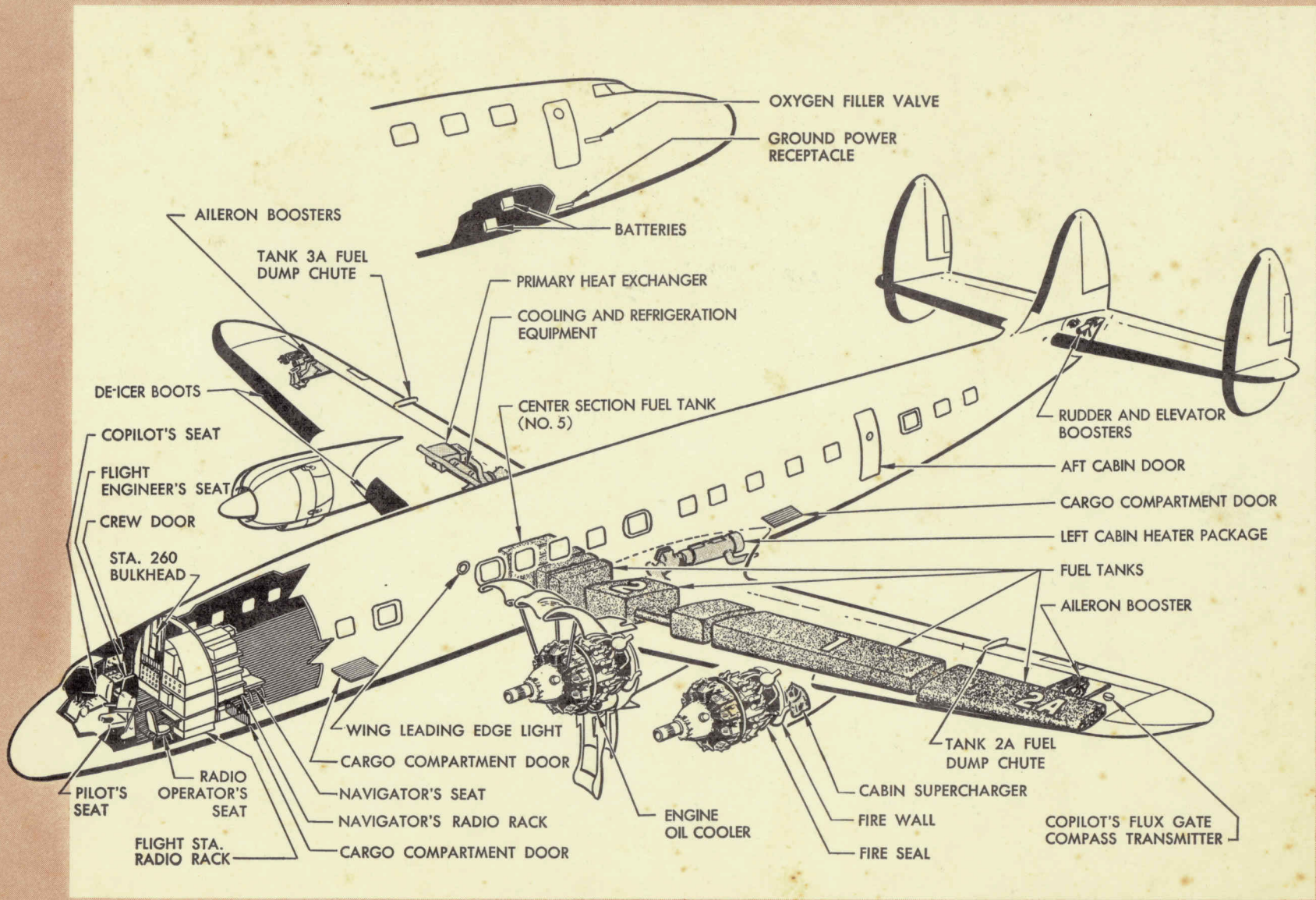
§The last three digits of the LAC aircraft serial numbers are listed as dash numbers following the report number.

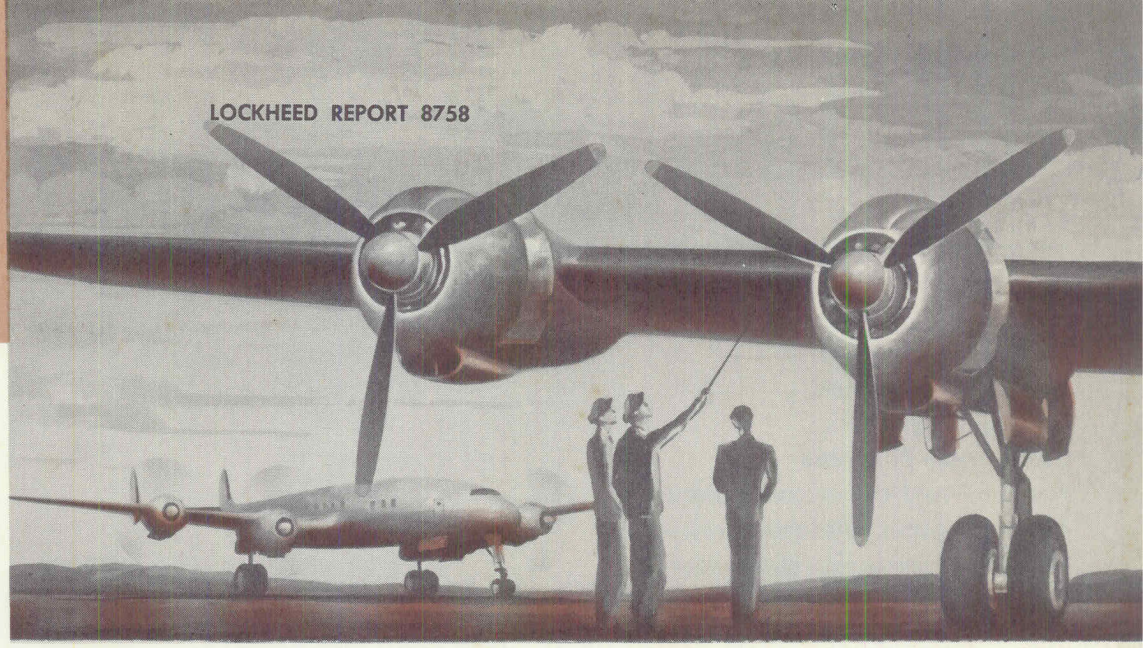
IMPORTANT

Descriptions, illustrations and items that are not applicable to all Model 1049C airplanes are serialized or footnoted.

general arrangement diagram

figure 1-1





Section I description

1–1. THE AIRCRAFT.

1–2. The Model 1049C Super Constellation is a four-engine, low-wing, monoplane designed to provide high-speed, long-range air transportation. The design gross take-off and landing weights are 133,000 and 110,000 pounds respectively.

1–3. The aircraft is powered by four Turbo-compound engines equipped with three-blade, full-feathering, reversible pitch propellers. The flight controls incorporate hydraulic boosters to assist with the movement of the control surfaces, and an automatic pilot is provided for automatic control of the aircraft.

1–4. FUSELAGE. The semi-monocoque fuselage is sealed for cabin pressurization between the forward and aft bulkheads. The forward bulkhead separates the flight station from the nose; the aft bulkhead is the rear wall of the cabin. The only other structural partition in the cabin is the bulkhead at the aft end of the flight station (station 260). This arrangement permits the functional arrangement of the interior to be changed into many combinations by merely removing or inserting specially designed partitions and changing seats. Refer to figure 4–37. Each version of the Super Constellation interior is also adaptable for either domestic or international use but all configurations include four lavatories, two located in the aft end of the cabin and two located adjacent to the propeller planes. Seats and equipment installed between the forward lavatories and the station 260 bulkhead can be removed to make that area available for carrying cargo. A lounge that will accommodate eight passengers with extra comfort can be arranged in many different ways or, that area can be used for standard chairs. The galley is located adjacent to the main cabin door. The equipment and arrangement of the galley can also be changed to meet varying requirements.

1–5. Two doors in the left side of the fuselage are provided for loading and unloading passengers.

1–6. Two cargo compartments, separated by the wing center section, are located below the cabin floor.

1–7. FLIGHT STATION. Stations for pilot, copilot, flight engineer, and radio operator are provided in the flight station. A station for a navigator is located on the left side of the crew compartment immediately aft of the station 260 partition in aircraft equipped for international service. Seats for the relief crew are installed on the right side opposite the navigator's station. In domestic service aircraft, passenger seats are installed in this compartment.

1–8. The crew door is located on the right side of the flight station aft of the flight engineer's desk. It is an upward-sliding door which can be opened from either side and latched in an open (up) position.

1–9. Two wide-angle lens windows, one in the crew door, and one in the left side of the flight station behind the pilot's seat, are focussed on the propellers so that they may be monitored from the flight engineer's station. The lens window in the crew door is openable; the one in the left side is fixed.

MAIN DIFFERENCE TABLE

	Super Constellation Model 1049C	Constellation Model 749A
Take-off weight limits	133,000 lbs.	107,000 lbs.
Landing weight limits	110,000 lbs.	89,500 lbs.
Fuselage length	113' 7"	95' 3"
Usable cabin floor area	744 sq. ft.	561 sq. ft.
Passenger and crew accommodations	43—82 §	47—63 §
Maximum cabin differential pressure	5.5 psi	4.1 psi
Maximum emergency relief pressure	5.66 psi	4.3 psi
Cabin windows	Rectangular, double safety thermosetting panes. Both inside and outside panes designed to withstand maximum permissible cabin pressure differential.	Round thermosetting panes. Inside pane not designed to withstand cabin pressure differential.
Windshield panels	25% increase in height of panels; equipped with alcohol anti-icing facilities with hot air defoggers, and some are equipped with Nesa glass.	Imbedded wire, or infra-red heaters for pilot's and copilot's panels; alcohol anti-icing for six panels; hot air defoggers on all or part of the panels.
Cargo space	656 cu. ft.	434 cu. ft.
Cargo loading doors, external	Three. Two in the forward and one in the rear compartment (2 interior access hatches which are equipped with wide angle inspection lenses).	Two. One in each compartment (2 interior access hatches).
Engines	Wright 972TC18DA1	Wright 749C18BD1
Propellers	Curtis electric C634S-C502* Hamilton Standard 43E60/6903A† both with autofeathering	Curtis electric (C632S-A14, C634S-C306, C634S-C308) Hamilton Standard (43E60/6869A) without autofeathering
Governor		
Direction of drive	Clockwise	Counterclockwise
Drive ratio	.857:1	.879:1
Propeller blade angles — Feather	91.2°* 80.5°†	81.5° (feather)
Propeller blade angles — Low	23.7°* 14.0°†	13.0°
Propeller blade angles — Reverse	—11.8°* —21.5°†	—20.5°
Fuel tanks	7 including center section tank	6
Fuel tank standpipes	Tanks 1, 2, 2A, 3, 3A, and 4	Tanks 1, 2, 3, and 4
Fuel tank selector levers—(open position)		
2A and 3A	Full forward	Half way
2 and 3	Half way	Full forward
Cabin refrigerator	2 units	1 unit
Torque meter constant	1.662	1.06
Rudder tabs	No servo action	Servo acting
Rudder area (including tabs)	91.2 sq. ft.	88 sq. ft.
Vertical stabilizer area	210.8 sq. ft.	154 sq. ft.
Elevator boost ratio	4.78 to 20:1	4.8 to 15:1
Elevator control system	Under-balanced with up spring on elevator.	Up and down spring on control column.
Brakes	Goodrich	Goodyear multi-disc and Bendix

*Curtis Electric Propellers †Hamilton Standard Propellers

§These figures vary with seating configurations specified by operators.

GENERAL DIMENSIONS AND LEADING PARTICULARS

Note

All dimensions are descriptive of the airplane in normal ground attitude with gear struts in static position, and tires inflated.

Length over all	113′ 7″
Wing span	123′ 0″
Ground clearance of aft end of fuselage (at jack point)	10′ 8″ approx
Ground clearance of flaps at full down position	5′ 0″ approx
Height over empennage	24′ 9″ approx
Tread (center-to-center)	28′ 0″
Tread (over all clearance from outside-to-outside of tires)	32′ 1″
Clearance under fuselage	7′ 0″ approx
Distance from ground to exterior cargo compartment doors:	
Forward cargo compartment:	
Forward loading door (in nose wheel well)	8′ 5″ approx
Aft loading door (in fuselage skin, lower right side)	8′ 3″ approx
Aft cargo compartment:	
Loading door (in fuselage skin, lower right side)	8′ 6″ approx
Minimum ground clearance, nose gear door open	7′ 0″ approx
Minimum ground clearance, main gear doors open	6′ 2″ approx
Height to main passenger door sill	9′ 4″ approx
Height to forward passenger door sill	11′ 2″ approx
Height to crew door sill	10′ 7″ approx
Stabilizer span	50′ 0″
Diameter of propeller disc	15′ 0″* 15′ 2″†
Propeller clearances:	
Minimum ground clearance, outboard propeller disc	3′ 5″ approx
Minimum ground clearance, inboard propeller disc	20″ approx
Minimum fuselage clearance, inboard propeller	14″ approx
Clearance between adjacent propellers (projected into same plane)	11.4″* 9.4″†
Clearance between adjacent propeller planes	9.4″
Maximum fuselage diameter	11′ 7½″
Total pressurized fuselage volume	7807 cu. ft.
Usable cabin floor area	744 sq. ft.
Usable cargo storage space	656 cu. ft.
Dihedral (Leading edge of geometric chord plane)	7° 36′
Sweep back (Leading edge of geometric chord plane)	7° 30′
Total wing area with flaps retracted (including ailerons and 244.4 sq. ft. of fuselage)	1650 sq. ft.
Flap area	295.4 sq. ft.
Maximum angular rotation of flaps	41° 28′
Aileron area (including 6.78 sq. ft. of tab area)	99.6 sq. ft.
Angular deflection of ailerons—up	25°
Angular deflection of ailerons—down	10°
Angular deflection of aileron tabs with aileron neutral—up	12° 30′
with aileron neutral—down	12°
with aileron up 25°, trim and servo—down	28° 30′
with aileron down 10°, trim and servo—up	20° 30′
Total horizontal tail surface area	436.58 sq. ft.
Maximum chord	11′ 2½″
Angle of incidence	+2° 1′
Horizontal stabilizer area (including 67.4 sq. ft. of fuselage area)	356.8 sq. ft.
Elevator area (including 10.9 sq. ft. of tab area)	106.8 sq. ft.
Angular deflection of elevator with boost on (shift lever down and locked)—up	40°
Angular deflection of elevator with boost on (shift lever down and locked)—down	20°
Angular deflection of elevator with boost off (shift lever up and locked)	
Minimum up	16° approx
Minimum down	6° approx

Note

Elevator travel is reduced in proportion to the increase in mechanical advantage. With boost off and shift lever up and locked, the mechanical advantage for manual operation (from full down to full up elevator) is approximately two to four times as great as for boost on control.

Total fore and aft travel of elevator control column	33° 42′

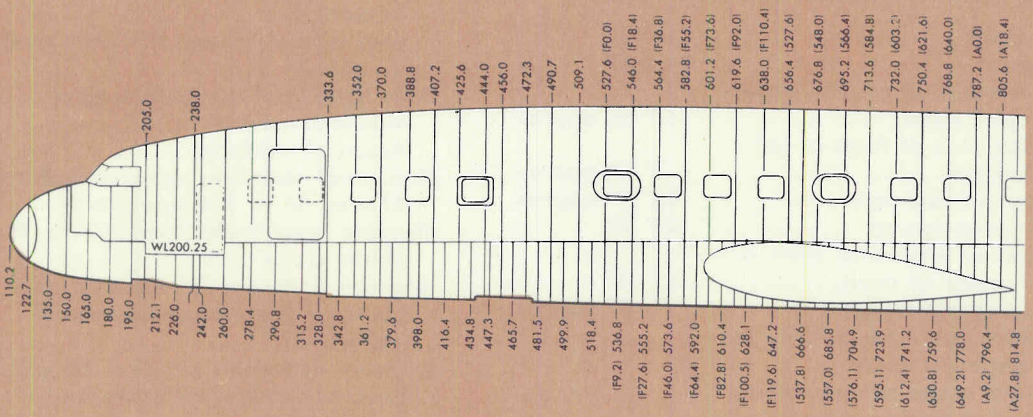
Note

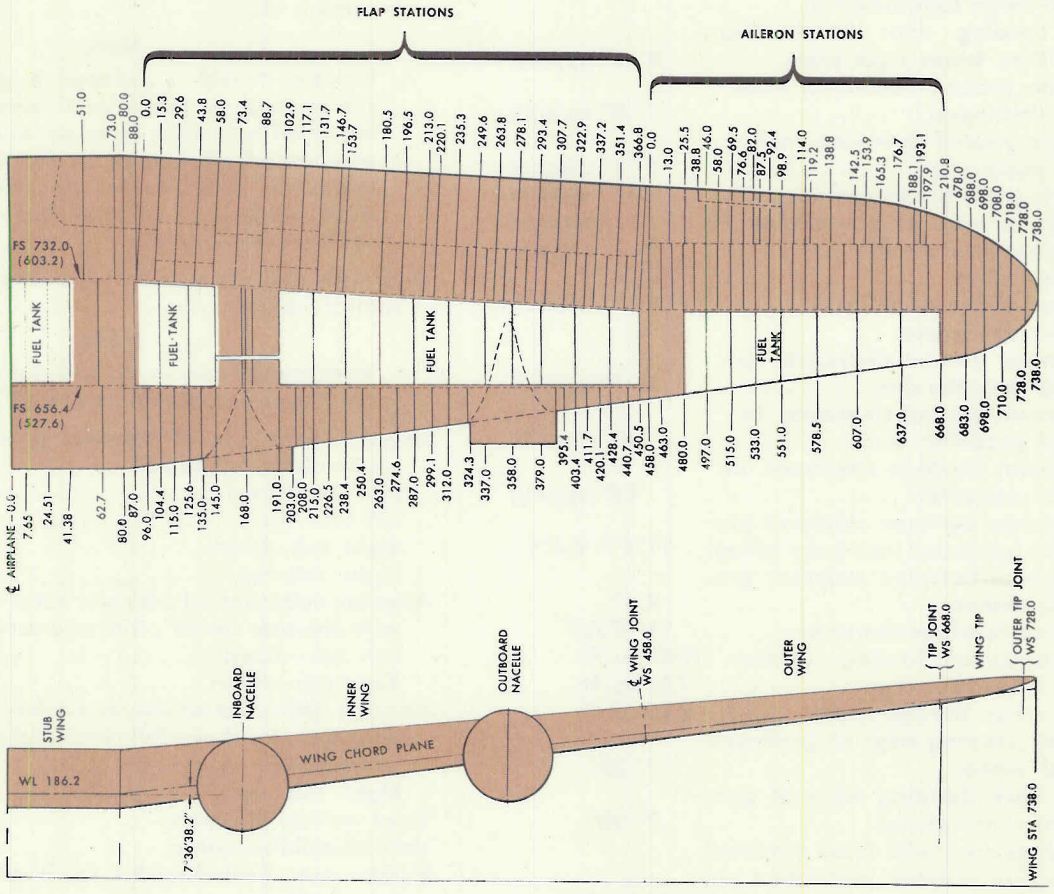
With control column at mid-point of fore and aft travel arc, elevators are 12° up.

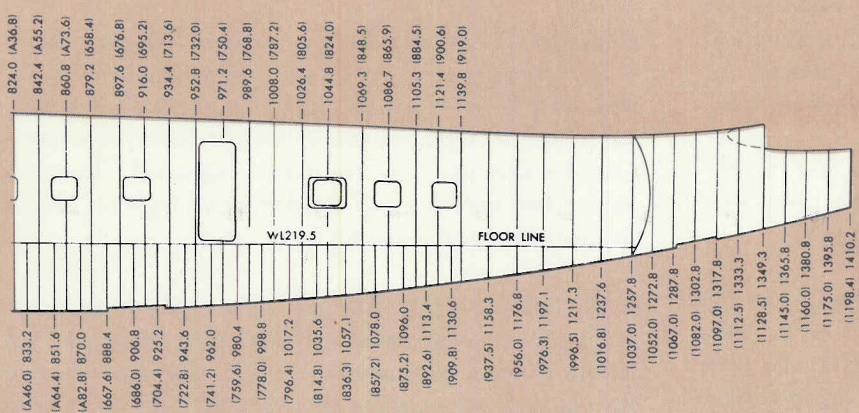
Angular deflection of elevator tabs—with elevator neutral:	
Left tab—down	22°
Left tab—up	22° 30′
Right tab down	21° 30′
Right tab—up	22° 30′
Angular deflection of elevator tabs—with elevator up 40°, trim and servo:	
Left tab—down	30°
Right tab—down	30°
Angular deflection of elevator tabs—with elevator down 20°, trim and servo:	
Left tab—up	27° 30′
Right tab—up	27°
Total vertical tail area	302 sq. ft.
Vertical stabilizer area	220.8 sq. ft.
Rudder area (including 8.1 sq. ft. of tab area)	91.2 sq. ft.
Angular deflection of rudders—	
Right	30°
Left	30°
Angular deflection of rudder tabs with rudder neutral:	
—Left	27°
—Right	25°

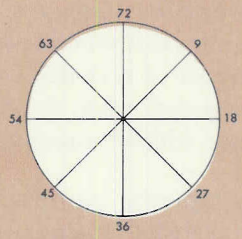
*Curtiss Electric Propellers †Hamilton Standard Propellers

stations diagram

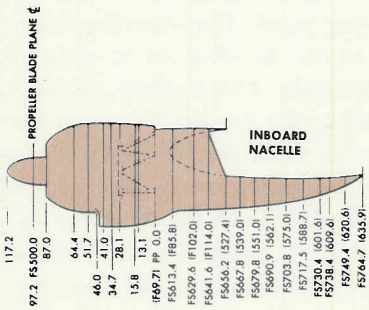


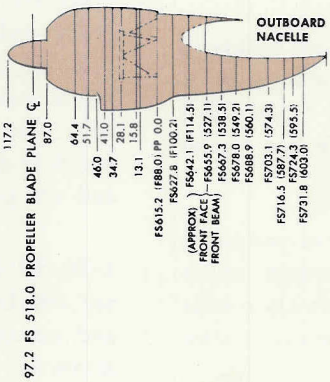






STRINGER LOCATIONS (LOOKING FORWARD)

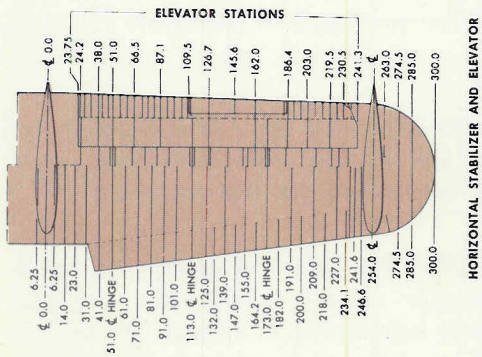


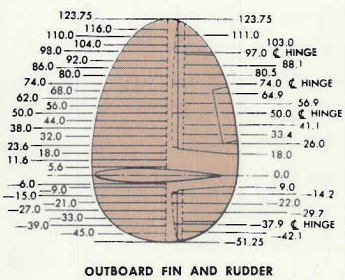


1 FUSELAGE STATION NUMBERS NOT IN PARENTHESES ( ) INDICATE DISTANCES IN INCHES FROM A REFERENCE DATUM 0.0 (ZERO). REFERENCE TO THESE STATIONS IS MADE IN SERVICE BULLETINS.

2 FUSELAGE STATION NUMBERS IN PARENTHESES ( ) ARE USED FOR ENGINEERING AND MANUFACTURING REFERENCE AND ARE STENCILLED ON THE AIRCRAFT STRUCTURE. REFERENCE TO THESE STATIONS IS MADE ON ENGINEERING DRAWINGS.

3 NACELLE STRUCTURE AFT OF THE FIRE WALL (POWER PLANT STATION 0.0) IS IDENTIFIED BY FUSELAGE STATIONS.





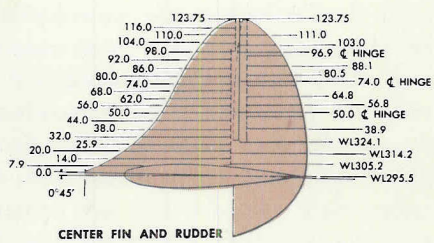


figure 1-2

1–10. The flight station windshield consists of seven shatterproof panels and is equipped with anti-icing, de-icing, and defogging devices to keep the panels clear. In addition, windshield wipers are installed on the pilot's and copilot's forward windshield panels. The second panels from the rear on each side are in low pressure areas, and may be opened, when the cabin is not pressurized, for clear vision without exposing the pilots to wind and rain.

1–11. WINDOWS, DOORS, EMERGENCY EXITS, ACCESS HATCHES. Large rectangular, double panel windows are located in the passenger compartments.

1–12. The two passenger entrance doors located in the left side of the aircraft may be opened from either side. Each has a six-inch circular window, and the forward door is equipped with a safety bar. The forward door opens outward and rotates forward. The rear door rotates inward and slides aft on tracks. Both doors can be opened or locked from the inside.

1–13. There are eight emergency exits, four on each side of the aircraft, that are enlargements of the cabin windows. The emergency exits may be opened from either side.

1–14. A circular manhole in the aft pressure bulkhead provides access to the unpressurized fuselage area aft of the cabin. It is opened by a removable key handle, and has an inspection window in it. The key is tied to the pilot's seat.

1–15. Both the forward and the aft cargo compartments may be entered from the cabin area through access hatches in the cabin floor. Each of the hatches has a wide angle plastic lens window through which the cargo compartments may be inspected in flight.

1–16. CARGO COMPARTMENTS. The space below the cabin floor is divided into two compartments forward and aft of the wing structure. These compartments are walled and sealed with laminated plasticized fibre glass to provide fire protection. Tubing, conduit, and cables pass through the area below the cabin floor behind the fibre glass sealing and are protected from damage by shifting cargo. Both compartments are equipped with flush fittings for attaching hold-down nets. The forward compartment has two inward-opening exterior cargo-loading doors. One loading door is located in the rear wall of the nose wheel well, and the other is located in the underside of the fuselage. The aft cargo compartment has one inward-opening door located in the underside of the fuselage.

1–17. WING. The wing is a full cantilever, all-metal, stressed skin structure, spanning 123 feet from tip to tip. It is fabricated and assembled in sections identified as the center section, inner wing panels, outer wing panels, wing tips, outer tips, flaps, ailerons, and trim tabs.

1–18. CENTER SECTION. The center section (stub wing) is an integral part of the fuselage structure, faired to the skin with fillets. It extends from the aircraft's longitudinal centerline right and left to wing stations 80, where it provides attachment for the inner wing panel. The center section fuel tank (5) and the reserve oil tank are located in this section of the wing.

1–19. INNER WING PANELS. The inner wing panels are attached to the center section at wing stations 80 and extend outward to wing stations 458, where attachments for the outer wing panels are provided. Each inner wing panel mounts two engine nacelles, two integral fuel tanks; the wing flaps; and the main landing gear and related controls. The cabin superchargers, refrigeration units, and related air conditioning system assemblies are also mounted in the inner wing panel. The centerlines of the inboard and outboard engine nacelles are at wing stations 168 and 358 respectively. The portions of the nacelles aft of and including the firewall are built integrally with the inner wing structure. The integral fuel tanks (1, 2, 3, and 4) are located between the two main beams from stations 87 to 450.5 and are separated by a wing rib. Each of the inboard tanks in the inner wing panels is divided into two sections by the main gear wells and are interconnected.

1–20. OUTER WING PANELS. The outer wing panels are attached to the inner wing panels at stations 458 and extend outward to stations 668, where the attachments for the wing tips are installed. Each outer wing contains an integral fuel tank (2A or 3A) between stations 480 and 667.4 extending from main beam to leading edge.

1–21. WING TIPS. The wing tips extend from stations 668, where they are attached to the outer wing panels, to stations 718, where the outer tips are mated.

1–22. OUTER TIPS. The outer tips or caps are removable and replaceable without removing the wing tips. They extend from stations 718 to stations 738, the outermost extremities of the wing structure. The position lights are mounted in the outer wing tip sections.

1–23. FLAPS. The high lift, modified Fowler-type wing flaps extend from the fuselage to the outboard end of the inner wing panels. The flaps in the left and right wing are interconnected to insure identical movement.

The effect of the initial, or outward, extension is to increase the wing area. Further movement produces a downward tilting angle which increases lift and drag.

1–24. AILERONS. The ailerons extend the full length of the trailing edge of the outer wing panels, and are attached with flush, continuous, anti-icing hinges. They are weighted for static and dynamic balance. Each is equipped with a controllable, irreversible trailing edge trim tab, also hinged with flush, continuous, anti-icing hinges.

1–25. EMPENNAGE. The empennage consists of three vertical fins and rudders mounted on a full cantilever horizontal stabilizer to which elevators are attached. The empennage is all metal with the exception of the rudders and rudder tabs, which are fabric covered.

1–26. STABILIZER. The horizontal stabilizer extends twenty-five feet to the right and left of the aircraft's longitudinal centerline. It has removable leading edges.

1–27. ELEVATORS. The elevators extend along the trailing edge from right and left stabilizer stations 23.8 to 240.8. The right and left elevators are rigidly interconnected to insure identical movement. They are mounted with anti-friction hinges and weighted for partial static balance. The leading edges of the elevators are designed to prevent excessive ice formation. A controllable, irreversible, trailing edge trim tab with servo action is installed in each elevator. These are mounted with continuous, flush, anti-icing hinges.

1–28. FINS. The center fin is mounted at station zero of the horizontal stabilizer. It rises 10′ 4″ above the transverse centerline of the stabilizer, and fairs into the tail cone of the aft fuselage below the plane of the stabilizer. The outboard fins are mounted at stabilizer stations 254, 46 inches inboard from the stabilizer tips. They rise 10′ 4″ above the stabilizer chord plane, and extend approximately four feet below it.

1–29. RUDDERS. The all-metal structural framework of each of the three rudders is covered with dope-impregnated fabric. The rudders are designed to prevent the formation of ice on their leading edges, and are hung with anti-friction type hinges. They are weighted for static and dynamic balance. Each outboard rudder is equipped with a controllable, irreversible, trailing edge trim tab. The tabs are hinged with flush anti-icing hinges.

1–30. ENGINES.

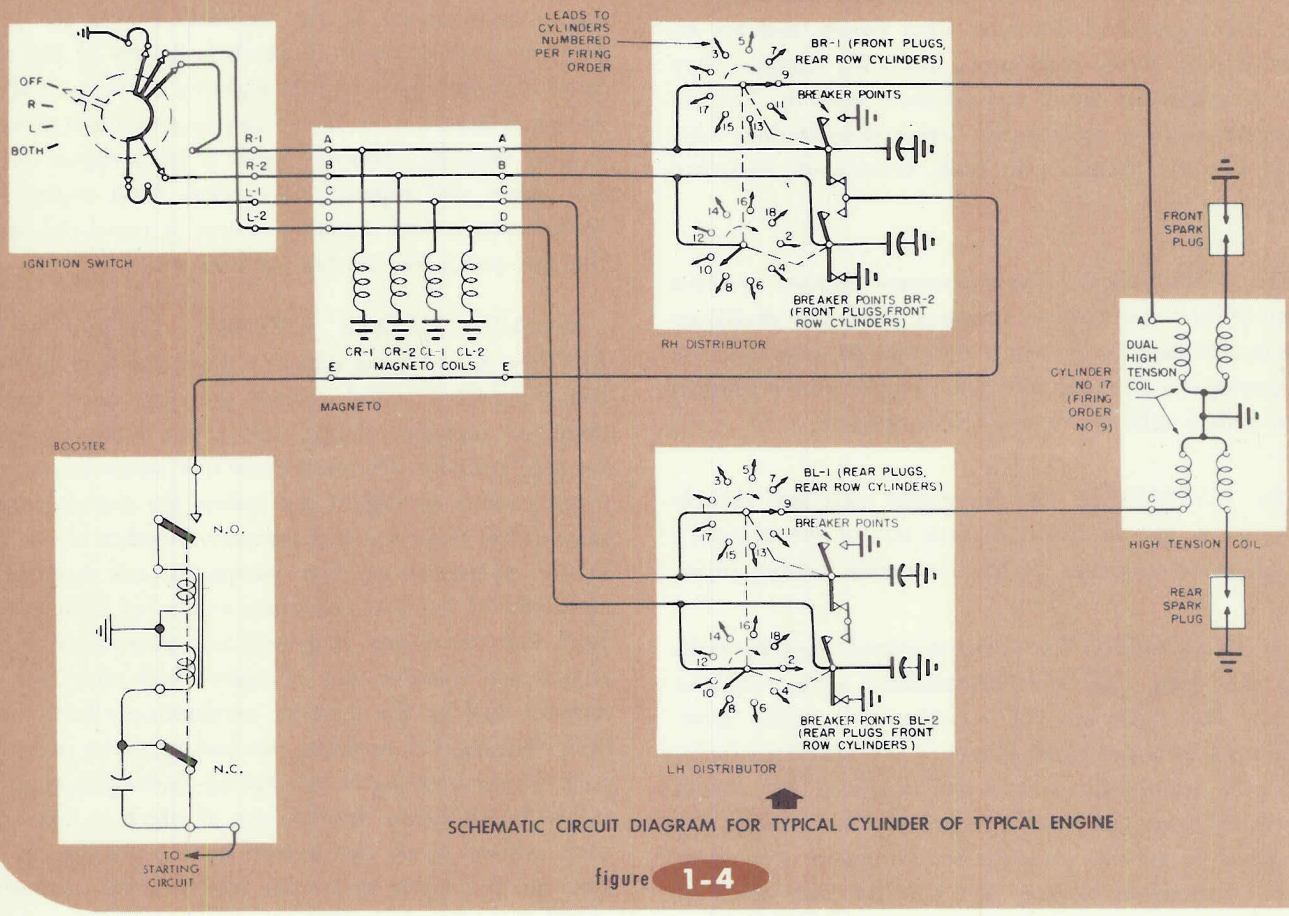
1–31. The four engines installed on the aircraft are Turbo-compound, 18-cylinder, air-cooled WAD 972TC-18DA1 engines. The total horsepower output of each engine is increased by the installation of three power recovery turbines, each of which is driven by the combined exhaust from six of the eighteen cylinders. Turbine energy is geared back to the engine crankshaft through a fluid coupling. Turbine speed is proportional to engine speed and requires no control. Each engine also incorporates a fuel injection system, a two-speed supercharger, and a low tension ignition system.

1–32. FUEL MASTER CONTROL UNIT (CARBURETOR). Each engine utilizes a direct fuel injection system (figure 1–3) which consists of a fuel master control unit, two injection pumps, and a fuel injection nozzle for each cylinder. The carburetor unit senses the amount of air passing through it and meters the correct proportion of fuel from the fuel pressure chamber of the carburetor to the two injection pumps that are mounted on each side of the rear crankcase section of each engine. Each injection pump is geared and thus timed to the engine and contains nine plungers which distribute the metered fuel to the cylinder combustion chambers. A synchronizing bar connects the fuel injection pumps to assure equal metering of fuel. Spring-loaded poppet valves in the fuel injection nozzles, one of which is located in each cylinder head, are opened by the pressure of the fuel and the nozzle sprays the fuel into the combustion chamber.

1–33. IGNITION SYSTEM. Each engine utilizes a low tension dual ignition system (figure 1–4). The low tension magneto installed on the rear accessory section produces a low voltage for the right and left distributors located on the nose section case. The right distributor directs low voltage to the high tension coils that fire the front plugs in each cylinder. The left distributor directs low voltage to the high tension coils that fire the rear plugs in each cylinder. A high tension coil is provided for each plug and is attached to a cylinder rocker box cover. An ignition booster is also employed to provide the hot spark that is required during cold starts and low starting speeds which are below the coming-in speed of the magneto. The booster discharges through a trail finger in the right distributor.

1–34. PRIMING SYSTEM. A solenoid priming valve, mounted on the housing of each carburetor pressure chamber, is actuated electrically by a momentary con-

engine ignition system



SCHEMATIC CIRCUIT DIAGRAM FOR TYPICAL CYLINDER OF TYPICAL ENGINE

figure 1-4

tact switch that is located adjacent to the engine starter button on the MJB (master junction box) No. 2 switch panel. Priming fuel is discharged from the fuel inlet chamber directly to the engine induction passage. Pressure is supplied by the auxiliary fuel pump, which must be turned on during priming operation.

1–35. STARTING SYSTEM. Each engine is equipped with a direct cranking electric starter mounted on the engine accessory section. The starter incorporates a disc-type clutch designed to slip when the engine offers abnormal resistance to cranking during starting operation, such as that caused by a hydraulic lock. A momentary contact-type switch push button for energizing the starter is located on the MJB No. 2 switch panel. The engine starter electrical circuit is shown on figure 1–5.

1–36. ENGINE CONTROLS.

1–37. THROTTLE LEVERS. One set of four throttle levers is located on the pilots' center control stand (figure 1–54) and another set of four throttle levers is located on the flight engineer's control quadrant (figure 1–57). The throttles are numbered from left to right, and the corresponding levers are mechanically interconnected to the carburetor butterfly shafts by cable, pulley, and linkage systems.

1–38. REVERSE PITCH THROTTLE LEVERS. The pilots' throttle levers incorporate an additional set of four reverse pitch throttle levers (figure 1–54) hinged on the main throttle arms. The reverse levers are normally folded forward and below the main throttle knobs so that they do not interfere with normal throttle operation. The reverse pitch throttle levers are connected by a linkage mechanism to the same cable system as the main throttle levers. When the main throttle levers are retarded to the full aft position, the reverse pitch throttle levers may be lifted upward and pulled aft. This action energizes the propeller controls that turn the blades to

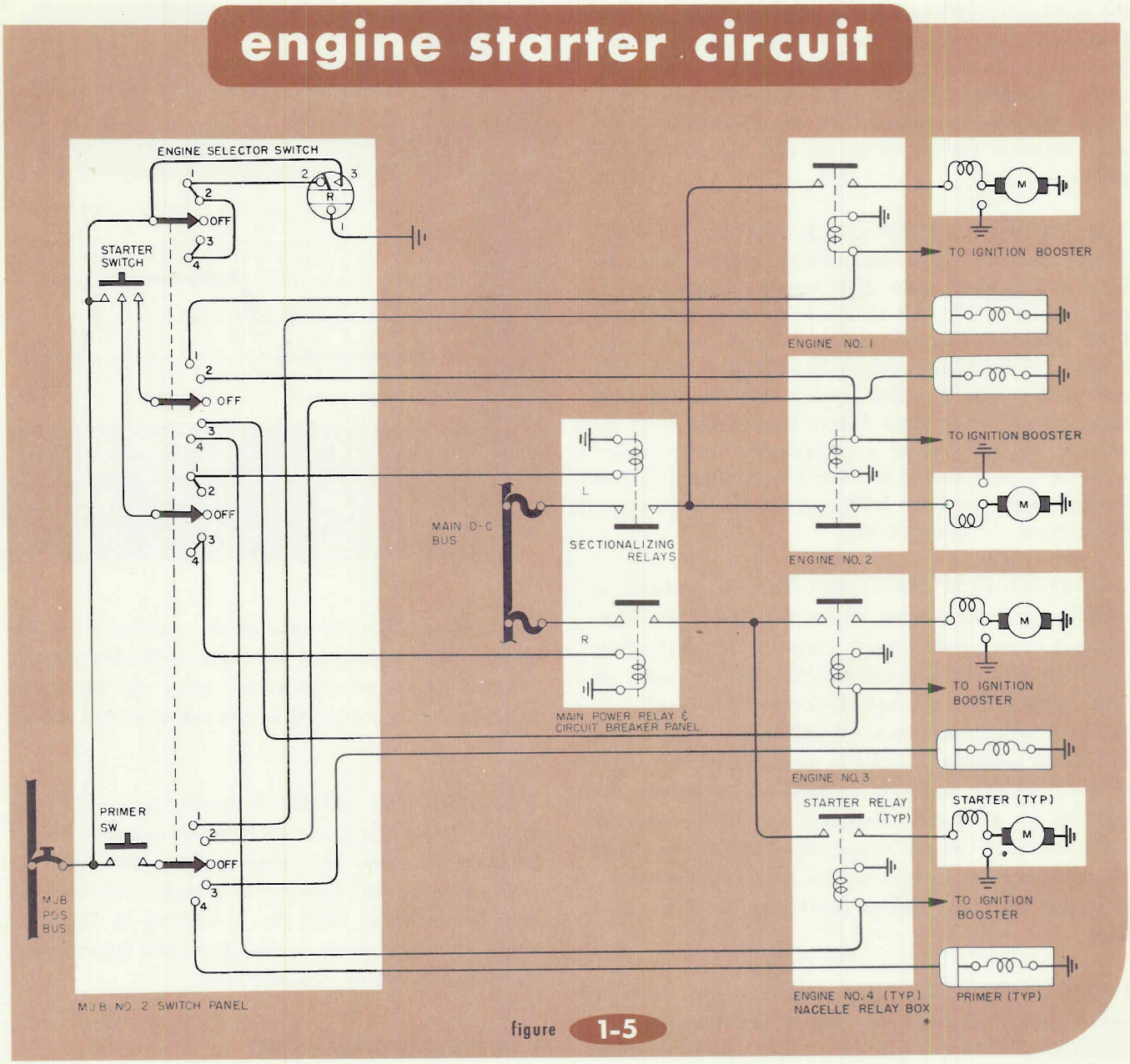


figure 1-5

the reverse pitch position. As the reverse pitch throttle levers are moved aft they open the engine throttle valves to increase power. The maximum travel of the carburetor butterfly valves is limited in reverse pitch by a cam in the reverse pitch throttle lever linkage.

1–39. MIXTURE CONTROL LEVERS. Four mixture control levers are located on the flight engineer's control quadrant (figure 1–57) and are mechanically linked to the carburetor mixture control valves. The mixture lever control quadrant is marked as follows: OFF, AUTO LEAN, and AUTO RICH. Serrated detent plates permit setting the mixture levers in the optimum position. Manual leaning may be accomplished by moving the mixture control levers inboard from the AUTO-RICH position toward the OFF position. This position is usually between the AUTO-LEAN and OFF positions. See MANUAL LEANING in Section VI for procedures.

1–40. CARBURETOR AIR CONTROL SWITCHES. Four toggle-type switches are located on the left side of the flight engineer's lower switch panel (figure 1–57) and are numbered from left to right. Each switch has three positions, OFF, COLD, and HOT and is spring-loaded from HOT to the OFF position. Holding the switch in the HOT position electrically actuates a rotary valve in

the carburetor air intake scoop, permitting hot air from behind the engine cylinders to enter the carburetor. Moving the switch to the COLD position rotates the valve, permitting unheated air to enter the carburetor. Limit switches are installed to automatically stop the valve when it reaches either the full hot or full cold position.

1–41. ENGINE SUPERCHARGER CONTROL LEVERS. There are four engine supercharger control levers located at the center of the flight engineer's control quadrant (figure 1–57). All of the levers have HIGH and LOW positions. The two outboard levers (engines No. 1 and 4) have third positions, in addition to the HIGH and LOW positions, which mechanically disconnect the cabin pressurization supercharger drive shafts from the engines. By compressing a spring-loaded lock mounted adjacent to the outboard levers and by pushing the levers through and beyond the LOW position, the cabin superchargers can be disconnected.

1–42. COWL FLAP SWITCHES. The four paddle-type cowl flap switches located on the left side of the flight engineer's lower switch panel (figure 1–57), have three positions: OFF, OPEN, and CLOSE. These switches on LAC Serials 4501 through 4512 are spring-loaded to the OFF position and must be held in either the OPEN or CLOSE positions in order to provide electrical power to the cowl flap actuators in each engine nacelle. On LAC Serials 4513 and subsequent aircraft the switches are momentary contact in only the CLOSED positions. The two actuators in each nacelle are interconnected by a flexible shaft that assures equal opening of the cowl flaps.

1–43. IGNITION SWITCHES. On the pilot's overhead switch panel (figure 1–51) there are four ignition switches, each of which has four positions. As the switches are rotated in a clockwise direction the positions are OFF, RIGHT, LEFT, and BOTH. When the ignition switch is placed in the RIGHT position, the circuit to the left distributor is grounded and the circuit to the right distributor, which fires the front plugs in each cylinder is ungrounded. The LEFT switch position grounds the right distributor circuit and ungrounds the circuit to the left distributor which fires the rear plugs in each cylinder. The BOTH position ungrounds the circuits to both the left and the right distributors and the OFF position grounds both circuits.

1–44. PRIMING SWITCH. A single priming switch, located on the MJB No. 2 switch panel (figure 1–58), is a momentary contact push button which electrically operates a solenoid primer valve on the carburetor and discharges fuel directly into the engine induction passage. Selection of the solenoid primer valve and the engine being primed is controlled by the engine starter selector switch.

automatic spark advance

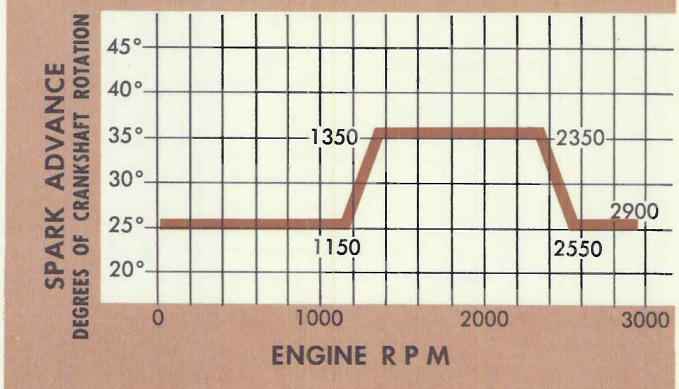


figure 1-6

1–45. STARTING SWITCHES. Located on the MJB No. 2 switch panel (figure 1–58) there are two switches for the starting system. One switch is the engine starter selector. It is a rotary-type switch with five positions, engine No. 1, No. 2, OFF, No. 3, and No. 4. The other switch is a momentary contact-type push button which energizes the selected engine starter.

1–46. ENGINE INDICATORS.

1–47. TACHOMETER INDICATORS. Engine rotational speed is transmitted by tachometer generators mounted on the rear case of each engine to four dual electric indicators. Two are located on the pilots' instrument panel (figure 1–49), and the other two are located on the flight engineer's lower instrument panel (figure 1–56). The indicators are calibrated to read in revolutions per minute.

1–48. CYLINDER HEAD TEMPERATURE INDICATORS. Two dual cylinder head temperature indicators and a two-position selector switch are located on the flight engineer's lower instrument panel (figure 1–56). A resistance bulb in cylinders No. 1 and 2 of each

engine electrically transmits by d.c. current the temperature to the indicators, which are calibrated in degrees Centigrade. The selector switch has A and B positions. The A position selects cylinder No. 1 on each engine and position B selects cylinder No. 2 on each engine.

1–49. MANIFOLD PRESSURE INDICATORS. Two dual manifold pressure indicators, located on the pilots' instrument panel (figure 1–49) and two dual indicators, located on the flight engineer's lower instrument panel (figure 1–56), electrically register the induction air pressures at the engine manifolds. These instruments are calibrated in inches of mercury.

1–50. COWL FLAP POSITION INDICATORS. Two dual cowl flap position indicators are located on the flight engineer's lower instrument panel (figure 1–56) and are calibrated from 0 to 100%. The indicators are electrically connected to position transmitters mounted on the actuator housing unit.

1–51. TORQUEMETERS (BMEP GAGES). Two dual torquemeter indicators, located on the flight engineer's lower instrument panel (figure 1–56), measure the torque at the propeller shaft. The indicator is calibrated in BMEP.

1–52. ENGINE HORSEPOWER FORMULA. The formula for determining horsepower for this engine is:

$$\frac{\text{RPM} \times \text{BMEP}}{236} = \text{BHP.}$$

1–53. CARBURETOR AIR TEMPERATURE INDICATORS. Two dual carburetor air temperature indicators, located on the lower left side of the flight engineer's middle instrument panel (figure 1–56), register the induction air temperature at the carburetor throat by means of temperature resistance bulbs. The indicators are calibrated in degrees Centigrade.

1–54. PROPELLERS. (LAC Serials 4501 through 4509.)

1–55. Curtiss electric, three-bladed, full feathering and reversible pitch propellers, Model C634S-C502, incorporating a fluid anti-icing system are installed on each engine. The model 858-5C4-0 blades are of extruded hollow steel construction. The propeller control system provides for constant speed governing during synchronization, individual selective increase or decrease rpm, manual and automatic feathering, and reversing. A master rpm control lever is also provided to change rpm of all engines simultaneously. The propellers have a diameter of 15 feet.

1–56. PRINCIPLES OF OPERATION.

1–57. Control of engine speed is maintained by changing the blade angle through electro-mechanical means. Refer to figure 1–7. Control current is applied to the propeller through contact brushes riding on slip rings which form a part of the hub assembly. The d.c. energizing current, transferred at this point from the stationary to the rotating parts, is conducted through connector rods within the hub to the power unit. This unit consists of an electric motor which drives a power gear through a two-stage system of planetary gearing called the speed reducer. The power gear is in continual mesh with gears at the shank of each blade. All blade angle changes are accomplished by this means. Limit switches mounted in the rear housing of the speed reducer are actuated by cam segments attached to the main drive gear of the speed reducer. By their location, the cam segments accurately control the low, high, feather, and reverse blade angle limits. A brake assembly mounted on the motor housing acts to prevent the blades from changing angle when no change is required. The synchronizer provides automatic constant-speed control by electrically matching engine speeds with the speed of the synchronizer motor.

1–58. The electrical matching of speeds is accomplished by contactors mounted on and driven by the synchronizer motor. These units compare the speed of the synchronizer motor with the speed of each individual engine by means of the frequency output of three-phase alternators mounted on and driven by the engines. The slightest variation in speed will cause the synchronizer unit to direct electrical energy to the propeller to provide the necessary blade angle correction required to maintain the desired speed.

1–59. SELECTIVE PITCH. The selective fixed-pitch operation provides a means for adjusting the blade angle to obtain the desired rpm for various operating conditions when automatic synchronized operation is not desired, or when operating conditions require this auxiliary method of control. A propeller may be operated in fixed-pitch whenever desired by placing the individual selector switch in the center or fixed-pitch position. With the switch in this position, the pitch change motor is disconnected from the synchronizer and the propeller will respond to changes in airspeed and throttle position as a fixed pitch propeller (i.e., rpm will not remain constant). Any blade angle position, to control rpm, may be obtained between the low pitch and full feather settings by actuation of the selector switch to the INC or DEC rpm positions. Refer to figure 1–8, sheet 1.

curtiss electric propeller hub

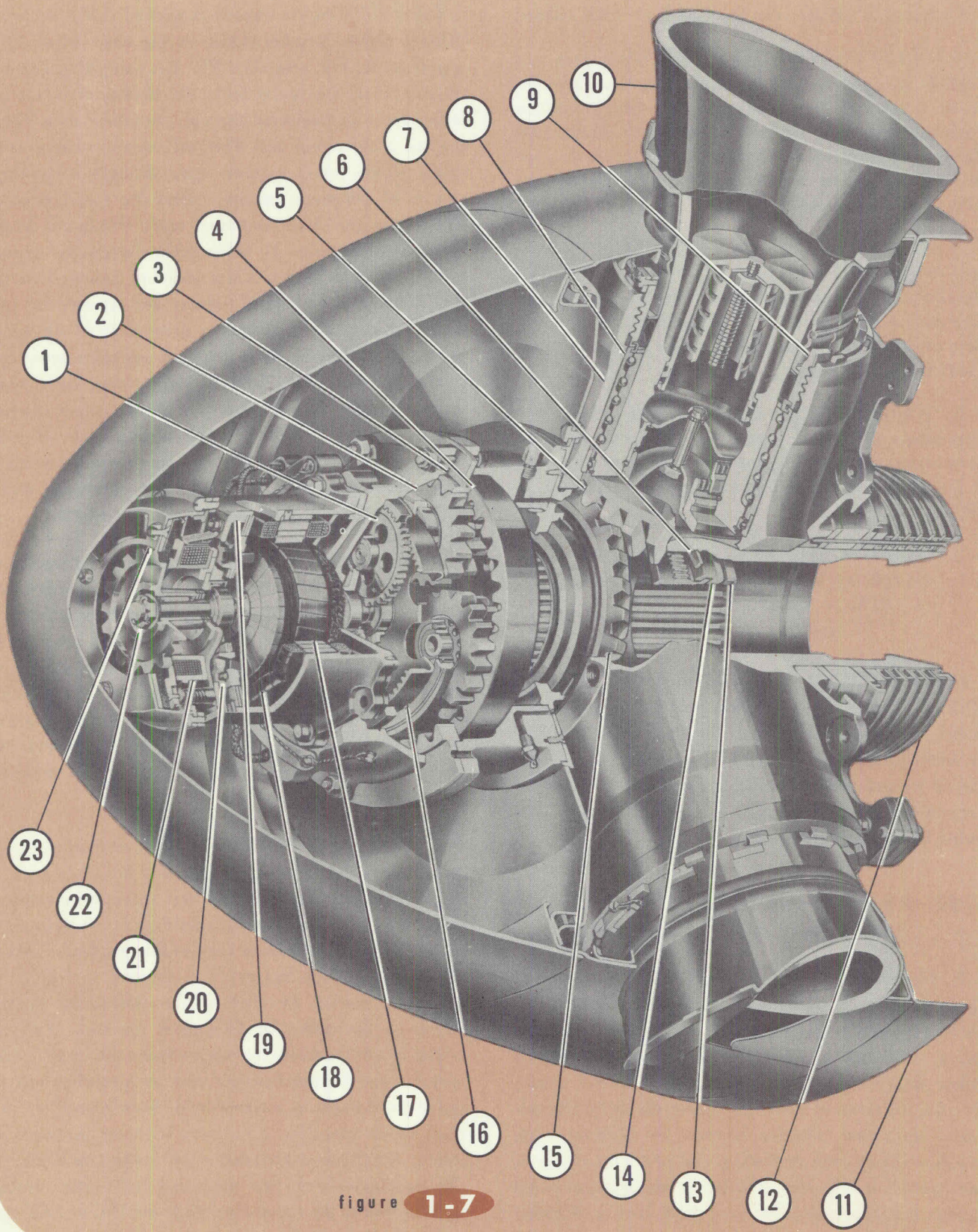


figure 1-7

1. High speed spider gear.
2. Low speed spider gear.
3. Low speed fixed ring gear.
4. Low speed bell gear.
5. Blade gear.
6. Snap ring.
7. Propeller hub.
8. Bearing stack.
9. Blade nut.
10. Propeller blade.
11. Propeller spinner.
12. Slip rings.
13. Grease seal and spreader ring.
14. Front cone.
15. Power gear.
16. High speed bell gear.
17. Armature.
18. Motor windings.
19. Motor housing.
20. Motor brush and spring assembly.
21. Brake solenoid and housing.
22. Disc retaining nut.
23. Brake disc assembly.

1–60. AUTOMATIC SYNCHRONIZATION. Normal propeller operation is obtained by setting the synchronizer motor at the desired rpm (as indicated on the synchronizer tachometer) by the master control lever with the four individual selector switches in AUTO RPM. In this position, the rpm of each engine will be automatically synchronized and controlled to match the rpm of the synchronizer motor. Refer to figure 1–8, sheet 2.

Note

The synchronizer will continue to govern and synchronize any one or more engines if the individual selector switch of the engine is in the AUTO RPM position irrespective of whether the remaining engines are being manually controlled, operated in fixed pitch or feathered.

1–61. FEATHERING. During feathering operation all other propeller circuits are automatically disconnected from the system. Boosted voltage is applied to the power unit electric motor which actuates the planetary gears, which, in turn, provides a quick blade angle change to the feather angle. The voltage booster is a motor-generator unit composed of a series motor driving an armature which operates within the motor field. The booster is controlled by a relay, the coil of which is in series with the generator. An electrical load applied to the generator closes the relay and starts the motor. The voltage booster is started by actuation of the feathering switch and stops automatically when the propeller blades reach the feather angle and the feather limit switch in the power unit opens. Refer to figure 1–8, sheet 3.

1–62. AUTOMATIC FEATHERING. The automatic feathering system will automatically feather the propeller of an engine if the BMEP drops to approximately 72-82 BMEP or less and remains there from 1½ to 2 seconds. The delay is introduced into the system to prevent automatic feathering in the event of momentary power losses and to prevent automatic feathering if the throttle is advanced rapidly enough to close the throttle switch before the BMEP has risen above its torque pressure switch setting. A means is provided to prevent the automatic feathering of more than one propeller by the installation of a blocking relay which renders the automatic feathering circuit inoperative when one propeller has been feathered automatically or manually. A master switch is also provided to permit optional selection of the automatic feature when required. Four system test switches are installed to bypass the throttle switches for ground testing the automatic feathering operation. Refer to figure 1–8, sheet 4.

Curtiss Electric Propeller Operation—Manual Circuits
LAC Serials 4501 Through 4509
Figure 1–8 Sheet 1

To be included when available.

Curtiss Electric Propeller Operation—Automatic Circuits
LAC Serials 4501 Through 4509
Figure 1–8 Sheet 2

To be included when available.

Curtiss Electric Propeller Operation—Feathering Circuits
LAC Serials 4501 Through 4509
Figure 1–8 Sheet 3

To be included when available.

Curtiss Electric Propeller Operation—Automatic Feathering Circuits
LAC Serials 4501 Through 4509
Figure 1–8 Sheet 4

To be included when available.

Curtiss Electric Propeller Operation—Reversing Circuits
LAC Serials 4501 Through 4509
Figure 1–8 Sheet 5

To be included when available.

Curtiss Electric Propeller Operation—Return from Reversing Circuits
LAC Serials 4501 Through 4509
Figure 1-8 Sheet 6

To be included when available.

1–63. UNFEATHERING. During unfeathering, the normal control circuits are restored by placing the FEATHER switch to the NORMAL position, and by placing the selector switch intermittently in the INC RPM position until the blade angle is reduced and the engine is operating at the desired rpm for starting and warm-up. After operating temperatures are reached, the engine rpm is adjusted to the operating speed by holding the selector switch in INC RPM until within 50 rpm of desired speed and then placing the switch in AUTO RPM—at the same time adjusting throttle to desired power.

Note

There are no restrictions on IAS when unfeathering. The propeller cannot go to reverse blade angle inadvertently due to the manual control which is maintained with the selector switch.

1–64. REVERSING. When the reverse throttle levers are moved into the reverse idle position, the throttle reverse switches are closed, thereby energizing the reverse switch and reverse pitch relays. Actuation of these relays opens the normal propeller control circuits and energizes the reverse circuit and the voltage booster thus sending the propeller to the reverse angle at an accelerated rate. Refer to figure 1–8, sheet 5. The sound of the voltage boosters will serve as an indication of the actual reversing of the blades. When the sound ceases, the reverse throttle levers may be pulled aft for the desired reverse thrust power. The pause in the idle reverse position is to prevent overspeeding of the engines when the propellers are in flat pitch.

1–65. UNREVERSING. When the reverse throttle levers are returned to the forward (normal) position, the throttle switches are opened which, in turn, permits the reverse switching relays to shift. This applies boosted voltage through the reverse pitch relays (which remains magnetically latched through the reverse-unreverse cycle) to the feather limit switches at the power unit motor. The blade angle changes toward the feather position until the low pitch limit switches close. This then applies power to the normalizing relays which, in turn, unlatch the reverse pitch relays, stopping the cycle and restoring control to the normal system. Refer to figure 1–8, sheet 6.

1–66. PROPELLER CONTROLS.

1–67. MASTER RPM CONTROL LEVER. Two master control levers are incorporated in the system, one on the flight engineer's control quadrant (figure 1–57) and one on the pilot's center control stand (figure 1–54). The levers are mechanically interconnected and either lever will accurately control the speed of the synchronizer motor. A small movement of the lever from the DEC (full aft) position toward INC (take-off) position, switches on the synchronizer. Positioning the lever between these points controls the rpm setting of the synchronizer. The speed of the synchronizer motor in terms of engine rpm is indicated on a tachometer located on the flight engineer's panel. A red warning light indicates whenever the synchronizer motor is not operating at the set governing speed.

1–68. INDIVIDUAL SELECTOR SWITCHES. These four selector switches, located on the flight engineer's lower switch panel (figure 1–57), provide individual propeller control and fixed pitch operation as well as automatic governing and synchronization. Each toggle switch has four positions, AUTO RPM, fixed pitch, DEC RPM, and INC RPM. The DEC RPM and INC RPM positions are momentary contact positions and must be held manually. When released, the switches automatically return to the fixed pitch position. When the switch is in the fixed pitch position, the propeller responds to changes in airspeed and throttle settings as a fixed pitch propeller. Any blade angle position may be obtained between the low pitch limit and feather by holding the switch in either the DEC RPM or the INC RPM position. When the four toggle switches are placed in the AUTO RPM position, the automatic governing and synchronizing feature is applied to the four propellers and the circuit for automatic feathering protection is completed (provided the automatic feathering master switch is ON).

1–69. FEATHER SWITCH. The feather switch, located on the flight engineer's lower switch panel (figure 1–57), has two positions FEATHER and NORMAL. When the switch is placed in the FEATHER position all other propeller change circuits are opened and the feathering circuit is completed thereby sending the propeller blades to the feather position.

1–70. REVERSE PITCH THROTTLE LEVERS. These levers are discussed under Engine Controls.

1–71. REVERSE LOCK OVERRIDE LEVER. A visible guarded flag cover is provided on the center control stand (figure 1–54) to the right of the No. 4 throttle lever. This flag lever may be pushed down to manually release the reverse throttle lock before weight of the aircraft is on the main gear, allowing reverse power to be applied at the initial touch-down. This actuator is connected by cables to the reverse throttle locking bar, which, when turning to the open position, lowers the flag lever, permitting the reverse throttle levers to be pulled aft for reverse thrust. An automatic means of releasing the reverse throttle lock is also provided. A

switch mounted on each main landing gear fulcrum releases the reverse throttle lock when the main gear shock struts pivot rearward (as brakes are applied during a rejected take-off or, as the wheels contact the runway during landing). A relay is provided to maintain the circuit established by the momentary operation of these switches. These switches will permit use of the reverse thrust power with partial weight on the main gear, and the scissors switch on the left main gear permits the use of reverse thrust power when full weight is on the landing gear. The throttle reverse lock is reset when both outboard throttles are advanced to the minimum take-off power and the weight is partially taken off the left main gear.

1–72. AUTOMATIC FEATHERING TEST SWITCHES. Four automatic feathering test switches are located on the flight engineer's upper switch panel (figure 1–56). Each switch is protected by a guard which must be lifted before the system test can be made. The test switches bypass the throttle switches and make it possible to test the system without reaching the 50-60% throttle position.

1–73. AUTOMATIC FEATHERING SYSTEM MASTER SWITCH. When the automatic feathering master switch, located on the flight engineer's upper switch panel (figure 1–56), is ON, electrical power is applied to the system indicator lights and the throttle switches. When the throttles are advanced to take-off power, the throttle switches close, applying power to the torque pressure switches of each engine. With the four individual selector toggle switches in the AUTO RPM position, the automatic feathering system is fully armed. Automatic feathering can take place only if the particular selector switch is in the AUTO RPM position. If it is desired to stop an automatic feathering cycle before full feathering is reached, the selector switch can be placed in the fixed pitch position. Returning it to AUTO RPM position restores synchronizer control.

Note

To prevent overspeeding following an interrupted automatic feathering operation, the propeller should be brought close to the speed of the other engines with the manual selector switch, as in unfeathering, then placed in AUTO RPM.

1–74. PROPELLER INDICATORS.

1–75. AUTOMATIC FEATHERING WARNING LIGHTS. Four red automatic feathering warning lights are located on the flight engineer's lower switch panel (figure 1–57). These lights are set to indicate which propeller is being feathered automatically.

1–76. AUTOMATIC FEATHERING ARMING LIGHTS. These amber lights, one on the flight engineer's upper switch panel (figure 1–56) and one on the pilot's instrument panel (figure 1–49), are set to light when the master switch is ON indicating that the system is armed. They will go out if any feathering switch is operated or if any automatic feathering cycle is initiated.

1–77. SYNCHRONIZING WARNING LIGHT. The red synchronizing warning light, located on the flight engineer's lower instrument panel (figure 1–56), will light when the synchronizer is not running at selected speed. When this light is on the propellers are in fixed pitch.

1–78. SYNCHRONIZER TACHOMETER. A tachometer, located on the flight engineer's lower instrument panel (figure 1–56), is calibrated to show synchronizer motor speed in terms of engine rpm and give an indication of the rpm at which the engines will be synchronized. The synchronizer motor tachometer is used for a reference only, due to the broad tolerances which are inherent in its design. Refer to engine tachometer for actual engine rpm.

1–79. PROPELLERS. (LAC Serials 4510 through 4519.)

1–80. Hamilton Standard Hydromatic, three-bladed, full-feathering and reversible pitch propellers are installed on each engine. Each propeller incorporates a fluid anti-icing distribution system. A propeller control system is provided for constant speed, synchronization, individual selector controls, a master control for changing rpm of all engines simultaneously, manual and automatic feathering, and reversing.

1–81. The constant speed, reversing and unreversing, feathering and unfeathering features of this propeller are controlled by a double-acting governor mounted on the top nose case of each engine. The governor consists of an engine-driven gear pump which takes oil from the engine oil system and boosts the pressure to that required for operation of the propeller pitch changing mechanism located in the propeller dome. Other components of the governor consist of a pilot valve actuated by spring-balanced flyweights which control the flow of oil to and from the propeller dome; a pressure operated check valve which allows high pressure oil from an auxiliary (feathering) pump to add to the governor output when the propeller is being feathered and unfeathered, or re-

hydromatic propeller hub

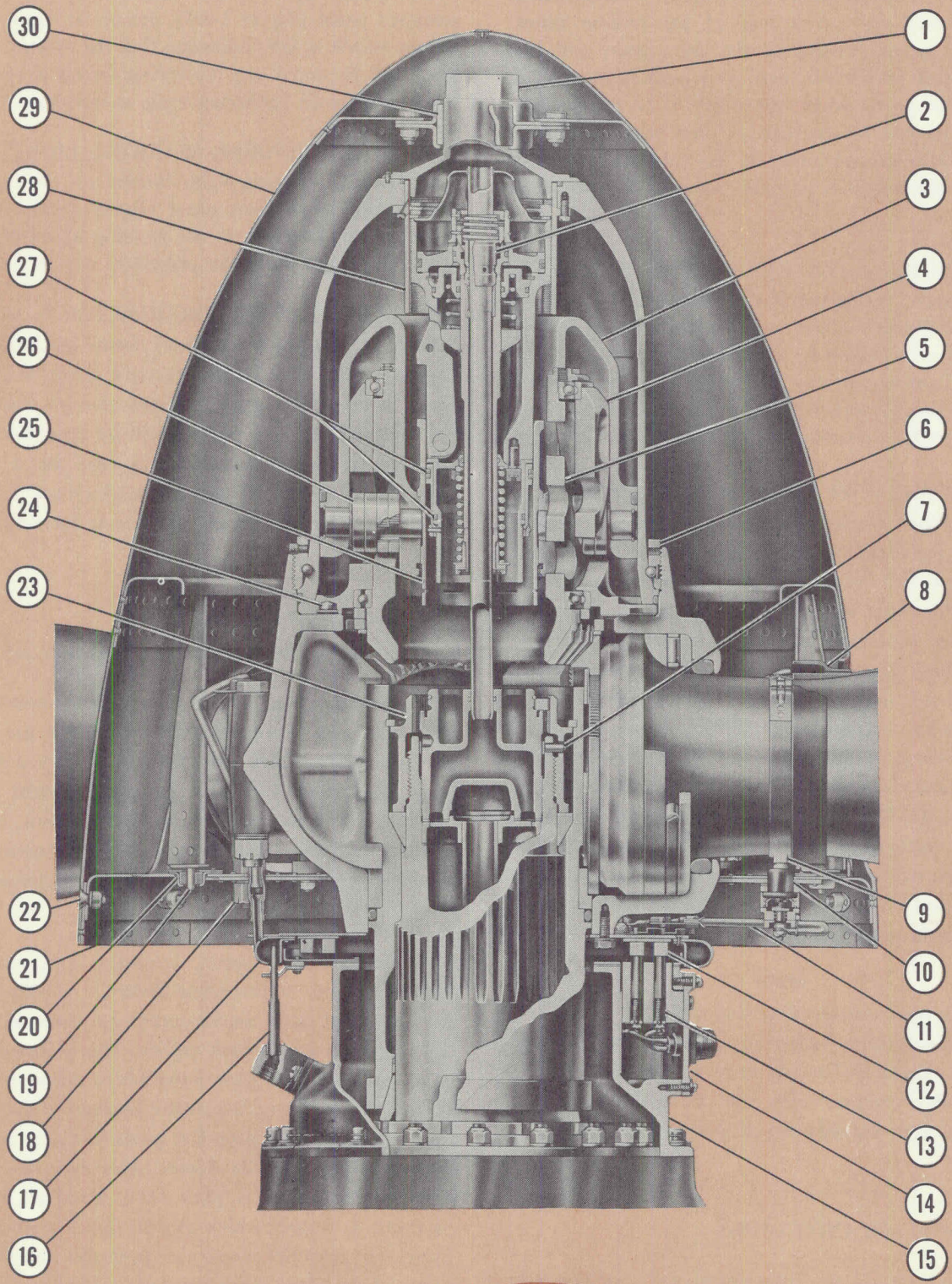


figure 1-9

1. Dome cap.
2. Servo valve.
3. Piston assembly.
4. Fixed cam.
5. Rotating cam.
6. Dome retaining nut.
7. Retaining nut lock assembly.
8. Blade slinger ring.
9. Blade switch cam.
10. Push button switch.
11. Conduit.
12. Slip rings.
13. Brush.
14. Slip ring brush housing.
15. Brush pad bracket.
16. Anti-icing outlet tube.
17. Slinger ring.
18. Spinner bulkhead mounting bolt.
19. Locating dowel pin.
20. Chafing bushing.
21. Spinner bulkhead assembly.
22. Spinner attachment screw.
23. Propeller retaining nut.
24. Locating dowel.
25. Dump valve.
26. Cam roller assembly.
27. Reverse stop adjusting sleeve and oil seal rings.
28. Lever sleeve bushing.
29. Spinner nose assembly.
30. Nose chafing ring.

versed and unreversed; a solenoid valve that is energized during the reverse cycle and directs the flow of oil from the auxiliary (feathering) pump to the aft side of the piston; a relief valve system which limits the output pressure of the gear pump, yet allows it to provide sufficient operating force to control the propeller under all conditions. Refer to figure 1–9.

1–82. SYNCHRONIZER. The synchronizer system provides a means of synchronizing the speed of all engines below take-off rpm down to 1350 rpm. A synchronizing button provides automatic electric synchronization of all propellers to a pre-selected master engine rpm. Refer to figure 1–11. Synchronization by 3% increments of existing rpm of the particular master engine (No. 1 or No. 2) may be accomplished by depressing and releasing the button until synchronization is reached. However, it is recommended that separate adjustment of each propeller governor be made by use of its respective individual control switch when rpm differs beyond the 3% range. Failure of either master engine (No. 1 or No. 2) will not decrease the rpm of the slave engines more than 3%.

1–83. FEATHERING. Refer to figure 1–10. When one of the feathering buttons is depressed, the electric motor-driven auxiliary (feathering) pump is energized and directs engine oil through the governor, which distributes and augments oil pressures through the propeller shaft to the forward side of the dome piston. As the piston is forced aft, a slotted cam gear is rotated which, in turn, rotates each of the three blades so that the blades move to the feathered position. Displaced oil from the aft side of the piston is forced back through the propeller shaft to the propeller governor to be returned to the engine oil system as long as the propeller feathering button is in the depressed position. Refer to figure 1–12, sheet 2. *After the propeller has been feathered, either manually or automatically, the feathering button must be returned manually to the normal position.*

1–84. AUTOMATIC FEATHERING. The automatic feathering system will automatically feather the propeller of an engine if the BMEP drops to 72-82 BMEP or less and remains there from 1½ to 2 seconds provided that the system is turned on. The delay is introduced into the

Propeller Feathering. and Reversing Circuit
LAC Serials 4510 Through 4519
Figure 1–10 Sheet 1

To be included when available.

Propeller Feathering and Reversing Circuit
LAC Serials 4510 Through 4519
Figure 1–10 Sheet 2

To be included when available.

system to prevent automatic feathering in the event of momentary power losses and to prevent automatic feathering if the throttle is advanced rapidly enough to close the throttle switch before the BMEP has risen above its torque pressure switch setting. The system is turned on by means of the automatic feathering master switch and the system is armed by advancing the throttles beyond approximately the 50 to 60 per cent position. A blocking relay is provided to disconnect the entire automatic feathering circuit when one propeller has feathered automatically. A master switch is provided to permit optional selection of the automatic feature when required. Four test switches are installed to bypass the throttle switches for testing the automatic operation before take-off.

1–85. UNFEATHERING. When unfeathering, the feathering button must be held out manually. This energizes the auxiliary (feathering) motor and pump and solenoid valve in the governor, which directs oil pressure to position the governor pilot valve in the decrease pitch position. The oil flows through the decrease pitch passages to the aft side of the propeller dome piston. The piston is forced forward, turning the blades toward low pitch. The oil on the forward side of the piston is forced back through the propeller shaft to the intake side of the propeller governor. Refer to figure 1–12, sheet 3. As soon as the propeller starts to turn, the feathering button must be released. When the engine is turning over, the propeller governor furnishes the oil pressure to unfeather the propeller. Unfeathering action can be terminated at any time by releasing the feathering button.

1–86. REVERSING. Refer to figure 1–16, sheet 4. When the reverse thrust throttle lever is moved into the reverse range, the auxiliary (feathering) pump and governor solenoid valve are energized and send high pressure oil through the propeller shaft to the aft side of the dome piston, moving it forward until the piston sleeve contacts the low-pitch stop levers. As additional oil pressure builds up, force is exerted on the servo piston valve, which becomes unseated, moves the wedge from under the low pitch stop levers which, in turn, retract, allowing the piston to move forward, rotating the cam gear and causing the blade angle to be decreased through zero pitch and into the reverse angle. Prior to reaching the reverse pitch stop, the feathering pump is shut off by the No. 2 blade angle switch and power for the last few degrees of travel is supplied by pressure from the governor. The full reverse angle stop is a fixed pitch position, and the blade is held in that position by oil pressure from the governor pump.

1–87. UNREVERSING. Refer to figure 1–12, sheet 5. When unreversing, high pressure oil from the auxiliary (feathering) pump is directed to the forward side of the dome piston, forcing the blades to the positive angle. Unreversing will continue until the blade cam contacts the No. 1 blade switch, which stops the auxiliary (feathering) pump. This occurs when the blade angle reaches a point before the low-pitch stop setting, where the constant speed control takes over.

1–88. PROPELLER CONTROLS.

1–89. MASTER CONTROL LEVERS. Propeller master control levers are located on the pilots' center control stand (figure 1–54), and on the flight engineer's control quadrant (figure 1–57). These levers reset all four propeller governors simultaneously throughout the governing range, and at the take-off rpm position actuate the calibrate switch which disconnects the synchronizer from the system and sets all governors to maximum rpm. The two levers are mechanically linked with no overriding feature for either the pilot or the flight engineer.

1–90. PROPELLER GOVERNOR CONTROL SWITCHES. Four individual governor control switches are located on the flight engineer's lower switch panel (figure 1–57) and are numbered from left to right. Each switch has three positions, INC RPM, OFF, and DEC RPM, and is spring-loaded to the OFF position.

1–91. MASTER ENGINE SELECTOR SWITCH. A master engine selector switch, located on the flight engineer's lower switch panel (figure 1–57), selects the synchronization function and permits the selection of either No. 1 or No. 2 engine as the master. This is a toggle-type switch that has three positions, ENG 1 MASTER. OFF, and ENG 2 MASTER.

1–92. FEATHERING BUTTONS AND LIGHTS. Four individual feathering buttons are located on the flight engineer's lower switch panel (figure 1–57) and are numbered from left to right. Each button is protected by a plastic cover to prevent inadvertent feathering and each cover is marked PUSH FEATHER, and PULL UNFEATHER. Pressure on the selected button energizes the auxiliary (feathering) pump, and a holding coil holds the button in during feathering operation. *After the blades have reached the feathered position, the button must be pulled to the midway position manually to de-energize the circuit and stop the auxiliary (feathering) pump.* The feathering button must be held out manually

propeller synchronizer circuit

LAC Serials 4510 Through 4519

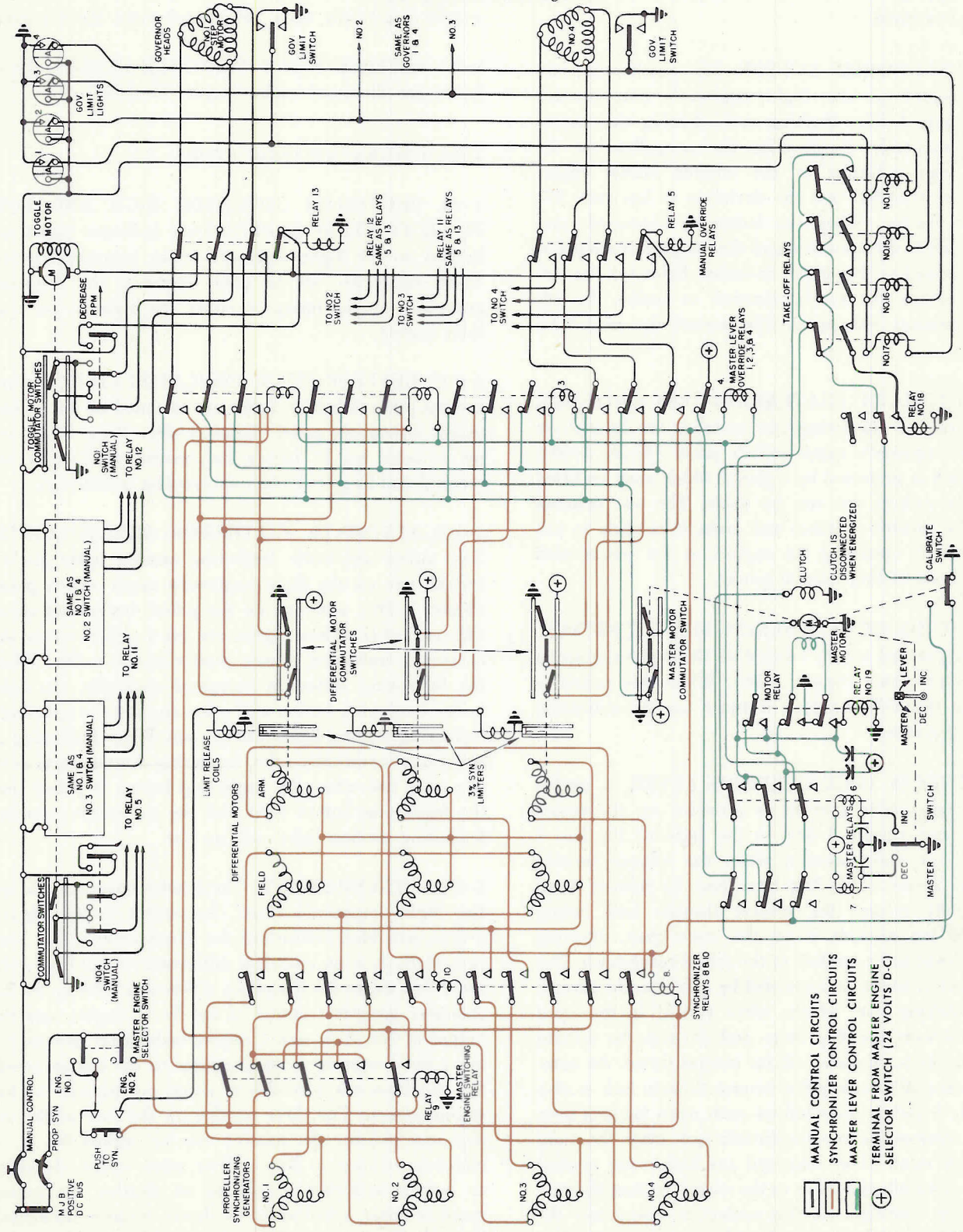


figure 1-11

to unfeather a propeller; however, the unfeathering action can be terminated by releasing the feathering button. A light is incorporated in each feathering button and the light glows whenever the auxiliary (feathering) pump is energized.

1–93. SYNCHRONIZE BUTTON. The synchronize button is located on the flight engineer's lower switch panel (figure 1–57). Pushing and releasing this button will automatically synchronize the propellers to the existing rpm indicated on the selected master engine tachometer provided that the deviation is less than 3% from the master. When the button is depressed, synchronization is disconnected and the range limitation feature is released so that it can re-center. Releasing the button re-connects the synchronization or makes the off-speed governors run up to 3% toward the master tachometer.

1–94. AUTOMATIC FEATHERING TEST SWITCHES. Four automatic feathering test switches are located on the flight engineer's upper switch panel (figure 1–56). Each switch is protected by a guard which must be lifted before the system test can be made. The test switches bypass the throttle switches and make it possible to test the system by operating the engines at low power with the circuit simulating take-off power.

1–95. AUTOMATIC FEATHERING MASTER SWITCH. This is a guarded switch located on the flight engineer's upper switch panel (figure 1–56). When this switch is placed in the ON position, it turns on the automatic feathering system.

1–96. REVERSE LOCK OVERRIDE LEVER. A visible guarded flag under a cover is provided on the center control stand (figure 1–54) to the right of the No. 4 throttle lever and indicates when the reverse throttle levers are locked. This flag lever may be pushed down to manually release the reverse throttle lock before weight of the aircraft is on the main gear, allowing reverse power to be applied at the initial touchdown. The reverse lock actuator is connected by cables to the reverse throttle locking bar, which, when turned to the open position, lowers the flag lever and permits the reverse throttle levers to be pulled aft for reverse thrust. An automatic means of releasing the reverse throttle lock is also provided. A switch mounted on each main landing gear fulcrum releases the reverse throttle lock when the main gear shock struts pivot rearward (as brakes are applied during a rejected take-off or as the wheels contact the runway during landing). As this contact is momentary the action of this switch is maintained by means of a holding relay. These switches will permit use of the reverse thrust power with partial weight on the main gear, and the scissors switch on the left main gear permits the use of reverse thrust power when full weight is on the landing gear. The throttle reverse lock is reset when both outboard throttles are advanced to the minimum take-off power and the weight is partially taken off the left main landing gear.

1–97. REVERSE PITCH THROTTLE LEVERS. These levers are discussed under Engine Controls.

1–98. PROPELLER INDICATORS.

1–99. PROPELLER GOVERNOR HIGH AND LOW PITCH POSITION LIGHTS. Four indicator lights are located on the flight engineer's lower instrument panel. These lights are set to glow whenever the propeller governors are operating at either the high or low rpm limit setting.

1–100. REVERSE PITCH INDICATOR LIGHTS. Four reverse pitch indicator lights are mounted on the pilots' center instrument panel (figure 1–49). These lights are set to come on 5° before the reverse pitch stops are reached and to go out when unreversing is initiated.

1–101. AUTOMATIC FEATHERING ARMING LIGHTS. Two amber automatic feathering arming lights are installed, one on the flight engineer's upper switch panel (figure 1–56), and one on the pilots' instrument panel (figure 1–49). These lights are set to glow when the automatic feathering system master switch is ON. When the feathering system is energized manually, the light in the feathering button will come on, and the automatic feathering arming lights will go out. When feathering is started automatically, the feathering button light will come on, and when the feathering button is pulled out, the feathering button light and the automatic propeller feathering arming lights will go out.

1–102. SYNCHROSCOPE. The synchroscope, located on the flight engineer's lower instrument panel (figure 1–56), provides indications for synchronizing the four propellers. It is an electrical differential motor-type indicator that shows the frequency differences between the tachometer generator output of the No. 1 engine, and the output of No. 2, 3, and 4 engine tachometer generators. Since the frequency is proportional to the engine speed, the synchroscope provides a visual comparison of the engine speeds. The three needles on the face of the instrument indicate the relative rpm of engines No. 2, 3, and 4 in relation to No. 1. They rotate either clockwise or counterclockwise, depending on whether the engine speed is faster (clockwise) or slower (counterclockwise) than the No. 1 engine. When the speeds of No. 2, 3 and 4 engines are synchronized with the No. 1 engine, the needles will be stationary.

propeller operating system

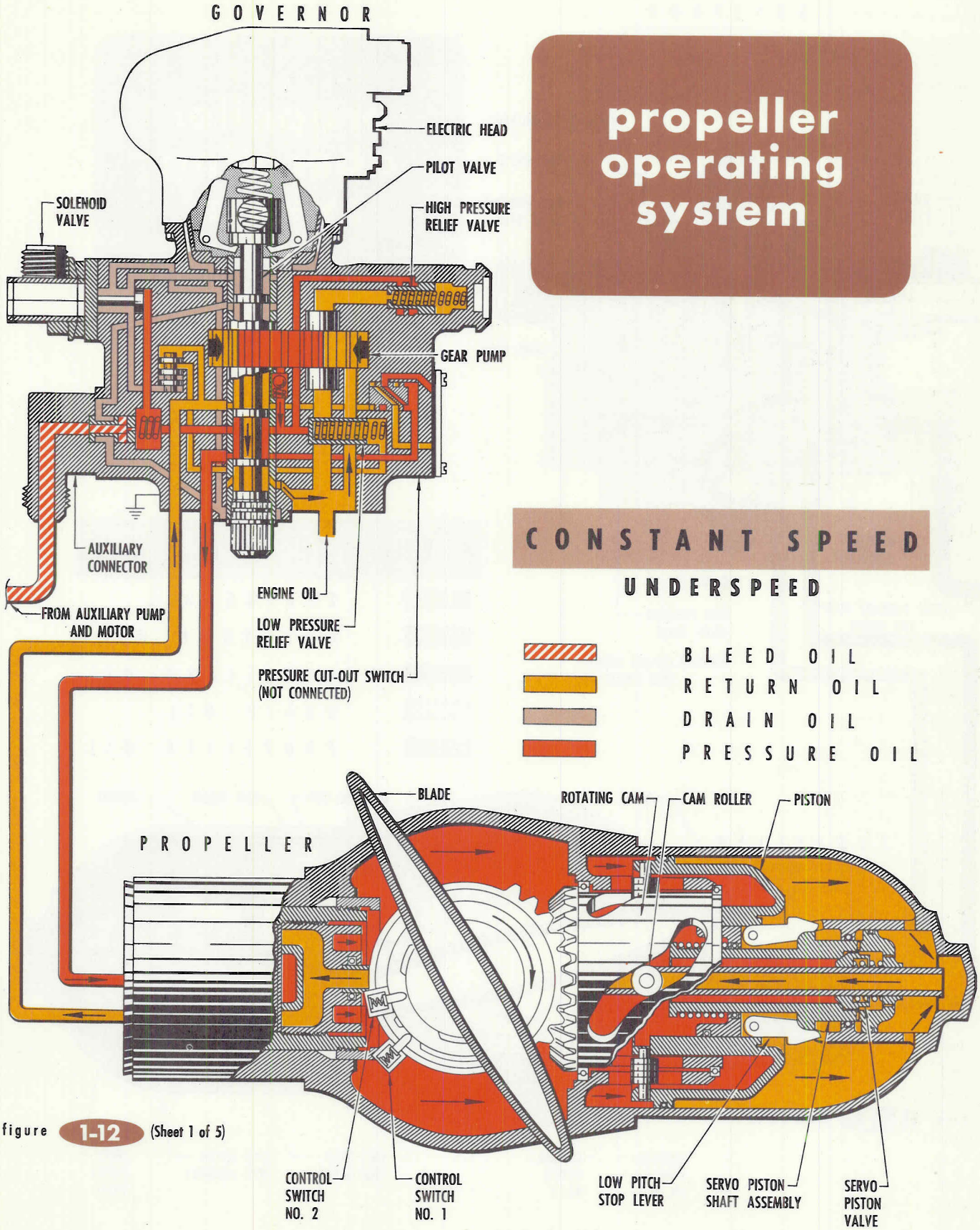


figure 1-12 (Sheet 1 of 5)

propeller operating system

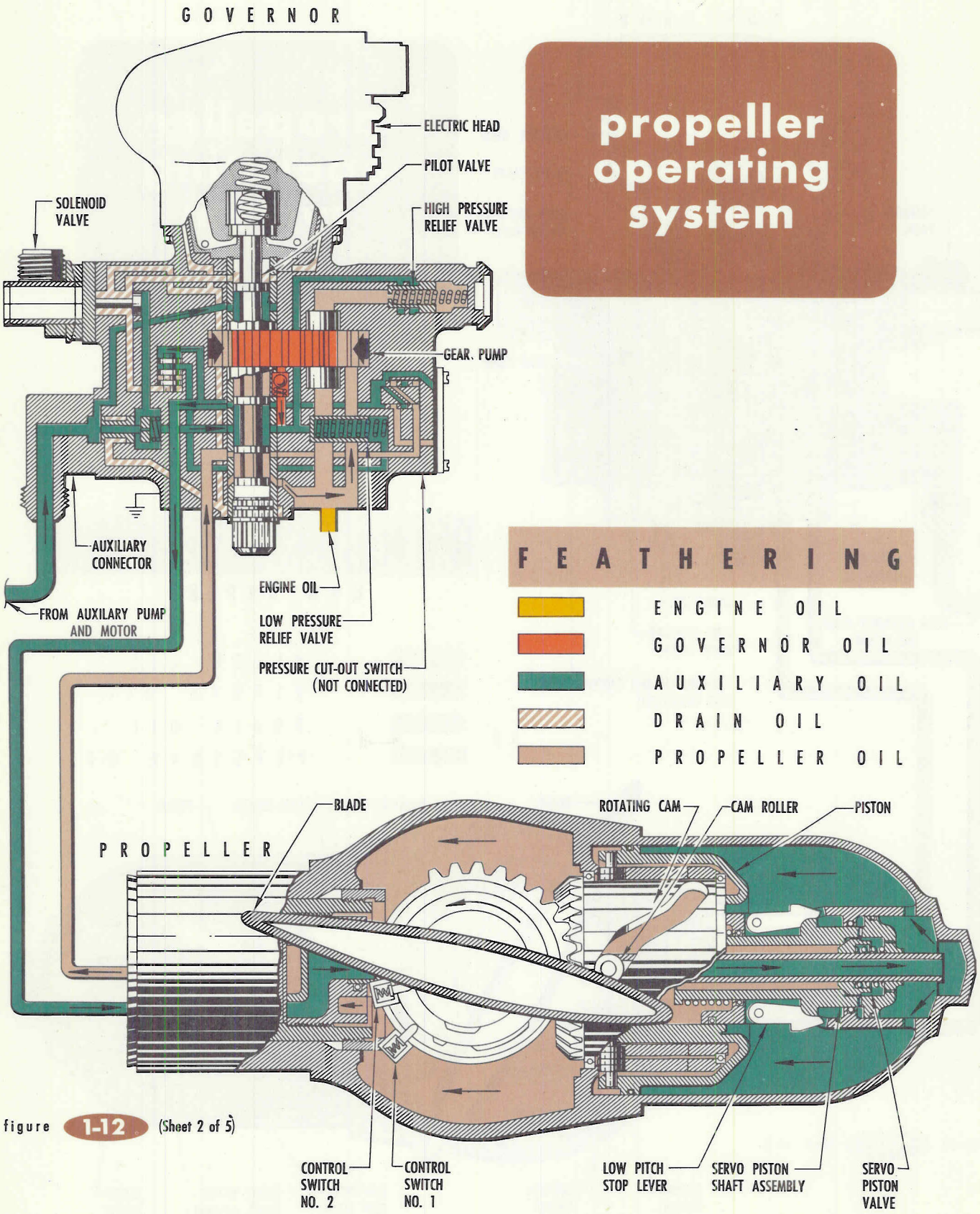


figure 1-12 (Sheet 2 of 5)

propeller operating system

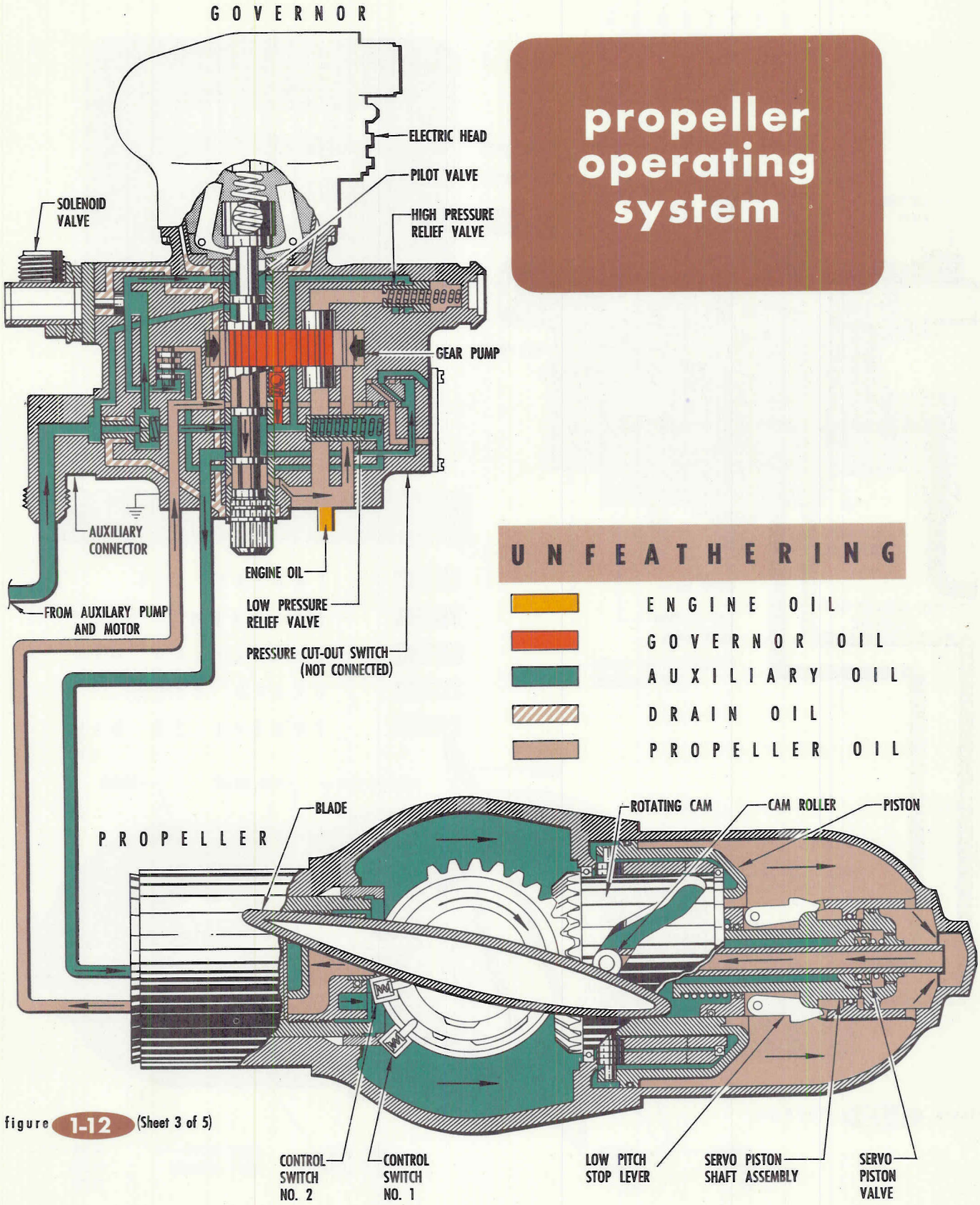


figure 1-12 (Sheet 3 of 5)

propeller operating system

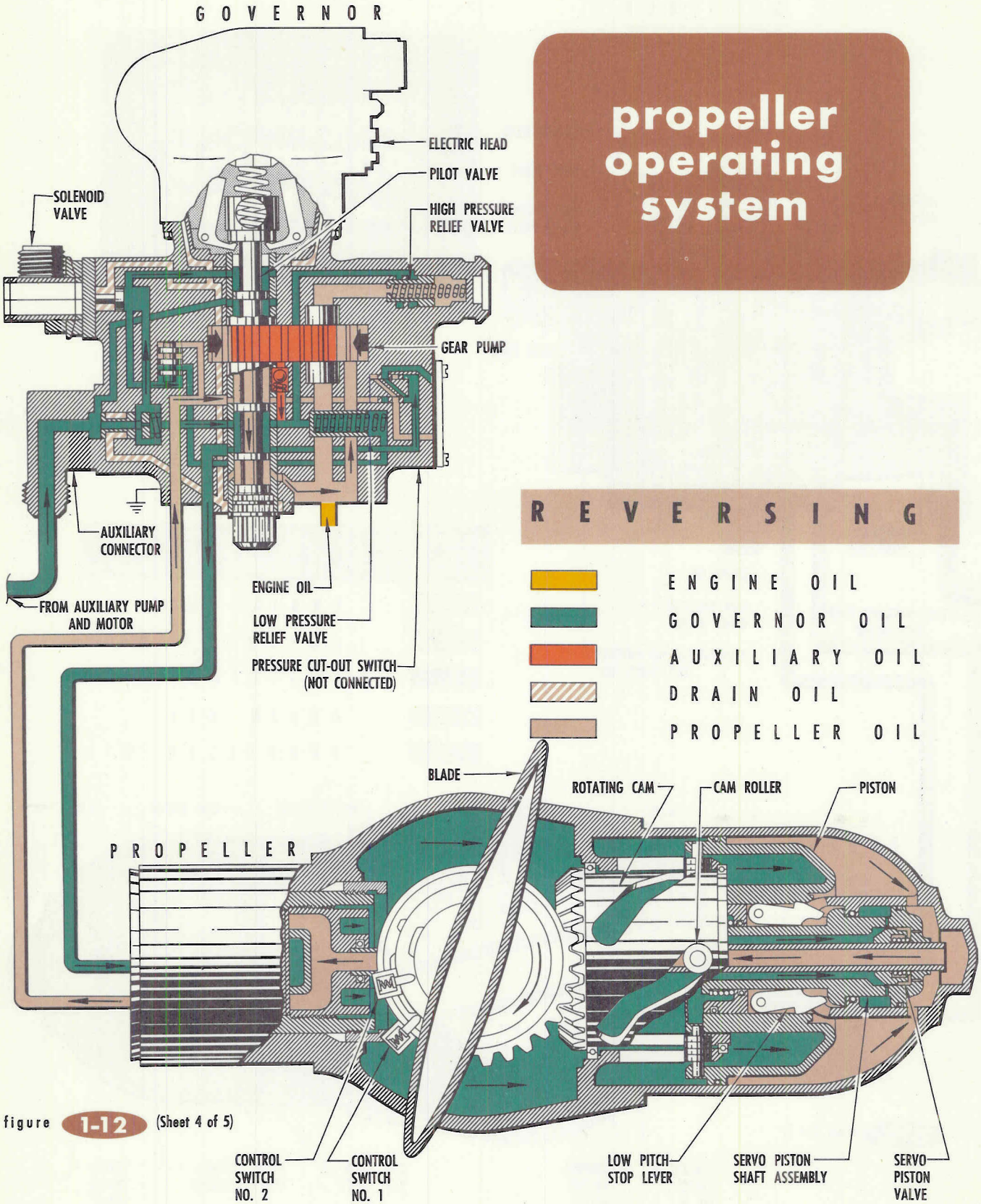


figure 1-12 (Sheet 4 of 5)

propeller operating system

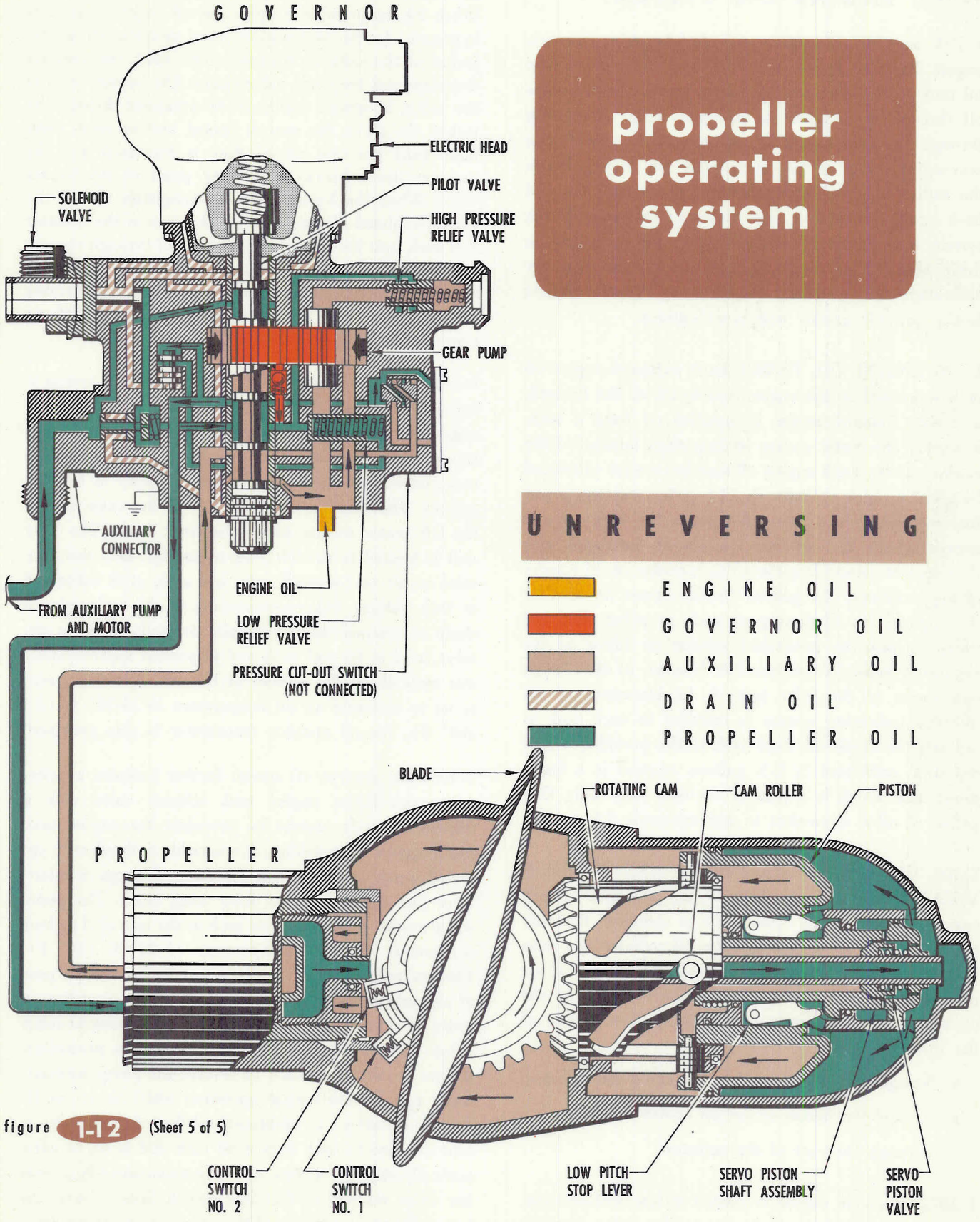


figure 1-12 (Sheet 5 of 5)

1–103. ENGINE OIL SYSTEM.

1–104. Separate oil systems provide lubrication for each engine. Refer to figure 1–13. Oil flows from the engine oil tank to the engine oil pressure pump, which pumps oil through the engine oil passages. After circulating through the engine, the oil is returned by the engine scavenging pump to the oil radiator for cooling. From the radiator, the oil flows through the return line and back into the engine oil tank. Complete drainage of each system is provided by a drain valve for each tank, a drain plug for each oil radiator, and a drain plug for each engine sump. Refer to the Servicing Diagram (figure 1–47) for oil grades and specifications.

1–105. ENGINE OIL TANKS. Each outboard engine oil tank is located in the engine nacelle aft of the firewall, and each inboard engine is supplied oil from a tank, located in the center section leading edge, inboard of the engine nacelle. Each engine oil tank has a total volume of 54 gallons which includes an 11.5 gallon expansion and foaming space. The total oil content for each tank is approximately 42.5 gallons. On aircraft equipped with Hamilton Standard propellers this includes an oil reserve of approximately 2.5 gallons (which cannot be used by the engine) for feathering of each propeller. External filling beyond the prescribed amount or filling of the expansion space is not possible because of the design and shape of the filler unit. A liquidometer-type oil quantity indicating system is installed in each tank to indicate the usable oil. Each tank is also provided with a dip stick, calibrated in U.S. gallons, encased in a foam-proof tube which is a part of the tank filler unit. One gallon of oil is equivalent to approximately 7.5 pounds.

1–106. OIL COOLER RADIATORS AND CONTROL VALVES. Refer to figure 1–14. On the underside of each engine nacelle, an oil cooler unit is installed. Ram air enters a scoop, passes through the oil radiator and exits past an oil cooler flap which controls the amount of air necessary for cooling. A control valve mounted on the oil radiator automatically routes the oil flow in one of the following ways:

a. Straight through the valve, bypassing the radiator.

b. Around the jacket of the oil cooler radiator.

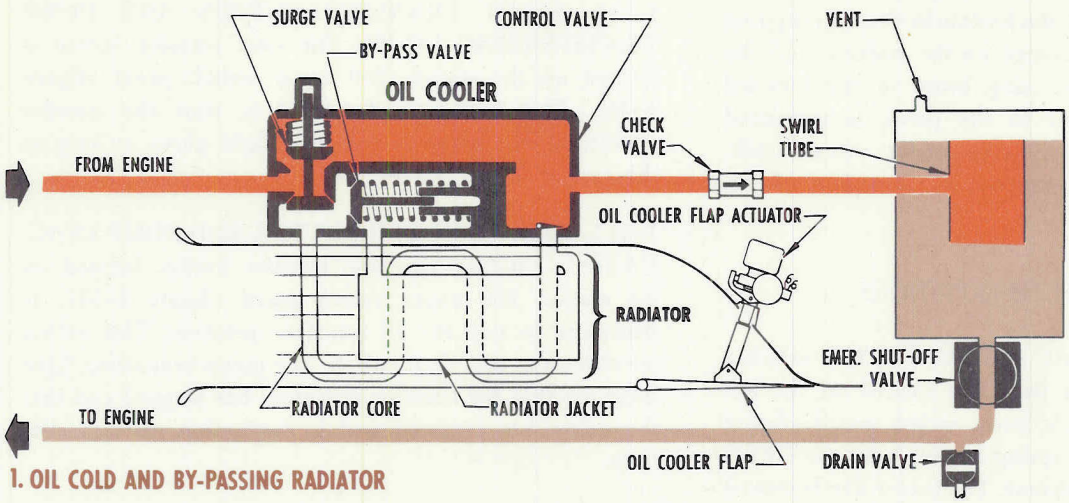
c. Through the core of the radiator.

1–107. When the engine is started at low ambient temperature, the viscosity of the oil in the cooler prevents oil flow through the radiator. Oil pressure builds up in the control valve until the pressure opens the surge valve. When the surge valve is open, the oil cooler radiator is bypassed. As the temperature rises and the oil in the jacket of the radiator becomes more fluid, the pressure decreases and the surge valve closes. The bypass valve to the jacket is opened and as oil is circulated through the jacket, the oil in the core is heated and becomes more fluid until the rate of oil flow is increased and the pressure drops below the closing point of the bypass valve. When the bypass valve is completely closed, the oil is circulated directly through the core of the radiator and back into the control valve, then out through the exit port to the oil tank return line. Under cruise conditions, the oil temperature is further controlled by actuating the oil cooler flap which regulates the amount of air passing through the radiator.

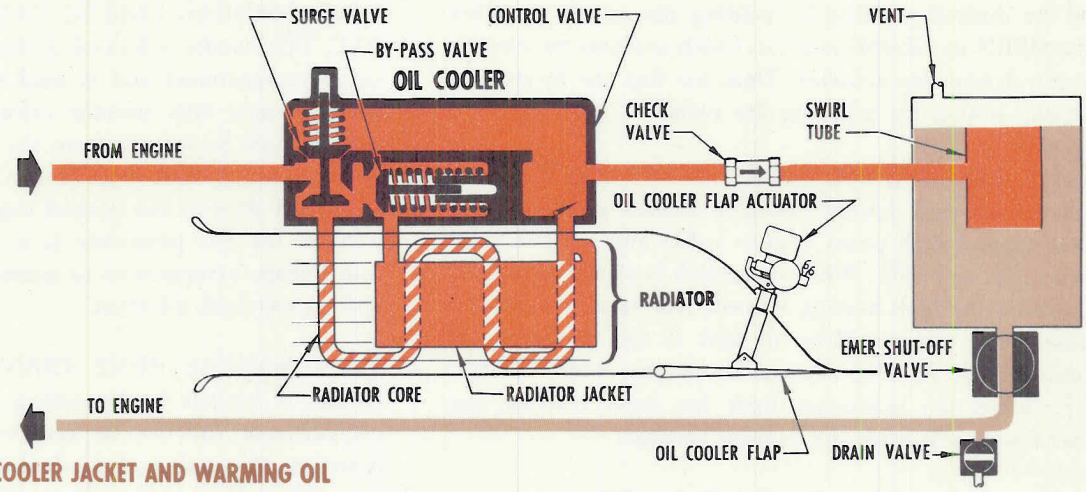
1–108. RESERVE OIL SYSTEM. A reserve oil system is installed to permit the selective addition of oil to each engine oil tank from a reserve oil supply tank. This supply tank consists of an insulated bladder cell-type construction and has a usable fluid capacity of 67 U.S. gallons. The location of this cell is in the outer bay of the left center section aft of the front beam. The filler unit is located in the left wing-to-fuselage fillet and contains an air vent shut-off valve and a dip stick calibrated in U.S. gallons. Other components of the tank unit include an internal thermostatically controlled heating element laced to the cell walls and suspended approximately one inch above the bottom of the cell. The thermostat is set to maintain an oil temperature of 21-74° C (70-165° F). An oil quantity transmitter is also provided.

1–109. The reserve oil system further includes an electric motor-driven engine tank selector valve with a manual override control to pre-select the engine tank that requires replenishing. A reversible hydraulically operated pump is installed in the forward cargo compartment just forward of the front wing beam. The pump will transfer oil to an engine tank at the rate of 3 gallons per minute at an oil temperature of 21° C (70° F). The reversing feature of the pump is for the purpose of evacuating the system lines after transfer operation in order to prevent the oil from congealing. Integral relief valves are provided in the pump for system protection. A float switch is installed to reverse the pump automatically for the evacuating operation which is set at 60 seconds duration. An additional oil float shut-off valve is also installed in each engine oil tank and is set to automatically stop the oil flow when the maximum filling level has been reached if the float switch fails to stop the pump. Normal operation of the system is conducted from the station 260 upper switch panel.

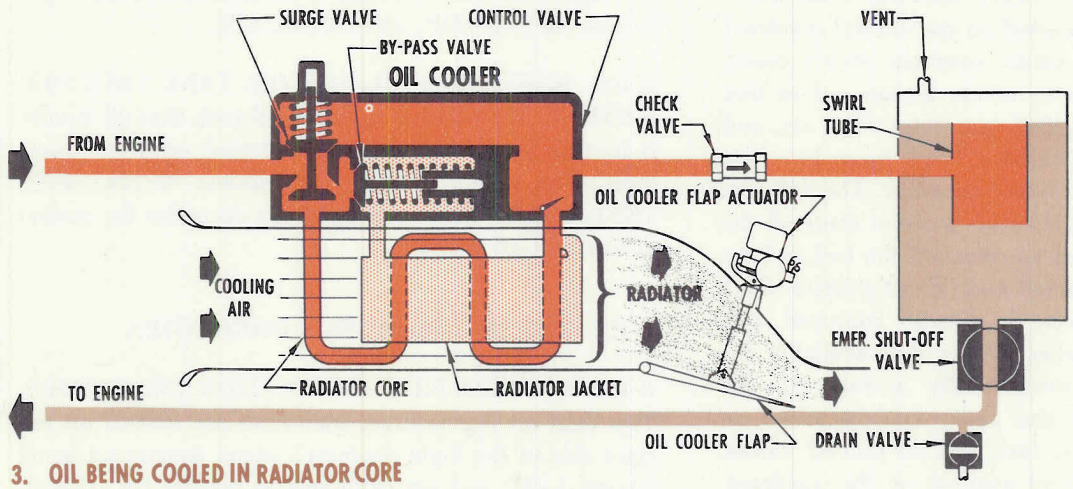
engine oil flow control valve



1. OIL COLD AND BY-PASSING RADIATOR



2. OIL FLOWING THROUGH COOLER JACKET AND WARMING OIL



3. OIL BEING COOLED IN RADIATOR CORE

ENGINE OIL SUPPLY
STATIC OIL
ENGINE OIL RETURN
CONGEALED OIL

figure 1-13

1–110. In the event of electrical power failure, an auxiliary manual oil transfer control panel is provided for operation of the system which includes three manual override controls to actuate the hydraulic-driven oil pump and valves. This panel is located on the underside of the floor forward of the front wing beam in the forward cargo compartment. Access to the panel is permitted through the forward cargo compartment access hatch. Refer to Section VI for sequence of operation of the auxiliary manual system.

1–111. ENGINE OIL SYSTEM CONTROLS.

1–112. OIL COOLER FLAP SWITCHES. The switches that operate the oil cooler flaps are located on the left side of the flight engineer's lower switch panel (figure 1–57). These switches are spring-loaded from the OPEN and CLOSE to the OFF positions. The cooler flap is moved to the desired position by holding the switch in either the OPEN or CLOSE position which actuates the electric motor-driven flap actuator. Thus, the flap can be stopped at any setting by releasing the switch.

1–113. RESERVE OIL TANK HEATER SWITCH. The reserve oil tank heater switch is located on the station 260 upper switch panel (figure 1–44) and has two positions, ON and OFF. When the switch is placed in the ON position, the tank heating element will raise the oil temperature in the auxiliary oil tank to the maximum set limit of the heating element thermostat (74° C, 165° F). When the maximum limit has been reached, the thermostat will cycle the heating element.

1–114. EMERGENCY SHUT-OFF LEVER. Four emergency shut-off levers are located on the control quadrant (figure 1–50) aft of the pilots' overhead switch panel. The functions of these levers are to actuate valves that shut off the hydraulic oil, fuel, generator blast air, and engine oil supply to the engines. Each lever has four notched positions on the control quadrant. The full forward position is ALL ON, the next position shuts off the hydraulic oil, the third position shuts off the fuel and the generator blast air, and the last and full aft position shuts off the engine oil. However, on aircraft equipped with Hamilton Standard propellers oil is still available for feathering. These levers mechanically operate cam arrangements through cable and pulley systems which, in turn, actuate the hydraulic, fuel, and oil shut-off valves. As the lever enters the third position on the quadrant, it trips a switch which operates a small electrical actuator, mounted on the aft face of the firewall, that shuts off the blast air.

1–115. ENGINE TANK SELECTOR SWITCH. This switch is located on the station 260 upper switch panel (figure 1–44) and is used to select the tank that is to be supplied oil from the reserve oil tank.

1–116. START TRANSFER BUTTON AND PUMP TRANSFERRING LIGHT. The start transfer button is located on the station 260 upper switch panel (figure 1–44). This button is depressed to start the transfer operation. The pump transferring light glows as long as the system is transferring oil.

1–117. STOP TRANSFER BUTTON AND PUMP EVACUATING LIGHT. The stop transfer button, located on the station 260 upper switch panel (figure 1–44), is depressed to stop the oil transfer operation. This switch overrides the tank float switch. The pump evacuating light indicates that the transfer operation has stopped and that the pump has reversed and is evacuating oil from the lines.

1–118. MANUAL ENGINE TANK SELECTOR HANDLE. This handle is located in the ceiling of the forward cargo compartment and is used to override the motor-driven engine tank selector valve. When this handle is used it must be rotated from the OFF position through the four engine tank stops to the END position, back to OFF, and then to the desired engine tank number. The purpose for this procedure is to sequence properly the cam linkage arrangement to mechanically assure positive and correct tank selection.

1–119. MANUAL PUMP TRANSFER HANDLE. This handle is located in the ceiling of the forward cargo compartment and can be used to manually control the direction of rotation of the hydraulic pump that pumps the engine oil from the reserve oil tank. It has three positions: OFF, PUMP, and EVACUATE.

1–120. MANUAL AUXILIARY OIL TANK SHUT-OFF HANDLE. The manual auxiliary oil tank shut-off handle is located in the ceiling of the forward cargo compartment. The handle has three positions: OPEN, NEUTRAL, and CLOSED and manually overrides the motor-driven shut-off valve.

1–121. ENGINE OIL SYSTEM INDICATORS.

1–122. OIL COOLER FLAP POSITION INDICATORS. Two dual oil flap position indicators are located on the right side of the flight engineer's upper instrument panel (figure 1–56) and are calibrated to register the position of the flaps in percentage of travel from the full closed position. Full open is nominally 100 per cent.

1–123. OIL TEMPERATURE INDICATORS. Four dual oil temperature indicators are located beneath the oil cooler flap indicators on the flight engineer's upper and

engine oil system

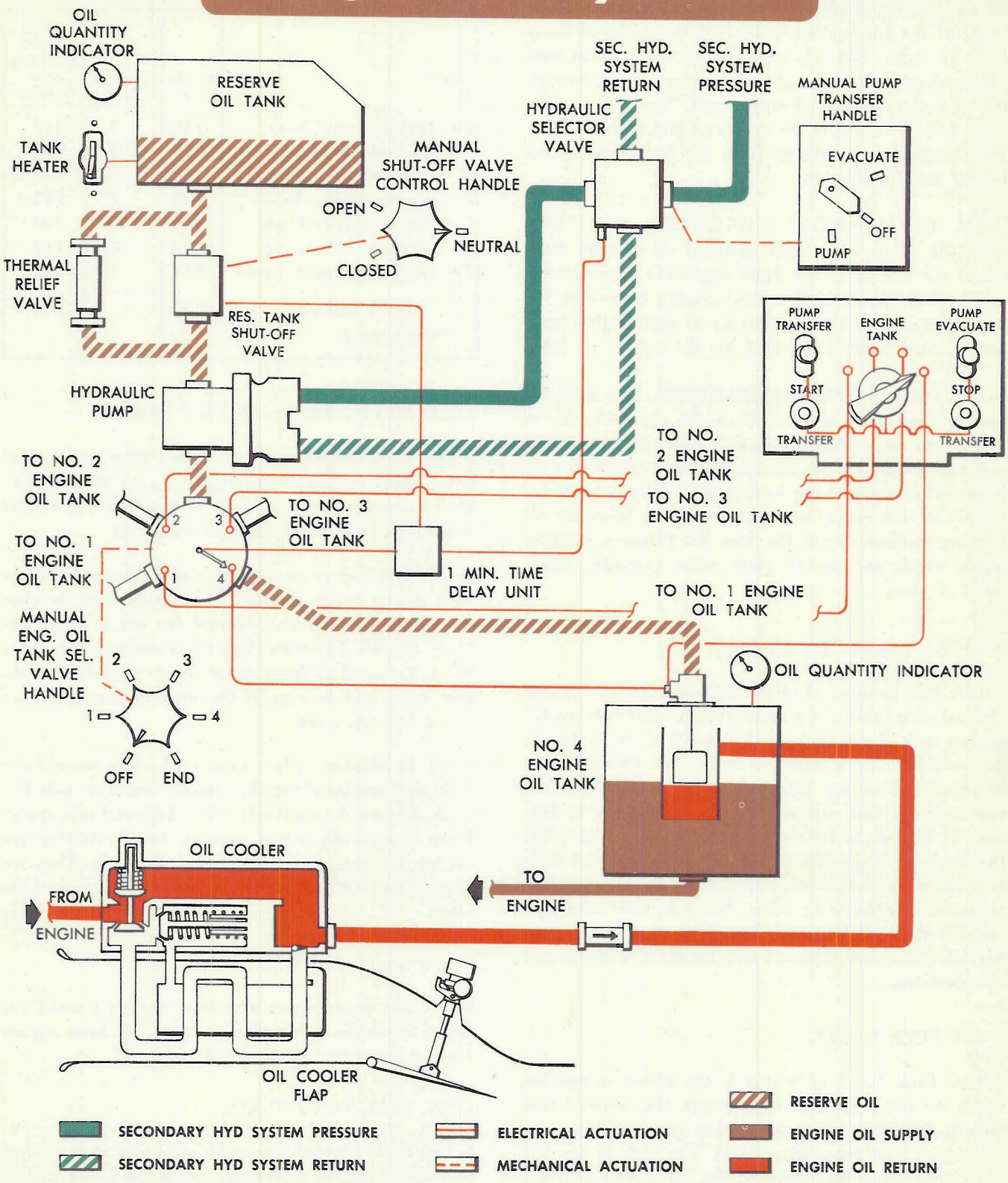


figure 1-14

lower instrument panels (figure 1–56) and are calibrated in degrees Centigrade. Two of these indicators register the oil outlet temperature of each engine by a bulb located in the oil-out line housing fitting near the engine oil sump case. The other two indicators register the oil inlet temperatures of each engine after the oil has passed through the oil cooler system and supply tank. The oil-in temperature bulb is located in the engine oil tank sump. Signals are transmitted electrically from the bulb transmitters to the panel indicators.

1–124. OIL QUANTITY INDICATORS AND TEST SWITCH. Three electrically operated oil quantity indicators are located on the flight engineer's upper instrument panel (figure 1–56). Dual needles on two of the indicators register the oil quantity of each engine tank, and one indicator is provided for the reserve oil tank.

1–125. OIL PRESSURE INDICATORS. Two dual oil pressure indicators are located on the right side of the flight engineer's lower instrument panel (figure 1–56) and register pressure in pounds per square inch. The oil pressure transmitters are located near the oil cooler assembly in each engine nacelle. Immediately below the oil pressure indicators are the four oil pressure warning lights which are set to glow when pressures reach 50 ± 5 psi.

1–126. FUEL SYSTEM.

1–127. Fuel is supplied to the engines from six separate integral wing tanks and a removable, bladder-type, center section tank. Refer to figure 1–15. All of the tanks are interconnected by a crossfeed line which allows fuel to be supplied from any tank to any engine. However, the recommended fuel consumption sequence given in Section VI should be followed. Check valves are installed that make it impossible to transfer fuel from one tank to another. Provisions are incorporated for dumping fuel from the integral wing tanks. For fuel tank capacities refer to the Fuel Quantity Data Table and refer to the Servicing Diagram (figure 1–47) for the fuel grades and specifications.

1–128. FUEL TANKS.

1–129. Tank No. 5 is located in the center section between the front and rear wing beams. One integral fuel tank is located in each outer wing panel and two are located in each inner wing panel. The tank in the left outer wing panel is designated No. 2A and that in the right outer wing panel, No. 3A. The four tanks in the inner wing panels are designated No. 1, 2, 3, and 4, in consecutive order, beginning with the tank adjacent to No. 2A in the left wing.

1–30. FUEL QUANTITY DATA TABLE (U.S. GALLONS).

Tank No.	Usable Fuel	Unusable Fuel	Usable Fuel Remaining After Dumping
2A (Left Outboard Tank)	565	3	149
1 (Left Middle Tank)	1555	3	145
2 (Left Inboard Tank)	790	16	145**
5 (Center Section Tank)	730	7	730
3 (Right Inboard Tank)	790	16	145**
4 (Right Middle Tank)	1555	3	145
3A (Right Outboard Tank)	565	3	149
Total Gallons	6550		1608**

**Calculated.

1–131. FILLER WELLS AND DIP STICKS.

1–132. Each integral fuel tank has a filler well located in the upper surface of the wing and each tank must be filled separately. The filler well for tank No. 5 is located in the upper surface of the right wing fillet.

1–133. Two fuel measuring dip sticks are stowed in the flight station on the station 260 bulkhead near the crew door. One dip stick is calibrated for use in tanks No. 2A, 5, and 3A. The other dip stick is calibrated for tanks No. 1, 2, 3, and 4. These dip sticks are used in the tank filler wells, and because of the wing dihedral, will not record low fuel levels.

1–134. In addition to the standard dip sticks, integral dip sticks are installed at the aft, inboard corners of tanks No. 1, 2A, 3A, and 4 on aircraft serials 4505 and subsequent. These integral dip sticks measure fuel levels that are too low to register on the standard dip sticks. They are screwed into and are flush with the upper surface of the wings.

1–135. VAPOR RETURN LINES.

1–136. The vapor return lines from engines 1 and 2 are routed to the No. 1 fuel tank, and the lines from engines 3 and 4 are routed to the No. 4 tank.

1–137. FUEL TANK VENTS.

1–138. Fuel is vented from each wing tank through vent lines to a common flush-type vent in the lower surface of the outer wing panels. Separate overboard lines are teed into the vent lines which incorporate pressure and suction relief valves to prevent any possibility of excessive pressure existing in the tanks, should icing close

the flush-type vent. The vent line from the No. 5 tank extends to the flush vent on the left wing. A suction relief inlet for this tank is located beneath the fuselage and the pressure relief scarf-type vent is located inboard of the left wing tank scarfed vents.

1–139. FUEL DUMP SYSTEM.

1–140. There are no provisions for dumping fuel from the No. 5 tank. Fuel may be dumped from tanks 1, 2, 3, and 4 by two symmetrical systems and from tanks 2A and 3A by another system. Control levers for dumping either tanks 1 and 2 or tanks 3 and 4 are located on the pilots' overhead control quadrant. The dump system consists of a common dump chute and individual cable-operated dump valves for each of the two tanks in each inner wing.

1–141. Fuel is dumped from tanks 2A and 3A by means of hydraulically operated fuel dump valves and a fuel dump chute for each tank. Secondary hydraulic pressure operates these valves through an actuating cylinder mounted on each valve. Flow of hydraulic fluid to the cylinders is controlled by a selector valve mounted beneath the door leading from the flight station to the cabin. Operation of the selector valve simultaneously dumps fuel from tanks 2A and 3A.

1–142. Standpipes are installed in all fuel tanks except tank No. 5 to limit the amount of fuel that can be dumped. Refer to the Fuel Quantity Data Table in this section.

1–143. FUEL SYSTEM COMPONENTS.

1–144. Located in the inboard, aft corner of each integral wing tank is a surge box that traps fuel when the attitude of the aircraft is other than straight and level. From the surge box the fuel flows to an electric motor-driven, submerged, auxiliary fuel pump located in the aft, inboard corner of each tank. The auxiliary fuel pump for tank No. 5 is located in the right, outboard cell of that tank. Each pump is remotely controlled from the flight engineer's lower switch panel and pumps fuel, under pressure, to the engine-driven fuel pumps in the nacelles. Fuel is forced from the auxiliary fuel pumps through check valves, that prevent the transfer of fuel from one tank to another, to cable-operated fuel tank selector valves. There are five tank selector valves in the system; three, serving tanks No. 1, 5, and 4, are two-way valves; the other two, serving tanks No. 2A and 2, and 3A and 3, are three-way valves. From the selector valves fuel flows through micronic filters to the crossfeed valves. There are four two-way cable-operated crossfeed valves. As long as the crossfeed valves are closed the fuel will flow directly to the engine associated with each tank, after passing through one of the four, cable-operated emergency shut-off valves, engine-driven fuel pumps, fuel-flow transmitters, and carburetors. A thermal relief valve is located in the crossfeed line to relieve pressure resulting from expansion when the crossfeed valves are closed. An additional thermal relief valve is incorporated downstream of each emergency shut-off valve to relieve pressure in the fuel lines caused by fuel expansion when the emergency shut-off valves are closed. Water drain valves are located at low points in the system.

1–145. FUEL SYSTEM CONTROLS.

1–146. FUEL TANK SELECTOR LEVERS. There are five fuel tank selector levers that control the opening and closing of the fuel tank shut-off valves. Four of these levers are located on the flight engineer's control quadrant (figure 1–57). The outside levers, of these four, are two-position ON and OFF levers, controlling tanks No. 1 and No. 4. The inside levers are three-position levers. The left inside lever is placarded OFF, No. 2, and No. 2A. The right inside lever is placarded OFF, No. 3 and No. 3A. Either of the two tanks placarded on each inside lever quadrant may be selected, but not both at the same time.

1–147. The lever for the center section fuel tank (tank No. 5) is located on the flight engineer's auxiliary control quadrant (figure 1–16), inboard of the fuel crossfeed levers. This is a two-position, OPEN and CLOSED, lever controlling fuel flow from tank No. 5 to the crossfeed line.

1–148. FUEL CROSSFEED LEVERS. There are four two-position fuel crossfeed levers, placarded OPEN and CLOSED and numbered to correspond to the engine positions, located on the flight engineer's auxiliary control quadrant (figure 1–16). These levers are used to direct fuel from any tank to any engine combination. These levers operate the fuel crossfeed valves through control cables.

1–149. EMERGENCY SHUT-OFF LEVERS. The emergency fuel shut-off valves are controlled by four, cable-operated emergency shut-off levers located on the pilots' overhead control quadrant (figure 1–50). Each lever has four notched positions on the quadrant. The third notch is the FUEL AND BLAST AIR shut-off position. Refer to Engine Controls for a description of the other control positions.

1–150. FUEL DUMP LEVERS (TANKS 1 & 2, 3 & 4). The fuel dump valves for fuel tanks 1 & 2, 3 & 4, are operated by control cables attached to two levers labelled LEFT WING TANKS and RIGHT WING TANKS, located on the pilots' overhead control quadrant (figure

fuel system

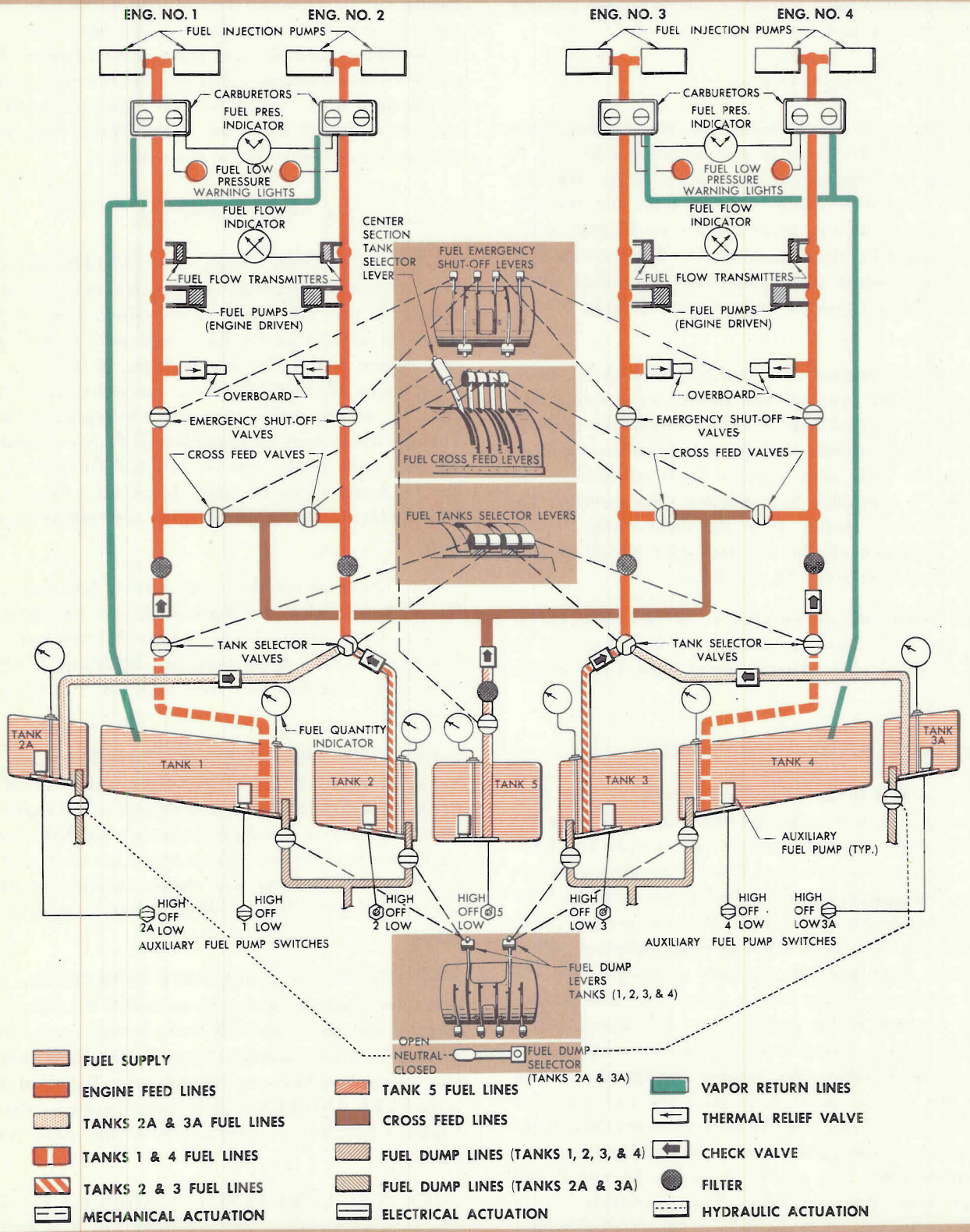


figure 1-15 Sheet 1

fuel system

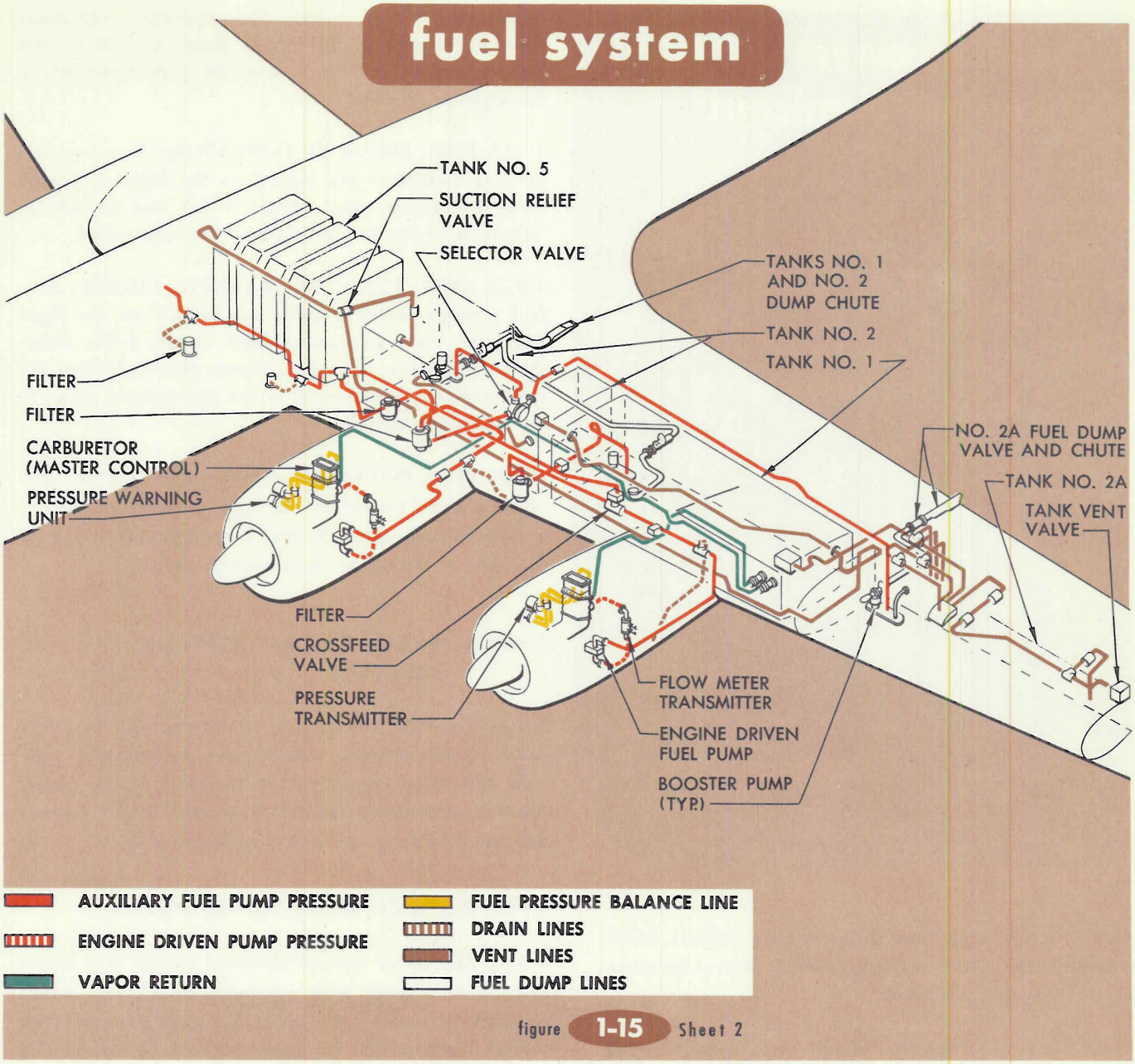


figure 1-15 Sheet 2

1–50). Movement of these levers, from the CLOSED position to the first stop position, extends the fuel dump chutes. Further movement of these levers, to the OPEN position, opens the dump valves in each tank allowing the fuel to dump. Return movement, from the OPEN positions to the red lines on the quadrant, closes the dump valves. Movement from the red lines to the stop positions permit the dump chutes to drain. Movement of the levers to the CLOSED position retracts the dump chutes.

1–151. FUEL DUMP LEVER (TANKS 2A & 3A). The dump valves for tanks 2A and 3A are hydraulically operated by a three-position OPEN, NEUTRAL, and CLOSE selector lever located in the flight station beneath the doorway leading to the cabin. Refer to figure 1–17. When the selector lever is in the OPEN position, secondary hydraulic pressure operates actuating cylinders which open the dump valves that allow the fuel to dump. The NEUTRAL position shuts off hydraulic pressure to the actuating cylinders. The CLOSE position of the lever reverses the direction of hydraulic fluid flow to the actuating cylinders which move the dump valves to the closed position.

1–152. AUXILIARY FUEL PUMP SWITCHES. Seven auxiliary fuel pump control switches are located on the right side of the flight engineer's lower switch panel

flight engineer's aux. control quadrant

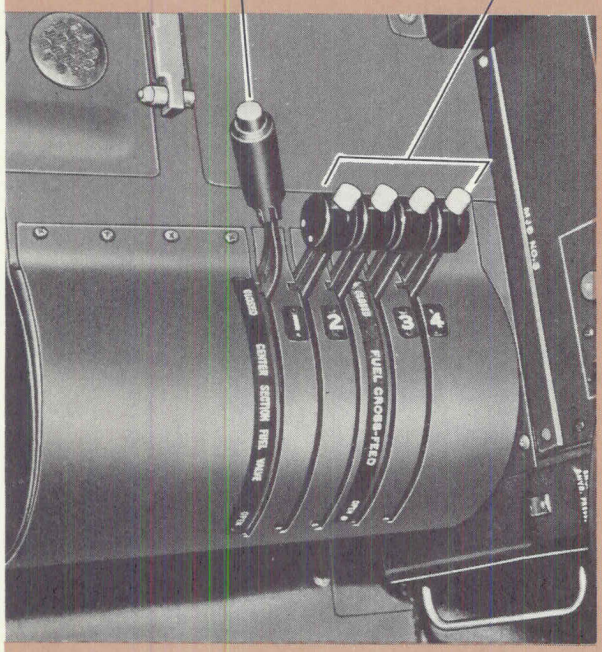


figure 1-16

(figure 1–57). They have three positions; HIGH, LOW, and OFF. The HIGH or LOW positions control the pump operating speed, as selected.

1–153. OUTER WING FUEL QUANTITY TEST SWITCH. There is a push-button fuel quantity test switch located on the flight engineer's upper instrument panel (figure 1–56). When pushed in it disconnects the electrical circuit from the outer wing fuel tank fuel quantity indicators, and the needles should move toward the empty position. When released, the needles should return to the original readings. This provides a check that will show whether the indicators are operative.

1–154. FUEL SYSTEM INDICATORS.

1–155. FUEL QUANTITY INDICATORS. There are three liquidometer and two capacitance-type fuel quantity indicators located on the flight engineer's upper instrument panel (figure 1–56). The capacitance indicators show the weight of fuel in the tanks, in pounds, and the liquidometer indicators show the quantity of fuel in the tanks in gallons.

1–156. FUEL PRESSURE INDICATORS. Two dual fuel pressure indicators are located on the flight engineer's lower instrument panel (figure 1–56) and provide an indication of the fuel pressure at the carburetors.

1–157. FUEL PRESSURE WARNING LIGHTS. Four fuel pressure warning lights are located on the flight engineer's lower instrument panel (figure 1–56) below the fuel pressure indicators. These glow red when the fuel pressure, as measured at the carburetors, drops to the minimum allowable.

1–158. FUEL FLOW INDICATORS. Two dual fuel flow indicators are located on the flight engineer's lower instrument panel (figure 1–56). They indicate the rate of fuel flow to the engine in pounds per hour.

1–159. ELECTRICAL POWER SYSTEM.

1–160. The basic electrical system is operated by direct current power sources, and inverters are utilized to provide alternating current power for some of the special items of equipment. The items operated by the various d.c. power sources are shown on figure 1–19.

1–161. D.C. ELECTRICAL POWER SYSTEM.

1–162. The direct current electrical system is a nominally 24-volt, single wire, grounded circuit with power supplied by four engine-driven d.c. generators and two storage batteries. The d.c. generators can be individually controlled and connected for parallel operation. They also incorporate feeder and internal generator ground fault protection, overvoltage protection, and reverse current and reverse polarity protection. A differential voltage reverse current relay and a voltage regulator are provided for each d.c. generator and its protective system. The regulators are located just aft of the pilot's and copilot's seats beneath the floor, and the differential voltage reverse current relays are located in the forward cargo compartment. Two a.c. motor-driven blowers provide cooling air for the voltage regulators. Refer to figure 1–18.

1–163. POWER DISTRIBUTION SYSTEM. The d.c. system consists of several busses and interconnecting power

tanks 2a and 3a fuel dump lever

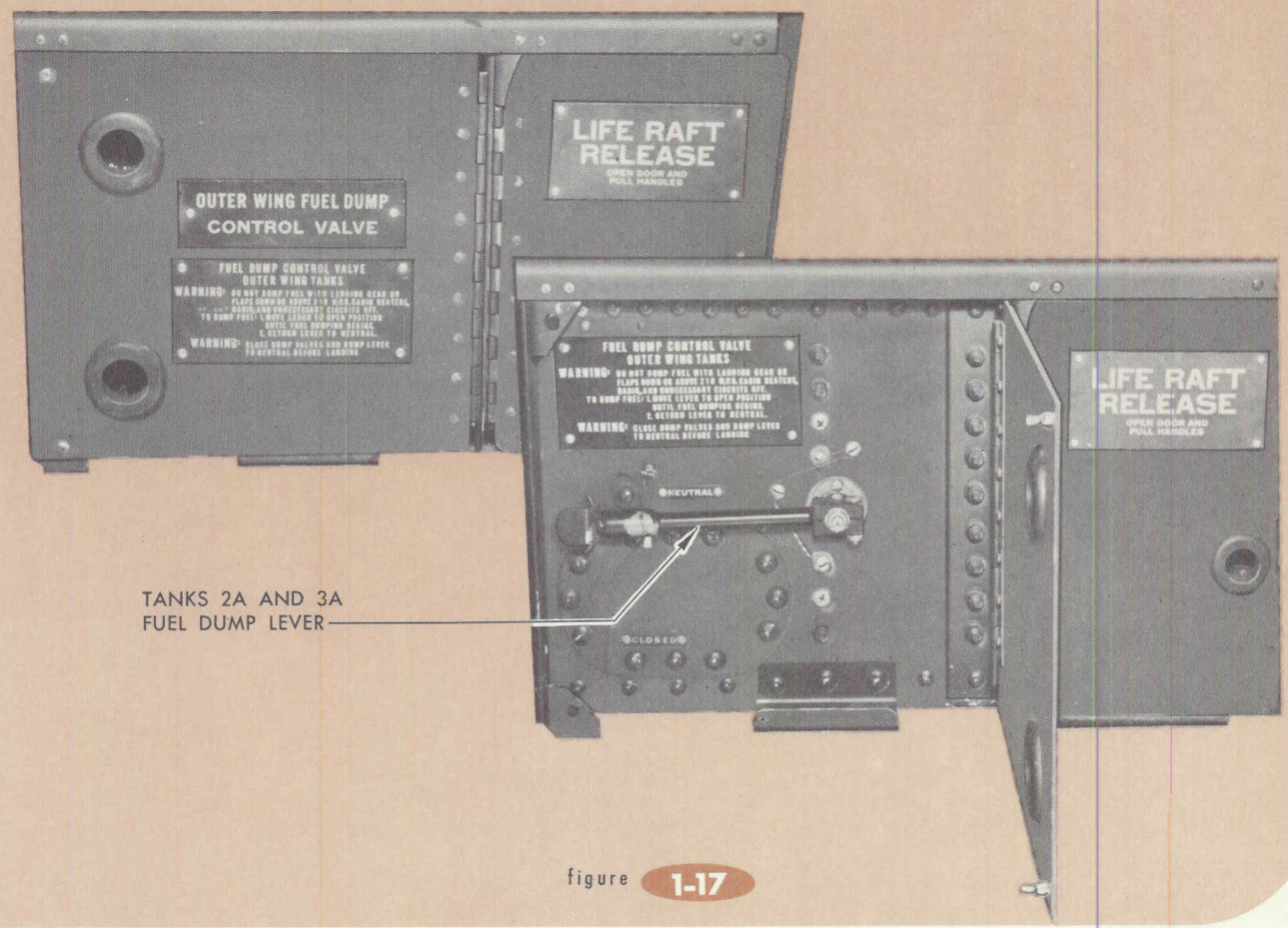


figure 1-17

feed conductors which supply the various fuse panels, circuit breaker panels, and control panels with power. The conductors, wherever necessary, are two or more wires paralleled, to reduce voltage drop and provide adequate current carrying capacity.

1–164. The busses consist of the main d.c. bus located in the main power relay panel near the aft end of the forward cargo compartment; the crew door bus located beneath the flight station floor directly below the crew door entrance; the MJB positive bus located beneath the floor directly below the MJB panels; and the station 260 upper panel bus located on the bulkhead directly above the air conditioning control panel.

1–165. An emergency d.c. power bus, connected directly to the battery power feed, is located in the aft side and directly below the flight engineer's table. This bus supplies battery d.c. power to all vital circuits and equipment which may be used during an emergency.

1–166. Power is supplied from nacelle busses for the major loads created by units in the nacelles such as starters, propeller feathering pump motors† and cowl flap actuators. These busses are isolated from the main d.c. bus by sectionalizing relays which are energized only when the specific equipment is in use. Other major direct-current loads, including inverter input, is supplied directly from the main direct-current bus through current limiters.

1–167. The two storage batteries are installed in the nose wheel well and a three-prong differential voltage, reverse current, and reverse polarity protected receptacle for

†LAC Serials 4510 through 4519

Electrical Power System Component Locations
Figure 1–18

To be included when available.

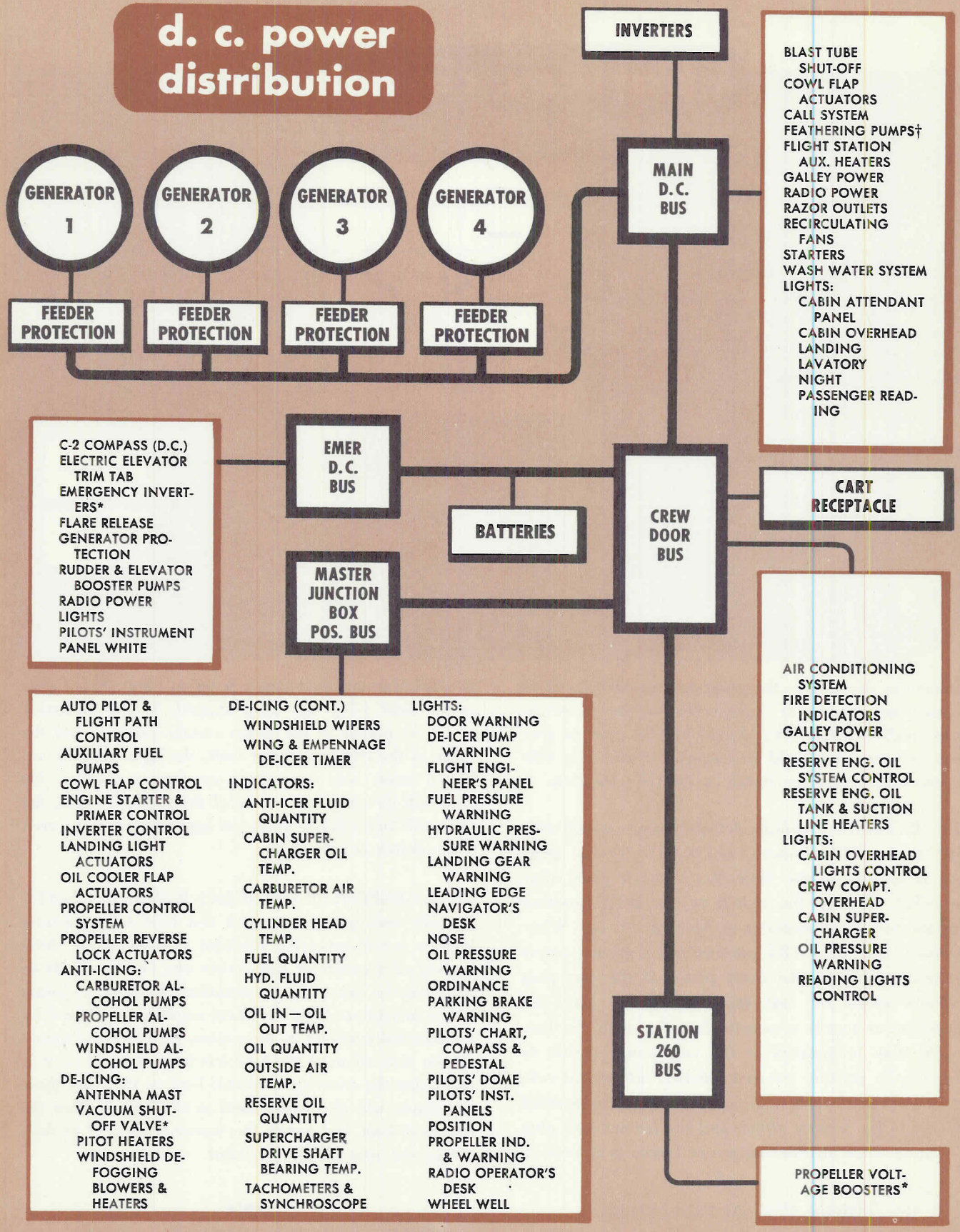
connecting an external d.c. power supply to the aircraft power system is located in the bottom of the fuselage to the right of the nose wheel well.

1–168. D.C. POWER SYSTEM CONTROLS.

1–169. GENERATOR SWITCHES. Each generator is controlled by a three-position switch located on the MJB No. 1 switch panel (figure 1–58). The switch positions are labelled ON (up), OFF (center), and can be placed in the down position to reset the generator field relays. Each switch is spring-loaded from the down to the OFF position. When a generator switch is placed in the ON position, output of the generator will be connected to the main d.c. bus provided load and special conditions are correct. The down position is a momentary contact position, which resets the field relay if it was tripped by overvoltage or by reversed generator polarity or was inadvertently left in the tripped position. If the relay was tripped by a feeder fault, it cannot be reset until the fault-sensing relay, located in the forward cargo compartment, is reset. This must not be done until the fault is located and cleared. In the OFF position the generator is disconnected from the d.c. bus, but the field is not de-energized.

1–170. GENERATOR FIELD CIRCUIT BREAKERS. Each generator is provided with a switch-type circuit breaker for emergency use. These circuit breakers are located on the MJB No. 1 switch panel (figure 1–58) and are guarded in the ON position. These circuit breakers should be placed in the OFF position only when

d. c. power distribution



* LAC Serials 4501 Through 4509

† LAC Serials 4510 Through 4519

figure 1-19

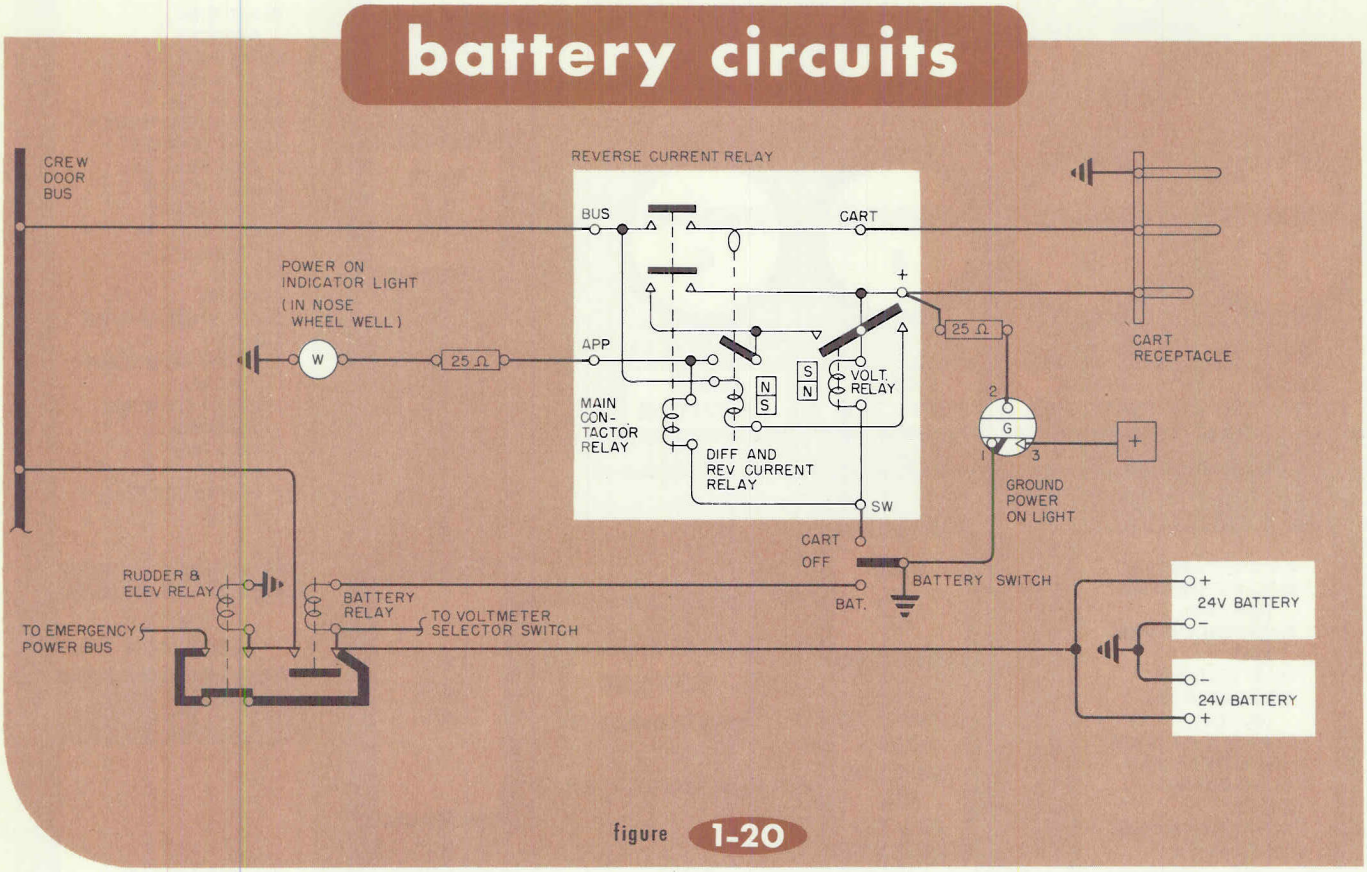


figure 1-20

necessary to de-energize the generators completely, as in an emergency landing or in the event that the protection system malfunctions. They should not be used as generator switches and should be opened or closed only with the associated generator switch in the OFF position.

1–171. BATTERY SWITCH. A three-position switch with SHIP (up), OFF (center), and CART (down) positions, is located on the MJB No. 1 switch panel (figure 1–58). Moving the switch to the SHIP position connects the aircraft batteries to the main d.c. bus. When the switch is in the CART position and a ground power source is connected, the short prong of the cart plug receptacle closes the cart relay and power from the ground power source is connected to the main d.c. bus. A cart relay is installed in the cart power circuit to automatically provide reversed polarity, differential voltage, and reversed current protection. Lights are installed adjacent to the battery switch and the battery cart plug to indicate when an external power source is connected.

1–172. D.C. POWER SYSTEM INDICATORS.

1–173. GENERATOR FIELD RELAYS TRIPPED WARNING LIGHTS. Beneath each of the four generator switches, located on the MJB No. 1 panel (figure 1–58), is a red warning light which is set to glow when a generator field relay has been tripped. If the generator switch is placed in the down (reset) position and the cause of the trip was feeder fault, the light will stay on. If the cause was overvoltage or reverse polarity, the light will go out. If the cause of the trip still exists, the light will immediately come on again and stay on even if the switch is held down.

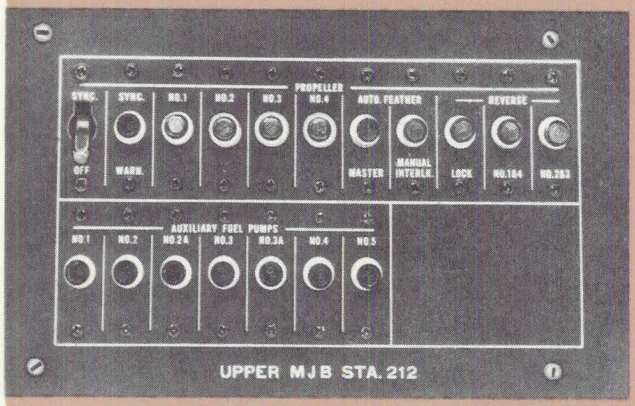
1–174. GENERATOR OVERHEAT WARNING LIGHTS. Beneath each generator switch and field relay warning light is a red generator overheat warning light. Overheating of a generator that causes one of these lights to glow may be caused by an electrical overload or failure of the generator. If the overheat condition is caused by an electrical overload on the system, the generator should not be shut off until the load has been reduced or it is likely that the resulting increased load on the other three generators will also cause them to overheat. Reduce the electrical load and watch the warning light. If it does not go out, shut off the generator.

Note

If the generator is operated for more than 10 minutes, with the overheat light on, it will be necessary to remove and replace the generator.

upper mjb sta. 212 circuit breaker panel

LAC Serials 4501 Through 4509



LAC Serials 4510 Through 4519

figure 1-21

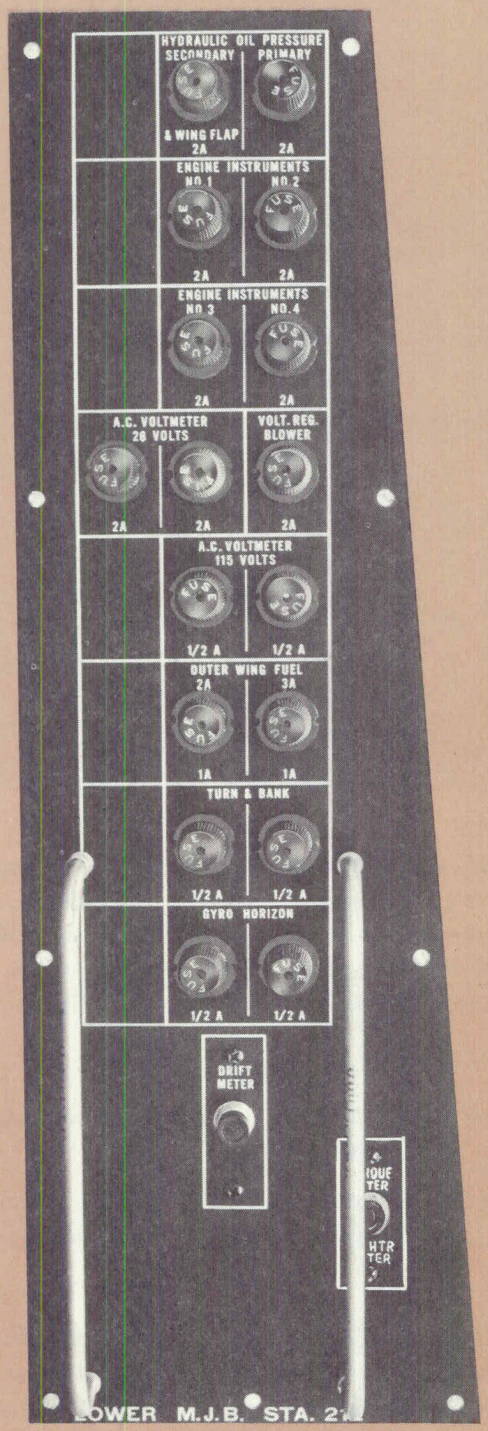
1–175. RELAY CLOSED INDICATOR LIGHTS. Two amber and two red indicator lights are located on the MJB No. 2 switch panel (figure 1–58) and installed as warning devices to indicate improper operation of relays connected to the wing busses. An amber fuselage relay indicator light and a red nacelle relay closed indicator light are provided for the left and right wing busses of the aircraft. These indicator lights are connected in such a manner that when an amber light is bright, the sectionalizing relay is closed and the wing bus is energized. When the relays are open both the amber and red lights should be dim and have equal brilliance. If, after one of the sectionalizing relays has operated, the amber light does not return to original brilliance, this indicates the sectionalizing relay has not opened. This does not represent any direct hazard to flight, but the condition should be corrected at the earliest opportunity. If the red light becomes bright after propeller feathering, unfeathering, reversing, or unreversing is completed, this indicates that the propeller feathering relay has remained closed, and subsequent operation of cowl flaps, engine starters, or propeller feathering, unfeathering, reversing or unreversing on that side of the aircraft will energize the feathering pump of the propeller whose previous operation caused the red light to burn bright.

WARNING

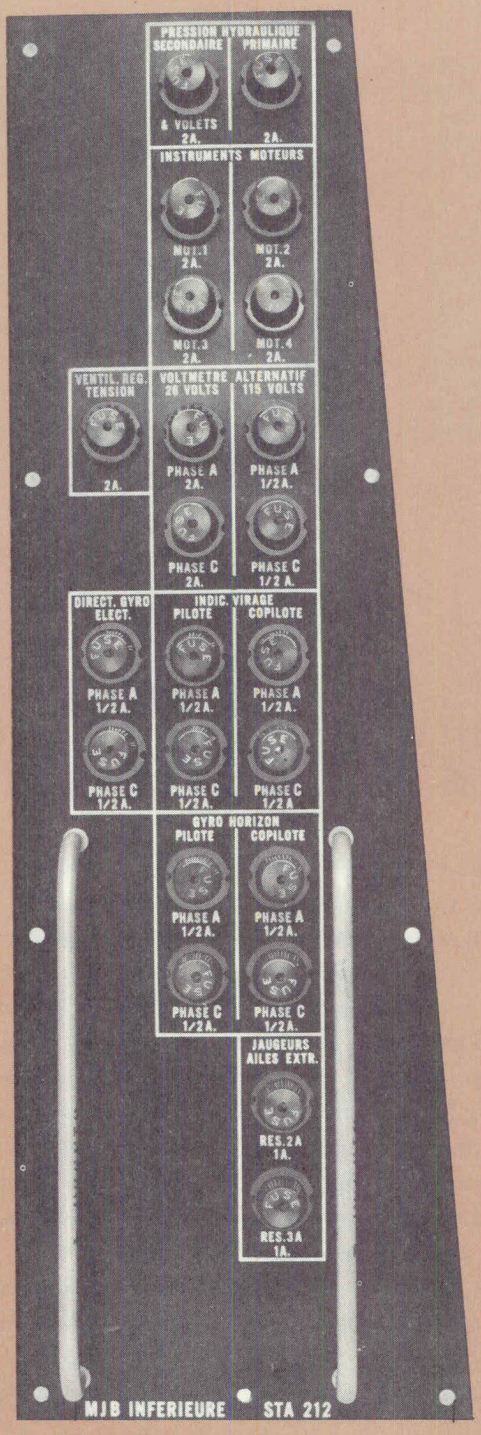
- If this condition occurs in flight, notify the pilot immediately.
- If this condition occurs while the aircraft is on the ground, it must be repaired before flight.

1–176. If, after engine starter or cowl flap operation, one of the red lights becomes bright, operation of the same engine starter or cowl flap will occur if engine starters, cowl flaps, or propeller feathering, unfeathering, reversing or unreversing electrical circuits on the same side of the aircraft are energized. Such operation is not hazardous but should be corrected at the earliest opportunity.

lower mjb sta. 212 circuit breaker panel



LAC Serials 4501 Through 4509

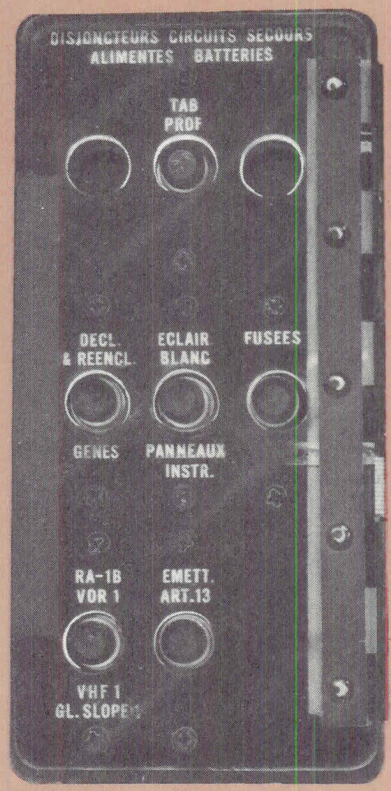


LAC Serials 4510 Through 4519

figure 1-22

essential circuit breaker panel

LAC Serials 4501 Through 4509



LAC Serials 4510 Through 4519

figure 1-23

Note

If this condition occurs on the ground, notify the ground crew.

1–177. D.C. VOLTMETER. A d.c. voltmeter, located on the MJB No. 1 switch panel (figure 1–58), is provided to indicate the output of the generators, batteries, and also the bus voltages. An eight-position switch, also located on the MJB No. 1 switch panel, provides selection of generators 1, 2, 3, 4, BAT., two bus positions, and OFF. Parallel operation of the generators and batteries necessitates that all but the item being checked be disconnected from the bus so that only its potential will be read.

1–178. GROUND POWER INDICATOR LIGHTS. A green light is located on the MJB No. 1 switch panel (figure 1–58) and indicates that ground power is connected to the d.c bus even though the cart switch may be OFF. A white indicator light is located adjacent to the ground power receptacle and glows whenever the ground power supply is connected to the aircraft.

1–179. A.C. ELECTRICAL POWER SYSTEM.

1–180. A.C. ELECTRICAL POWER SYSTEM. (LAC Serials 4501 through 4509.) The a.c. electrical system receives its power from five d.c. motor-driven inverters. Three 2000 VA, 400-cycle, 115-volt inverters convert d.c. to a.c. power for operation of instruments, radio equipment, automatic pilot, and other a.c. equipment. These inverters provide three-phase power on a grounded 2-wire system. One inverter is connected to the radio equipment, the second is connected to the a.c. operated instruments, and the third serves as a spare. The spare inverter will provide emergency power to the radio and instrument sys-

a.c. power system

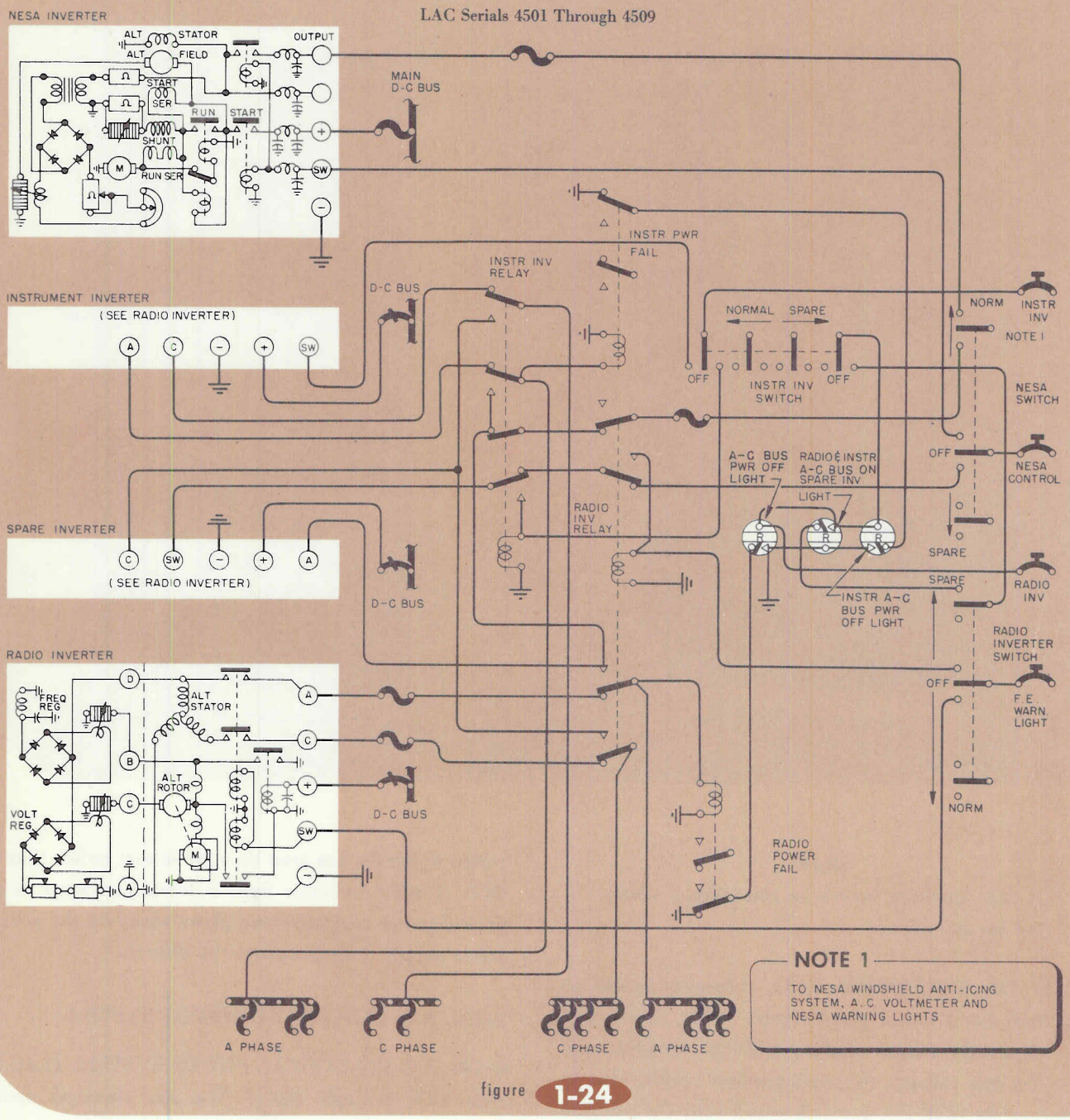


figure 1-24

tems, or to the Nesa system. A 2500 VA Nesa inverter normally furnishes single-phase power to operate the Nesa windshield anti-icing systems. If the Nesa system is being operated by the spare inverter and either the radio or instrument inverter switches are moved to the spare position, power to the Nesa system will be automatically disconnected.

1–181. A 250 VA 3-phase emergency inverter is also installed to furnish power to certain radio equipment and the C-2 gyrosyn compass in the event of failure of the three 2000 VA inverters or complete shut down of the d.c. system. The emergency inverter receives its power from the emergency d.c. bus. This inverter is connected so that it delivers only single-phase power.

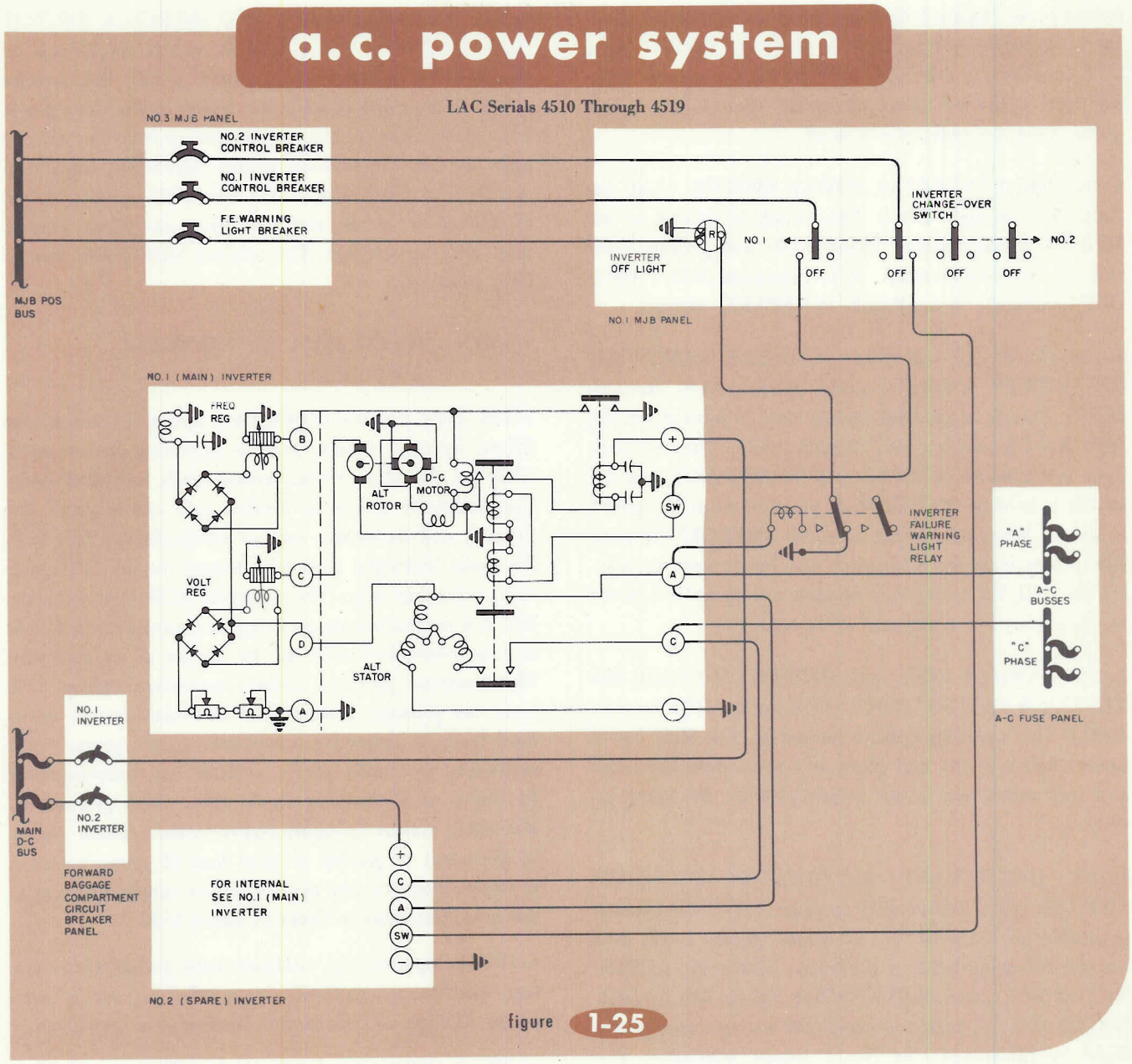


figure 1-25

1–182. A.C. ELECTRICAL POWER SYSTEM. (LAC Serials 4510 through 4519.) Two 2000 VA, 400-cycle, 115-volt inverters consisting of a d.c. motor and an a.c. generator convert d.c. to a.c. power for operation of instruments, radio equipment, automatic pilot and other a.c. equipment. While one inverter operates the a.c. equipment the other serves as a spare and may be cut in manually in the event of failure of the main inverter.

1–183. One emergency alternator is installed on each outboard engine to provide emergency power for operation of the turn and bank indicators, the gyro horizons, and the directional gyro.

1–184. A.C. ELECTRICAL POWER SYSTEM CONTROLS AND INDICATORS.

1–185. INSTRUMENT INVERTER SWITCH. (LAC Serials 4501 through 4509.) This switch is located on the MJB No. 2 switch panel (figure 1–58) and permits selection of either the instrument or spare inverter. It is placarded INST (up), OFF (middle), and SPARE INVERTER (down). A red warning light is located above the instrument inverter switch and glows if the a.c. instrument power is off.

1–186. RADIO INVERTER SWITCH. (LAC Serials 4501 through 4509.) This switch is located on the MJB No. 2

switch panel (figure 1–58) and permits selection of either the radio or spare inverter. It is placarded RADIO (up), OFF (middle), and SPARE INVERTER (down). A warning light is located above the radio inverter switch and glows if the a.c. radio power is off.

1–187. NESA INVERTER POWER SWITCH. (LAC Serials 4501 through 4509.) This switch is located on the MJB No. 2 switch panel (figure 1–58) and permits selection of the Nesa inverter. It is placarded NESA (up), OFF (middle), and SPARE INVERTER (down).

1–188. GYROSYN COMPASS AND EMERGENCY RADIO POWER SWITCH. (LAC Serials 4501 through 4509.) This is a guarded switch that is located on the MJB No. 2A switch panel (figure 1–58). The two positions are labelled NORMAL and EMERGENCY and the switch is held in the NORMAL position when the guard is closed. When this switch is in the EMERGENCY position power from the emergency d.c. bus is used to operate the 250 VA emergency inverter that provides power to the gyrosyn compass and radio equipment.

1–189. RADIO & INST. A.C. POWER ON SPARE INVERTER WARNING LIGHT. (LAC Serials 4501 through 4509.) This warning light is located on the MJB No. 2 panel (figure 1–58) and glows red when both the radio and instrument a.c. power is provided by the spare inverter.

1–190. INSTRUMENT ALTERNATOR SELECTOR SWITCH. (LAC Serials 4510 through 4519.) This switch is located on the MJB No. 2A panel (figure 1–58) and has the following labelled positions: NORMAL, ALTERNATOR NO. 1, and ALTERNATOR NO. 4. The ALTERNATOR NO. 1 position connects the a.c. operated pilots' flight instruments to the No. 1 engine alternator. The NORMAL (center) position connects the instruments to the a.c. bus and the ALTERNATOR NO. 4 connects the instruments to the No. 4 engine alternator.

1–191. MAIN INVERTER SWITCH. (LAC Serials 4510 through 4519.) The main inverter switch, located on the MJB No. 1 panel (figure 1–58), has NO. 1, OFF, and NO. 2 positions. When this switch is placed in either the NO. 1 or NO. 2 positions, the selected inverter is connected to the a.c. bus. The other serves as a standby. When the main inverter switch is in the OFF position, both a.c. and d.c. power are disconnected from the C-2 compass and the automatic pilot. An inverter off warning light is located adjacent to the main inverter switch. This light glows when there is no power on the a.c. bus.

1–192. A.C. VOLTMETER AND SELECTOR SWITCH. An a.c. voltmeter and a selector switch are located on the MJB No. 1 switch panel (figure 1–58). The selector switch is provided to select any phase of the three-phase, 115-volt a.c. bus, or the output voltage from the left and right 26-volt, single-phase engine instrument transformers. On LAC Serials 4501 through 4509 aircraft, output of any phase of the radio inverter, and Nesa inverter may also be selected. The selector switch also has an OFF position.

1–193. HYDRAULIC POWER SYSTEM.

1–194. Four variable displacement hydraulic pumps, one driven by each engine, provide operating power up to 1700 psi for the various hydraulically operated units. The hydraulic power is divided into two systems, the primary and secondary, each of which obtains fluid from the main hydraulic reservoir, located in the left center section leading edge. The reservoir is divided vertically into two compartments up to approximately 5/8 its height and is pressurized with air by means of an aspirator. The reservoir partition divides secondary system fluid from the primary system fluid and each system draws fluid from its respective compartment. The primary and secondary hydraulic power systems are interconnected by means of a crossover check valve which permits the secondary system to supply power to the primary system in the event of partial or total loss of primary system pressure. The primary system cannot supply pressure to the secondary system. Refer to figure 1–26.

1–195. A separate and auxiliary hand pump power system, with its own reservoir, is provided for use in emergency braking or emergency landing gear extension.

1–196. A pump control valve is installed near each engine-driven hydraulic pump to perform and control multiple system functions. Each valve incorporates a shut-off valve, a thermal relief valve, a pressure relief valve, and a pressure switch, all of which are within the same body.

1–197. PRIMARY HYDRAULIC SYSTEM. The primary hydraulic system supplies pressure for operation of the surface control boosters, aspirator, and left wing secondary heat exchanger fan motor. The hydraulic pumps on engines No. 1 and 2 furnish the volume and pressure required for operation of the primary system. Return lines from all primary units are manifolded into a common return line through the main primary filter to the primary return port of the main hydraulic reservoir.

hydraulic power system

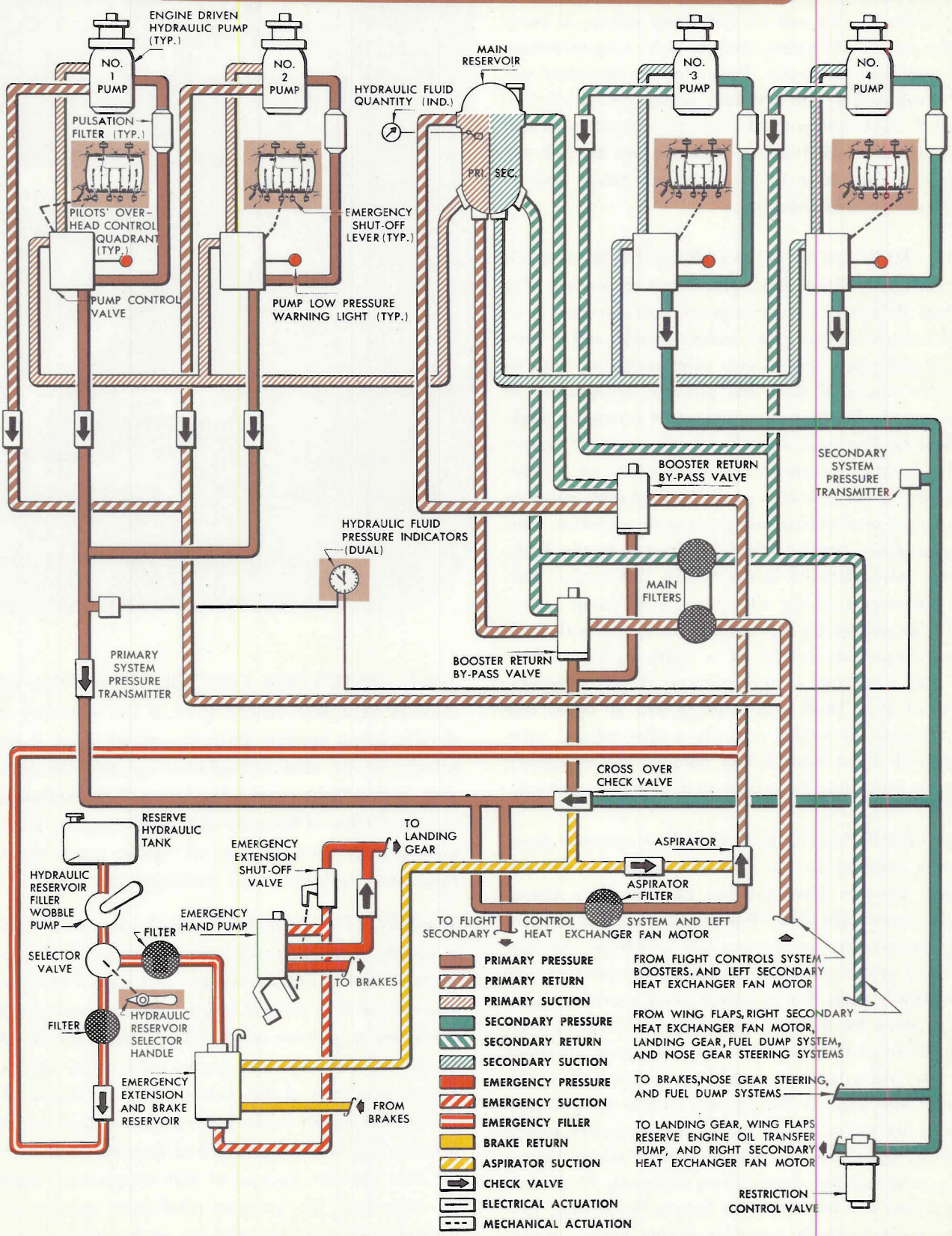
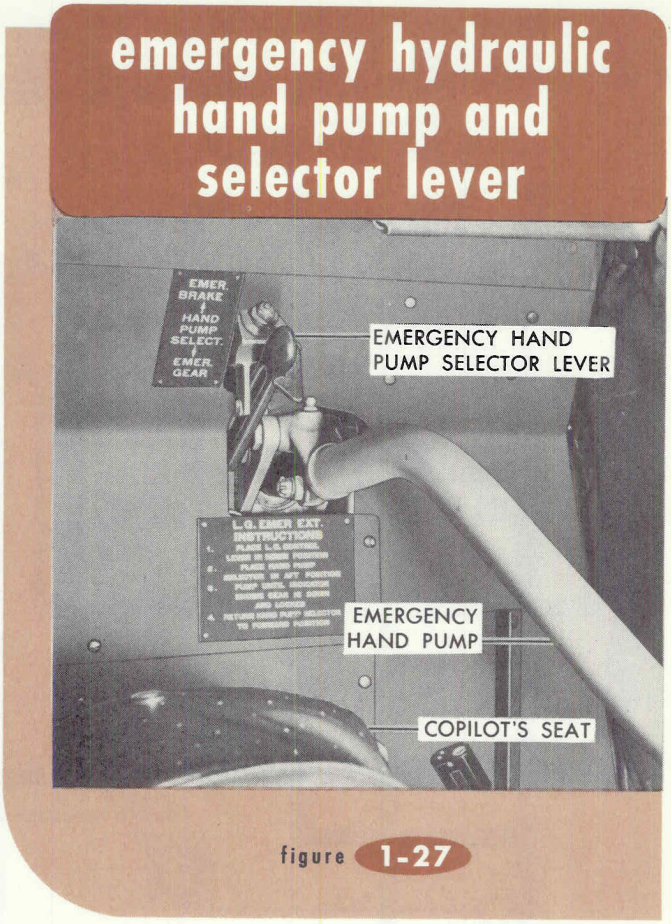


figure 1-26

1–198. SECONDARY HYDRAULIC SYSTEM. The secondary hydraulic system supplies pressure for operation of the landing gear, brakes, nose wheel steering, wing flaps, tanks No. 2A and 3A fuel dump valves, oil pump for the reserve oil system, and the right wing secondary heat exchanger fan motor. Power for the secondary system is supplied by the hydraulic pumps on engines No. 3 and 4. Return lines from all of the secondary system units are manifolded into a common line through the main secondary filter to the secondary return port of the main hydraulic reservoir.

1–199. EMERGENCY HAND PUMP POWER SYSTEM. The emergency hand pump power system consists of a separate fluid reservoir (emergency extension tank), located forward of the pilot's rudder pedals, and a combined hand pump and selector valve which provides an auxiliary source of fluid and pressure, independent of the normal hydraulic system, for use in emergency braking and landing gear extension in the event of normal system failure. A separate and independent set of lines connected to the downside of the landing gear actuating cylinders is used during emergency gear extension. During emergency braking, fluid is directed to the brake selector valve. Refer to Brake System, this section. Further components of the emergency hand pump system include provisions for replenishing the system with fluid. These components consist of a spare hydraulic fluid tank with a capacity of approximately 4½ U.S. gallons, connected to a hand wobble pump and an outlet line that connects the wobble pump to a filler selector valve which will direct replenishing fluid to the emergency extension tank or to the main system hydraulic reservoir.

1–200. CROSSOVER CHECK VALVE. A crossover check valve is installed in the hydraulic system to prevent primary pressure from entering the secondary system during normal operation. However, in the event pressure in the primary system becomes 300 to 400 psi less than secondary system pressure, the differential pressure will automatically open this valve and allow secondary pressure to assist the primary system. In the event of complete failure of the primary system, crossover operation will take place, and the secondary system will supply pressure and fluid to the primary system components; however, operation time of some of the secondary system hydraulic units may be slower. Booster return bypass valves automatically direct return hydraulic fluid from the aspirator and booster return lines to the primary side of the main hydraulic reservoir during normal operation or to the secondary side during crossover operation.



1–201. RESTRICTION CONTROL VALVE. This valve operates as a flow control valve if the secondary hydraulic system pressure drops to a preset value. It gives priority to the vital hydraulically operated equipment, such as the flight control boosters and the brakes and reduces the flow of hydraulic fluid to the wing flap motors, landing gear, reserve engine oil transfer pump, and the right hand secondary heat exchanger fan motor.

1–202. PUMP CONTROL VALVE. A pump control valve is installed with each engine-driven hydraulic pump and performs several functions; it acts as a manual emergency shut-off valve; a thermal relief valve, a pressure relief valve, and a pressure switch. The manual shut-off valve consists of a cam-operated poppet valve acting against a suction inlet port of the control valve. A thermal relief valve automatically bypasses the hydraulic fluid from the pressure side to the suction side of the control valve when the fluid pressure, because of high temperature, reaches the high limit. The pressure relief valve operates automatically when system pressure reaches the maximum limit by allowing a valve piston to open which diverts

fluid to the suction side of the control valve. The pressure switch consists of a spring-loaded piston which actuates an electric switch that closes the circuit to the indicator light, located in the flight station, when the hydraulic pressure drops to the minimum limit.

1–203. PULSATION FILTERS. Vibration of the hydraulic lines is reduced by the installation of a pulsation filter in each pump pressure line. The filter is cylindrical in shape, and is so constructed that the pressure inlet allows the pump-delivered fluid to enter an enlarged chamber. The outlet, at the opposite end of the chamber, tapers very abruptly to a slightly smaller size than the pressure inlet. The accumulated volume of fluid within the chamber serves to damp out the pulsations of the engine-driven hydraulic pumps, thus resulting in less vibration and noise in the hydraulic lines.

1–204. HYDRAULIC POWER SYSTEM CONTROLS.

1–205. EMERGENCY SHUT-OFF VALVE LEVERS. The emergency shut-off levers are located on a control quadrant in the ceiling of the flight station (figure 1–50). There is one lever for each engine, and each lever has four notched positions on the quadrant. The second stop position, as the lever is moved from the full forward position, mechanically shuts off the hydraulic oil supply to the engine-driven pump at the pump control valve. The emergency shut-off levers and the pump control valves are mechanically connected by a cable and pulley system. Refer to Engine Oil System Controls for a description of the other control lever positions.

1–206. EMERGENCY HAND PUMP AND SELECTOR LEVER. The emergency hand pump and selector lever are located on the flight station floor, outboard of the copilot's seat. Refer to figure 1–27. The selector lever has two positions, EMER. BRAKES and EMER. GEAR. When the lever is in the EMER. BRAKES position, the hand pump may be used to direct fluid and pressure to the brake selector valve. Refer to Brake System, this section. When the selector lever is placed in the EMER. GEAR position, the hand pump lever may be used to supply pressure through an independent system of lines to the downside of the landing gear actuating cylinders.

1–207. EMERGENCY HYDRAULIC RESERVOIR FILLER SELECTOR LEVER AND WOBBLE PUMP. A hand wobble pump and selector lever are located on the flight station floor offset behind the pilot's seat (figure 6–3) and are used to replenish the main or emergency hydraulic systems with fluid. The wobble pump has an inlet line attached to a tank located beneath the floor of the flight station, approximately below the pilot's feet, and an outlet line connected to the selector lever. The selector lever has two positions so that fluid can be pumped to the main system hydraulic reservoir or to the emergency extension reservoir.

1–208. HYDRAULIC POWER SYSTEM INDICATORS.

1–209. HYDRAULIC FLUID QUANTITY INDICATOR. The main hydraulic reservoir quantity indicator is located on the flight engineer's upper instrument panel (figure 1–56). The indicator is an electric Liquidometer-type and is actuated by a Liquidometer transmitter in the primary side of the main fluid reservoir. The dial is calibrated in quarters from empty to full.

1–210. HYDRAULIC SYSTEM PRESSURE INDICATORS. Two dual hydraulic oil pressure indicators are installed, one on the copilot's auxiliary instrument panel (figure 1–49) and one on the flight engineer's upper instrument panel (figure 1–56). These indicators are calibrated in psi. One needle in each instrument indicates the hydraulic pressure in the primary system and the other needle indicates the pressure in the secondary system. Each indicator is electrically connected to a pressure transmitter located in the pressure lines of each system.

1–211. HYDRAULIC PUMP LOW-PRESSURE WARNING LIGHTS. Four pump low-pressure warning lights are installed on the flight engineer's lower instrument panel (figure 1–56) and on the copilot's auxiliary instrument panel (figure 1–49). These lights are numbered from left to right and are electrically connected to the pressure side of their respective pump control valves. When the pump pressure decreases to the low limit, the pump control valve pressure switch will close the circuit to the respective light on each panel.

1–212. EMERGENCY HYDRAULIC RESERVOIR SIGHT GAGE. A sight gage, mounted on the emergency extension reservoir, is visible from the flight engineer's station and is marked at the MAX. and MIN. fluid levels.

flight controls hydraulic system

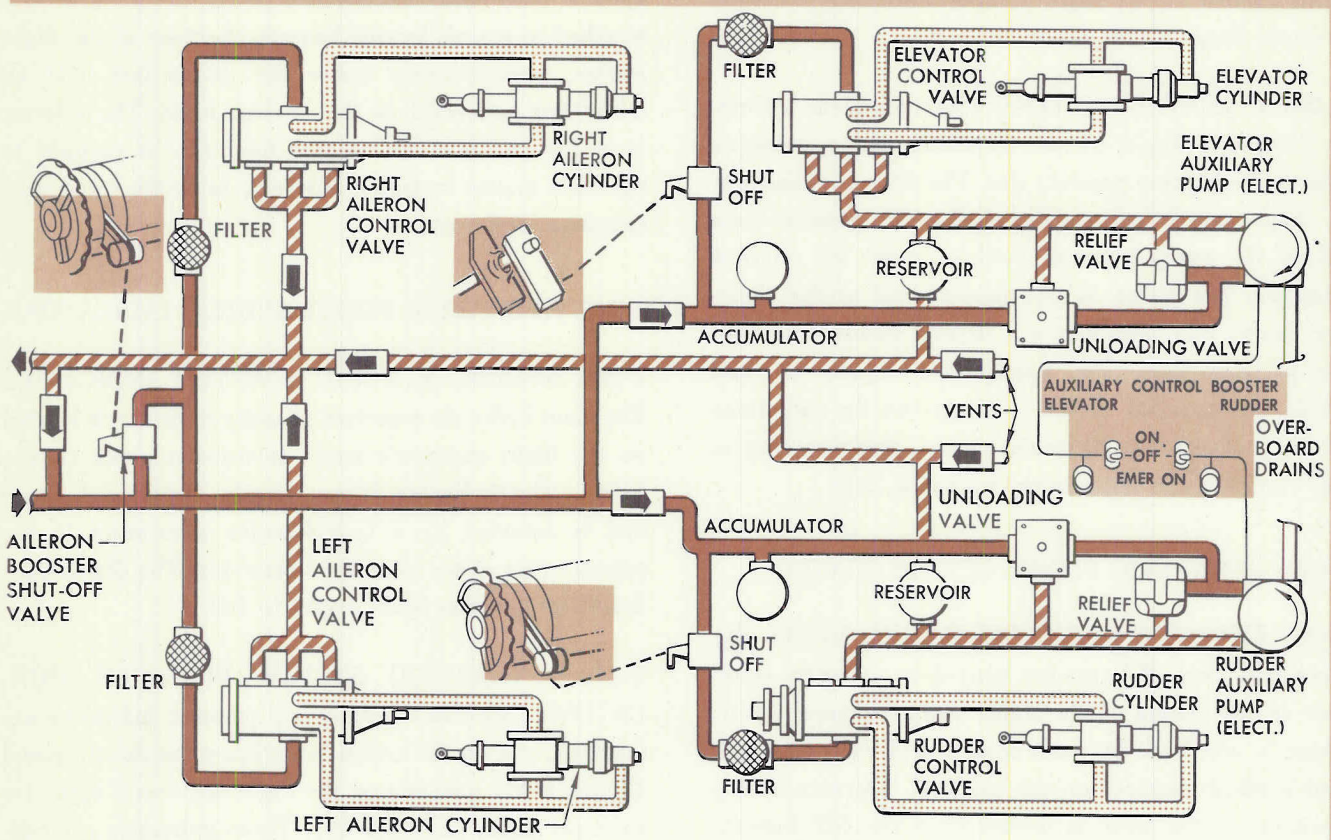


figure 1-28

1–213. FLIGHT CONTROL SYSTEM.

1–214. The elevators, rudders, and ailerons are actuated by cable and pulley systems which incorporate tension regulators that automatically maintain constant tension in the cable systems. Each outboard rudder, each elevator, and each aileron is also provided with a cable-operated trim tab controlled from the flight station. Hydraulic booster units are built into the elevator, rudder, and aileron cable systems to assist the pilot in moving the control surfaces. Refer to figure 1–28. The elevator and the rudder booster systems incorporate a complete electrical power unit that will provide an auxiliary source of hydraulic power to the booster assemblies in the event of primary or secondary hydraulic system failure. There is no source of auxiliary hydraulic power for the aileron booster system.

1–215. FLIGHT CONTROL BOOSTERS. Hydraulic pressure for the flight control boosters is supplied normally by the primary hydraulic system. However, if primary system pressure drops 300 to 400 psi below secondary system pressure, the crossover check valve automatically will direct secondary pressure to the boosters to replace the primary pressure loss. The pressure demand of the boosters will be supplied at the expense of the units normally served by the secondary system except for the brakes and the nose wheel steering.

1–216. Each booster assembly includes a hydraulic actuating cylinder which applies the force, and a four-way control valve which regulates the speed and direction of movement of the actuating cylinder piston. Any movement of the rudder pedals or control wheel opens the

aileron control system

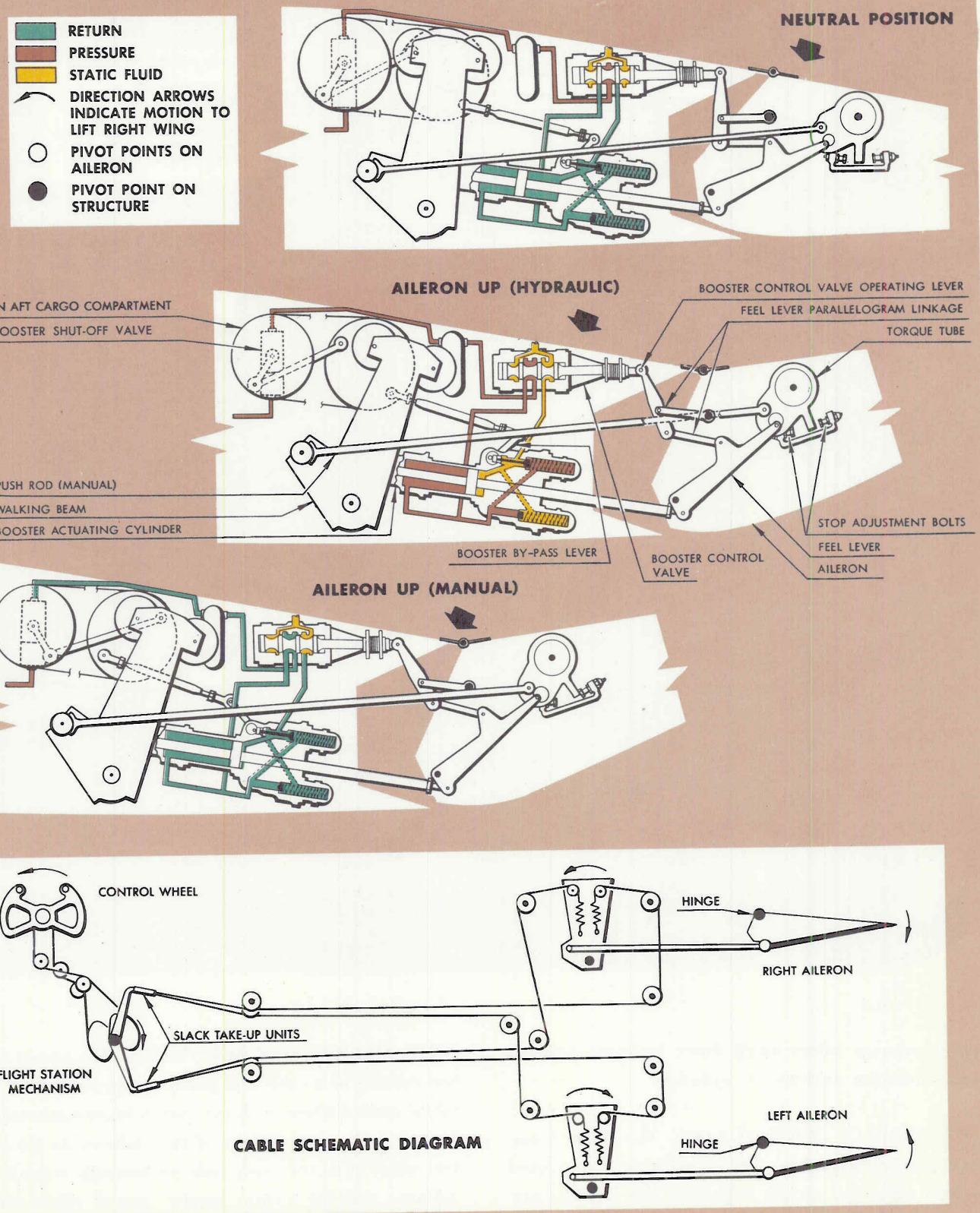


figure 1-29

elevator control system

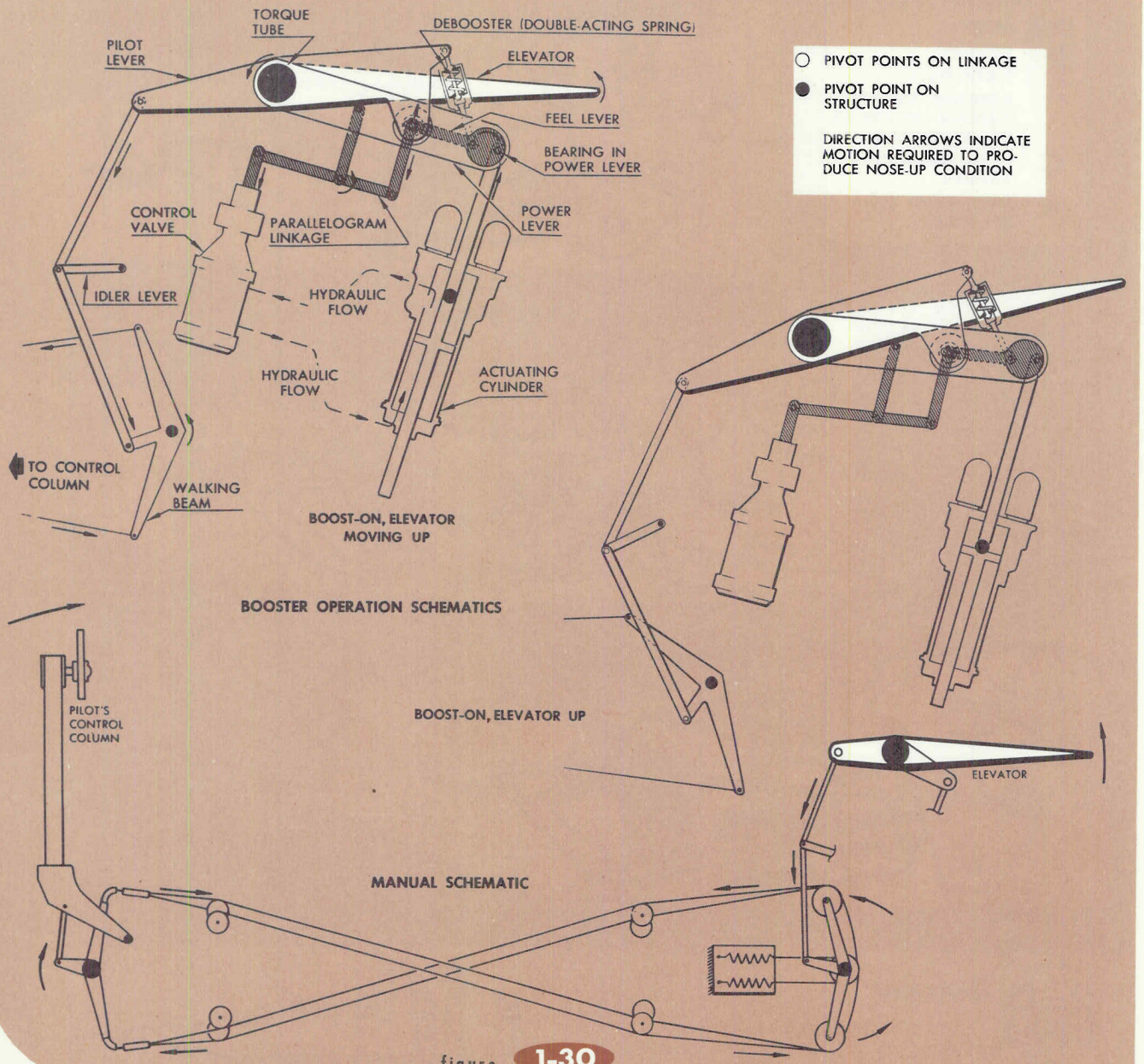


figure 1-30

control valve or valves which direct hydraulic pressure to the actuating cylinder or cylinders.

1–217. SURFACE CONTROL LOCK. The effect of surface control locks is achieved by engaging the flight control boosters while the aircraft is parked. The boosters provide sufficient resistance in the system to absorb the impact loads caused by gusts.

1–218. AILERON CONTROL SYSTEM. The aileron control consists of a cable and pulley system connecting the pilots' control wheels with the aileron booster assemblies, located in the wing forward of each aileron. As the control wheel is moved, push rods mechanically actuate the ailerons, and the aileron booster control valves which hydraulically boost the control wheel action. Refer to figure 1–29.

rudder control system

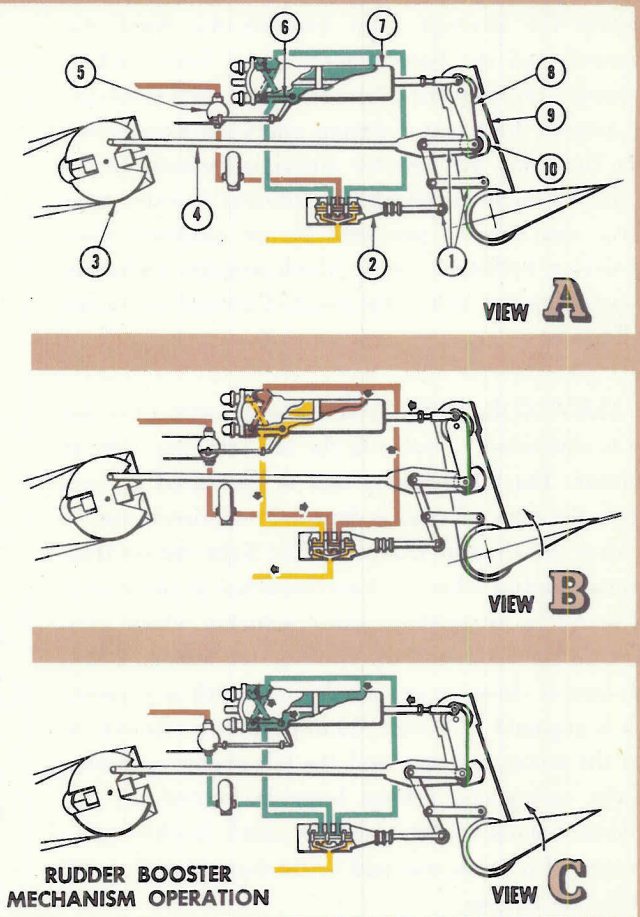
VIEW A illustrates the rudder booster mechanism with the rudder approximately 15 degrees to right. The parallelogram linkage (1) is positioned to hold control valve (2) in neutral. Any movement of lever (8) from alignment with rudder-operating arm (9) will open the control valve.

VIEW B illustrates opening of the control valve by force initiated by the pilot. The control cables have rotated rudder quadrant (3) and, by pulling push-pull feel bar (4), have rotated lever (8) about the actuating-cylinder piston-rod attaching bearing. The rudder moves slightly as the control valve is opened.

Hydraulic pressure is directed by the control valve to the actuating-cylinder, as long as the rudder quadrant is rotated in advance of the rudder-operating arm, or as long as force is necessary to overcome air load on the rudder. Hydraulic pressure, acting upon the cylinder piston, creates a force proportional to that applied to the push-pull feel bar (4) by the pilot. These combined forces move the rudder, and because the pilot must furnish a part of the force to move the rudder, he has a continuous "feel" of the air load on the rudder.

When the movement of the rudder quadrant is discontinued the hydraulic pressure continues the movement of the rudder-operating arm (9) until the arm is aligned with lever (8) and the valve is thereby returned to neutral.

VIEW C illustrates the operation of the rudder by manual force alone. The cable-controlled shut-off valve (5) has been closed and the bypass valve (6) opened, leaving the cylinder piston free to move. Rotation of the rudder quadrant by the cables has moved lever (8) until it has taken up the lost motion in the oversize hole (10) in the rudder-operating arm. Direct force is then applied in moving the rudder-operating arm and the rudder to the right.



WITH THE TRAIL CENTER CONTROL VALUE CENTERED AS SHOWN IN VIEW "A," RESIDUAL EQUAL PRESSURE IS PRESENT ON BOTH SIDES OF THE ACTUATED CYLINDER PISTON.

figure 1-31

1–219. AILERON TRIM TABS. A trim tab is located in the trailing edge of each aileron and is controlled mechanically through a cable system. Movement of the cables is converted by a tab actuating unit, located in the outer wing structure, into rod linkage servo-action. The rod linkage is connected to the tab and passes through the aileron to the aileron tab actuating unit.

1–220. ELEVATOR CONTROL SYSTEM. Refer to figure 1–30. The control columns are connected by cable to an elevator walking beam which is, in turn, connected by a linkage system to the elevators. Direct linkage connects the elevators and the hydraulic booster assembly. The booster assembly is similar in principle of operation to the aileron booster. An actuating cylinder, a control valve, and connecting linkage are the essential parts of

the booster assembly. The emergency elevator booster shift control is connected by cable to the shifter walking beam at the elevator booster unit. When the shifter control is pulled out, it shuts off the boost, and, at the same time alters the leverage ratio between the flight station controls and the booster mechanism. This position of the control provides the pilot with a mechanical advantage to actuate the elevator during operation without the booster. However, the elevator travel is reduced to increase the mechanical advantage. Elevator booster control force can also be provided by an auxiliary electrically driven hydraulic motor which supplies hydraulic power to the booster unit in the event of normal hydraulic system failure.

1–221. ELEVATOR TRIM TABS. The elevator trim tab control is connected by cable to the tab actuating unit at the elevator. The tab actuator unit is connected by rod linkage to the trim tab and is designed to provide servo-action when the elevator is moved. The flight station trim tab manual control wheel is interconnected at the center control stand to an electric motor actuator which provides thumb tip control of the elevator tab action. When the slide-button (nose-up or nose-down) switch is pressed, a clutch is engaged by a solenoid to provide a connection between the motor actuator and the tab operating mechanism. An emergency release lever is located on the center control stand to disengage the clutch mechanically in the event of a stuck solenoid or mechanical failure of the clutch mechanism.

1–222. RUDDER CONTROL SYSTEM. The rudder pedals are connected by cable to a quadrant assembly, located in the aft fuselage section. The quadrant assembly is connected by push-pull rods to the center rudder. Another set of push-pull rods interconnect the center rudder with each outboard rudder. Linkage also connects the cable quadrant with the rudder booster assembly which is different in mechanical arrangement from the aileron and elevator booster assemblies using a trail center valve. The linkage is arranged so that the movement of the rudder pedals supplies part of the force necessary to actuate the rudders. Refer to figure 1–31.

1–223. RUDDER TRIM TABS. The flight station trim tab control is connected by cable to each outboard rudder tab actuating unit. The center rudder is not provided with a trim tab. The tab actuating units are connected to the tabs by adjustable link rods which screw forward and aft by action of the actuator, thus deflecting the tabs. The rudder trim tabs have no servo action.

1–224. FLIGHT CONTROL SYSTEM CONTROLS.

1–225. AILERON BOOSTER CONTROL LEVER. The aileron booster control lever is located on the center control stand (figure 1–54) to the left of the throttle controls. When the booster control lever is pulled to the OFF (aft) position, a cable system actuates a hydraulic shut-off valve and opens a bypass valve in each aileron actuating cylinder. Fluid from the hydraulic system is then shut off from the boosters, and the bypass valves in each cylinder allow the fluid to flow freely from one end of the cylinder to the other as the ailerons are moved. When the boosters are shut off, the control wheel forces are transmitted to the ailerons through the mechanical system of cables and linkage.

1–226. AILERON TRIM TAB HANDCRANK. The aileron trim tab handcrank is located on the center control stand (figure 1–54) and is rotated to actuate a cable system routed to each aileron tab. Internal stops limit the number of turns of the handcrank in each direction from the neutral position. Tab position is shown by a needle forward of the handle and by a dial indicator below the handcrank. The needle on the lower dial gives the most sensitive indication and moves from the neutral position toward either the LEFT or RIGHT extremities as the handcrank is rotated.

1–227. EMERGENCY ELEVATOR BOOSTER SHIFT CONTROL. The elevator booster shift control is located on the left side of the central control stand (figure 1–54) and consists of a shaft with a push-button lock on the handle grip. Normally, the control is in the forward and downward position for boost ON. It is pulled upward and aft for boost OFF. (Refer to the Elevator Control System described in this section.)

1–228. ELEVATOR AUXILIARY BOOSTER SWITCH. The auxiliary booster toggle switch, located on the pilots' overhead switch panel (figure 1–51), has three positions, ON, OFF, and EMERGENCY ON. It is spring-loaded to OFF from the EMERGENCY ON position. When the switch is placed in the ON position, the electrically-driven auxiliary hydraulic motor is energized and supplies hydraulic power to the booster. In the event of electrical system failure, the switch can be held in the EMERGENCY ON position to energize the auxiliary booster. The electrical circuit to the EMERGENCY ON position is direct from the aircraft batteries and is not protected by circuit breakers.

CAUTION

Do not use the EMERGENCY ON position unless the circuit breaker has tripped and use of the booster is mandatory. Fire may result.

1–229. ELEVATOR TRIM TAB CONTROL WHEELS. The elevator trim tabs may be controlled manually by control wheels located on each side of the pilots' center control stand (figure 1–54), that are interconnected by a shaft which drives a drum pulley. A control cable connects the drum pulley in the stand with the tab actuating units. The control wheel is rotated forward for nose-down and rotated aft for nose-up trim. A dial needle indicator, driven by the drum shaft by means of gears, is mounted inboard of the wheels on the control stand and indicates the relative position of the tabs.

1–230. ELEVATOR TRIM TAB SWITCHES. The elevator trim tabs may be operated electrically (as well as manually) by an electric motor-driven reduction unit, mounted in the control stand. The three-position slide switch, mounted on top of the left hand grip of the pilot's control wheel, is spring-loaded to the center position. As the switch is moved to either the nose-up or nose-down position, a clutch in the reduction unit is engaged by a solenoid, and the electric motor actuator is energized. The actuator is connected by a chain to sprockets on the drum pulley shaft.

1–231. ELECTRIC ELEVATOR TRIM TAB CLUTCH LEVER. The emergency clutch lever is located on the center control stand (figure 1–54) and has two positions, NORMAL and EMERGENCY. The lever is normally kept in the NORMAL (forward and disengaged) position. When the electric elevator trim tab is used, the lever is placed in the EMERGENCY (aft and engaged) position which allows a solenoid to engage the clutch. In the event of solenoid or mechanical failure, the lever may be placed in the NORMAL position, disengaging the clutch and permitting manual operation of the trim tab control wheel.

1–232. RUDDER BOOSTER CONTROL LEVER. The rudder booster control lever is located on the center control stand (figure 1–54) to the left of the throttle controls. When the booster control lever is pulled to the OFF (aft) position, a control cable actuates a hydraulic shut-off valve and opens a bypass valve in the rudder actuating cylinder. Fluid from the hydraulic system is then shut off from the booster, and the bypass valve in the cylinder opens and allows the fluid to flow freely from one end of the cylinder to the other as the rudder is moved. When the rudder booster is shut off the rudder pedal forces are transmitted to the rudders through the mechanical system of cables and linkage.

1–233. RUDDER AUXILIARY BOOSTER SWITCH. The rudder auxiliary booster switch, located on the pilots' overhead switch panel (figure 1–51), has three positions, ON, OFF, and EMERGENCY ON. It is spring-loaded to OFF from the EMERGENCY ON position. When the switch is moved to the ON position, the electric hydraulic motor is energized which supplies auxiliary hydraulic power to the rudder booster in the event normal hydraulic power is not available. When the switch is held in the EMERGENCY ON position, electrical power is supplied directly to the auxiliary motor from the d.c. bus or, if that bus is dead, direct from the aircraft batteries without the protection of circuit breakers.

CAUTION

Do not use the EMERGENCY ON position unless the circuit breaker has tripped and use of the booster is mandatory. Fire may result.

1–234. RUDDER TAB HANDCRANK. The rudder tab handcrank is located on the center control stand (figure 1–54) and is rotated to drive a drum in the control unit. This drum is connected by cables to a similar drum in each of the two tab-actuating units located in the outboard rudders. Internal stops limit the number of turns of the handcrank in each direction from the neutral position. Tab position is shown by a dial indicator forward of the handcrank. The needle on the dial moves from the neutral position toward either the LEFT or RIGHT extremities as the handcrank is rotated.

1–235. FLIGHT CONTROL INDICATORS.

1–236. ELEVATOR AUXILIARY BOOSTER CONTROL INDICATOR LIGHT. The auxiliary booster indicator light is located on the pilots' overhead switch panel (figure 1–51) adjacent to the elevator auxiliary booster switch. The indicator light glows amber whenever the auxiliary boost pump is in operation.

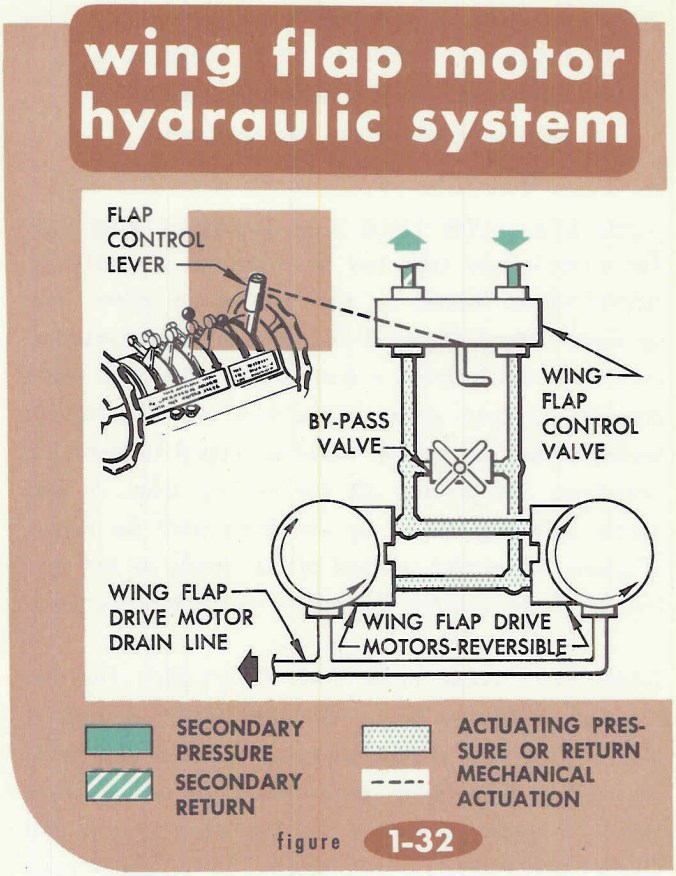
1–237. RUDDER AUXILIARY BOOSTER CONTROL INDICATOR LIGHT. The rudder auxiliary booster indicator light is located on the pilots' overhead switch panel (figure 1–51) adjacent to the rudder auxiliary booster switch. The indicator light glows amber whenever the auxiliary boost pump is in operation.

1–238. THREE AXIS TRIM INDICATOR. Refer to Automatic Pilot Indicators in Section IV.

1–239. WING FLAPS.

1–240. The wing flaps are Fowler-type and the flap motion, during extension, is a combination of an aft and a downward tilting movement. There are twelve flap sections, ten of which are located in the inner wing panels (five in each wing) and two in the wing center section, (one on each side). The flap control lever is connected by cables to the flap control unit located in the wing center section. The flap control unit consists of a hydraulic selector valve and a follow-up mechanism that controls two hydraulically-driven motors which supply the driving force for the wing flaps. The control unit also allows pre-positioning of the flaps and changing of the flap movement at any time without completing flap carriages. The carriages are attached to the wing flap sections and roll on tracks riveted to adjacent wing ribs. Spring units take up the slack on the loose side of the chains to prevent jamming.

1–241. In the event that the wing flaps fail to operate by normal means, the flaps may be extended or retracted manually by engaging a handcrank in a shaft-and-gear mechanism and opening a bypass valve. Refer to figure 1–33. Access to the shaft-and-gear mechanism and bypass valve is a selected cycle. The two hydraulic motors are located on the rear beam in the wing center section and are powered by the secondary hydraulic system. Refer to figure 1–32. Output of the hydraulic motors is transmitted by a main drive shaft to drive shafts that extend into each inner wing panel to operate separate intermediate drive units. There are fourteen intermediate drive units bolted to carriage track ribs and to brackets on the wing rear beam. The intermediate drive units turn sprockets that are connected by chains-and-cables to the wing through the flap emergency access door, centrally located in the cabin floor slightly aft of the right hand window emergency exit in the main passenger compartments. Before the handcrank is used, the bypass valve, located near the aft edge of the access door, must be turned to the open position so that hydraulic fluid can be circulated through the hydraulic flap motors, thus preventing a hydraulic lock.



1–242. WING FLAP CONTROLS.

1–243. WING FLAP CONTROL LEVER. The wing flap control lever is located on the top, right side of the center control stand (figure 1–54). There are four placarded positions on the quadrant, TAKE-OFF, APPROACH, 80%, and LANDING. When the lever is full forward, the flaps are retracted or are in the up position. Moving the flap lever progressively aft permits the following flap extensions:

TAKE-OFF	(60% extension)
APPROACH	(66% extension)
80%	(80% extension)
LANDING	(100% extension)

Note

There is no detent at the APPROACH position, however, the lever will remain at that position.

1–244. EMERGENCY EXTENSION HANDCRANK. The emergency handcrank is strapped in the left forward coat closet. It fits onto the emergency extension crank square drive located below the wing flap emergency extension access door.

wing flap emergency extension bypass valve and handcrank drive

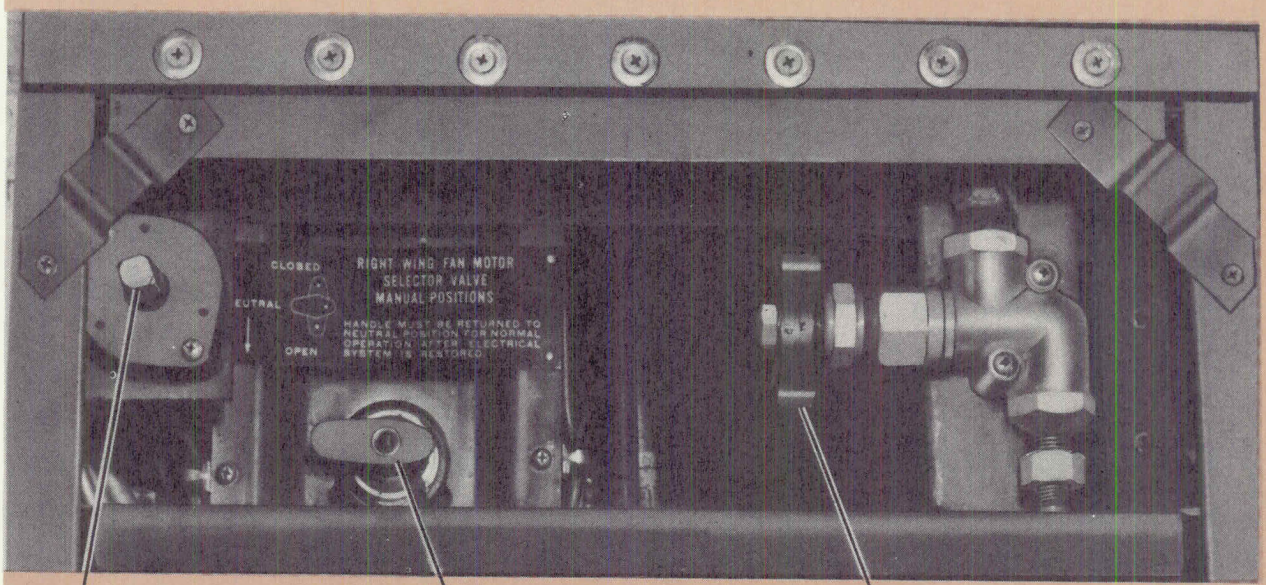


figure 1-33

1-245. WING FLAP INDICATORS.

1-246. WING FLAP POSITION INDICATOR. The wing flap indicator is located on the pilots' center instrument panel* (figure 1-49) or on the copilot's instrument panel† (figure 1-49). The DOWN position corresponds to the 100% extension.

1-247. LANDING GEAR.

1-248. The aircraft is equipped with a fully retractable tricycle landing gear. When the gear retracts, the nose gear pivots aft into the underside of the fuselage, and the main gears pivot forward into the nacelle wheel wells. Landing gear doors, which are mechanically operated by the gear oleo pneumatic shock struts, lie flush with the airplane contour when the gears are retracted. The secondary hydraulic system provides the hydraulic pressure to operate the uplocks, downlocks, and actuating cylinders which extend and retract the landing gear. Refer to figure 1-34.

1-249. The nose and main gears have oleo pneumatic shock struts, which utilize air and hydraulic fluid to give controlled resistance to taxiing, take-off, and landing shocks. Dual wheels are mounted on each of the landing gear shock struts. The nose gear wheels are cambered 12 degrees to help forward castering. A centering saddle cam is built into the nose gear shock strut to align the gear when there is no weight on it. Scissor links keep the landing gear shock strut pistons and cylinders in alignment. For ground handling, the nose gear scissor link may be quickly disconnected by removing the center pivot bolt.

1-250. HYDRAULIC SYSTEM. A cable-actuated hydraulic selector valve, located in the aft end of the forward cargo compartment, directs secondary hydraulic pressure to either the retracting or extending ends of the landing gear actuating cylinders and to the uplocks or downlocks. The main gear actuating cylinders, which are located on each upper drag strut assembly, have a run-around valve which allows hydraulic fluid to pass from one side of the actuating cylinder pistons to the other

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

landing gear hydraulic system

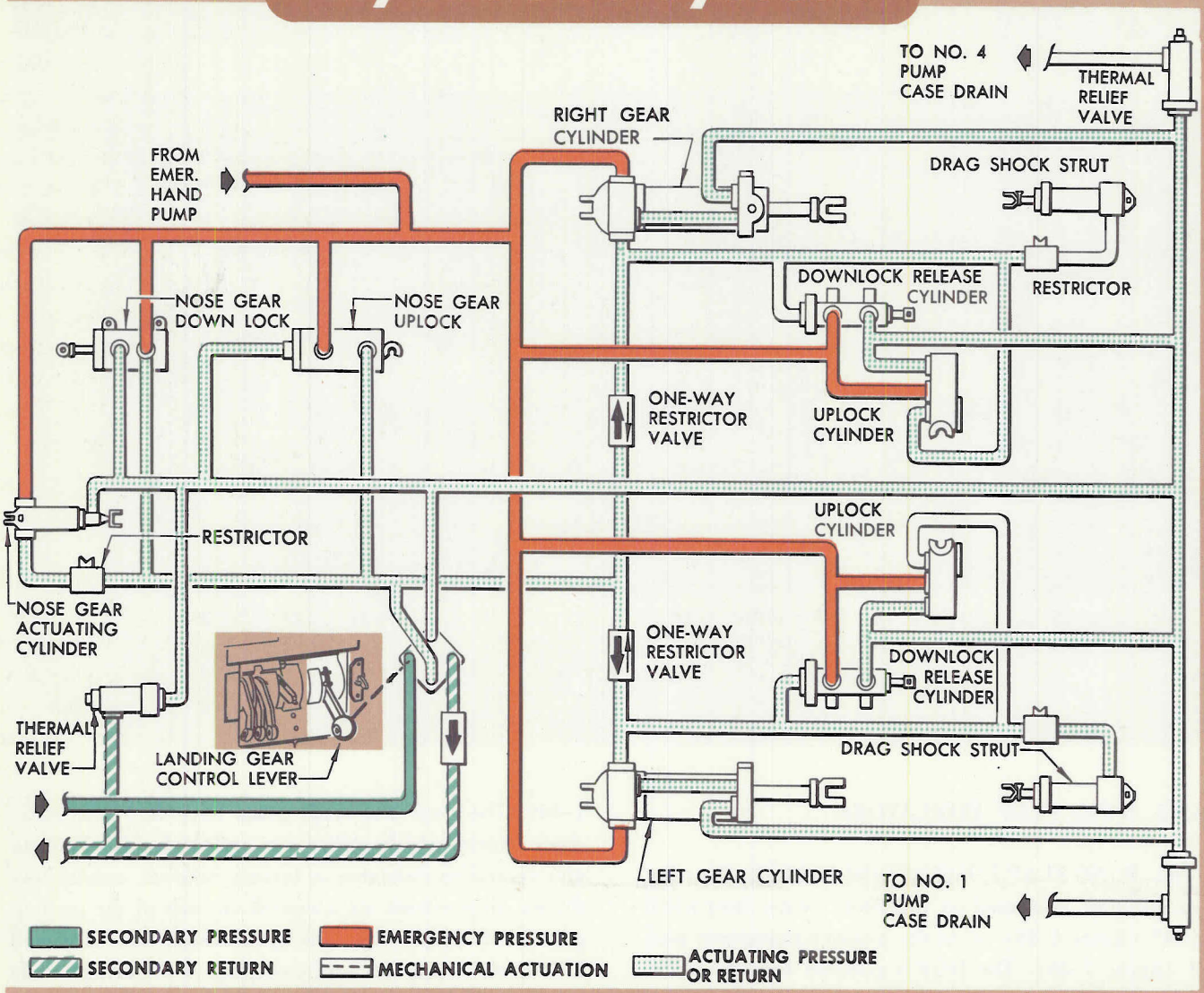


figure 1-34

without returning the fluid to the hydraulic reservoir when the gears extend, thus reducing operating time.

1–251. The right wing secondary heat exchanger fan motor receives its hydraulic fluid from the secondary hydraulic system. Normally, the motor is shut off by a main gear scissors switch during retraction of the gear. In the event of failure of this switch, landing gear operating time may be extended, since the fluid flow to the fan motor will tend to starve the landing gear.

1–252. EMERGENCY LANDING GEAR EXTENSION. In the event that the secondary hydraulic system does not supply sufficient pressure, the landing gear can be extended by means of a hand pump system. Hydraulic fluid for the hand pump is taken from an emergency extension hydraulic reservoir and is directed to the uplocks, gear actuating cylinders, and downlocks through separate hydraulic lines. No emergency means is provided for gear retraction.

nose gear steering hydraulic system

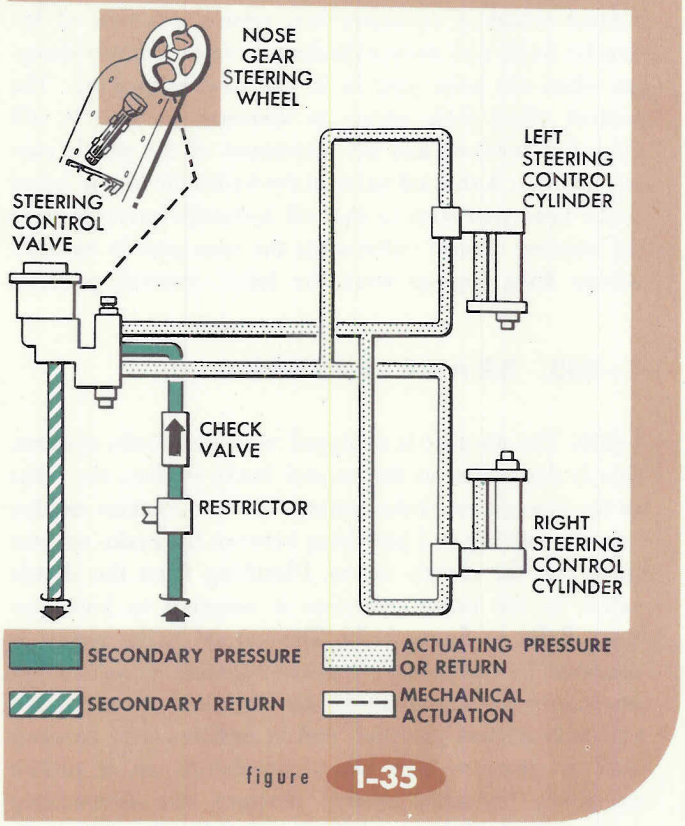


figure 1-35

1–253. MAIN GEAR DRAG STRUTS. The main gear drag strut assembly consists of an upper and lower drag strut. The upper strut is composed of two rigid triangular forgings, which are bolted together with pivot points at each end. The lower drag strut is a hydraulic cylinder that absorbs forward and aft shock loads of landing and taxiing by the combined action of an internal spring and a metering orifice. There is no circulation of fluid through the lower drag strut, but when the landing gear selector lever is in the DOWN position pressure from the secondary hydraulic system is used to maintain hydraulic fluid in the lower drag strut.

1–254. UPLOCKS AND DOWNLOCKS. The main gear uplocks are mechanically latched to the landing gears which trip triggers when they are completely retracted. The locks are released by hydraulic pressure and are held open by springs and pressure as the gear extends. The nose gear uplock operation is similar to that of the main gear. The gears cannot be released from the uplocks by maneuvering loads.

1–255. When each main gear is in the down position, a downlock strut prevents the drag strut from folding. One end of the downlock strut connects to the pivot that connects the upper and lower drag struts, and the other end hooks over a lock shaft, mounted in the wheel well. A spring-loaded latch in the hook prevents disengagement except by operation of a hydraulically operated downlock release cylinder. The nose gear downlock is a mechanical cam that locks the drag strut in the extended position. The gear cannot retract until the cam is released by the hydraulically operated nose gear downlock release cylinder. When the aircraft is parked, ground safety pins must be inserted through the downlock mechanism. These pins will prevent accidental folding of the gears, should inadvertent downlock release occur because of mispositioning of the landing gear lever when secondary hydraulic system pressure is available. These pins cannot be removed if the hydraulic forces are reversed.

1–256. LANDING GEAR CONTROLS.

1–257. LANDING GEAR CONTROL LEVER AND SOLENOID LOCK RELEASE. The landing gear control lever is located on the right aft face of the center control stand (figure 1–54) and actuates the landing gear selector valve by control cables. It has three notched positions, UP, DOWN, and NEUTRAL. The lever is moved to the UP position to retract the landing gear and to the DOWN position to extend it. The NEUTRAL position is midway between the UP and DOWN positions and the landing gear control lever must be pulled out to pass through the NEUTRAL position. When moving the lever to the UP position, the release trigger to the right of the control lever must be held toward the lever. After the landing gear has been retracted, the control lever should be moved to the NEUTRAL position to decrease the possibility of leaks occurring in the landing gear system, by shutting off unnecessary hydraulic pressure. The uplocks are sufficient to hold the gear in the retracted position. When the landing gear is extended, the control lever should be left in the DOWN position.

1–258. A solenoid lock is provided for the landing gear control lever to prevent accidental movement of the lever into the UP position when the weight of the aircraft is on the gear. The solenoid lock is operated by a series circuit through both main gear scissors switches. The solenoid lock may be manually released by depressing the landing gear lock solenoid lock release accessible through a hole in the right side of the center control stand.

1–259. EMERGENCY HAND PUMP AND SELECTOR LEVER. The emergency hand pump and selector lever are located on the flight station floor outboard of the copilot's seat. The selector lever has two positions, EMER. BRAKES and EMER. GEAR. When the selector lever is in the EMER. GEAR (aft) position, the hand pump may be used to supply pressure through independent emergency extension lines to the uplocks, actuating cylinders, and downlocks. The selector lever is spring-latched to the EMER. BRAKE (forward) position.

1–260. LANDING GEAR INDICATORS.

1–261. LANDING GEAR "GEAR DOWN" LIGHTS. Three green landing gear position indicator lights are located on the copilot's instrument panel (figure 1–49) on LAC Serials 4501 through 4509, and on the pilots' center instrument panel (figure 1–49) on LAC Serials 4510 through 4519. One light is connected to the downlock switch of each gear. As a gear is locked in the down position the corresponding green light comes on.

1–262. LANDING GEAR WARNING LIGHT. This light is located near the landing gear position indicator lights. It glows (red) whenever the landing gear is in an unlocked or unsymmetrical position. It goes out when all gears are in the full retracted position or the extended and locked position. The "push-to-test" feature of this light is not operative when the gears are down and locked.

1–263. LANDING GEAR WARNING HORN AND RELEASE LEVER. A landing gear warning horn is operated by four throttle switches connected in parallel, and the unlock contacts of the downlock switches are also connected in parallel. This horn will sound if one or more of the throttles are retarded beyond a critical setting and all gears are not down and locked. The landing gear warning horn can be silenced either by locking the landing gear down, by advancing the throttles, or by raising the horn release lever, located on the left side of the center control stand. When the throttles are re-advanced, the warning horn circuit is reset.

1–264. NOSE GEAR STEERING WHEEL. When the nose gear is extended it can be turned by the small control wheel, located on the left side of the pilot's station. Turning the control wheel operates the control cables which actuate the steering control valve and directs secondary hydraulic pressure to the left or the right steering control actuating cylinder and turns the nose gear. Refer to figure 1–35. The control wheel must be held to keep the nose gear turned, and when the wheel is released, the nose gear will return to the neutral (central) position. Approximately 1½ turns of the control wheel will deflect the nose gear 58½ degrees, which is the maximum. When the nose gear is turned that amount, the inside main gear shock strut will turn on a radius of 12 feet. Oscillations are dampened by orifices in the steering control actuating cylinders that restrict the flow of hydraulic fluid, and these cylinders serve as shimmy dampers when the nose gear is in the neutral position. The control wheel folds along its diameter, so that it will clear full forward and aft movement of the pilot's control column. A shut-off valve in the hydraulic line is linked to the nose gear strut to shut off hydraulic pressure from the steering control valve when the nose gear is approximately 36½ degrees from the fully retracted position.

1–265. BRAKE SYSTEM.

1–266. The aircraft is equipped with two brake systems. One is designated as the normal brake system; the other as the emergency brake system. The two systems employ separate valving and plumbing between the brake selector valve and the shuttle valves. Plumbing from the shuttle valves to the brake cylinders is common to both systems. Refer to figure 1–36. The normal brake system is operated by secondary hydraulic system pressure. The emergency brake system is also operated by secondary hydraulic system pressure, and in addition may be operated by pressure from the accumulators, or, if neither secondary hydraulic system pressure nor accumulator pressure is available, and if time permits, the emergency brake system may be operated with pressure applied by the emergency hand pump.

1–267. NORMAL BRAKE SYSTEM. The normal brake system is selected by placing the brake selector valve lever in the NORM. position. When the toe pedals are depressed, pressure from the secondary hydraulic system is transmitted through the brake selector valve and through the normal side of the dual brake control valves to the deboosters. From the deboosters, pressure reduced to the optimum for braking action, is transmitted through the shuttle valves to the brakes.

1–268. EMERGENCY BRAKE SYSTEM. The emergency brake system is selected by placing the brake selector valve lever in the EMER. position. When the toe pedals are depressed, secondary hydraulic system pressure, accumulator pressure, or pressure supplied by the emergency hand pump is transmitted through the emergency porting of the brake selector valve and through the emergency side of the dual brake control valves to the lockout deboosters. From the lockout deboosters, pres-

brake system

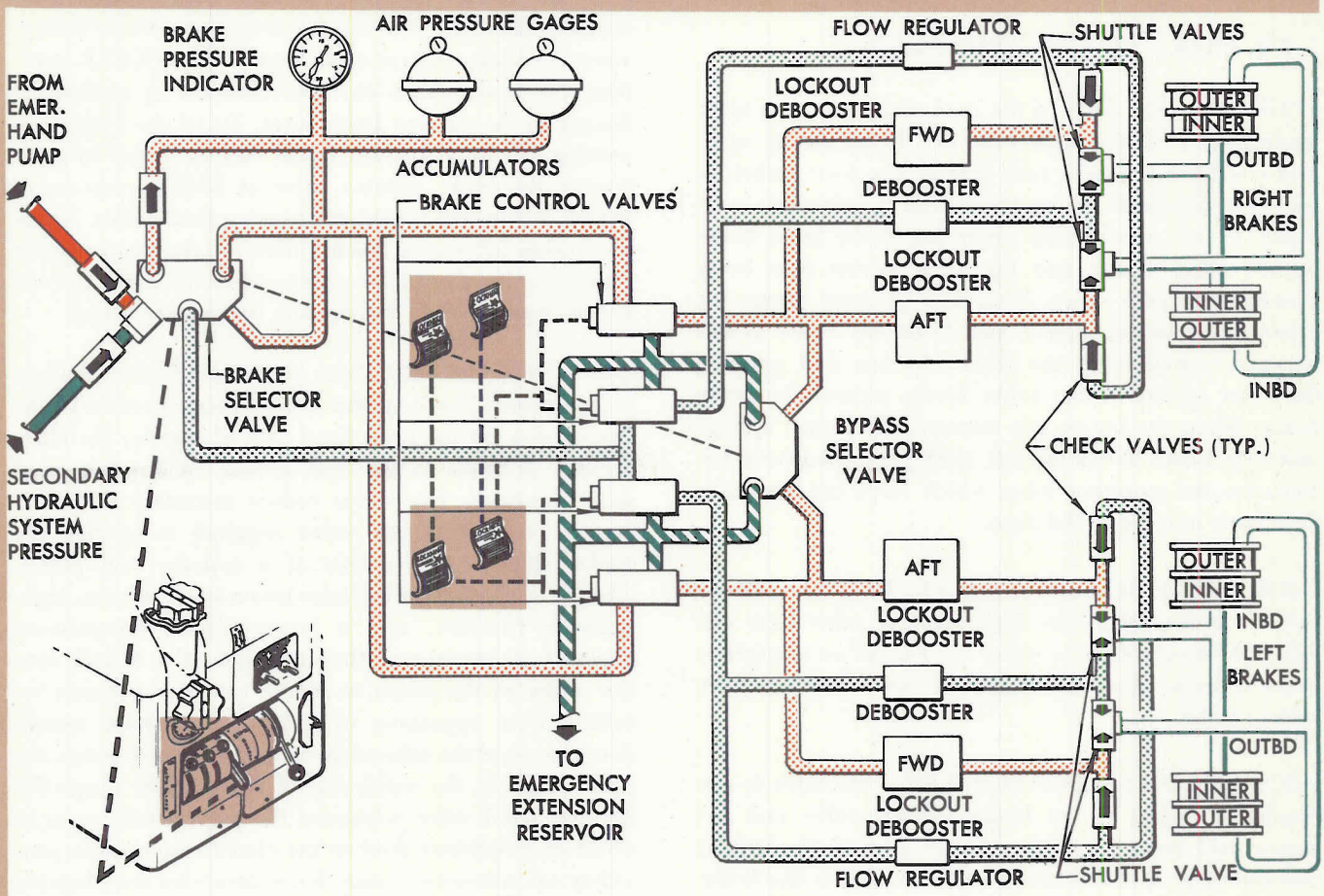


figure 1-36

sure reduced to the optimum for braking action, is transmitted through the shuttle valves to the brakes.

1–269. *With secondary hydraulic system pressure* available, brake operation with the brake selector valve lever in the EMER. position is similar to operation with the brake selector valve lever in the NORM. position, except that secondary hydraulic system pressure is directed to the brakes through the emergency brake system valving and plumbing instead of through the normal brake system plumbing.

1–270. *Without secondary hydraulic system pressure, but with accumulator pressure* (see paragraph 1–282), brake operation with the brake selector valve lever in the EMER. position is also similar to operation with the brake selector valve lever in the NORM. position, except that accumulator pressure, instead of secondary hydraulic system pressure, is directed to the brakes through the emergency system valving and plumbing, and the number of brake applications is limited to that which is available from the pressure stored in the accumulators.

1–271. If neither secondary hydraulic system pressure nor accumulator pressure is available, and sufficient time is available, hydraulic pressure to operate the brakes can be built up with the emergency hand pump with the brake selector in the EMER. position. In this configuration, pressure from the emergency hand pump is directed to the brakes through the emergency brake system valv-

ing and plumbing. This procedure should be used as a last resort because of the time required to build up pressure manually.

1–272. BRAKE SYSTEM COMPONENTS.

1–273. BRAKES. Each of the dual wheels on each main landing gear is equipped with two hydraulically operated Goodrich expander tube brakes. The four brakes on each pair of wheels are interconnected in pairs; the inner brake on one wheel being connected to the inner brake on the other wheel, and the outer brakes also being connected to each other. Hydraulic pressure causes the expander tubes to expand and force the brake blocks outward, compressing the return springs and pressing the outer surface of the brake blocks against the brake drum. When the brakes are released, the return springs move the brake blocks inward, away from the drum, and compress the expander tubes which force the hydraulic fluid back into the brake lines.

1–274. BRAKE SELECTOR VALVE. The brake selector valve is controlled by the brake selector valve lever and directs hydraulic fluid to either the normal or emergency brake systems. This valve is located forward of the center control stand.

1–275. BYPASS SELECTOR VALVE. This valve is mechanically linked to the brake selector valve and bypasses fluid from the high pressure side of the lockout deboosters, around the brake control valves to the brake return lines when the fluid supply in the low pressure side of the debooster lockouts is replaced and the debooster lockout pistons are moved upward. This occurs when the brakes are applied with the brake selector valve lever in the NORM. position. The valve is closed when the brake selector valve lever is in the EMER. position.

1–276. FLOW REGULATORS. When the brake pedals are depressed with the brake selector valve lever in the NORM. position, secondary hydraulic system fluid flows through flow regulators and into the lines between the shuttle valves and the lockout debooster pistons. The flow regulators limit the amount of fluid to approximately one quart per minute so as not to affect function of the normal brake system.

1–277. BRAKE CONTROL VALVES. The brake control valves are actuated by the toe portion of the pilots' rudder pedals to which they are connected by link rods. Depressing the toe pedals opens ports in the brake valves that meter hydraulic pressure to the deboosters or lockout deboosters. The two dual brake control valves are located on the bulkhead just forward of the pilot's rudder pedals. One side of each valve controls the fluid flow to the normal brake system, when the brake selector valve lever is in the NORM. position; the other side of each valve controls the fluid flow to the emergency brake system when the brake selector valve lever is in the EMER. position. The brake valves are also connected by mechanical linkage to the parking brake lever. To set the brakes for parking, the brake control valves may be locked by positioning the brake selector valve at EMER., depressing the toe pedals and raising the parking brake lever. To set the brakes for engine run-up prior to take-off, the brake selector valve should be positioned at NORM., the toe pedals depressed and the parking brake lever raised.

1–278. DEBOOSTERS. There are two debooster cylinders in the normal brake system. One reduces pressure to the four brakes on the right hand pair of wheels; the other reduces pressure to the four brakes on the left hand pair of wheels. The valves reduce secondary hydraulic system pressure to the value required to operate the brakes. Each valve consists of a cylinder and piston. The piston divides the cylinder into a small-volume, high-pressure chamber, and a larger-volume, low-pressure chamber. A poppet-type thermal relief valve is built into the center of the piston to relieve excessive pressure resulting from expansion of fluid in the closed system downstream of the deboosters with the brakes reduced. An upset screw in the outlet end of the cylinder opens the thermal relief valve whenever the piston bottoms as a result of insufficient fluid in the closed system, thus providing an automatic means for maintaining an adequate supply of fluid downstream from the deboosters for effective braking action.

1–279. LOCKOUT DEBOOSTERS. There are four lockout deboosters in the emergency brake system; two for each pair of wheels. One lockout debooster reduces pressure to the inner brake on one wheel and the inner brake on the other wheel of the right hand landing gear; the second lockout debooster reduces pressure to the outer brake on the first wheel and the outer brake of the second wheel on the same gear. The four brakes on the two wheels of each landing gear are similarly operated, so that one brake on each wheel will be effective in the event of failure of a hydraulic pressure line downstream from either lockout debooster. The lockout deboosters differ from the deboosters in the normal brake system in that they do not have an upset screw to open the thermal relief valve when the piston is bottomed. Adequate fluid supply in the low pressure section of the emergency brake system, downstream from the lockout deboosters, is maintained during normal operation of the brake system by the emergency lockout debooster bleed system.

brake pedal angle vs. brake system hydraulic pressure

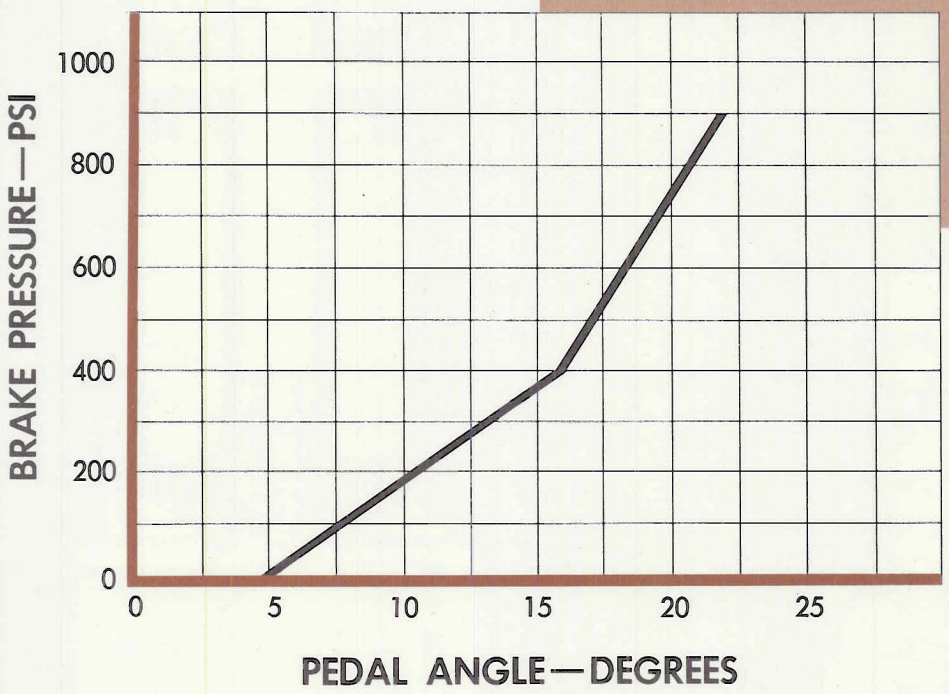


figure 1-37

1–280. The piston of each lockout debooster is equipped with a rod assembly which extends through the head of the debooster cylinder. (Refer to figure 1–38.) This assembly provides a means of bleeding both chambers of the lockout debooster when necessary. It also serves as a position indicator for the piston. The rod is encased in a metal cover with a lengthwise slot through which the piston rod is visible. Part of the nameplate, attached to the cover adjacent to the slot, is colored red. When the washer-indicator, near the top of the rod, is positioned in the red area with full brakes applied, it is an indication that the brakes must be bled.

1–281. SHUTTLE VALVES. The normal and emergency brake systems are connected upstream from the brake cylinders by four shuttle valves. From the shuttle valves to the brake cylinders, the plumbing is common to both systems. The shuttle valves are positioned automatically by system pressure and direct pressure either from the normal or emergency brake system to the brakes.

1–282. BRAKE ACCUMULATORS. Two ten-inch accumulators are installed in the emergency brake system to provide pressure for limited operation of the brakes in the absence of secondary hydraulic system pressure. The air chamber of each accumulator is precharged with 1000 psi air pressure, with no hydraulic pressure on the fluid side. The fluid chambers can be charged with fluid from the secondary hydraulic system when the brake selector valve lever is in the EMER. position, or, if secondary hydraulic system pressure is not available, they

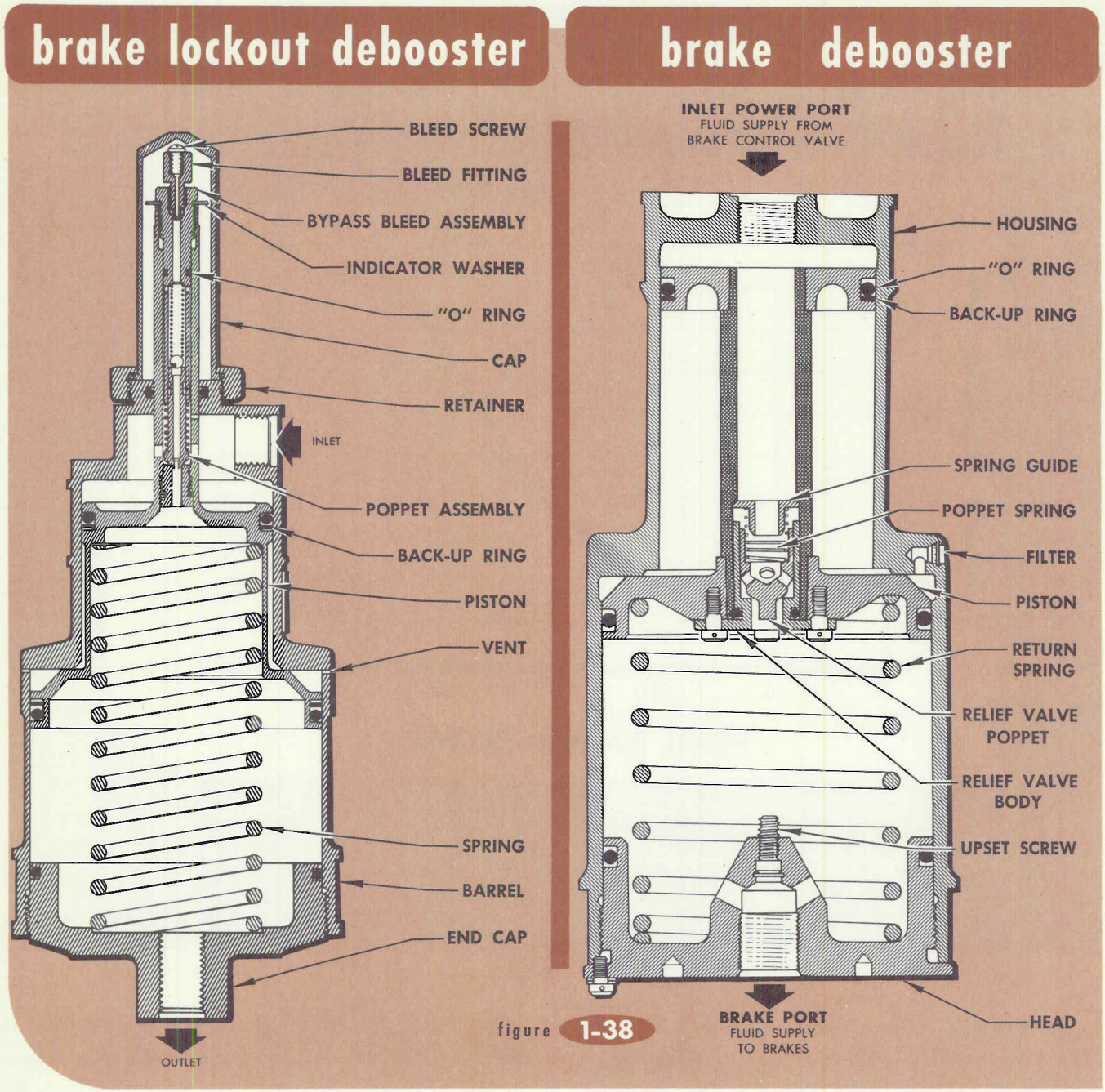


figure 1-38

may be charged with the emergency hand pump with fluid from the emergency extension reservoir, while the emergency hand pump selector lever is positioned at EMER. BRAKES, and the brake selector valve lever is positioned at EMER. Without secondary hydraulic system pressure, and with the brake selector valve lever in the EMER. position, application of the brakes allows the compressed air charge to force the fluid out of the accumulators into the emergency brake system to supply the pressure to operate the brakes.

1–283. EMERGENCY HAND PUMP The emergency hand pump handle is located to the right of the copilot's seat. The pump is used to develop hydraulic pressure for emergency operation of the brakes and emergency extension of the landing gear in the absence of secondary hydraulic system pressure. Each cycle of the pump handle moves approximately 1 cu. in. of fluid. Fluid is drawn from the emergency extension reservoir.

1–284. PARKING BRAKES. The parking brake holds the brake control valves open after the toe pedals have been depressed. When the brake selector valve is in the EMER. position, the accumulators supply the pressure

necessary to keep the brakes set after the engines have been shut down, and secondary hydraulic system pressure is no longer available. Fully charged, the accumulators will maintain adequate pressure to park the aircraft for about 24 hours.

CAUTION

Never move the brake selector valve lever while the toe pedals are depressed nor while the parking brake is set.

1–285. BRAKE SYSTEM CONTROLS AND INDICATORS.

1–286. BRAKE PEDALS. The brakes are controlled by the toe portion of the rudder pedals, which are connected to the brake control valves. The pilot's and copilot's brake pedals are interconnected by cables. Slack take-up springs are installed on each cable to take up the slack when the pilot's brakes are applied. The linkage is so arranged that the toe pedals can be depressed 5° before pressure is fed to the brakes. As the pedals are depressed beyond 5°, the pressure increases in the relationship shown on figure 1–37. The rudder pedals are hinged, and geometry of the linkage is such that pedal movement for rudder control does not actuate the brake valve unless the pedals are tilted forward by toe pressure.

1–287. PARKING BRAKE HANDLE. There are two parking brake handles, one on each side of the center control stand. They are both connected to a lever at the rear of the control stand. With the parking brake handle in the lowered position, the parking brake is off. When raised, after the toe pedals have been depressed, the mechanical linkage holds the brake valves in the open position.

1–288. PARKING BRAKE WARNING LIGHT. The parking brake warning light, located on the lower right of the pilot's instrument panel (figure 1–49), is actuated by the parking brake control mechanism when the parking brake handle is raised.

1–289. EMERGENCY BRAKE PRESSURE GAGE. The emergency brake pressure gage is located on the pilot's auxiliary instrument panel* (figure 1–49) or adjacent to the copilot's side panel† (figure 1–49). It is a direct pressure instrument calibrated in psi, actuated by hydraulic pressure in the emergency brake system.

1–290. BRAKE SELECTOR VALVE LEVER. The brake selector valve lever is located on the aft face of the center control stand (figure 1–54) where it is accessible to both pilots. It is placarded BRAKES, with its two positions, EMER. (up) and NORM. (down). The lever is mechanically connected with and operates the brake selector valve.

1–291. EMERGENCY HAND PUMP SELECTOR VALVE LEVER. The emergency hand pump selector valve lever (figure 1–27) is located near the base of the emergency hand pump to the right of the copilot's seat. The lever is placarded EMER. BRAKES (forward) and EMER. GEAR (aft). The lever is normally in the EMER. BRAKES position, and must be in this position when the emergency hand pump is used to supply emergency brake pressure.

1–292. PITOT STATIC SYSTEM.

1–293. The pitot static system includes the pitot system through which impact air pressure is transmitted to the airspeed indicators and the static system through which outside static air pressure is transmitted to the altimeters, airspeed indicators, rate of climb indicators, cabin differential pressure indicator, altitude control of the automatic pilot, and altitude control of the Zero Reader. (Refer to figure 1–39.) Two separate pitot systems are provided, each of which includes a pitot head installed on the lower fuselage nose. The left pitot head supplies impact air pressure for the pilot's and navigator's airspeed indicators, and the right pitot head supplies impact air pressure for the copilot's and the flight engineer's airspeed indicators.

1–294. The static system flush-type openings are located on each side of the fuselage nose. Two separate systems, first static and second static, are installed to provide separate and alternate static selection to both the pilot and copilot in an emergency. The selection of either system is controlled by the static selector valves on the pilot's and copilot's instrument panels.

1–295. ALTIMETERS. Five sensitive altimeters are mounted in the aircraft. One is located on the air conditioning control panel and one each is installed in the pilot's, copilot's, flight engineer's upper, and navigator's instrument panels. The altimeters have a range of 50,000 feet altitude and a ground setting scale settable in inches of mercury.

1–296. AIRSPEED INDICATORS. An airspeed indicator is mounted on the pilot's, copilot's, flight engineer's, up-

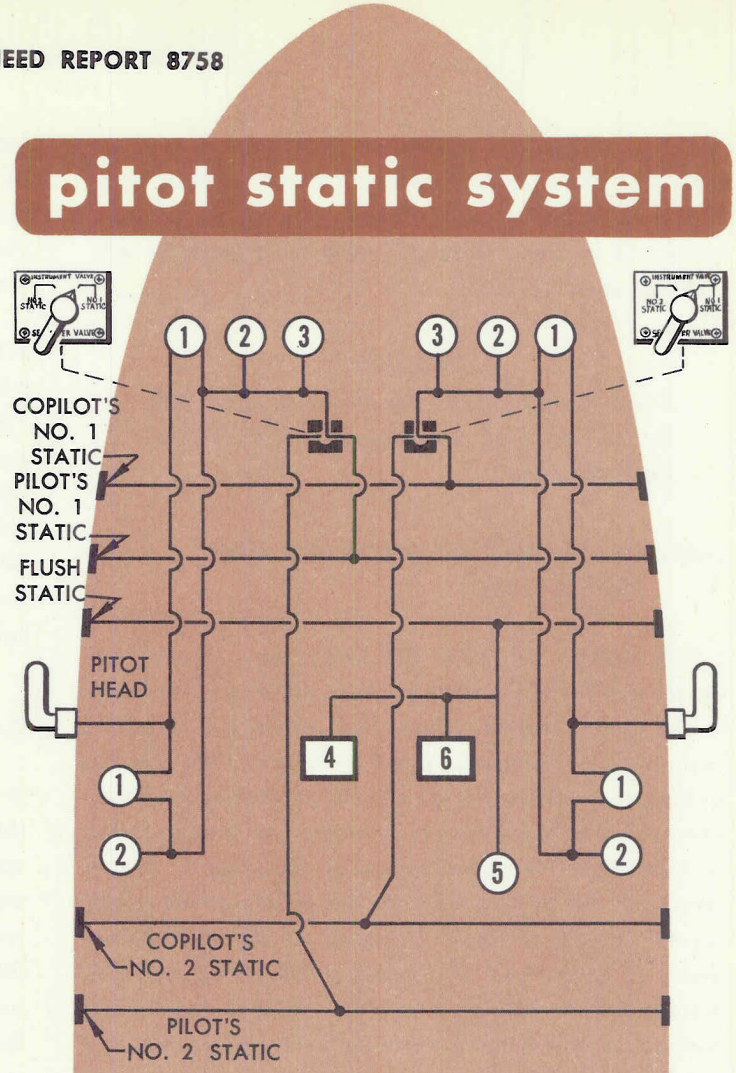
*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

per, and the navigator's instrument panel. The airspeed indicators are calibrated in knots.

1–297. RATE OF CLIMB INDICATORS. An instrument indicating vertical speed, climb, or descent, is mounted on the pilot's and copilot's instrument panels and the air conditioning control panel. The rate of climb indicator on the air conditioning control panel indicates only the equivalent cabin pressure rate of change. The other two indicators show the aircraft rate of climb or descent.

1–298. ZERO READER SYSTEM.

1–299. The Zero Reader system combines the aircraft attitude, heading, altitude, and radio information electronically and indicates the results on a single indicator. The Zero Reader indicator incorporates two bars; one vertical and one horizontal which, when centered, advise the pilot that the aircraft is either on the pre-selected course or the attitude is correct to return to the selected course. Such a course may call for the use of the system as a flight instrument, as a navigational instrument utilizing radio system signals, as an aid when making landing approaches under adverse weather conditions, and as a climb indicator for making go-arounds. Thus, under all circumstances the Zero Reader system combines indications of the gyro horizon, the compass, the directional gyro, the altimeter, and the deviation indicator (ILS cross-pointer). Therefore, in maintaining any selected flight plan with the Zero Reader, it is only necessary to observe a single indicator, and to maneuver the aircraft in pitch and roll so that the indicator bars are centered. The Zero Reader system receives and generates electrical signals that measure the attitude and displacement of the aircraft relative to a selected flight path. If the aircraft attitude is in error with respect to this path, the bars of the indicator will be displaced from the center. Such displacements are demands on the pilot for the execution of control that will return the aircraft to a flight attitude appropriate for the selected path. The system components include a Zero Reader system switch, selector switch, heading selector, indicators, control unit, and a go-around push-button. Refer to figure 1–40.



1. Airspeed indicator
2. Altimeter
3. Rate of climb indicator
4. Automatic pilot altitude control
5. Cabin differential pressure indicator
6. Zero reader altitude control

figure 1-39

zero reader controls

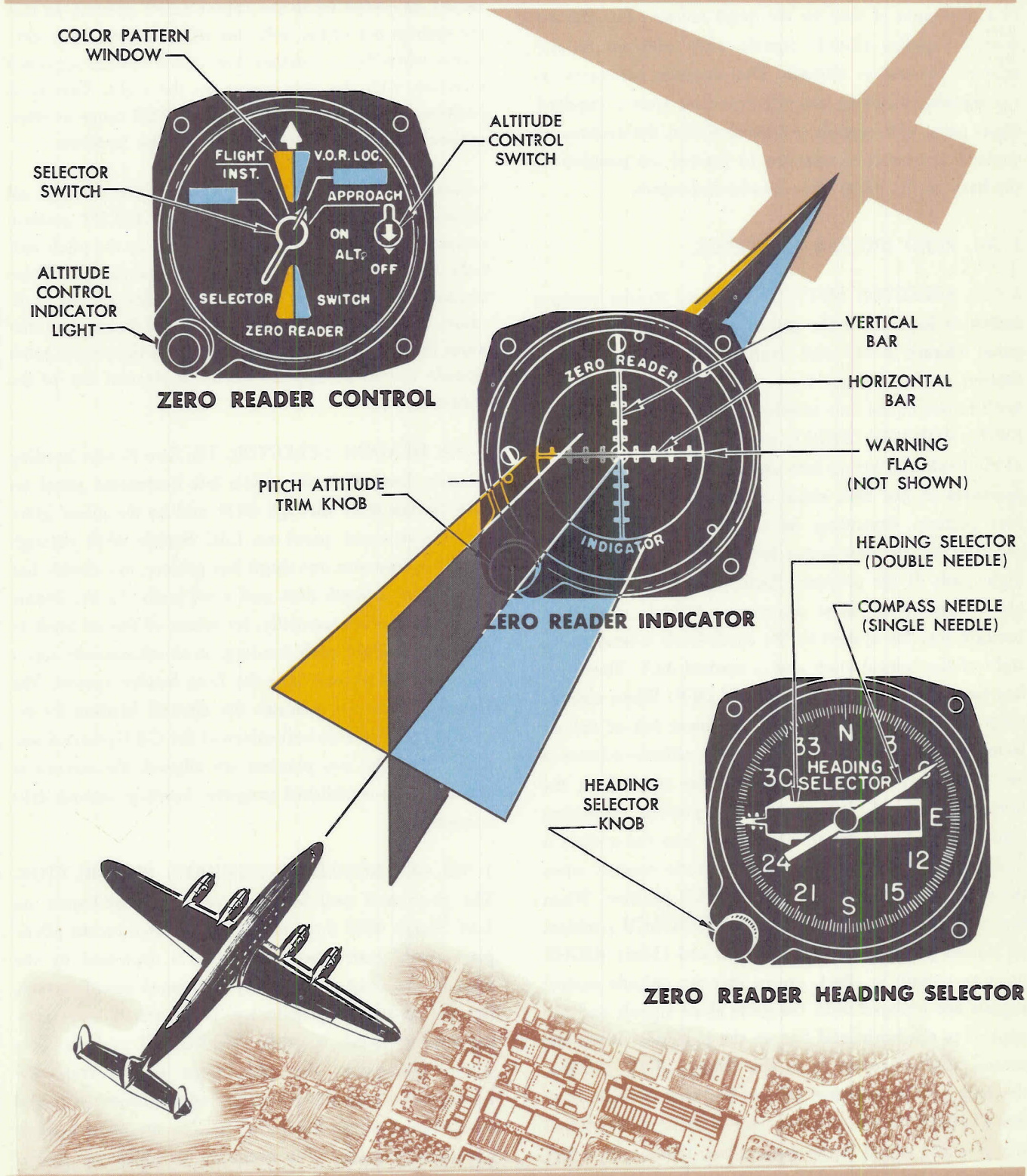


figure 1-40

1–300. ZERO READER CONTROL UNIT. The control unit located on the radio rack contains the vertical gyro, the quick erector, the altitude control, and the amplifier. The vertical gyro is the source of roll and pitch signals. Its gyroscope is brought to a vertical operating position in a minimum of time by the quick erector. The altitude control supplies altitude signals with reference to any selected barometric altitude. The amplifier compares error signals, caused by aircraft departure from a required flight path, with signals produced within the system, by corrective aircraft maneuvers, to control the position of the bars on the pilots' Zero Reader indicators.

1–301. ZERO READER CONTROLS.

1–302. SELECTOR SWITCH. The Zero Reader selector switch is located on the pilots' glare shield instrument panel (figure 1–41) and enables the pilot to select a desired mode of flight by rotating the central selector knob to one of the four positions marked LEFT, FLIGHT INST., VOR-LOC. RIGHT, and APPROACH. Rotation of the knob also brings into view, through two triangular apertures in the dial, either a blue-yellow or a yellow-blue pattern, depending on whether the selected path requires that the blue sector be to the left or right of the flight path. If the proposed flight path is without radio, black appears in these apertures. Altitude control is brought into the system by the small knob located to the right of the central knob and is marked ALT. This knob has two positions marked ON, and OFF. When altitude control is off, a green light at the lower left of the selector switch will come on. When the altitude control is on, signals of the altitude control are applied to the horizontal bar of the indicator. To prevent conflicting signals from being fed simultaneously into the system, a mechanical interlock disconnects altitude control when the selector switch is in the APPROACH position. When the central selector knob is in the APPROACH position, all signals present in the VOR-LOC. and (blue) RIGHT position remain in effect, except that the altitude control signals are replaced with the glide slope signals and are applied to the horizontal bar on the indicator. When the central selector switch is in the (blue) LEFT position, the bars on the indicator receive the same signals as in the FLIGHT INST. position but a radio navigational signal is also added to the vertical bar. The source of this signal may be a normal approach localizer leg for outbound flight, the reciprocal leg of the localizer for inbound flight, or VOR beam range provided the blue sector is on the left of the flight path.

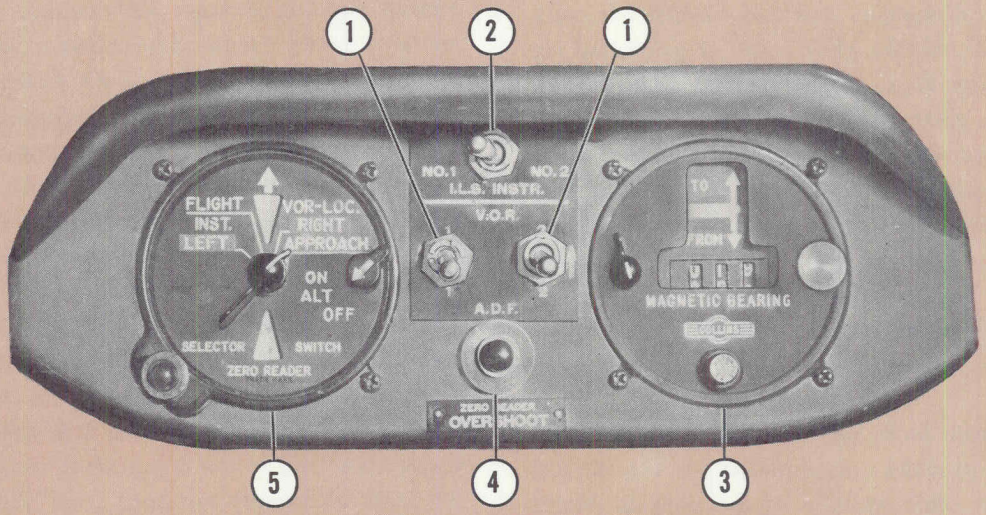
1–303. In the VOR-LOC. (blue) RIGHT position of the knob, the directional sensing of the radio signals is reversed, as compared to the (blue) LEFT position so that the vertical bar of the indicator will provide proper indication when flying localizer beam in a normal approach direction with the blue sector on the right. This knob position is always used when flying a VOR range or when outbound on the reciprocal beam of the localizer.

1–304. With the knob in the APPROACH position, all signals present in the VOR-LOC (blue) RIGHT position remain in effect, except that the altitude or the pitch attitude trim are replaced with glide slope signals. These signals are applied to the horizontal bar on the indicator. The approach go-around circuit is designed so that when the go-around button is depressed the proper pitch attitude correction appears on the horizontal bar of the indicator.

1–305. HEADING SELECTOR. The Zero Reader heading selector, located on the pilot's left instrument panel on LAC Serials 4501 through 4509, and on the pilots' glare shield instrument panel on LAC Serials 4510 through 4519, incorporates one single bar pointer, one double bar pointer, an azimuth dial, and a set knob. As the double bar pointer is set manually, by means of the set knob to the desired flight path heading, it simultaneously introduces voltage signals into the Zero Reader system. The single bar pointer indicates the aircraft heading by repeating the magnetic indications of the C-2 Gyrosyn Compass. When the two pointers are aligned, the aircraft is following the established magnetic heading without drift correction.

1–306. GO-AROUND (OVERSHOOT) PUSH-BUTTON. The go-around push-button (overshoot push-button on LAC Serials 4501 through 4509) is located on the pilots' glare shield instrument panel and is depressed by the pilot in the event an approach is deemed unsatisfactory, but the go-around push-button is connected only when the selector switch is in the APPROACH position. This action disconnects the glide slope signals from the horizontal bar on the indicator and establishes a biased fly-up signal to the horizontal bar. In the event another approach is made, it is necessary to move the central control knob away from and then back to the APPROACH position to restore normal system operation.

glare shield instrument panels



LAC Serials 4501 Through 4509

1. VOR-ADF selector switches
2. ILS instrument selector switches
3. Omni bearing selector
4. Zero reader go-around (overshoot) push button
5. Zero reader selector switch

Glare Shield Instrument Panel
for
LAC Serials 4510 Through 4519

To be included when available.

figure 1-41

1–307. ZERO READER INDICATORS. The two indicators located on the pilots' left and right instrument panels provide visual indication of the flight attitude of the aircraft with respect to a selected flight path. The indicator indices consist of a vertical bar, actuated by heading, radio, and roll signals; and a horizontal bar, actuated by pitch and altitude, glide slope, or go-around signals. Two warning flags, located behind and near the edge of the face glass, serve as operational safety indicators. One of these flags is red and is an OFF flag whose appearance indicates that a.c. power is not being supplied to the system, that voltage is not being supplied to the amplifier, and that the gyro has not erected to the specified limits. The second flag is yellow and is a go-around flag which is visible only during go-around operations.

1–308. A pitch trim knob located on the lower left face of the indicator provides compensation for the changes from the normal pitch attitude of the aircraft during flight. Such trim is made inoperative either when the altitude control is ON, or when the selector switch is set to the APPROACH position.

1–309. INSTRUMENTS.

1–310. Instruments are grouped on the pilots', flight engineer's, and the navigator's instrument panels; on the glare shield instrument panel; and on the air conditioning control panel. Refer to figures 1–49, 1–56, 1–41, and 4–9. The instruments that are not discussed in the following paragraphs are those which are a part of a complete system. Those instruments are discussed with the appropriate system.

1–311. DIRECTION INDICATOR (FLUX GATE). The Flux Gate direction indicator is located on the copilot's instrument panel (figure 1–49) on LAC Serials 4501 through 4509 and on pilots' center instrument panel on LAC Serials 4510 through 4519 and indicates the magnetic heading of the aircraft. The azimuth dial is directly connected through gears and linkage to an induction motor which operates both directionally and proportionally to changes of the magnetic heading of the aircraft. The gyro Flux Gate transmitter, mounted in the left wing, senses the aircraft heading changes, because of its change of position in the earth's magnetic field, and transmits an electrical signal to the Flux Gate direction indicator. The MDI contains a transmitting autosyn which furnishes change in heading information to the automatic pilot. Refer to Automatic Pilot Controls, Section IV. Power for operation of the Flux Gate direction indicator system is supplied by the aircraft a.c. electrical system.

1–312. GYROSYN COMPASS. The gyrosyn compass system provides an accurate, stabilized indication of the aircraft heading through 360 degrees of azimuth and operates on the combined principles of the gyroscope and the magnetic compass. The pilot's master direction indicator is located on the pilot's instrument panel (figure 1–49), and a compass repeater indicator is located on the navigator's instrument panel (figure 4–33). The pilot's indicator has a small window (annunciator) in the upper right hand corner in which will appear a dot or a cross if the dial is not aligned with the flux valve. The dial is actuated by an electrically operated gyro and is set by a knob on the indicator to neutralize the annunciator. The knob is labeled with a dot, a cross, and arrows to show which direction to turn it in order to cancel the signal appearing in the annunciator window. Depressing the knob disengages the cord from the gyro allowing it to be turned without disturbing the gyro. It is necessary to observe carefully the direction in which the knob is turned because if the knob is turned the wrong direction a false null will be reached (annunciator window clear) at approximately 180° from the correct heading. This is an unstable condition and any deviation will result in constant slaving until the 180° error is corrected. A GYROSYN COMPASS switch is mounted on the pilot's instrument panel and has two positions, COMPASS and D.G. When the switch is placed in the D.G. position, the gyro is operated as a free directional gyro, and the large dial may be set independently. The gyrosyn compass signal system utilizes a.c. electrical power for its operation, and the vacuum tubes in the set are warmed by d.c. electrical power.

1–313. GYRO HORIZON. One gyro horizon indicator is mounted on the pilot's instrument panel and another is mounted on the copilot's instrument panel (figure 1–49). On LAC Serials 4501 through 4509 the copilot's gyro horizon is operated by a.c. power, while the pilot's is vacuum operated. The vacuum operated instruments are provided with caging knobs and both types of instruments incorporate knobs that provide adjustment of the horizontal reference bar to correspond to different pitch attitudes. Both the pilot's and the copilot's instruments installed in the LAC Serials 4510 through 4519 are operated by a.c. power.

1–314. TURN AND BANK INDICATOR. One turn and bank indicator is mounted on the pilot's instrument panel* or pilot's auxiliary instrument panel† and another

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

is mounted on the copilot's instrument panel. Refer to figure 1–49. On LAC Serials 4501 through 4509 the copilot's turn and bank indicator is operated by a.c. power while the pilot's is vacuum operated. Both the pilot's and copilot's instruments installed in LAC Serials 4510 through 4519 are operated by a.c. power.

1–315. DIRECTIONAL GYRO. On LAC Serials 4510 through 4519, an electric directional gyro is installed on the copilot's instrument panel (figure 1–49).

1–316. COMPASS (STANDBY). The standby compass is mounted above the center windshield panel. The compass contains a graduated reading card, calibrated in degrees and indicating the direction of flight with reference to magnetic north. A compass correction card is mounted on the pilot's and copilot's auxiliary instrument panels and each card shows the compass deviation corrections.

1–317. OUTSIDE AIR TEMPERATURE INDICATOR. Air temperature indicators are mounted on the pilot's* or pilots' center† (figure 1–49), flight engineer's upper (figure 1–56), and the navigator's instrument panels (figure 4–33). The indicators are energized by electrical resistance bulbs located in the right side of the nose wheel well.

1–318. CLOCK. Eight-day clocks with sweep second hands are installed on the pilot's, copilot's*, flight engineer's upper and the navigator's instrument panels. Refer to figures 1–49, 1–56, and 4–33.

1–319. INCLINOMETER. An inclinometer is mounted on the flight engineer's lower instrument panel (figure 1–56). The instrument is a ball-bank type and indicates the pitch attitude of the aircraft about the lateral axis.

1–320. EMERGENCY EQUIPMENT.

1–321. FIRE DETECTION SYSTEM.

1–322. Heat-sensitive fire detector switches are installed in each zone of all engine nacelles and in each cabin heater compartment. These switches close and complete the electric circuits to the fire warning bell if the temperature in any of these areas rises to the setting of the switches. The switches in zone 1 are set at 316°C (600°F) and all of the other switches are set at 232°C (450°F). They reset themselves automatically after cooling below this temperature. Each circuit is a double loop with two-wire (ungrounded) detectors in parallel between the loops. There is one circuit for zone 1 and one circuit for zones 2 and 3 of each nacelle. There is also one circuit for each cabin heater installation. Refer to figure 1–42. A resistor is connected in parallel with each individual area warning light and master relay coil, so that the system will not be rendered inoperative by a defective bulb or a master relay coil open circuit. If a short to ground occurs any place in the fire warning system, the circuit breaker will trip to prevent any false warning. Neither the warning lights nor the warning bell will operate. A short circuit within the detector switches will activate both bell and lights.

1–323. There is one test switch for each nacelle and one for both of the heaters. These switches break both loops and connect them in series around the fire detector switches.

1–324. The forward and aft cargo compartments are insulated and sealed from the rest of the fuselage, thus minimizing the danger of a flaming fire in those areas. When loading doors and hatches are closed and latched, there is very little air circulation through the cargo compartments. Therefore, fire detection equipment has not been provided for those areas. Lights illuminating both cargo compartments and the area aft of the aft pressure bulkhead are controlled by a switch on the flight engineer's upper switch panel and wide angle lenses are installed for inspection of those parts of the aircraft.

1–325. FIRE DETECTION INDICATORS.

1–326. MASTER FIRE WARNING LIGHTS AND WARNING BELL. A master fire warning light is located in the top center of the pilot's instrument panel (figure 1–49) and on the flight engineer's lower instrument panel (figure 1–56). The fire warning bell is located on the bulkhead behind the copilot's seat. These lights and the bell are energized simultaneously by the d.c. electrical system and actuated when one or more fire detector switches close. Each warning light can be tested by pressing its cap.

1–327. INDIVIDUAL AREA FIRE WARNING LIGHTS. Fire warning lights for each nacelle are located adjacent to the placarded zone 2 and 3 positions for the engine fire extinguisher selector handle above the station 260 upper switch panel. The zone 1 engine fire warning lights are located on the station 260 upper switch panel (figure 1–44). Fire warning lights for the left and right cabin heater compartments are located adjacent to the cabin heater fire extinguisher selector handle near the floor on the station 260 bulkhead. Each of the warning lights may be pressed to test. The master warning lights on the flight engineer's lower instrument panel and on the pilot's

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

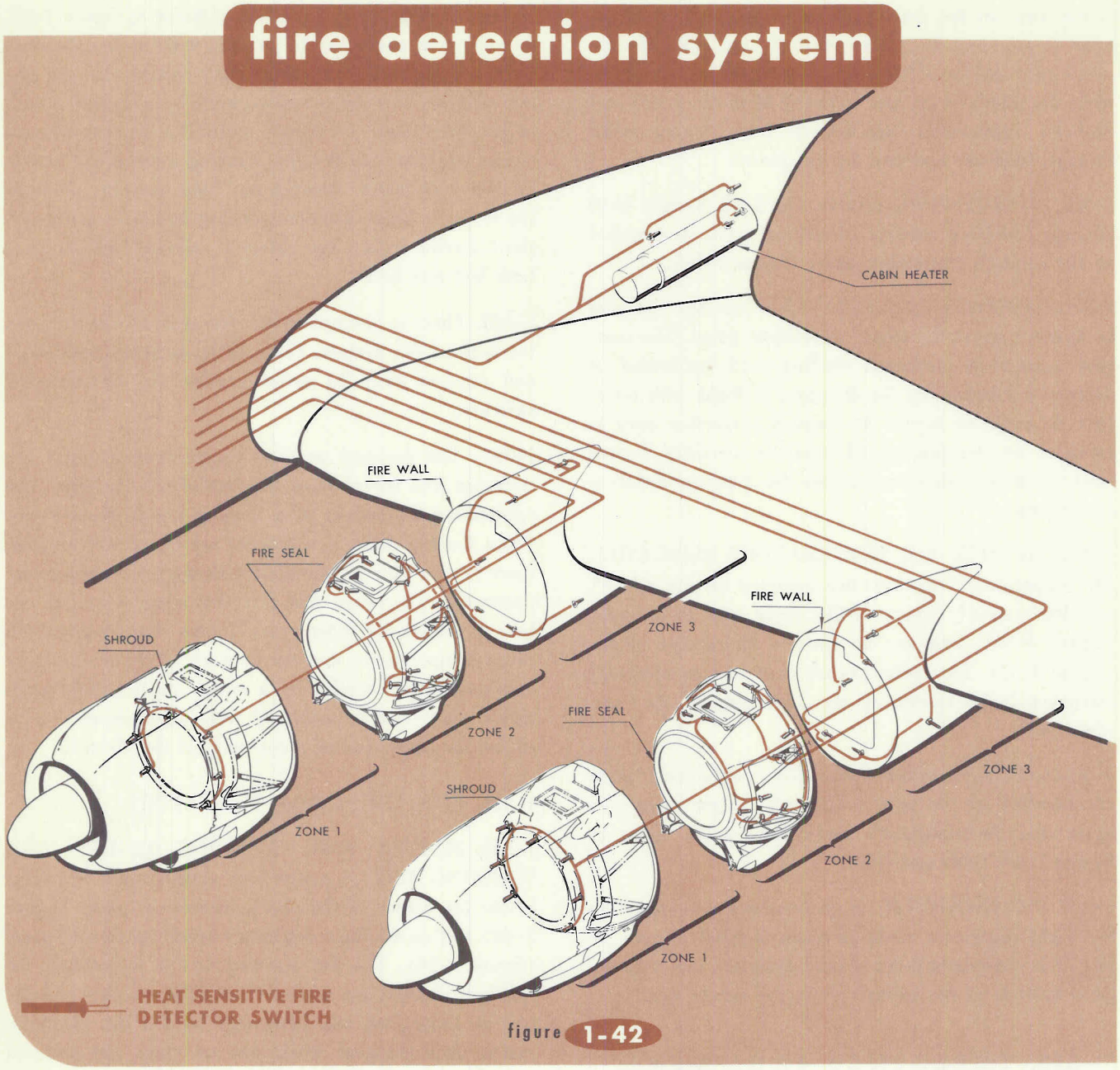


figure 1-42

center instrument panel will glow, and the fire warning bell will sound whenever one or more of the area warning lights are energized, either for test or by fire.

1–328. FIRE EXTINGUISHING SYSTEM.

1–329. A two-shot fire extinguishing system (figure 1–43) is installed to extinguish fires in engine zones No. 2 and No. 3 and in the cabin heater compartments. In addition to this system, portable hand-operated carbon dioxide fire extinguishers are provided.

1–330. The fire extinguishing system consists of two separately controlled groups of three 12.5 pound cylinders of carbon dioxide, operating heads, two selector valves, cable controls, and a distribution system.

1–331. The carbon dioxide cylinders are mounted on the right side of the forward cargo compartment. Gas is released from each group of three cylinders when the seal of the master cylinder is broken. Pulling one of the fire extinguisher control handles on the station 260 bulkhead mechanically breaks the seal of the master cylinder in the selected group, and the pressure released from the master cylinder actuates pistons that puncture the seals of the other two cylinders in that group. Once the control handle has been pulled and the gas charge in the master cylinder has been released, the charges in all of

fire extinguishing system

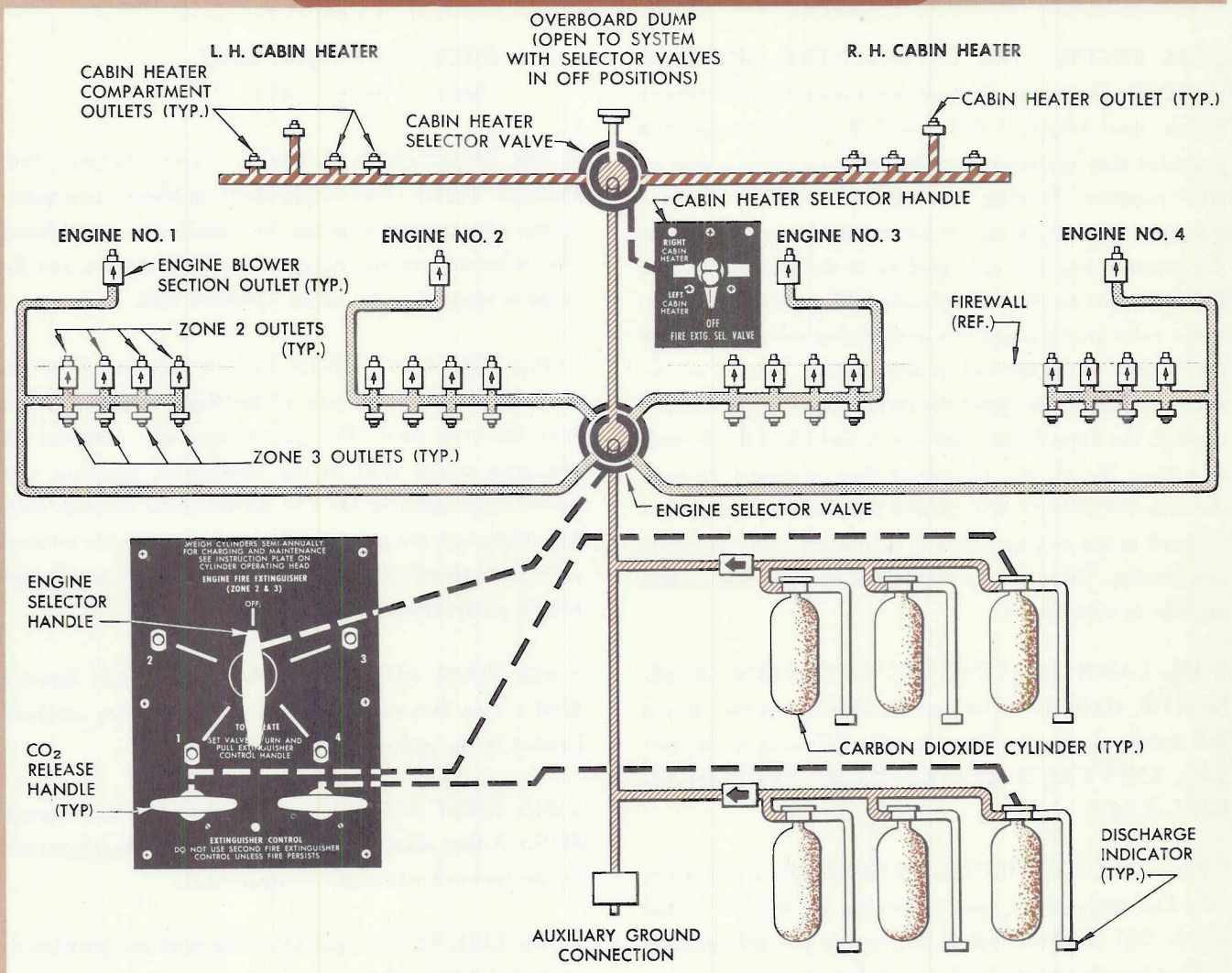


figure 1-43

the cylinders in that group are released. The selector valves are connected in series, and the engine fire extinguisher handle must be in the OFF position to extinguish a cabin heater fire.

1–332. An auxiliary ground connection is located on the right wall of the nose wheel well to permit attachment of a ground CO_2 supply which may be directed to the selector valves in the same manner as the aircraft CO_2 supply. However, the release must be accomplished by the ground operator. This connection is installed to provide for a greater CO_2 supply than the standard installation. A safety disc is provided in the head of each cylinder which will break and allow the cylinder to discharge if the pressure becomes too high because of overcharging or excessive heat. The safety discharge ports terminate in the right side of the fuselage forward of the wing and each is capped with a red celluloid seal. If the cylinder

discharges, the seal will break. A broken seal indicates that the system should be checked, the trouble corrected, and the cylinder recharged.

1–333. FIRE EXTINGUISHING SYSTEM CONTROLS.

1–334. ENGINE FIRE EXTINGUISHER SELECTOR HANDLE. The handle, located above the station 260 upper switch panel (figure 1–44), has 1, 2, 3, and 4 numbered positions that correspond to the engine numbers, and an OFF position. Turning the handle remotely controls a disc-type selector valve, by control cables, and connects the pressure line to a line leading to the selected engine. Normally, the handle is left in the OFF position. Each selector valve port is piped to a distributing tube mounted on the aft face of the firewall in each nacelle. Nozzles are attached to the tube to direct the carbon dioxide gas forward through the firewall into zone No. 2, and aft of the firewall into zone No. 3. An additional line is routed forward through the firewall and carries the carbon dioxide gas forward to the engine where it is injected into the induction section. There are no provisions for spraying carbon dioxide in zone No. 1.

1–335. CABIN HEATER FIRE EXTINGUISHER SELECTOR HANDLE. The handle, located on the station 260 bulkhead near the floor, has the following three positions: LEFT CABIN HEATER, RIGHT CABIN HEATER, and OFF.

1–336. FIRE EXTINGUISHER CONTROL HANDLES. Two fire extinguisher control handles are located on the station 260 bulkhead below the engine fire extinguisher selector handle (figure 1–44). Each fire extinguisher selector handle releases one of the two carbon dioxide charges available. If one charge, consisting of three bottles, is insufficient to smother the fire, the second shot may be released by turning and pulling the other handle.

1–337. CARBON DIOXIDE PORTABLE FIRE EXTINGUISHERS. (LAC Serials 4501 through 4509.) Five portable fire extinguishers are provided. One is clamped to the flight engineer's seat, another is located in each forward coat closet, and the other two are located in the galley coat closet.

1–338. CARBON DIOXIDE PORTABLE FIRE EXTINGUISHERS. (LAC Serials 4510 through 4519.) Five portable fire extinguishers are provided. One is clamped to the flight engineer's seat, the second is located on the navigator's radio rack, the third is located in the right forward coat closet, the fourth is located in the lounge aft partition, and the fifth is installed in the right aft coat closet.

1–339. EMERGENCY EQUIPMENT.
(Refer to figure 1–45.)

1–340. EMERGENCY LIGHTS. (LAC Serials 4501 through 4509.) Two dry-battery operated emergency lights, with integral switches, are installed in swivel bases. One is located on the ceiling of the flight station, and the other is stowed on the cabin overhead rack.

1–341. FIREMAN'S HAND AXE. A fireman's hand axe is installed on the aft side of the flight engineer's desk, near the crew door. The axe is especially designed for chopping escape exits in the fuselage or breaking windows in emergencies. On LAC Serials 4501 through 4509 two other axes are provided. One is located in the forward right coat closet and the other is stowed in the aft passenger compartment baggage rack.

1–342. FIRST AID KITS. (LAC Serials 4501 through 4509.) Two first aid kits are provided and they are both located in the galley coat closet.

1–343. FIRST AID KITS. (LAC Serials 4510 through 4519.) A first aid kit is located in the right baggage rack in the forward passenger compartment.

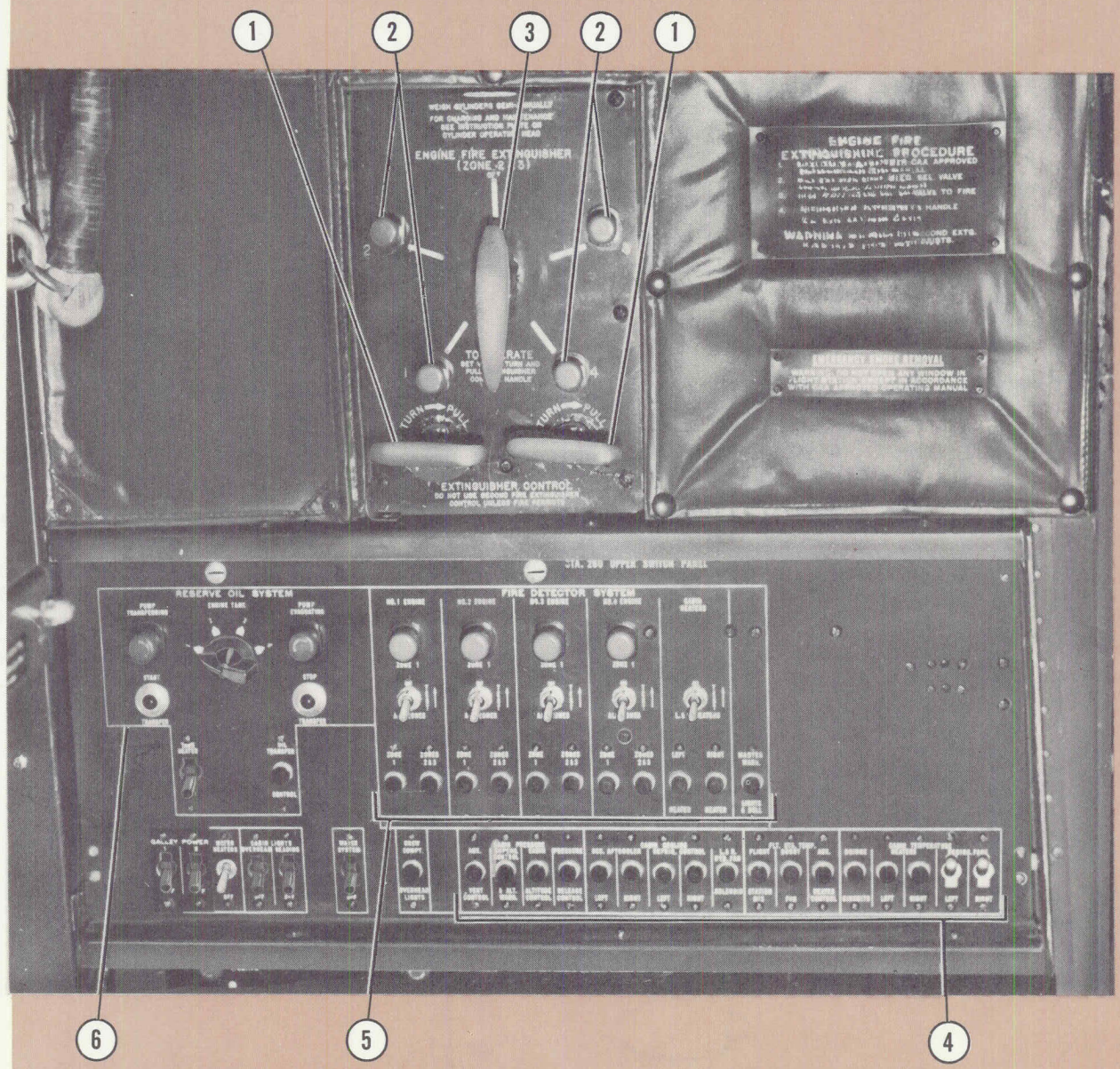
1–344. LIFE VESTS. Individual life vests are installed in each passenger seat.

1–345. FLASHLIGHTS. Two flashlights, equipped with dry batteries, are installed in the aircraft. One is clipped under the front edge of the copilot's seat, and the other is clipped to the nose wheel steering column.

1–346. LADDERS. An emergency rope ladder is stowed in a bag in the galley coat closet, and may be used to descend from the aircraft after landing at a location where ground ladders are not available.

1–347. LIFE RAFTS. One 20-man life raft is installed in the right inner wing, inboard and aft of the inner nacelle, and two 20-man life rafts are installed in the left inner wing inboard and outboard of the inner nacelle. The wing

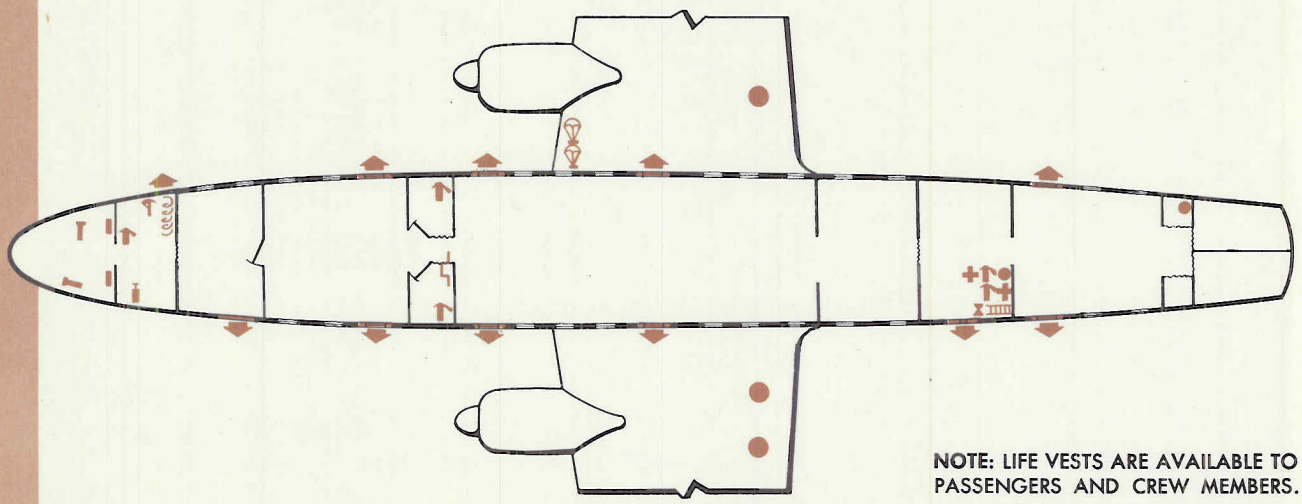
station 260 upper panel



1. Fire extinguisher control handles
2. Engine fire indicator lights (zones 2 and 3)
3. Engine fire extinguisher selector handle
4. Air conditioning system circuit breakers
5. Engine fire indicator lights (zone 1) and circuit test switches
6. Reserve engine oil system controls

figure 1-44

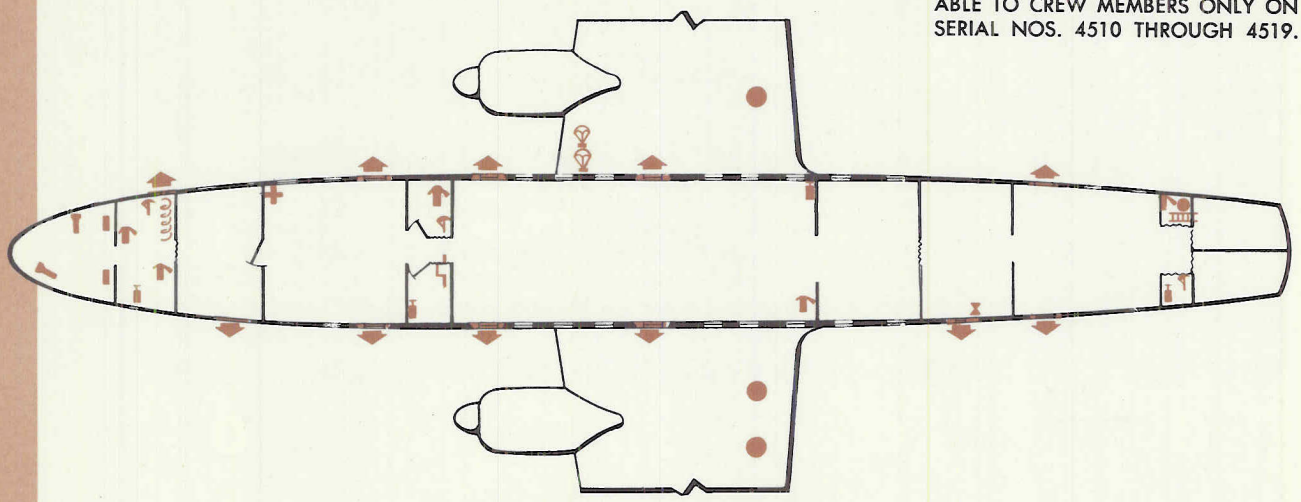
emergency equipment locations



LAC Serials 4501 Through 4509

NOTE: LIFE VESTS ARE AVAILABLE TO PASSENGERS AND CREW MEMBERS.

OXYGEN MASKS ARE AVAILABLE TO PASSENGERS AND CREW MEMBERS ON SERIAL NOS. 4501 THROUGH 4509. OXYGEN MASKS ARE AVAILABLE TO CREW MEMBERS ONLY ON SERIAL NOS. 4510 THROUGH 4519.

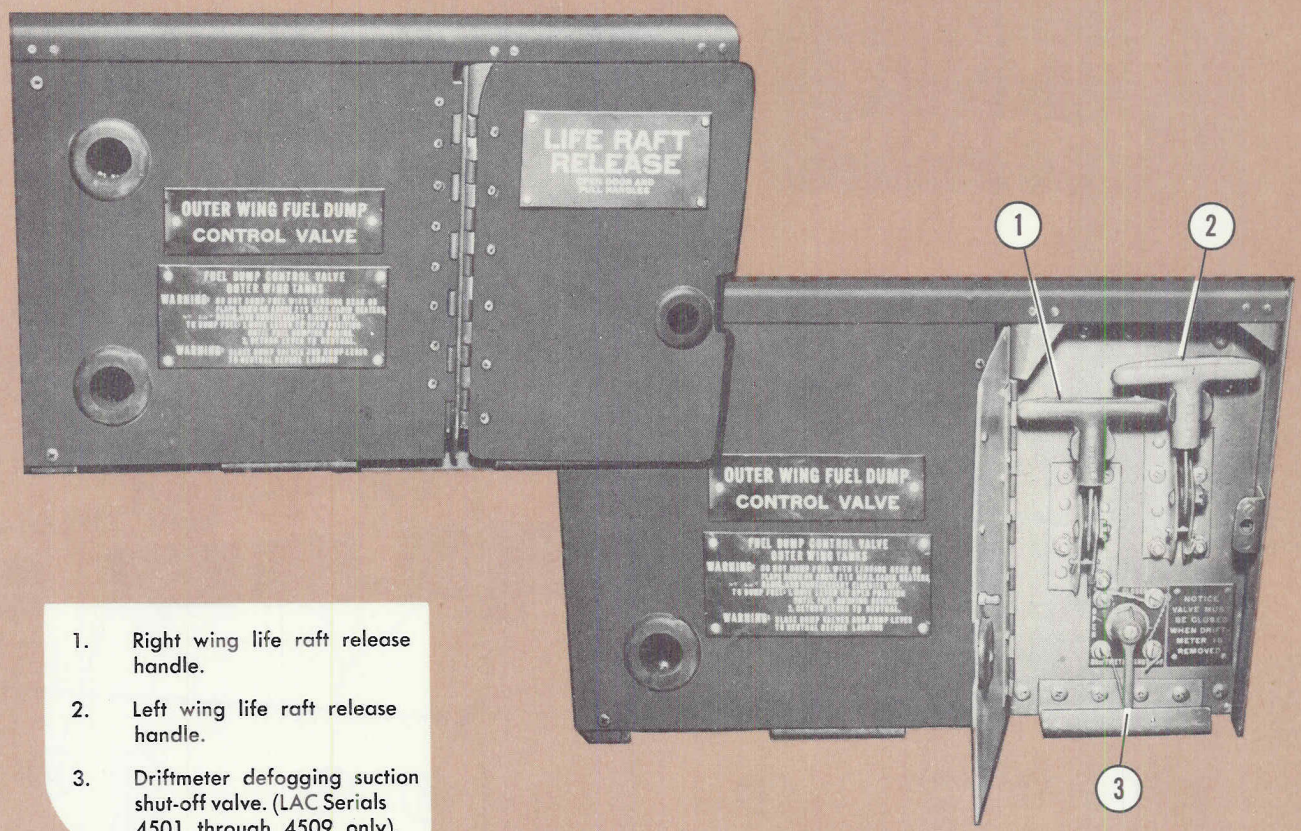


LAC Serials 4510 Through 4519

- Portable CO_2 Fire Extinguishers
- First Aid Kit
- Twenty-Man Life Raft
- Hand Axe
- Portable Life Raft Transmitter
- Emergency Exit
- Emergency Ladder
- Portable Oxygen Bottle
- Flash Light
- Emergency Wing Flap Crank
- Emergency Exit Rope
- Parachute Flares
- Emergency Check-List

figure 1-45

life raft release handles



1. Right wing life raft release handle.
2. Left wing life raft release handle.
3. Driftmeter defogging suction shut-off valve. (LAC Serials 4501 through 4509 only).

figure 1-46

life raft release handles are shown on figure 1–46. In addition, provisions are made to stow one life raft in the galley coat closet and another in the aft right coat closet.

1–348. LANDING FLARES.

1–349. Two Pioneer flares, type SA-8, are installed in separate chutes located in the wing leading edge inboard of No. 3 engine. Each flare weighs 16 pounds and is provided with a parachute which allows it to descend at the rate of approximately 360 feet per minute. Burning time of the flare is three minutes and the light output is 300,000 to 400,000 candlepower. At 2500 feet above the terrain the light range is 1½ miles.

1–350. The release and triggering provisions consist of release switches, cover latch, lanyard and d.c. operated solenoids. When the release switches are actuated, the solenoid triggers the latch and the flare drops through the flare chute.

Note

The cover plate is a thin sheet of aluminum alloy and is pushed out by the weight of the falling flare.

1–351. The flare will not ignite, nor will the parachute be ejected, if the release switch is inadvertently closed when the aircraft is on the ground, because the lanyard is long enough to permit the flare to drop to the ground without tripping the parachute release and flare ignition mechanism. In flight the flare falls a considerable distance below the aircraft before the parachute is ejected and the flare is ignited.

servicing diagram

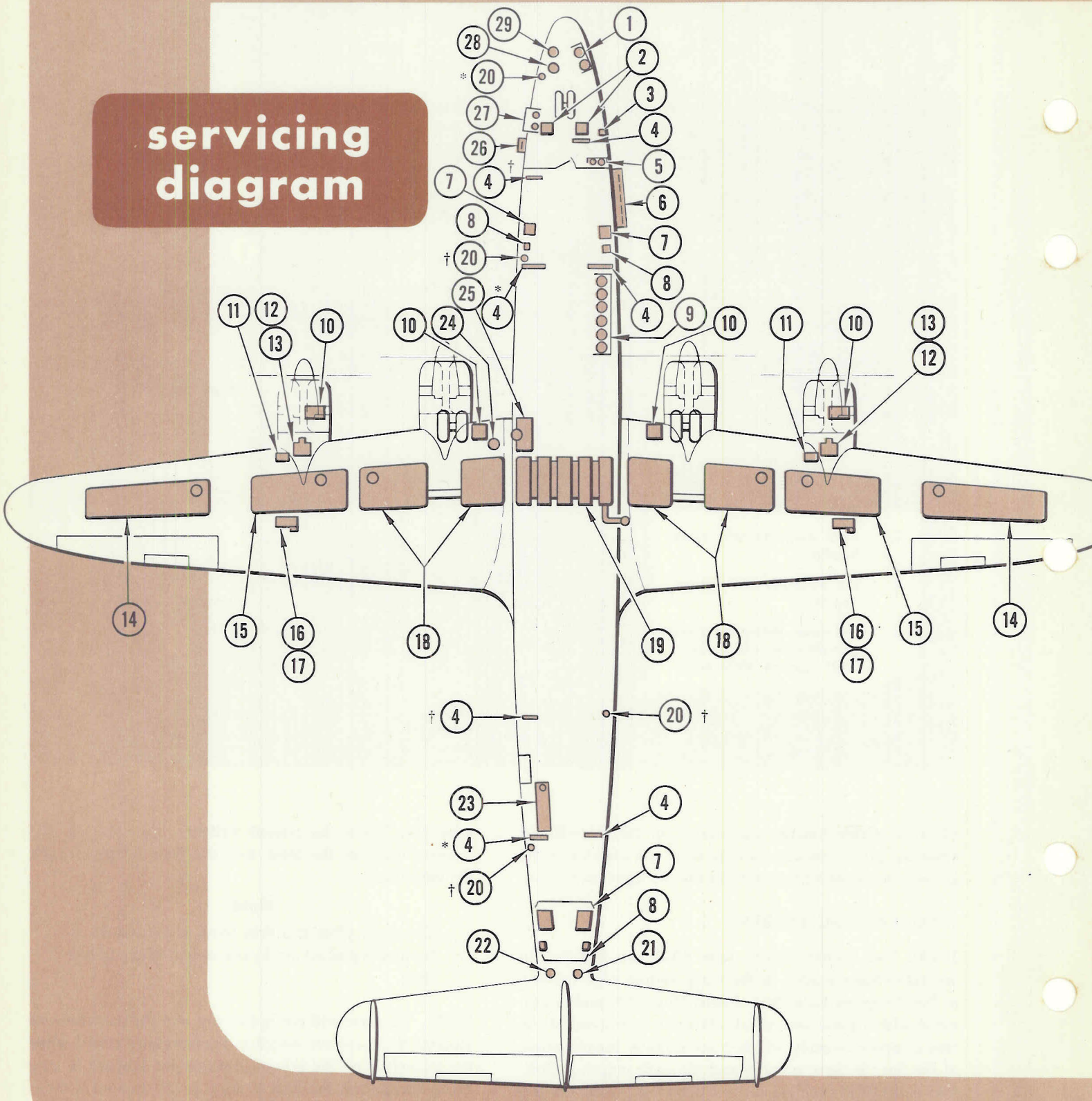


figure 1-47

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

REF	PART	NO. OF POINTS	CAPACITY	REPLENISH WITH	REMARKS
	FUEL SYSTEM				
15	Tanks 1 and 4	1 each	1555 U.S. gals. (9330 lbs.)	Grade 115/145, AMS 3036A	Integral dip-sticks in aft inboard corners of tanks
18	Tanks 2 and 3	1 each	790 U.S. gals. (4740 lbs)	Grade 115/145, AMS 3036A	
14	Tanks 2A and 3A	1 each	565 U.S. gals. (3390 lbs)	Grade 115/145, AMS 3036A	
19	Tank 5	1	730 U.S. gals. (4380 lbs)	Grade 115/145, AMS 3036A	
	ENGINE OIL SYSTEM				
10	Engine oil tank	4	42.5 U.S. gals. (315 lbs ea)	Grade 120, WAD No. 5815 or Grade 100, WAD No. 5818	Integral dip-sticks in filler necks
25	Reserve engine oil tank	1	67 U.S. gals. (496 lbs)	Grade 120, WAD No. 5815 or Grade 100, WAD No. 5818	Integral dip-stick in filler neck
	HYDRAULIC SYSTEM				
24	Main hydraulic reservoir	1	7.1 U.S. gals.	MIL-O-5606 (AN-O-366)	
28	Emergency filler hydraulic reservoir	1	4.5 U.S. gals.	MIL-O-5606 (AN-O-366)	
29	Emergency hydraulic extension tank	1	3.2 U.S. gals.	MIL-O-5606 (AN-O-366)	
1	Brake accumulators	2	1000 PSI	Air	Charge without hydraulic pressure
21	Rudder auxiliary booster accumulators	1	600 PSI	Air	Charge without hydraulic pressure
22	Elevator auxiliary booster accumulators	1	600 PSI	Air	Charge without hydraulic pressure
	AIR CONDITIONING SYSTEM				
13	Cabin supercharger oil tank	1	2 U.S. gals.	Aeroshell 1 AC	Drain and refill at 200-400 hours supercharger operation
12	Cabin supercharger drive shaft disconnect	1	690 cc ea (approx)	Aeroshell 1 AC (or SAE 10W)	Replenish at 160 ± 50 hours Fill to plug level
16	Secondary heat exchanger motor	1	450 cc ea (approx)	Aeroshell 1 AC	Replenish to maintain full level
17	Refrigeration unit sump	1	492.7 cc ea	Aeroshell 1 AC	Drain and refill at 500 hours
	ANTI-ICING SYSTEM				
11	Anti-icing fluid tank	2	20 U.S. gal.	MIL-F-5566	
	OXYGEN SYSTEM				
3	Oxygen filler valve	1			
27	Oxygen system supply cylinders	2	63.7 cu ft ea* 107 cu ft†		Charge cylinders from filler valve
20	Portable oxygen bottles	1* 3†			Replace with pre-charged cylinders
26	Indicators, oxygen overboard discharge	1		Celluloid seal	Replace when ruptured
	FIRE EXTINGUISHER SYSTEM				
9	CO_2 cylinders—fixed fire systems	6	12.5 lbs ea		Replace with charged cylinders
4	CO_2 cylinders—portable	5	8 lbs ea		Replace with charged cylinders
6	Indicators, CO_2 overboard discharge	6		Celluloid seal	Replace when ruptured
	WATER SYSTEM				
8	Dental water tanks	4	6 qt ea	Water	
23	Main water supply tank	1	60 U.S. gal.	Water	Filler on underside of fuselage
	MISCELLANEOUS				
7	Toilets	4	15 U.S. gal. ea (fwd lav) 30 U.S. gal. ea (aft lav)	Water	
5	Dip sticks	2			1 for tank Nos. 2A, 5, and 3A 1 for tank Nos. 1, 2, 3, and 4
2	Batteries	2		Distilled water	

1–352. CONTROLS. Flare release switches are located near the top and aft end of the pilot's switch panel (figure 1–52). Guards cover the flare release switches and are safetied in the closed position. The circuit breaker is located on the MJB panel.

Note

Do not release the flares at airspeeds greater than that used in approach unless absolutely necessary. However, flares have been successfully ejected at 217 knots (250 mph) indicated airspeed.

1–353. CREW SEATS.

1–354. Seats for pilot, copilot, flight engineer, and radio operator are installed in the flight station. In the transcontinental configuration, a seat for the navigator and two seat bunks are provided in the space immediately aft of the station 260 bulkhead.

1–355. Each seat is equipped with a lap-type safety belt. The safety belts are equipped with quick-action buckles which may be released with a single movement of the right hand.

1–356. PILOTS' SEATS.

1–357. The pilot's and copilot's seats are track-mounted to provide fore-and-aft positioning. They have tilting backs, and are adjustable for height. Each seat is equipped with folding arm rests and a removable head rest.

1–358. PILOTS' SEAT CONTROLS. Levers for tilting the backs and for adjusting the height of the pilots' seats are located on the outboard side of each seat. The handles for releasing the seats for fore-and-aft movement and for locking them in position are located on the inboard sides near the floor. Height adjustment is accomplished by overcoming the up-spring action when the control lever is lifted to release the position lock. Both arm rests rotate aft.

1–359. FLIGHT ENGINEER'S AND RADIO OPERATOR'S SEATS.

1–360. The seats for the flight engineer and radio operator are similar. Both are track-mounted to provide back-and-forth position adjustment, and are arranged to swivel. The chairs may be locked in any selected position.

1–361. FLIGHT ENGINEER'S AND RADIO OPERATOR'S SEAT CONTROLS. The position control adjustment lever for the flight engineer's and radio operator's seat is a horizontal bar below the front edge of the seat which may be reached and operated with the feet or hands. The position locking mechanism is released by depressing the bar. The swivel lock is controlled by a lever located to the left of center, below the seat. Detents in the control mechanism permit the seat to be locked in any one of several selected positions.

1–362. NAVIGATOR'S SEAT.

1–363. The navigator's seat is a stool with a back rest. The height of the stool can be adjusted through a range of approximately eleven inches by pulling the knob located under the left side of the seat pan, raising or lowering the seat to the required height, and releasing the locking knob so that the pin engages with a hole in the seat support shaft.

1–364. CABIN ATTENDANTS' SEATS.

1–365. Two single cabin attendant seats are provided in the aisles forward of the aft lavatories and a double cabin attendant's seat is located near the main cabin door. The cabin attendants' seats fold out of the way when not in use.

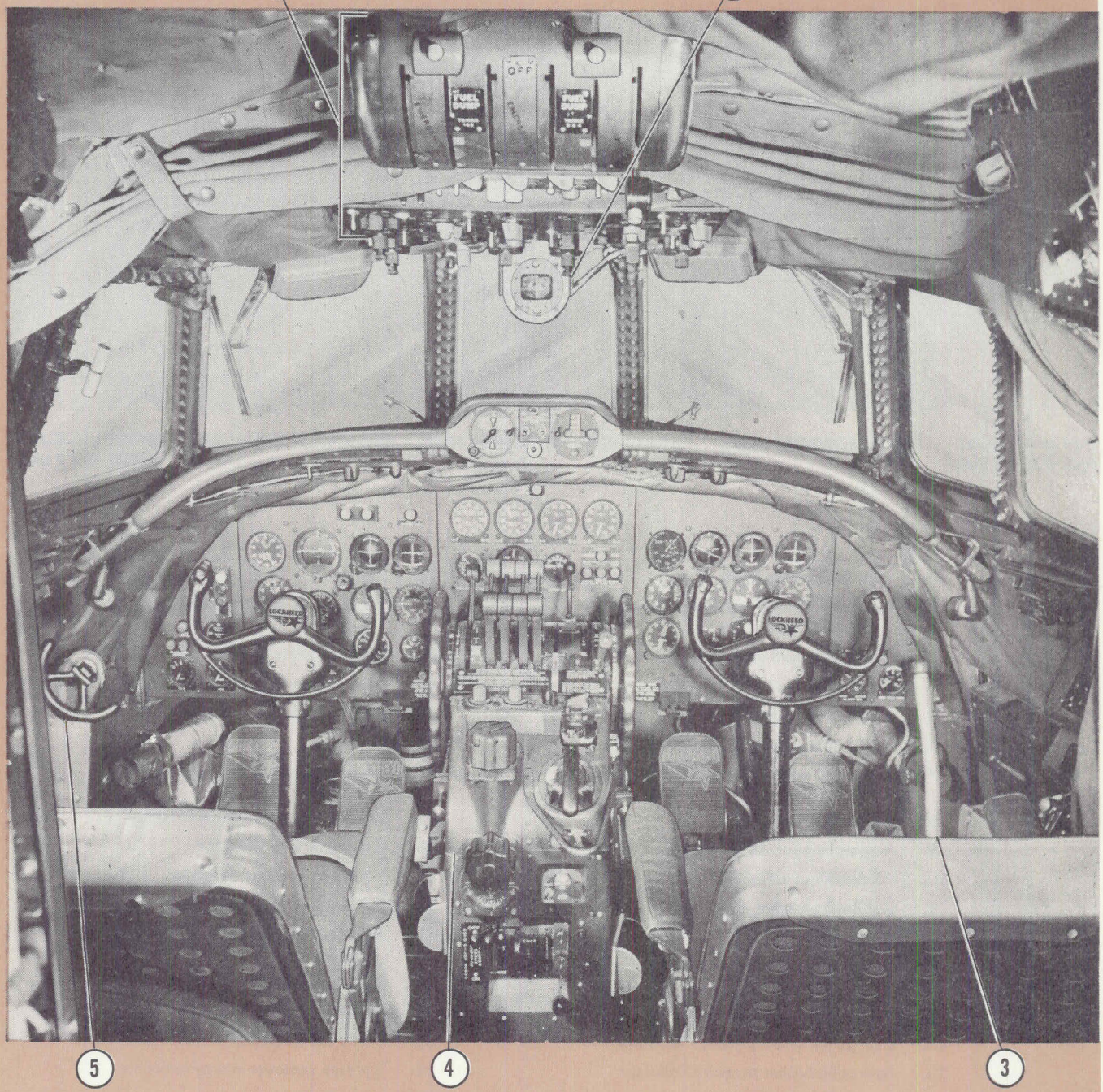
1–366. RELIEF CREW SEAT-BUNK.

1–367. The relief crew seats are installed on the right side of the fuselage opposite the navigator's station, one facing forward and the other facing aft. They are convertible into upper and lower bunks, and in this configuration, have fittings which permit the lap belts to be used as safety belts on the upper bunk. The back rests swing up to a horizontal position where they are joined and on the inboard a vertical member attached to the ceiling of the cabin is connected to the inboard edge of the bunk to help support it. The lower bunk is formed by unfolding the double cushions of both seats. A rod that fastens into a wedjit in the floor helps support the inboard side of the lower bunk.

1–368. AUXILIARY EQUIPMENT.

1–369. Auxiliary equipment, such as the air conditioning, communication, electronic, lighting, oxygen, automatic pilot, navigation, and special equipments are discussed in Section IV of this manual.

pilots' stations (typical)

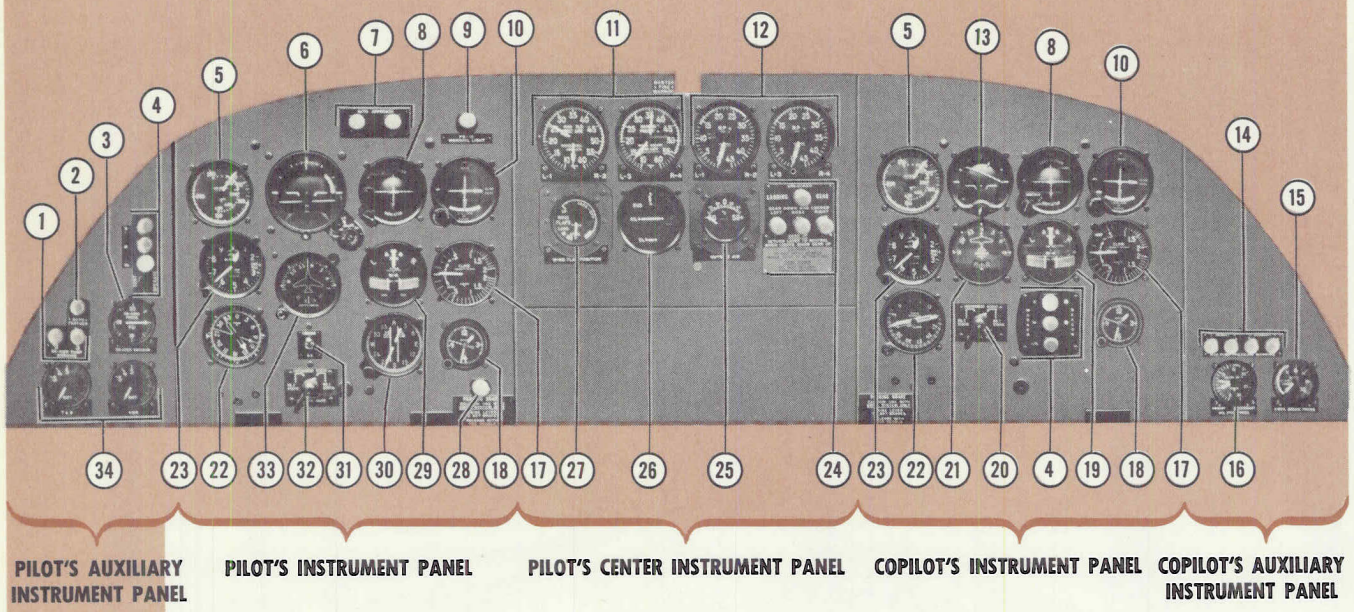


1. Pilots' overhead controls
2. Standby compass
3. Emergency hydraulic hand pump
4. Center control stand
5. Nose gear steering wheel

figure 1-48

pilots' instrument panels

LAC Serials 4501 Through 4509

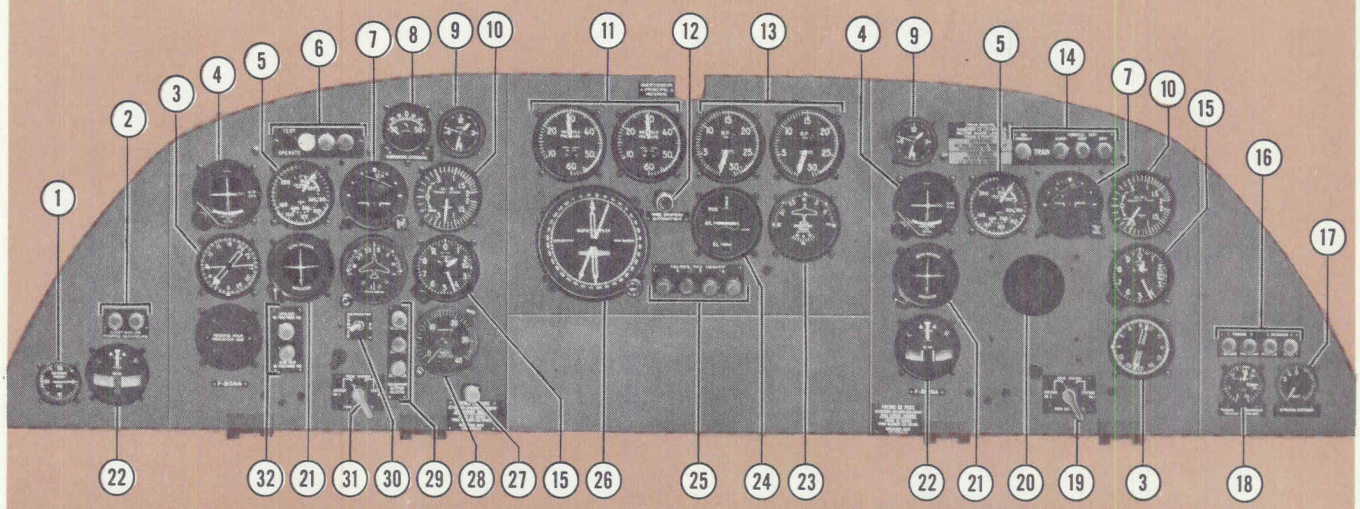


1. Vacuum warning lights
2. Automatic feathering system — armed — indicator light
3. De-icer pressure indicator
4. Marker beacon indicator lights
5. Airspeed indicators
6. Gyro horizon (vacuum operated)
7. Automatic approach indicator lights (inoperative)
8. Zero reader indicators
9. Automatic pilot warning light
10. ILS deviation indicators
11. Manifold pressure gages
12. Tachometers
13. Gyro horizon (electric operated)
14. Hydraulic pump low pressure warning lights
15. Emergency brake pressure indicator
16. Hydraulic system pressure indicator
17. Rate of climb indicators
18. Clocks
19. Turn and bank indicator (electric operated)
20. Copilot's static selector
21. Flux gate compass master indicator
22. Radio magnetic indicators (RMI)
23. Altimeters
24. Landing gear position indicator lights
25. Outside air temperature indicator
26. Three axis trim indicator
27. Wing flap position indicator
28. Parking brake warning light
29. Turn and bank indicator (vacuum operated)
30. Zero reader heading selector
31. Gyrosyn compass slaving switch
32. Pilot's static selector
33. Gyrosyn compass master indicator
34. Vacuum gages

figure 1-49 Sheet 1

pilots' instrument panels

LAC Serials 4510 Through 4519

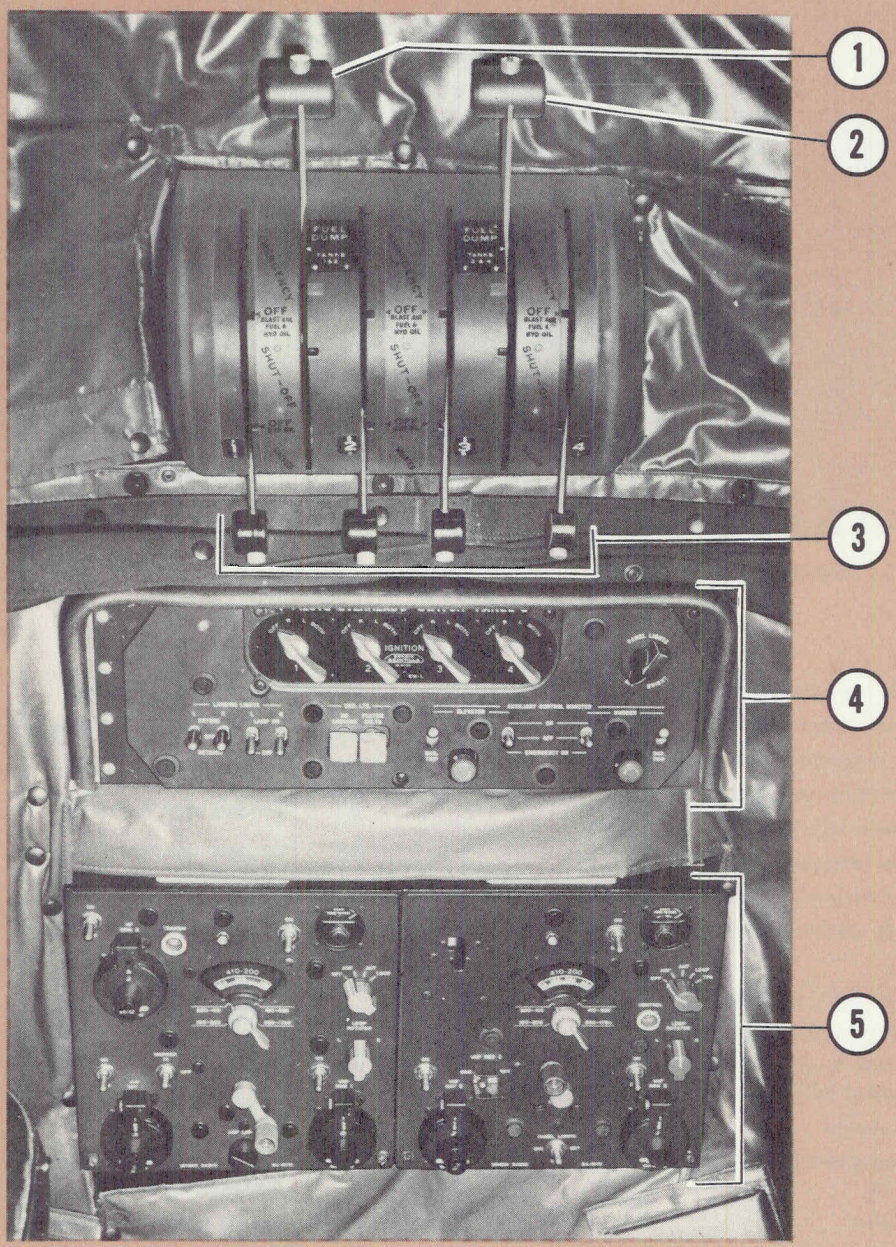


1. De-icer pressure indicator
2. Vacuum warning lights
3. Radio magnetic indicators (RMI)
4. ILS deviation indicators
5. Airspeed indicators
6. Marker beacon indicator lights
7. Gyro horizons
8. Outside air temperature indicator
9. Clocks
10. Rate of climb indicators
11. Manifold pressure gages
12. Automatic feathering system armed warning light
13. Tachometers
14. Landing gear position indicator lights
15. Altimeters
16. Hydraulic pump low pressure warning lights
17. Vacuum gage
18. Hydraulic system pressure indicator
19. Copilot's static selector
20. Directional gyro (not shown)
21. Zero reader indicators
22. Turn and bank indicators
23. Flux gate compass master indicator
24. Three axis trim indicator
25. Propeller reverse pitch indicator lights
26. Dual ADF indicator
27. Parking brake warning light
28. Radio altimeter indicator (AVQ-6)
29. Radio altimeter indicator lights (AVQ-6)
30. Gyrosyn compass slaving switch
31. Pilot's static selector
32. Localizer inoperative and glide path inoperative warning lights (inoperative)

figure 1-49 Sheet 2

pilots' overhead panel

LAC Serials 4501 Through 4509



1. Fuel dump lever (tanks 1 and 2)
2. Fuel dump lever (tanks 3 and 4)
3. Emergency shut-off levers
4. Overhead switch panel
5. Overhead radio control panel

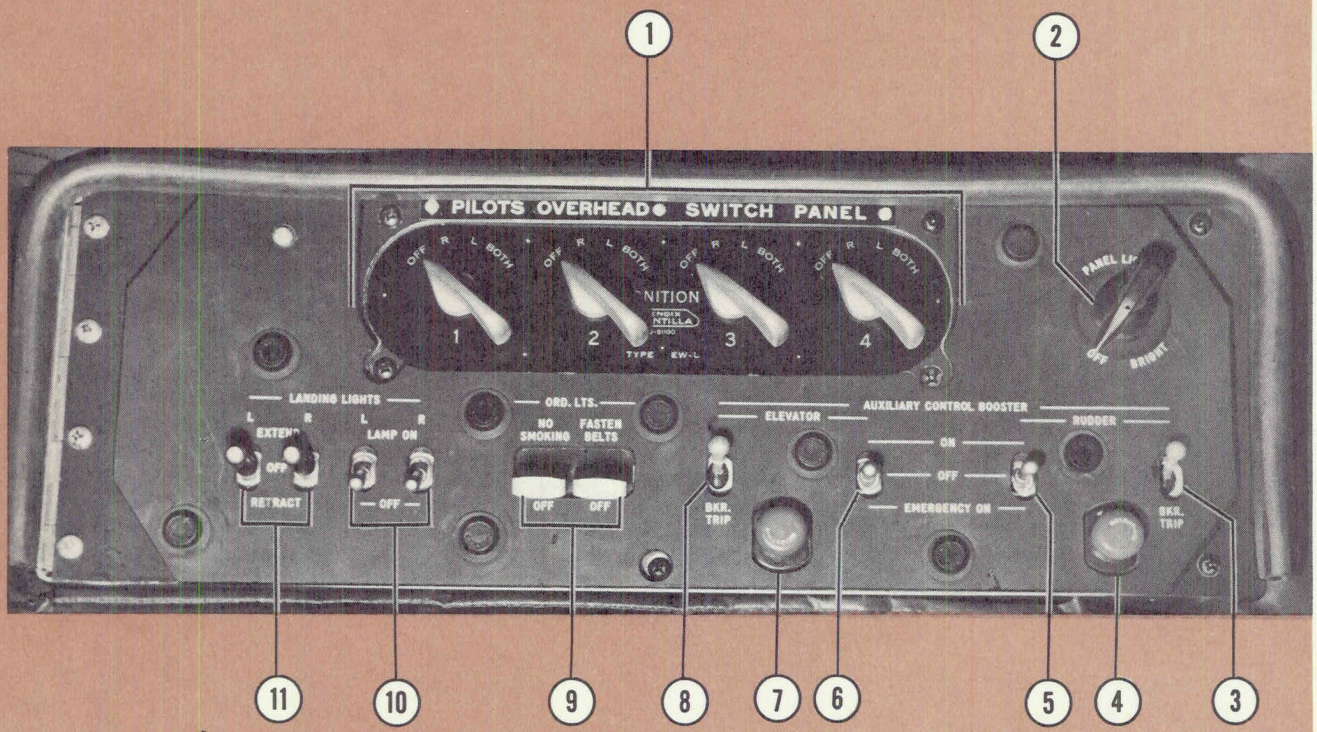
figure 1-50 Sheet 1

Pilots' Overhead Panels
LAC Serials 4510 Through 4519
Figure 1–50 Sheet 2

To be included when available.

pilots' overhead switch panel

LAC Serials 4501 Through 4509



1. Ignition switches
2. Panel light switch
3. Rudder auxiliary booster circuit breaker switch
4. Rudder auxiliary booster indicator light
5. Rudder auxiliary booster switch
6. Elevator auxiliary booster switch
7. Elevator auxiliary booster indicator light
8. Elevator auxiliary booster circuit breaker switch
9. Ordinance light switches
10. Landing light lamp switches
11. Landing light extend-retract switches

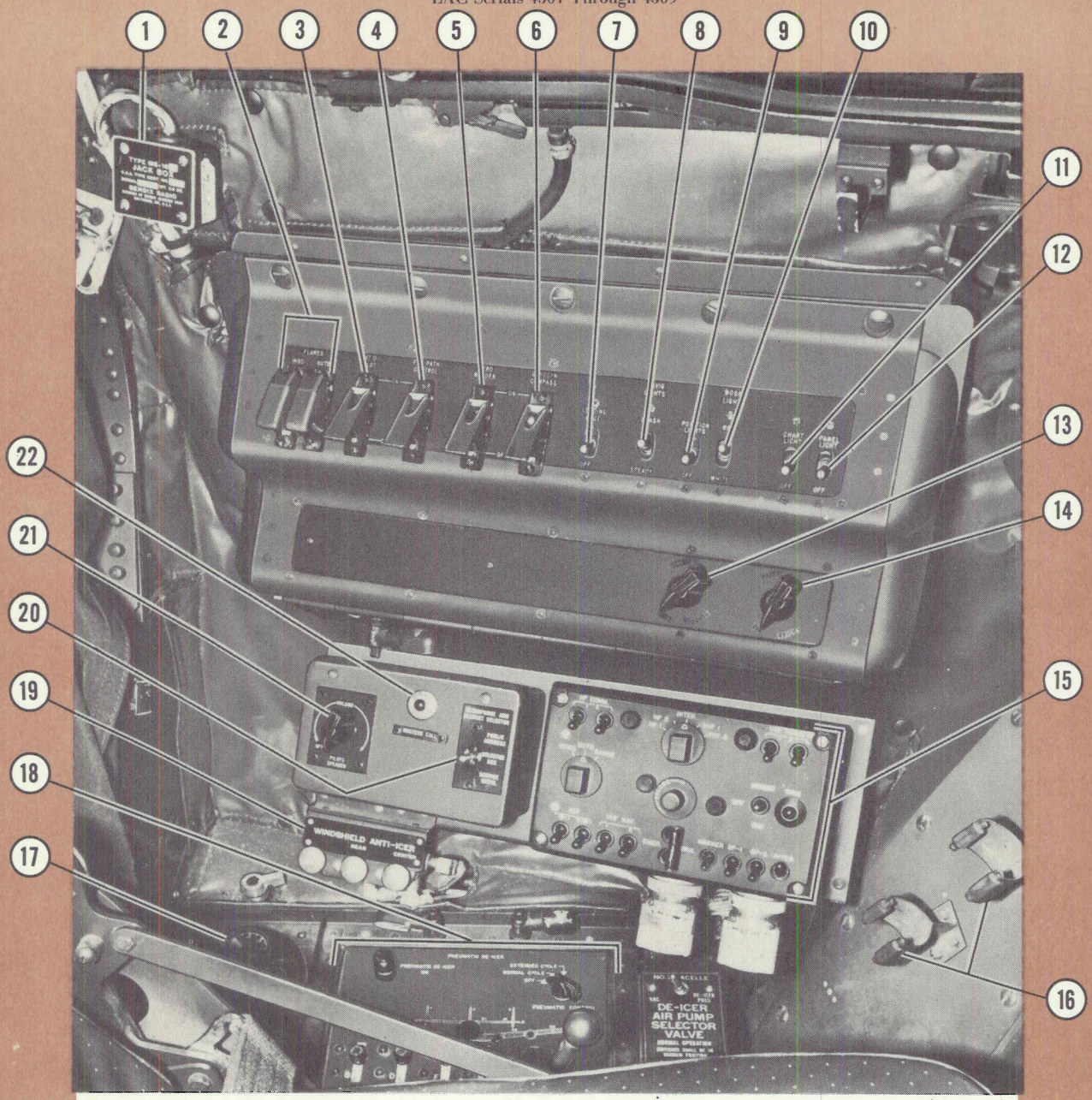
figure 1-51 Sheet 1

Pilots' Overhead Switch Panel
LAC Serials 4510 Through 4519
Figure 1–51 Sheet 2

To be included when available.

pilot's side panel

LAC Serials 4501 Through 4509



1. Pilot's jack box
2. Flare release switches
3. Automatic pilot switch
4. Flight path control switch
5. Zero reader switch
6. Gyrosyn compass switch
7. Leading edge lights switch
8. Navigation lights switch
9. Position lights switch
10. Nose lights switch
11. Chart light switch
12. Panel light switch
13. Chart light rheostat
14. Panel light rheostat
15. Radio selector box
16. Flashlight holder
17. Oxygen regulator
18. Pneumatic de-icer control panel
19. Windshield anti-icer fluid control valves
20. Microphone and headset selector switch
21. Speaker volume control
22. Hostess call button

figure 1-52 Sheet 1

Pilot's Side Panel
LAC Serials 4510 Through 4519
Figure 1–52 Sheet 2

To be included when available.

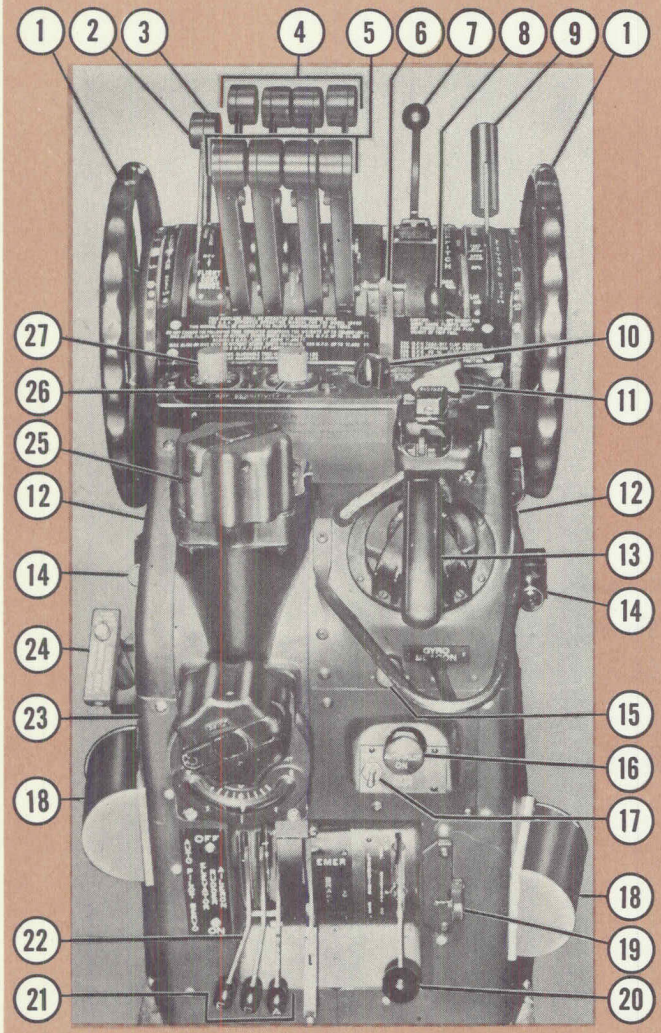
Copilot's Side Panel
LAC Serials 4501 Through 4509
Figure 1–53 Sheet 1

To be included when available.

Copilot's Side Panel
LAC Serials 4510 Through 4519
Figure 1–53 Sheet 2

To be included when available.

center control stand



LAC Serials 4501 Through 4509

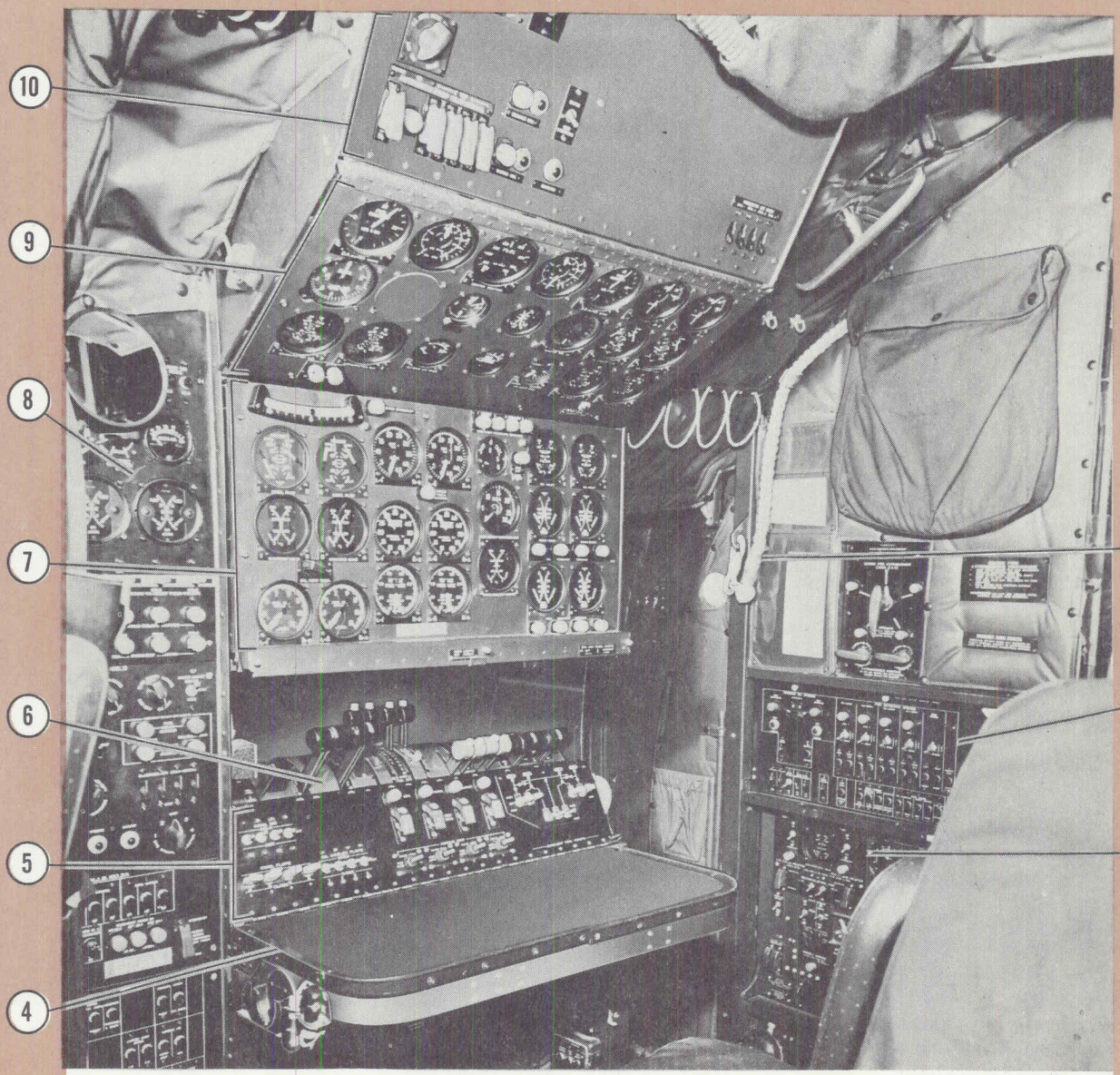
1. Elevator trim tab control wheels
2. Rudder booster control lever
3. Aileron booster control lever
4. Reverse pitch throttle levers
5. Throttle levers
6. Reverse lock override lever
7. Electric elevator trim tab clutch lever
8. Master propeller pitch control lever
9. Wing flap control lever
10. Flight path selector switch
11. Flight path direction selector switch
12. Parking brake levers (hidden)
13. Automatic pilot pistol grip turn handle
14. Ventilation damper (foot warmer) control knobs
15. Automatic pilot gyro beacon light
16. Automatic pilot clutch switch
17. Automatic pilot Flux-Gate caging switch
18. Ash receiver
19. Landing gear control lever release trigger
20. Landing gear control lever
21. Automatic pilot servo disconnect levers
22. Brake selector valve lever
23. Aileron trim tab handcrank
24. Emergency elevator booster shift control
25. Rudder trim tab handcrank
26. No. 2 ADF sensitivity control
27. No. 1 ADF sensitivity control

Center Control Stand
for
LAC Serials 4510 Through 4519

To be included when available.

figure 1-54

flight engineer's station (typical)



1. Ditching rope
2. Station 260 upper panel
3. Air conditioning control panel
4. Desk
5. Lower switch panel
6. Control quadrant
7. Lower instrument panel
8. MJB panels
9. Upper instrument panel
10. Upper switch panel

figure 1-55

flight engineer's instrument panels

LAC Serials 4501 Through 4509

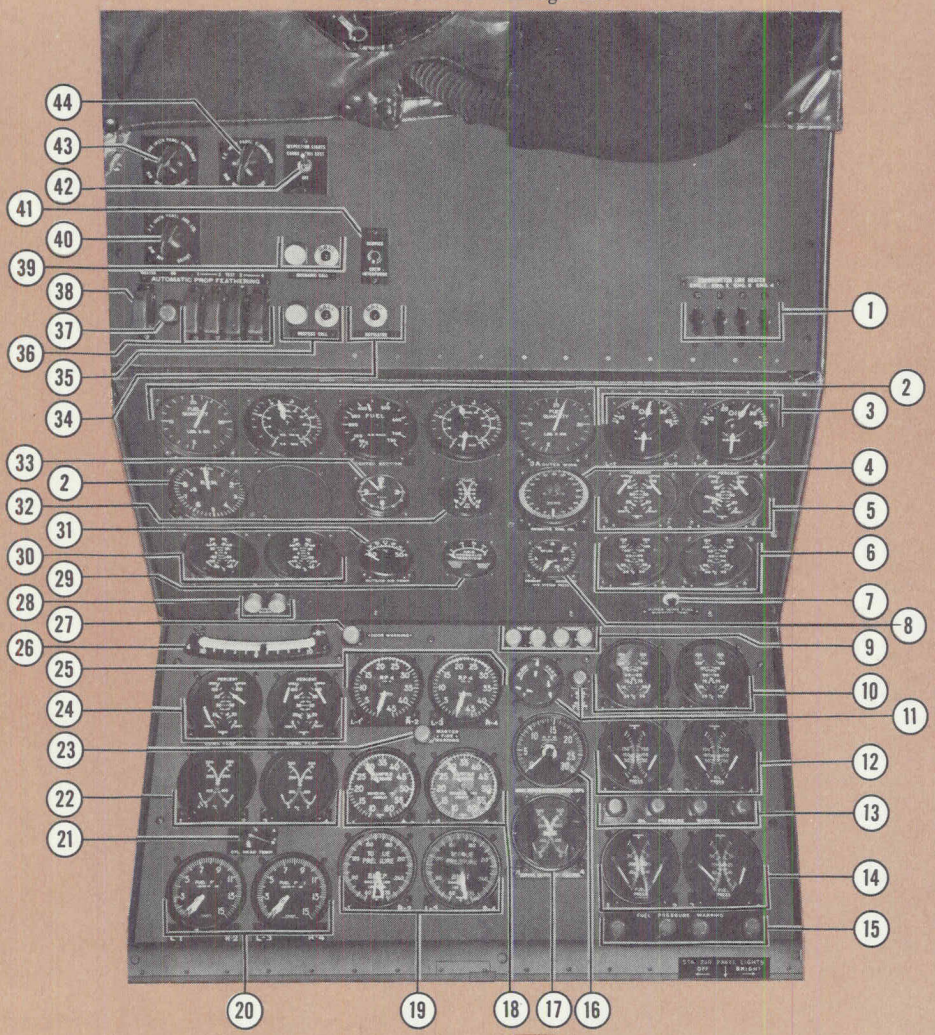


figure 1-56 Sheet 1

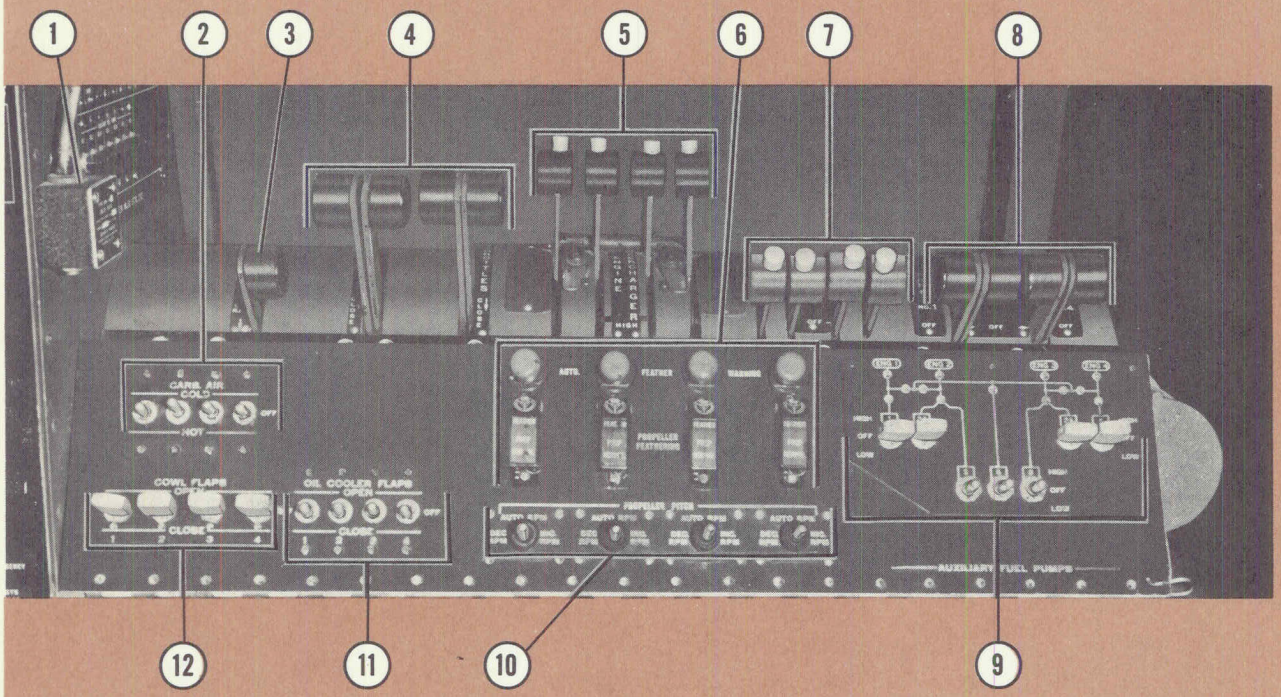
1. Torquemeter line heater switches
2. Fuel quantity indicators
3. Oil quantity indicators
4. Reserve engine oil quantity indicator
5. Oil cooler flap position indicators
6. Oil temperature indicators (oil out)
7. Outer wing fuel quantity indicator — test switch
8. Hydraulic system pressure indicator
9. Hydraulic pump low pressure warning lights
10. Oil temperature indicators (oil in)
11. Synchroscope and synchroscope-off warning light
12. Oil pressure indicators
13. Oil low pressure warning lights
14. Fuel pressure indicators
15. Fuel low pressure warning lights
16. Propeller synchronizer tachometer
17. Cabin supercharger drive-shaft rear bearing temperature indicator
18. Manifold pressure indicators
19. BMEP gages (torquemeters)
20. Fuel flow indicators
21. Cylinder head temperature selector switch
22. Cylinder head temperature indicators
23. Master fire warning light
24. Cowl flap position indicators
25. Tachometers
26. Inclinometer
27. Door warning light
28. Vacuum warning lights
29. Main hydraulic reservoir fluid quantity indicator
30. Carburetor air temperature indicators
31. Outside air temperature indicator
32. Anti-icer tanks fluid quantity indicator
33. Clock
34. Navigator call button
35. Hostess call button and light
36. Automatic feathering test switches
37. Automatic feathering system — armed — indicator light
38. Automatic feathering master switch
39. Mechanic call button and light
40. Flight engineer's instrument panel auxiliary lights switch
41. Service or crew interphone selector switch
42. Cargo and tail section inspection lights switch
43. Station 260 instrument panel floodlight switch
44. Flight engineer's instrument panel floodlights switch
45. Oxygen regulator

Flight Engineer's Instrument Panels
LAC Serials 4510 Through 4519
Figure 1–56 Sheet 2

To be included when available.

flight engineer's control quadrant and lower switch panel

LAC Serials 4501 Through 4509



1. Flight engineer's jack box
2. Carburetor air control switches
3. Master propeller control lever
4. Throttle levers
5. Engine supercharger control levers
6. Propeller feathering lights and switches
7. Mixture control levers
8. Fuel tank selector levers
9. Auxiliary fuel pump switches
10. Propeller selector switches
11. Oil cooler flap switches
12. Cowl flap switches

figure 1-57 Sheet 1

Flight Engineer's Control Quadrant and Lower Switch Panel
LAC Serials 4510 Through 4519
Figure 157 Sheet 2

To be included when available.

main junction box panels

LAC Serials 4501 Through 4509

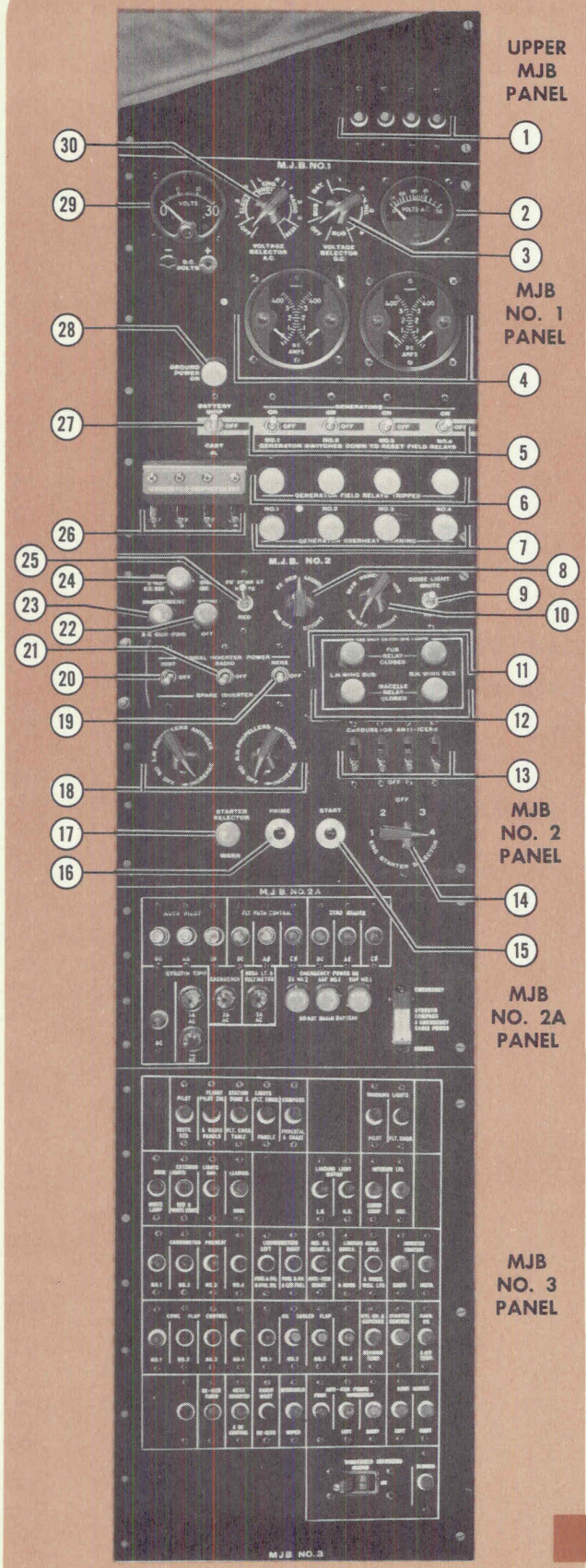


figure 1-58 Sheet 1

1. Generator field trip and reset relays
2. A.C. voltmeter
3. D.C. voltage selector switch
4. D.C. ammeters
5. Generator switches
6. Generator field relays tripped warning lights
7. Generator overheat warning lights
8. Flight engineer's desk lights switch
9. Dome light switch
10. MJB panel lights switch
11. Fuselage relay CLOSED indicator lights
12. Nacelle relay CLOSED indicator lights
13. Carburetor anti-icer switches
14. Engine starter selector switch
15. Engine starter switch
16. Engine primer switch
17. Engine starter selector switch warning light
18. Propeller anti-icer switches
19. Nesa inverter switch
20. Instrument inverter switch
21. Radio inverter switch
22. Radio inverter power OFF warning light
23. Instrument inverter power OFF warning light
24. Radio and instrument A.C. power ON spare inverter warning light
25. Flight engineer's desk lights switch
26. Generator field circuit breakers
27. Battery switch
28. Ground power ON indicator light
29. D.C. voltmeter
30. A.C. voltage selector switch

main junction box panels

LAC Serials 4510 Through 4519

1. Generator field trip and reset relays
2. A.C. voltmeter
3. D.C. voltage selector switch
4. D.C. ammeters
5. Generator switches
6. Generator field relays trip warning lights
7. Generator overheat warning lights
8. Flight engineer's desk light switch
9. Dome light switch
10. MJB panel lights switch
11. Fuselage relay CLOSED indicator lights
12. Nacelle relay CLOSED indicator lights
13. Carburetor anti-icer switches
14. Engine starter selector switch
15. Engine starter switch
16. Instrument alternator selector switch
17. Engine primer switch
18. Engine starter selector switch warning light
19. Propeller anti-icer switches
20. Flight engineer's desk lights switch
21. Generator field circuit breakers
22. Battery switch
23. Ground power ON indicator light
24. Inverter OFF warning light
25. Main inverter switch
26. D.C. voltmeter
27. A.C. voltage selector switch

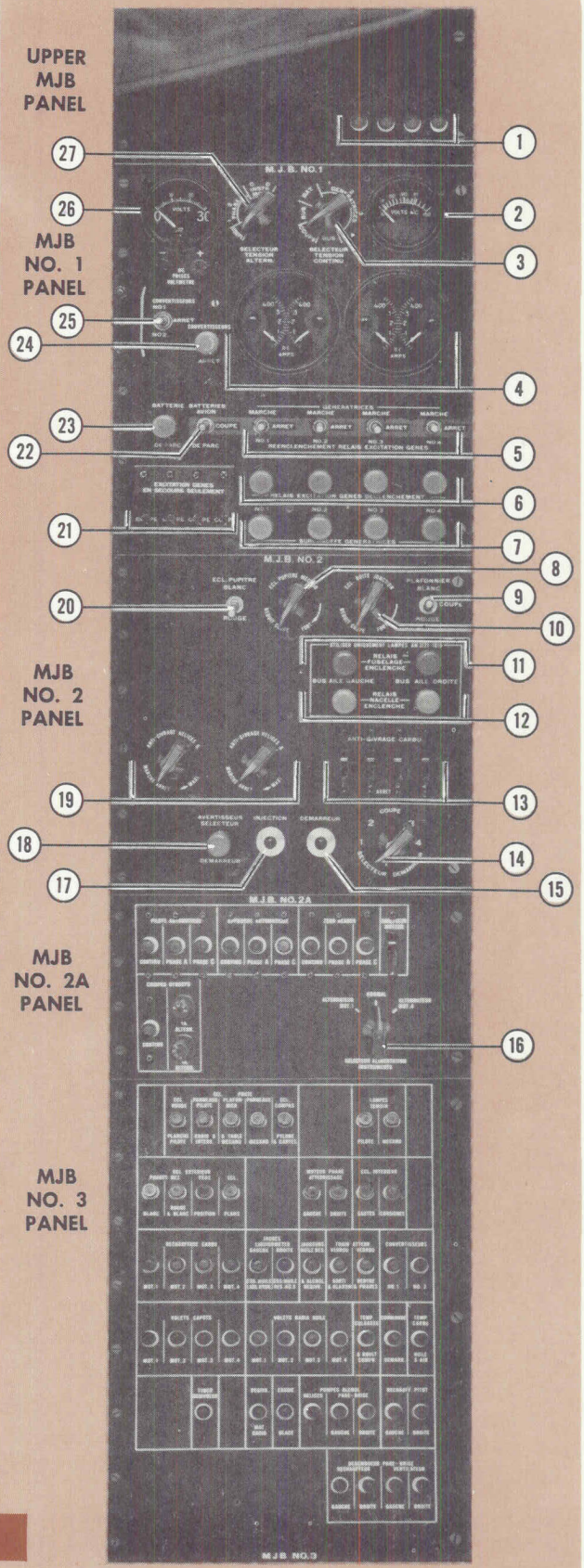


figure 1-58 Sheet 2

MODEL 1049C ABBREVIATED COCKPIT CHECK LIST

BEFORE STARTING ENGINES

1	CP	Landing Gear Lever	DOWN
2	CP	Ignition Switches	OFF
3	PCPE	Circuit Breakers & Switches	SET
4	E	Ground Power	ON
5	CP	Hand Pump Selector	EMER BRAKES
6	P	Brake Selector Lever	EMER
7	P	Emer. Brake Pressure	CHECK
8	P	Parking Brake	SET
9	P	Electric Elevator Tab	CHECKED
10	P	Aileron & Rudder Boosters	ON
11	P	Elevator Shift	CHECKED, ON
12	P	Aux. Control Boosters	CHECKED, OFF
13	P	Ordinance Lights	ON
14	E	Dump Valves (Tanks 1 & 2, 3 & 4)	CLOSED
15	E	Emergency Shut-off Levers	ALL ON
16	E	Battery Voltage	VOLTS
17	E	Inverters	CHECK SPARES, ON NORMAL
18	E	Generators	OFF
19	PCPE	De-Icers & Anti-Icers	OFF
20	P	De-Icer Air Pump Selector Valve Switches	VAC
21	E	Tank 5 and Fuel Crossfeed Levers	CLOSED
22	E	Vacuum Shut-off Valve and De-Icer Vacuum Switch	OPEN & ON
23	E	Master RPM Control	FULL INC. RPM
24	E	Engine Superchargers	LOW
25	E	Fuel Tank Selectors 1, 2, 3, 4	ON
26	E	Cowl Flaps	OPEN
27	E	Carburetor Air	COLD
28	E	Master Eng. Selector (if installed)	ON (1 or 2)
29	E	Oil Cooler Flaps	OPEN
30	E	Air Conditioning	POSITION A & PANEL SET
31	E	Tanks 2A, 3A Dump Fuel Lever	NEUTRAL
32	E	Anti-Icer Fluid	GALS.
33	E	Hydraulic Fluid Reservoirs, Main, Emer., Reserve	FULL
34	E	Fuel Quantity	LBS. GALS.
35	E	Engine Oil Quantity	GALS.
36	E	Gross Weight & CG	LBS. %
37	Crew	Oxygen & Smoke Masks	CHECKED
38	PE	Fire Warning System	CHECKED
39	E	Start Engines	
40	P	Control Boosters (Check crossover after No. 3 Engine is started)	CHECKED
41	P	Auto Pilot and Servo Disconnect Levers	CHECKED OFF

DURING WARM-UP

1	E	Instrument Alternator Selector Switch (if installed)	CHECK NO. 1 & 4—ON NORMAL
2	P	Instrument Vacuum	CHECKED
3	PCPN	Flight Instruments	CHECKED & SET
4	CP	Hydraulic Pressure	PRI. & SEC. CHECKED
5	E	Pitot Covers & Gear Pins	ABOARD
6	E	Ground Power	REMOVED
7	E	Batteries & Generators	ON
8	PE	Engine Instruments	CHECKED
9	PCP	Radios	CHECKED

TAXIING

1	PCPEN	Clocks & Altimeters	SET
2	P	Brake Selector Lever (After brakes are released)	NORM
3	PCP	All Turn Indicators	CHECKED
4	P	Propeller Reversing	CHECKED

BEFORE TAKE-OFF

1	E	Run-up (Propellers, Generators, Engine Superchargers & Ignition)	COMPLETED
2	PCPE	Doors & Windows	CLOSED
3	P	Trim Tabs	CHECKED
4	CP	Wing Flaps	TAKE-OFF
5	CP	Aux. Control Boosters	ON
6	E	Propellers Controls	SET FOR TAKE-OFF
7	E	Mixtures	AUTO RICH
8	E	Carburetor Air	COLD
9	E	Air Conditioning	PANEL SET
10	E	Fuel Pumps 1, 2, 3, 4	HIGH
11	E	Oil Cooler Flaps	SET
12	E	Auto Feathering	AS REQUIRED

TAKE-OFF CLEARANCE

13	E	Cowl Flaps	SET (30%)
14	P	Controls	FREE

CLIMB

1	CP	Landing Lights	RETRACTED & OFF
2	CP	Aux. Control Boosters	OFF
3	P	Ordinance Lights	OFF
4	CP	Landing Gear Lever	UP, THEN NEUTRAL
5	CP	Wing Flaps	UP
6	E	Fuel Pumps	LOW
7	E	Oil Cooler Flaps	AS REQUIRED
8	E	Auto Feathering	OFF
9	E	Cowl Flaps	AS REQUIRED

IN RANGE TRAFFIC PATTERN

1	P	Auto Pilot Servo Disconnect Levers	OFF
2	P	Ordinance Lights	ON
3	CP	Altimeter	SET
4	E	Engine Superchargers	LOW
5	E	Fuel Tank Selectors 1, 2A, 3A, 4	ON
6	E	Tank 5 and Fuel Crossfeed Levers	CLOSED
7	E	Cabin Pressure	SET FOR LANDING
8	E	Landing Weight	CHECKED

BEFORE LANDING—FINAL

1	P	De-Icer Boots	OFF
2	E	Mixtures	AUTO RICH
3	E	Fuel Pumps 1, 2A, 3A, 4	HIGH
4	E	Carburetor Air	COLD
5	CP	Aux. Control Boosters	ON
6	CP	Wing Flaps	AS REQUIRED
7	CP	Landing Gear	DOWN & LOCKED
8	E	Propellers	2600 RPM
9	P	Brakes	CHECKED & ON NORM

AFTER LANDING

1	E	Cowl Flaps	OPEN
2	E	Oil Cooler Flaps	OPEN
3	E	Fuel Pumps	OFF
4	E	Master RPM Control	FULL INC. RPM
5	CP	Aux. Control Boosters	OFF
6	CP	Wing Flaps	UP

PARKING

1	P	Brake Selector Lever	EMER
2	Crew	All Unnecessary Switches	OFF

Section II

normal operating procedure

2–1. BEFORE ENTERING THE AIRCRAFT.

2–2. FLIGHT RESTRICTIONS.

2–3. Refer to Section V for the information concerning operating limitations.

2–4. WEIGHT AND BALANCE.

2–5. It is the responsibility of the pilot in command to ascertain that the aircraft is properly loaded and balanced and that center of gravity limits are not exceeded.

2–6. EXTERIOR INSPECTION.

2–7. A check should be made of the take-off and anticipated landing gross weights, and that the grades and weight of fuel, oil, and special equipment carried are suited to the flight.

Note

The current aircraft status and aircraft log should be checked with the maintenance crew chief for irregular items that may have been reported on the previous flight.

2–8. A visual pre-flight inspection of the aircraft should be made before boarding, in accordance with the items noted in figure 2–1.

2–9. After the items listed on figure 2–1 have been checked, a top-wing inspection should be made as follows:

a. All fuel tanks—check fuel quantity with dip sticks and secure filler caps.

b. All oil tanks—check oil quantity with dip sticks and secure filler caps.

c. Main hydraulic reservoir—check fluid quantity with dip stick and secure filler cap and access cover.

d. Anti-icer fluid tanks—check fluid quantity and secure filler caps.

e. De-icer boots—check condition.

f. Wing and nacelle skin—check general condition.

2–10. ON ENTERING THE AIRCRAFT.

2–11. INTERIOR CHECK (CABIN).

a. Emergency equipment—aboard and secure.

1. First aid kits.
2. Fire extinguishers.
3. Life rafts (and life vests).
4. Escape ropes and axe.
5. Ladders.
6. Flashlights.
7. Portable oxygen bottles.
8. Portable emergency transmitters.
9. Ditching light.†
10. Cabin furnishings.

b. Galley equipment—checked.

c. Seats—secured.

d. Lavatories—checked.

†LAC Serials 4510 through 4519.

e. Water taps and drain valves—closed.

f. Water tanks—full.

g. Emergency exits—secured.

h. Cabin doors—condition and check operation.

i. Windows—condition, crazing.

j. Emergency flap extension bypass valve—closed.

k. Right secondary heat exchanger hydraulic fan valve—neutral.

l. Flap extension handcrank—secured.

2–12. INTERIOR CHECK (NAVIGATOR'S STATION, OVERWATER FLIGHTS).

a. Periscopic sextant—checked.

b. Viewing window—clean and locked.

c. Forms, logs, and handbooks—aboard.

d. Oxygen masks and equipment—supply and flow check.

e. Spare fuses and bulbs—stowed.

f. Driftmeter (if installed)—caged.

2–13. INTERIOR CHECK (FLIGHT STATION).

PILOTS

a. Landing gear lever—DOWN.

b. Ignition switches—OFF.

c. De-icer boot cycle selector—OFF.

d. De-icer air pump selector valve switches—VAC.

e. De-icer vacuum switch*—ON.

f. Vacuum shut-off valve—OPEN.

g. Nesa system switches*—OFF.

h. Pitot heater switches—OFF.

i. Windshield anti-icer pump switches—OFF.

j. Windshield defogger switches—OFF.

k. Mast de-icer switch*—OFF.

l. Fire warning lights and bell—test.

m. Light switches—OFF or as required. Refer to INTERIOR CHECK (NIGHT FLIGHTS).

n. Flare switches—OFF.

o. Automatic pilot switch—ON.

p. Flight path control switches—OFF.

q. Zero Reader switch—ON.

r. Gyrosyn compass switch—ON.

s. Hand pump selector—EMER. BRAKE.

t. Brake selector lever—EMER.

u. Parking brake—set.

v. Brake pressure—check, if lower than 1250 psi, raise pressure with hand pump.

w. Electric elevator trim tab—check.

x. Aileron and rudder booster control levers—ON.

y. Emergency elevator booster shift lever—check, and on boost.

FLIGHT ENGINEER

a. Circuit breakers—check.

b. Battery switch—CART.

Note

If ground power source is not available, the battery switch may be positioned to SHIP to accomplish check list; return switch to OFF to conserve battery until ready to start engines.

c. Warning and indicator lights—press to test, as encountered.

d. Tanks 1 & 2, 3 & 4, fuel dump levers—CLOSED.

e. Emergency shut-off levers—ALL ON.

f. Battery voltage— _____volts.

g. Inverters*—check SPARE—on NORMAL.

or

Main inverter switch†—check on No. 2, then leave on No. 1 position.

h. Generator switches—OFF.

i. Propeller and carburetor anti-icer switches—OFF.

j. Light switches—OFF or as required. Refer to INTERIOR CHECK (NIGHT FLIGHTS).

k. Nesa inverter switch*—OFF.

l. Engine starter selector switch—OFF.

m. Tank No. 5 selector and fuel crossfeed levers—CLOSED.

n. Cabin pressure regulator vacuum shut-off valve—OPEN.

o. Master rpm control—full INC. RPM.

p. Engine supercharger levers—LOW.

q. Mixture control levers—OFF.

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

exterior inspection

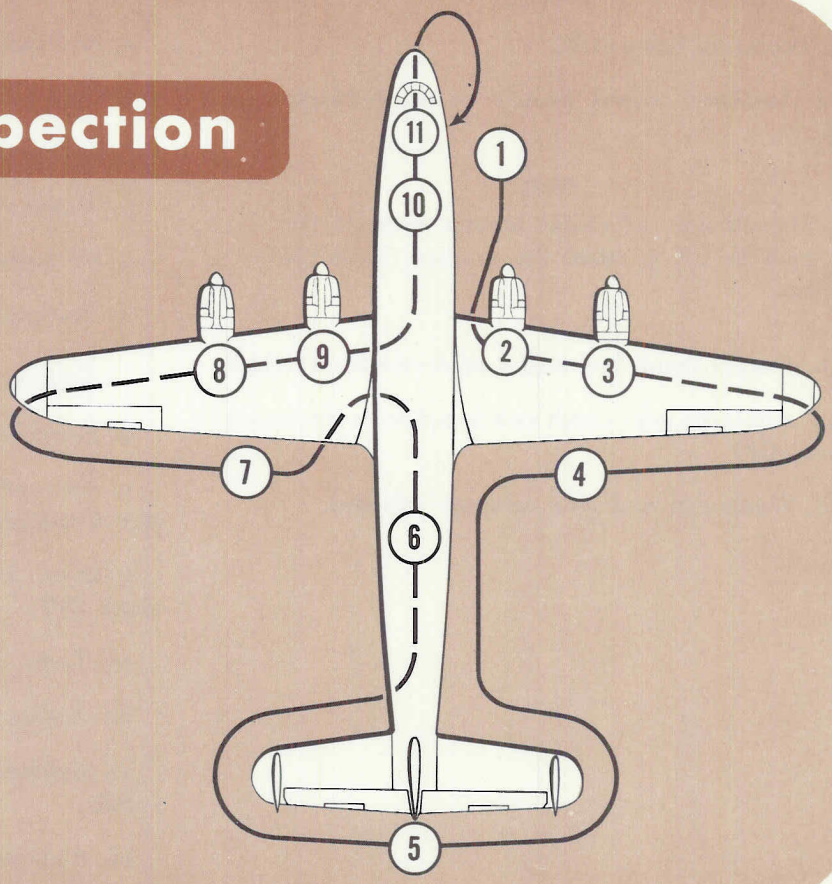


figure 2-1

1. Fuselage — right side
   - (A) Fuselage skin — **condition**
   - (B) CO_2 overboard safety discharge outlets — **intact**
   - (C) Parachute flare shields — **intact**

2. Inboard engine and main gear
   - (A) Engine cowling — **condition and secured**
   - (B) Propeller — **blades for cuts, nicks; dome for leaks**
   - (C) Cowl flaps — **condition**
   - (D) Engine — **leaks; oil and fuel**
   - (E) Engine breather lines and vents — **open**
   - (F) Engine exhaust system — **condition and secured**
   - (G) Tires — **condition and proper inflation**
   - (H) Brakes — **leaks; fittings and bleed plugs secured**
   - (I) Brake debooster rack — **fittings and leakage; piston on lockout deboosters positioned above the "bleed brake" mark with brakes set.**
   - (J) Main gear struts — **leakage and proper inflation**
   - (K) Main gear up-locks — **opened**
   - (M) Main gear doors and attachments — **condition**
   - (N) Main gear safety pin — **installed**
   - (P) Wheel chock — **in place**
   - (Q) Ground wire (right main gear) — **touching ground**

3. Outboard engine — **repeat steps (A) through (F) of 2**

4. Underside wing surface
   - (A) Scoops and access doors — **condition and secured**
   - (B) Wing surface — **fuel leaks**
   - (C) De-icer boots — **condition**
   - (D) Exterior lights — **lenses clean and intact**
   - (E) Flaps, ailerons, and aileron trim tabs — **condition**
   - (F) Cabin heater area — **condition**

5. Empennage surfaces
   - (A) Stabilizer — **condition**
   - (B) De-icer boots — **condition**
   - (C) Elevators and trim tabs — **condition**
   - (D) Rudders and trim tabs — **condition**
   - (E) Tail cone, navigation lights — **condition**

6. Fuselage underside
   - (A) Fuselage — **general condition**
   - (B) Antennas and masts — **condition and secure**
   - (C) Cargo and access doors — **closed and secured**
   - (D) Auxiliary vent exit valve — **position and clear**

7. Under side wing surface — **repeat steps (A) through (F) of 4**

8. Outboard engine — **repeat steps (A) through (F) of 2**

9. Inboard engine and main gear — **repeat steps (A) through (P) of 2**

10. Fuselage — left side
    - (A) Fuselage skin — **condition**
    - (B) Oxygen overboard safety discharge outlet — **intact**

11. Nose gear and wheel well
    - (A) Nose gear up-lock — **opened**
    - (B) Nose gear safety pin — **installed**
    - (C) Batteries — **secured**
    - (D) Battery acid traps — **empty**
    - (E) Nose gear strut — **leaks and inflation**
    - (F) Nose wheel tires — **condition and inflation**
    - (G) Nose gear steering — **leakage, bleed plugs, torsion link**
    - (H) Nose well doors — **condition and secure**
    - (I) Pitot heads — **covers removed**
    - (J) Taxi lights — **glass intact and clean**

PILOTS

z. Ordinance lights—ON.

aa. Auxiliary control booster switches—check, and OFF.

Note

The elevator and rudder booster control levers must be ON to utilize the auxiliary boost system.

ab. Oxygen supply and masks, smoke masks—checked.

ac. Automatic pilot clutch switch and servo disconnect levers—OFF.

ad. Windshield and side windows—checked.

FLIGHT ENGINEER

r. Fuel tank selector levers (1, 2, 3, 4)—ON.

s. Cowl flaps—OPEN.

t. Carburetor air switches—COLD.

u. Master engine selector switch†—on (1 or 2).

v. Oil cooler flaps—OPEN.

w. Feathering switches*—NORMAL.
or
Feathering buttons†—neutral.

x. Reserve oil tank heater switch—ON.

y. Air conditioning—aux. vent. control knob to position A and panel set.

z. Cabin heater fire extinguisher selector handle—check OFF.

aa. Tanks 2A and 3A fuel dump lever—NEUTRAL.

ab. Anti-icer fluid—full.

ac. Hydraulic fluid reservoirs—emergency and reserve—full.

ad. Automatic feathering switches—OFF.

ae. Oxygen and smoke masks—checked.

af. Fuel quantity—check against desired loading and stick reading.

ag. Engine oil quantity—check against desired loading and stick reading.

ah. Gross weight and CG.—_____lbs._____%.

2–14. INTERIOR CHECK (NIGHT FLIGHTS).

a. Panel light switches—set.

b. Flashlights—aboard and secure.

c. Navigation light switch—ON.

d. Nose lights (taxi and passing)—check operation.

e. Position lights switch—set.

f. Landing light switches—EXTEND, check LAMP ON, OFF, and RETRACT.

g. Wheel well lights switch—check operation of lights.

h. Leading edge lights switch—check operation of lights.

i. Chart lights switches—check operation.

a. Panel light switches—set.

b. Cargo and tail section inspection lights switches—check.

c. Desk lights switch—adjust.

d. Cabin overhead lights, night lights, lavatory lights, and other crew station lights—check operation and set.

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

PILOTS

FLIGHT ENGINEER

j. Pedestal rear light switch—check operation.

k. Compass light switch—set.

l. Radio selector box panel light switches—set.

m. De-icer control panel light switches—set.

2–15. BEFORE STARTING ENGINES.

Note

Before starting, the engines must be turned over a minimum of six blades with the starter while the ignition switch is off. This is necessary because of the possible existence of a liquid lock which may seriously damage the engine. If a liquid lock exists, the lower cylinder spark plugs must be removed and the propellers again rotated to remove the oil from the cylinder.

WARNING

The propellers should not be moved by hand and must never be moved opposite to normal engine rotation.

2–16. PROPELLER FEATHER CHECK (Curtiss Electric Propellers) LAC Serials 4501 through 4509.

a. Feather switch—FEATHER. Observe that propeller blades go to full feather position at an accelerated rate.

CAUTION

Allow propeller to complete cycle. Do not repeat feather check on any one propeller more than once in any five-minute period.

b. Propeller selector switch—hold to INC. RPM. Note that no blade angle change occurs.

c. Feather switch—return to NORMAL then hold propeller selector switch to INC. RPM. Observe that propeller returns to low blade angle—then place switch in AUTO RPM position.

d. Repeat the above steps on each remaining propeller.

2–17. ENGINE STARTING PROCEDURE.

2–18. The engine starting order is: 3, 4, 2, and 1. The engines are started in this order to provide immediate secondary hydraulic pressure. After obtaining all-clear signal from ramp mechanic, complete starting procedure as follows:

a. Engine fire extinguisher selector handle—set to each engine as started, OFF after all engines are started.

Note

For engine fires during start, refer to engine fire extinguishing procedures in Section III.

b. Engine starter selector switch—set.

PILOTS

g. Ignition switch—BOTH.

Note

Ignition switch should be turned on after the propeller has turned six blades.

Note

After engines 3 and 4 have been started, check secondary hydraulic system for pressure and check operation of flight controls.

FLIGHT ENGINEER

c. Throttle lever—set to approx. 1200 rpm.

d. Auxiliary fuel pump switch—LOW (tank being used, others OFF).

e. Mixture control lever—check OFF.

f. Starter switch—engage.

Note

Avoid throttle movement until engine is running smoothly. Do not exceed 1400 rpm on start.

h. Mixture control lever—AUTO RICH. (When starting a hot engine, or an engine which tends to load up, move the mixture control to OFF momentarily.)

Note

- Priming will only be necessary during cold starts. Under these conditions operate the primer and starter engaging switch simultaneously.
- Should the engine fail to start within 30 seconds, let the starter cool and then repeat the starting procedure.

CAUTION

Observe the oil pressure gages. Stop the engine if rear oil pressure does not register within 10 seconds or reach 40 psi within 20 seconds.

Note

When it is necessary to start the engine on the ship batteries, minimize the electrical load. It is recommended that when one engine is started, the generator on that engine be turned ON and the throttle set to 1400 rpm before starting the other engines.

i. Engine starter selector switch—OFF, after all engines have been started.

2–19. ENGINE GROUND OPERATION.

2–20. When all engines have been started, proceed as follows:

a. The radio equipment should be turned on and checked.

b. Altimeters—set.

c. Clocks—wind and set.

a. Check that gear pins and pitot covers are aboard the aircraft.

b. Signal ground crew to remove ground power supply. (Moving battery switch to SHIP position turns light out at cart receptacle and is signal to pull cart.)

c. Battery switch—SHIP.

d. Generator switches—ON.

PILOTS

d. Gyrosyn compass—set.

e. Flux Gate compass—caged and uncaged.

f. Directional gyro†—set.

FLIGHT ENGINEER

e. Warm engines at 1200-1400 rpm until a 10°C (50°F) rise in engine oil temperature is obtained. Then use 800-1000 rpm.

f. Water system switch—ON.

g. Water heater switch—ON.

2–21. GROUND TESTS.

a. Check hydraulic systems pressure within normal limits.

Note

If a pressure check of each hydraulic pump is desired, the output of all but one hydraulic pump may be bypassed by moving three emergency shut-off levers to the HYDRAULIC OIL—OFF positions. However, the pumps should not be operated for an extended period on the ground in that condition or they will overheat. An extended pressure check can be made by operating each engine individually.

b. Air conditioning panel—set.

c. Propeller switches†—set to full INC. RPM.

d. Check all engine indicators for normal operation.

e. Extend and retract wing flaps and check indicator.

2–22. THE BRAKE SYSTEMS SHOULD BE CHECKED PRIOR TO TAXIING IN ACCORDANCE WITH THE FOLLOWING PROCEDURES:

a. Emergency extension reservoir fluid level—check.

b. Secondary hydraulic system pressure—check (1500 to 1725 psi).

c. Brake selector valve lever—check EMER.

d. Emergency brake pressure—check (approx. 1600 psi).

e. Signal ground crew to remove wheel chocks.

f. Parking brake—release, light out.

g. Depress toe pedals, noting pedal reaction and observing emergency brake pressure indicator.

Note

When unparking, release parking brake lever and toe pedals before moving brake selector valve lever from EMER. to NORM.

h. Brake selector valve lever (after brakes are released)—NORM.

i. Depress toe pedals, noting pedal reaction.

Note

If the brake systems are checked in accordance with this procedure, a potential brake failure may be detected, and necessary emergency action taken.

†LAC Serials 4510 through 4519.

PILOTS

FLIGHT ENGINEER

2–23. TAXIING INSTRUCTIONS.

a. If low power is required for taxiing, it is preferable to retard the throttles of the inboard and advance the throttles of the outboard engines in order to assure adequate generator output and ground refrigeration, if required.

2–24. PROPELLER REVERSE CHECK (Curtiss Electric Propellers) LAC Serials 4501 through 4509.

a. Aux. vent. control knob—position A for propeller reverse test to prevent engine exhaust fumes from entering cabin.

b. Reverse throttle levers—move to the reverse range. Observe that the propellers go to the negative angle.

c. Propeller selector switches—hold to INC. RPM and then to DEC. RPM positions. Note that no change in blade angle occurs.

Note

If blade angle change occurs, it is an indication of mis-wiring and the system should be checked immediately.

d. Selector switches—place in AUTO RPM positions.

e. Reverse throttle levers—move to the forward range. Observe that propellers return to normal low blade angles at an accelerated rate.

f. Aux. vent. control knob—CLOSED (after propeller reverse test) for pressurized flight or position between B and OPEN for auxiliary ventilation flight.

g. Upon reaching run-up area, set parking brake by depressing toe pedals and raising parking lever.

h. Parking brake warning light—check for indication.

Note

Stop the aircraft smoothly with the nose wheel straight in order not to place severe side loads on the nose wheel tires and strut during run-up.

2–25. PROPELLER REVERSE CHECK (Hamilton Standard Propellers) LAC Serials 4510 through 4519.

a. Aux. vent. control knob—position A for propeller reverse test to prevent engine exhaust fumes from entering cabin.

b. Reverse throttle levers—move to the reverse range.

c. Reverse pitch indicator lights—check ON.

d. Feathering button lights—check ON. (These should go off when the reverse pitch indicator lights come on.)

PILOTS

g. Reverse throttle levers—move to the forward range.

h. Feathering button lights—check ON, should go off in 3 or 4 seconds.

i. Reverse switch indicator lights—OFF.

j. Upon reaching run-up area, set parking brake by depressing toe pedals and raising parking brake lever.

k. Parking brake warning light—check for indication.

Note

Stop the aircraft smoothly with the nose wheel straight in order not to place severe side loads on the nose wheel tires and strut during run-up.

FLIGHT ENGINEER

e. Sectionalizing bus relay lights—check ON.

f. Aux. vent. control—CLOSED (after propeller reverse test) for pressurized flight and position between B and OPEN for auxiliary ventilation flight.

2–26. METHODS OF STOPPING THE AIRCRAFT.

2–27. POWER-ON AND POWER-OFF STOPS. Because of the hydraulic drag shock struts on the main gears, two basic methods are recommended for coming to a stop after taxiing to prevent a rocking motion—with power-on and with power-off. The power-on stop should be used when run-up is to be made and the power-off stop upon station arrival, or when it is desirable to stop with the engines idling.

2–28. POWER-ON STOPS. Ease the aircraft to a normal stop as an approximate 1500 rpm is applied to all four engines. This is ample power to prevent rocking rearward. Maintain this minimum power setting during run-up. If it is necessary to hold before take-off and it is desired to reduce power to idle rpm, release the brakes as the throttles are closed, thereby allowing the gear to move forward, then re-apply the brakes.

2–29. POWER-OFF STOPS. For a no-power stop, apply the brakes in the normal manner but release and re-apply them as the aircraft stops, thus allowing the gear to move forward instead of the aircraft rocking rearward. If it is desired to run-up after a no-power stop, allow the aircraft to roll forward slightly and then stop in the power-on manner described above.

CAUTION

- Sharp turns at high speed impose excessive forces on the inside nose wheel tire, strut components, and aircraft structure. Side loads may prove sufficient at high speeds to pull the inside tire off the wheel.
- With the nose wheel fully deflected in either direction, power should be applied until the aircraft starts rolling before using the steering wheel.

PILOTS FLIGHT ENGINEER

2–30. BEFORE TAKE-OFF.

2–31. PRE-FLIGHT ENGINE AND PROPELLER CHECK.

2–32. Generators and Curtiss Electric propellers should be checked as follows (LAC Serials 4501 through 4509):

a. Propeller master control lever—advance to 1700 rpm.

b. Each individual selector switch—hold in DEC. RPM position—note 200 to 300 rpm drop.

c. Individual selector switches—hold in INC. RPM position—note rise to 1700 rpm.

Note

Proper response to the above checks indicates that the blades are in the forward thrust range.

d. Generator amperage and voltage—check.

2–33. Curtiss Electric propeller synchronizer check (LAC Serials 4501 through 4509):

a. Each individual propeller selector switch—AUTO RPM position.

b. Propeller master control lever—retard until a 200 to 300 rpm drop is noted on each engine.

c. Synchronizer warning light—check.

Note

Synchronizer warning light should be off when synchronizer motor is operating at selected speed.

d. Propeller master control lever—advance to full INC. RPM position and note even rise in rpm on each engine.

2–34. Generators and Hamilton Standard propellers should be checked as follows (LAC Serials 4510 through 4519):

a. Propeller master control lever—full INC. RPM.

b. Throttle lever—set 1700 rpm (each engine).

c. Generator amperage and voltage—check.

d. Propeller master control lever—full DEC. RPM.

Note

The propeller governor indicator lights should light and remain on. The rpm should drop to the low limit setting (1300-1400 rpm) and stabilize.

e. Propeller master control lever—full INC. RPM.

Note

The indicator lights should go out, then come on again and stay lighted. The rpm should increase to the original setting of 1700 rpm and stabilize.

PILOTS

FLIGHT ENGINEER

f. Repeat the preceding test using the individual propeller governor control switches.

g. Feathering buttons—engage momentarily (on each engine).

Note

If the rpm increases, the blades are in reverse pitch and take-off should not be attempted. If the rpm decreases, the blades are in forward pitch, and the operation is normal.

2–35. Check the engine superchargers as follows:

a. Engine speed—set to 1600 rpm.

b. Engine supercharger control lever—HIGH. Move rapidly and lock.

c. Throttle lever—open to 30″ Hg.

d. Engine supercharger control lever—LOW.

Note

A sudden decrease in manifold pressure indicates that the two-speed mechanism is working properly. Do not make more than two such checks on any one engine within a five-minute interval.

2–36. Check the magnetos of each engine as follows:

a. Throttle lever—open to obtain field barometric manifold pressure. Do not exceed 2300 rpm.

b. Ignition switch—left.

Note

The pilot will coordinate movement of the ignition switches with the flight engineer when checking the magnetos.

CAUTION

A variation of greater than 100 rpm between engines, set at the same manifold pressure, should be immediately investigated.

c. Engine rpm—check.

d. Ignition switch—BOTH.

e. Engine rpm—check.

f. Repeat this procedure for the RIGHT position.

f. Repeat this procedure for the RIGHT position.

Note

Atmospheric conditions will influence the readings obtained; however, a drop of not more than 30 rpm or a 10 rpm rise is considered satisfactory provided no engine roughness is encountered.

PILOTS

FLIGHT ENGINEER

2–37. The setting and operation of the torque pressure switches of each Curtiss Electric Propeller (LAC Serials 4501 through 4509) should be checked as follows:

a. All throttle levers—open to 95 BMEP, then retard to 85 BMEP.

b. Automatic feathering master switch—check ON.

c. Automatic feathering system indicator lights—check ON.

d. All four automatic feathering test switches—ON.

e. Note that none of the propellers feather.

f. All throttle levers—retard to 70 BMEP. Note that only one propeller starts feathering cycle after approximately two seconds.

g. Check that corresponding automatic feathering warning light comes on.

h. Immediately interrupt feathering cycle by placing the selector switch to fixed pitch position and, *after a momentary pause,* hold the selector switch to INC. RPM position to regain rpm. Return the selector switch to AUTO RPM position.

CAUTION

The momentary pause in step h. above must be accomplished to allow the pitch change motor to come to a complete stop before being energized in the opposite direction.

Note

Interruption of the automatic feathering cycle must be started soon enough to prevent the engine rpm from becoming too low. If the engine rpm is allowed to become too low, the system will be slow to respond or will become entirely inoperative in automatic.

i. Automatic feathering test switch—for propeller that has feathered—OFF.

j. Automatic feathering master switch—reset (OFF and then ON).

k. Another propeller should start to feather. Repeat steps g. through j. until each propeller has been checked.

l. After the fourth propeller has been checked, without resetting master switch, turn on all four test switches. Automatic feathering indicator light should be out and no feathering should occur.

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FLIGHT ENGINEER

2–38. The automatic feathering system of each Hamilton Standard Propeller should be checked as follows (LAC Serials 4501 through 4519):

a. All throttle levers—open to 95 BMEP then retard to 85 BMEP.

b. Automatic feathering master switch—ON.

c. Automatic feathering indicator light—check ON.

c. Automatic feathering indicator light—check ON.

d. All four automatic feathering test switches—ON.

e. Note that none of the propellers feather.

f. All throttle levers—retard to 70 BMEP (feathering button light should come on at 70-85 BMEP). Note that only one propeller starts feathering cycle.

g. Feathering button—for propeller that has feathered—pull out to neutral position to reject feathering cycle. Light in the feathering button will go out and rpm will rise.

h. Automatic feathering test switch—for propeller that has feathered—OFF.

i. Automatic feathering master switch—reset (OFF and then ON).

j. Another propeller should start to feather. Repeat steps g. through i. until each remaining propeller has been checked.

Note

After the fourth propeller has been checked, without resetting master switch, turn on all four test switches. Automatic feathering indicator light should be out and no feathering should occur.

2–39. PRE-FLIGHT AIRCRAFT CHECK.

Note

Refer to Section VI for fuel system management.

a. Trim tabs—set.

b. Wing flap control lever—TAKE-OFF.

c. Windows—closed and latched.

d. Check flight controls for full free movement.

e. Auxiliary elevator and rudder boost switches—ON.

a. Propeller controls—set for take-off.

b. Auxiliary fuel pump switches—HIGH; tanks 1, 2, 3, and 4.

c. Oil cooler flaps—as desired.

d. Cowl flaps—30 per cent.

e. Temperatures and pressures—normal.

f. Door warning lights—check, out.

g. Carburetor air switches—COLD.

h. Mixture control levers—AUTO RICH.

i. Air conditioning control panel—set.

j. Automatic feathering master switch—as desired.

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2–40. TAKE-OFF.

a. Throttle levers—advance. Make take-off as shown on figure 2–2.

b. Throttle levers—trim to even power.

c. Use nose wheel steering for directional control until the rudders become effective.

d. Ease nose wheel off the runway gradually as take-off speed is reached.

2–41. AFTER TAKE-OFF.

a. Landing gear control lever—UP.

CAUTION

Do not apply the brakes to stop wheel rotation during or after gear retraction.

b. Request power reduction to METO power, when safe altitude and airspeed have been attained.

c. METO power—set.

d. Wing flap control lever–UP (after gear is fully retracted).

2–42. CLIMB.

a. Request climb power (after wing flaps are up).
b. Auxiliary elevator and rudder boost switches—OFF.
c. Landing gear control lever—NEUTRAL.

a. Climb power—set.
b. Auxiliary fuel pump switches—LOW.
c. Cowl flaps—set for climb.
d. Pressures and temperatures—normal.
e. Automatic feathering master switch—OFF.
f. Engine superchargers—shift to HIGH (when additional power is required at high alt.).

2–43. SYSTEMS OPERATION.

2–44. Refer to Section VI for additional information regarding operation of the various systems.

2–45. DESCENT.

a. Engine supercharger control levers—LOW.
b. Oil cooler flaps—adjust as desired.
c. Cowl flaps—set as required.
d. Air conditioning control panel—set.

2–46. IN RANGE PATTERN.

a. Automatic pilot servo levers—OFF.
b. Ordinance lights—ON.
c. Altimeters—set.
d. Landing weight—checked.

a. Fuel tank selector levers (1, 2A, 3A, 4)—ON.
b. Fuel tank selector lever (5)—CLOSED.
c. Fuel crossfeed levers—CLOSED.
d. Pressures and temperatures—normal.

take-off pattern

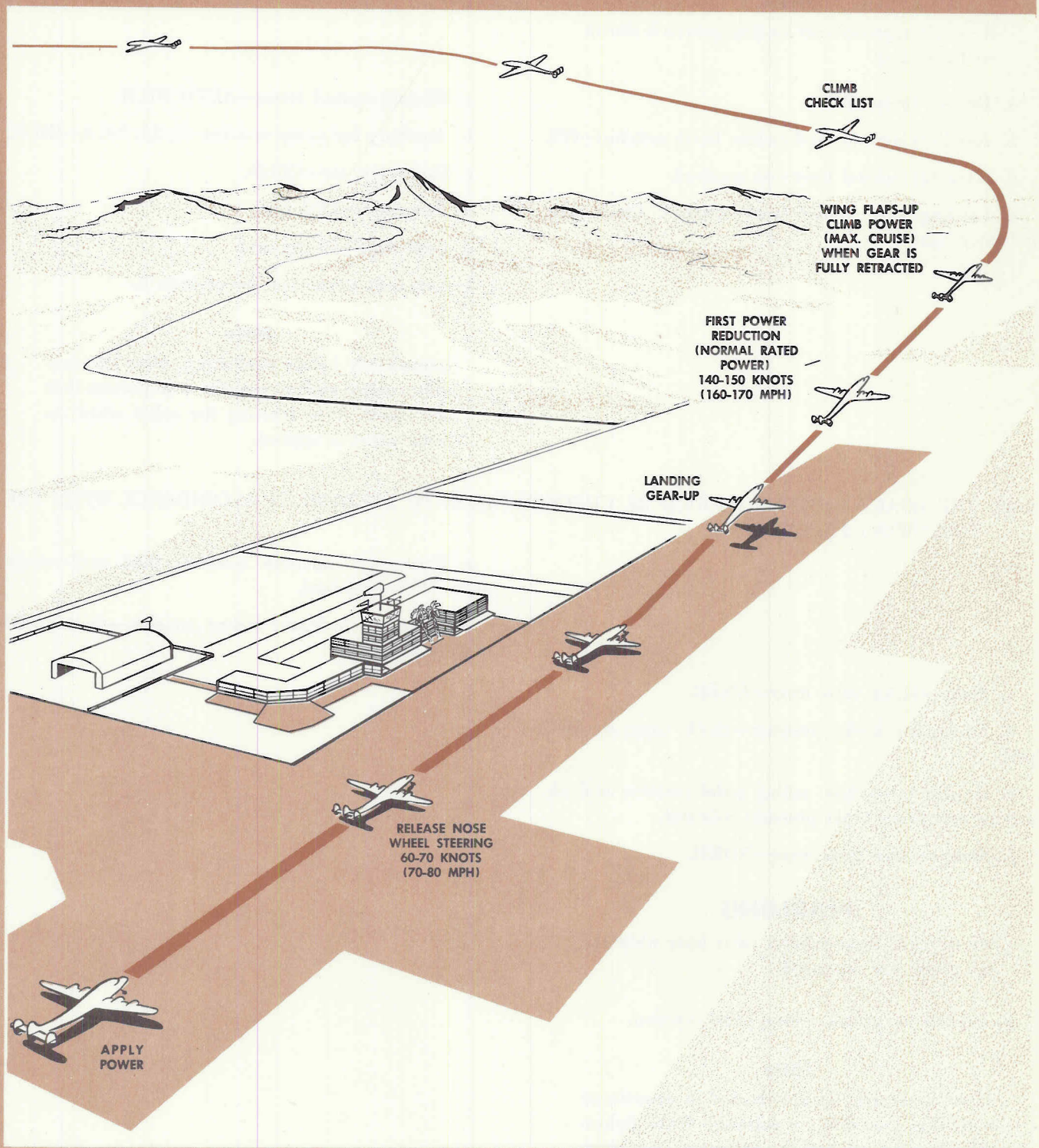

figure 2-2

PILOTS

FLIGHT ENGINEER

2–47. BEFORE LANDING—FINAL.

Note

A sample approach and landing pattern is shown on figure 2–3.

a. De-icer boots—OFF.

b. Auxiliary elevator and rudder boost switches—ON.

c. Wing flap control lever—as required.

d. Landing gear control lever—DOWN. Check gear indicator lights.

a. Mixture control levers—AUTO RICH.

b. Auxiliary fuel pump switches—1, 2A, 3A, 4—HIGH.

c. Carburetor air—COLD.

d. Propellers—2600 rpm.

e. Cowl flaps—30 per cent.

f. Aux. vent. control knob—position A.

Note

Immediately before touchdown, place the aux. vent. control knob to position A to prevent dust and fumes from entering the cabin when reverse power is applied.

2–48. THE BRAKE SYSTEMS SHOULD BE CHECKED PRIOR TO LANDING IN ACCORDANCE WITH THE FOLLOWING PROCEDURES:

a. Emergency extension reservoir fluid level—check above MIN. fluid level.

b. Secondary hydraulic system pressure—check (1500 to 1725 psi).

c. Brake selector valve lever—EMER.

d. Emergency brake pressure—check (approx. 1600 psi).

e. Depress toe pedals, noting pedal reaction and observing emergency brake pressure indicator.

f. Brake selector valve lever—NORM.

WARNING

Never move brake selector valve lever while the toe pedals are depressed.

g. Depress toe pedals, noting pedal reaction.

Note

If the brake systems are checked in accordance with this procedure, a potential brake failure may be detected, and the necessary emergency action taken.

2–49. LANDING.

a. Wing flaps—landing position.

landing pattern

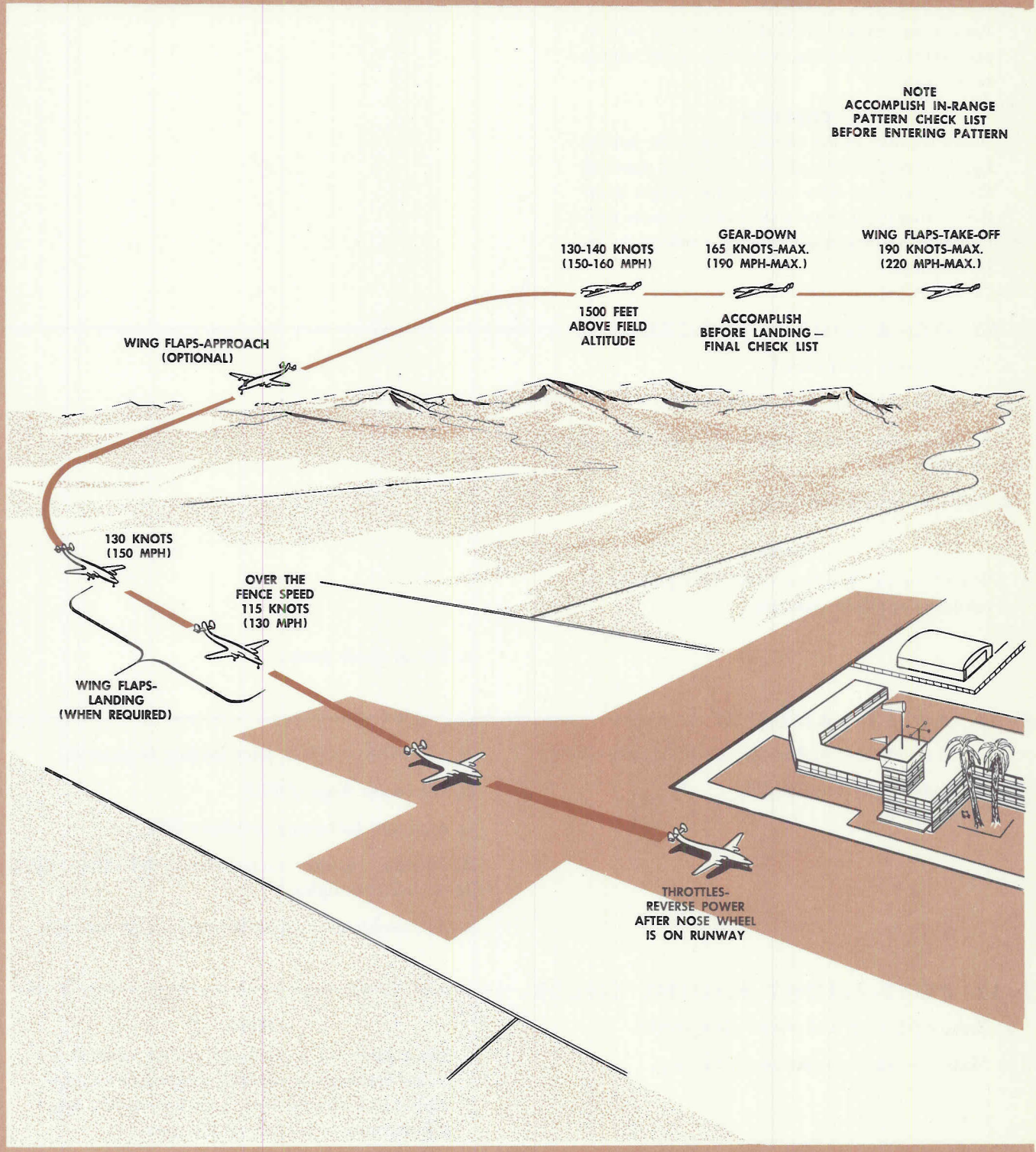

figure 2-3

PILOTS

b. Reverse pitch throttle levers—use as desired.

Note

Return the reverse pitch throttle levers to normal position as soon as possible to avoid engine overheating.

CAUTION

When landing on wet runways, apply the brakes lightly and intermittently for the initial phase of the landing run. After most of the weight is on the landing gear, more brake pedal pressure may be used, but applications must continue to be intermittent.

2–50. GO-AROUND PROCEDURE.

a. Apply power as required.

b. Wing flap control lever—TAKE-OFF.

c. Landing gear control lever—UP (after flaps are at take-off position).

d. Request climb power (after gear is UP).

Note

Wing flaps may be left at TAKE-OFF position or retracted at pilot's discretion.

FLIGHT ENGINEER

e. Set up climb power.

2–51. AFTER LANDING.

a. Auxiliary elevator and rudder boost switches—OFF.

b. Wing flap control lever—UP.

a. Cowl flaps—OPEN after landing is assured.

b. Oil cooler flaps—OPEN.

c. Auxiliary fuel pump switches—OFF.

d. Propeller master control lever—full INC. RPM. (Check indicator lights.)

e. Air conditioning controls—position as required.

2–52. POST-FLIGHT ENGINE CHECK.

a. Make equipment and power plant checks.

b. Make necessary entries on aircraft log.

Note

Idle engines for a minimum of two minutes to permit crankcase scavenging and reduce the possibility of hydraulic lock. Taxi time at idle rpm will consume a portion of this time.

2–53. STOPPING ENGINES.

a. Brake selector valve lever—EMER. position.

b. Parking brake lever—ON.

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c. All unnecessary switches—OFF.

e. Ignition switches—OFF (after engines stop).

FLIGHT ENGINEER

d. Mixture control levers—OFF.

f. Generator switches—OFF.

g. Battery switch—OFF.

h. All unnecessary switches—OFF.

2–54. BEFORE LEAVING AIRCRAFT.

a. Flight control booster levers—leave ON.

Note

Leaving the control boosters on, will dampen movement of the surfaces when moved by wind gusts.

d. Release parking brake (after chocks are placed).

b. Signal ground crew to place wheel chocks.

c. Signal ground crew to install landing gear pins and pitot covers.

Note

When cabin lights, navigation lights, etc. are to be left on and energized by a ground power source, the battery switch should be placed in CART position.

Note: Items shown in ***bold face italics*** are in addition to engine failure if ***fire*** is indicated.

MODEL 1049C ABBREVIATED EMERGENCY PROCEDURES

ENGINE FAILURE and/or *ENGINE FIRE*

Gear ..... UP

Wing Flaps ..... AT PILOT'S DISCRETION

1. Throttle ..... CLOSED
2. Feathering Switch* ..... FEATHER
   or
   Feathering Button† ..... PUSH
3. Mixture ..... OFF
4. ***Emergency Shut-off Lever*** ..... FULL ***OFF*** POSITION
5. Fuel Tank Selectors, of Operating Engines ..... NORMAL
6. Fuel Tank Selector, of Inoperative Engine ..... OFF
7. Auxiliary Fuel Pump ..... OFF
8. Tank 5 & Fuel Crossfeed Levers ..... CLOSED
9. Cowl Flaps ..... FAIRED - ***OPEN***
10. ***Propeller & Carburetor Anti-Icers*** ..... ***OFF***
11. Generator and Generator Field Circuit Breaker ..... OFF
12. ***Engine Fire Extinguisher Selector*** ..... ***SET***
    (Cabin Heater Fire Ext. Selector—OFF)
13. ***CO_2 Release Handle (At Pilot's Order)*** ..... ***DISCHARGE***
14. Feathering Button† ..... NEUTRAL
15. Propeller Governor Switch† ..... FULL DEC. RPM
16. Ignition Switch ..... OFF
17. Propeller Selector Switch* ..... FIXED PITCH
18. Oil Cooler Flap ..... FAIRED
19. Cowl Flaps (After Fire) ..... FAIRED
20. Fuel Crossfeed Levers (After Fire) ..... AS REQUIRED

ENGINES No. 1 & No. 4 OUT

1. Descend to Safe Altitude
2. Aux. Vent. Knob (At Safe Altitude) ..... OPEN
3. Nos. 2 & 3 Vacuum Pump Switches ..... DE-ICER PRESSURE

HEATER FIRE

1. Cabin Heater Switches ..... OFF
2. Cabin Recirculating Fans ..... OFF
3. Engine Fire Extinguisher Selector ..... OFF
4. Cabin Heater Fire Extinguisher Selector ..... TO FIRE LOCATION
5. CO_2 Release Handle ..... DISCHARGE

ELECTRICAL FIRE

Note: If it can be determined fire is caused by short circuit, isolate the affected circuit if possible. If this cannot be accomplished quickly, proceed as follows:

1. Gyrosyn Compass & Emergency Radio Power Switch* ..... EMERGENCY
2. Generator Switches ..... OFF
3. Battery Switch ..... OFF
4. Generator Field Circuit Breakers ..... OFF
5. Master Radio Switches ..... OFF
6. Use CO_2 Extinguisher.

CABIN FIRE

1. Execute Rapid Descent Procedure
   (Do not exceed placarded airspeeds)
2. Aux. Vent. Knob ..... POSITION B
3. Cabin Recirculating Fans ..... OFF
4. Use Portable Fire Ext. ..... BY DESIGNATED CREW MEMBER

SMOKE REMOVAL PROCEDURE

1. Execute Rapid Descent Procedure
   (Do not exceed placarded airspeeds)
2. Emergency Depressurize (Heaters & All Fans OFF)
3. Open Sta. 260 Door.
4. Reduce Airspeed to 175 knots (200 mph) or less.
5. FIRST, Open one or more emergency exits over the wings.
6. SECOND, Open flight station windows.

WARNING

Do not open any exits or vents forward of the plane of propeller rotation before there is an opening in the cabin over the wings.

GEAR EMERGENCY EXTENSION

1. Landing Gear Lever ..... DOWN
2. Hand Pump Selector ..... EMER. GEAR (AFT)
3. Pump Until Gear Down & Locked ..... CHECK GEAR IND. LIGHTS
4. Hand Pump Selector ..... EMER. BRAKES (FWD)

BRAKES EMERGENCY

1. Brake Selector Lever ..... EMER.
   If brakes are not effective:
2. Emer. Hand Pump ..... PUMP
3. Depress pedals and hold. Do not pump pedals.
4. Propellers ..... REVERSE

FUEL DUMPING PROCEDURE

1. Gear & Wing Flaps ..... UP
2. Airspeed ..... IAS 150-190 KNOTS (175-218 mph)
3. Heater Switches ..... OFF
4. Ordinance Lights ..... ON
5. All Radio Equipment ..... OFF
6. Unnecessary Electrical Equipment ..... OFF
7. Fuel Dump Levers (1 & 2, 3 & 4) ..... OPEN
8. Fuel Dump Lever (2A & 3A) ..... OPEN

   Note: When Tanks 2A & 3A start to dump ..... RETURN LEVER TO NEUTRAL

9. Flight Path ..... STRAIGHT AND LEVEL
10. After Dumping Tanks Nos. 1 & 2, 3 & 4
    (a) Return Levers to "Red Line"
    (b) Then to "Intermediate" for 15-30 seconds.
    (c) Then CLOSED POSITIONS.
11. After Dumping Tanks
    Nos. 2A & 3A ..... Lever CLOSED then to NEUTRAL

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519

Section III

emergency operating procedure

3–1. ENGINE FAILURE.

3–2. The corrective action required after an engine failure occurs, consists of shutting down the failed engine, feathering the propeller, and then retrimming the aircraft to continue flight. The longer the delay between detection of a malfunction and the actual feathering the more severe the damage will be.

3–3. Feather or stop the engine when:

a. An extreme or abnormal engine vibration occurs.

b. An excessive or uncontrollable power loss occurs.

c. A sudden or uncontrollable rise in oil temperature occurs.

d. A sudden or uncontrollable drop in oil pressure occurs.

e. A sudden and uncontrollable rise of cylinder head temperature occurs.

f. A heavy discharge of oil is seen to emit from the engine breather or exhaust system.

g. Any other condition that indicates feathering is advisable.

3–4. Where continued operation of any engine evidencing any of the foregoing conditions of malfunction is considered imperative in the interest of safety of the aircraft and passengers and crew. It is recommended that operation of the engine be conducted with caution and at the minimum power consistent with requirements.

3–5. FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS.

3–6. Flight characteristics of this aircraft with either inboard engine inoperative remain unchanged and rapid trim changes are not required. With either outboard engine inoperative a slight yawing of the aircraft may be noticeable to the pilot and rudder trim may be required.

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3–7. PROCEDURE ON ENCOUNTERING ENGINE FAILURE—Curtis Electric Propeller (LAC Serials 4501 through 4509).

a. Throttle lever—CLOSED.

b. Feathering switch—FEATHER position (Auto feathering OFF).

Note

If propeller windmills in counterclockwise direction, place feather switch to NORMAL then place propeller selector switch in INC. RPM position momentarily until rotation stops. Return selector switch to fixed pitch position when propeller stops turning.

c. Mixture control lever—OFF.

d. Emergency shut-off lever—full OFF position (Hyd. oil, fuel, blast air, and eng. oil).

e. Fuel tank selector levers of operating engines—normal (tank to engine).

f. Fuel tank selector lever of inoperative engine—OFF.

g. Auxiliary fuel pump switch of inoperative engine—OFF.

h. Fuel crossfeed levers—CLOSED.

i. Tank 5 fuel selector lever—CLOSED.

j. Cowl flaps—faired on inoperative engine.

k. Propeller and carburetor anti-icer switches—OFF.

l. Generator switch—OFF.

m. Engine fire extinguisher selector handle—set to feathered engine (cabin heater fire extinguisher selector handle—OFF).

n. Ignition switch—OFF

o. Propeller selection switch—fixed pitch position.

p. Oil cooler flaps—faired.

q. Set up necessary three-engine power.

r. Re-position fuel crossfeed levers (if it will not add to any fire hazard) to equalize fuel load.

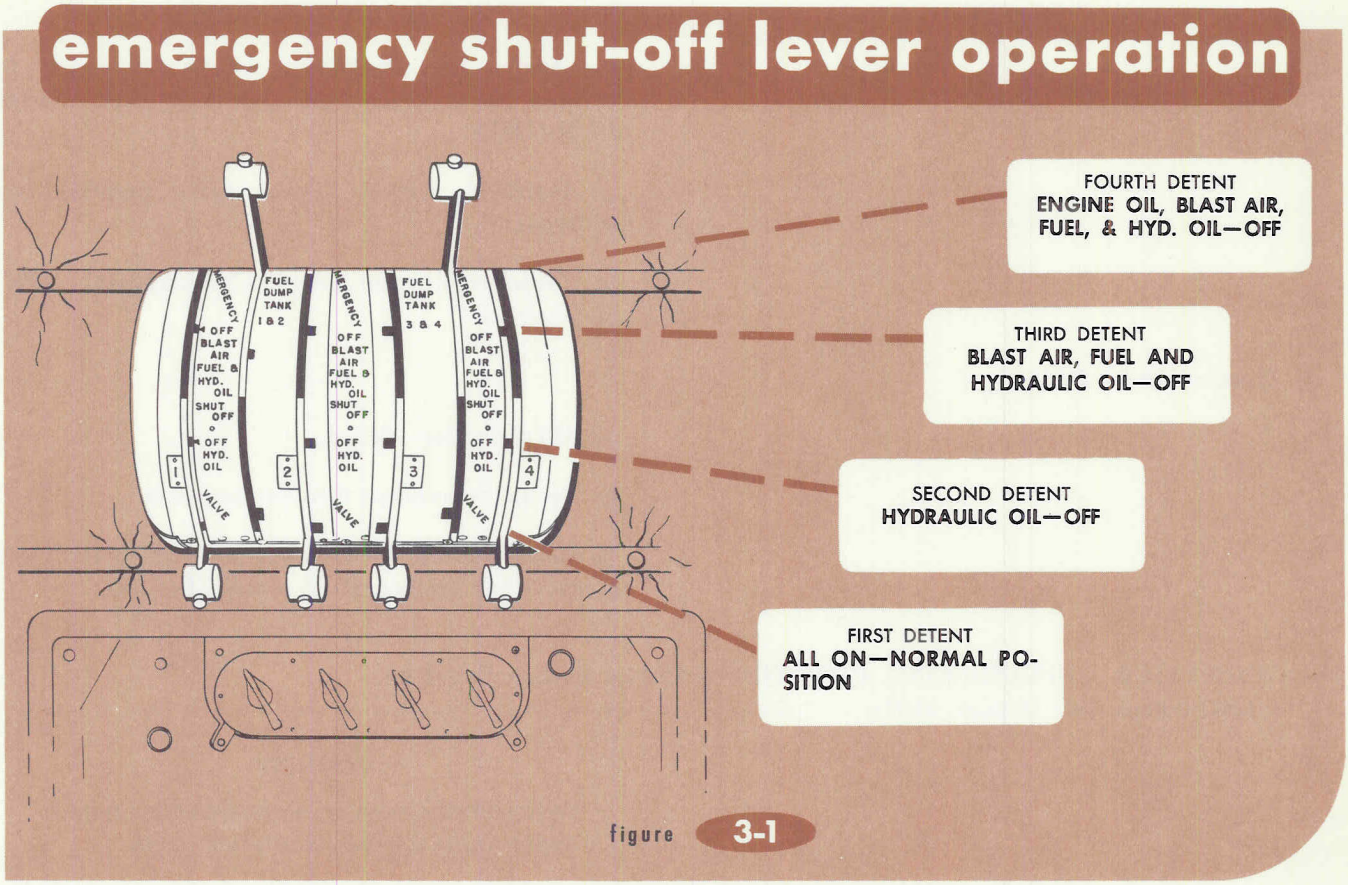

figure 3-1

PILOTS FLIGHT ENGINEER

3-8. PROCEDURE ON ENCOUNTERING ENGINE FAILURE—Hamilton Standard Propellers (LAC Serials 4510 through 4519).

3-9. Following is a check list procedure to be followed in shutting down a malfunctioning engine:

a. Throttle lever—CLOSED.

b. Feathering button light—check light on. If light is not on, push feathering button.

c. Mixture control lever—OFF.

d. Emergency shut-off lever—full OFF position (Hyd. oil, fuel, blast air, and eng. oil).

e. Fuel tank selector levers of operating engines—normal (tank-to-engine).

f. Fuel tank selector lever of inoperative engine—OFF.

g. Auxiliary fuel pump switch of inoperative engine—OFF.

h. Fuel crossfeed levers—CLOSED.

i. Tank 5 fuel selector lever—CLOSED.

j. Cowl flaps—faired on inoperative engine.

k. Propeller and carburetor anti-icer switches—OFF.

l. Generator switch—OFF.

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m. Engine fire extinguisher selector handle—set to feathered engine (cabin heater fire extinguisher selector handle—OFF).

n. Feathering button—neutral (after propeller has feathered).

o. Propeller governor control switch—full DEC. RPM, check light on.

p. Ignition switch—OFF.

q. Oil cooler flap—faired.

r. Set up the necessary three-engine power.

s. Re-position the fuel crossfeed valve levers (if it will not add to any fire hazard) to equalize fuel load.

3–10. PROPELLER UNFEATHERING PROCEDURE—Curtiss Electric Propellers (LAC Serials 4501 through 4509).

CAUTION

Do not attempt to unfeather propeller and restart engine unless a greater emergency exists.

a. Feather switch—NORMAL position.

b. Emergency shut-off lever—ALL ON position.

c. Starter switch—engage (ignition OFF) to check for liquid lock.

d. Throttle lever—CLOSED.

e. Mixture control lever—OFF.

f. Propeller selector switch—INC. RPM position intermittently until propeller windmills at 600-700 rpm. Then place switch to fixed pitch position.

g. Ignition switch—BOTH.

h. Mixture control lever—AUTO RICH.

i. Allow engine to warm until oil pressure and temperatures are normal.

j. Propeller selector switch—INC. RPM position intermittently until engine rpm is within 50 rpm of other engines. Then place selector switch to AUTO RPM.

k. Generator switch—ON.

l. Cowl flaps and oil cooler—as desired.

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3–11. PROPELLER UNFEATHERING PROCEDURE—Hamilton Standard Propellers (LAC Serials 4510 through 4519).

3–12. The recommended unfeathering procedure is as follows:

CAUTION

Do not attempt to unfeather propeller and restart engine unless a greater emergency exists.

a. Propeller governor control switch—full DEC. RPM (indicator light on).

b. Airspeed—do not exceed 139 knots (160 mph).

c. Emergency shut-off lever—ALL ON position.

d. Propeller—turn at least six blades with starter (ignition—OFF).

e. Throttle lever—CLOSED.

f. Mixture control lever—OFF.

g. Ignition switch—ON.

h. Fuel tank selector lever—ON.

i. Auxiliary fuel pump switch—LOW.

j. Feathering button—pull.

CAUTION

- The propeller must be under observation at the time that the feathering button is pulled out so that the button can be released when the propeller first starts to rotate. If unfeathering is being accomplished at night, adequate illumination must be used to permit observation of propeller operation.
- The tachometer is not to be used as a guide for determining when the feathering button is to be released.

Note

If the steps in the preceding caution are not carefully adhered to, the propeller blades may unfeather very quickly to the low pitch stop and thus cause overspeeding.

k. As soon as the propeller is definitely rotating, allow the governor to control the rpm without further use of the feathering button.

Note

Propeller governing will occur at approximately 1350 rpm.

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l. Mixture control lever—AUTO RICH (move control smoothly when rpm reaches 500-800).

m. After unfeathering and after governor is controlling the rpm (engine oil pressure and temperatures normal), synchronize with the governor head control switch and then push the synchronizer reset button as required.

n. Generator switch—ON.

o. Cowl flaps and oil cooler flaps—as desired.

3–13. ENGINE FAILURE DURING TAKE-OFF.

3–14. If an engine should fail during take-off with adequate runway left to stop the aircraft with brakes and propeller reversing, close the throttles and stop. If an engine fails after the aircraft has proceeded too far down the runway to be stopped, take-off should be continued. If the automatic feathering system has been turned on, the propeller should feather automatically and the engine should be shut down as described in PROCEDURE ON ENCOUNTERING ENGINE FAILURE.

3–15. ENGINE FAILURE DURING FLIGHT.

3–16. Shut down the engines as described in PROCEDURE ON ENCOUNTERING ENGINE FAILURE.

3–17. LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

Note

The following notes and procedures are in addition to the normal landing procedures. It is assumed that the landing area is within landing range and that feathering procedure has been completed.

3–18. Landing with only one engine inoperative will not seriously affect the normal flight characteristics of the aircraft. However, with engine No. 3 or No. 4 inoperative, the reduction in output to the secondary hydraulic system may cause the landing gear and wing flap operation to be slower than normal. After landing, the wing flaps should not be raised until after the full use of nose wheel steering and full use of the brakes is not critical. When landing with any two engines feathered, the windmilling drag is reduced by half and the deceleration with closed throttles is less than normal. Hence, excessive speed on approach should be anticipated and avoided. However, a slightly high final approach with low power is considered good practice.

3–19. ENGINES NO. 1 AND NO. 2 INOPERATIVE.

Note

With engines No. 1 and No. 2 inoperative, primary hydraulic system pressure will not be available. However, the surface control boosters will be operated by hydraulic pressure supplied by the secondary system through the crossover check valve. Landing gear extension and wing

PILOTS

flap operation may be slower than normal because the restriction control valve in the secondary system will give priority to control booster operation.

b. Landing gear control lever—DOWN.

c. Wing flap control lever—as required.

d. Use propeller reversing with caution and only when nose wheel is on the ground.

FLIGHT ENGINEER

a. Left- and right-hand refrigerator cooling fan switches —OFF.

3–20. ENGINES NO. 2 AND NO. 3 INOPERATIVE.

Note

- With engines No. 2 and No. 3 inoperative, the vacuum system will not be operable and suction will not be available for any vacuum operated instruments and/or the de-icer boots.
- The hydraulic pump driven by engine No. 4 will supply hydraulic pressure for operation of the landing gear, wing flaps, brakes, tanks 2A and 3A fuel dump actuation, and nose wheel steering. The restriction control valve may slow operation of the wing flaps and landing gear while giving priority to the other systems. The hydraulic pump driven by engine No. 1 will supply hydraulic pressure for operation of the flight control boosters.

a. Landing gear control lever—DOWN.

b. Wing flap control lever—as required.

c. Propeller reversing—use only when nose wheel is on the ground.

3–21. ENGINES NO. 3 AND NO. 4 INOPERATIVE.

CAUTION

With engines No. 3 and No. 4 inoperative, secondary hydraulic system pressure will not be available. Wing flaps must be operated with the emergency hand crank. Refer to paragraph 3–125. The landing gear must be extended with the emergency hydraulic hand pump. Refer to paragraph 3–128. Once the landing gear has been extended it cannot be retracted. Nose wheel steering and the normal brake system will be inoperative. Refer to paragraph 3–130 for EMERGENCY BRAKE OPERATION. In addition, it will be impossible to dump fuel from tanks 2A and 3A.

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FLIGHT ENGINEER

a. Left- and right-hand refrigerator cooling fan switches —OFF.

b. Landing gear—use EMERGENCY LANDING GEAR EXTENSION procedure.

c. Wing flaps—use EMERGENCY WING FLAP OPERATION procedure.

CAUTION

Use propeller reversing with caution.

3–22. ENGINES NO. 1 AND NO. 4 INOPERATIVE.

Note

The hydraulic pump driven by engine No. 3 will supply hydraulic pressure for operation of the landing gear, wing flaps, brakes, tanks 2A and 3A fuel dump actuation, and nose wheel steering. The restriction control valve may slow operation of the wing flaps and landing gear while giving priority to the other systems. The hydraulic pump driven by engine No. 2 will supply hydraulic pressure for operation of the flight control boosters.

a. Left- and right-hand refrigerator cooling fan switches —OFF.

b. Landing gear control lever—DOWN.

c. Wing flap control lever—as required.

d. Use propeller reversing when nose wheel is on the ground.

3–23. GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE.

3–24. GO-AROUND PROCEDURE—THREE ENGINES OPERATING, FLIGHT CONTROL BOOSTERS ON.

3–25. A go-around can be accomplished if the altitude is more than 50 feet and the airspeed is more than 115 knots (132 mph). Use the following procedure:

a. Apply power as required.

b. Wing flap control lever—TAKE-OFF.

c. Landing gear control lever—UP (after flaps are at TAKE-OFF position).

d. Set up climb power after gears are up.

e. Landing gear control lever—NEUTRAL.

f. Wing flaps may be left at TAKE-OFF position or retracted at pilot's discretion.

PILOTS FLIGHT ENGINEER

3–26. GO-AROUND PROCEDURE—TWO ENGINES OPERATING, FLIGHT CONTROL BOOSTERS ON.

3–27. A go-around can be accomplished if the altitude is not less than 200 feet and the airspeed is not less than 130 knots (150 mph) and provided that the inoperative engines are not 3 and 4. Use the procedure given in the preceding paragraph. If engines 3 and 4 are inoperative, a go-around is impossible since the landing gear cannot be retracted.

3–28. PROPELLER MALFUNCTION—Curtiss Electric Propellers (LAC Serials 4501 through 4509).

CAUTION

Propeller circuit breakers will not be opened except by an overcurrent trip. Trouble should be determined and corrected before the circuit breakers are closed.

3–29. PROPELLER OVERSPEEDING ON TAKE-OFF (Automatic Feathering Off).

a. Throttle—retard on overspeeding engine to hold rpm within operating limits.

Note

Overspeeding is most likely to occur after a momentary loss of power that is followed by a return to full engine power.

b. Propeller selector switch—toggle to DEC. RPM position.

c. Feathering switch—FEATHER (if reduced throttle does not hold rpm within limits).

Note

After reaching safe altitude—propeller may be unfeathered if considered safe.

3–30. PROPELLER UNDERSPEED ON TAKE-OFF (Automatic Feathering Off).

a. Propeller selector switch—fixed pitch position.

b. Manually control rpm with selector switch as required to maintain constant engine speed.

Note

If the rpm cannot be controlled, place feathering switch to FEATHER. After reaching safe altitude, unfeather, if desired.

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3–31. PROPELLER OVERSPEEDING IN FLIGHT.

a. Decrease airspeed to the minimum safe value.

b. Use propeller selector switch and throttle to synchronize affected engine with good engines, if possible.

c. If manual or automatic propeller control is not possible, use feathering procedure.

Note

Evacuate personnel from the forward lavatories and descend to minimum safe altitude.

3–32. FEATHERING OPERATING PROCEDURE WITH FEATHER SWITCH INOPERATIVE.

Note

A propeller may be feathered at normal voltage by placing the feather switch to NORMAL and holding the respective propeller selector switch in DEC. RPM position. This will allow feathering in the event of voltage booster failure.

3–33. PROPELLER MALFUNCTION—Hamilton Standard Propeller (LAC Serials 4510 through 4519).

3–34. INADVERTENT REVERSING IN FLIGHT.

a. Pull out the propeller reverse circuit breaker.

b. Feathering button—push and complete feathering procedure.

3–35. PROPELLER OVERSPEEDING IN FLIGHT.

a. Throttle lever—close and decrease airspeed.

b. Propeller selector switch—toggle to DEC. RPM position.

c. If overspeeding cannot be controlled—attempt feathering.

d. Decrease airspeed to the minimum safe value. If overspeeding still cannot be controlled:

e. Evacuate personnel from the forward lavatories and descend to minimum safe altitude.

PILOTS FLIGHT ENGINEER

3–36. FIRE.

3–37. ENGINE FIRE.

3–38. Judgment and precision are equally as important as speed when putting out an engine fire. Closing a wrong valve can cause more trouble than a few seconds delay in controlling the fire. The procedures vary for fires which occur during start, after start, and in flight.

3–39. ENGINE INDUCTION FIRE DURING START.

3–40. If the fire occurs before the engine takes hold during the starting operation:

a. Discontinue priming.

b. Continue cranking to draw the fire through the engine.

c. Smother fire with carbon dioxide from a ground source and/or aircraft fire extinguishing system.

d. Mixture control lever—OFF.

e. Auxiliary fuel pump switch—OFF.

3–41. ENGINE FIRE IN ZONES 2 OR 3 DURING OR AFTER START.

3–42. If the fire occurs after the engine starts:

a. Throttle lever—CLOSED.

b. Mixture control lever—OFF.

c. Emergency shut-off lever—full OFF position.

d. Fuel tank selector lever—OFF.

e. Auxiliary fuel pump switch—OFF.

f. Cowl flaps—open.

g. Ignition—OFF.

h. Smother fire with carbon dioxide from a ground source and/or aircraft fire extinguishing system.

CAUTION

Do not attempt to restart engine until cause of the fire has been determined and corrected.

3–43. ENGINE FIRE DURING FLIGHT—Curtiss Electric Propellers (LAC Serials 4501 through 4509).

3–44. The important things in controlling an in-flight engine fire are to get the affected engine feathered and the combustible fluids shut off as quickly as possible. Determine which engine is on fire and, with gear up and flaps as required, proceed as follows upon the pilot's order:

a. Throttle lever—CLOSED.

PILOTS

FLIGHT ENGINEER

b. Feather switch—FEATHER position.

Note

If propeller windmills in counterclockwise direction, place feather switch to NORMAL, then place propeller selector switch in INC. RPM position momentarily until rotation stops. Place selector switch in DEC. RPM position to stop clockwise rotation of the propeller. Return selector switch to fixed pitch position when propeller stops turning.

c. Mixture control lever—OFF.

d. Emergency shut-off lever—full OFF position.

e. Fuel tank selector—normal to operating engine.

f. Fuel tank selector lever of inoperative engine—OFF.

g. Auxiliary fuel pump switch—OFF.

h. Fuel crossfeed lever of inoperative engine—CLOSED.

i. Tank 5 fuel selector lever—CLOSED.

j. Cowl flaps—OPEN.

k. Propeller and carburetor anti-icer switches—OFF.

l. Generator switch—OFF.

m. Engine fire extinguisher selector handle—set to engine on fire.

n. Cabin heater fire extinguisher selector handle—OFF.

o. Release one CO_2 charge on pilot's order—stand by to release second charge.

p. Ignition switch—OFF.

q. Propeller selector switch—fixed pitch position.

r. Oil cooler flaps—faired.

s. Cowl flaps (after fire)—faired.

t. Fuel crossfeed lever—as required (if no further fire hazard).

Note

Do not release second CO_2 charge until it is definitely determined that the first charge has not smothered the fire. One charge will be effective for approximately three minutes.

WARNING

Do not attempt to restart engine.

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FLIGHT ENGINEER

3–45. ENGINE FIRE DURING FLIGHT—Hamilton Standard Propellers (LAC Serials 4510 through 4519).

3–46. The important things in controlling an in-flight engine fire are to get the affected engine feathered and the combustible fluids shut off as quickly as possible. Determine which engine is on fire and, with gear up and flaps as required, proceed as follows upon the pilot's order:

a. Throttle lever—CLOSED.

b. Feathering button—push.

c. Mixture control lever—OFF.

d. Emergency shut-off lever—full OFF position.

e. Fuel tank selector—normal to operating engines.

f. Fuel tank selector lever of inoperative engine—OFF.

g. Auxiliary fuel pump switch—OFF.

h. Fuel crossfeed lever of inoperative engine and tank 5 selector—CLOSED.

i. Cowl flaps—full OPEN.

j. Propeller and carburetor anti-icer switches—OFF.

k. Generator switch—OFF.

l. Engine fire extinguisher selector handle—set to engine on fire—cabin heater fire extinguisher selector handle—OFF.

m. Release one CO_2 charge on pilot's order—stand by to release second charge.

CAUTION

Visually check propeller position after feathering operation and at frequent intervals to see that propeller remains feathered.

n. Feathering button—neutral (after propeller has feathered).

o. Propeller governor control switch—full DEC. RPM.

p. Ignition switch—OFF.

q. Oil cooler flaps—faired.

r. Cowl flaps (after fire is extinguished)—faired.

s. Fuel crossfeed lever—as required (if no further fire hazard).

Note

Do not release second CO_2 charge until it is definitely determined that the first charge has not smothered the fire. One charge will be effective for approximately three minutes.

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3–47. FUSELAGE FIRE.

3–48. Anytime smoke is noticed or a fire occurs in the aircraft, the crew should breathe 100% oxygen, shut off the recirculating fans, and block open the curtain and door between the cabin and flight station. These steps will protect the flight crew and help to prevent spread of the fire. If smoke should become dense, follow the SMOKE REMOVAL procedure given in this section.

3–49. If an open fire should occur in the cabin or flight station, it can be controlled by smothering with CO_2 from one of the portable fire extinguishers. If smoke or fire should originate beneath the floor, attempt to isolate the cause and shut off any fluids that may be feeding the fire. Then proceed as follows:

CAUTION

Do not open the hatches in the cabin floor. The resulting draft could cause a smoldering fire to burst into flames.

a. Close throttles and start rapid descent, gear and flaps up. Do not exceed placarded airspeeds.

Note

Auxiliary boost will still be available for rudders and elevators and should be turned ON if the hydraulic system has been turned OFF. Aileron boost should be bypassed to reduce forces. If the generators are shut off the auxiliary boost motors will deplete the batteries very rapidly and, since the batteries may be the only power available for operation of the propellers, radio instruments, etc., the auxiliary boost should be turned OFF as soon as safety permits. To reduce control forces, the rudder boost should then be bypassed and the emergency manual elevator control pulled out and locked.

b. Aux. vent. control knob—position B (anticipate rapid depressurization).

Note

By placing the aux. vent. control knob in the B position, the cabin superchargers are dumped and put on "minimum flow"; the cabin safety relief and dump valve is opened, the aux. vent. inlet and exit valves are opened, and the air recirculation check valves are closed. This position affords moderate ventilation without excessive air circulation which might fan the fire.

c. Fuel tank selector levers—normal (not on crossfeed).

d. All fuel crossfeed levers and tank No. 5 selector lever—CLOSED.

Note

If it is definitely known that the hydraulic or electrical systems are not involved in the fire, steps e. and f. below may be omitted.

e. All emergency shut-off levers—HYD. OIL OFF (first position).

f. If the fire is of an electrical origin, proceed as directed in ELECTRICAL FIRE.

PILOTS FLIGHT ENGINEER

3–50. CABIN HEATER FIRE.

3–51. If a fire should occur in the cabin heaters or cabin heater compartments, the fire detectors will energize the warning lights and then the fire can be extinguished with the integral fire extinguishing system.

a. Cabin heater switches—OFF.

b. All cabin fans—OFF.

c. Engine fire extinguisher selector handle—OFF.

d. Cabin heater fire extinguisher selector handle—set (to fire location).

e. Pull either CO_2 release handle.

WARNING

Do not release second CO_2 charge until it is definitely determined that the first charge has not smothered the fire. One charge will be effective for approximately three minutes.

3–52. ELECTRICAL FIRE.

3–53. Fires caused by an active short circuit cannot be extinguished until the circuit involved is dead. It is essential, therefore, to locate the fire and interrupt any circuits which may be involved as quickly as possible. If it is necessary to shut off the electrical system, the generator field circuit breakers should be opened. This prevents the generators from developing any electrical potential.

WARNING

The generator switches must be OFF before the field circuit breakers are opened.

3–54. ELECTRICAL FIRE EXTINGUISHING PROCEDURE. If the fire source cannot be determined with a minimum loss of time, proceed as follows:

a. Zero Reader master switch—OFF.

b. Automatic pilot switch—OFF.

a. Gyrosyn compass and emergency radio power switch*—EMERGENCY.

b. Generator switches—OFF.

c. Battery switch—OFF.

d. Generator field circuit breakers—OFF.

e. Radio power switches and a.c. fuses—OFF.

f. Smother fire—with portable CO_2 extinguisher.

3–55. After the fire is out:

a. Identify the affected circuit, if possible, and isolate it from the main bus.

b. Circuit breakers in affected circuit or circuits—OFF.

*LAC Serials 4501 through 4509.

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CAUTION

- Before turning the battery switch ON, it is imperative that the source of the trouble be located and the affected circuit isolated from the main bus.
- Conservation of battery power for necessary radio communication and auxiliary booster operation for landing is of vital importance.

c. Restore electrical power to unaffected circuits as follows:

1. Battery switch—ON.
2. Generator field circuit breakers—ON (one at a time).
3. Generator switches—ON (one at a time).

d. Watch for recurrence of trouble during remainder of the flight.

3–56. RAPID DESCENT PROCEDURES.

3–57. Emergency rapid descent from high altitudes may be made in either of two configurations: clean, or with landing gear down and wing flaps in the take-off position.

3–58. EMERGENCY RAPID DESCENT PROCEDURE (Clean Configuration).

3–59. Descent in clean configuration can be made at speeds up to V_{NE}. The most rapid rate of descent can be made in this configuration.

Note

If fuselage fire is the reason for the descent, the descent must be made in the clean configuration.

3–60. To make a rapid descent in the clean configuration, proceed as follows:

a. Automatic pilot—disengage.

b. Throttle levers—close smoothly.

c. Engine supercharger control levers—LOW.

d. Propellers—set to take-off rpm.

e. Cowl flaps—100% open.

f. Oil cooler flaps—100% open.

g. Auxiliary control booster switches—ON.

h. Descend at airspeed up to V_{NE}.

Note

Refer to Section V, Part I for V_{NE}.

PILOTS FLIGHT ENGINEER

3–61. EMERGENCY RAPID DESCENT PROCEDURE (Landing gear DOWN and wing flaps in TAKE-OFF position).

3–62. Descent with landing gear lowered and wing flaps in TAKE-OFF position may be made at speeds up to V_{LE}. This configuration produces a steeper angle than the clean configuration, but the rate of descent is lower because of the lower airspeed necessitated by the landing gear extended placard limits.

Note

If rough air, or the possibility of structural damage indicates the advisability of descending at low airspeed, rapid loss of altitude can be achieved at relatively low airspeeds in this configuration.

3–63. To make a rapid descent with landing gear DOWN and wing flaps in TAKE-OFF position, proceed as follows:

a. Automatic pilot—disengage.
b. Throttle levers—close smoothly.
c. Engine supercharger control levers—LOW.
d. Propellers—set to take-off rpm.
e. Cowl flaps—100% open.
f. Oil cooler flaps—100% open.
g. Wing flaps—TAKE-OFF (60%).
h. Landing gear lever—DOWN.
. Auxiliary control booster switches—ON.
j. Descend at airspeeds up to V_{LE}.

Note

Refer to Section V, Part I for V_{LE}.

3–64. SMOKE ELIMINATION.

3–65. In the event that it becomes necessary to clear the cabin of noxious fumes or gases of any kind, the following smoke elimination procedure should be used:

WARNING

Sound judgment is required to measure the relative danger involved in fanning the fire with fresh air and subjecting the passengers and crew to high altitude as against the alternate danger of asphyxiation. If immediate smoke removal is felt to be necessary, the following procedure may be initiated:

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3–66. PRESSURIZED FLIGHT.

a. Close throttles and start a rapid descent, gear and flaps UP. Refer to paragraph 3–60.

b. Depressurize cabin by dumping both superchargers. (Aux. vent. knob to full OPEN then to position A when cabin differential drops to about 1″ Hg).

Note

Position A supplies no ventilating air to the cockpit and cabin through the normal ventilating system; therefore, the use of position A should be limited to situations requiring windows to be opened for ventilation.

c. Turn recirculating and flight station fans OFF.

d. When depressurized, remove smoke as follows:

1. Block open curtain and door to provide a clear path for the air.

2. Slow down to 175 knots (200 mph) or less to facilitate opening emergency exits.

3. First, open one or more of the emergency exits over the wing.

Note

If unable to open emergency exit, break window with an axe or heavy object. Personnel should stay clear of the opening, particularly if the window must be broken at full cabin pressure differential.

4. Second, open the pilots' windows.

WARNING

Never open a vent in the cockpit before there is an opening in the cabin over the wing. Never open an emergency exit forward of the propeller plane. The pressure outside of the cockpit is low and a vent in this area will suck air forward into the flight station. By first opening a vent over the wing, where the pressure is even lower, air will be sucked aft from the flight station and out over the wing.

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3–67. UNPRESSURIZED FLIGHT.

a. Close auxiliary ventilation valves. (Aux. vent. knob to position A).

Note

Position A supplies no ventilating air to the cockpit and cabin through the normal ventilating system; therefore, the use of position A should be limited to situations when windows may be opened for ventilation or 100% oxygen can be used by all personnel.

b. Turn recirculating and flight station fans OFF.

c. Remove smoke as follows:

1. Block open connecting door to provide a clear path for the air.

2. Reduce speed to 175 knots (200 mph) or less to facilitate opening emergency exits.

3. First, open one or more of the emergency exits over the wing.

Note

If unable to open emergency exit, break window with an axe or heavy object. Personnel should stay clear of the opening.

4. Second, open the pilots' windows.

WARNING

Never open a vent in the cockpit before there is an opening in the cabin over the wing. Never open an emergency exit in front of the propeller plane. The pressure outside of the cockpit is low and a vent in this area will suck air forward into the flight station. By first opening a vent over the wing, where the pressure is even lower, air will be sucked aft from the flight station and out over the wing.

3–68. LANDING EMERGENCIES.

3–69. LANDING ON SOFT GROUND OR UNPREPARED RUNWAYS. If it should become necessary to land on soft ground or on unprepared runway, the landing should be made with the landing gear retracted.

3–70. LANDING WITH A FLAT TIRE. Since each gear of this aircraft is equipped with dual wheels, a flat tire does not present an emergency and a normal landing can be made.

3–71. LANDING WITHOUT ALL GEARS EXTENDED. In the event that all gears can neither be extended nor retracted, land with the aircraft level and hold it that way as long as possible after the extended gear contacts the runway.

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3–72. LANDING WITH GEAR RETRACTED. It is possible in an emergency to land this aircraft with gear retracted without seriously damaging it. With the exception of those procedures which are obviously peculiar to ditching, the procedures for a gear-up landing are very similar to those recommended for ditching. Escape routes are shown on figure 3–2. The recommended landing procedure is given in the following steps:

Note

The pilot in command should designate a crew member to open all emergency exits prior to touchdown.

a. Notify crew of intention to make a gear-up landing.

b. Notify ground stations giving position.

c. Advise cabin attendants to provide passengers with padding. Show them how to brace when the signal is given.

d. Reduce gross weight of aircraft by dumping fuel.

e. If possible, move center of gravity to approximately 25% to 30% MAC.

f. Order passenger seat belts fastened.

g. Secure or stow loose equipment.

h. Open all doors; remove and stow securely all emergency exit covers.

i. Make a wide enough approach to permit feathering and positioning of inboard propellers before starting the downwind leg.

j. Feather propellers 2 and 3, positioning them with one blade up. Use engine starters to position blades.

k. Emergency shut-off levers for feathered engines—full OFF position.

l. Ignition to feathered engines—OFF.

m. All auxiliary fuel pumps—OFF.

n. Rudder and elevator auxiliary booster switches—ON.

o. Wing flaps—extend to LANDING position as soon as it is certain landing area can be reached.

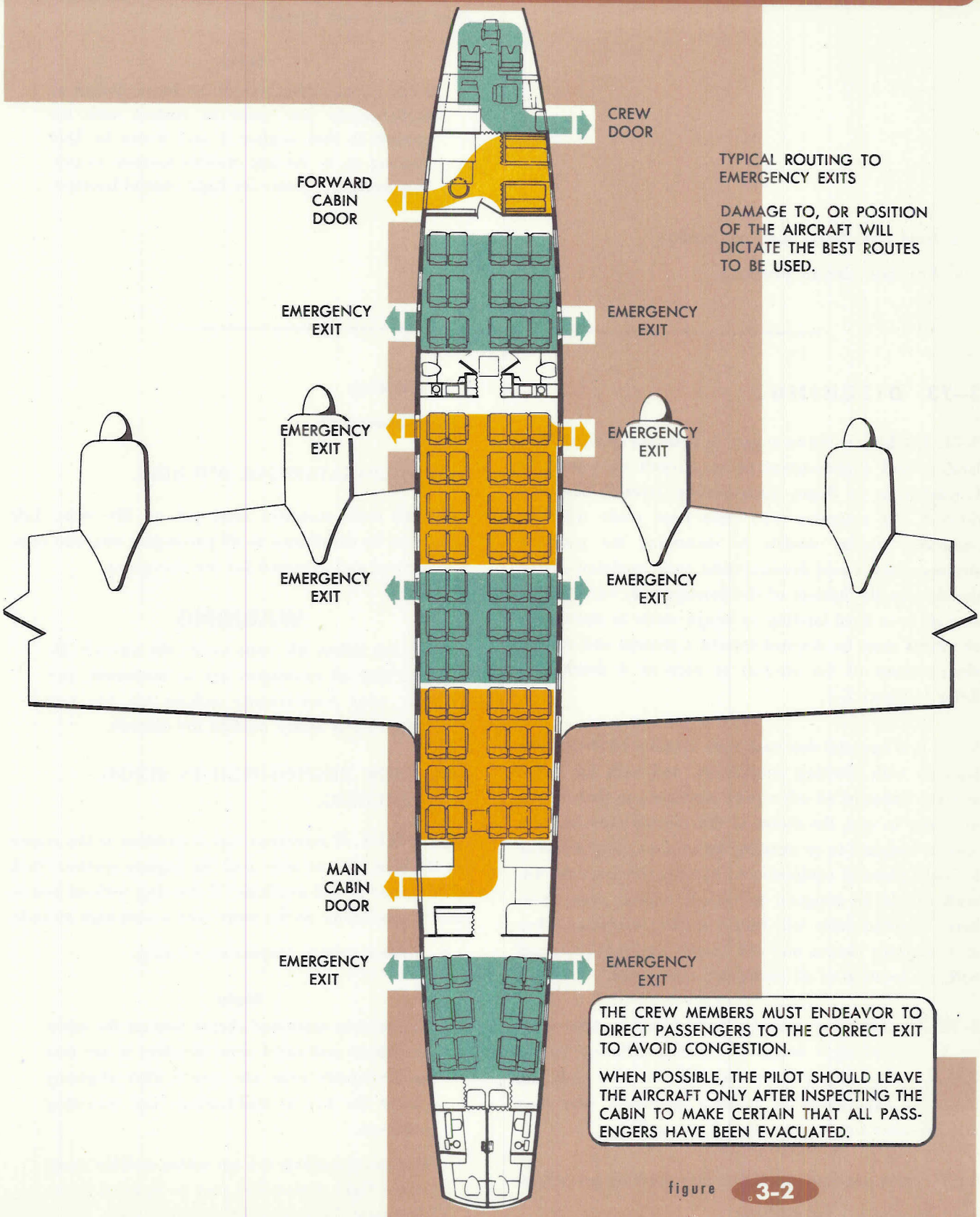
p. Give order to brace, 30 seconds before contact.

q. Mixture control levers, engines 1 and 4—OFF.

r. Fuel tank selector levers—OFF.

s. Ignition switches—OFF.

emergency escape routes—land



TYPICAL ROUTING TO EMERGENCY EXITS

DAMAGE TO, OR POSITION OF THE AIRCRAFT WILL DICTATE THE BEST ROUTES TO BE USED.

THE CREW MEMBERS MUST ENDEAVOR TO DIRECT PASSENGERS TO THE CORRECT EXIT TO AVOID CONGESTION.

WHEN POSSIBLE, THE PILOT SHOULD LEAVE THE AIRCRAFT ONLY AFTER INSPECTING THE CABIN TO MAKE CERTAIN THAT ALL PASSENGERS HAVE BEEN EVACUATED.

figure 3-2

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u. Hold nose fairly high for landing.

v. Evacuate aircraft promptly.

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t. All electrical power (batteries, generators, and generator field circuit breakers)—OFF, as soon as possible after contact with ground.

Note

Steps q., r., and s. should be accomplished simultaneously just prior to contact with the ground so that engines 1 and 4 can be kept running up to the last possible moment to provide hydraulic power for flight control boosters.

3–73. DITCHING.

3–74. Ditching is the term used to describe an emergency landing and abandonment of an aircraft on water. No Constellation or Super Constellation aircraft has been ditched, but extensive tests have been made with dynamically similar models to determine the probable stresses which would develop under such conditions. Since the skin on the bottom of the fuselage may be damaged enough by a hard landing on rough water to start leaks, all efforts must be directed toward a prompt and orderly abandonment of the aircraft as soon as it decelerates. Refer to figure 3–3.

3–75. It is essential that each crew member be thoroughly familiar with ditching procedures, and with his duties and the duties of all other crew members, so that in case of injury to one, the duties of the injured crew member may be assigned to or assumed by another. Responsibility for each piece of equipment to be removed from the aircraft should be assigned to various regular crew members. Periodic drills will insure orderly operation when an emergency occurs, and will familiarize flight personnel with the location of all emergency equipment.

3–76. The following procedures are based on tests made on a scale strength model of the Constellation by the NACA in the Langley Aeronautical Laboratory tank, and upon the experiences of military personnel who have ditched other four-engine aircraft successfully.

3–77. There are three phases of any ditching procedure:

a. Preparation for ditching.

b. Alighting.

c. Abandonment.

3–78. PREPARATION FOR DITCHING.

3–79. All crew members must put on life vests. Life vests must be distributed to all passengers who also must be informed and prepared for the emergency.

WARNING

Do not inflate life vests inside the aircraft. Be sure that all passengers are so instructed, and that none inadvertently inflates his life vest before he is safely outside the aircraft.

3–80. CREW RESPONSIBILITIES BEFORE DITCHING.

3–81. PILOT. If imminent fuel exhaustion is the reason for ditching, do not wait until the engines sputter. Ditch while power is still available. If ditching without power, plan to touchdown on the water with a nose-high attitude.

a. Instruct crew to prepare for ditching.

Note

The pilot in command should instruct the cabin attendants and relief crew members to see that no emergency exits are opened after alighting except the two at mid-fuselage and mid-wing positions.

If cabin attendants are not within audible range of the flight station they may be signaled by intermittent flashing of the seat belt sign.

b. Set course for nearest land or surface vessel.

c. Order distress messages.

Note

Surface stations and ships should be informed of the existence of an emergency as soon as it arises. This should be done even if it is not certain that the aircraft will have to be ditched. It is easy enough to cancel the call after the emergency is over.

d. Ordinance lights—ON.

e. Order fuel to be dumped.

WARNING

Do not use flares when dumping fuel.

f. Use or jettison landing flares.

g. Fasten own seat belt.

h. Give signal to BRACE approximately 30 seconds before contact with the water.

3–82. COPILOT.

a. Execute specific orders from the pilot and assist in the management of the aircraft.

b. Secure loose gear in cockpit.

c. Fasten seat belt.

3–83. FLIGHT ENGINEER.

a. Dump fuel when so instructed by pilot.

b. Depressurize cabin.

Note

Do not attempt to open emergency exits until cabin is depressurized, except under extreme circumstances. Then if it is necessary to dump pressure in a hurry in order to get emergency exits opened, open the window in the flight station door or throw an axe through a window. Stand clear when so doing.

c. Fasten seat belt, turn seat to face aft, and double up when ordered to brace.

3–84. CABIN ATTENDANTS. Passenger morale and safety are important responsibilities of the cabin attendants. A calm, purposeful approach will do much to forestall panic. Instruct passengers clearly. The flight attendants shall divide the passengers equally between them and assist each other whenever possible.

a. Pass out life vests or instruct passengers where to find them. Demonstrate the proper method for putting them on, and explain their use. Work from forward to midship and from midship aft simultaneously.

WARNING

Caution passengers NOT to inflate life vests until AFTER they have left the aircraft. In the event of rapid submersion, an inflated life vest will make it impossible for the wearer to dive to the exit level to escape from the sinking aircraft.

b. Provide passengers with pillows, blankets, or coats for padding and check all seat belts to be sure they are fastened tightly.

c. Instruct passengers to adjust seats in a full forward position.

Note

- Passengers in the forward seats should be moved to any vacant seats aft or, if none is available, they should sit on the floor facing aft, and brace themselves against the forward bulkhead. Mothers with babies or small children should be placed in this location.
- Passengers remaining in seats should brace their feet with the trunk of the body doubled up and with head on a pillow on knees.

d. Instruct passengers to remove all sharp objects and breakables, from their persons, and stow in lavatories.

CAUTION

Do not remove rafts from their carrying cases inside of the aircraft.

e. Tie open the curtain and door between flight station and cabin.

Note

Secure door so that it will not slam and jam shut when the aircraft decelerates.

f. Stow loose articles from the cabin and overhead racks in the lavatories and close the doors securely. Tie down or secure all loose articles in the galley.

WARNING

Unsecured articles may fly through the cabin like projectiles at the time of impact with the water.

g. Check all emergency equipment and prepare it for rapid removal from the airplane.

Note

In addition to life rafts, first aid kits, emergency radio and flashlights, make certain that water, food, coffee, and fruit juices are ready to be removed if they are available.

h. Remove and stow securely the covers from the emergency exits over the wings.

i. Turn on ditching light (if installed).

j. Advise the pilot that the cabin is prepared for ditching.

k. Take stations in cabin, preferably in empty passenger seats, as far aft as possible, with seat belts securely fastened, or facing aft and braced against forward bulkhead.

Note

It is essential that crew, including flight attendants, exert every effort to protect themselves from injury since their leadership is essential to the safe, orderly evacuation of the aircraft. Accordingly it is recommended that flight attendants place pillows under their seat belts, and blankets before their faces.

l. Relay pilot's instructions to BRACE to passengers.

3–85. ALIGHTING.

3–86. The procedures for setting a land aircraft down on water depend on conditions encountered. No specific instructions can be given. However, the NACA tests indicate the best general technique to be as follows:

Note

It is difficult to judge height above the water when the sea is calm. At night, landing lights may make estimate of distance above water even more difficult.

a. Reduce fuel load to the lowest practical minimum before landing. Empty or nearly empty fuel tanks will provide an advantage of approximately 50,000 pounds of flotation buoyancy.

WARNING

Make certain fuel dump valves are closed before making contact with the water.

b. Close all openings below waterline and near waterline. This includes two cabin doors and flight station door, auxiliary ventilation intakes and exits, and outflow valves.

Note

The outflow valves can be closed after the cabin has been depressurized by setting the controls for pressurization which will automatically close the valve openings. Re-pressurization of the cabin can be prevented by opening the emergency exit hatches over the wings.

c. Make landing parallel to the swell, near the crest, unless there is a strong crosswind of 30 mph or more.

d. If there is a strong crosswind, land into the wind, making contact on upslope of a swell near the top.

Note

Wave motion is indicative of wind direction; swell does not necessarily move with the wind. Conditions of water surface are indicative of wind speed. The following table may be helpful:

Surface Condition	Approx. Wind Velocity	
	Knots	MPH
Few white crests	9-17	10-20
Many white crests	17-26	20-30
Streaks of foam from crests	26-35	30-40
Spray blown from tops of waves	35-43	40-50

e. Use power (if available) to control point of contact and to flatten approach.

emergency escape routes—water

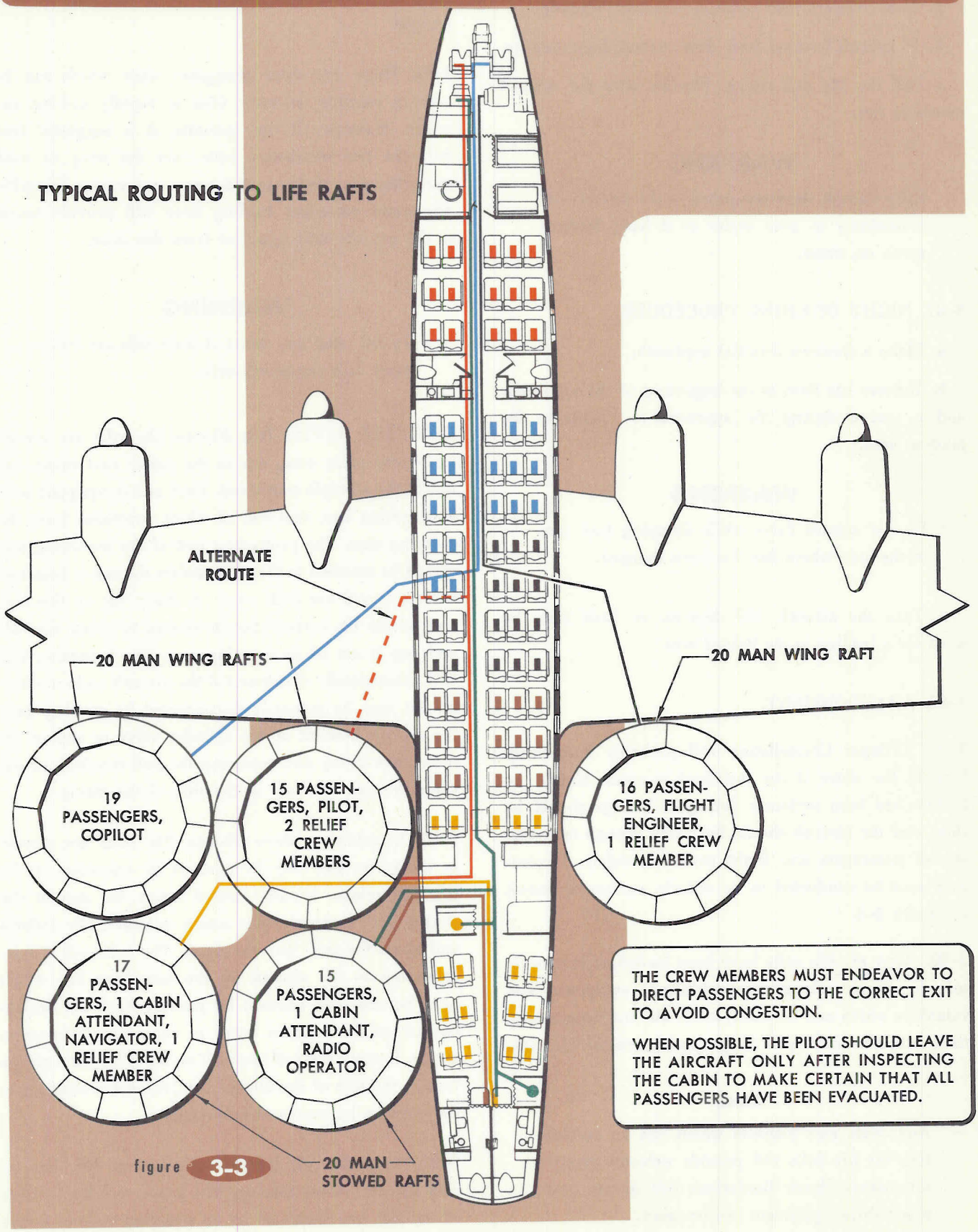

figure 3-3

THE CREW MEMBERS MUST ENDEAVOR TO DIRECT PASSENGERS TO THE CORRECT EXIT TO AVOID CONGESTION.

WHEN POSSIBLE, THE PILOT SHOULD LEAVE THE AIRCRAFT ONLY AFTER INSPECTING THE CABIN TO MAKE CERTAIN THAT ALL PASSENGERS HAVE BEEN EVACUATED.

f. The optimum configuration for alighting on water is with flaps fully extended and landing gear retracted.

g. Make contact with medium nose-high attitude.

h. If aircraft bounces from first contact, keep nose up.

i. Pull the life raft release handles after the aircraft comes to rest.

WARNING

Keep cockpit windows closed as the aircraft has a tendency to nose under as it loses forward speed on water.

3–87. NIGHT DITCHING PROCEDURE.

a. Make a downwind initial approach.

b. Release one flare at the beginning of the approach, and a second during the approach to illuminate the landing area.

WARNING

Do not release flares while dumping fuel, nor in the area where fuel has been dumped.

c. Turn the aircraft 180 degrees, or back into the wind for a landing in the lighted area.

3–88. ABANDONMENT.

3–89. A Super Constellation will probably float fairly high in the water if the fuel load is small. Unless the bottom has been seriously damaged, leakage should be slow, and the aircraft should float long enough to evacuate all passengers and flight personnel safely. Evacuation must be conducted in an orderly manner as shown on figure 3–3.

3–90. After the life rafts have been loaded, if it appears safe to do so, salvage any additional equipment and valuables which can be transported without jeopardizing the comfort and safety of the people aboard the life rafts.

Note

Any coats and blankets which can be carried into the life rafts will provide welcome protection afloat. Space limitations will dictate how much extra equipment can be taken.

3–91. EXITS. The crew door, forward and main passenger doors provide the easiest means of exit; however, these may be unusable because their sills may be submerged.

3–92. There are eight emergency exits which can be used in extreme necessity (due to rapidly sinking aircraft). However, if time permits, it is suggested that only the two emergency exits over the wing be used since they provide the easiest access to the wing life rafts. The main passenger loading door will provide access to the two life rafts launched from this door.

WARNING

Do not open any doors if their sills are below water. Use emergency exits.

3–93. LIFE RAFTS. Two 20-man life rafts are stowed inside the cabin area, one in the galley coat closet and one in the aft right coat closet. Each raft is equipped with a launching line, one end of which protrudes from the carrying case. The protruding end of the launching line should be attached to the plane before the raft is launched so that it will not drift away. A sharp tug on this line will release the carbon dioxide charge to inflate the raft and pop it out of its carrying case. The launching line will automatically disconnect if the aircraft sinks suddenly, but may be manually disconnected by pushing back the flexible conduit at the cylinder valve to expose the disconnect fitting and removing the ball terminal on the cable through the hole in the side of the fitting.

3–94. In addition, three 20-man life rafts are stowed in the wings and may be released by operation of the life raft release handles located below the step at the station 260 doorway. This action automatically inflates and ejects the rafts into the water. The rafts will still be connected to the aircraft by the launching line which must be manually released by pushing back the flexible conduit at the cylinder valve to expose the disconnect fitting. Remove the ball terminal on the cable through the hole in the side of the fitting. The raft is still attached to the airplane by means of a lanyard.

3–95. Since the raft is symmetrical about the deck, it may be used either side up. The upper and lower tubes of the raft are connected by an equalizer tube to insure

equal inflation. When the raft is fully inflated, close the clamp on the equalizer tube to prevent a leak in one of the tubes from deflating both tubes. The upper and lower tubes are each equipped with a pair of diaphragms which seal off a short section of the tube. These tube sections remain uninflated. The section in the upper tube serves as a boarding station, and may be pumped up when all the passengers are aboard. The section in the lower tube should be pumped up with the hand pump. The submerged auxiliary buoyancy chamber in the center of the raft should be pumped up to support the deck. The upper chamber is left folded flat against the deck. As the raft loses pressure, it may be pumped up with the hand pump.

3–96. TO INFLATE RAFTS STOWED IN CABIN.

Note

- Do not remove rafts from their carrying cases inside the airplane.
- Do not inflate raft before launching.
- Do not allow the pressure to rise so high the raft becomes hard. It should be about as firm as a seat cushion.

a. Throw or push rafts through the main cabin door, retaining a firm grip on the launching line protruding from the carrying case.

Note

Launching lines should be attached to the aircraft if possible.

b. After the raft is outside the aircraft, jerk the launching line to inflate.

c. Leave launching line secured to aircraft, so that raft will not drift away.

WARNING

Do not moor rafts with the escape rope which is fastened to the aircraft at each regular door. This rope is intended to help passengers descend to life rafts, and is strong enough to pull the raft under if aircraft sinks while raft is tied to it.

d. Launch one raft at a time.

3–97. EVACUATION AND ABANDONMENT.

CAUTION

Keep life rafts away from any damaged surfaces which might tear them.

a. Disperse passengers as evenly as possible among exits selected for evacuation to minimize congestion.

WARNING

It is difficult to wriggle through an emergency exit with an inflated life vest on. Remind passengers not to inflate until after they are outside aircraft.

b. Caution passengers not to jump into life rafts. Women with high heeled shoes should be particularly careful to remove shoes. Exercise caution to avoid tearing the bottom of the raft.

c. Distribute emergency supplies among rafts, and tie them down in the center of the raft to prevent them from being lost in case the raft should capsize.

d. See that vests are inflated after passengers have left the cabin.

e. Place each life raft under the command of a member of the flight crew or relief crew.

f. Load life rafts as equally as possible. Redistribute load if haste has resulted in overloading any of the rafts.

g. After a raft is loaded, move it clear of the aircraft.

h. Rope all rafts together so that they will not drift apart, become separated, and complicate rescue.

i. Remain in the vicinity of the aircraft as long as it remains afloat. One hundred and twenty-three feet of wing is easier to locate on an ocean expanse than a few bobbing life rafts.

3–98. CREW RESPONSIBILITIES DURING EVACUATION AND ABANDONMENT. The following distribution of crew responsibility during evacuation and abandonment of the aircraft is suggested:

3–99. PILOT.

a. Supervise and assist in launching life rafts.

b. Make certain water, food, first aid kit and other necessities are removed from aircraft.

c. Supervise and help crew to abandon aircraft.

d. Take command of left wing raft; remove mooring line; get them clear of the aircraft and rally rafts together.

3–100. COPILOT.

a. Assist with launching of other life rafts.

b. Launch and load one of the left wing life rafts. Passenger loading may be done through the left side emergency exit. Refer to figure 3–3.

c. Supervise evacuation of passengers.

3–101. FLIGHT ENGINEER.

a. Launch and load the right wing life raft. Passenger loading must be done through the right side emergency exit. Refer to figure 3–3.

b. Remain on wing to assist with the stowing of emergency supplies, evacuation and embarkation of passengers.

c. Take command of own life raft.

3–102. RADIO OPERATOR AND NAVIGATOR. When distress messages have been transmitted, the radio operator and navigator should assist the cabin attendants in their duties. In addition, and after alighting, the radio operator must remove the emergency dinghy transmitter from the galley coat closet and assist in the launching of the first life raft through the main passenger loading door. Refer to ditching diagram, figure 3–3.

3–103. CABIN ATTENDANTS.

a. Launch and inflate life rafts from main passenger door (if door still is above water).

b. Distribute and secure emergency supplies in launched life rafts.

c. Supervise and assist evacuation of passengers.

d. Take command of separate life rafts.

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3–104. AIRCRAFT SYSTEMS.

3–105. FUEL DUMPING.

3–106. Certain definite fuel dumping precautions must be observed in the interests of safety. Following is the recommended procedure:

a. Advise ground station that fuel is to be dumped, and that radio contact will be discontinued during dumping.

WARNING

In the event of fire in any location, do not dump fuel until the fire is definitely out.

b. Radio and all electrical equipment—OFF.

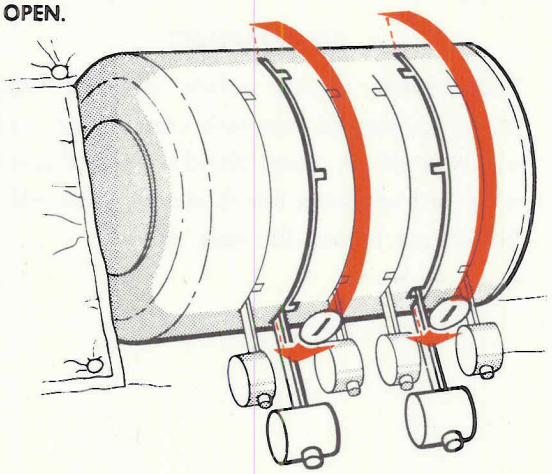
WARNING

- Vaporized fuel may be ignited by sparks from the radio installations and electrical equipment.
- Fuel should not be dumped when static is heavy.

fuel dump valve lever operation

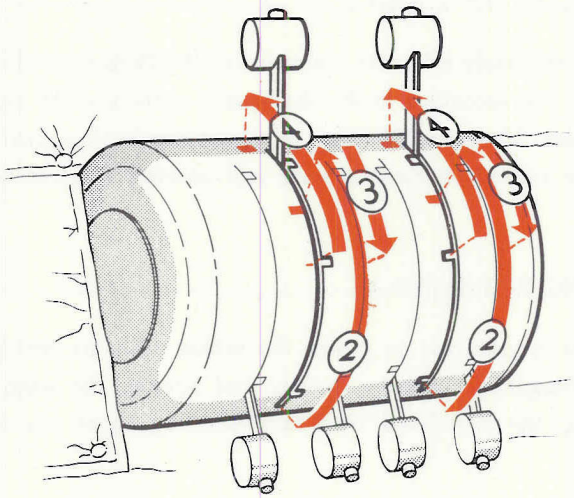
TANKS NOS. 1, 2, 3, AND 4

1. FUEL DUMP LEVER FOR TANKS NOS. 1, 2, 3 AND 4—FULL **OPEN.**



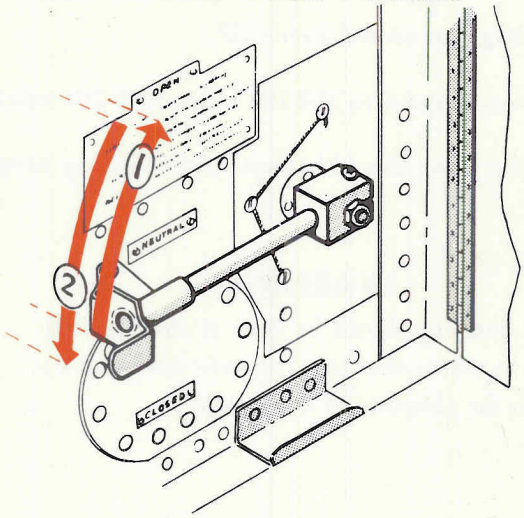
AFTER THE DESIRED QUANTITY OF FUEL HAS BEEN DUMPED:

2. MOVE CONTROL HANDLES TO RED LINES ON QUADRANT.
3. MOVE BACK TO **INTERMEDIATE** FOR 15 TO 30 SECONDS.
4. MOVE TO **CLOSED** POSITION.



TANKS NOS. 2A AND 3A

1. FUEL DUMP LEVER FOR TANKS NOS. 2A AND 3A — **OPEN.**
2. AFTER FUEL STARTS TO DUMP — **NEUTRAL.**



3. FUEL DUMP LEVERS FOR TANKS NOS. 2A AND 3A—**CLOSED.**
4. AFTER FUEL STOPS DUMPING (VALVES CLOSED) — **NEUTRAL.**

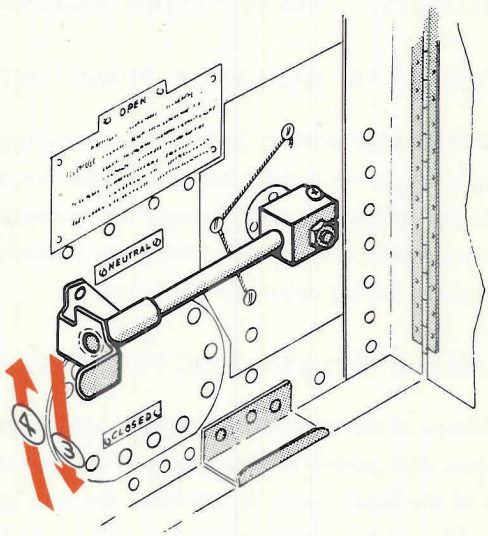


figure 3-4

PILOTS

c. No smoking sign—ON. Advise cabin attendants or designate crew member to see that passengers do not smoke during or immediately after fuel dumping operation.

e. Wing flap control lever—UP.

f. Landing gear control lever—UP.

g. Reduce airspeed to 150-190 knots (175-218 mph).

h. Engine power should be kept constant during dumping.

WARNING

Fuel dumping should be done at sufficient altitude to reduce the hazard of static discharge between the aircraft and the ground.

FLIGHT ENGINEER

d. Cabin heaters—OFF.

WARNING

Cabin heater exhaust outlets and fuel dump chutes are located near each other on the trailing edge of the wing. Should any turbulence whip fuel or fumes into heater exhausts while heaters are in use, fire may result.

i. Refer to figure 3–4 for Fuel Dump Valve Lever Operation.

Note

For fuel dumping rates, refer to figure 3–5.

3–107. HYDRAULIC POWER SYSTEM FAILURE.

3–108. FAILURE OF HYDRAULIC PUMPS DRIVEN BY ENGINES 1 AND 2.

3–109. Failure of the primary hydraulic system pumps does not adversely affect the operation of the flight control boosters, or the left-hand secondary heat exchanger fan motor, since the secondary hydraulic system automatically supplies pressure to the primary system through the crossover check valve. However, the wing flaps and the landing gear may operate more slowly since those systems are downstream of the restriction control valve and priority is given to the control boosters during crossover operation.

3–110. FAILURE OF HYDRAULIC PUMPS DRIVEN BY ENGINES 3 AND 4.

3–111. Failure of the secondary hydraulic system pumps makes it necessary to power the brakes with the emergency brake system and extend the landing gear by means of the emergency extension system, and operate the wing flaps by means of the hand crank. In addition, the nose gear steering, the right-hand secondary heat exchanger fan motor, and tanks 2A and 3A fuel dump valves will be inoperative.

3–112. FAILURE OF THE PRIMARY AND SECONDARY HYDRAULIC SYSTEMS.

Note

In addition to the hydraulic units rendered inoperative, as noted in paragraphs preceding,

Fuel Dump Rates
Figure 3–5

To be included when available.

PILOTS

FLIGHT ENGINEER

the normal flight control boosters and the left-hand secondary heat exchanger fan motor will also become inoperative. Under these circumstances, auxiliary elevator and rudder boost will be available. Procedures in this event are as follows:

a. Auxiliary elevator and rudder boost switches—ON.

b. Aileron booster control lever—OFF.

3–113. LOSS OF BOOSTERS IN FLIGHT.

3–114. In the event of complete loss of hydraulic pressure to the boosters in flight, proceed as follows:

a. Automatic pilot—OFF.

b. Elevator and rudder auxiliary booster switches—ON.

c. Aileron booster control lever—OFF.

WARNING

In the event that the elevator booster system malfunction or failure is without simultaneous loss of hydraulic pressure, do not turn the auxiliary booster switch ON. Pull out the emergency elevator booster shift control.

3–115. In the event that a hydraulic system failure should disable both the primary and secondary hydraulic systems, the automatic pilot, with boost off, may be used in preference to the auxiliary (electrically driven) booster system in cruising, particularly for a long flight. Under these conditions, the use of the automatic pilot would save the auxiliary booster motors for landing at the end of the flight. Use of the automatic pilot in preference to manual flying of the aircraft with boost off also presents an obvious advantage to the pilot.

3–116. It is intended that the automatic pilot forces be supplemented by the hydraulic boost, just as the forces supplied by the human pilot are supplemented by the hydraulic boost. However, with the hydraulic boost off, the automatic pilot will do a partial job of flying the aircraft.

3–117. The automatic pilot should never be used under conditions wherein the boosters are being shifted off and on. It is very important to make certain that the automatic pilot is disconnected before shifting the boosters either from OFF to ON or ON to OFF.

3–118. In rough air, if the automatic pilot is used with the surface control boosters off, it is important to realize that the automatic pilot cannot control the aircraft properly; hence, a gust can cause the aircraft to be placed in an unusual attitude if too much reliance is placed on the automatic pilot. Therefore, the human pilot should monitor the controls very closely under these conditions.

3–119. No automatic pilot malfunction tests have been conducted with the surface control boosters OFF. In the event of an automatic pilot malfunction, the forces applied to the surface controls by the automatic pilot are not great enough

PILOTS FLIGHT ENGINEER

to cause a quick attitude change of the aircraft. However, it is possible that an automatic pilot malfunction could cause a very slow and gradual maneuver, such as a diving spiral. Boost off recovery from such a maneuver, should it become well developed before corrective action is initiated, could become very difficult. Therefore, the pilot should be prepared at all times to immediately take corrective action should a malfunction occur.

3–120. Use of the automatic pilot with the surface control boosters off is approved; however, it is not necessarily recommended for all conditions. When using the automatic pilot with boosters off, the various limitations described in these paragraphs should be clearly understood.

3–121. BOOST-OFF LANDING.

Note

When a boost-off landing is necessary, the aircraft loading should be arranged to give a gear down CG of 23% to 30% MAC. The forward CG position is limited by inability to flare for landing because of reduced elevator travel (elevator shift lever pulled out to EMER position). The aft CG position is limited by the possibility of the lack of down elevator in case it is necessary to use full power at low airspeed in rough air.

a. When possible, reduce aircraft weight as much as practicable.

b. Wing flaps—TAKE-OFF position.

c. Approach speed should be increased slightly.

d. Make approach longer, flatter and with more power than normally necessary to reduce the amount of flare and attitude change.

e. The electric elevator trim tab may be used to assist the pilot in accomplishing the landing.

3–122. FLIGHT CONTROL SYSTEMS.

3–123. TURNING BOOSTERS ON IN FLIGHT.

3–124. In the event a decision is made to turn the boosters on, once they have been turned off in flight, due to malfunction causes, use the following procedure:

a. Automatic pilot—OFF.

b. Reduce airspeed to 156 knots (180 mph).

c. Retrim aircraft to fly hands-off.

d. Move the booster controls individually to ON very slowly.

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CAUTION

Slow and deliberate movement of the booster controls to the ON position will minimize the possibility of abrupt control surface deflection. A boost control valve may have been slightly opened at the time booster malfunction occurred.

3–125. EMERGENCY WING FLAP OPERATION.

3–126. The wing flaps may be extended or retracted manually in the event of hydraulic system failure. However, movement of the flaps is very slow when using the emergency hand crank. For this reason, extension in flight beyond the TAKE-OFF setting is not recommended, and emergency retraction is not normally considered although it is possible. Procedure for extension of the wing flaps is as follows:

a. Move the emergency shut-off levers for engines 3 and 4 to the HYD. OIL OFF position. With these levers OFF the secondary hydraulic system will be inoperative.

WARNING

Do not attempt to operate any other equipment on the secondary hydraulic system while operating the flaps manually. If the hydraulic flap motors become activated while the hand crank is engaged, action is fast enough and powerful enough to whirl the hand crank rapidly and cause serious injury to personnel.

b. Flap motor bypass valve—OPEN.

c. Definitely determine that flaps will not operate by movement of the flap control lever, then move the lever to a position between TAKE-OFF and 70%, if flaps are to be lowered.

CAUTION

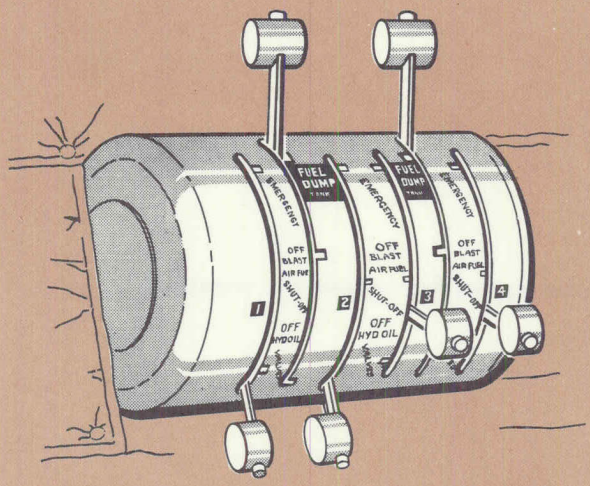
Leaving the flap control lever in the UP position permits the flap control valve to remain open, allowing bypass of fluid which will keep hand crank torque at a minimum.

d. Engage hand crank in drive unit and crank to TAKE-OFF position. Approximately 360 turns are required to lower the flaps to the TAKE-OFF position.

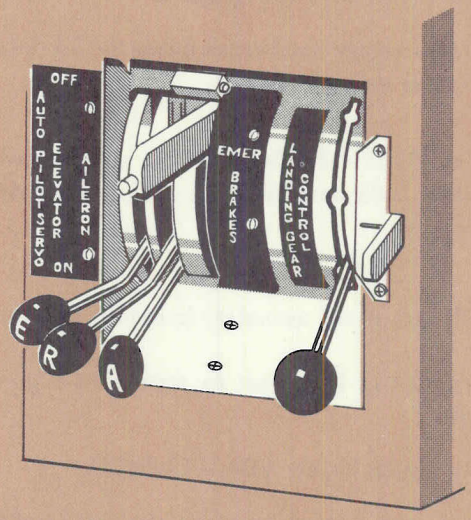
Note

Crank *counterclockwise to extend* the flaps.

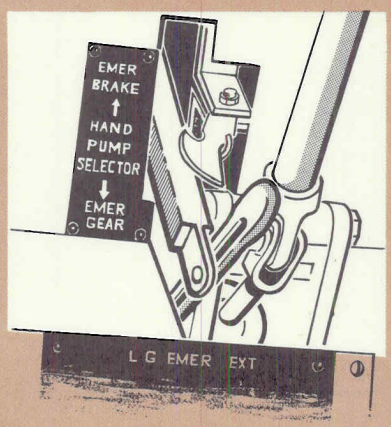
landing gear emergency extension procedure



1. Emergency shut-off levers for engines No. 3 and No. 4 — HYDRAULIC OIL OFF positions.

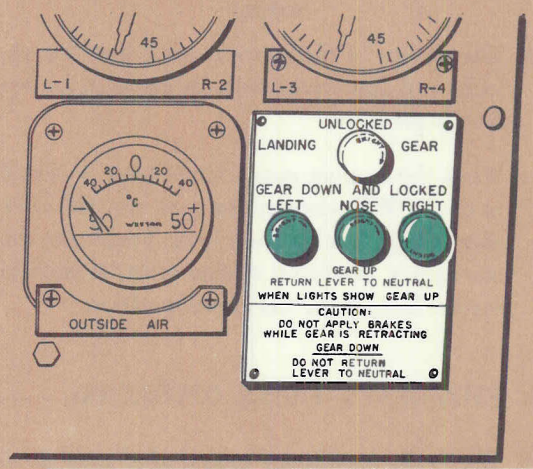


2. Landing gear control lever — DOWN.



3. Emergency hand pump selector lever — EMER. GEAR (aft) position.

4. Use full strokes of the hand pump. About 245 full strokes are necessary over a period of 2 1/2 to 3 minutes to extend and lock all the gears.



5. Landing gear position indicator lights — THREE GREEN.

6. Emergency hand pump selector lever — EMER. BRAKES (forward) position.

figure 3-6

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WARNING

- Never engage hand crank unless the emergency shut-off levers for engines 3 and 4 are in the HYD. OIL OFF position.
- Never engage hand crank unless the flap motor bypass valve is OPEN.

e. When TAKE-OFF flap position, as indicated by the flap position indicator, has been achieved, remove hand crank.

3–127. To restore the secondary hydraulic system after shut-down for manual flap extension or retraction:

a. Flap control lever—set to approximate position of wing flaps.

b. Flap motor bypass valve—CLOSED.

c. Emergency shut-off levers for engines 3 and 4—ALL ON position.

3–128. EMERGENCY LANDING GEAR EXTENSION.

3–129. If the landing gear fails to extend normally, accomplish the steps shown on figure 3–6.

Note

- The design of the gears is such that the uplocks and downlocks must be operated by hydraulic pressure.
- When the landing gear control lever is placed in the DOWN position, the gear may fall of its own weight but may not lock. Therefore, the emergency extension system must be used to assure locking in the down position.

3–130. EMERGENCY BRAKE OPERATION.

3–131. If a brake emergency occurs after touchdown, in which little or no braking action can be developed by any of the following emergency procedures, propeller reversing is available for aerodynamic braking. However, reversing should be used judiciously if the secondary hydraulic system is inoperative, because nose wheel steering will not be available.

3–132. WITH NORMAL SECONDARY HYDRAULIC SYSTEM PRESSURE:

3–133. If there is no braking action with the brake selector valve lever in the NORM position:

a. Brake selector valve lever—EMER.

b. Stand by to operate the hand pump.

PILOTS FLIGHT ENGINEER

3–134. WITH SECONDARY HYDRAULIC SYSTEM PARTIALLY INOPERATIVE:

Note

With propeller feathered on either No. 3 or No. 4 engine, or with the hydraulic pump on either of these engines shut down, landing gear actuation, wing flap drive, ground steering action, and operation of the right secondary heat exchanger fan motor may be slower than normal.

3–135. If there is no braking action with the brake selector in the NORM position:

a. Brake selector valve lever—EMER.

3–136. If there is still no braking action:

a. Operate the hand pump as rapidly as possible.

3–137. WITH SECONDARY HYDRAULIC SYSTEM COMPLETELY INOPERATIVE:

3–138. Prior to gear extension:

a. Emergency extension tank—check fluid level.

Note

Sight gage should show fluid at or above minimum fluid level. Fluid may be added, if necessary, from the emergency filler reservoir by positioning the emergency hydraulic supply filler selector valve handle at EMER RES and operating the wobble pump.

3–139. Prior to landing, but after landing gear has been locked down by means of the emergency extension procedure:

a. Emergency hand pump selector lever—check EMER BRAKES position.

b. Brake selector valve lever—EMER.

c. Emergency brake pressure indicator—check. If less than 1250 psi, raise pressure to 1250 psi with hand pump.

d. Depress toe pedals once, and observe emergency brake pressure indicator.

Note

A slight pressure drop with one application of the brakes is normal. If the pressure drop is excessive (more than 100 psi), a reduction in the number of brake applications available may be anticipated.

e. *Restore emergency brake pressure to not less than 1250 psi with the hand pump.*

PILOTS

FLIGHT ENGINEER

WARNING

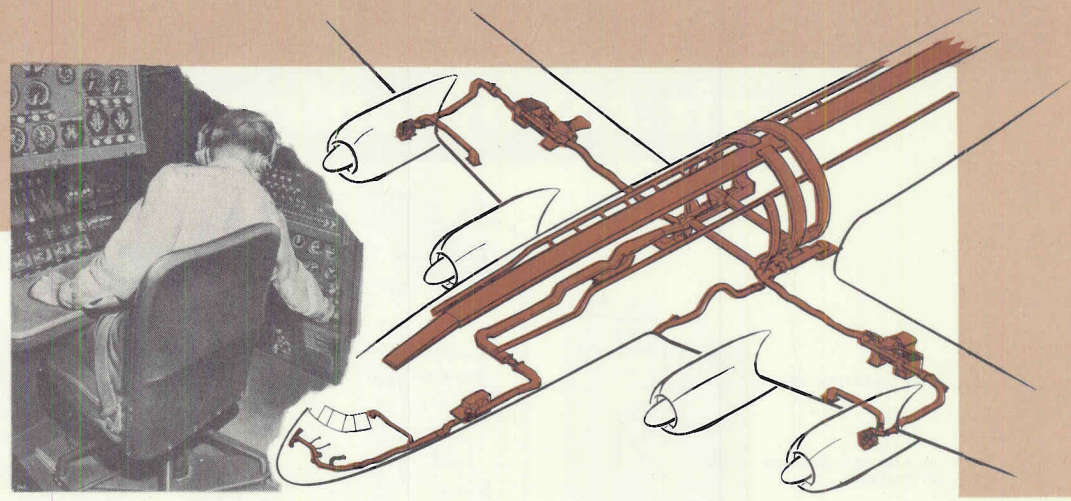
During maneuvers requiring extreme movement of the rudder pedals, it is possible that the toe pedals may be depressed inadvertently, thus depleting the accumulator charge. Utmost care should be exercised to avoid this. In order to provide a positive means of isolating the accumulator charge until it is needed for braking action, the brake selector valve lever may be placed in NORM position until immediately before touchdown at which time it should be returned to the EMER position.

3–140. After landing:

a. Operate the emergency hand pump continuously during the landing roll.

Note

Avoid pumping the toe pedals because this will reduce the number of useful brake applications available.



Section IV

description and operation of auxiliary equipment

4–1. AIR CONDITIONING SYSTEM.

4–2. The air conditioning system (figure 4–1) provides cabin pressurization, auxiliary ventilation, heating, and cooling. For pressurized operation, the air supply to the fuselage is furnished by two engine-driven cabin superchargers located in the outboard nacelles. For auxiliary ventilation, ram air is ducted into the distribution system from inlets in the leading edges of the wings, adjacent to the fuselage. Heat for the cabin and flight station is provided by two combustion heater packages located within the wing fillets. Supplementary heat for the flight station is supplied by an electric heater, located within the flight station ducting, and is dispersed through the pilot's and copilot's face and foot outlets. Cooling and/or refrigerated air for both the cabin and flight station is provided by two cooling units and associated equipment located within the inner wing panels.

4–3. The controls for operating the air conditioning system are located on the station 260 bulkhead (figure 1–55) and are operated by the flight engineer. By proper selection of the controls, the following air conditioning combinations can be obtained:

a. Pressurized flight with heating, and/or cooling and/or refrigeration. It is also possible to have cooling in the flight station with heating in the cabin or heating in the flight station with cooling in the cabin.

b. Auxiliary ventilation in flight with or without heating.

c. Ground refrigeration with outboard engines operating.

d. Ground ventilation with mixed air (fresh and recirculated air)—the recirculated air, heated if desired.

e. Ground truck heating or cooling.

4–4. AIR DISTRIBUTION SYSTEM.

4–5. During pressurized operation, ambient air is ducted to the cabin superchargers from inlets in the lower leading edges of the wings, between the inboard and outboard nacelles. After being compressed by each cabin supercharger, it is ducted aft through the outboard nacelles, then inboard through the wing panels to the cooling and refrigeration equipment. At this point the ducting splits and passes the air through one or more sections of this equipment and returns to a single duct downstream of the cabin air mixing valve. From this valve, the air is ducted into the fuselage to the flight station mixing valve and to the bottom of the left and right forward risers which supply individual cold air outlets (gaspers) in the cabin. The bottoms of the forward risers are interconnected by a duct that permits equal air distribution during single cabin supercharger operation. This interconnecting duct also furnishes cabin supercharger or auxiliary ventilation ram air (during aux. vent. operation) to the electrically actuated, controllable flight station mixing valve where it is mixed with heated or recirculated air, as desired.

4–6. MAIN CABIN RISERS. Air from the bottom of the forward risers is ducted to manifolds at the bottom of

air conditioning system

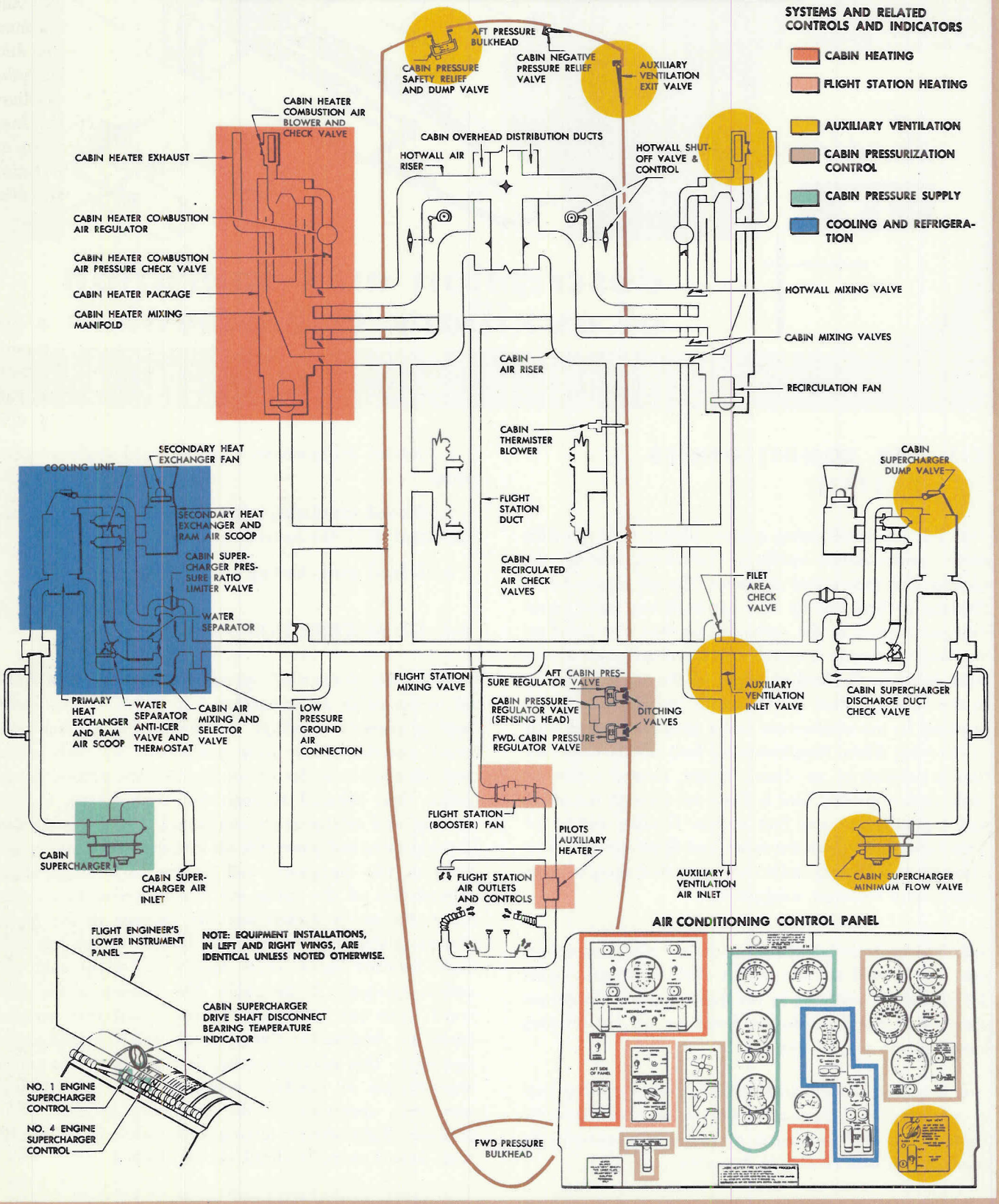


figure 4-1

the cabin risers where it is mixed with recirculated air from the cabin mixing valves. The recirculated air may or may not be heated, depending upon cabin temperature selection. The main cabin risers are located between the fuselage bulkheads and duct the mixed air from the manifolds upward to supply the outer portion of the overhead duct in the cabin. Outlets in the overhead duct permit the optimum flow of air to the cabin.

4–7. HOTWALL AND CABIN RETURN AIR DISTRIBUTION. The left and right hotwall risers, which are located aft of the main cabin risers, also receive recirculated air from the cabin mixing valves and supply this air to the inner portion of the cabin overhead duct. Manually controlled shut-off valves (operated by a special equipment key, usually stored in the flight engineer's desk) are installed in the risers so that the cabin wall and window heating system may be shut off to conserve heat in case of a cabin heater failure. The hotwall air flows through holes in the inner portion of the overhead duct; then, via lateral ducting, to the hotwall spaces in the fuselage sidewalls, except that in the window bays the lateral ducting connects directly to defogging nozzles, which direct hotwall air between the inner and outer panes preventing fogging. The exhaust air from the windows passes through check valves (which prevent sudden depressurization should an outer pane fail) to the lower bay areas. From the areas beneath the windows and the bays without windows, the hotwall air travels downward to perforated strips or grilles above the cabin floor. In certain bays this air enters the cabin through these strips. In the remainder of the bays the wall air passes into the area beneath the cabin floor and between the fuselage and the aft cargo compartment liner. The air entering the area around the forward cargo compartment is exhausted overboard through the outflow valves. The air entering the area around the aft cargo compartment passes to the cabin recirculation fans through check valves near the forward end of the compartment and is recirculated through the cabin distribution system. During auxiliary ventilation, cabin air exhausts overboard through the auxiliary ventilation exit valve located on the aft left side of the fuselage below the floor. A portion of the cabin air also exhausts through venturis; one located in each lavatory; one in the galley; one near the radio racks; and one at the cabin thermistor.

4–8. FLIGHT STATION AIR DISTRIBUTION. Heating and ventilating air for the flight station consists of recirculated cabin air mixed with fresh air, as desired, or fresh cold air for the pilot and copilot dispersed through individual outlets. The recirculated air (heated or unheated) is provided by a duct interconnecting the left and right cabin heater packages. The fresh air is supplied by either the cabin supercharger or auxiliary ventilation systems and is mixed with the recirculated air at the flight station mixing valve. The mixed air passes forward from the mixing valve to the aft side of the pilot's and copilot's instrument panels where it is divided into manually controlled face and foot outlets. Located in the duct between the flight station mixing valve and the pilot outlets is a flight station booster fan, and pilots' auxiliary heater. A branch duct runs transversely through the fuselage from the duct between the fan and heater to an air outlet in the station 260 bulkhead near the flight station door. The air entering the flight station from this outlet cannot be heated by the pilot's auxiliary heater.

4–9. PRESSURIZATION SYSTEM.

4–10. The pressurized portion (figure 4–4) of the aircraft includes all crew, passenger, and cargo compartments contained within the fuselage structure. The mass flow of pressurized air entering the cabin varies with flight altitudes, and air temperatures. The following altitudes are obtainable:

Cabin Pressure Altitude		Aircraft Pressure Altitude
Sea Level	to	12,300 feet
5,000 feet	at	20,000 feet
8,000 feet	at	22,800 feet
10,600 feet	at	25,000 feet

4–11. The cabin superchargers provide the pressurized air supply, and the cabin pressure regulators supply the cabin pressurization control.

4–12. PRESSURIZED AIR SUPPLY SYSTEM.

4–13. Ambient air is ducted from inlets in the leading edge of the wings to the cabin superchargers, which are located in the outboard nacelles. It is then compressed and passed through the refrigeration and cooling equipment located in the wings (the path through this equipment is dependent upon cabin temperature selection) and then into the fuselage to pressurize and ventilate the cabin.

4–14. CABIN SUPERCHARGERS. Each cabin supercharger assembly consists of a single-stage, variable-speed impeller controlled by a two-speed gear train and planetary gear system. Each supercharger has an integral oil reservoir and hydraulic system. Other component parts, both pneumatic and hydraulic, provide control of the gear train so that the impeller rotates at a speed necessary to maintain the required air flow. The cabin super-

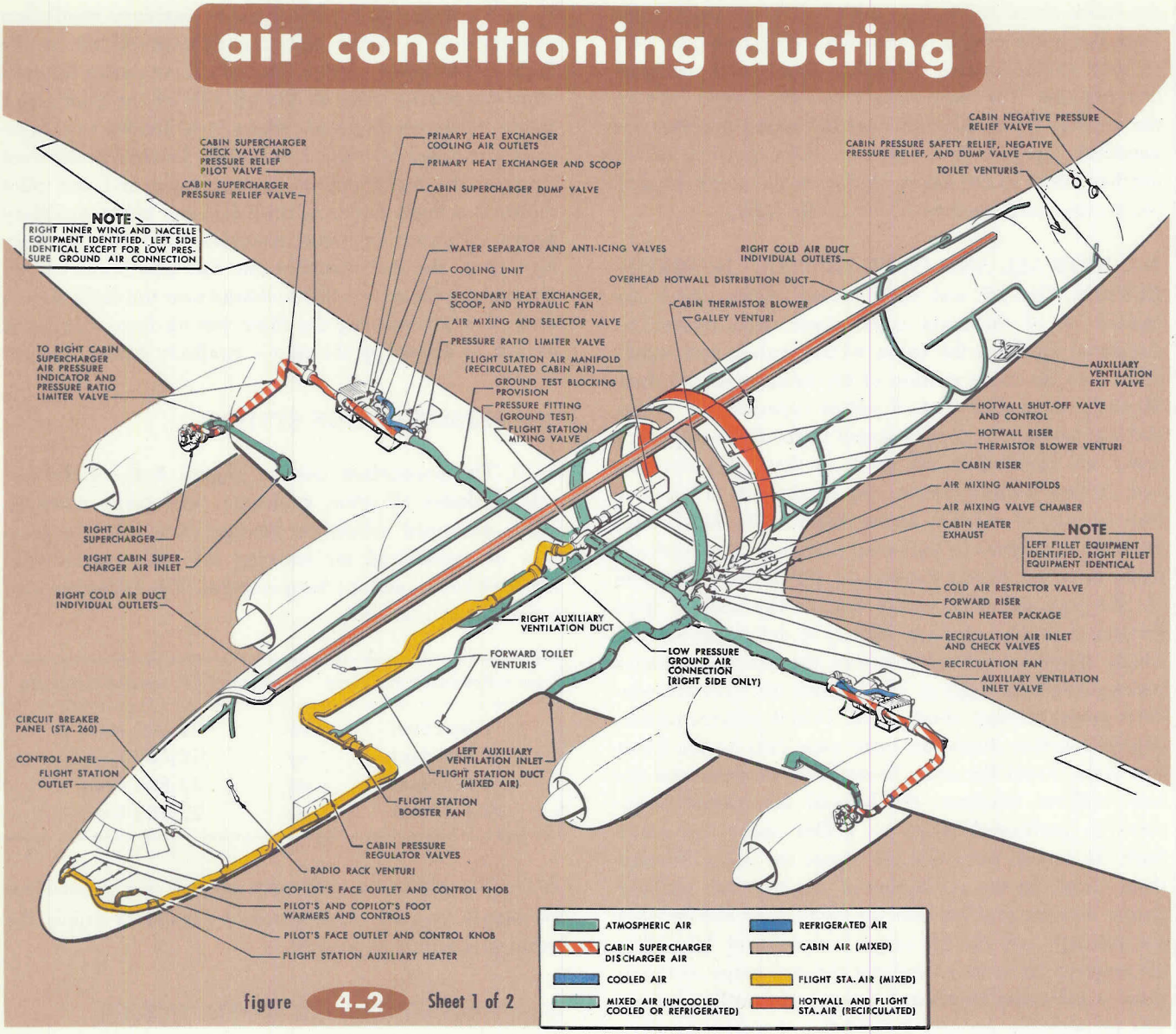


figure 4-2 Sheet 1 of 2

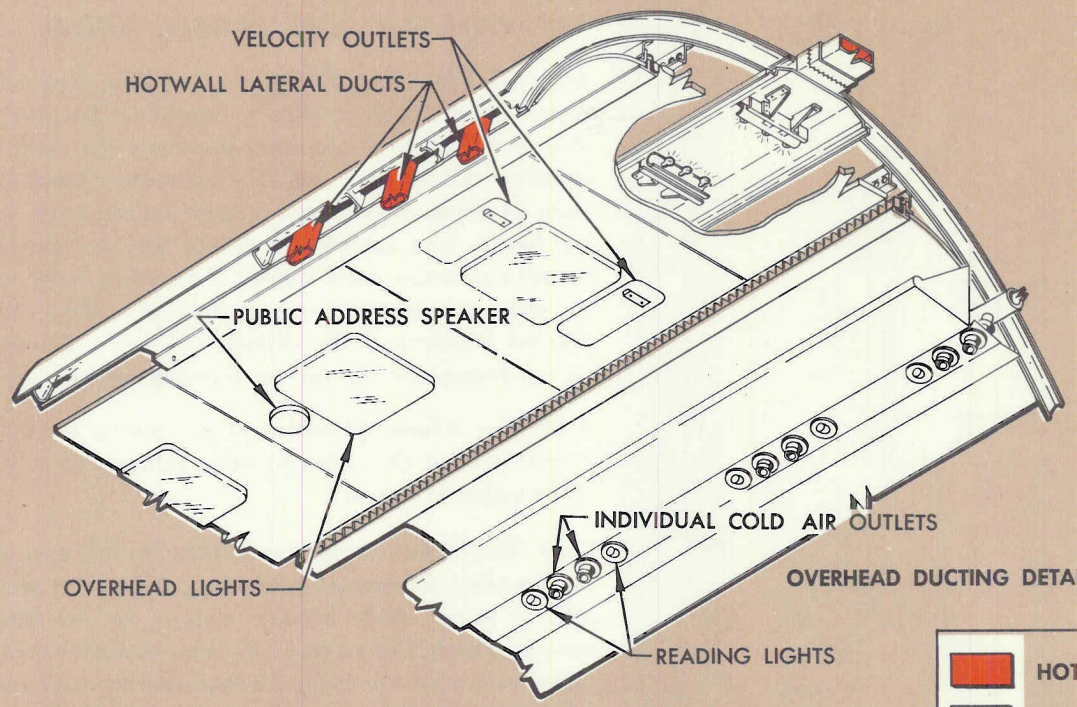
chargers are driven by direct-coupled drive shafts that rotate at 3.11 times engine speed. They afford a maximum air flow of 70 pounds per minute per supercharger, 140 pounds per minute combined.

4–15. CABIN SUPERCHARGER DRIVE SYSTEM. High-gear ratio (high impeller speed to input shaft speed) is obtained through a hydraulically operated, plate-type clutch. Low gear ratio is obtained through an overriding type clutch.

4–16. The cabin superchargers are in low-gear ratio whenever they are not being rotated. When starting the engines, the cabin supercharger gear systems are in low ratio until the lubricating oil pressure reaches 25 psi, at which point the systems shift to high-gear ratio. The cabin superchargers will remain in high-gear ratio as long as they are being rotated and the engine speed does not exceed 1430 rpm. This is the normal condition for ground operation where a high volume of air, at low engine rpm, is required for refrigeration. The full cabin supercharger output is at 1200 engine rpm during ground operation and at 1730 engine rpm (and above) during flight. The supercharger is in low-gear ratio above 1430 engine rpm.

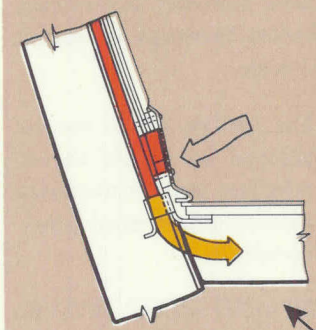
4–17. While increasing engine rpm, with the cabin supercharger oil pressure above the minimum of 25 psi, the high-to-low gear shift is made at 1430 engine rpm. While

air conditioning ducting



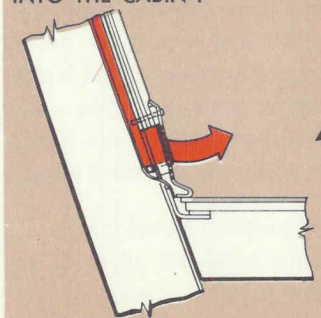
OVERHEAD DUCTING DETAIL

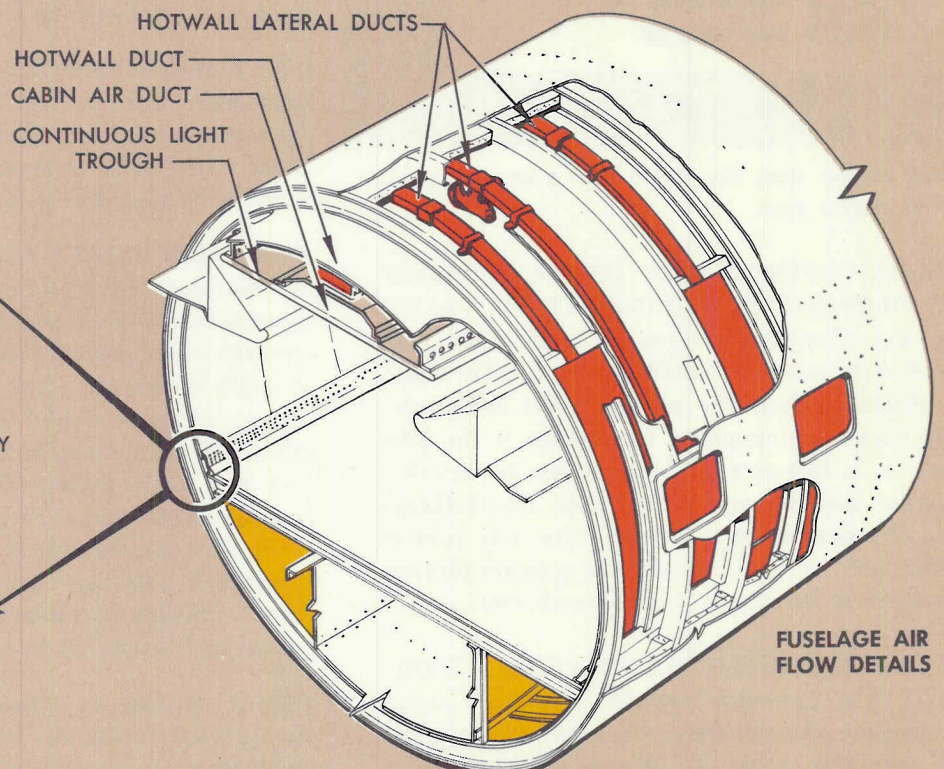
HOTWALL AIR
CABIN AIR
MIXED AIR



IN SOME BAYS, THE CABIN RETURN AIR MIXES WITH THE HOTWALL AIR AND FLOWS BELOW THE FLOOR.

IN ALL OTHER BAYS, THE HOTWALL AIR FLOWS DIRECTLY INTO THE CABIN.





FUSELAGE AIR FLOW DETAILS

figure 4-2 Sheet 2

window ducting

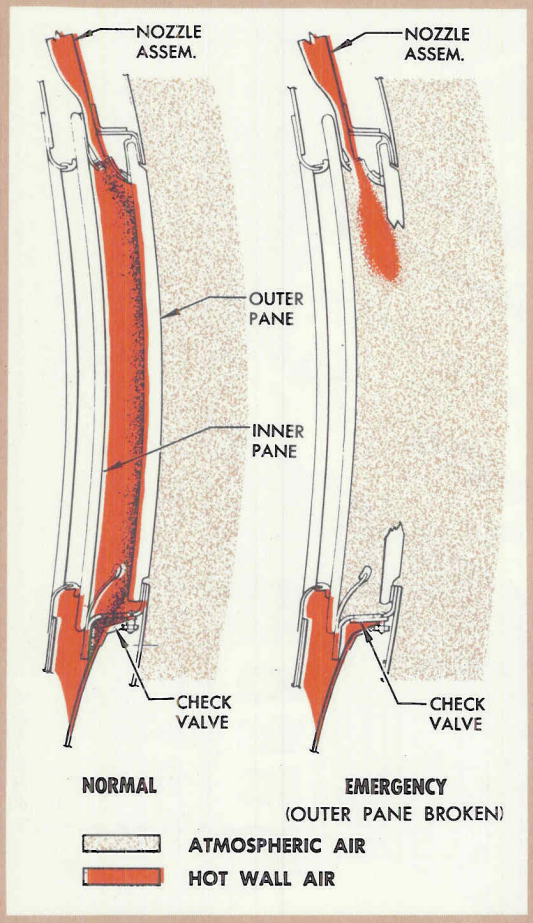


figure 4-3

decreasing engine rpm, the low-to-high gear shift point is at 1130 engine rpm.

4–18. CABIN SUPERCHARGER PRESSURE RELIEF VALVE, PILOT VALVE, AND DUCT CHECK VALVE. A cabin supercharger duct pressure relief valve, pilot valve, and check valve are installed in each cabin supercharger discharge duct. The pressure relief valve automatically opens to atmosphere, in response to the pilot and check valve, whenever the back pressure in the cabin supercharger duct becomes greater than the discharge pressure. The purpose of the check valve is to prevent "back-flow" and resultant loss of cabin pressure through an inoperative or low output cabin supercharger.

4–19. CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT. The disconnect assembly provides a means of mechanically disconnecting the cabin supercharger from its respective engine. The disconnect is located between the forward bearing housing and the mounting pad at the rear of the engine. The disconnects are cable-actuated by the engine supercharger control levers. Once the cabin superchargers are disconnected they cannot be reconnected in flight.

4–20. PRESSURIZATION CONTROL SYSTEM.

4–21. AUTOMATIC CONTROL. Two cabin pressure regulator valves (outflow valves), located in the lower left side of the fuselage, automatically meter the outflow of cabin air in response to variable pneumatic control forces from an adjacent pressure regulator control valve (sensing head). The outflow valves also act as suction and negative pressure relief valves. The sensing head varies the pneumatic control forces in response to the manually selected positions of the altitude and rate-of-change selectors located on the air conditioning control panel.

4–22. The differential section of the sensing head is adjusted to limit the cabin pressure differential to 11.12 ±.20 inches of mercury.

4–23. The outflow valves are held in the full open position by cabin differential pressure or, if the cabin altitude selector is set above aircraft altitude, by the aircraft vacuum system. The selection of cabin differential pressure or vacuum is automatically accomplished by a three-port, solenoid-type valve controlled by the right landing gear scissors switch circuit. When energized, during ground operation, the solenoid-type valve connects the sensing head to the vacuum system and when de-energized, during flight, to atmospheric static pressure.

4–24. MANUAL CONTROL. The outflow valves can be individually and manually positioned by proper use of the cabin pressure regulator selectors and depressurize needle valve located on the air conditioning control panel. Refer to Normal Operating Procedures.

4–25. CABIN SAFETY RELIEF AND DUMP VALVE. A cabin safety relief and dump valve is installed in the upper section of the aft pressure bulkhead. It automatically prevents cabin pressure from exceeding the maximum allowable differential (5.60 psi, 11.9″ Hg) by relieving excess pressure overboard. It acts as a negative pressure relief valve when atmospheric pressure exceeds cabin pressure, as a cabin pressure dump valve during auxiliary ventilation operation (figure 4–5), and as a dump valve in the event that the aircraft is inadvertently landed while pressurized. This valve is vacuum-operated during auxiliary ventilation operation in response to an aux. vent. control knob located on the air conditioning control panel.

4–26. A vacuum, or negative pressure relief valve, is also installed in the aft pressure bulkhead adjacent to the cabin safety relief and dump valve. This valve is hinged from the top to permit it to swing inward if outside pressure is greater than the cabin pressure.

pressurization system

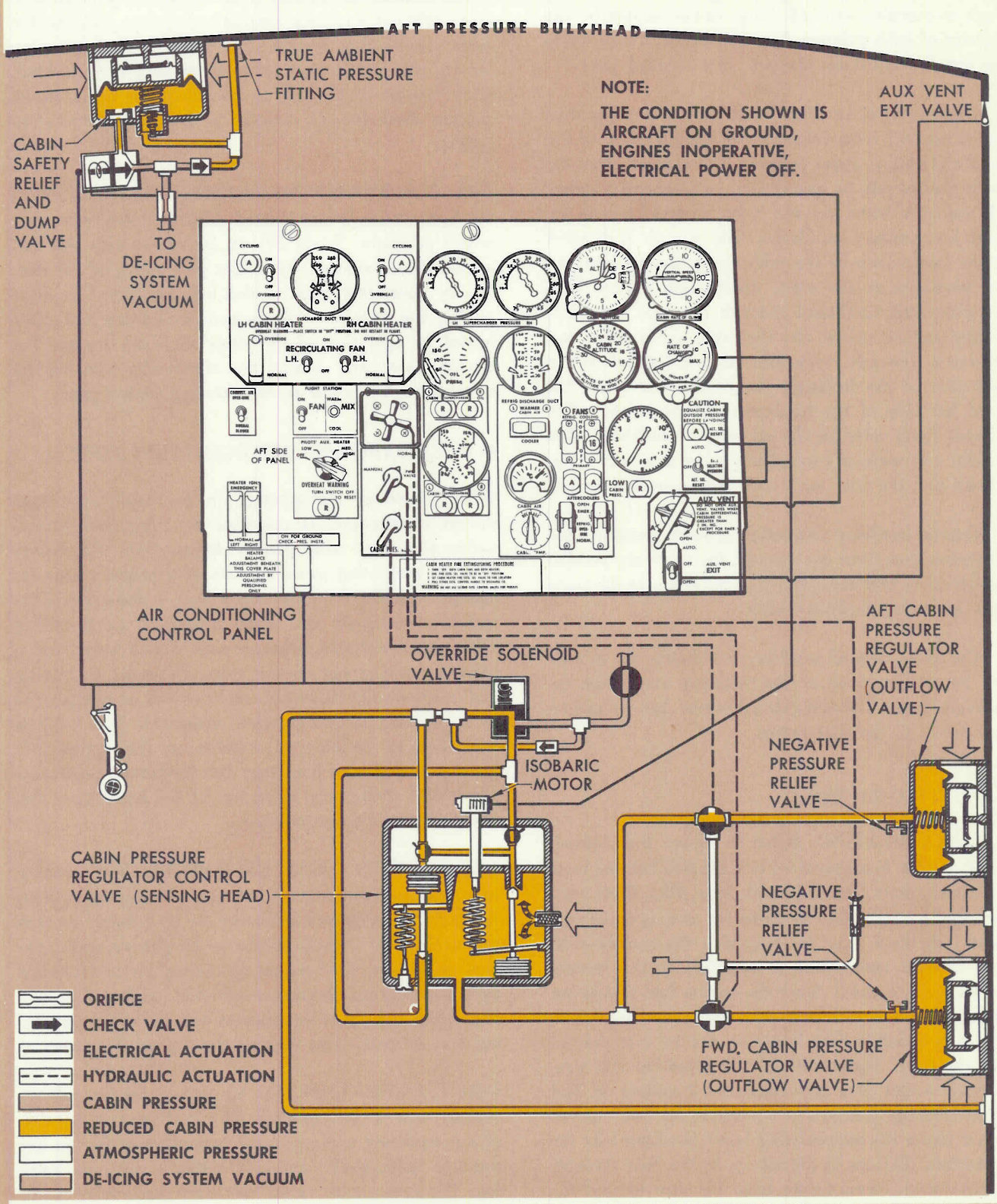


figure 4-4

4–27. AUXILIARY VENTILATION SYSTEM.

4–28. During auxiliary ventilation (figure 4–5), the discharge air from the cabin superchargers flows overboard through electrically actuated dump valves located on the aft header of each primary heat exchanger. These dump valves are controlled by the aux. vent. control knob.

4–29. During flight, auxiliary ventilation is accomplished by using ram air from inlets in the leading edges of the left and right wing center sections. The ram air from the inlets is ducted aft to electrically actuated inlet valves which are open when the aux. vent. control knob is positioned for auxiliary ventilation. The ram air is directed from the inlet valves to the cabin recirculating fans and heater packages, to the cabin distribution system. This air is exhausted overboard through the aux. vent. exit valve, the outflow valves, and the cabin safety relief and dump valve. The aux. vent. exit valve is located on the aft left side of the fuselage; the outflow valves on the forward left side of the fuselage; and the cabin safety relief and dump valve on the aft pressure bulkhead. The aux. vent. exit valve is controlled by the aux. vent. control knob and the aux. vent. exit valve override switch.

4–30. During auxiliary ventilation ground operation, the recirculation fans draw air through the auxiliary ventilation inlet valves and distribute it to the cabin in the same manner as during flight operation.

4–31. The mass flow of auxiliary ventilation air is controlled by the positions of the auxiliary ventilation inlet and exit valves. The exit valve, however, can be opened independently of the inlet valves.

4–32. HEATING SYSTEM.

4–33. CABIN HEATING. Refer to figure 4–6. Heated air for the cabin is supplied by two 125,000 btu per hour combustion heaters located in each wing fillet. Each heater package, or assembly, contains its own ignition system and individual units for supplying the correct combustion fuel/air ratio. Fuel is supplied to the heaters from fuel tanks 2 and 3. Since the engine fuel outlets are at a lower level (11 gallons lower) than the cabin heater outlets, it is possible that fuel may not be available to operate the cabin heaters unless it is saved for that purpose. Each heater uses approximately 2 gallons of fuel per hour. During pressurized operation, the recirculated cabin air (from the recirculation fans) is warmed by the cabin heaters. This air is picked up by the fans through the recirculation check valves from the area around the outside of the aft cargo compartment liner. During auxiliary ventilation operation, outside ram air is delivered to the recirculation fans, and, if delivered in sufficient volume, will close the recirculating air check valves. The heated air from the output side of the heaters is mixed with fresh air from the cabin superchargers (during pressurization) or ram air from the auxiliary ventilation inlets (during auxiliary ventilation) before entering the cabin distribution system. The heat-rise-of-compression that is supplied by the cabin superchargers is utilized, when heating is desired, by directing the cabin supercharger discharge air directly to the cabin distribution system.

4–34. FLIGHT STATION HEATING. The heated air for the flight station is recirculated cabin air from both cabin heater packages. Fresh air can be mixed with this air, in the desired amount, by proper positioning of the electrically controlled flight station mixing valve. If, after mixing, the air is not as warm as desired, it can be further heated by operation of the pilots' auxiliary heater. The mixing valve and heater are electrically actuated by switches located on the air conditioning control panel.

4–35. COOLING AND REFRIGERATION SYSTEM.

4–36. Cooled or refrigerated air, for cabin and flight station distribution, is provided by equipment located within the inner wing panels (figure 4–7). The equipment in each wing panel consists of a primary heat exchanger, cooling unit, secondary heat exchanger and associated cooling-air fan, water separator, air throttling valve and thermostat, pressure ratio limiter valve, and a cabin air mixing and selector valve. The cabin air mixing and selector valve directs air to be cooled or refrigerated to the cooling or refrigeration equipment. This valve is controlled by paddle-type switches on the station 260 panel. A refrigerator discharge duct temperature indicator provides a continuous indication of the inner wing discharge duct air temperature.

4–37. PRIMARY HEAT EXCHANGER. The primary heat exchanger removes the heat-rise-of-compression from the cabin supercharger discharge air by passing ambient ram cooling air over the discharge air passing within the heat exchanger. The amount of cooling air is controlled by a modulating, electrically actuated, cooling-air scoop that opens and closes in sequence with the cabin air mixing and selector valve varying the degree of cooling.

4–38. COOLING UNIT. The air that passes through the cooling unit is refrigerated. The cooling unit consists of a compressor and expansion turbine operating on one common drive shaft contained within a common housing. The compressor raises the cabin supercharger discharge air pressure for refrigeration, which takes place in the expansion turbine. The air flowing through the expansion turbine drives the common drive shaft.

auxiliary ventilation system

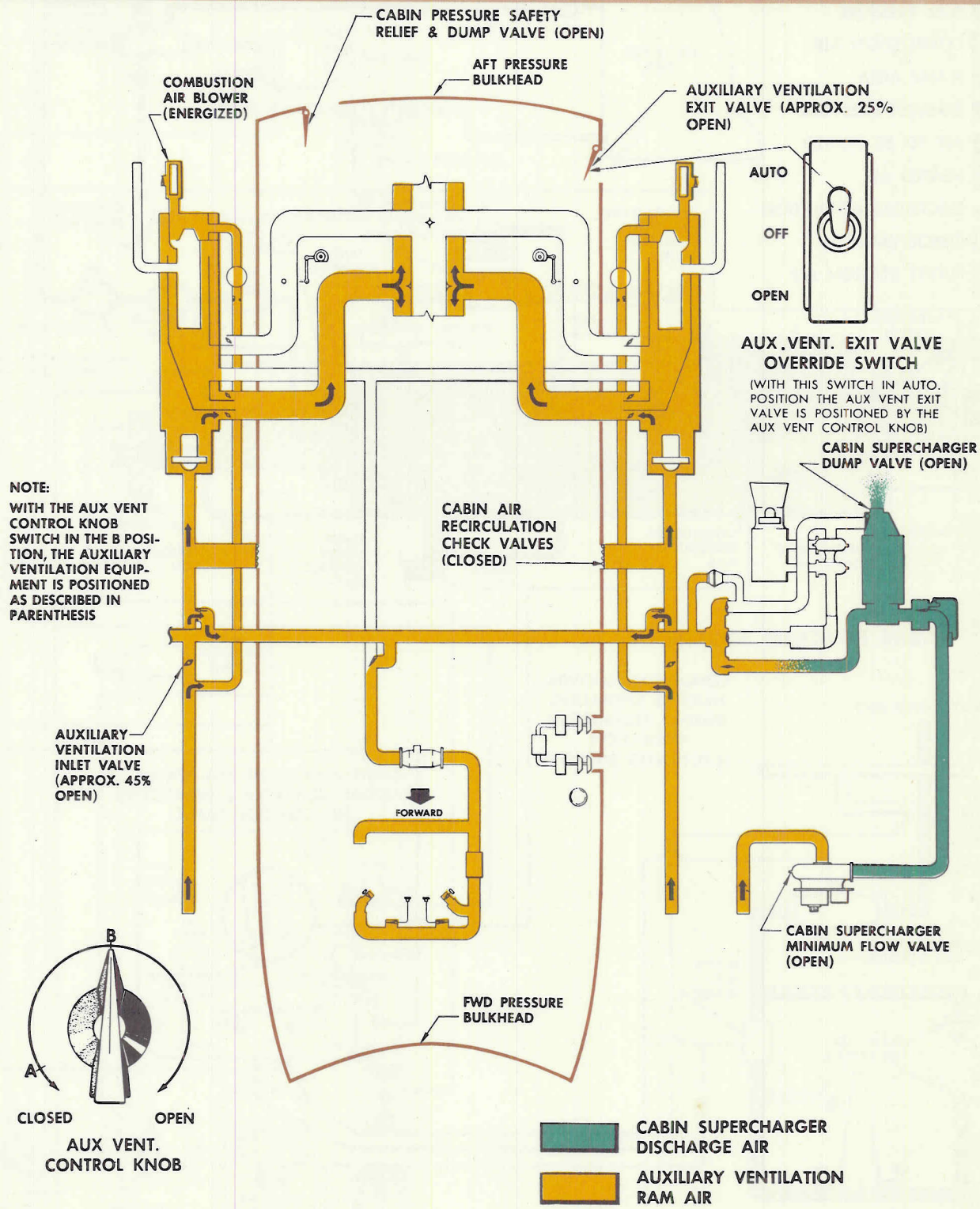


figure 4-5

cabin & flight sta. heating system

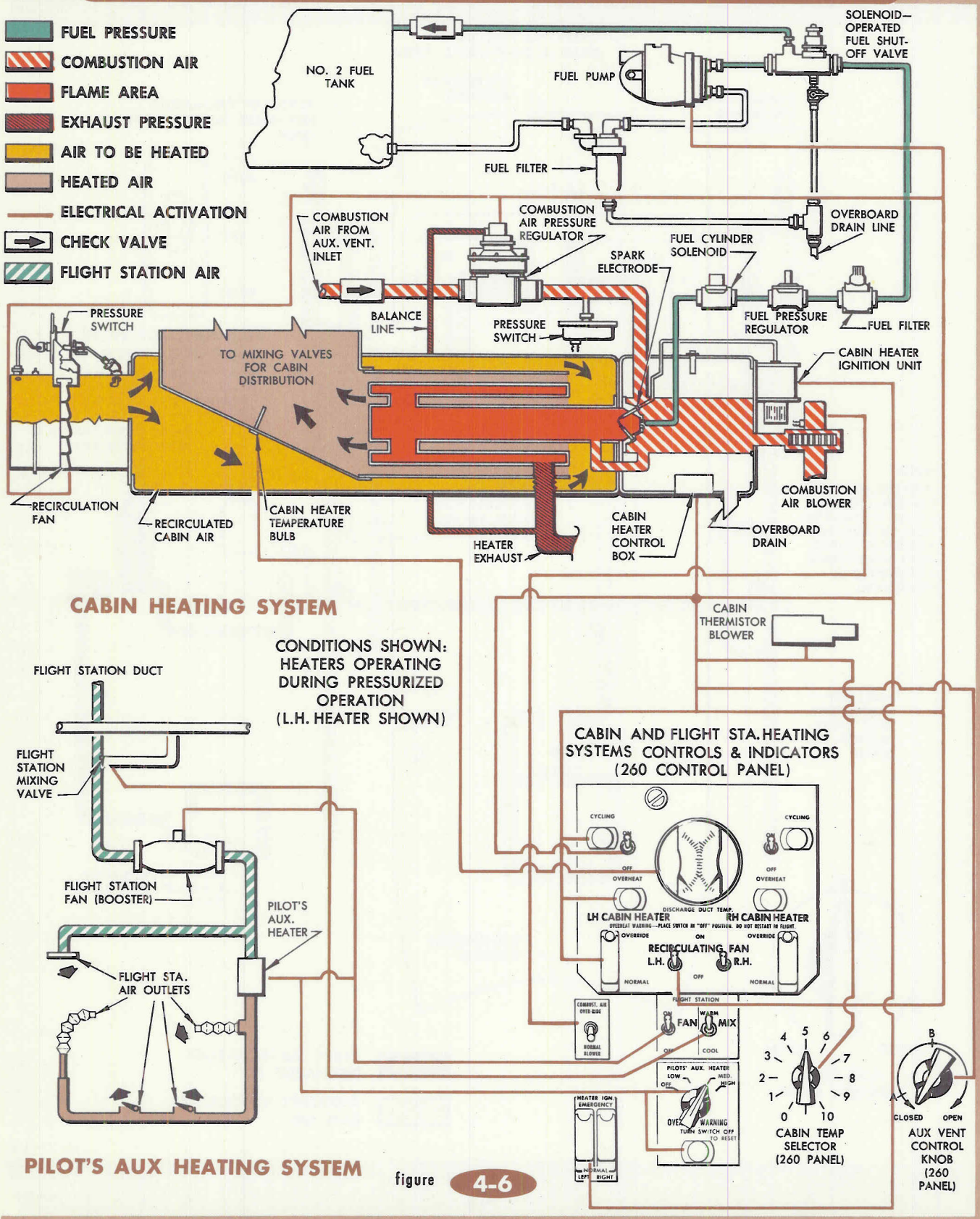


figure 4-6

4–39. SECONDARY HEAT EXCHANGER. The secondary heat exchanger removes the heat-rise-of-compression from the air that has passed through the cooling unit compressor. The exchanger has a two-position, cooling-air scoop that is open during the refrigeration phase of the cabin air mixing and selector valve control cycle.

4–40. SECONDARY HEAT EXCHANGER (GROUND COOLING) FAN. The secondary heat exchanger fan is located on the aft header of the secondary heat exchanger. This fan provides circulation of cooling air for the exchanger when the refrigeration unit is being operated on the ground. The right secondary heat exchanger fan motor is driven by the secondary hydraulic system (figure 4–8) and the left is driven by the primary hydraulic system. The right fan motor is turned off by a microswitch on the flap selector valve, during extension or retraction of the wing flaps, and both fans are turned off by the landing gear scissors switch on take-off. During flight, cooling air is supplied by ram air.

4–41. WATER SEPARATOR. The water separator removes the moisture released by refrigeration of the air passing through the expansion turbine. This is accomplished by passing the air through condenser bags backed up with baffle tubes. The condensed water drains overboard.

4–42. AIR THROTTLING VALVE AND THERMOSTAT. An air throttling valve, controlled by a thermostat, is incorporated to prevent freezing of condensed vapor in the water separator. Whenever the temperature, at the water separator, reaches approximately 2°C (35° F), the thermostat opens the air throttling valve allowing hot air (from the cabin supercharger discharge duct) to mix with the refrigerated air from the expansion turbine. The throttling valve meters the amount of hot air flow and maintains the temperature of the air entering the water separator above freezing.

4–43. PRESSURE RATIO LIMITER VALVE. In the event the cabin supercharger pressure ratio becomes excessive (water separator ices up, etc.), this valve will open and allow air to bypass the cabin air mixing and selector valve. It is activated when the cabin supercharger pressure ratio exceeds 1.92 to 1 (indicated by the cabin supercharger differential pressure indicators on the air conditioning control panel).

4–44. CABIN AIR MIXING AND SELECTOR VALVE. The cabin air mixing and selector valve is located downstream of the cooling and refrigeration equipment. It consists of four ports, three of which contain butterfly valves and the fourth discharges air to the cabin. The three sources of air to the butterfly valves are: (a) the cabin supercharger (uncooled and relatively hot air); (b) the primary heat exchanger (relatively warm air); (c) the cooling unit (cold or refrigerated air).

4–45. Any desired mixture of hot air and warm air, or cold air and warm air, can be obtained by proper positioning of the butterfly valves. Each valve is positioned by a cam arrangement with an electric actuator and controlled by a WARMER and COOLER paddle-type switch on the air conditioning control panel.

Note

Uncooled air is air that has been heated by the heat-rise-of-compression of the cabin superchargers. This air is warmer than outside air and is ducted directly to the fuselage, bypassing the cooling and refrigeration equipment, when warm air or heating is required in the cabin.

4–46. COOLING. Air being cooled is at cabin supercharger discharge pressure. The position of the air mixing and selector valve directs this air through the primary heat exchanger before reaching the fuselage. Modulation of the amount of cooling is then determined by the position of the ram air scoop which, in the open position, controls the amount of ram cooling air flowing around the cooling tubes within the exchanger. A heat transfer from the cabin supercharger air within the tubes is made to the ram air around the tubes. The ram air is then exhausted overboard through slots in the upper surface of the wing.

4–47. REFRIGERATION. Air being refrigerated is at cabin supercharger discharge pressure. The position of the air mixing and selector valve directs the air through the primary heat exchanger, as in cooling. From the outlet side of the primary heat exchanger, the air flows into the compressor turbine of the cooling unit. From the compressor, the air passes through the secondary heat exchanger (ram air scoop open), then into the expansion turbine of the cooling unit. From the expansion turbine, the air flows through the water separator to the air mixing and selector valve which directs it to the fuselage duct as refrigerated air.

Note

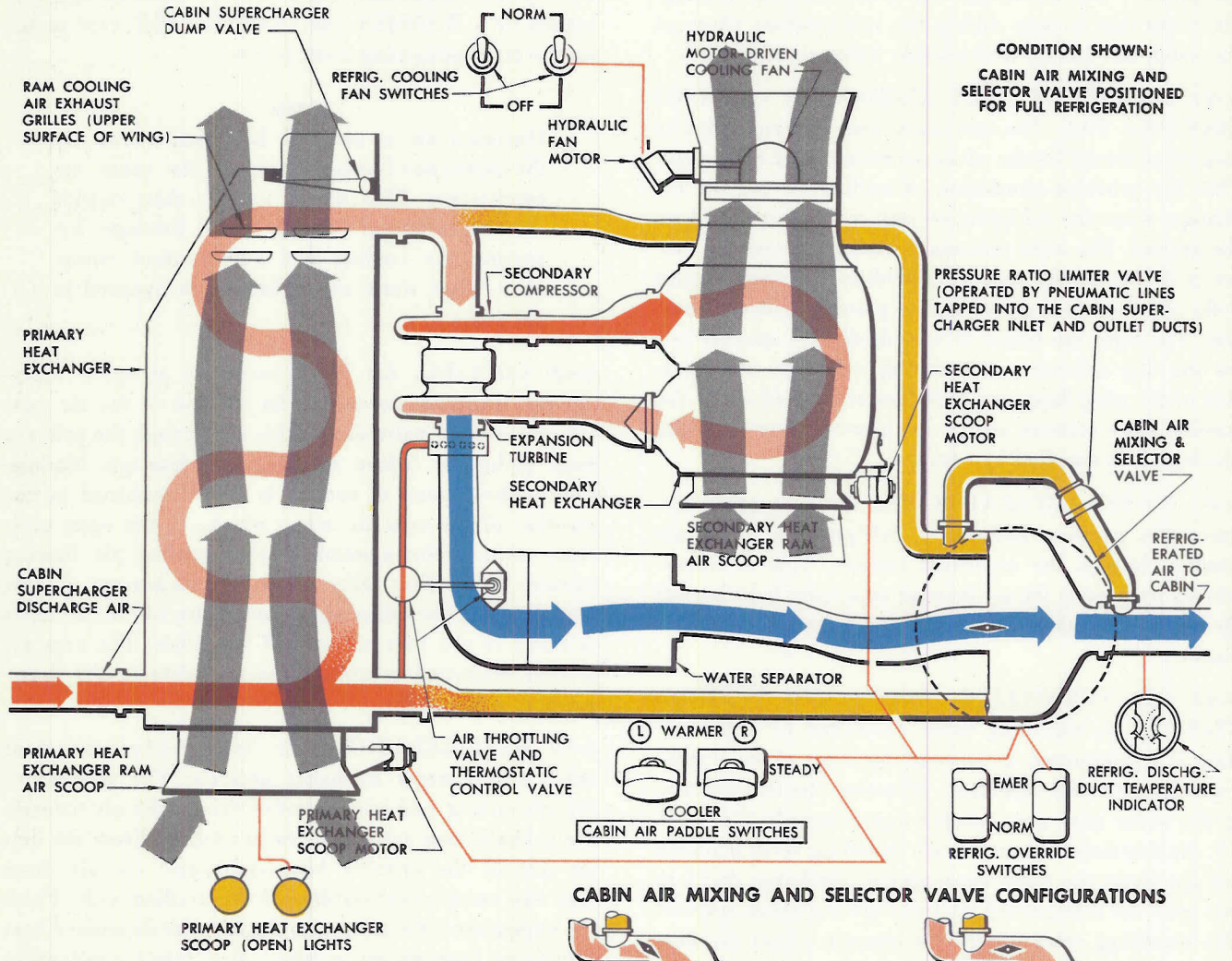
There will be an increase in cabin supercharger discharge air pressure, indicated on the cabin supercharger differential pressure indicator, during refrigeration.

4–48. AIR CONDITIONING SYSTEM CONTROLS.

4–49. The following air conditioning controls are located on the station 260 bulkhead air conditioning control panel (figure 4–9), unless noted otherwise.

4–50. CABIN HEATER SWITCHES (LEFT & RIGHT). The cabin heater switches are two-position ON and OFF switches (figure 4–9) which energize the heater control circuit.

refrigeration system



STATIC AIR

PRIMARY AND SECONDARY HEAT EXCHANGER DISCHARGE AIR

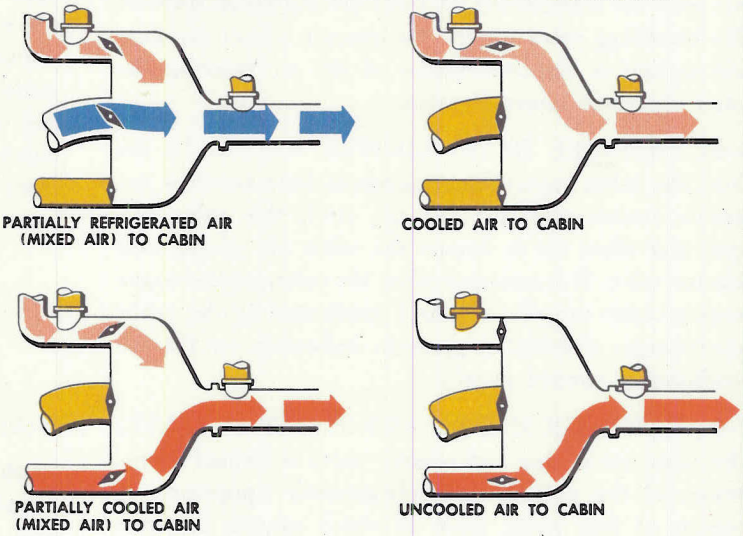
CABIN SUPERCHARGER AND SECONDARY COMPRESSOR DISCHARGE AIR

EXPANSION TURBINE DISCHARGE AIR

AMBIENT RAM AIR (HEAT EXCHANGER COOLING AIR)

ELECTRICAL ACTUATION

CABIN AIR MIXING AND SELECTOR VALVE CONFIGURATIONS



PARTIALLY REFRIGERATED AIR (MIXED AIR) TO CABIN

COOLED AIR TO CABIN

PARTIALLY COOLED AIR (MIXED AIR) TO CABIN

UNCOOLED AIR TO CABIN

NOTE:

RIGHT WING EQUIPMENT SHOWN—LEFT WING IDENTICAL

figure 4-7

secondary heat exchanger fan motor hydraulic system

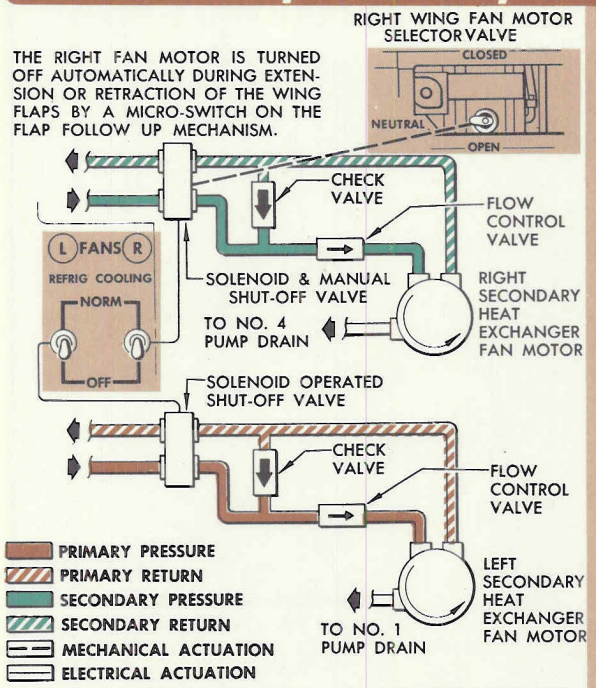


figure 4-8

4–51. CABIN HEATER TEMPERATURE CONTROL OVERRIDE SWITCHES (LEFT & RIGHT). The temperature control override switches (figure 4–9) are electrically operated, two-position, guarded switches, with positions placarded NORMAL and OVERRIDE. In the OVERRIDE position these switches bypass the normal control circuit for operation when the normal cycling control malfunctions. Example: Cabin temperature is below selected temperature yet cabin heater does not operate.

4–52. CABIN HEATER COMBUSTION AIR BLOWER SWITCH. The combustion air blower switch (figure 4–9) has two positions, OVERRIDE and NORMAL. In the OVERRIDE position, this switch permits the combustion air blower to operate when the quantity of ram air, during pressurized flight, is insufficient.

4–53. CABIN HEATER EMERGENCY IGNITION SWITCHES (LEFT & RIGHT). The cabin heater emergency ignition switches (figure 4–9) are two-position, guarded switches, placarded EMERGENCY and NORMAL. In the EMERGENCY position, an alternate set of cabin heater ignition points is selected.

4–54. RECIRCULATING FAN SWITCHES (LEFT & RIGHT). The recirculating fan switches (figure 4–9) are two-position switches, placarded ON and OFF. They control the electrically driven recirculating air fans located on the forward end of each cabin heater assembly, which should be ON during normal auxiliary ventilation or pressurized flight.

4–55. CABIN TEMPERATURE SELECTOR RHEOSTAT. The cabin temperature selector rheostat (figure 4–9) is placarded from 0 to 10. Zero is the minimum heat position and 10, the maximum heat position.

4–56. PILOTS' AUXILIARY HEATER SWITCH. The pilots' auxiliary heater switch (figure 4–9) provides OFF, LOW, MED., and HIGH control of the 3 kilowatt pilots' auxiliary heater. This switch will not operate the heater unless the flight station fan is ON.

4–57. FLIGHT STATION FAN SWITCH. The flight station fan switch (figure 4–9) is a two-position, ON and OFF switch that arms the pilots' auxiliary heater and controls the flight station fan. When ON, air circulation in the flight station is increased and heat from the pilots' auxiliary heater is dissipated.

4–58. FLIGHT STATION MIXING VALVE CONTROL SWITCH. The flight station mixing valve control is a three-position switch (figure 4–9) that positions the flight station mixing valve. STEADY is the normal position. For the desired flight station air temperature, hold this switch in either the WARM or COOL position, until the flight station temperature is as desired.

4–59. CABIN AIR PADDLE SWITCHES (LEFT & RIGHT). The electrically operated cabin air mixing and selector valves are controlled by three-position paddle switches (figure 4–9). STEADY is the normal position. To obtain either a WARMER or COOLER inner wing duct temperature, move the switches until the required temperature is registered on the refrigerator discharge duct temperature indicator located directly above the switches.

4–60. REFRIGERATOR COOLING FAN SWITCHES (LEFT & RIGHT). The cooling fan switches (figure 4–7) have two positions which are placarded NORM and OFF. In the NORM position the hydraulically driven cooling air fans, located on the aft side of the secondary heat exchanger, operate supplying cooling air for the secondary heat exchanger during ground refrigeration.

4–61. REFRIGERATOR OVERRIDE SWITCHES (LEFT & RIGHT). The refrigerator override switches (figure 4–9) are guarded and have two positions. NORM is the down position. In EMER, these switches bypass the

air conditioning control panel

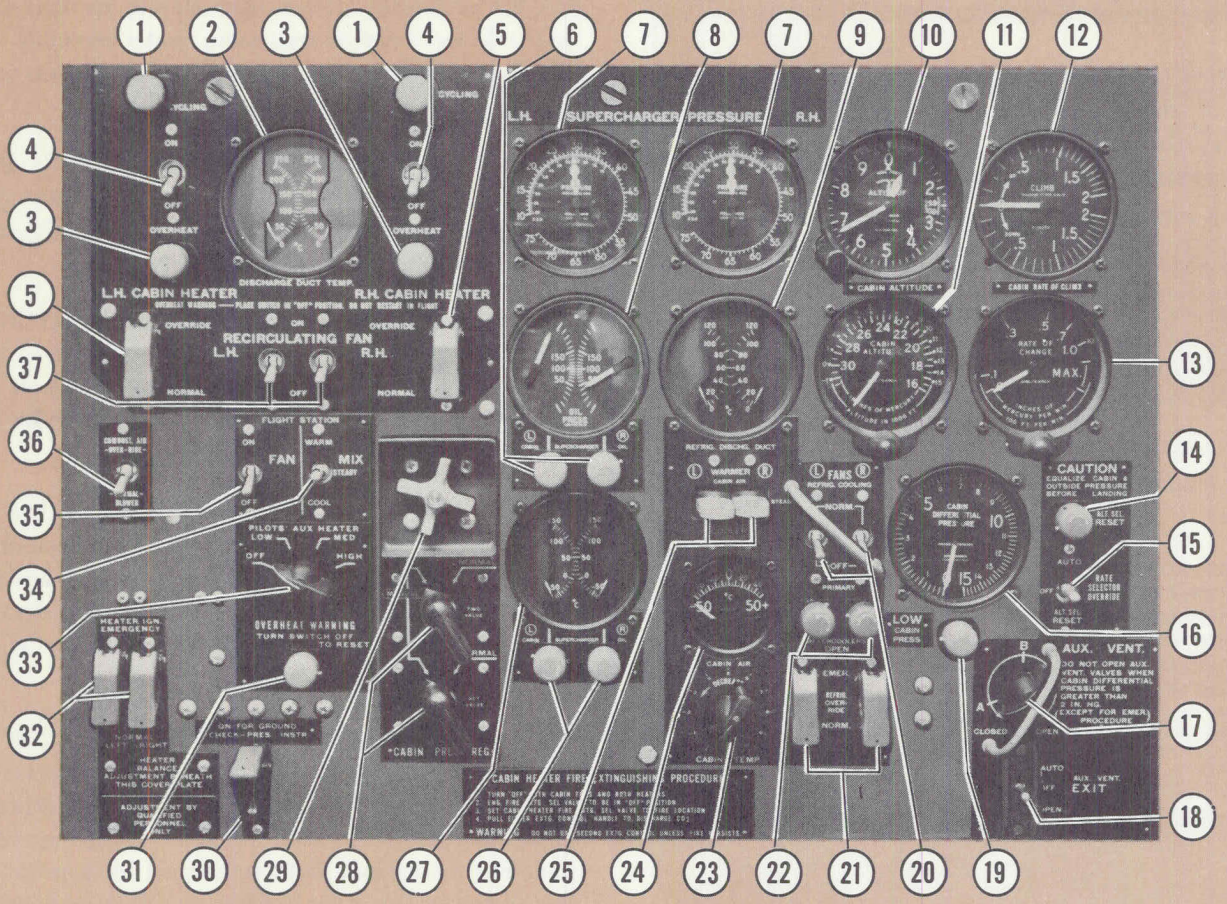


figure 4-9

1. Cabin heater cycling lights (left & right)
2. Cabin heater discharge duct temperature indicator
3. Cabin heater overheat warning lights (left & right)
4. Cabin heater switches (left & right)
5. Cabin heater temperature control override switches (left & right)
6. Cabin supercharger low oil pressure warning lights (left & right)
7. Cabin supercharger differential air pressure indicators (left & right)
8. Cabin supercharger oil pressure indicator
9. Refrigeration discharge duct temperature indicator
10. Cabin altitude indicator
11. Cabin altitude selector switch
12. Cabin rate of climb indicator
13. Cabin rate of change selector switch
14. Cabin altitude selector reset light
15. Rate selector override switch
16. Cabin differential pressure indicator
17. Aux. vent. control knob switch
18. Aux. vent. exit valve override switch
19. Low cabin pressure warning light
20. Refrigerator cooling fan switches (left & right)
21. Refrigerator override switches (left & right)
22. Primary heat exchanger (aftercooler) scoop lights (left & right)
23. Cabin temperature selector switch
24. Cabin air temperature indicator
25. Cabin air paddle switches (left & right)
26. Cabin supercharger high oil temperature warning lights (left & right)
27. Cabin supercharger oil temperature indicator
28. Cabin pressure regulator selector valves (fwd & aft)
29. Cabin pressure regulator control valve
30. Ground check switch
31. Pilot's auxiliary heater overheat warning light
32. Cabin heater emergency ignition switches
33. Pilot's auxiliary heater switch
34. Flight station mixing valve control switch
35. Flight station fan switch
36. Cabin heater combustion air blower switch
37. Recirculating fan switches (left & right)

sequence switches in the cabin air mixing and selector valve actuator disconnecting the primary heat exchanger scoop from the cabin air mixing valve control cycle. This allows the cabin air mixing and selector valve to be positioned in the event that the primary heat exchanger scoop actuator is inoperative.

4–62. AUX. VENT. CONTROL KNOB. The aux. vent. control knob (figure 4–9) is a rheostat, placarded CLOSED, A, B, and OPEN. It controls the opening and closing of the auxiliary ventilation inlet valves and exit valve in their proper sequence. It also controls the dumping of the cabin supercharger discharge air; it puts the cabin superchargers on minimum flow; it controls the opening and closing of the cabin safety relief and dump valve; and it energizes the combustion air blower if cabin heating is required. Refer to figure 4–10.

4–63. AUX. VENT. EXIT VALVE OVERRIDE SWITCH. The aux. vent. exit valve override switch (figure 4–9) is a three-position switch, placarded AUTO, OFF, and OPEN. In the OPEN position, the aux. vent. exit door is opened. In the AUTO position, the aux. vent. exit door is positioned by the aux. vent. control knob. In the OFF position, the door remains where it was previously positioned.

4–64. CABIN ALTITUDE SELECTOR. The desired cabin pressure altitude may be obtained by setting the desired cabin altitude on the indicator by means of the control knob. The indicator (figure 4–9) is placarded in inches of mercury and thousands of feet.

4–65. CABIN RATE-OF-CHANGE SELECTOR. The desired cabin pressure altitude rate-of-change may be obtained by positioning the control knob on this instrument (figure 4–9). This selector is placarded in feet per minute.

4–66. RATE SELECTOR OVERRIDE SWITCH AND ALTITUDE SELECTOR RESET LIGHT. The rate selector override switch (figure 4–9) is a three-position switch. AUTO is the normal position for all conditions of flight. The ALT. SEL. RESET position is used to run the isobaric changer assembly (in the sensing head valve) to a position corresponding to that selected on the cabin altitude selector. The OFF position will stop the changer assembly at the existing position.

4–67. Whenever the isobaric changer is running, with the rate selector override switch in ALT. SEL. RESET, the altitude selector reset light glows. When the light goes out the desired cabin pressure altitude has been obtained.

4–68. CABIN PRESSURE REGULATOR SELECTOR VALVES—FWD & AFT. In the NORMAL position the outflow valves (figure 4–9) are automatically controlled by the cabin altitude selector. In the MANUAL position the outflow valves are controlled by the cabin pressure regulator control valve (above). Either one, or both, of the outflow valves may be controlled manually.

4–69. CABIN PRESSURE REGULATOR CONTROL VALVE. The cabin pressure regulator (figure 4–9) is a needle-type valve that meters a source of vacuum to the cabin pressure regulator valves (outflow valves). Turn this valve counterclockwise to depressurize and clockwise to pressurize. It is effective only when the cabin pressure regulator selector is in the MANUAL position.

4–70. GROUND CHECK SWITCH. This switch (figure 4–9) is guarded and has ON and OFF positions. In the ON position it permits pressurization tests on the ground by removing the vacuum source from the cabin pressure safety relief and dump valve, which allows it to close.

4–71. HOTWALL SHUT-OFF VALVES (LEFT & RIGHT). A hotwall shut-off valve is located in each hotwall air riser approximately six feet above the cabin floor. This valve is opened and closed by use of a special equipment key (usually stored in the flight engineer's desk). This valve is closed only when maximum ground refrigeration is desired or in the event of a single cabin heater failure in flight, with low ambient temperatures.

4–72. CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT LEVER. The cabin supercharger drive shafts are disconnected by moving the respective engine supercharger lever (figure 1–57) past the LOW position to the quadrant stop. Refer to Air Conditioning System Emergency Procedures.

4–73. AIR CONDITIONING SYSTEM INDICATORS.

4–74. CABIN HEATER CYCLING LIGHTS (LEFT & RIGHT). The amber cabin heater cycling lights (figure 4–9) flicker whenever the cabin heaters are operating.

4–75. CABIN HEATER DISCHARGE DUCT TEMPERATURE INDICATOR. The discharge duct temperature indicator (figure 4–9) is a dual gage providing a continuous indication of left and right cabin heater discharge air temperatures in degrees Centigrade.

4–76. CABIN HEATER OVERHEAT WARNING LIGHTS (LEFT & RIGHT). The cabin heater overheat warning lights (figure 4–9) glow red whenever the cabin heaters reach an unsafe temperature. When one of these lights glows, it also indicates that the cabin heater is in a "locked-out," off, condition.

4–77. PILOTS' AUXILIARY HEATER OVERHEAT WARNING LIGHT. The pilots' auxiliary heater warning light (figure 4–9) glows red whenever the pilots' auxiliary heater temperature exceeds a safe value. When this light glows, it also indicates that the heater is in a "locked-out" condition.

4–78. CABIN SUPERCHARGER DIFFERENTIAL AIR PRESSURE INDICATORS (LEFT & RIGHT). The cabin supercharger differential air pressure indicators (figure 4–9) provide a continuous indication of the pressure differential, in inches of mercury (absolute), existing between the inlet and outlet ducts of the cabin superchargers.

4–79. CABIN SUPERCHARGER OIL TEMPERATURE INDICATOR. The cabin supercharger oil temperature indicator (figure 4–9) is a dual indicator providing the "oil-in" temperature of the cabin superchargers in degrees Centigrade.

4–80. CABIN SUPERCHARGER HIGH OIL TEMPERATURE WARNING LIGHTS (LEFT & RIGHT). The cabin supercharger high oil temperature lights (figure 4–9) glow red whenever the "oil-in" temperature exceeds a safe value (90.6°C). When one of these lights glows, the cabin supercharger should be disconnected.

4–81. CABIN SUPERCHARGER OIL PRESSURE INDICATOR. The cabin supercharger oil pressure indicator (figure 4–9) is a dual gage providing a continuous indication of the cabin supercharger "oil-in" pressure in pounds per square inch.

4–82. CABIN SUPERCHARGER LOW OIL PRESSURE WARNING LIGHTS (LEFT & RIGHT). The cabin supercharger low oil pressure warning lights (figure 4–9) glow red whenever the "oil-in" pressure is below a safe value (35±5 psi). The affected cabin supercharger should be disconnected when this light glows.

4–83. CABIN DIFFERENTIAL PRESSURE INDICATOR. The cabin differential pressure indicator (figure 4–9) provides a continuous indication, in inches of mercury, of the differential pressure between cabin and atmospheric pressures.

4–84. LOW CABIN PRESSURE WARNING LIGHT. The low cabin pressure warning light (figure 4–9) glows red whenever the cabin altitude is 10,300 feet or above.

4–85. CABIN ALTITUDE INDICATOR. The cabin altitude indicator (figure 4–9) provides a continuous indication of the equivalent cabin pressure altitude in feet.

4–86. CABIN RATE OF CLIMB INDICATOR. The cabin rate of climb indicator (figure 4–9) provides a continuous indication of sudden changes in the cabin pressure. The cabin rate of ascent and descent is indicated in feet per minute.

4–87. ALTITUDE SELECTOR RESET INDICATOR LIGHT. Refer to rate selector override switch under Air Conditioning Controls.

4–88. CABIN SUPERCHARGER DRIVE SHAFT REAR BEARING TEMPERATURE INDICATOR. The cabin supercharger drive shaft rear bearing temperatures are sensed by electrical resistance-type bulbs connected to the rear bearing temperature indicator located on the flight engineer's lower instrument panel (figure 1–56). This indicator is a dual gage.

4–89. CABIN AIR TEMPERATURE INDICATOR. The cabin air temperature indicator (figure 4–9) provides a continuous indication of cabin air temperature, in degrees Centigrade.

4–90. REFRIGERATION DISCHARGE DUCT TEMPERATURE INDICATOR. The refrigeration discharge duct temperature indicator (figure 4–9) is a dual gage providing a continuous indication of the inner wing duct air temperature downstream of the cabin air mixing and selector valve. This instrument indicates the temperature of refrigerated, cooled, or uncooled air to the cabin and flight station distribution system.

4–91. PRIMARY HEAT EXCHANGER SCOOP LIGHTS (LEFT & RIGHT). The primary heat exchanger scoop lights (figure 4–9) glow amber whenever the primary heat exchanger scoops are in the full open position.

4–92. NORMAL OPERATING PROCEDURES.

4–93. GROUND TRUCK HEATING OR COOLING.

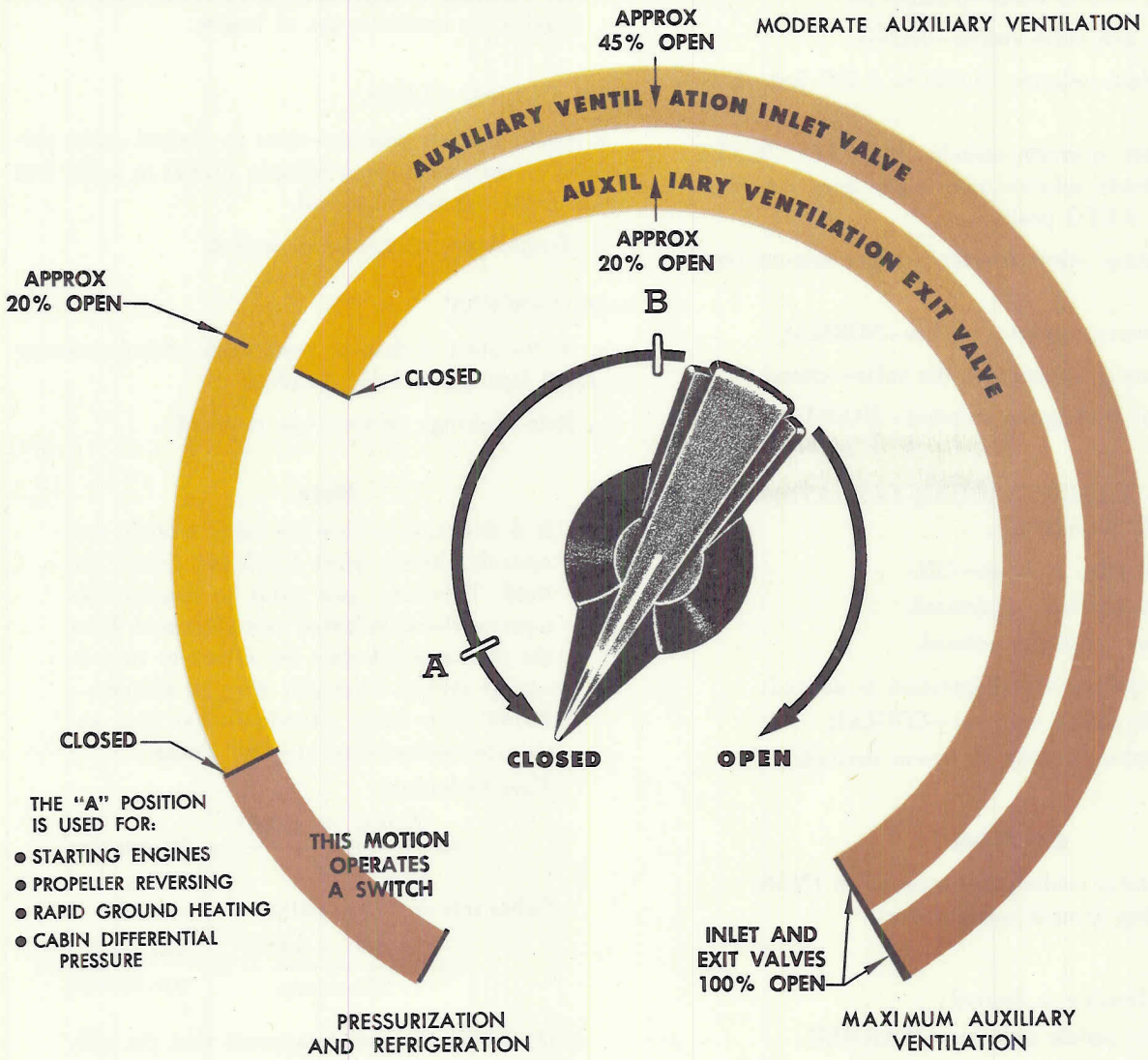
a. Attach low-pressure truck to the ground-air connection.

b. Attach electrical ground power cart. Energize the electrical system, and position the controls as follows:

1. Recirculating fan switches—OFF.
2. Aux. vent. control knob—CLOSED.
3. Cabin air paddle switches—COOLER.
4. Cabin heater switches—OFF.
5. Flight station fan switch—ON.
6. Flight station mixing valve switch—COOL.

c. If additional flight station heat is desired, switch on the pilots' auxiliary heater.

auxiliary ventilation control knob (normal operation)



The auxiliary ventilation control knob is a rheostat-type switch placarded CLOSED, A, B, and OPEN. In the A position, the aux. vent. control knob dumps the cabin superchargers and puts them on minimum flow; completes an electrical circuit to the combustion air blowers (they will operate if the flight station or cabin thermostatic controls call for heat); and opens the vacuum-controlled cabin safety, relief and dump valve (if the inboard engines are operating to supply vacuum to the system).

Clockwise movement of the aux. vent. control knob, past the A position, progressively opens the auxiliary ventilation inlet and exit valves. When the inlet valves are 20% open (approximately the 10:00 o'clock position on the control knob) the aux. vent. exit valves start to open. The last 80% travel of the control knob completes the opening of both inlet and exit valves. Any degree of open is obtainable by positioning the control knob. The position B of the aux. vent. control system is a recommended position for moderate cabin and flight station ventilation without excessive air circulation. The OPEN position provides maximum auxiliary ventilation (the aux. vent. inlets and exits are fully open). In the CLOSED position the cabin superchargers are supplying air to the fuselage according to flow requirements; the cabin safety, relief and dump valve is closed; the combustion air blower is de-energized; and the aux. vent. inlets and exits are closed.

figure 4-10

4–94. PRESSURIZED FLIGHT.

4–95. BEFORE STARTING ENGINES.

a. All circuit breakers—closed.

b. Ground test switch—OFF (down).

c. Aux. vent. control knob—position A.

d. Aux. vent. exit valve switch—AUTO.

e. Cabin altitude selector—1,000 to 1,500 feet above field altitude.

f. Rate selector override switch—ALT. SEL. RESET until cabin altitude selector reset light goes out, then move switch to AUTO position.

g. Rate-of-change selector—300 feet per minute (recommended).

h. Cabin pressure regulator valves—NORMAL.

i. Cabin pressure regulator needle valve—closed.

j. Refrigerator cooling fan switches—NORMAL.

4–96. DURING ENGINE GROUND OPERATION (BEFORE TAXIING).

a. Recirculating fan switches—ON.

1. Flight station fan—as desired.

b. All windows and doors—closed.

c. If ground cooling or refrigeration is desired:

1. Cabin air paddle switches—COOLER.

2. Flight station mixing valve—as desired.

CAUTION

The refrigerator cooling fans must be on (NORMAL) during ground refrigeration.

d. If ground heating is desired:

1. Cabin air paddle switches—WARMER.

2. If additional heat is required:

(a) Cabin heater switches—ON.

(b) Cabin heater temperature selector—as desired.

(c) Pilots' aux. heater—as desired. If turned on, flight station fan ON and flight station air outlets at least partially open.

4–97. TAXIING.

a. Aux. vent. control knob—position A, before propeller reverse check.

b. Aux. vent. control knob—CLOSED, after propeller reverse check.

Note

When refrigeration is necessary during taxiing, because of very high ambient air temperatures, operate the outboard engines at 1200 rpm and idle the inboard engines. This will provide the necessary rpm for the cabin superchargers without resulting in high taxi speeds which would require the excessive use of brakes.

4–98. DURING CLIMB.

a. Cabin altitude selector—reset to desired cabin altitude *after* the preset cabin altitude (1,000 to 1,500 feet above field) has been obtained.

b. Temperature controls—as desired.

4–99. DESCENT.

a. At the start of descent, reset cabin altitude selector to 1,000 feet above field altitude.

b. Rate-of-change selector—as required.

Note

- It is desirable to have the cabin altitude and aircraft altitude meet 1,000 feet above the field. Therefore, just prior to descent, determine the anticipated rate-of-descent from the pilot and calculate the necessary rate-of-change setting. Example: Aircraft altitude—20,000 feet, cabin altitude—8,000 feet, anticipated rate-of-descent—950 ft/min.

  Time to descend

  $$= \frac{20{,}000' - 1{,}000'}{950'} = 20 \text{ minutes}$$

  Cabin rate-of-change setting

  $$= \frac{8{,}000' - 1{,}000'}{20 \text{ minutes}} = \frac{350 \text{ feet}}{\text{per minute}}$$

- If, during descent, it appears that the altitudes will not meet at approximately 1,000 feet above the field, increase or decrease the cabin rate-of-change setting, as required.

4–100. BEFORE LANDING.

a. Heater switches—OFF.

b. Aux. vent. control knob—position A.

4–101. AFTER LANDING.

a. If heating is desired:

1. Cabin heater switches—ON.

2. Aux. vent. control knob—CLOSED.

3. Cabin air paddle switches—WARMER.

b. If cooling or refrigeration is desired:

1. Aux. vent. control knob—CLOSED.
2. Cabin air paddle switches—COOLER.

4–102. AUXILIARY VENTILATION FLIGHT.

4–103. BEFORE STARTING ENGINES.

a. All circuit breakers—closed.

b. Aux. vent. control knob—position A.

c. Aux. vent. exit valve switch—AUTO.

d. Rate-selector-override switch—OFF.

e. Cabin pressure regulator valves—NORMAL.

f. Cabin pressure regulator needle valve—closed.

4–104. DURING GROUND OPERATION.

a. Recirculating fan switches—ON.

b. Flight station fan—as desired.

c. All windows and doors—closed.

d. If heating is desired:

1. Cabin heater switches—ON.
2. Cabin heater temperature selector—as desired.
3. Pilots' aux. heater—as desired. If turned on, flight station fan ON and flight station air outlets at least partially open.

4–105. BEFORE TAKE-OFF.

a. Aux. vent. control knob—between B and OPEN.

4–106. DURING FLIGHT.

a. Aux. vent. control knob—as required to maintain adequate ventilation.

4–107. BEFORE LANDING.

a. Heater switches—OFF.

b. Aux. vent. control knob—position A.

4–108. AFTER LANDING.

a. Cabin heater switches—as desired.

4–109. PRESSURIZATION CONTROL.

4–110. AUTOMATIC TO MANUAL PRESSURIZATION.

a. Simultaneously, place the forward cabin pressure regulator valve on MANUAL and open the cabin pressure regulator needle valve one to one and one-half turns.

b. Watch the rate-of-climb indicator and turn the cabin pressure regulator needle valve, as required, to stabilize. Turning the needle valve counterclockwise will depressurize and turning it clockwise will pressurize the cabin.

Note

There is a lag of a few seconds so *do not over-control* with the cabin pressure regulator needle valve.

c. Bring the cabin altitude to the desired setting with the cabin pressure regulator needle valve.

d. Aft cabin pressure regulator valve—MANUAL.

e. Cabin pressure regulator needle valve—a slight adjustment will be necessary to bring the cabin altitude back to the automatic setting.

Note

- Do not turn both cabin pressure regulator valves to MANUAL at the same time as it will result in too great a cabin altitude change with very high rates of cabin altitude climb or descent.
- If the cabin pressure altitude is not stabilized to the desired setting when the aft cabin pressure regulator valve is shifted to MANUAL, a change of cabin altitude will occur but will not be as severe as when the forward valve was moved to MANUAL.
- If no change in aircraft altitude is made, the cabin pressure altitude will remain steady, otherwise, the manual system will have to be monitored (with the cabin pressure regulator needle valve) to compensate for aircraft altitude changes.

4–111. MANUAL TO AUTOMATIC OPERATION.

a. Cabin altitude selector—set to the existing cabin altitude.

Note

If the setting is made carefully, no change in cabin pressure altitude or rate-of-climb will occur. If the setting is not made carefully, the cabin pressure altitude will climb or dive to the cabin altitude set.

b. Cabin pressure regulator valves (forward and aft)—NORMAL.

c. Cabin pressure regulator needle valve—closed.

4–112. CABIN HEATER OPERATION. The recirculating fans must be ON for cabin heater operation. To operate the cabin heaters, set the desired cabin temperature on the cabin temperature selector and then move the cabin heater switches to the ON position. During ground operation, be sure that the aux. vent. control knob is positioned open to at least the A position. This assures combustion air by arming the combustion air blower.

4–113. PILOTS' AUX. HEATER OPERATION. The flight station fan must be ON for operation of the pilots' aux. heater. The face and foot air outlets should be partially or fully open to assure adequate air flow over the pilots' heater elements.

4–114. AIR CONDITIONING SYSTEM EMERGENCY PROCEDURES.

4–115. CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT.

a. Release hook-type lock on engine supercharger control lever.

b. Move control lever past the LOW position to the end of travel.

c. Return lever to desired engine supercharger position.

CAUTION

Observe engine supercharger shift precautions if disconnecting from HIGH position.

4–116. When the cabin supercharger drive shaft is completely disconnected, one or more of the following indications will be noted:

a. A drop in cabin supercharger oil temperature.

b. Oil pressure warning light (if not already lighted).

c. No pressure rise on the dual pressure gage.

CAUTION

The propeller of the affected engine should be feathered immediately if the cabin supercharger does not disconnect.

4–117. EMERGENCY DEPRESSURIZATION. (Refer to figure 4–11.)

a. Place the aux. vent. control knob in the full OPEN position and then return the knob to position A as soon as the cabin differential pressure is one inch of mercury. The aux. vent. control knob must be returned to position A to prevent partial pressurization of the cabin by the auxiliary ventilation system, which is sufficient to interfere with the opening of windows and doors.

b. Recirculating fans and flight station fan—OFF.

c. Cabin and pilots' aux. heater switches—OFF.

d. Descend to a low, safe altitude.

4–118. EMERGENCY SMOKE REMOVAL. For aux. vent. control knob operation refer to figure 4–11. For procedures, refer to Section III.

4–119. FUSELAGE AND CARGO EMERGENCY FIRE PROCEDURES. For aux. vent. control knob operation refer to figure 4–11. For procedures, refer to Section III.

4–120. CABIN HEATER FIRE CONTROL PROCEDURE.

a. Cabin heater switches—OFF.

b. Recirculating fans and flight station fan—OFF.

c. Engine fire extinguishing selector—OFF.

d. Cabin heater fire extinguisher selector—SET (to fire location).

e. Pull either CO_2 release handle.

Note

Do not release the second CO_2 charge unless it is obvious that the first discharge failed to put out the fire. A CO_2 discharge in a cabin heater area is effective for more than three minutes.

4–121. CABIN HEATER MALFUNCTION. If the heater does not operate properly, as indicated by the cycling lights not glowing or by low cabin temperature, accomplish the following:

a. Check the recirculating fans and circuit breakers. Be sure they are ON.

b. Turn the cabin temperature selector to a higher setting (toward 10). If the heaters still do not cycle place the emergency override switches on OVERRIDE.

c. Switch to alternate ignition points by placing the cabin heater emergency ignition switches on EMERGENCY.

d. Place combustion air blower on OVERRIDE.

e. Check fuel quantities in tanks 2 and 3. Heaters will not operate if fuel levels are below approximately 11 gallons.

f. Each cabin heater is protected by a Fenwal overheat switch. Should both the cycling controls fail or some other unit malfunction, causing the heater to overheat, the Fenwal switch will shut off the heater and electrically lock it off at an indicated temperature of approximately 180°C (356°F). Occasionally, under extreme conditions of air flow, a rapid rise of the combustion chamber temperature may also cause a heater to lock "off" with an indicated temperature that does seem excessive. The heater circuit may be re-energized by placing the heater switch to the OFF position, then returning the switch to the ON position. If the Fenwal switch has cooled, the heater will start.

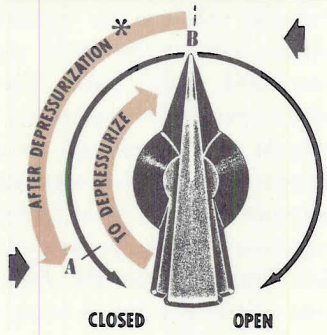
CAUTION

If the heater circuit locks OFF twice in succession, it should not be reset until the cause has been determined.

4–122. PILOTS' AUX. HEATER INOPERATIVE. When the pilots' aux. heater red overheat warning light glows,

auxiliary ventilation control knob (emergency operation)

The cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is opened; and the auxiliary ventilation inlet and exit valves are closed.



Auxiliary ventilation inlet valves are approximately 45% open; the auxiliary ventilation exit valve is approximately 25% open; the air recirculation check valves are closed.

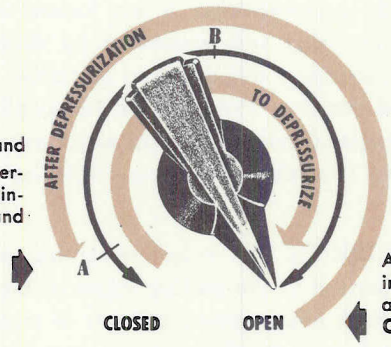
Depressurization, without excessive air circulation that might fan a fire, is accomplished by placing the auxiliary ventilation control knob in the "B" position. If the cabin is occupied, the auxiliary ventilation control knob is to be left in the "B" position as it affords moderate auxiliary ventilation.

* If the cabin is not occupied and oxygen is available for crew members, the aux vent knob is to be placed in the A position (after depressurization) to minimize air circulation.

FUSELAGE FIRE PROCEDURE

After depressurization, the auxiliary ventilation control knob is placed at position "A" so that the auxiliary ventilation system is closed and will not circulate smoke through the cabin or flight station.

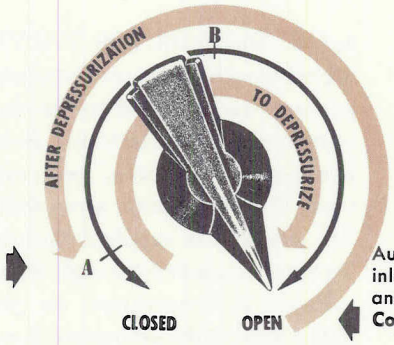
Auxiliary ventilation inlet valves and exit valve are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.



Aux vent. inlet valves and exit valve— **Completely OPEN**

SMOKE REMOVAL

Auxiliary ventilation inlet valves and exit valve are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.



Aux vent. inlet valves and exit valve— **Completely OPEN**

After depressurization, the auxiliary ventilation control knob is placed at position "A" so that the auxiliary ventilation system will be closed and will not partially pressurize the airplane. Partial pressurization could interfere with the opening of windows and doors.

EMERGENCY DEPRESSURIZATION

figure 4-11

the heater is in a "locked-out" (off) condition. The heater may be reset by turning the selector switch to OFF, waiting for the heater to cool, then selecting the desired on position.

CAUTION

The face and foot air outlets should be partially or fully open to assure adequate air flow over the pilots' heater elements or the heater will lock-out again.

4–123. ANTI-ICING, DE-ICING, AND DEFOGGING SYSTEMS.

4–124. Anti-icing or de-icing facilities are provided for the leading edges of the wing and empennage, windshield panels, carburetors, propellers, radio antenna mast and pitot heads. Defogging facilities are provided for the windshield and cabin windows and windshield wipers are provided for the forward windshield panels.

4–125. WING AND EMPENNAGE LEADING EDGE DE-ICING SYSTEM.

4–126. Ice may be removed after it has formed on the leading edges of the wing and empennage by electronic-timed, pneumatic inflation and deflation of rubber boots cemented to those surfaces. Pressure can be supplied by any of the four engine-driven air pumps and vacuum can be supplied by the two inboard pumps. (Refer to figure 4–12.)

4–127. DE-ICER BOOTS. The de-icer boots are made in segments firmly bonded to the leading edges of the wing and empennage. Each boot segment consists of a number of small rubber tubes sandwiched between two layers of soft, pliable rubber. The tubes are laid parallel to each other and to the leading edges of the surfaces. Each segment incorporates two separate systems of tubes with independent connections to their respective distributor valves except those segments attached to the tips of the stabilizer and to the fins, each of which has one system of cells. The boots are surfaced with a conductive coating to prevent the accumulation of static electricity, which when discharged, would interfere with radio reception. They are designed to operate efficiently at temperatures ranging from —53 to 71°C (—63 to 160°F) and at speeds up to 260 knots (300 mph) at 25,000 feet altitude without auto-inflation when held in place by suction.

4–128. DE-ICER BOOT PUMPS. Four rotary, four-vane, positive displacement type, engine-driven air pumps, one mounted on each engine, supply air pressure and vacuum for the pneumatic de-icer system. The two outboard pumps supply pressure; the two inboard pumps supply vacuum for normal operation, but can be used as pressure sources in an emergency. Air for the pneumatic system is drawn from the cabin supercharger air ducts, and cooling air for the pumps is drawn from the oil cooler scoop ahead of the radiator.

4–129. DE-ICER BOOT PRESSURE SYSTEM. Pneumatic pressure from the two outboard pumps is directed through oil separators to pressure regulators and filters. Solenoid valves in the regulators maintain 22 pounds per square inch at the outlet ports, discharging excess air overboard. Relief valves between the pumps and regulators protect the regulators from pressure surges of 24 pounds per square inch or above. Check valves downstream from the oil separators prevent loss of system pressure in the event of failure of either pump. From the regulators, the compressed air passes to the main pressure line. Branches from the main pressure line extend to the nine distributor valves from which pressure is delivered to the de-icer boot segments in metered pulsations.

4–130. DE-ICER BOOT VACUUM SYSTEM. The two inboard pumps supply suction for the de-icer boot, the cabin pressure regulator valves, and the cabin pressure safety relief and dump valve. On some airplanes these pumps also supply suction to defog the driftmeter and operate the flight instruments. Normally, the output from the pressure side of the two pumps, which supply vacuum, is bypassed around the air regulator and filter, and is vented overboard. In an emergency, the vacuum pumps may be used as a source of pressure instead of vacuum, by moving the de-icer air pump selector valve switches from VAC to DE-ICER PRES.

4–131. DE-ICER BOOT INFLATION CYCLE TIMER. The electronic de-icer boot timer, which controls the nine solenoid-operated distributor valves, is located in the flight station below the pilot's switch panel (figure 1–52). Timer controls and indicators are located on the upper face of the de-icer boot timer. The electronic timer establishes the inflation-deflation cadence of the de-icer boot cells. It is designed for continuous duty in flight, and receives its power from the MJB positive bus.

4–132. DISTRIBUTOR VALVES. The nine-solenoid-operated manifold de-icer distributor valves deliver alternate pressure and vacuum to the de-icer boot segments when energized by the electronic de-icer timer. Each valve has five ports, two inlets, two outlets, and one overboard vent. The outlet ports serve individual boot tube systems. Air pressure is supplied through one of the inlet ports. Vacuum is applied through the other inlet port. When the solenoid is de-energized, air pressure flows through the outlet port to the associated boot segment. When the solenoid is de-energized, pressure is relieved overboard until the pressure drops to approximately 1 inch of mercury when 4 inches of mercury suction is applied through the vacuum port to evacuate the tubes and flatten the boot segment against the leading edge surface.

4–133. DE-ICER BOOT CONTROLS.

4–134. CYCLE SELECTOR SWITCH. The electronic timer is controlled by a 3-position switch (figure 4–13) located on the timer control panel, and is placarded EXTENDED CYCLE, NORMAL CYCLE, and OFF. When the switch is placed in either EXTENDED or NORMAL CYCLE position, the system will warm up within 20 seconds, and the cycling lights will flash in sequence with the inflation-deflation cadence of the de-icer boot segments. In NORMAL position, the inflation cycle requires 60 seconds; in the EXTENDED position, it requires 90 seconds. The selector switch may be turned OFF at any stage of the cycling sequence, and a stepper relay will return the electronic timer to its starting position.

4–135. DE-ICER BOOT SEGMENT SWITCHES. Six three-position switches (figure 4–13), located on the control panel between the two rows of cycling lights, permit out-of-sequence inflation of any individual boot segment. These switches are placarded with the identification letters of the inflation tube groups they control. A schematic diagram etched on the face of the control panel shows the corresponding location of each tube group. When any individual switch is moved to either of its ON positions, the adjacent indicator light will flash to show that the individual circuit is closed and the selected boot tube group is inflated. When more than one switch is closed, the one to the left will control, and until it is released, the switches to the right of it will be inoperative. Energizing the individual boot segment switches does not affect the cadence of the inflation-deflation cycle.

4–136. DE-ICER AIR PUMP SELECTOR VALVE SWITCHES. Two two-position toggle switches (figure 4–13), located forward of the de-icer boot timer control panel, operate the de-icer pump selector valves which permit the use of either or both of the vacuum pumps as sources of de-icer boot pressure. The valves are positioned by electric motors and are controlled by two switches with positions placarded VAC and DE-ICER PRES. In the normal position, VAC, the valves dump the pressure output overboard. When the switches are positioned at DE-ICER PRES, cabin supercharger air is ducted to the vacuum line upstream from the pump, and the output is routed around the overboard dump into the de-icer boot pressure system. In this switch position, the vacuum pumps supply air pressure to the de-icer boots and output of the outboard pumps is directed overboard.

4–137. CABIN PRESSURE REGULATOR VACUUM SHUT-OFF VALVE. The cabin pressure regulator vacuum shut-off valve lever is located on the offset in the flight station floor behind the pilot's seat (figure 6–3), and is normally safetied in the ON position. In the OFF position the valve shuts off suction to the vacuum-operated cabin pressure regulator selector valves (outflow valves). The valve is located upstream from the line for the vacuum-operated flight instruments (if they are installed) and is used, in emergencies, to conserve suction for the operation of flight instruments.

4–138. MOTOR-DRIVEN DE-ICER BOOT VACUUM SHUT-OFF VALVE (LAC SERIALS 4501 THROUGH 4509). The de-icer boot vacuum shut-off valve switch is located aft of the de-icer boot timer control box at the left of the pilot's seat (figure 4–13) and is guarded in the ON position. It operates the motor-driven valve located in the main vacuum line upstream from the line to the vacuum-operated flight instruments. In the OFF position, it shuts off suction to the de-icer boots to conserve suction for the operation of the vacuum-operated flight instruments.

4–139. DE-ICER BOOT INDICATORS.

4–140. DE-ICER PRESSURE INDICATOR. One direct reading pressure gage is mounted on the pilot's auxiliary instrument panel (figure 1–49). It registers the pressure in pounds per square inch available in the de-icer pressure system.

4–141. VACUUM INDICATORS.* Below the de-icer pressure gage, on the pilot's auxiliary instrument panel (figure 1–49), are two vacuum gages which register the vacuum in the de-icer and flight instrument system.

4–142. VACUUM INDICATOR.† A de-icer vacuum gage is located on the copilot's auxiliary instrument panel (figure 1–49) to indicate the suction in the pneumatic de-icer lines.

4–143. VACUUM WARNING LIGHTS. A warning light for each vacuum pump is located on the pilot's auxiliary instrument panel (figure 1–49) and on the flight engineer's upper instrument panel (figure 1–56). They are energized by vacuum warning units in the vacuum lines upstream of the suction relief valves and glow whenever the vacuum drops below 4 inches of mercury.

4–144. ELECTRONIC TIMER INDICATOR LIGHTS. When the electronic switch is placed in either NORMAL or EXTENDED CYCLE position, an indicator light (figure 4–13) in the upper left corner of the timer control panel will glow. This light may be dimmed or brightened by turning its cover. The double bank of lights at the bottom of the control panel are the cycling lights which indicate the progress of the pressure vacuum cycle through the de-icer boot segments.

4–145. NORMAL OPERATING PROCEDURE FOR DE-ICER BOOTS.

4–146. Ice may be eliminated more effectively from the leading edges of the wing and empennage if it is permitted to build up to between 1/8 inch and 1/4 inch in thickness before the de-icer boots are turned on. A thin

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

vacuum & pneumatic de-icing system

LAC Serials 4501 Through 4509

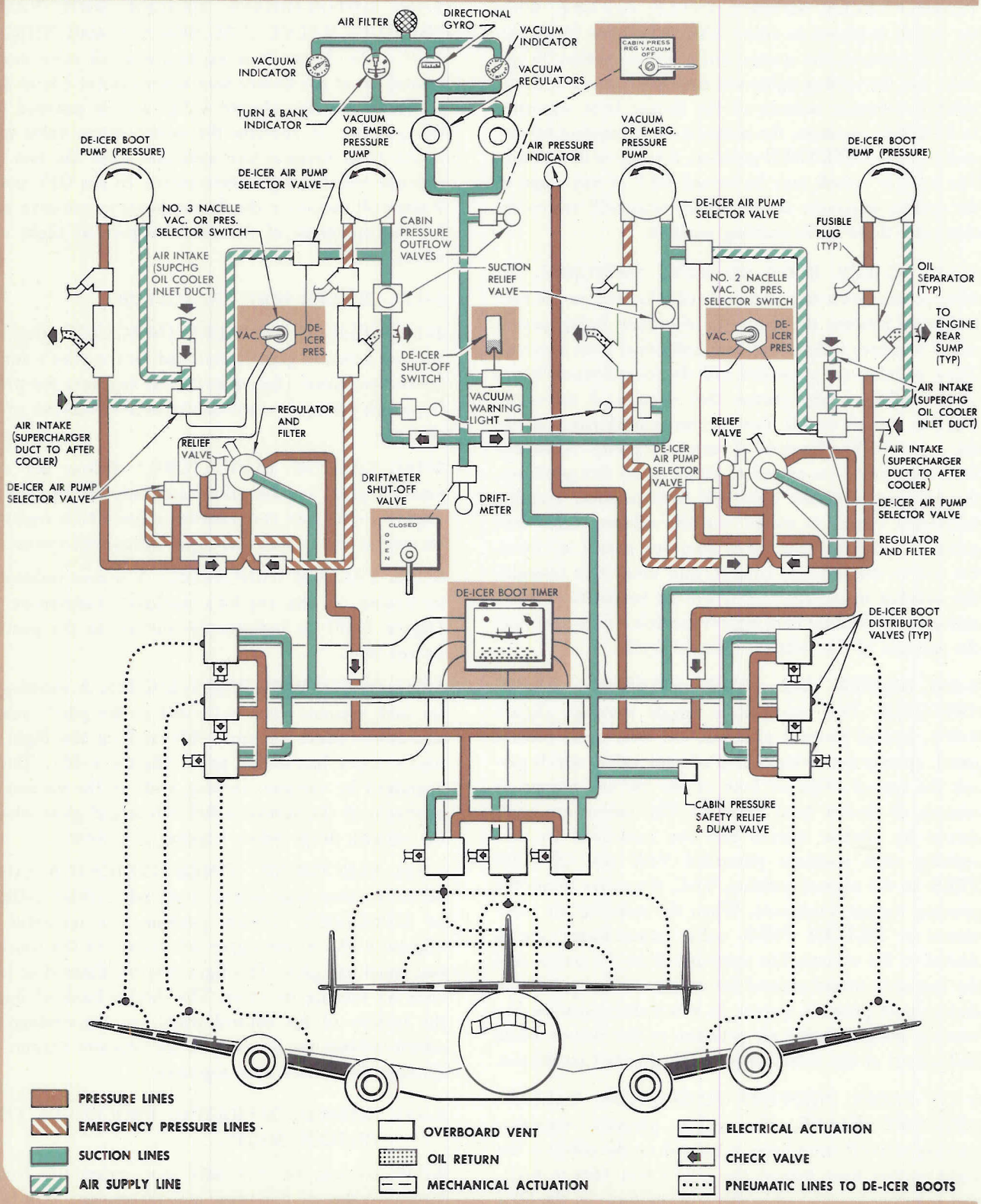


figure 4-12 Sheet 1

vacuum & pneumatic de-icing system

LAC Serials 4510 Through 4519

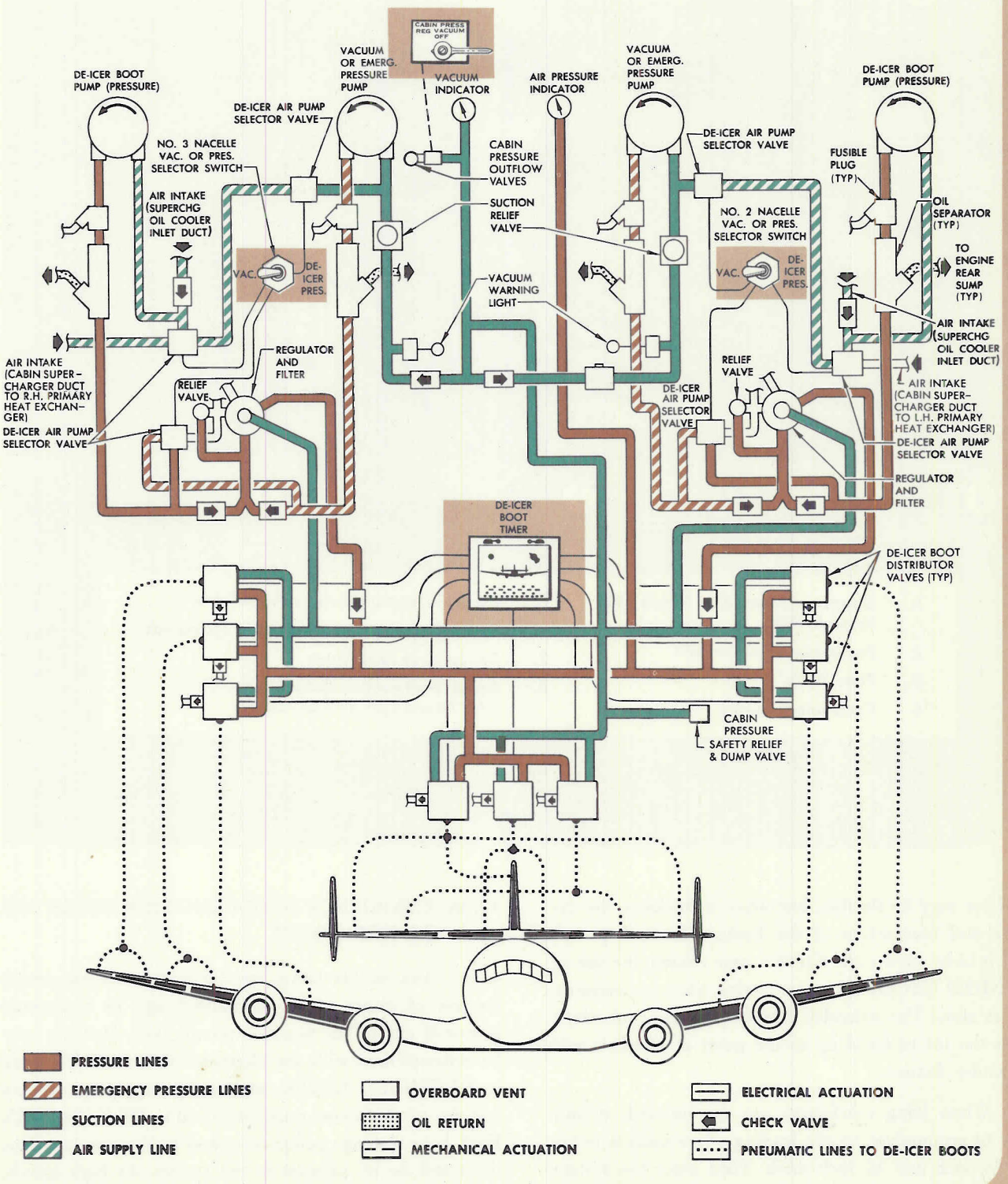
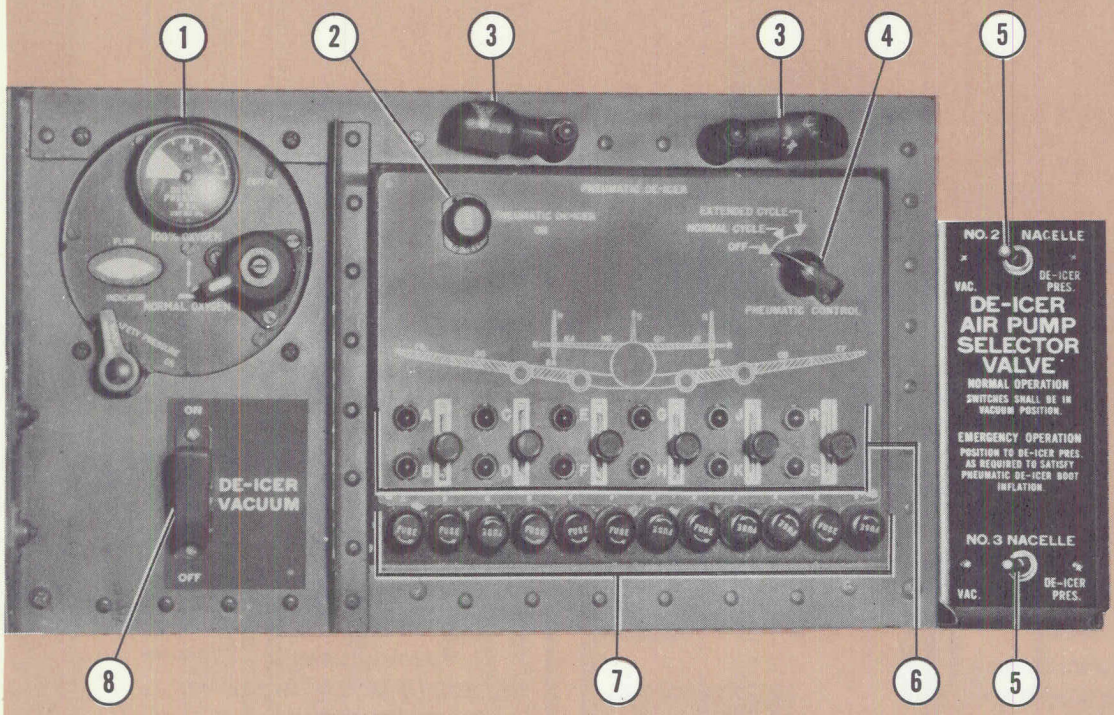


figure 4-12 Sheet 2

de-icer boot timer



1. Oxygen regulator (LAC Serials 4501 through 4509)
2. Pneumatic de-icer on light
3. Panel lights
4. Cycle selector switch
5. De-icer air pump selector valve switches
6. De-icer boot segment switches and cycling lights
7. De-icer cycle circuit fuses
8. De-icer boot vacuum shut-off valve switch (LAC Serials 4501 through 4509)

figure 4-13

film of ice may be flexible, but when it thickens, the expansion and contraction of the boots will crack it and permit it to be blown off. For the same reason, the use of EXTENDED CYCLE is more effective when ice accumulation is slow. The extended interval between pulsations permits the ice to build up to the point at which it will crack under flexure.

4–147. When icing conditions are encountered, permit the ice to accumulate on the leading edges until it is between ⅛ inch and ¼ inch thick. Then place the system in operation by moving the de-icer boot cycle selector switch to NORMAL CYCLE or EXTENDED CYCLE, depending upon the rate of icing.

4–148. EMERGENCY OPERATING PROCEDURE FOR DE-ICER BOOTS.

4–149. The de-icer pump selector valve switches permit the use of either of the vacuum pumps as a pressure source if one of the pressure pumps fails. De-icing may be accomplished with the electronic timer switch moved to EXTENDED CYCLE, one pump supplying vacuum and the other vacuum pump switched to DE-ICER PRES. With both vacuum pumps switched to the pressure line, there will be no vacuum in the system. At high speeds, de-icer boots may auto-inflate. If this should occur, reduce the airspeed until vacuum pumps can be returned to their normal function.

4–150. In the event of inadequate pressure in the de-icer boot system, resulting from failure of one or both of the pressure pumps, move one (or both, if necessary) of the de-icer air pump selector valve switches from VAC to DE-ICER PRES and move the cycle selector switch to EXTENDED CYCLE. Return to VAC when the need for pressure no longer exists, or when vacuum is required. The individual boot segment switches permit out-of-cadence or repeated inflation of any segment if ice accumulates unevenly in any area. In the event of uneven icing, or in case ice fails to come off any boot segment, move the appropriate segment switch as required.

4–151. NESA WINDSHIELD ANTI-ICING SYSTEM (LAC Serials 4501 through 4509).

4–152. The three center windshield panels can be warmed by electrically generated heat to prevent the formation of ice on the exterior surfaces, or to melt it after it has formed. The interior surfaces can be kept fog-free, or cleared of fog, by the same means. These panels of Nesa glass can be internally heated. Current for heating the Nesa glass is supplied by a single-phase inverter driven by power from the main d.c. bus. The spare inverter can be used as an alternate source of power.

4–153. NESA WINDSHIELD PANELS. The Nesa panels are a laminated product consisting of a ¼ inch layer of vinyl plastic between two sheets of glass. The outside sheet is 3/16 inch thick; the inside sheet is ⅜ inch thick and is structurally designed to contain maximum cabin differential pressure in the event of failure of the outer sheet of glass. The inner surface of the outside layer of glass is coated with a transparent resistant material which generates heat when electric current is passed through it. Bus bars, imbedded in the top and bottom of the panels, distribute electric current uniformly to the resistance coating. Thermistors, one imbedded in the vinyl layer of each panel and connected in parallel, control the application of power to the panels.

4–154. NESA CIRCUIT. Alternating current is cycled through the three Nesa windshield panels by means of a wheatstone bridge which is energized by direct current from the MJB bus. The resistance of the thermistors varies with temperature to provide the resistance variable that unbalances the bridge to produce the cycling action in the system and automatically controls the temperature of the panels.

4–155. NESA SYSTEM CONTROLS.

4–156. NESA INVERTER SWITCH. The Nesa inverter switch is located on the MJB No. 2 switch panel (figure 1–58) and permits selection of the Nesa inverter or the spare inverter as a power source for the Nesa system. It is placarded NESA, OFF, and SPARE INVERTER. If the switch is positioned at NESA, the Nesa inverter is the power source; if the switch is positioned at OFF, the Nesa system is inoperative; if the switch is positioned at SPARE INVERTER, the spare inverter is the power source.

4–157. NESA SYSTEM SWITCH. The Nesa system is a three-position switch, located on the copilot's switch panel (figure 1–53), which energizes the Nesa system. It is placarded HIGH (up), OFF (center), and NORMAL (down). In the HIGH position, a more rapid and greater temperature rise in the outer sheet of glass is possible.

4–158. NESA RESET SWITCH. The spring-loaded, push-button Nesa RESET switch, located near the Nesa system switch on the copilot's switch panel (figure 1–53), performs two functions which are electrically separate, but mechanically combined. First, by means of this switch, the cycling rate may be increased, and second, cycling can be initiated when outside air temperatures are so low (approximately —40°C, or —40°F) that the thermistor resistance is too high to pass enough current to start the system.

4–159. NESA SYSTEM INDICATORS.

4–160. NESA SYSTEM POWER-ON LIGHT. This light, located adjacent to the Nesa system switch (figure 1–53), is illuminated whenever power for the Nesa system switch is available. It will come on whenever the Nesa inverter switch is in either the NESA or the SPARE inverter position.

4–161. NESA CYCLING LIGHT. The Nesa cycling light (figure 1–53), located next to the system power-on light, glows whenever the resistance material in the Nesa windshield panels is energized and goes off when current to the panels is interrupted by the cycling circuit.

4–162. NORMAL OPERATING PROCEDURE FOR NESA WINDSHIELD ANTI-ICING SYSTEM.

4–163. Generally, the NORMAL position of the Nesa system switch provides adequate heat in the windshield panels to prevent icing and fogging and to maintain the vinyl layer within the temperature range in which it possesses its maximum resistance to shattering. Use of the HIGH position is not recommended except for abnormal conditions.

4–164. GROUND OPERATION. Use the normal setting of this Nesa system switch for ground operation. The HIGH power setting should be used on the ground only for established maintenance procedures and then for periods not exceeding one minute.

a. To remove ice from the windshield of a stationary aircraft, turn the Nesa inverter switch to NESA and the Nesa system switch to NORMAL.

b. If uneven melting occurs, turn the Nesa system switch OFF for one minute, then to NORMAL for one minute. Repeat this manual cycling at one minute intervals until the windshield is cleared of ice. This procedure is recommended to minimize internal stresses that develop when uneven melting occurs.

c. Whenever ambient air temperature is less than 27°C (81°F), turn the Nesa system switch to NORMAL at least 10 minutes prior to take-off. This procedure is recommended to raise the temperature of the vinyl plastic layer to the range in which it best resists shattering that might result from impact. Approximately 10 minutes are required for the heat to penetrate the vinyl layer and the thicker inner sheet of glass.

d. Before starting engines, turn the Nesa inverter and Nesa system switches OFF.

4–165. IN-FLIGHT OPERATION. The use of Nesa windshield heat in flight is recommended whenever the free air temperature is less than 27°C (80°F) to improve the bird resistance of the windshield panels. Since there is little probability of bird strikes at altitudes above 12,000 feet, Nesa heat is recommended for use above this altitude only when required for defogging, de-frosting, or de-icing the windshield.

a. During climb, turn Nesa inverter switch to NESA inverter.

b. Turn Nesa system switch to NORMAL.

4–166. ANTICIPATED ICING CONDITIONS. Place the Nesa system in operation ten minutes before entering the icing conditions.

4–167. HEAVY ICING CONDITIONS. If the cycling light remains on continuously, it is an indication that NORMAL power is not sufficient to maintain the windshields in an ice-free condition, move the Nesa system switch to HIGH.

Note

The use of NORMAL power for three minutes before switching to HIGH power diminishes the thermal shock to the windshields, and is strongly recommended, although HIGH power may be used, if necessary, without warm-up, provided icing is not anticipated.

CAUTION

If HIGH power is used without prior warming of the panels with NORMAL power, the resultant thermal shock may cause local delamination of the outer layer of glass from the vinyl plastic core or in the cracking of the outer layer of glass. If visibility is not impaired, cracking of the outer layer of glass is not an emergency condition, since the inner layer is structurally capable of containing the maximum cabin pressure differential.

4–168. DEFOGGING. Continuous operation of the Nesa system with the Nesa system switch in NORMAL is usually sufficient to prevent fogging of the inner surfaces of the windshield panels.

4–169. HIGH TEMPERATURE—HIGH HUMIDITY CONDITIONS. In conditions of high humidity and high temperature, the dew point may occur at a temperature above the lower limit of the Nesa cycling temperature differential, and windshield fogging may occur. If this condition occurs, push the Nesa reset switch and release when the cycling light comes on. This procedure will raise the lower limit of the cycling temperature differential to within 3°C of the upper limit, and maintain the temperature of the inner surface of the windshield above the cockpit dew point.

4–170. LOW TEMPERATURE—HEAVY FOGGING CONDITIONS. At low ambient temperatures, NORMAL power may fail to maintain fog-free windshield panels. If this occurs, move the Nesa system switch to HIGH.

4–171. EXTREMELY COLD WEATHER OPERATION. In extremely cold weather, when the temperature at the sensing point in the windshield falls below —40°C (—40°F), the Nesa system may fail to start when the switches are turned on because the resistance of the thermistors at this temperature, and lower, is too great to pass enough current to start a heating cycle. If this occurs, push the Nesa reset switch and release when the cycling light comes on. Normal control will then continue without interruption.

4–172. EMERGENCY OPERATING PROCEDURE FOR NESA WINDSHIELD ANTI-ICING SYSTEM. In the event of failure of the Nesa inverter, move the Nesa inverter switch to the SPARE inverter position.

Note

- If either the radio or the instrument inverter switch is being operated by the SPARE inverter, the Nesa system will be automatically disconnected.
- If power for the Nesa system is supplied by the spare inverter, high power is reduced by approximately one-third because of the lower inverter rating.

4–173. ALCOHOL ANTI-ICING SYSTEMS.

4–174. The alcohol anti-icing systems provide the means for removing ice from the carburetors, windshields, and

propellers. With the exception of the alcohol tanks, the systems are independent. Refer to figure 4–14.

4–175. ALCOHOL ANTI-ICING TANKS. One 20-gallon alcohol tank is mounted in the aft end of each outboard engine nacelle. The filler wells are located in the upper surface of the wing and are equipped with drains leading overboard. The carburetors and propellers are supplied from the tank located on their respective sides of the aircraft. The five windshield panels are supplied from either or both alcohol tanks. There is no interconnection between the two tanks and crossfeeding is not possible.

4–176. ALCOHOL ANTI-ICING TANK FLUID QUANTITY INDICATOR. Each alcohol tank is equipped with a d.c. electrically operated Liquidometer-type, fluid quantity transmitter which registers alcohol quantity in gallons on a dual indicator mounted on the flight engineer's middle instrument panel (figure 1–56).

4–177. ALCOHOL ANTI-ICING PUMPS. Four electrically driven anti-icing pumps are mounted side by side, aft of the alcohol tank in each outboard nacelle. One pump supplies alcohol to the inboard and outboard propellers; the second pump supplies alcohol to the windshield anti-icing system; and the third and fourth pumps serve the inboard and outboard engine carburetors. The pump serving the propellers delivers a minimum of five gallons of alcohol per hour (2.5 gallons per propeller); each pump serving the carburetors is capable of delivering 26 gallons per hour at 51 psi; each or both pumps serving the windshield panels afford a maximum flow of 14 gallons per hour.

4–178. WINDSHIELD ALCOHOL ANTI-ICING SYSTEM. The windshield alcohol anti-icer system is supplied from either or both alcohol tanks. A pump in each outboard nacelle delivers fluid to the manifolds mounted outside and below each of the five forward windshield panels which distribute and direct the fluid to the windshield panels. Either or both pumps can be used as a pressure source.

4–179. WINDSHIELD ANTI-ICER PUMP SWITCHES (LEFT & RIGHT). Two single-pole, single-throw windshield anti-icer pump switches are located on the copilot's side panel (figure 1–53). In the (Up) position, the pump is energized and in the (Neutral) position the pump is inoperative.

4–180. WINDSHIELD ANTI-ICER FLUID CONTROL VALVES. Three windshield panel anti-icer fluid control valves are located on the pilot's side panel (figure 1–52) and three are located on the copilot's side panel (figure 1–53). Each valve controls the rate of alcohol flow to one of the five windshield panels except for the one not labelled on the pilot's side. That one is inoperative.

4–181. NORMAL OPERATING PROCEDURE FOR WINDSHIELD ANTI-ICING SYSTEM.

4–182. To start the windshield alcohol anti-icing system:

a. Energize either or both windshield de-icer pumps by turning on the anti-icer pump switch, or switches on the copilot's side panel.

b. Adjust delivery flow to all or selected windshield panels to the desired rate by means of the individual windshield panel anti-icer valves located on the pilot's and copilot's side panels.

4–183. CARBURETOR ALCOHOL ANTI-ICING SYSTEM.

4–184. Alcohol may be used to dislodge ice after it has formed in the carburetors. The carburetor alcohol anti-icing system delivers alcohol to the carburetors through three dual outlets in each throat, each positioned to provide adequate coverage of the critical carburetor icing area.

4–185. CARBURETOR ANTI-ICER SWITCHES. The four carburetor anti-icing system alcohol pumps are individually controlled by momentary switch-type circuit breakers which are spring-loaded to OFF. The switches are mounted on the MJB No. 2 switch panel (figure 1–58).

4–186. NORMAL OPERATING PROCEDURE FOR THE CARBURETOR ALCOHOL ANTI-ICING SYSTEM. When alcohol injection is necessary to combat carburetor icing, momentary application (from 3 to 5 seconds) is usually sufficient. If more alcohol is necessary to control heavy or continued icing, it should be injected intermittently. Refer to Section VI, Carburetor Icing, for further discussion of this procedure.

a. Close the appropriate switch or switches momentarily, and release.

b. Repeat, if necessary, until engine power is stabilized.

4–187. PROPELLER ALCOHOL ANTI-ICING SYSTEM.

4–188. One of the two outlets of each propeller anti-icing pump supplies the outboard propeller, and the other supplies the inboard propeller. Alcohol is delivered by the pumps to the propeller slinger rings. Centrifugal force propels the alcohol to the outside of the slinger ring and through feeder tubes to the grooved boots mounted on the leading edges of the propeller blades. The regulator check valve in the alcohol line prevents the alcohol from escaping except when the pumps are operating.

4–189. PROPELLER ANTI-ICER SWITCHES. The regulator check valves and the alcohol pumps are controlled by two rheostat switches located on the MJB No. 2 switch panel (figure 1–58). One switch controls alcohol delivery to the two left propellers, the other controls delivery to the two right propellers. The switches are la-

belled OFF, ON, and, at the extreme clockwise limit of the arc, INCREASE. The ON position energizes the pumps; the positions clockwise from ON control the delivery rate of the alcohol.

4–190. NORMAL OPERATING PROCEDURE FOR PROPELLER ANTI-ICING SYSTEM.

4–191. To start the propeller alcohol anti-icing system:

a. Turn propeller anti-icer rheostats clockwise to full INCREASE, then back to the position which will give the desired delivery rate.

b. Increase or decrease the alcohol delivery rate as may be required by icing conditions.

c. To stop the propeller anti-icing system, turn the rheostat switches counterclockwise to OFF.

4–192. RADIO ANTENNA MAST DE-ICING SYSTEM.

4–193. The forward top radio mast is equipped with an electrically heated rubber boot on its leading edge to keep it free of ice. The heating element in the boot is energized from the main d.c. bus. A microswitch, operated by the left main gear scissors switch, automatically disconnects the radio mast de-icer whenever the aircraft is on the ground.

4–194. MAST DE-ICER SWITCH. A two-position toggle switch located on the copilot's switch panel (figure 1–53), turns on the radio mast de-icer when it is placed in MAST DE-ICER (up) position.

4–195. NORMAL OPERATING PROCEDURE FOR RADIO ANTENNA MAST DE-ICING SYSTEM.

4–196. Ice will accumulate on the leading edge of the radio antenna mast whenever it forms on other surfaces visible from the flight station. However, it is preferable to anticipate icing, if possible, and to energize the de-icer boot before such conditions are encountered.

4–197. PITOT HEAD DE-ICING SYSTEM.

4–198. Electrically energized resistance elements mounted inside the two pitot heads provide heat to prevent the accumulation of moisture or the formation of ice in the impact tubes. The heating elements operate from the d.c. electrical system and automatically maintain adequate temperature for the conditions encountered.

4–199. PITOT HEAT SWITCHES AND INDICATOR LIGHTS. A two-position toggle switch for each pitot heater is mounted on the copilot's switch panel (figure 1–53). These two switches are placarded LEFT or RIGHT, and OFF. The heaters are energized when the switches are in the up position. Two indicator lights, mounted between the switches, glow when the pitot heaters are energized and operating normally.

CAUTION

Pitot heaters must be turned OFF when the aircraft is on the ground to avoid burning the ground personnel and to prevent damage to the pitot heads when covered.

4–200. WINDOW DEFOGGING SYSTEM. (Refer to figure 4–15.)

4–201. WINDSHIELD DEFOGGING. On LAC Serials 4501 through 4509, the two aft windshield panels on each side of the flight station are equipped with distributor manifolds through which heated air may be directed up and against the inner surface of the panels to prevent fogging. A d.c. electrically energized heater-blower assembly, mounted forward of the pilot's instrument panels, supplies warm air for the system. The heater is protected by a special low-melting point alloy link which will open a relay circuit and turn the heater off if the heater becomes overheated. The blower and heater are further protected by circuit breakers located on the MJB No. 3 panel. The circuit is designed so that the heater will function only when the blower is operating. The blower, however, may be operated without the heater.

4–202. On LAC Serials 4510 through 4519, all seven windshield panels are equipped with distributor manifolds through which heated air may be directed down and against the inner surface of the panels to prevent fogging. An electrically energized heater-blower assembly is mounted above and aft of each pilot's rear windshield and supplies warm air for the system. Each heater is protected by a special low-melting point alloy link which will open a separate relay circuit and turn the heater off if the heater becomes overheated. The unaffected heater, however, will continue to operate. The blower and heater are further protected by circuit breakers located on the MJB No. 3 panel. The heater will function only when its blower is operating. The blowers, however, may be operated without the heaters.

4–203. CABIN WINDOW DEFOGGING. The space between the inner and outer cabin window panels is ventilated by warm air from the air conditioning system to prevent fogging and icing.

4–204. WINDSHIELD DEFOGGING BLOWER SWITCH. A three-position toggle switch on the pilot's switch panel (figure 1–52) controls the blower and arms the heater circuit so that the heater may be turned on if required. On LAC Serials 4510 through 4519, both defogging blowers are controlled and both heater circuits are armed by this switch. The placarded switch positions are HIGH, OFF, and LOW.

4–205. WINDSHIELD DEFOGGING HEATER SWITCH. A windshield defogging heater control switch, placarded HEAT and OFF, is located on the copilot's switch panel (figure 1–53). On LAC Serials 4510 through 4519, both heaters are controlled by this switch.

alcohol anti-icing system

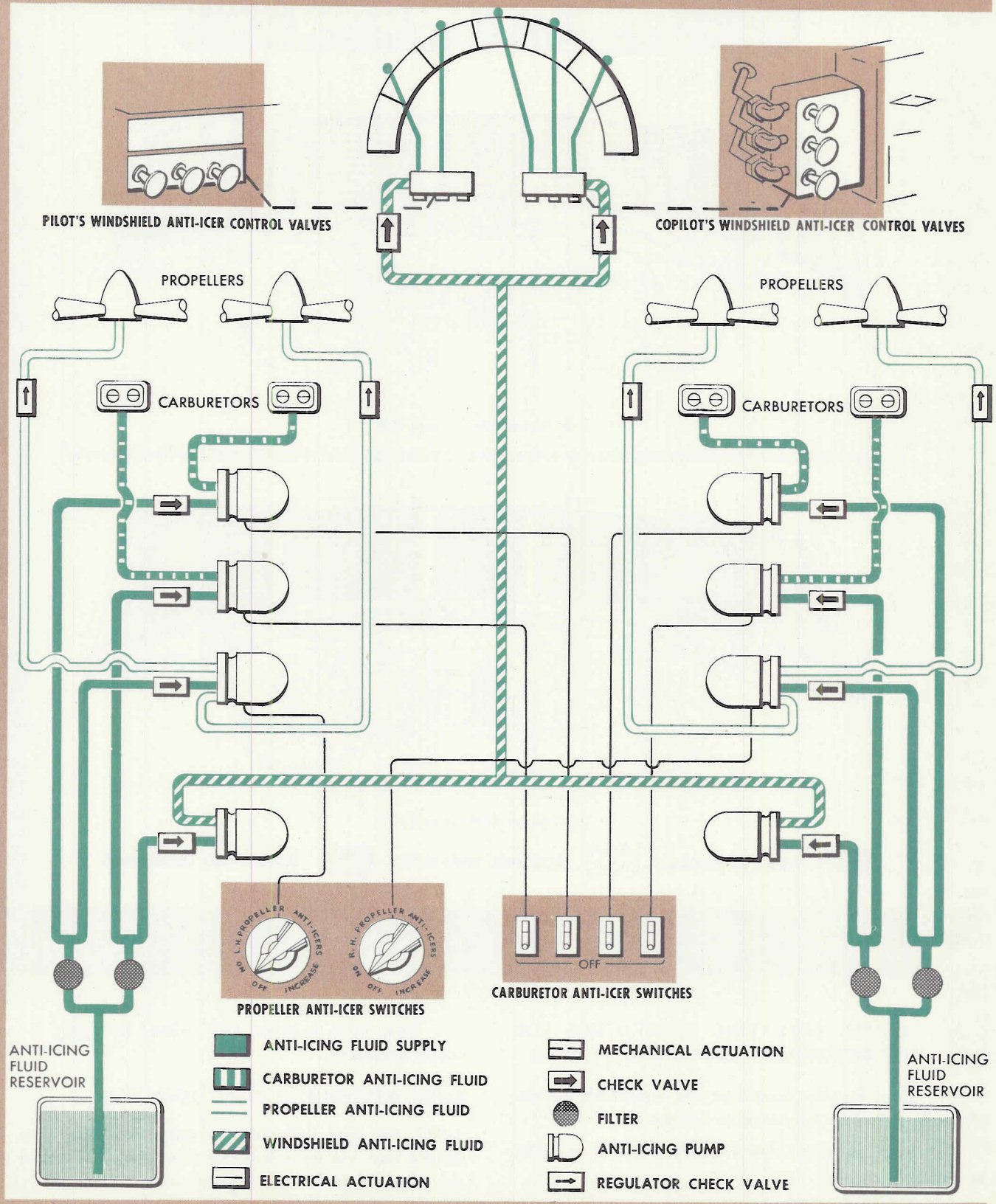
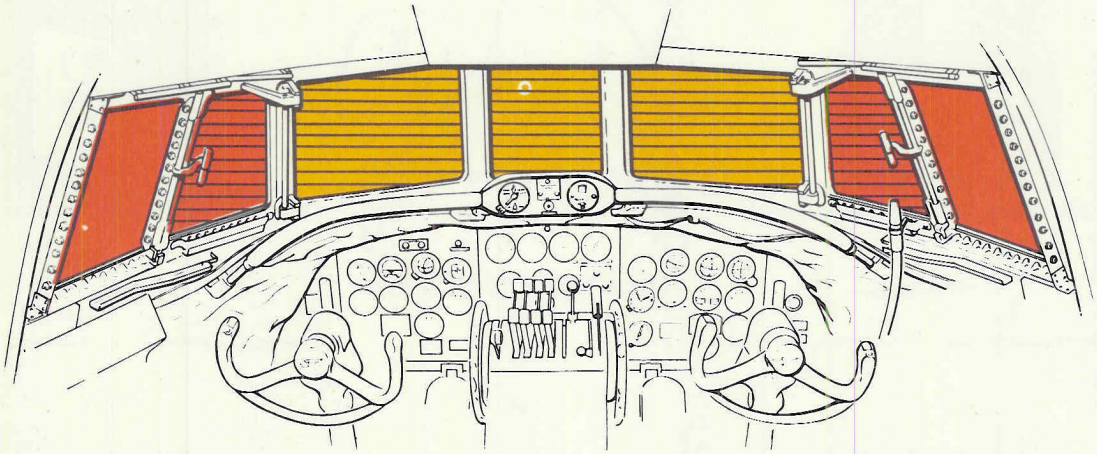
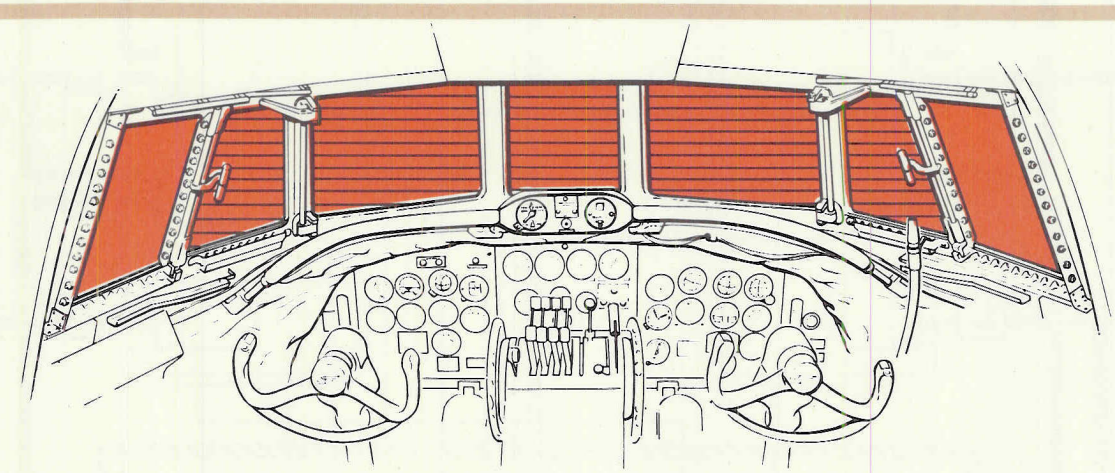


figure 4-14

windshield anti-icing and defogging



LAC Serials 4501 Through 4509



LAC Serials 4510 Through 4519

NESA ANTI-ICING ALCOHOL ANTI-ICING WINDSHIELD DEFOGGING

figure 4-15

4–206. NORMAL OPERATING PROCEDURES FOR THE WINDSHIELD DEFOGGING SYSTEM.

4–207. When fogging occurs on the windshield panels, place the system in operation as follows:

a. To start, move the blower switch to HIGH or LOW, as required.

b. If heat is necessary, move the heater switch to HEAT.

c. Turn both switches OFF when defogging is no longer necessary.

4–208. WINDSHIELD SPOT DEFOGGER.

4–209. For spot defogging of any windshield area, a flexible hose has been provided which can be attached to the pilots' foot or face airduct outlets, and warm air from the air conditioning system of the aircraft can be directed against the windshield. When not in use, the

hose is coiled and stowed in a canvas sling attached to the flight station canopy.

4–210. WINDSHIELD WIPERS.

4–211. Electric windshield wipers are provided for the pilot's and copilot's forward windshield panels. Both wipers are driven through a flexible shaft by a d.c. electric motor mounted on the flight station canopy above the MJB switch panels.

CAUTION

Do not operate windshield wipers on dry glass.

4–212. WINDSHIELD WIPER SWITCH. The windshield wipers are controlled by a three-position switch located left of the center on the under side of the instrument panel glare shield. The switch is placarded ON, OFF, and PARK. The PARK position is a momentary contact provided to position the blades at the sides of the panels so that they will not obstruct vision.

4–213. COMMUNICATIONS AND RADIO NAVIGATION EQUIPMENT (LAC Serials 4501 through 4509).

4–214. Electronic equipment is installed in the aircraft for radio communications, navigation and intercommunications among the crew members. Most of the radio equipment is installed in the radio equipment rack in the flight station, and in the navigator's radio equipment rack. The radio junction box containing the master switches, circuit breakers, and fuses controlling the radio circuits, is mounted vertically on the inboard face of the navigator's rack. Radio selector boxes containing switches for the aural reception of the radio communication and navigation receivers are provided for the pilot, copilot, navigator, and radio operator. Remote controls for the ADF receivers, VHF communications, and navigation receivers and one (No. 2) MF/HF communications receiver are located on the pilots' overhead radio control panel.

4–215. TABLE OF RADIO EQUIPMENT.

4–216. The following is a list of the communications and radio navigation equipment installed in this aircraft:

Bendix MI-32A Flight Crew Interphone System
LA-17 Service Interphone System
CLV Interphone Loudspeaker System
MI-36 Public Address System
T-47/ART-13 MF/HF Communications Transmitters (Dual)
BC-348 MF/HF Communications Receivers (Dual)
Aercom AR-144 MF/HF Communications Receiver
Bendix TA-18B VHF Transmitter
RT-18/ARC-1A VHF Transmitter/Receiver
Bendix MN-62A ADF Receivers (Dual)
Collins 51V-1 Glide Slope Receivers (Dual)
Collins MN-85D VOR Receivers (Dual)
Bendix MN-61B Marker Beacon Receiver
RCA AVR-26 Loran Navigation Receiver
RCA AVQ-9 High-Range Radio Altimeter
Distance Measuring Equipment (Provisions only)

4–217. RADIO POWER SYSTEM.

4–218. All electrical power for operation of the radio equipment is distributed to the individual units through the radio junction box. Direct current is supplied to the radio junction box from two d.c. busses, the main d.c. bus and the emergency d.c. bus. During normal operation of the electrical system, the main d.c. bus is energized by the batteries and engine-driven generators and the emergency d.c. bus is energized by current from the main d.c. bus. Located on the aft face of the radio junction box are three switch-type circuit breakers that serve as master radio power switches. If all units of radio equipment are to be utilized, the three master switches must be placed in the ON positions. In the event of failure of the main d.c. system, the emergency d.c. bus can be energized directly by the batteries by placing the battery switch in the OFF position; this action causes a relay to release which connects the emergency d.c. bus to the battery bus. The following radio equipment are operated by direct current from the emergency d.c. bus: No. 2 MF/HF communication receiver, No. 2 MF/HF communication transmitter, No. 1 VHF receiver (No. 2 VOR), No. 1 VHF transmitter, and No. 1 ADF receiver.

4–219. Any one of three inverters can supply a.c. current for the operation of certain radio equipment. Two of these inverters are 2000 v.a., 3-phase, 400-cycle inverters which are the radio and spare inverters. The third inverter is a 250 v.a., 3-phase, 400-cycle inverter for emergency use only. The radio and spare inverters are controlled by a single three-position toggle switch located with the instrument and Nesa inverter switches on the MJB No. 2 panel. In the event of failure of the normal radio inverter, as indicated by illumination of the "radio bus power off" warning light located above the inverter switch, the spare inverter can be turned on by placing the radio inverter switch in the SPARE INVERTER position (down). This action should cause the "radio bus power off" warning light to go out and the "radio and instrument a.c. bus on spare inverter" light to come on, indicating to the flight engineer that the radio bus has been successfully re-energized by the spare inverter. In the event of failure of both the radio inverter and the spare inverter, the emergency inverter can be used to

supply a.c. power to the following radio equipment: MF/HF No. 2, ADF No. 1, and VHF No. 1. The emergency inverter is controlled by a guarded, two-position toggle switch labeled Gyrosyn Compass & Emergency Radio Power; this switch is located on the MJB No. 2A panel. Placing the switch in the EMERGENCY position will turn the emergency inverter on. Located on the left of the emergency inverter switch are three red warning lights which come on individually as the radio equipment operated by the emergency inverter is turned on. In the event that the emergency inverter is being operated by power from the emergency d.c. bus following failure of the main d.c. system, electrical loads placed on the emergency inverter should be closely monitored to conserve battery strength.

4–220. RADIO JUNCTION BOX. The radio junction box is located inboard of the navigator's radio rack. All electrical power, both d.c. and a.c., for operation of the radio equipment is distributed to the individual units through this junction box. The radio junction box contains the three master radio power switches, circuit breakers for the d.c. circuits and fuses for the a.c. circuits. The service life of the d.c. circuit breakers is shortened when the breaker is used frequently as a switch. Circuits should not be turned off by pulling these breakers when other means are available. When necessary to de-energize the radio equipment, use the master switches whenever possible. In the case of the a.c. circuits, however, fuses may be removed to de-energize a circuit.

4–221. RADIO EXHAUST SYSTEM. When the aircraft is in flight, a venturi creates suction which removes heated air from the navigator's radio rack and the flight station radio rack areas. A butterfly valve in the system, by which the volume of air can be regulated, is controlled from the navigator's station by a knob which extends through the interphone speaker panel.

4–222. ANTENNA SYSTEM.

4–223. The antenna system is installed as shown on figure 4–16.

4–224. RADIO SELECTOR BOXES. A radio selector box is provided for the pilot, the copilot, the radio operator, and the navigator. The selector boxes provide a means of selecting the audio output of any one or combination of five radio communication receivers, four navigation receivers, and a marker beacon receiver; the selection of any one of four communication transmitters; and interphone communications. Refer to figure 4–17. Although the radio selector boxes permit selection of the output of several receivers at one time, the possibility of interference from unwanted signals causing failure to receive an important message, increases as the output of each additional receiver is added to the total number of receivers connected to the headsets. For this reason, only those receivers actually in use or associated with radio channels which must be guarded according to definite orders, should be connected to the headsets at any one time.

4–225. The toggle switches that select the radio receivers are ON when the switches are placed in the up position. The audio switch labeled SP-1 is connected to the No. 3 MF/HF communications receiver (Aercom AR-144); the switch labeled SP-2 is not connected. The toggle switch labeled VHF COMM 1 is connected to the No. 2 VOR receiver when the VOR receiver is used for communication purposes; the VHF COMM 2 switch is connected to the RT-18/ARC-1A receiver. The other audio switches connect receivers as indicated on the face of the radio selector box.

4–226. The microphone selector switch consists of a five-position, rotary-type switch that provides a means of connecting the microphone to a desired transmitter. The switch positions are assigned as follows:

HF-1—No. 1 T-47/ART-13 transmitter
HF-2—No. 2 T-47/ART-13 transmitter
INTER—Interphone circuits
VHF-1—TA-18B transmitter
VHF-2—RT-18/ARC-1A transmitter

4–227. The audio output of the ADF and VHF navigation receivers passes through the range filter switch which provides a means of selecting the mode of reception from these receivers.

4–228. The volume control operates on the MF/HF and VHF receivers only. Volume controls for the ADF receivers are located on the center control stand.

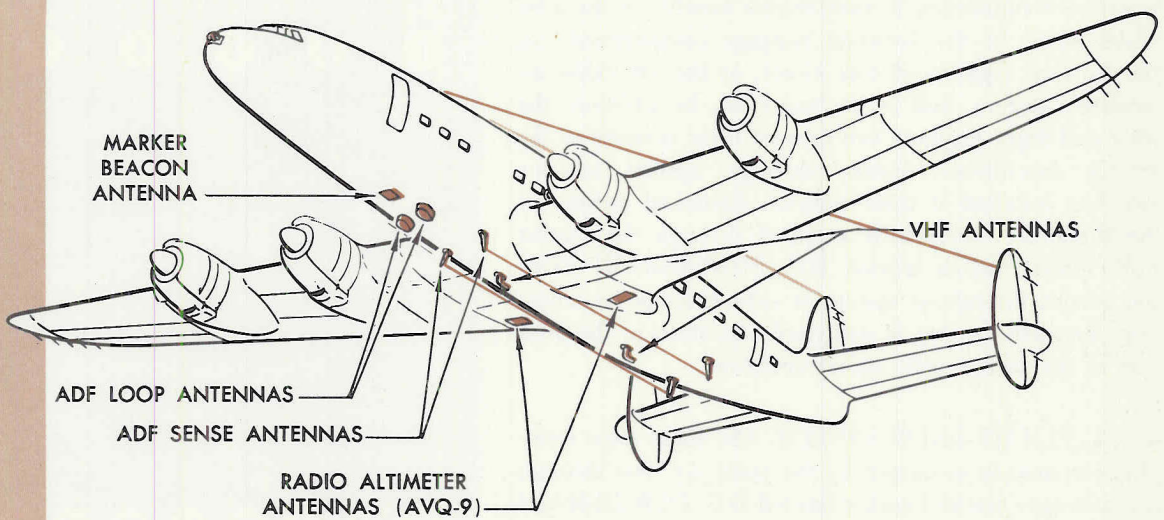
4–229. The EMER-NORM switch consists of two toggle switches ganged together to act as one switch. Should one or more amplifiers fail or should power to the radio selector box be cut off, communications can be maintained by placing the switch in the EMER position. This action causes the failed isolation amplifier to be bypassed and the audio output of the interphone or selected communication receiver to go directly to the headset. In this case, the audio output is selected by placing the toggle switch for the desired receiver up (On) and placing all those toggle switches to the left down (Off). Only one position is usable at a time when the EMER-NORM switch is in the EMER position, the furthermost left switch taking precedence.

4–230. INTERPHONE SYSTEM.

4–231. The interphone system provides the aircraft crew with simplified control over radio receivers and transmitters aboard and with dual interphone systems ar-

antenna diagram

LAC Serials 4501 Through 4509



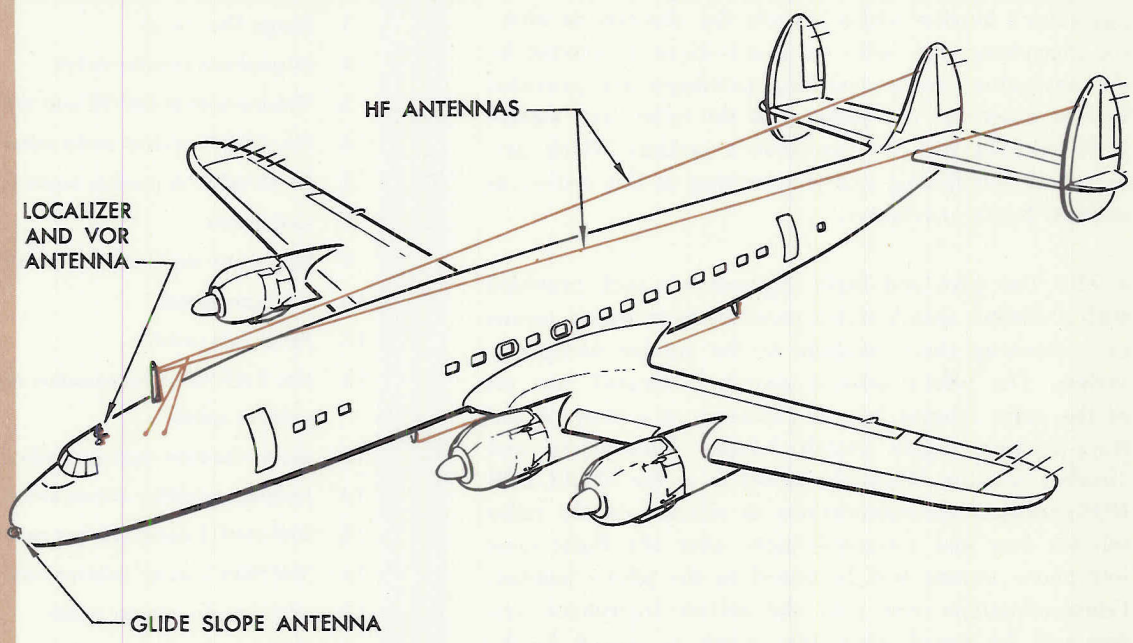


figure 4-16

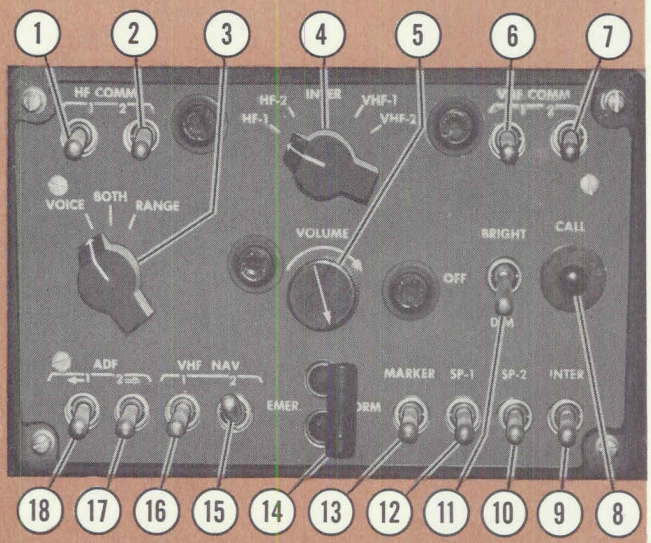
ranged to permit maximum flexibility of communication facilities. The interphone circuits are known as the "flight crew system" and the "service interphone system." The flight crew system includes the pilot, copilot, flight engineer, navigator, radio operator, observer, and relief crew bunk stations. The service interphone system includes an interphone connection in each engine nacelle, on the nose wheel strut, in the forward baggage compartment, in the forward right-hand coat closet, at the aft cabin attendant's station, and in the tail cone. In addition, the pilot and flight engineer can connect their headsets to the service interphone system through special selector switches installed at their stations. Electrical power for the flight crew system is supplied through the master radio power switch labeled D.C. POWER-MAIN BUS; the service interphone system is automatically on whenever the main d.c. bus is energized regardless of the position of the master radio power switches.

4–232. FLIGHT CREW SYSTEM. The flight crew interphone system is energized by the main d.c. bus through a switch-type circuit breaker labeled D.C. POWER-MAIN BUS located on the radio junction box. The amplifier for the system is installed on the navigator's radio rack. The system provides radio communications facilities for the pilot, copilot, radio operator, and navigator. The jackbox at the observer's station is in parallel with the navigator's headset which permits the observer to monitor interphone and radio communications as selected by the navigator; no transmitting privileges are provided for the observer. The jackbox at the relief crew station is in parallel with the navigator's jackbox which permits both monitoring and transmitting at this station as selected by the navigator.

4–233. The pilot and flight engineer are each provided with a selector switch which provides them with a means of connecting their headsets to the service interphone system. The pilot's selector switch is located just aft of the radio selector box and consists of a conventional three-position toggle switch labeled Microphone and Headset Selector. When the switch is in the SELECTOR BOX position, communications as selected on the radio selector box and communications over the flight crew interphone system will be heard in the pilot's headset. Communications over only the service interphone system will be heard when the switch is placed in the SERVICE INTPH position. The PUBLIC ADDRESS position is a momentary-contact position that is used when the pilot desires to make general announcements to the passengers. The flight engineer's interphone selector switch is a conventional two-position toggle switch located on the upper switch panel. This switch performs the same functions as the pilot's selector switch except that no public address position is provided.

radio selector box

LAC Serials 4501 Through 4509



1. No. 1 HF communication receiver audio selector switch
2. No. 2 HF communication receiver audio selector switch
3. Range filter switch
4. Microphone selector switch
5. Volume control (MF/HF and VHF receivers only)
6. No. 2 VOR receiver audio selector switch
7. RT-18/ARC-1A receiver audio selector switch
8. Call button
9. Interphone audio selector switch
10. (Not connected)
11. Panel light switch
12. No. 3 MF/HF communication receiver audio selector switch
13. Marker beacon receiver audio selector switch
14. Isolation amplifier cut-out switch
15. VHF NAV 2 audio selector switch
16. VHF NAV 1 audio selector switch
17. ADF 2 audio selector switch
18. ADF 1 audio selector switch

figure 4-17

4–234. As an aid to monitoring radio and interphone communications without the necessity for continuous use of headsets, loudspeakers are installed in the flight station and in the navigator's station. When the pilot, copilot, or navigator uses his microphone button during interphone operation, the loudspeakers near his station are muted, thereby preventing acoustic feedback. The flight station loudspeaker is connected to the audio output of the pilot's radio selector box and the navigator's loudspeaker is connected to his radio selector box. In each case, the loudspeaker amplifier and headphones are in parallel. Signals to the headsets during interphone operation are not muted. A muting rheostat for the flight station loudspeaker is located on the pilot's side panel and is used to regulate the muting of the loudspeaker. The muting rheostat for the navigator's loudspeaker is located below the speaker which is installed on the radio equipment rack in his station. Muting relays are not energized when the NORM-EMER switch on the radio selector box is in the EMER position. The loudspeaker amplifier includes two independent channels so that the navigator's and flight station loudspeakers can be independently controlled. The radio operator's muting relay is not connected to the loudspeaker system but wiring to the radio operator's selector box is provided for this facility should it be desired at a later date.

4–235. SERVICE INTERPHONE SYSTEM. The service interphone system includes stations at the following locations: Nose wheel strut, in each engine nacelle, in the forward cargo compartment, in the forward right-hand coat closet, at the aft cabin attendant's station, and in the tail cone. In addition, the pilot and flight engineer, who are normally in the flight crew system, can connect their headsets to the service interphone system by means of interphone selector switches installed at each of their stations. The pilot's interphone selector switch is located on a small panel aft of the radio selector box and the flight engineer's switch is installed on the upper switch panel. The service interphone system is on whenever the main d.c. bus is energized. Call facilities are provided for each station on the service interphone circuit. When a mechanic's call button is pressed the call light on the flight engineer's upper switch panel is energized in addition to the call lights at each of the other mechanic stations. Buzzers are also provided at each of the mechanic stations. The station at the nose wheel strut is not provided with a call light or buzzer but the call button at this station will energize a call light on the flight engineer's upper switch panel. The nose wheel station is provided with a box for stowing a boom-type microphone and headset. A microswitch opens the microphone circuit to the jack in the ramp box when the box door is closed, thereby preventing sound from being transmitted through the service interphone system during flight.

4–236. INTERPHONE CALL SYSTEM. All interphone stations, except the observer and relief crew stations, are provided with call buttons and, in some cases, with call lights. The pilot is provided with two call buttons; the call button on his radio selector box is used to call the navigator and the call button installed on the small panel aft of his radio selector box is used to call the cabin attendants. The call button on the copilot's radio selector box energizes a buzzer in the navigator's station. Located on the flight engineer's upper switch panel are three call buttons by which he can call the mechanic stations, navigator, or cabin attendants. Installed next to the call buttons on the upper switch panel are three call lights which, when illuminated, indicate to the flight engineer the station initiating a call. The call button on the radio operator's radio selector box is used to call the navigator and the call button on the navigator's radio selector box is used to call the cabin attendants. Two call buttons are installed in the right-hand forward coat closet and two are installed on the aft cabin attendant's control panel to call the other cabin attendant station or the flight station. Call lights are also located next to these call buttons. The interphone stations in the engine nacelles, forward baggage compartment, and tail cone are equipped with call buttons, call lights, and buzzers. The call buttons are used to call the flight engineer. The call button on the nose wheel strut is used by the ramp attendant or mechanic to call the flight engineer.

Note

Each of the cabin attendant call buttons energizes the chimes in the passenger cabin; the navigator call button energizes a buzzer in the navigator's station and the flight station call button energizes a one-stroke gong in the flight station.

4–237. PUBLIC ADDRESS SYSTEM. The public address system consists, mainly, of an amplifier installed on the navigator's radio rack, eleven loudspeakers installed in the ceiling of the passenger cabin and speaking facilities at the pilot's station and cabin attendant's station. The pilot's speaking facility consists of a handset installed on the left side of the flight station and the cabin attendant is provided with a microphone located on the cabin attendant's control panel. The public address system is operated by power from the main d.c. bus through the master switch on the radio junction box. The system also requires a.c. power from one of the inverters. Volume controls by which the audio output of the public address amplifier can be regulated are located on the public address amplifier. These controls consist of rheostats concealed by two buttons on the front panel of the amplifier. A screwdriver is used to adjust the rheostats. LO volume is adjusted without the

engines in operation but the HI volume is adjusted in flight with the engines operating at normal cruise power. Located on the cabin attendant's control panel is a two-position toggle switch by which the attendant can select either LO or HI volume for public address announcements. When the microphone button at the cabin attendant's control panel is depressed, the loudspeaker muting relay at that station is actuated, removing the speaker from the circuit and connecting a five-ohm resistor in its place. That prevents feedback through the cabin attendant's microphone, which would impair system intelligibility. The pilot uses the public address system by holding the microphone and headset selector switch in the PUBLIC ADDRESS position (momentary-contact).

4–238. HIGH-FREQUENCY COMMUNICATION SYSTEM.

4–239. High-frequency communications are provided by two transmitters and three receivers. The two transmitters (ART-13) and two of the receivers (one BC-348 and the AR-144) are divided into two HF communication systems designated as No. 1 HF and No. 2 HF. The No. 1 HF system consists of one transmitter (ART-13) and one receiver (BC-348) which are controlled by the radio operator only and the No. 2 HF system consists of one transmitter (ART-13) and one receiver (AR-144) which can be controlled by either the radio operator or the pilots, although the system is intended to be used primarily by the pilots. The third receiver (BC-348 labeled HF-3) is a special receiver for monitoring purposes that is under control of the radio operator.

4–240. The transmitters are installed on the flight station radio rack and are remotely controlled from two panels installed on the fuselage sidewall of the radio operator's station. The aft panel (left) controls the No. 1 transmitter and the forward panel (right) controls the No. 2 transmitter (and the AR-144 receiver). In addition, the No. 2 transmitter can be operated by remote controls installed on the overhead panel in the flight station. The transmitters operate in the frequency range of 200 to 1500 kc and 2000 to 18,000 kc and are modified to increase the autotune channels to 107; they are also modified to include an external low-frequency oscillator. An antenna loading coil is automatically switched into the circuit when the No. 1 transmitter is used in the lower broadcast frequency band. Power for the transmitters is obtained from the main d.c. bus. The telegraph keys are connected in parallel and are generally used with the No. 1 transmitter but the No. 2 transmitter can also be keyed when the No. 2 function switch is placed in the CW or MCW position.

4–241. The BC-348 receivers, designated No. 1 and No. 3 receivers, are six-band, locally controlled units covering a frequency range from 200 to 500 kilocycles and from 1.5 to 18.0 megacycles. Each receiver is locally tuned by controls located on the face of each unit. The No. 1 receiver is part of the No. 1 HF communication system; the No. 3 receiver is a special monitoring receiver. The audio output of either of the receivers can be monitored at any flight station provided with a radio selector box by placing the audio switches labeled HF COMM 1 and SP-1 (No. 3 receiver) in the up position. Power for the receivers is obtained from the main d.c. bus.

4–242. The AR-144 receiver, designated No. 2 HF, is a 24-channel, remotely controlled receiver. A maximum of 6 crystals per channel are installed, making a total of 144 pre-set frequencies that may be selected. The frequency range of the unit is from 2100 to 18,000 kc. The receiver is used in conjunction with the No. 2 HF transmitter and is turned on and frequencies selected automatically by the same controls which operate the No. 2 transmitter. Audio output of the receiver is selected at the radio selector boxes by means of the HF COMM 2 switches. The receiver is installed on the navigator's radio rack and is powered by direct-current from the emergency d.c. bus.

4–243. HF COMMUNICATION SYSTEM CONTROLS.

4–244. The following controls are associated with the HF transmitters:

4–245. FUNCTION SWITCHES. Two function switches, one for each transmitter, are installed on the remote control panels in the radio operator's station. The switches are used to turn the equipment on and to select the mode of transmission desired. Although both switches are provided with a position labeled PILOT, this position is operative only on the forward panel which is associated with the No. 2 HF transmitter. When the switch on the No. 2 control panel (forward) is placed in the PILOT position, the radio operator's remote controls are rendered inoperative and the transmitter must be controlled by the remote controls installed on the red panel in the pilot's overhead radio control panel. Control of the No. 1 HF transmitter cannot be transferred to the pilots' station.

4–246. ON-OFF SWITCH. A conventional on-off toggle switch, which provides the pilots with a means of turning the No. 2 transmitter on or off, is installed on the pilots' overhead radio control panel. This switch is used when the function switch in the radio operator's station is in the PILOT position.

4–247. FREQUENCY SELECTOR SWITCHES. The radio operator is provided with a frequency selector switch for the No. 1 and No. 2 transmitters and the pilots are provided with a frequency selector switch for the No. 2 transmitter only. The radio operator's selector switches are located on the remote control panels and the pilot's switch is installed on the red panel of the radio control panel in the flight station. The frequency selector switches consist of two concentric knobs; the large knob selects the code letter and the small knob selects the code number assigned to the desired frequency. The selected channel number appears in the vertical window of the selector unit.

4–248. MICROPHONE SELECTOR SWITCHES. The microphone selector switches are located on the radio selector boxes and positions labeled HF-1 and HF-2 are associated with the HF transmitters.

4–249. STANDBY-TRANSMIT SWITCHES. A standby-transmit switch for each HF transmitter is installed on the transmitter remote control panels in the radio operator's station. If a transmitter is to be used for voice transmissions, the switch associated with the transmitter must be placed in the STANDBY position and if the transmitter is to be used for CW transmissions, the switch must be placed in the TRANSMIT position.

4–250. TUNING LIGHTS. A tuning light is installed on each HF transmitter remote control panel. The lights will glow while the transmitters are going through the autotune process during a change in frequency and will go out when the selected frequency is tuned in and ready for use. Transmissions cannot be made while the lights are illuminated. Located next to the HF COMM 2 frequency selector switch on the radio control panel in the pilots' station is an indicator light labeled TRANSM. This light will glow when the pilot is in control of the HF No. 2 transmitter and a change in frequency is being made.

4–251. "DYNAMOTOR ON" INDICATOR LIGHTS. A "dynamotor on" indicator light for each HF transmitter is installed on the transmitter remote control panel in the radio operator's station. The lights will glow while the transmitter dynamotor is in operation. The dynamotor will operate when the standby-transmit switch is in the TRANSMIT position or when a microphone button is depressed during voice transmissions. The indicator light labeled TRANSM, located on the pilot's radio control panel, will also glow when the HF No. 2 transmitter dynamotor is in operation.

4–252. The following controls are associated with the BC-348 receivers:

4–253. AVC-OFF-MVC SWITCH. The avc-off-mvc switch is used to turn the receiver on and to select either automatic or manual volume control.

4–254. BAND SWITCH. The band switch is a flanged knob located below the frequency dial on the face of the receiver. Any one of six frequency bands can be selected by rotating the knob until the desired frequency band appears in the frequency dial.

4–255. TUNING CRANK. The tuning crank is located below the frequency dial. After the correct frequency band is selected, a desired frequency is tuned by rotating the crank until the frequency values appear opposite the marker line in the face of the frequency dial.

4–256. CRYSTAL IN-OUT SWITCH. The crystal in-out switch provides a means of selecting normal or extreme receiver selectivity. Extreme selectivity is obtained when an i-f crystal filter is switched into the circuit by placing the switch at the IN position.

4–257. CW OSC ON-OFF SWITCH. The cw osc on-off switch should be placed in the ON position when receiving cw signals.

4–258. BEAT FREQ. CONTROL. The beat frequency control is used to adjust the received cw signal for tone or pitch. The switch operates in conjunction with the cw osc on-off switch.

4–259. VOLUME CONTROL. The volume control is used to adjust the audio level of the received signal.

4–260. NORMAL-MONITOR SWITCH. A normal-monitor switch for each receiver is located on the radio operator's HF transmitter remote control panels. This switch, when placed in the MONITOR position, maintains the squelch circuit closed at all times, and consequently, radiation from the transmitters can be detected by the receivers.

Note

The AR-144 receiver is automatically tuned by means of the frequency selector switches associated with the No. 2 HF transmitter.

4–261. HF COMMUNICATION SYSTEM OPERATION.

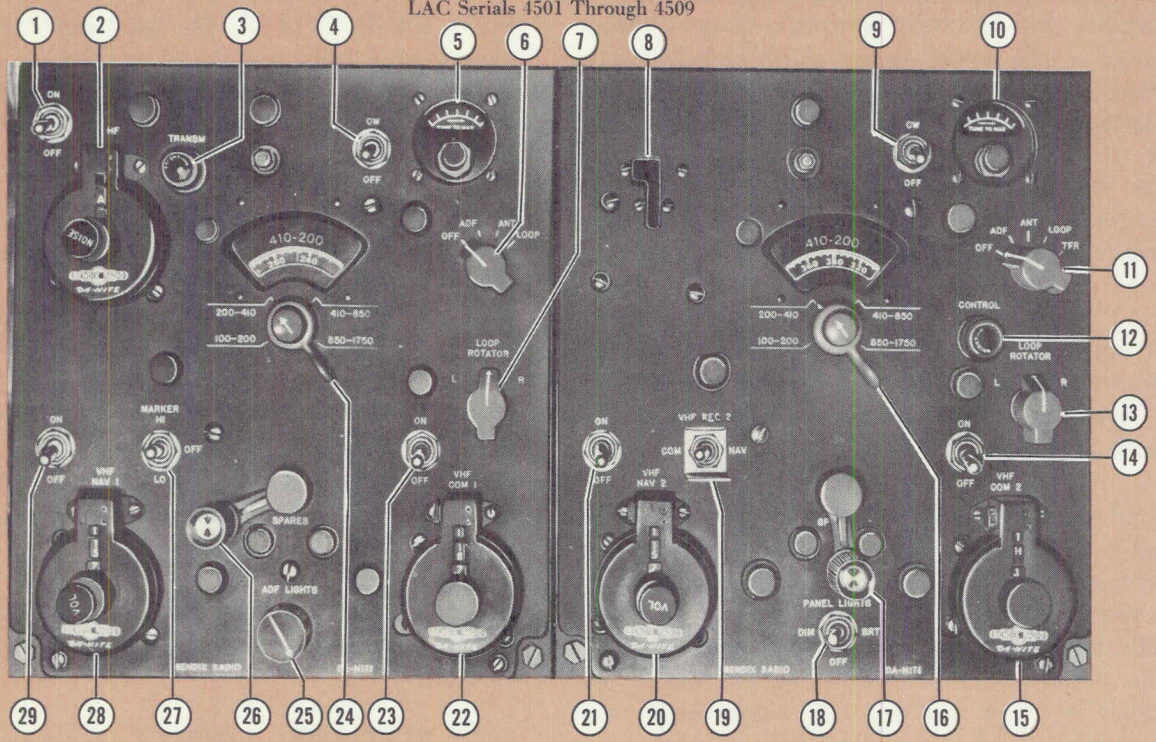
4–262. To place the HF transmitters in operation, proceed as follows:

a. Master radio power switches—ON.

b. Function switches—rotate to position associated with desired mode of operation.

pilots' overhead radio control panel

LAC Serials 4501 Through 4509



1. HF communication ON—OFF switch
2. HF communication frequency selector switch
3. HF communication tuning light
4. ADF No. 1 CW—OFF switch
5. ADF No. 1 tuning meter
6. ADF No. 1 function switch
7. ADF No. 1 loop rotator switch
8. HF No. 1 control (wiring and space provisions)
9. ADF No. 2 CW—OFF switch
10. ADF No. 2 tuning meter
11. ADF No. 2 function switch
12. ADF control indicator light
13. ADF No. 2 loop rotator switch
14. VHF COM 2 power switch
15. VHF COM 2 frequency selector switch
16. ADF No. 2 band selector switch
17. ADF No. 2 tuning crank
18. Radio control panel lights switch
19. VHF REC 2 switch
20. VHF NAV 2 frequency selector switch
21. VHF NAV 2 power switch
22. VHF COM 1 frequency selector switch
23. VHF COM 1 power switch
24. ADF No. 1 band selector switch
25. ADF light control switch
26. ADF No. 1 tuning crank
27. Marker beacon HI—LO—OFF switch
28. VHF NAV 1 frequency selector
29. VHF NAV 1 power switch

figure 4-18

Note

If the No. 2 HF transmitter is to be remotely controlled by the pilots, rotate the No. 2 function switch to the PILOT position and place the standby-transmit switch in the STANDBY position. The pilot must place his on-off switch in the ON position.

c. Frequency selector switches—rotate knobs until desired channel numbers appear in the vertical windows.

d. Standby-transmit switch—place in STANDBY position for voice communications or TRANSMIT for cw communications.

Note

Check to see that the local-remote switch on the face of the receiver unit is in the REMOTE position and that the function switch is in the OFF position.

4–263. To place the HF receivers (BC-348) in operation, proceed as follows:

a. Avc-off-mvc switch—place in AVC or MVC, as desired.

b. Band switch—rotate until required frequency band appears.

c. Tuning crank—rotate until desired frequency appears opposite the marker in the face of the frequency dial.

d. Cw osc on-off switch—ON (for cw operation).

e. Crystal in-out switch—IN.

f. Beat freq. control—adjust as desired (cw operation).

g. Volume control—adjust as required.

4–264. VHF COMMUNICATION SYSTEMS.

4–265. VHF communication facilities are provided by one transmitter (TA-18B) and the No. 2 VOR receiver. This transmitter-receiver combination is designated as the VHF COM 1 system, and is remotely controlled by the VHF COM 1 switches on the pilots' overhead radio control panel. Space, weight, and power provisions have been made for the future installation of a modified RT-18/ARC-1A VHF transmitter-receiver unit, designated as the VHF COM 2 system, which will also be remotely controlled by switches (VHF COM 2) installed on the pilots' overhead radio control panel.

4–266. The VHF transmitters and receivers are used as indicated on the following table:

Frequency (Megacycles)	Purpose	Equipment
108.0—117.0	Localizer, VOR and weather reports.	VOR receiver using navigation antenna.
118.0—121.9	Tower communication.	VOR receiver using navigation antenna and VHF transmitter and receiver using communication antenna.
122.0—135.9	General communication.	VOR receiver using communication antenna and VHF transmitter and receiver using communication antenna.

4–267. The No. 1 VHF transmitter (RT-18B) and the No. 1 VHF receiver (VOR No. 2) receive power from the emergency d.c. bus which means that VHF communication facilities will be available in the event that the main d.c. bus fails. The No. 1 VHF receiver (VOR No. 2) also requires a.c. power which can be obtained from the normal radio inverter, the spare inverter, or the emergency inverter. The No. 2 VHF transmitter/receiver receives power from the main d.c. bus only.

4–268. VHF COMMUNICATION SYSTEM CONTROLS.

4–269. POWER SWITCHES. Conventional on-off toggle switches by which the VHF units are turned on or off, are located on the pilots' overhead radio control panel. These switches are installed next to the frequency selector switches associated with each VHF system.

4–270. VHF REC 2 SWITCH. The VHF REC 2 switch is located above the VHF NAV 2 frequency selector switch on the right side of the pilots' overhead radio control panel. The switch provides a means of independently utilizing the No. 2 VOR receiver as a communications receiver or navigation receiver. When the switch is in the NAV position, the VHF NAV 2 frequency selector switch controls the receiver. Placing the switch in the COM position transfers control of the receiver to the VHF COM 1 frequency selector switch and the receiver will automatically tune to receiver on the frequency set on the VHF COM 1 selector. The VHF NAV 2 frequency selector will have no control over the receiver when the VHF REC 2 switch is in the COM position.

4–271. AUDIO SWITCHES. The audio switches, labeled VHF COM 1 and 2, on the radio selector boxes, are used to connect the headsets to the VHF receivers. When VOR receiver No. 2 is used as a navigation receiver, the audio switch labeled VHF NAV 2 must be used.

4–272. MICROPHONE SELECTOR SWITCH. Positions labeled VHF 1 and VHF 2 are used to connect the microphone to the VHF transmitters. The VHF 2 position is unconnected until the R-18/ARC-1A transmitter is installed.

4–273. VHF COMMUNICATION SYSTEM OPERATION.

4–274. To place the VHF system in operation, proceed as follows:

a. Master radio power switches—ON.

b. VHF power switches—ON.

c. VHF REC 2 switch—COM (if receiver is to be used for communication purposes).

d. Frequency selector switches—rotate large and small knobs until desired frequency appears in channel window.

Note

VOR receiver No. 2 will automatically tune to frequency selected by the VHF COM 1 frequency selector switch.

e. VHF COM 1 and 2 audio switches—place in UP position.

radio operator's station

LAC Serials 4501 Through 4509

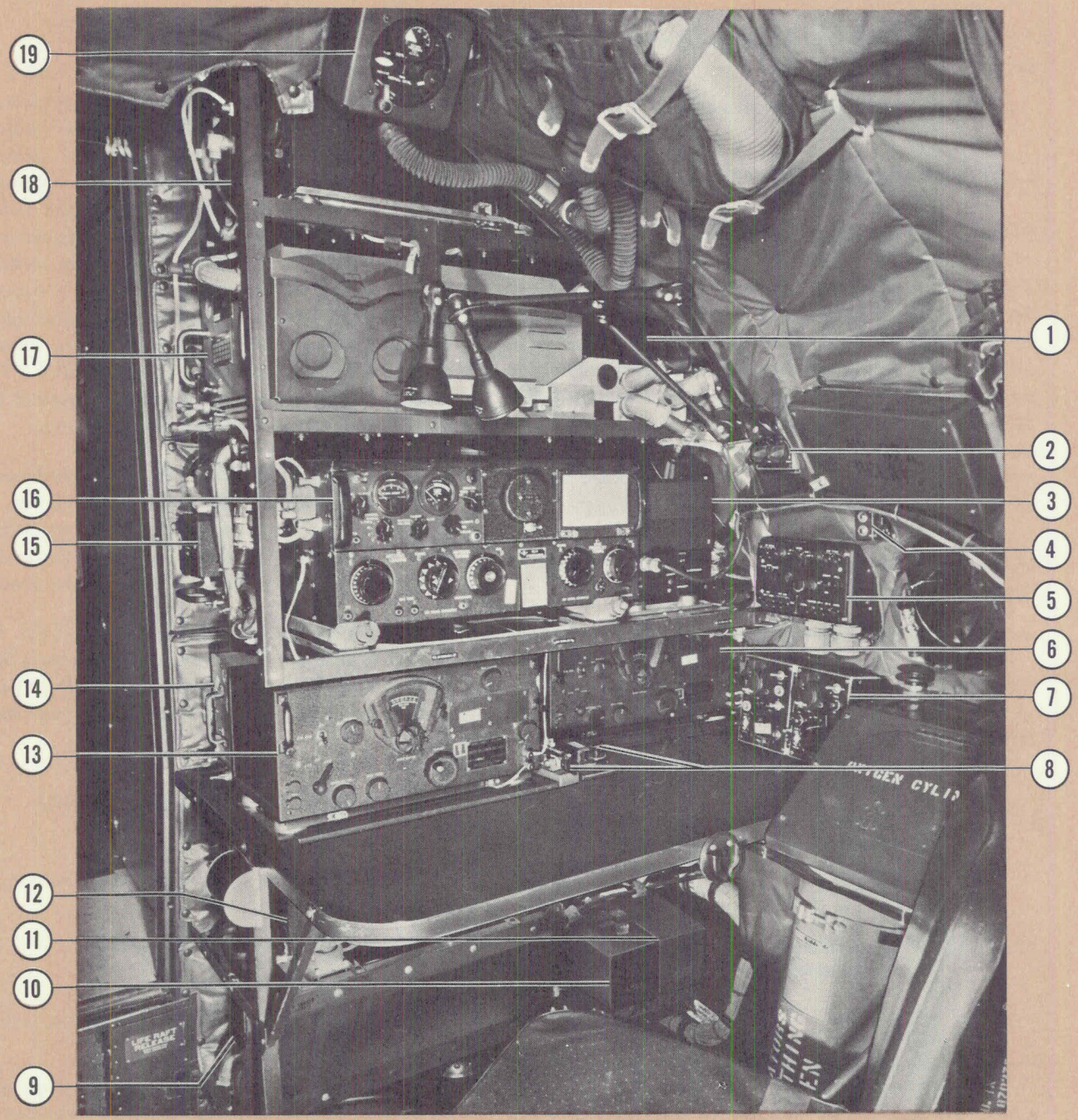


figure 4-19 Sheet 1

1. Loud speaker amplifier
2. Light switches
3. Engine analyzer amplifier
4. Jack box
5. Radio selector box
6. HF receiver no. 3 (BC-348)
7. HF transmitter remote control panels
8. Telegraph keys
9. Zero reader
10. Glide slope receiver no. 1 (51V-1)
11. Glide slope receiver no. 2 (51V-1)
12. VOR receiver no. 2 and accessory unit (MN-85D)
13. HF receiver No. 1 (BC-348)
14. Marker beacon receiver (MN-61B)
15. VOR receiver No. 1 (MN-85D)
16. HF Transmitter No. 1 (T-47/ART-13)
17. PB-10 automatic pilot amplifier
18. Antenna leading unit
19. Oxygen regulator

Note

If VOR receiver No. 2 is used as a navigation receiver the audio switch labeled VHF NAV 2 must be used.

f. Microphone selector switch—VHF 1 or VHF 2.

g. Microphone button—press to talk.

4–275. AUTOMATIC DIRECTION FINDER (ADF) SYSTEMS.

4–276. The ADF equipment is used as a navigational aid and for aural reception of CW and modulated radio signals in the LF and MHF range between 100 and 1750 KC. The ADF installation is essentially two independent Bendix NA-1 systems, each consisting of a superheterodyne receiver with additional circuits necessary for automatic radio compass operation, a loop antenna, sense antenna, bearing indicator system, and remote control facilities. The No. 1 system (Red) is controlled by the pilots only, but the No. 2 system (Green) can be controlled by either the pilots or the navigator. Both receivers may be operated at the same time to give simultaneous bearings on two different stations. Bearing information is exhibited on the pilot's radio magnetic indicator and on the copilot's azimuth indicator; simultaneously, aural reception over the selected frequency is available using the sense antennas. Power for the No. 1 ADF receiver is obtained from the emergency d.c. bus and from the radio or emergency inverter through the No. 1 function switch. Power for the No. 2 ADF receiver is brought through the ADF control transfer relay from the main d.c. bus and the selected inverter. The No. 1 ADF receiver may be used during emergency operation but the No. 2 receiver is disabled if the main d.c. bus fails.

4–277. ADF SYSTEM CONTROLS.

4–278. FUNCTION SWITCH. The function switch is used to turn the set on and to select the desired type of operation. In the ADF position, the set functions as an automatic direction finder with both the loop and sense antennas being used. It is only in this position that the automatic features of the set are functioning. In the ANT position, the receiver is switched from the loop to the sense antenna giving the same performance as a communications receiver. In the LOOP position, the loop antenna can be manually rotated by use of the loop rotator switch. This position is used for aural-null procedures, or, in the case of extreme static, for best reception. The function switch on the ADF No. 2 control panel is provided with an additional position labeled TFR, which is used when it is desired to transfer control of the No. 2 receiver to the navigator.

4–279. BAND SELECTOR SWITCH. The band switch provides a means of selecting any one of four frequency bands as follows: Band I, 100 to 200 kc; Band II, 200 to 410 kc; Band III, 410 to 850 kc; Band IV, 850 to 1750 kc.

4–280. LOOP ROTATOR SWITCH. The loop rotator switch is located below the function switch and is used to manually rotate the loop antenna when the function switch is in the LOOP position. Direction and speed of rotation are determined by the displacement of the switch from its neutral position, rotation speed increasing as the switch is moved away from the neutral position.

4–281. CW-OFF SWITCH. The cw-off switch controls the type of reception, i.e., when the switch is in the CW position, the receiver will receive cw signals in addition to modulated signals.

4–282. TUNING CRANK. The tuning crank rotates the dial of the selected frequency band to the desired frequency.

4–283. SENSITIVITY CONTROLS. Two sensitivity controls are installed on the pilots' center control stand and the knobs are numbered around the circumference from one to ten, thus enabling pre-set sensitivities to be established. Each sensitivity control includes two ganged potentiometers. One potentiometer is in the audio output and is connected only during ADF operation. The other potentiometer controls the r-f gain and is used only during ANT or LOOP operation.

4–284. VOR-ADF SELECTOR SWITCHES. The VOR-ADF selector switches are installed on a small panel located above the center instrument panel. The switches are used to connect the pointer needles of the pilot's radio magnetic indicator (RMI) or the copilot's azimuth indicator to the VOR receivers or to the ADF receivers. Signals from the ADF receivers are directed to the indicators when the switches are placed in the ADF 1 and ADF 2 positions.

4–285. CONTROL INDICATOR LIGHT. The control indicator light glows after the operator has obtained control of the receiver by momentarily placing the function switch (green) in the TFR position, indicating that the changeover has been successfully completed.

4–286. TUNING METER. The tuning meter, which is installed on each ADF control panel, indicates the intensity of the carrier wave reception. The meter is used as an aid in tuning the receiver.

4–287. RADIO MAGNETIC INDICATOR AND AZIMUTH INDICATORS. The pilot is provided with a radio magnetic indicator and the copilot and navigator are each provided with an azimuth indicator. Both the pilot's and copilot's indicators are dual pointer instruments which are fed signals from either the ADF or VOR receivers. The double needles (green) receive signals from the receivers connected to the green control panel and the single needles receive signals from receivers connected to the red control panel. The VOR-ADF selector switches provide a means of connecting the receivers to the indicators in various combinations as desired by the pilots. The navigator's azimuth indicator is a single-needle instrument that receives signals from the No. 2 ADF receiver (green) only.

4–288. ADF SYSTEM OPERATION.

4–289. To place the ADF receivers in operation, proceed as follows:

a. Radio master power switches—ON.

b. Radio inverter switch—ON.

c. Function switches—place in desired position (ADF, ANT, or LOOP).

d. Band switches—rotate to desired frequency band.

e. Tuning crank—rotate to desired frequency (tune for maximum deflection of tuning indicator).

f. Audio switches—place in the Up position.

g. Sensitivity controls—adjust as desired.

h. VOR-ADF selector switches—set as desired.

4–290. GLIDE SLOPE RECEIVERS.

4–291. A single glide slope receiver is installed on the flight station radio rack (space, weight, and power provisions have been made for a second glide slope receiver at this location). The receiver is connected to the glide slope antenna in the nose of the aircraft. The glide slope receivers operate in conjunction with the VOR receivers during instrument approaches and landings. The power switches by which the VOR receivers are turned on also supply power to the glide slope receivers. The receivers detect 90/150 cps tune-modulated signals in the VHF range between 329 and 335 megacycles and are automatically tuned to the correct VHF channel when a localizer channel is selected by the VOR receiver frequency selector switch. The No. 1 glide slope receiver is presently wired to operate with either the No. 1 or No. 2 VOR receiver. The receivers provide a signal to the horizontal needle of the deviation indicators, Zero Reader, and flight path control (provisions).

Note

The glide slope receivers are automatically operated by the VOR receiver controls which are described in the paragraphs dealing with the VOR system.

4–292. VOR NAVIGATION SYSTEM.

4–293. The VHF omni-directional navigation system provides the pilot and copilot with all of the radio aids to navigation now available in the VHF frequency range between 108.0 and 135.9 megacycles inclusive. This frequency range includes both military and commercial amplitude-modulated communications channels, omnirange (VOR) channels, runway localizer channels and two-course visual-aural range (VAR) navigation channels. All of the navigation information is visual and is observed on indicator units mounted on the pilots' instrument panels. Facilities are also provided for reception of audible identification signals. Because the receivers operate in the VHF bands, reception is limited to line-of-sight, the distance from a station whose signals are received depending largely upon the airplane altitude. Remote controls for the receivers are installed on the pilots' overhead radio control panel. The two receivers, which are installed on the flight station radio rack, are connected in parallel with the VOR antenna. The coaxial lead-in from the antenna goes to a tee fitting on the coaxial relay. The lead-in to the No. 1 VOR receiver is connected to one side of the tee, the other side of the tee enters the coaxial relay. The relay switches either the VHF communication antenna or the VOR navigation antenna to the No. 2 VOR receiver. When a channel between 122.0 and 135.9 megacyles is selected for the No. 2 VOR receiver, the coaxial relay automatically connects the communication antenna, through the TA-18B transmitter, to the No. 2 VOR receiver. Usually communication channels can be received on the No. 1 VOR receiver but at reduced efficiency.

4–294. The VOR on-off switches on the pilots' overhead radio control panel operate relays which connect a.c. and d.c. power to the VOR receivers and to the glide slope receivers. The No. 2 receiver is connected to the emergency d.c. bus so that communication facilities are retained in the event that the main d.c. bus fails. The navigational features of the No. 2 VOR receiver are not useful during emergency operation because the navigation system requires heading information from the Fluxgate compass.

4–295. VOR NAVIGATION SYSTEM CONTROLS.

4–296. FREQUENCY SELECTOR SWITCHES. A frequency selector switch for each VOR receiver is installed on the pilots' overhead radio control panel. The switches are labeled VHF NAV 1 and VHF NAV 2. Each switch consists of two concentric knobs; the large knob selects whole megacycles and the smaller knob selects tenths of megacycles.

4–297. POWER SWITCHES. A conventional on-off toggle switch, by which both a.c. and d.c. power is applied to the receiver, is provided for each receiver. The switches are located next to the frequency selector switches on the pilots' overhead radio control panel.

4–298. VHF NAV 2 SWITCH. The VHF Nav. 2 switch is installed above the VHF Nav. 2 frequency selector switch on the right side of the pilots' overhead radio control panel. The switch has two positions: COM and NAV. The switch provides a means of utilizing the No. 2 receiver as a communications receiver or a navigation receiver. When the switch is in the NAV position, the receiver is connected to the VHF NAV 2 frequency selector switch; when the switch is placed in the COM position, the VOR control transfer relay switches control of the receiver to the VHF COM 1 frequency selector switch on the left side of the pilots' overhead radio control panel.

4–299. AUDIO SWITCHES. Audio switches labeled VHF NAV 1 and 2 are installed on each of the radio selector boxes. When the VHF REC 2 switch is on the COM position, the audio output of the receiver is connected to the headsets by means of the VHF COM 2 audio switches on the radio selector boxes.

4–300. RANGE FILTER SWITCH. The audio output of the No. 1 VOR receiver is connected through the range filter switch on the radio selector boxes. The range filter switch provides a means of selecting voice signals only, range signals only, or both range and voice signals.

4–301. VOR-ADF SELECTOR SWITCHES. Two VOR-ADF selector switches are installed on the glare shield instrument panel. The switches are used to connect either the VOR receivers or ADF receivers to the pilot's radio magnetic indicator and the copilot's azimuth indicator.

4–302. ILS INSTRUMENT SELECTOR SWITCH. The ILS instrument selector switch is installed on the control panel located above the instrument panel glare shield. The switch is used to connect the deviation indicators (pilot's and copilot's) to the No. 1 VOR and glide slope receivers or to the No. 2 VOR and glide slope receivers.

4–303. VOR NAVIGATION SYSTEM INDICATORS.

4–304. OMNI-BEARING SELECTOR. The omni-bearing selector is installed on the glare shield instrument panel. Any magnetic course may be set on the omni-bearing selector in whole degrees, measured to or from the VOR station. The flag marker on the selector indicates whether the aircraft is heading to or from the station. The flag marker can be used as a station marker because the flag indicates TO until the station is reached and swings to FROM as the station is passed. When the strength of either the reference or variable signal falls below a safe level, the flag moves to a neutral position.

4–305. DEVIATION INDICATORS. A deviation indicator is installed on the pilot's and on the copilot's instrument panels. The indicators exhibit information from both the glide slope receivers and the VOR receivers. When used exclusively with the VOR system, the vertical needle deflects if the aircraft course differs from the heading set on the omni-bearing selector. When the aircraft course agrees with the set heading, the vertical needle is aligned with the vertical mark at the center of the dial. The horizontal needle is supplied signals from the glide slope receiver when an ILS channel is selected by the VOR receiver frequency selector switch. Signals are also supplied to the Zero Reader and flight path control (provisions).

4–306. VOR NAVIGATION SYSTEM OPERATION.

4–307. To place the VOR system in operation, proceed as follows:

a. Master radio power switches—ON.

b. Radio inverter—ON.

c. VHF-NAV power switches—ON.

d. VHF-REC 2 switch—NAV.

Note

If VHF NAV 2 receiver is to be used as a communications receiver, place the VHF REC 2 switch in the COM position.

e. VOR-ADF switches—set as desired.

f. ILS instrument switch—set as desired.

g. Frequency selector switches—rotate large and small knobs until desired channel appears in vertical windows.

Note

- If the VHF REC 2 switch is in the COM position, the receiver will automatically be tuned to the frequency selected by the VHF

COM 1 frequency selector switch. The VHF NAV 2 frequency selector switch controls the No. 2 receiver only when the VHF REC 2 switch is in the NAV position.

- When a frequency within the ILS band is selected the glide slope receivers will be turned on and the correct VHF frequency automatically tuned.

4–308. MARKER BEACON RECEIVER.

4–309. The marker beacon receiver is used as a navigating and landing aid. The receiver gives the pilots an aural and visual signal while the aircraft is passing over a 75-megacycle marker beacon transmitter. The marker beacon signals may originate from fan-type marker beacons associated with low-frequency radio ranges, from the cone-of-silence markers (2-type), or from any other system which transmits 75-megacycle signals. The presence of such a signal is indicated to the pilots by a tone in the headsets plus illumination of indicator lights on the pilot's auxiliary instrument panel and on the copilot's instrument panel. Direct-current power for the marker beacon receiver is obtained from the main d.c. bus through the master radio power switch on the radio junction box. The receiver unit is on the forward radio rack. The marker beacon antenna is flush-mounted on the underside of the fuselage at the aircraft center-line and about 18 inches forward of the loop antennas.

4–310. MARKER BEACON RECEIVER CONTROLS.

4–311. AUDIO SELECTOR SWITCH. A marker beacon audio selector switch, by which the audio output of the receiver is connected to the headset, is located on each of the radio selector boxes; the switches are labeled MARKER and are on when placed in the up position.

4–312. HI-LO-OFF SELECTOR SWITCH. The HI-LO-OFF selector switch is located on the pilots' overhead radio control panel, and is used to turn the receiver on and to select high or low receiver sensitivity. When the switch is placed in the HI position, the received signals will be heard for a longer period of time.

4–313. MARKER BEACON INDICATOR LIGHTS. Three marker beacon indicator lights (white, amber, and blue) are installed on the pilot's auxiliary instrument panel and on the copilot's instrument panel. While the aircraft is flying over a marker beacon transmitter, the lights will remain lighted or flash regularly, depending upon the type of transmission received. Fan-type markers and Civil Aeronautics Administration instrument-landing markers are identified by keying, and their intermittent flashes enable the pilot to identify the marker over which his plane is flying. Cone-of-silence markers are not keyed but transmit a steady signal. The lights function as shown on the following table:

LIGHT	AURAL IDENTIFICATION	VISUAL IDENTIFICATION	TYPE OF MARKER
White	3000 cps steady tone	Steady	Airways marker
White	3000 cps dashed tone	On-off in dashes	Airways fan-marker
Amber	1300 cps dotted tone	On-off in dots	Instrument landing system inner marker
Blue	400 cps dashed tone	On-off in dashes	Instrument landing system outer marker

4–314. The length of time during which the indicator lights glow while passing over a marker beacon transmitter depends upon the speed of the aircraft, the type of transmitter being flown over, and the altitude. This time may be from a few seconds to several minutes. Indications over cone-of-silence markers last about one minute at 10,000 feet when the speed of the aircraft is 150 miles per hour. Cone-of-silence markers utilize non-directional antenna arrays which cause indications of equal duration for any direction of flight.

4–315. LORAN RADAR SET.

4–316. The Loran Radar Set is an airborne navigation receiver-indicator unit that receives, amplifies, and detects LORAN signals and displays them on the screen of a cathode-ray tube. The set will operate at any altitude between sea level and 40,000 feet and at any temperature within the range of —55°C (—67°F) to 50°C (122°F). The receiver-indicator unit, which is located in the navigator's station, is connected, through a coupling unit, to the center overhead wire antenna. Because this antenna is also used by the No. 1 HF equipment, the antenna lead-in to the Loran-Receiver is grounded when either of the HF transmitters is used. The receiver requires a.c. power which is obtained from the inverters.

4–317. LORAN RADAR SET CONTROLS.

4–318. RECEIVER GAIN AND POWER CONTROL KNOB. This control is used to turn the equipment on and to adjust the pulse for desired amplitude.

4–319. R. F. CHANNEL SELECTOR. The channel selector is used to select one of four preset channels. All four channels lie within the r-f band between 1.7 and

2.5 megacycles. The channels are set as follows: Channel 1, 1.95 mc; Channel 2, 1.85 mc; Channel 3, 1.9 mc; Channel 4, 1.75 mc.

4–320. AMPLITUDE BALANCE CONTROL. The amplitude balance control is used to vary the amplitude of the A and B pulse. The two pulse forms should be adjusted so that they are equal in height.

4–321. COARSE DELAY CONTROL. The coarse delay control is used to make coarse alignments of the B-pedestal and B-pulse. The B-pedestal should be directly under the B-pulse.

4–322. FINE DELAY CONTROL. The fine delay control is used to make fine adjustments of the B-pedestal and the B-pulse. Move the fine delay control until the extreme left end of the B-pedestal is under the B-pulse.

4–323. STATION SELECTOR. With the station selector in any one of its eight positions, pulses of several sizes and shapes may appear on the indicator screen. By moving the control to each of the positions, one setting will be found when the longest and most regular pulses are stationary. These are the proper pulses for use in determining the position of the aircraft.

4-324. PRR H-L SWITCH. This switch is used to synchronize the indicator with the available ground station.

4–325. LEFT-RIGHT SWITCH. The left-right switch is used to move the received signal indications to the left or right, as desired.

4–326. FUNCTION CONTROL. The function control provides a means of selecting eight sweep speeds. Positions 1 through 4 are used to position the A and B pulses. Positions 5 through 8 are used in calculating the time differences, in microseconds, between the A and B pulses.

4–327. DRIFT CONTROL. The drift control is used to adjust the crystal phasing control to keep the received pulses in a stationary position.

4–328. LORAN OPERATION.

4–329. To place the radar set in operation, proceed as follows:

a. Radio inverter—ON.

b. Amplitude balance control—set to center position of rotation.

c. Fine delay control—set to center position of rotation.

d. Drift control—set to center position of rotation.

Note

This step is necessary only for equipment which is being operated for the first time. After operation, the control remains in the position where it was last used.

e. Receiver gain control—rotate clockwise until the station rate identification (pilot light) illuminates. Allow at least five minutes for the equipment to warm up.

4–330. RADIO ALTIMETER (AVQ-9).

4–331. The AVQ-9 radio altimeter gives visual indication of the aircraft altitude above terrain and has a nominal range of zero to 40,000 feet. Altitude measurement is exhibited on the indicator unit in the navigator's station by the appearance of a lobe on the face of a cathode-ray tube whose circular base is calibrated in feet from zero to 5000 feet. Two flush antennas are utilized by the transmitter-receiver unit; the transmitting antenna is installed in the lower surface of the left wing center section and the receiving antenna is installed in the lower surface of the right wing center section. When the equipment is in operation two lobes will always appear on the cathode tube. The lobe appearing at the zero point on the scale is the transmitted signal; the second lobe, appearing elsewhere on the scale between zero and 5000 feet, represents the aircraft altitude above the underlying terrain. The set requires 115-volt, 400-cycle a.c. current, which is obtained from either the normal radio inverter or the standby inverter. The transmitter-receiver unit contains built-in power units that produce the necessary plate and filament voltages.

4–332. RADIO ALTIMETER CONTROLS.

4–333. The following controls are located on the indicator unit in the navigator's station:

4–334. OFF-ON REC. GAIN SWITCH. This switch is used to turn the equipment on and to adjust the height of the lobes appearing on the cathode-ray tube. Operation of the set at a higher gain than is necessary will result in a fuzzy or blurred trace.

4–335. CIRCLE SIZE CONTROL KNOB. This control is used to adjust the size of the circle on the cathode-ray tube.

Note

Circle centering and rounding adjustment controls are located beneath the indicator dust cover. A trace that is off center or not truly circular will result in inaccurate readings.

4–336. SCALE SWITCH. The scale switch has two positions: TIMES ONE and TIMES TEN. The TIMES ONE position is used when the aircraft is flying below 5000 feet and the TIMES TEN position is used when flying above 5000 feet.

4–337. ZERO ADJUSTMENT KNOBS. The two control knobs labeled TIMES ONE ZERO ADJ. and TIMES TEN ZERO ADJ. are used to adjust the reference indicator lobe (transmitted signal) to the zero position of the scale on the indicator dial.

4–338. RADIO ALTIMETER OPERATION.

a. Radio inverter (normal or standby)—ON.

b. OFF-ON REC GAIN switch—ON (continue turning clockwise until desired height of lobes is obtained).

c. Circle size control knob—adjust as required.

d. Scale switch—set as required.

e. Zero adjustment knobs—adjust reference indicator lobe to zero point.

Note

The position of the scale switch determines which of the zero adjustment knobs is to be used for this adjustment.

4–339. COMMUNICATIONS AND RADIO NAVIGATION EQUIPMENT (LAC Serials 4510 through 4519).

4–340. Electronic equipment is installed in the aircraft for radio communications, navigation and inter-communications among the crew members. Most of the radio equipment is installed in the radio equipment rack in the flight station and in the navigator's radio equipment rack. The radio junction box containing the master switches, circuit breakers, and fuses controlling the radio circuits, is mounted vertically on the inboard face of the navigator's rack. Radio selector boxes containing switches for the aural reception of the radio communication and navigation receivers are provided for the pilot, copilot, navigator, and radio operator. Remote controls for the ADF receivers, VHF communications, HF communications, and navigation receivers, are located on the pilots' overhead radio control panel. Switches are also located on the pilots' overhead switch panel to control the lighting and sensitivity of the marker beacon receiver.

4–341. One section of the radio operator's remote control panel includes the No. 1 HF system channel selector and function controls, the AR-144 sensitivity and BFO rheostats, the AT-144 "dynamotor on" light and a STANDBY-TRANSMIT switch. The STANDBY-TRANSMIT switch must be at the TRANSMIT position before the telegraph key can be used with the AT-144 equipment. A key selector switch which transfers the telegraph key to either the T-47/ART-13 circuit or to the AT-144 circuit is also provided.

4–342. Another section of the radio operator's control panel has five monitor lights, a RECEIVER SELECTOR switch, and a MONITOR TRANSMITTER switch. The monitor lights operate in conjunction with the emergency d.c. power system and indicate when the No. 2 HF transmitter, the No. 1 VOR receiver, the No. 1 glide slope receiver, the No. 1 VHF set, or the No. 3 HF receiver is operated on battery power only from the emergency d.c. bus. The receiver selector switch operates antenna relays and connecting sidetone circuits to allow various HF transmitter-receiver combinations to be selected. This switch has HF-2 (BC-348), HF-2/HF-3, HF-3 (RA-1B), and HF-3 AVEC EM HF-1 positions. The monitor transmitter switch overrides certain protective disabling features for the HF receivers, and enables T-47/ART-13 signals to be detected through the HF-2 (BC-348) or HF-3 (RA-1B) receivers.

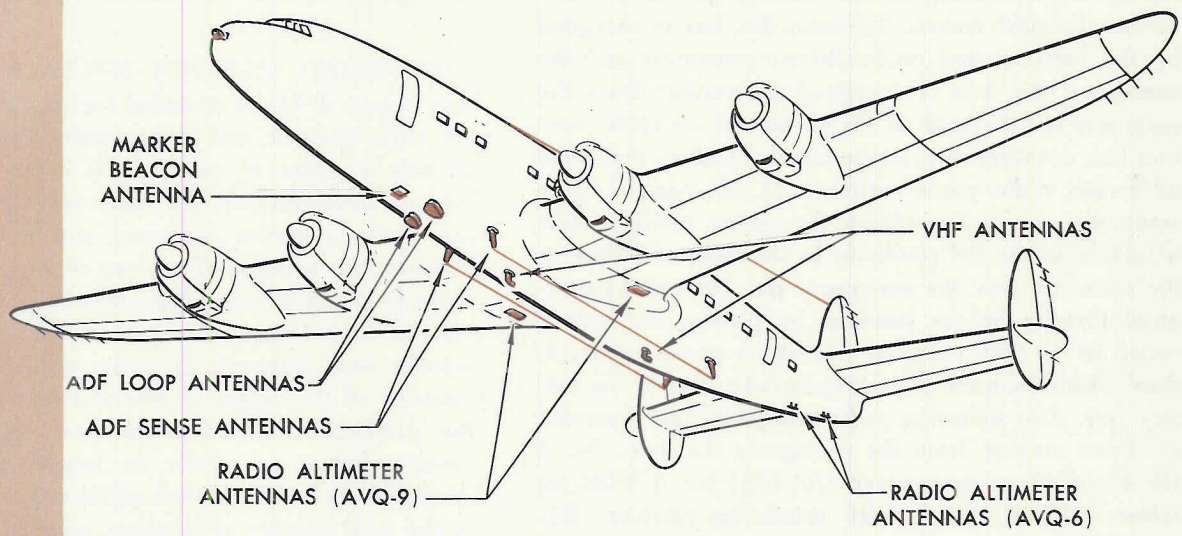
4–343. TABLE OF RADIO EQUIPMENT.

4–344. The following is a list of the communications and radio navigation equipment installed in this aircraft.

LA-17A Service Interphone System
MI-36A Public Address System
T-47/ART-13 MF/HF Communications Transmitter
BC-348Q HF Communications Receiver
Bendix RA-1B HF Communications Receiver
Aercom AT-144 HF Communications Transmitter
Aercom AR-144 HF Communications Receiver
RT-18/ARC-1 VHF Transmitter Receiver
STR-12C VHF Transmitter Receiver
Bendix MN-62A ADF Receivers (Dual)
Collins 51V-1 Glide Slope Receivers (Dual)
Collins 51R-3 VOR Receivers (Dual)
Bendix MN-53B Marker Beacon Receiver
RCA AVR-26 Loran Navigation Receiver
RCA AVQ-9 High-Range Radio Altimeter
RCA AVQ-6 Low-Range Radio Altimeter

antenna diagram

LAC Serials 4510 Through 4519



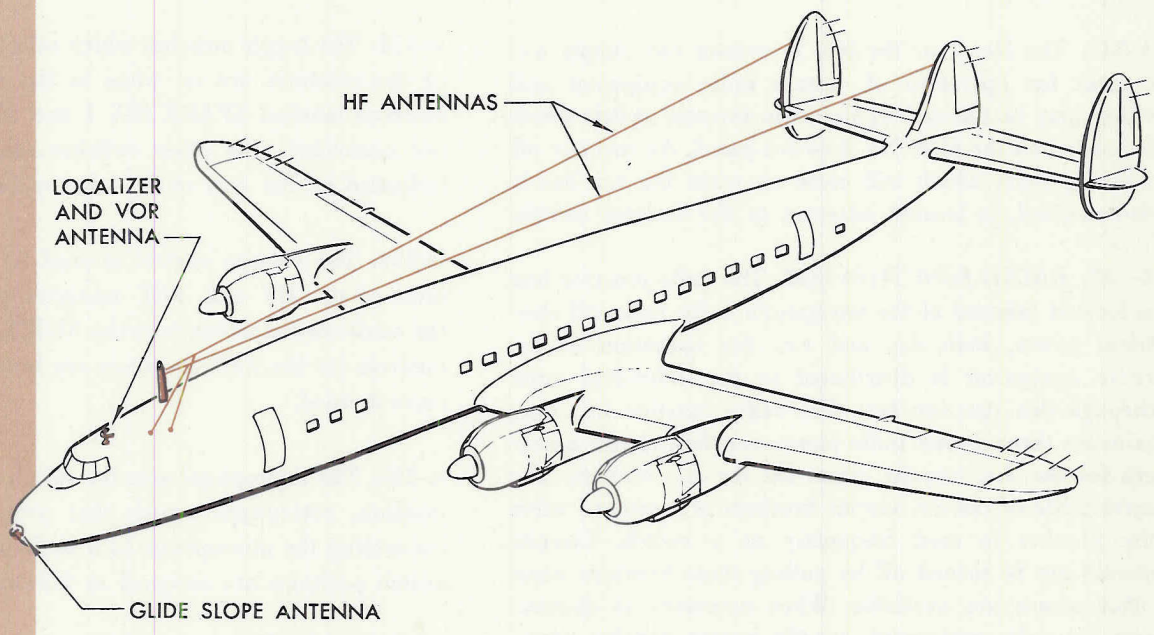


figure 4-20

4–345.. RADIO POWER SYSTEM.

4–346. All electrical power for operation of the radio equipment is distributed to the individual units through the radio junction box. Direct current is supplied to the radio junction box from two d.c. busses, the main d.c. bus and the emergency d.c. bus. During normal operation of the electrical system, the main d.c. bus is energized by the batteries and engine-driven generators and the emergency d.c. bus is energized by current from the main d.c. bus. Located on the aft face of the radio junction box are three switch-type circuit breakers that serve as master radio power switches. If all units of radio equipment are to be utilized, the master switches must be placed in the ON positions. In the event of failure of the main d.c. bus, the emergency d.c. bus can be energized directly by the batteries by placing the battery switch in the OFF position; this action causes a relay to close which connects the emergency d.c. bus to the battery bus. The following radio equipment are operated by direct current from the emergency d.c. bus: No. 3 HF communications receiver (RA-1B), No. 1 VOR receiver (51R-3), No. 1 VHF transmitter-receiver (RT-18/ARC-1), No. 1 glide slope receiver (51V-1), and No. 2 HF communications transmitter (T-47/ART-13). Four monitor lights on the radio operator's panel come on when the transmitter and receivers on the emergency bus are operated on battery power only.

4–347. The No. 1 or the No. 2 inverter can supply a.c. current for operation of certain radio equipment and either may be selected by the main inverter switch which is located on the MJB No. 1 switch panel. An inverter off warning light, which will come on when the a.c. bus is de-energized, is located adjacent to the inverter switch.

4–348. RADIO JUNCTION BOX. The radio junction box is located inboard of the navigator's radio rack. All electrical power, both d.c. and a.c., for operation of the radio equipment is distributed to the individual units through this junction box. The radio junction box contains the three master radio power switches, circuit breakers for the d.c. circuits, fuses for the a.c. circuits. The service life of the d.c. circuit breakers is shortened when the breaker is used frequently as a switch. Circuits should not be turned off by pulling these breakers when other means are available. When necessary to de-energize the radio equipment, use the master switches whenever possible. In the case of the a.c. circuits, however, fuses may be removed to de-energize a circuit.

4–349. ANTENNA SYSTEM.

4–350. The antenna system is installed as shown on figure 4–20.

4–351. RADIO EXHAUST SYSTEM. When the aircraft is in flight a venturi creates suction which removes heated air from the navigator's radio rack and the flight station radio rack areas. A butterfly valve in the system, by which the volume of air can be regulated, is controlled from the navigator's station by a knob which extends through the navigator's instrument panel.

4–352. RADIO SELECTOR BOXES. A radio selector box (figure 4–21) is provided for the pilot, the copilot, the radio operator, and the navigator. The selector boxes provide a means of selecting the audio output of any one or combination of five radio communication receivers, four navigation receivers, and a marker beacon receiver; the selection of any one of four communication transmitters; and interphone communications. Transmission facilities are not connected to the navigator's radio selector box. Although the radio selector boxes permit selection of the output of several receivers at one time, the possibility of interference from unwanted signals causing failure to receive an important message, increases as the output of each additional receiver is added to the total number of receivers connected to the headsets. For this reason, only those receivers actually in use or associated with radio channels which must be guarded according to definite orders, should be connected to the headsets at any one time.

4–353. The toggle switches which select the audio output of the receivers are on when in the up positions. The switches labelled SPARE NO. 1 and SPARE NO. 2 are not connected. The other switches connect receivers as indicated on the face of the selector box.

4–354. The volume control is used to adjust the audio level of the HF and VHF receivers only except when the auxil-normal switch is in the AUXIL position. Volume controls for the ADF receivers are located on the center control stand.

4–355. The microphone selector switch consists of a five-position, rotary-type switch that provides a means of connecting the microphone to a desired transmitter. The switch positions are assigned as follows:

PUBLIC ADDRESS	—MI-36A P.A. System (operative on pilot's box only)
HF No. 1	—AT-144 Transmitter
HF No. 2	—T-47/ART-13 Transmitter
VHF No. 1	—RT-18/ARC-1 Transmitter
VHF No. 2	—STR-12C Transmitter

4–356. The AUXIL-NORMAL switch is a guarded two-position toggle switch located below the lower right corner of each radio selector box. Should one or more amplifiers fail or should power to the radio selector box be cut off, communications can be maintained by placing the switch in the AUXIL position. This action causes the failed isolation amplifier to be bypassed and the audio output of the selected communications receiver to go directly to the headset. In this case, the audio output is selected by placing the toggle switch associated with the desired receiver up (On) and placing all those toggle switches to the left down (Off). Only one position at a time is usable when the auxil-normal switch is in the AUXIL position, the furthermost switch to the left taking precedence.

4–357. A range filter switch is provided on each radio selector box. Audio from the ADF and VOR sets is connected when the filter switch is in the NORMAL position and the filter is bypassed. When the switch is at VOICE or RANGE the appropriate type of signal is selected from the filter.

Radio Selector Box
LAC Serials 4510 Through 4519
Figure 4–21

To be included when available.

4–358. The ECLAIR REDUIT (light dimming) control switch selects bright or dim panel lighting.

4–359. The HAUT PARLEUR-CASQUE (loudspeaker-headset) switch connects the audio output from the selector box to either the loudspeaker circuit or to the headset jack. This permits the operator to monitor broadcasts with the loudspeaker at his station or with the headset. The loudspeaker circuit from each box is channeled separately through the amplifiers. Separate amplifier gain controls for each operator are provided beneath the circuit breakers on the radio junction box. An additional adjustment is provided by the muting volume control located beside each speaker, except the navigator's. When the operator depresses his microphone button, or when the control circuit of a selected radio transmitter is energized, a muting rheostat is connected in parallel with the speaker to reduce the speaker volume output. The purpose of this muting is to prevent acoustic feedback between the loudspeaker and the microphone. Muting is not provided for the navigator's speaker.

4–360. INTERPHONE AND INTERPHONE CALL SYSTEM.

4–361. CREW CALL SYSTEM.

4–362. Crew call facilities enable mechanics and the cabin attendants to signal the flight engineer, the flight engineer to signal the mechanics and the cabin attendants, and the pilot to signal the navigator. When a mechanics call

button is depressed, the call lights on the flight engineer's upper switch panel and on the jack boxes are lighted. Also, buzzers on the jack box sound. The ramp box has no call light or buzzer, but a call button is provided. The flight engineer signals the cabin attendant by a button on the upper switch panel which energizes the cabin chimes and a light on the cabin attendant's control panel, provided that the chimes have not been turned off by the cabin attendant. The call switch on the pilot's switch panel energizes a buzzer and a light located at the navigator's station.

4–363. SERVICE INTERPHONE SYSTEM. The service interphone system provides communication between the flight engineer and the mechanics stations. Mechanics interphone stations are located at the nose wheel strut, in each of the four engine nacelles, in the forward cargo compartment, and in the tail cone. An ON-OFF switch for the service interphone amplifier is located on the flight engineer's upper switch panel. A mechanics ramp box is provided on the nose landing gear for stowing a boom microphone and headset. A micro-switch operated by the ramp box cover opens the microphone circuit to the jack in the ramp box when the box is open. Thus, even though the microphone at this station remains plugged into the jack after the box is closed, no sound can be transmitted to the service interphone system.

4–364. PUBLIC ADDRESS SYSTEM. The public address system consists, mainly, of an amplifier installed on the navigator's radio rack, eleven loudspeakers installed in the ceiling of the cabin, and speaking facilities at the pilot's station and cabin attendant's station. The public address system is operated by power from the main d.c. bus which is continuously supplied without on-off switching. The P.A. system dynamotor is started when the control circuit is grounded by closing a microphone button during P.A. announcements. Volume controls by which the audio output of the public address amplifier can be regulated are located on the public address amplifier. These controls consist of rheostats concealed by two buttons on the front panel of the amplifier. A screwdriver is used to adjust the rheostats. LO volume is adjusted without the engines in operation but the HI volume is adjusted in flight with the engines operating at normal cruise power. Located on the cabin attendant's control panel is a two-position toggle switch by which the attendant can select either LO or HI volume for public address announcements. When the microphone button at the cabin attendant's control panel is depressed, the loudspeaker muting relay at that station is actuated, removing the speaker from the circuit and connecting a five-ohm resistor in its place. That prevents feedback through the cabin attendant's microphone, which would impair system intelligibility. The pilot uses the public address system by placing the microphone selector switch on his radio selector box in the PUBLIC ADDRESS position.

4–365. HIGH-FREQUENCY COMMUNICATION SYSTEM.

4–366. High frequency communications are provided by two transmitters and three receivers. The two transmitters (AT-144 and ART-13) and two of the receivers (AR-144 and BC-348) are divided into two HF communication systems designated as No. 1 HF and No. 2 HF. The No. 1 HF system is comprised of the AT-144 transmitter and the AR-144 receiver; the ART-13 transmitter and the BC-348 receiver comprise the No. 2 HF system. The No. 1 HF system is intended for use primarily by the pilots although the system can also be controlled by the radio operator. The No. 2 HF system will normally be used by the radio operator although the No. 2 HF transmitter (but not the receiver) can be remotely operated by the pilots.

4–367. The AT-144 transmitter (No. 1 HF) provides transmitting facilities in the frequency range of 1.6 to 1.75 megacycles and 2.0 to 22.0 megacycles. Tuning controls for the transmitter are located on the radio operator's remote control panel installed on the fuselage sidewall of his station and on the pilots' overhead radio control panel. These controls simultaneously select a crystal in the transmitter and a crystal in the receiver (AR-144). Once the crystal is selected the transmitter automatically finds the correct band (eight bands in the transmitter) and resonates all circuits properly. Tuning time varies from two to seven seconds. Power for the transmitter is taken from the main d.c. bus.

4–368. The ART-13 transmitter (No. 2 HF) operates in the frequency range of 200 to 1500 kilocycles and 2000 to 18,000 kilocycles, and is modified to permit the use of 20 autotune channels. An antenna loading coil is automatically switched into the circuit when the transmitter is used in the lower broadcast frequency band. Controls for the transmitter are located on the radio operator's remote control panel and on the pilots' overhead radio control panel. Power for the transmitter is obtained from the emergency d.c. bus.

4–369. The AR-144 receiver (No. 1 HF) is a 24-channel, remotely controlled receiver. A maximum of six crystals per channel are installed, making a total of 144 pre-set frequencies that may be selected. The frequency range of the set is from 2100 to 18,000 kilocycles. The receiver is used in conjunction with the No. 1 HF transmitter (AR-144) and is turned on and frequencies selected automatically by the same controls which operate the No. 1 HF transmitter. Audio output of the receiver is selected at the radio selector boxes by means of the HF-2

switches. The receiver is installed on the navigator's radio rack and is powered by direct-current from the main d.c. bus.

4–370. The BC-348 receiver (No. 2 HF) is a six-band, locally controlled set covering a frequency range of 200 to 500 kilocycles and 1.5 to 18.0 megacycles. The receiver can be controlled only by the radio operator through controls located on the face of the receiver box. The audio output of the receiver can be monitored at any flight station provided with a radio selector box by placing the audio switch labeled HF-2 in the up position. Power for the receiver is obtained from the main d.c. bus.

4–371. The RA-1B receiver (No. 3 HF) is a six-band set covering a frequency range of 150 to 1,500 kilocycles and 1.8 to 15.0 megacycles. The set will receive both modulated and unmodulated signals with either automatic or manual volume control. The RA-1B can be operated by either the radio operator or the pilots by means of a control transfer switch, labeled LOCAL-REMOTE, located on the face of the receiver unit. When the switch is placed in the REMOTE position, the receiver can be controlled by the HF-1 controls on the pilots' overhead radio control panel. Power for the receiver is obtained from the d.c. emergency bus. Operation of the No. 3 HF receiver on the emergency bus following failure of the main d.c. bus is indicated by the illumination of the REC HF-3 monitor light located on the panel to the right of the radio control panel in the radio operator's station.

4–372. HF COMMUNICATION SYSTEM CONTROLS.

4–373. FUNCTION SWITCH. The function switch is a five-position, rotary-type switch located on the No. 1 HF control panel in the radio operator's station. The switch is used to turn on the No. 1 HF transmitter and receiver (when locally controlled by the radio operator) and to select the desired mode of transmission. When the switch is rotated to the PILOT (PILOTE) position, control of the transmitter and receiver is transferred to the No. 1 HF power switch and frequency selector located on the pilots' overhead radio control panel.

4–374. POWER SWITCHES. Two conventional ON-OFF toggle switches, one for the HF-1 transmitter and receiver and one for the HF-2 transmitter, are located on the pilots' overhead radio control panel. These switches are operative only when control of these two HF systems has been transferred by the radio operator to the pilots.

4–375. LOCAL-REMOTE SWITCH. The local-remote switch is a two-position toggle switch located on the face of the HF-2 transmitter (ART-13). The switch is used by the radio operator to either retain control of the transmitter or transfer control to the pilots. If the switch is in the REMOTE position, the HF-2 power switch and frequency selector switch on the pilots' overhead radio control panel are in control of the transmitter.

4–376. FREQUENCY SELECTOR SWITCHES. Two frequency selector switches by which the pilots can control the HF-1 transmitter and receiver and the HF-2 transmitter are located on the pilots' overhead radio control panel. These switches consist of two concentric knobs with a small frequency window located above the knobs. Frequency selection is accomplished by merely rotating the large and small knobs until the desired frequency appears in the window. These frequency selectors are inoperative unless the radio operator's HF-1 function switch is in the PILOT (PILOTE) position and the HF-2 local-remote switch is in the REMOTE position. The frequency selector switch for the HF-1 system simultaneously controls frequency selection for both the transmitter and receiver. The HF-2 frequency selector controls the HF-2 transmitter only. The radio operator is provided with a similar frequency selector switch for the HF-1 system. This switch is located on the HF-1 remote control panel installed on the fuselage sidewall of the radio operator's station. Frequency selection on the HF-2 system is accomplished by the radio operator through controls located on the face of the transmitter (ART-13) and receiver (BC-348) units. Frequency selection for the HF-3 receiver (RA-1B) can be accomplished by either the radio operator or pilots through controls located on the receiver unit or through remote cable-operated controls located on the pilots' overhead radio control panel. The remote controls for this receiver will have no control over the receiver unless the local-remote switch on the receiver unit is in the REMOTE position.

4–377. MANIP SWITCH. The manip switch is a two-position toggle switch located on the radio operator's HF-1 remote control panel. The switch is used to connect the telegraph key to either the HF-1 transmitter (AT-144) or the HF-2 transmitter (ART-13).

4–378. STANDBY-TRANSMIT (PARE-EMMISSION) SWITCH. The standby-transmit (pare-emmission) switch is a two-position switch located on the radio operator's HF-1 remote control panel. If the HF transmitters are to be used for voice transmissions, the switch must be placed in the STANDBY (PARE) position and if the transmitters are to be used for CW transmissions the switch must be placed in the TRANSMIT (EMMISSION) position.

Note

When the standby-transmit (pare-emmission) switch is in the STANDBY (PARE) position and the radio operator's function switch is in the CW or MCW position, all HF receivers are disabled.

4–379. RECEIVER SELECTOR SWITCH (RECEPTEUR AVEC EM HF-2). The receiver selector switch is a four-position rotary-type selector switch located on the radio operator's remote control panel. When the switch is in the HF-2 position, the HF-2 receiver (BC-348) is connected to the center antenna lead-in (except when a HF transmitter is keyed) and the HF-2 transmitter (ART-13) sidetone is connected to the HF-2 audio circuit. When the switch is in the HF-2/HF-3 position, the HF-2 transmitter sidetone is connected to both the HF-2 receiver (BC-348) and the HF-3 receiver (RA-1B). This position connects HF-2 and HF-3 audio output without isolation, and enables the two receivers to be used together. The HF-2 transmitter sidetone is connected to the HF-3 receiver when the switch is rotated to the HF-3 position. When the switch is in the HF-3 AVEC EM HF-1 position, power to the HF-1 receiver (AR-144) is disconnected and the sidetone of the HF-1 transmitter (AT-144) is connected to the HF-3 receiver; the sidetone of the HF-2 transmitter is also disconnected.

4–380. NORMAL-MONITOR (NORMAL-ECOUTE) SWITCH. The normal-monitor switch is a two-position toggle switch located on the radio operator's HF-1 remote control panel. When the switch is in the NORMAL position, only the HF-1 transmitter sidetones will be heard in the headphones. When the switch is in the MONITOR (ECOUTE) position, transmitter sidetone is disconnected from the HF-1 circuits and the HF-1 receiver (AR-144) is used for direct reception of HF-1 transmissions, provided the HF-1 function switch is in the CW or MCW position.

4–381. MONITOR TRANSMITTER (ECOUTE EMETTEUR) SWITCH. The monitor transmitter (ecoute emetteur) switch is a three-position, rotary-type selector switch located on the radio operator's remote control panel. When the switch is in the NORMAL position, only the sidetones from the HF transmitters will be heard in the earphones. When the switch is rotated to either the REC HF-2 or REC HF-3 position, transmitter sidetone is disconnected and HF transmissions will be heard through the audio circuits of the selected receiver.

4–382. ACCORD REC BFO SWITCH. The accord rec bfo switch is located on the radio operator's HF-1 remote control panel and is used to adjust the beat frequency oscillator of the HF-1 receiver (AR-144).

4–383. HF COMMUNICATION SYSTEM INDICATORS.

4–384. MONITOR LIGHTS. Five radio monitor lights are located on the radio operator's remote control panel to indicate, when illuminated, that the radio set associated with the light is being operated on power obtained from the emergency d.c. bus. A light is provided for each one of the following radio sets: HF-2 transmitter (ART-13), HF-3 receiver (RA-1B), VHF-1 (ARC-1), VOR-1 (51R-2), and glide slope receiver No. 1 (51V-1).

4–385. CONTROL (CONTROLE) INDICATOR LIGHTS. Located on the pilots' overhead radio control panel are two radio control indicator lights to indicate, when illuminated, that the remote controls associated with the lights are in control of the radio sets to which they are connected.

4–386. "DYNAMOTOR ON" INDICATOR LIGHT. A "dynamotor on" indicator light, labeled DYN, is located on the HF-1 remote control panel in the radio operator's station. The light will glow while the transmitter dynamotor is in operation during CW or VOICE transmission.

4–387. HF COMMUNICATION SYSTEM OPERATION.

4–388. To place the HF transmitters in operation, proceed as follows:

a. Master radio power switches—ON.

b. Radio circuit breakers and fuses—pushed in and tight.

c. HF-1 function switch—PILOT (for remote control).

Note

Rotating the HF-1 function switch away from the OFF (COUPE) position, will automatically turn on both the HF-1 transmitter and receiver, except when the switch is placed in the PILOT (PILOTE) position. When the function switch is placed in the PILOT position, the HF-1 power switch on the pilots' overhead radio control panel must be used to turn the transmitter and receiver on.

d. Local-remote switch (on ART-13)—LOCAL (REMOTE for pilot control).

e. Standby-transmit switch—STANDBY.

Note

This switch must be in the STANDBY position during remote control (pilots') of the HF-1 system. For CW transmissions, rotate the function switch to the CW or MCW position and place the standby-transmit switch in the TRANSMIT position.

Pilots' Overhead Radio Control Panel
LAC Serials 4510 Through 4519
Figure 4–22

To be included when available.

f. Frequency selector switch—rotate until desired frequency is obtained.

Note

The frequency selector switches associated with the HF-1 system will automatically tune the transmitter and receiver to the same frequency. The frequency selector switch labeled HF-2 on the pilots' overhead radio control panel will tune the HF-2 (ART-13) transmitter only, provided the local-remote switch on the face of the transmitter is in the REMOTE position. The HF-2 receiver (BC-348) must be locally tuned by the radio operator.

g. Normal-monitor switch—NORMAL.

h. Manip switch—set to desired transmitter (CW only).

4–389. To place the BC-348 and RA-1B receivers in operation, proceed as follows:

a. Master radio power switches—ON.

b. Radio circuit breakers and fuses—pushed in and tight.

c. Local-remote switch (RA-1B)—set as desired.

Note

If the RA-1B local-remote switch, which is located on the receiver unit, is in the REMOTE

position, the receiver can be controlled by the pilots through remote controls located on the overhead radio control panel. The remote controls are the same as those on the receiver unit.

d. Power switch (RA-1B)—ON.

e. Avc-off-mvc switch (BC-348)—AVC or MVC, as desired.

Note

Moving this switch away from the OFF position will turn the receiver on.

f. Avc on-off switch (RA-1B)—set as desired.

g. CW osc on-off switch (BC-348)—ON (for CW operation).

h. CW on-off switch (RA-1B)—ON (for CW operation).

i. Crystal in-out switch (BC-348)—IN.

j. Antenna switch (RA-1B)—set as desired.

k. Band switch (BC-348 and RA-1B)—rotate until desired frequency band appears in the frequency window.

l. Tuning crank (BC-348 and RA-1B)—rotate until desired frequency appears in the frequency window.

m. Beat freq. control (BC-348)—adjust as desired (CW operation).

n. Volume controls—adjust for desired audio level.

o. Receiver selector switch (radio oper. remote panel)—HF-2.

p. Monitor-transmitter switch (radio oper. remote panel)—NORMAL.

4–390. VHF COMMUNICATION SYSTEM.

4–391. One RT-18/ARC-1 transmitter-receiver set and one STR-12C transmitter-receiver set provide radio telephone communication facilities within the VHF frequency range. The two transmitter-receiver units, which are located on the radio equipment rack in the navigator's station, are remotely controlled by the pilots through switches and controls located on the pilots' overhead radio control panel and on the radio selector boxes. The RT-18/ARC-1 is designated as the No. 1 VHF equipment and is modified to operate on any one of 50 crystal-tuned channels within the allotted VHF communications band. The RT-18/ARC-1 is connected to the forward VHF communications antenna and to the radio emergency power supply. Transmission and reception is always on the same frequency. The STR-12C transmitter-receiver is designated as the No. 2 VHF equipment and will provide communications over any one of 140 crystal-tuned frequencies within the frequency band of 118.0 to 131.9 megacycles. This transmitter-receiver unit is connected to the aft VHF communications antenna and to the normal radio power supply only. Transmission and reception on the STR-12C set is always on the same frequency. Because both the No. 1 and No. 2 VHF sets operate in the VHF frequency band their range is effectively limited to line-of-sight although under certain atmospheric conditions signals may be heard at distances more or less than line-of-sight range.

4–392. VHF COMMUNICATION SYSTEM CONTROLS.

4–393. FREQUENCY SELECTOR SWITCHES. Frequency selector switches for the VHF transmitters and receivers are located on the pilots' overhead radio control panel. The switches are designated VHF-1 and VHF-2. The VHF-1 frequency selector switch (RT-18/ARC-1) consists of two concentric knobs which are rotated until the desired frequency value appears in the vertical window above the knobs. The frequency selector switches for the VHF-2 (STR-12C) consist of two large dials mounted side-by-side on the right side of the radio control panel. One dial selects whole megacycles and the other selects tenths of megacycles.

4–394. POWER SWITCHES. The power switches for the VHF transmitter-receiver units consist of conventional ON-OFF (MARCHE-COUPE) toggle switches located next to the frequency selector switches for each radio set. Electrical power is applied to the transmitter-receiver units when the switches are placed in the ON (MARCHE) position.

Note

The VHF-1 transmitter-receiver units receive power from the radio emergency power bus and can, therefore, be operated on battery current alone in the event of failure of the d.c. engine-driven generators. Operation of the VHF-1 on battery power only is indicated by the illumination of the VHF-1 monitor light located on the radio operator's remote control panel.

4–395. VOLUME CONTROLS. The volume control for the VHF-1 radio set consists of a knob extending from the frequency selector switch for the equipment. The volume control for the VHF-2 radio set is located below the two frequency selector dials for the equipment.

4–396. VHF COMMUNICATION SYSTEM OPERATION.

4–397. To place the VHF radio sets in operation, proceed as follows:

a. Master radio power switches—ON.

b. Radio circuit breakers—pushed in.

c. Power switches—ON (MARCHE).

d. Frequency selector switches—rotate until desired frequency is obtained.

e. Microphone selector switch—VHF-1 or VHF-2.

f. Audio switches VHF-1 and VHF-2—UP.

g. Microphone buttons—press to transmit and release to receive.

4–398. AUTOMATIC DIRECTION FINDER (ADF) SYSTEMS.

4–399. The ADF equipment is used as a navigational aid and for aural reception of CW and modulated radio signals in the LF and MHF range between 100 and 1750 kc. The ADF installation is essentially two independent Bendix NA-1 systems, each consisting of a superheterodyne receiver with additional circuits necessary for automatic radio compass operation, a loop antenna, sense antenna, bearing indicator system, and remote control facilities. The No. 1 system (Red) is controlled by the pilots only, but the No. 2 system (Green) can be controlled by either the pilots or the navigator. The green controls are interlocked so that the pilot's function switch must be off before the navigator can operate the No. 2 ADF. Both receivers may be operated at the same time to give simultaneous bearings on two different stations. Bearing information is exhibited on the pilot's radio magnetic indicator and on the copilot's azimuth indicator; simultaneously, aural reception over the selected frequency is available using the sense antennas. Power for the No. 1 ADF receiver is obtained from the main d.c. bus and from the selected inverter through the No. 1 function switch. Power for the No. 2 ADF receiver is brought through the ADF control transfer relay from the main d.c. bus and the selected inverter. Both receivers are disabled if the main d.c. bus fails.

4–400. ADF SYSTEMS CONTROLS.

4–401. FUNCTION SWITCH. The function switch on the pilots' overhead radio control panel, or the navigator's transfer switch when the pilots' switch is off (COUPE) are used to turn the sets on and to select the desired type of operation. In the COMP position, the set functions as an automatic direction finder with both the loop and sense antennas being used. It is only in this position that the automatic features of the set are functioning. In the ANT position, the receiver is switched from the loop to the sense antenna giving the same performance as a communications receiver. In the LOOP (CADRE) position, the loop antenna can be manually rotated by use of the loop rotator switch. This position is used for aural-null procedures, or, in the case of extreme static, for best reception.

4–402. BAND SELECTOR SWITCH. The band switch provides a means of selecting any one of four frequency bands as follows: Band I, 100 to 200 kc; Band II, 200 to 410 kc; Band III, 410 to 850 kc; Band IV, 850 to 1750 kc.

4–403. LOOP ROTATOR SWITCH (CADRE). The loop rotator switch is located below the function switch and is used to manually rotate the loop antenna when the function switch is in the LOOP (CADRE) position. Direction and speed of rotation are determined by the displacement of the switch from its neutral position, rotation speed increasing as the switch is moved away from the neutral position.

4–404. CW-PHONIE SWITCH. A CW-PHONIE switch, one for each ADF receiver, is located on the ADF controls panel on the pilots' overhead radio control panel. The switches control the beat frequency oscillator in the receivers.

4–405. TUNING METER SELECTOR SWITCH. The tuning meter selector switch is located below the tuning meter on the ADF control panel. The switch is used to connect the tuning meter to either of the ADF receivers by moving the switch to either the RED (ROUGE) or GREEN (VERT) position.

4–406. RANGE FILTER SWITCH (FILTRE). The range filter switch on the radio selector boxes connects filters to the radio compass audio output to attenuate either the range (CW) or voice signals of the receiver so that unwanted signals do not reach the operator.

4–407. TUNING CRANK (RECH.). The tuning crank rotates the dial of the selected frequency band to the desired frequency.

4–408. SENSITIVITY CONTROLS. Two sensitivity controls are installed on the pilots' center control stand and the knobs are numbered around the circumference from one to ten, thus enabling pre-set sensitivities to be established. Each sensitivity control includes two ganged potentiometers. One potentiometer is in the audio output and is connected only during COMP operation. The other potentiometer controls the r-f gain and is used only during ANT or CADRE operation.

4–409. ADF INDICATORS.

4–410. ADF AZIMUTH INDICATOR. A single, dual-pointer azimuth indicator for the two radio compass re-

ceivers is located on the pilots' center instrument panel. The No. 1 ADF receiver is connected to the single-bar pointer and the No. 2 receiver is connected to the double-bar pointer. The pointers are operated by synchro systems which report the direction the loops are pointing with respect to the aircraft heading.

4–411. CONTROL INDICATOR LIGHTS. A dial light adjacent to the band selector switch on each ADF control panel comes on when that panel is in control.

Note

The GREEN controls are interlocked so that the pilots' function switch must be OFF before the navigator can transfer No. 2 ADF receiver controls.

4–412. TUNING METER (ACCORD VISUEL). The tuning meter indicates the intensity of the carrier wave reception and is used as an aid in tuning the receiver. The meter can be connected to either of the ADF systems by the ROUGE-VERT switch located immediately below the meter.

4–413. ADF SYSTEMS OPERATION.

4–414. To place the ADF receivers in operation, proceed as follows:

a. Radio master power switches—ON.

b. Inverter switch—on No. 1 or No. 2.

c. Function switches—place in desired position (ANT, COMP, or CADRE).

d. Band switches—rotate to desired frequency band.

e. Tuning crank—rotate to desired frequency (tune for maximum deflection of tuning indicator).

f. Audio switches—place in the Up position.

g. Sensitivity controls—adjust as desired.

h. VOR-ADF selector switches—set as desired.

4–415. GLIDE SLOPE RECEIVERS.

4–416. Two glide slope receivers are installed on the flight station radio rack. The receivers are connected through a coaxial tee fitting to the glide slope antennas in the nose of the aircraft. The glide slope receivers operate in conjunction with the VOR (localizer) receivers during instrument approaches and landings. The power switches by which the VOR receivers are turned on also supply power to the glide slope receivers. The receivers detect 90/150 cps tone-modulated signals in the VHF range between 329 and 335 megacycles and are automatically tuned to the correct VHF channel when a localizer channel is selected by the VOR receiver frequency selector switches. The No. 1 glide slope receiver is wired to operate with the No. 2 VOR receiver. The No. 1 VOR and glide slope receiver combination receives power from the emergency d.c. bus so that ILS facilities are retained in the event of failure of the main d.c. bus. The glide slope receivers are connected to the deviation indicators, as desired, through the VOR 1-2 switch located on the pilots' overhead radio control panel.

4–417. VOR NAVIGATION SYSTEM.

4–418. The VHF omni-directional navigation system provides the pilot and copilot with all of the radio aids to navigation now available in the VHF frequency range between 108.0 and 135.9 megacycles inclusive. This frequency range includes both military and commercial amplitude-modulated communications channels, omni-range (VOR) channels, runway localizer channels and two-course visual-aural range (VAR) navigation channels. All of the navigation information is visual and is observed on indicator units mounted on the pilots' instrument panels. Facilities are also provided for reception of audible identification signals. Because the receivers operate in the VHF bands, reception is limited to line-of-sight, the distance from a station whose signals are received depending largely upon the aircraft altitude. Remote controls for the receivers are installed on the pilots' overhead radio control panel. The two receivers, which are installed on the flight station radio rack, are connected in parallel with the VOR antenna.

4–419. Remote channel selector, volume, and on-off controls for each system are located on the pilots' overhead radio control panel. The VOR on-off (MARCHE-COUPE) switches on the pilots' overhead radio control panel operate relays which connect a.c. and d.c. power to the VOR receivers. The No. 1 VOR receiver is connected to the emergency d.c. bus so that ILS facilities are retained in the event that the main d.c. bus fails. While the No. 1 omni-bearing indicator and localizer service function properly during emergency operation, heading information from the fluxgate compass fails, which renders the readings of the radio magnetic indicators (RMI) inaccurate. Audio output from the VOR receivers can be directed through the range filter switch (FILTRE) on the radio selector boxes so that either the voice or range portions of the received signal can be attenuated.

4–420. VOR NAVIGATION SYSTEM CONTROLS.

4–421. FREQUENCY SELECTOR SWITCHES. A frequency selector switch for each VOR receiver is installed on the pilots' overhead radio control panel. The switches are labeled VOR-1 and VOR-2. Each switch consists of two concentric knobs; the large knob selects whole megacycles and the smaller knob selects tenths of megacycles.

Radio Operator's Station
LAC Serials 4510 Through 4519
Figure 4–23

To be included when available.

4–422. POWER SWITCHES. A conventional on-off (MARCHE-COUPE) toggle switch, by which both a.c. and d.c. power is applied to the receiver, is provided for each receiver. The switches are located next to the frequency selector switches on the pilots' overhead radio control panel.

4–423. AUDIO SWITCHES. Audio switches labeled VOR NO. 1 and VOR NO. 2 are installed on each of the radio selector boxes.

4–424. RANGE FILTER SWITCH (FILTRE). The audio outputs of the VOR receivers are connected through the range filter switch on the radio selector boxes. The range filter switch provides a means of selecting voice signals only, range signals only, or both range and voice signals.

4–425. VOR 1-2 SWITCH. This switch is installed on the pilots' overhead radio control panel. The switch is used to connect the deviation indicators (pilot's and copilot's) to the No. 1 VOR and glide slope receivers or to the No. 2 VOR and glide slope receivers.

4–426. VOR NAVIGATION SYSTEM INDICATORS.

4–427. OMNI-BEARING SELECTOR. The omni-bearing selector is installed on the glare shield instrument panel. Any magnetic course may be set on the omni-bearing selector in whole degrees, measured to or from the VOR station. The flag marker on the selector indicates whether the aircraft is heading To or From the station. The flag marker can be used as a station marker because the flag indicates TO until the station is reached and swings to FROM as the station is passed. When the strength of either the reference or variable signal falls below a safe level, the flag moves to a neutral position.

4–428. DEVIATION INDICATORS. A deviation indicator is installed on the pilot's and on the copilot's instrument panels. The indicators exhibit information from both the glide slope receivers and the VOR receivers. When used exclusively with the VOR system, the vertical needle deflects if the aircraft course differs from the heading set on the omni-bearing selector. When the aircraft course agrees with the set heading, the vertical needle is aligned with the vertical mark at the center of the dial. The horizontal needle is supplied signals from the glide slope receiver when an ILS channel is selected by the VOR receiver frequency selector switch. A coil in the deviation indicator pulls a warning flag away from the indicator when the equipment is functioning correctly. In either VOR or ILS operation, if the signals fall below a minimum value, the flag returns across the vertical needle. During ILS landings, a second flag on the deviation indicator warns of faulty glide slope operation.

4–429. LOCALIZER INOPERATIVE AND GLIDE PATH INOPERATIVE WARNING LIGHTS. These lights are located on the pilot's instrument panel to warn of inoperative or unsafe localizer or glide path signals at the flight path computer and that automatic pilot operation has replaced the disabled signal.

Note

These lights are not part of the VOR and ILS systems presently installed in the aircraft but are intended for use with the Pioneer flight path control system which will be installed at some future date.

4–430. VOR NAVIGATION SYSTEM OPERATION.

4–431. To place the VOR system in operation, proceed as follows:

a. Master radio power switches—ON.

b. Radio inverter—ON (NO. 1 or NO. 2).

c. VOR power switches—ON (MARCHE).

d. VOR 1-2 switch—set as desired.

e. Frequency selector switches—rotate large and small knobs until desired channel appears in vertical windows.

4–432. MARKER BEACON RECEIVER.

4–433. The marker beacon receiver is used as a navigating and landing aid. The receiver gives the pilots an aural and visual signal while the aircraft is passing over a 75-megacycle marker beacon transmitter. The marker beacon signals may originate from fan-type marker beacons associated with low-frequency radio ranges, from the cone-of-silence markers (z-type), or from any other system which transmits 75-megacycle signals. The presence of such a signal is indicated to the pilots by a tone in the headsets plus illumination of indicator lights on the pilot's instrument panel. Direct-current power for the marker beacon receiver is obtained from the main d.c. bus through the master radio power switch on the radio junction box. The receiver unit is on the navigator's radio rack. The marker beacon antenna is flush-mounted on the underside of the fuselage at the aircraft centerline and about 18 inches forward of the loop antennas.

4–434. MARKER BEACON RECEIVER CONTROLS.

4–435. AUDIO SELECTOR SWITCH. A marker beacon audio selector switch, by which the audio output of the receiver is connected to the headset, is located on each of the radio selector boxes; the switches are labeled MARKER and are on when placed in the up position.

4–436. FORT-COUPE-FAIBLE HI-LO-OFF SELECTOR SWITCH. This selector switch is located on the pilots' overhead radio control panel in the flight station, and is used to turn the receiver on and to select high or low receiver sensitivity. When the switch is placed in the FORT (HI) position, the received signals will be heard for a longer period of time.

4–437. MARKER BEACON INDICATOR LIGHTS. Three marker beacon indicator lights (white, amber, and blue) are installed on the pilot's instrument panel. While the aircraft is flying over a marker beacon transmitter, the lights will remain lighted or flash regularly, depending upon the type of transmission received. Fan-type markers and Civil Aeronautics Administration instrument-landing markers are identified by keying, and their intermittent flashes enable the pilot to identify the marker over which his plane is flying. Cone-of-silence markers are not keyed but transmit a steady signal. The lights function as shown on the following table:

LIGHT	AURAL IDENTIFICATION	VISUAL IDENTIFICATION	TYPE OF MARKER
White	3000 cps steady tone	Steady	Airways marker
White	3000 cps dashed tone	On-off in dashes	Airways fan-marker
Amber	1300 cps dotted tone	On-off in dots	Instrument landing system inner marker
Blue	400 cps dashed tone	On-off in dashes	Instrument landing system outer marker

4–438. The length of time during which the indicator lights glow while passing over a marker beacon transmitter depends upon the speed of the aircraft, the type of transmitter being flown over, and the altitude. This time may be from a few seconds to several minutes. Indications over cone-of-silence markers last about one minute at 10,000 feet when the speed of the aircraft is 150 miles per hour. Cone-of-silence markers utilize non-directional antenna arrays which cause indications of equal duration for any direction of flight.

4–439. LORAN RADAR SET.

4–440. The Loran Radar Set is an airborne navigation receiver-indicator unit that receives, amplifies, and detects LORAN signals and displays them on the screen of a cathode-ray tube. The set will operate at any altitude between sea level and 40,000 feet and at any temperature within the range of —55°C (—67°F) to 50°C (122°F). The receiver-indicator unit, which is located in the navigator's station, is connected, through a coupling unit, to the center overhead wire antenna. Because this antenna is also used by the HF communications equipment, the antenna lead-in to the Loran receiver is grounded when either of the HF transmitters is used. The receiver requires a.c. power which is obtained from the inverters.

4–441. LORAN RADAR SET CONTROLS.

4–442. RECEIVER GAIN AND POWER CONTROL KNOB. This control is used to turn the equipment on and to adjust the pulse for desired amplitude.

4–443. R. F. CHANNEL SELECTOR. The channel selector is used to select one of four pre-set channels. All four channels lie within the r-f band between 1.7 and 2.5 megacycles. The channels are set as follows: Channel 1, 1.95 mc; Channel 2, 1.85 mc; Channel 3, 1.9 mc; Channel 4, 1.75 mc.

4–444. AMPLITUDE BALANCE CONTROL. The amplitude balance control is used to vary the amplitude of the A and B pulse. The two pulse forms should be adjusted so that they are equal in height.

4–445. COARSE DELAY CONTROL. The coarse delay control is used to make coarse alignments of the B-pedestal and B-pulse. The B-pedestal should be directly under the B-pulse.

4–446. FINE DELAY CONTROL. The fine delay control is used to make fine adjustments of the B-pedestal and the B-pulse. Move the fine delay control until the extreme left end of the B-pedestal is under the B-pulse.

4–447. STATION SELECTOR. With the station selector in any one of its eight positions, pulses of several sizes and shapes may appear on the indicator screen. By moving the control to each of the positions, one setting will be found when the longest and most regular pulses are stationary. These are the proper pulses for use in determining the position of the aircraft.

4–448. PRR H-L SWITCH. This switch is used to synchronize the indicator with the available ground station.

4–449. LEFT-RIGHT SWITCH. The left-right switch is used to move the received signal indications to the left or right, as desired.

4–450. FUNCTION CONTROL. The function control provides a means of selecting eight sweep speeds. Positions 1 through 4 are used to position the A and B pulses.

Positions 5 through 8 are used in calculating the time differences, in microseconds, between the A and B pulses.

4–451. DRIFT CONTROL. The drift control is used to adjust the crystal phasing control to keep the received pulses in a stationary position.

4–452. LORAN OPERATION.

4–453. To place the radar set in operation, proceed as follows:

a. Radio inverter—ON.

b. Amplitude balance control—set to center position of rotation.

c. Fine delay control—set to center position of rotation.

d. Drift control—set at center position of rotation.

Note

This step is necessary only for equipment which is being operated for the first time. After operation, the control remains in the position where it was last used.

e. Receiver gain control—rotate clockwise until the station rate identification (pilot light) illuminates. Allow at least five minutes for the equipment to warm up.

4–454. RADIO ALTIMETER (AVQ-9).

4–455. The AVQ-9 radio altimeter gives visual indication of the aircraft altitude above terrain and has a nominal range of zero to 40,000 feet. Altitude measurement is exhibited on the indicator unit in the navigator's station by the appearance of a lobe on the face of a cathode-ray tube whose circular base is calibrated in feet from zero to 5000 feet. Two flush antennas are utilized by the transmitter-receiver unit; the transmitting antenna is installed in the lower surface of the left wing center section and the receiving antenna is installed in the lower surface of the right wing center section. When the equipment is in operation two lobes will always appear on the cathode tube; the lobe appearing at the zero point on the scale is the transmitted signal; the second lobe, appearing elsewhere on the scale between zero and 5,000 feet, represents the aircraft altitude above the underlying terrain. The set requires 115-volt, 400-cycle a.c. current, which is obtained from either the normal radio inverter or the standby inverter. The transmitter-receiver unit contains built-in power units that produce the necessary plate and filament voltages.

Note

The AVQ-9 altimeter is electrically interlocked with the AVQ-6 altimeter. Simultaneous operation of both altimeters would cause mutual radio interference between the two systems. To prevent this interference, the power leads to the AVQ-9 altimeter are routed through a relay in the radio junction box so that this relay is energized whenever the pilot turns on the AVQ-6 altimeter, thereby breaking the power circuit to the AVQ-9 altimeter.

4–456. RADIO ALTIMETER CONTROLS (AVQ-9).

4–457. The following controls are located on the indicator unit in the navigator's station:

4–458. OFF-ON REC GAIN SWITCH. This switch is used to turn the equipment on and to adjust the height of the lobes appearing on the cathode-ray tube. Operation of the set at a higher gain than is necessary will result in a fuzzy or blurred trace.

4–459. CIRCLE SIZE CONTROL KNOB. This control is used to adjust the size of the circle on the cathode-ray tube.

Note

Circle centering and rounding adjustment controls are located beneath the indicator dust cover. A trace that is off center or not truly circular will result in inaccurate readings.

4–460. SCALE SWITCH. The scale switch has two positions: TIMES ONE and TIMES TEN. The TIMES ONE position is used when the aircraft is flying below 5000 feet and the TIMES TEN position is used when flying above 5000 feet.

4–461. ZERO ADJUSTMENT KNOBS. The two control knobs labeled TIMES ONE ZERO ADJ. and TIMES TEN ZERO ADJ. are used to adjust the reference indicator lobe (transmitted signal) to the zero position of the scale on the indicator dial.

4–462. RADIO ALTIMETER OPERATION (AVQ-9).

a. Radio inverter (normal or standby)—ON.

b. OFF-ON REC GAIN switch—ON (continue turning clockwise until desired height of lobes is obtained).

c. Circle size control knob—adjust as required.

d. Scale switch—set as required.

e. Zero adjustment knob—adjust reference indicator lobe to zero point.

Note

The position of the scale switch determines which of the zero adjustment knobs is to be used for this adjustment.

4–463. RADIO ALTIMETER AVQ-6.

4–464. The AVQ-6 radio altimeter gives indication of the altitude above the terrain for navigational purposes. The altimeter is useful in determining altitude under adverse weather conditions, particularly when barometric corrections are not available. An interlocking relay in the radio junction box prevents operation of the AVQ-9 altimeter when the AVQ-6 altimeter is energized.

4–465. RADIO ALTIMETER CONTROLS (AVQ-6).

4–466. POWER SWITCH. The radio altimeter power switch is located on the altimeter indicator on the pilot's instrument panel. Power is applied to the equipment when the switch is rotated to the ON position.

Note

The AVQ-9 radio altimeter will be rendered inoperative when the AVQ-6 radio altimeter is in operation.

4–467. RANGE SWITCH. The range switch is also located on the radio altimeter indicator on the pilot's instrument panel. The altimeter can be set to give indications in either of two ranges; Low Range, 0-400 feet, and High Range, 400-4000 feet.

4–468. LIMIT SWITCH. The radio altimeter limit switch is located next to the nose wheel steering wheel on the pilot's side of the flight station. The switch operates in conjunction with the range switch and the altitude limit warning lights. The setting of the switch determines the altitude at which the indicator lights will function. The switch is set to the minimum altitude at which the pilot desires to fly.

4–469. RADIO ALTIMETER INDICATORS (AVQ-6).

4–470. RADIO ALTIMETER INDICATOR. The radio altimeter indicator is located on the pilot's instrument panel. The numerals 1, 2, 3, and 4 are read as hundreds of feet when operating in the low range; the numerals 10, 20, 30, 40 are also read as hundreds of feet when operating in the high range. Accurate readings cannot be obtained when the range switch is set at HIGH RANGE and the aircraft is flying below 400 feet, consequently, the range switch should not be set at HIGH RANGE during take-off or landing.

4–471. ALTITUDE LIMIT WARNING LIGHTS. Three altitude limit warning lights are located to the left of the radio altimeter indicator and operate in conjunction with the range switch and the limit switch. The green light will glow when the aircraft is flying at an altitude above the set altitude; the red light will glow when flying below the set altitude and the amber light will glow when the aircraft is flying at the set altitude.

4–472. LIGHTING SYSTEM.

4–473. EXTERIOR LIGHTS.

4–474. The exterior lights include the landing lights, taxi light, passing light, leading edge lights, fuselage lights, wing tip lights, tail lights, and wheel well lights. All of these lights are operated by the d.c. electrical system, and the control systems incorporate the necessary switches and relays. The wheel well lights come on automatically when the position lights are on and the gear uplocks are released. A flasher is provided for operation of the position lights. Circuit breakers, protecting the external light circuits, are located on the MJB No. 3 panel.

4–475. EXTERIOR LIGHT CONTROLS.

4–476. NAVIGATION LIGHTS SWITCH. This switch is located on the pilot's switch panel (figure 1–52) and controls the navigation lights. It has FLASH (up), off (center), and STEADY (down) positions. When the switch is placed in the FLASH position, the wing tip lights and the white tail cone light will flash alternately with the top and bottom fuselage lights and the red tail light. When the switch is placed in the STEADY position the wing tip lights and the white tail light burn steadily. This switch also arms the landing gear wheel well light circuits.

4–477. POSITION LIGHTS SWITCH. The position lights switch is located on the pilot's switch panel (figure 1–52) and is used to turn the position lights on.

4–478. NOSE LIGHTS SWITCH. A white, 450-watt taxi light is installed within a plexiglass housing in the nose of the fuselage. This light is turned on by moving the nose lights switch located on the pilot's switch panel (figure 1–52) to the WHITE position. A passing light, consisting of a 50-watt sealed-beam light with a red glass lens, is installed next to the taxi light in the nose of the fuselage. This light is turned on by moving the nose lights switch to the RED (up) position.

4–479. LANDING LIGHTS SWITCHES. Two 600-watt landing lights are installed in the lower surface of each outer wing panel and are controlled by switches on the pilots' overhead switch panel (figure 1–51). A switch for each light, labelled LAMP ON and OFF, turns the light on or off. Another switch for each light, labelled EXTEND, OFF, and RETRACT, controls the motors which extend or retract the lights. It is possible to turn the lights on while they are extended, retracted, or in any intermediate position.

4–480. LEADING EDGE LIGHTS SWITCH. A switch located on the pilot's switch panel (figure 1–52) controls the two white lights mounted on each side of the fuselage. These lights are used to illuminate the wing leading edge for detection of ice, etc.

4–481. INTERIOR LIGHTS.

4–482. Interior lighting provides for cabin, flight station, cargo compartment, tail section illumination, and for illuminating the various controls and panels provided for the flight crew. The crew compartment, lavatories, cabin, and night light circuits are protected by circuit breakers on the station 260 upper switch panel. Circuit breakers protecting the remaining internal light circuits are located on the MJB No. 3 panel and the radio junction box panel.

4–483. INTERIOR LIGHT CONTROLS.

4–484. PILOTS' INSTRUMENT PANEL LIGHTS SWITCHES. Direct red and direct white lighting is provided for the pilots' instrument panels. Four switches controlling these lights are located on the underside of the glare shield and are labelled EMERGENCY WHITE, PILOT'S RED, GLARE SHIELD, and COPILOT'S RED. Each switch has DIM, OFF, and BRIGHT positions. The EMERGENCY WHITE and PILOT'S RED switches are located on the pilot's side and the other two are located on the copilot's side.

4–485. PILOT'S SWITCH PANELS LIGHTS SWITCHES. A switch, located on each pilot's switch panel (figures 1–52 and 1–53), labelled PANEL LIGHT, OFF, controls the respective switch panel lights. A rheostat, located directly below the panel light switch, on each pilot's switch panel, controls the intensity of these lights. The rheostat is labelled PANEL LIGHT, DIM, BRIGHT.

4–486. CHART LIGHTS SWITCHES. A switch labelled CHART LIGHT, OFF, and a rheostat labelled CHART LIGHT, DIM, BRIGHT, are installed on the pilots' switch panels (figures 1–52 and 1–53). They are used to control chart lights on each side of the overhead panel. Each light has a removable red lens and the light can be removed from its base for hand use as a flashlight.

4–487. PEDESTAL REAR LIGHT SWITCH. A light, controlled by a two-position toggle switch on the copilot's switch panel (figure 1–53), labelled PEDESTAL REAR LT., illuminates the area between the pilots' seats, aft of the center control stand.

4–488. COMPASS LIGHT SWITCH. This switch, located on the copilot's switch panel (figure 1–53), has OFF, DIM, and BRIGHT positions and may be used to turn on the light in the standby compass and to control its intensity.

4–489. RADIO SELECTOR BOX LIGHT SWITCHES. The radio remote control panels are illuminated by small red lights installed in each panel. The light switch installed on the panel has BRIGHT, DIM, and OFF positions.

4–490. ORDINANCE LIGHTS (NO SMOKING AND FASTEN BELTS) SWITCHES. These switches are located on the pilots' overhead switch panel (figure 1–51) and turn the ordinance lights on or off. A switch is installed on the cabin attendants' switch panel that allows the cabin attendant to dim the ordinance lights.

4–491. PILOTS' OVERHEAD RADIO CONTROL PANEL LIGHT SWITCHES. A three-position toggle switch is provided to control the panel lights. The switch has OFF, DIM, and BRT. positions.

4–492. DE-ICER CONTROL PANEL LIGHTS SWITCHES. The pneumatic de-icer panel, located to the left of the pilot, is illuminated by direct red incandescent floodlights (figure 4–13) with integral switches.

4–493. CARGO AND TAIL SECTION INSPECTION LIGHTS SWITCH. A switch, located on the flight engineer's upper switch panel (figure 1–56), labelled INSPECTION LIGHTS CARGO & TAIL SECTION, controls the lights in the forward and aft cargo compartments and aft of the rear pressure bulkhead. The cargo compartment lights are automatically energized when their respective cargo compartment doors are opened, regardless of the position of the inspection lights switch. The door switches also actuate the door warning light located on the flight engineer's lower instrument panel.

4–494. FLIGHT ENGINEER'S INSTRUMENT PANELS FLOODLIGHTS SWITCH. A switch, located on the flight engineer's upper switch panel (figure 1–56), may be

used to illuminate the flight engineer's instrument panels with either red or white floodlights. The switch has DIM, OFF, and BRIGHT positions.

4–495. FLIGHT ENGINEER'S INSTRUMENT PANEL AUXILIARY LIGHTS SWITCH. A switch, located on the flight engineer's upper switch panel (figure 1–56), controls the small incandescent lights installed in a glare shield below the instrument panels. The switch has OFF, DIM, and BRIGHT positions.

4–496. STATION 260 INSTRUMENT PANEL FLOODLIGHT SWITCH. A switch, installed on the flight engineer's upper switch panel (figure 1–56), controls the floodlight that illuminates the station 260 panel. This switch has DIM, OFF, and BRIGHT positions.

4–497. STATION 260 PANEL LIGHTS SWITCH. This rheostat is located below the flight engineer's lower instrument panel (figure 1–56) and has positions between BRIGHT and OFF.

4–498. FLIGHT ENGINEER'S DESK LIGHT SWITCH. A rheostat type switch, located on the MJB No. 2 panel (figure 1–58), controls the lights for the flight engineer's desk. This switch has OFF, DIM, and BRIGHT positions. A toggle switch with RED and WHITE positions is installed adjacent to this switch to permit selection of red or white lighting.

4–499. MASTER JUNCTION BOX PANEL LIGHTS SWITCH. A switch, located on the MJB No. 2 switch panel (figure 1–58), with positions labelled OFF, DIM, and BRIGHT, controls the lights that illuminate the MJB panels.

4–500. RADIO OPERATOR'S STATION LIGHTS SWITCHES. Switches, located at the radio station, labelled RED and WHITE, are used to select either an adjustable white arm light, or an adjustable red arm light for illumination of the radio rack and radio operator's table. Each switch has OFF and BRIGHT positions for turning on and controlling the intensity of the selected light.

4–501. NAVIGATOR'S STATION LIGHTS SWITCHES. Two adjustable white arm lights are provided to illuminate the navigator's station. The rheostat type switch for controlling the lights is located on the radio junction box panel and the positions are labelled OFF and BRIGHT.

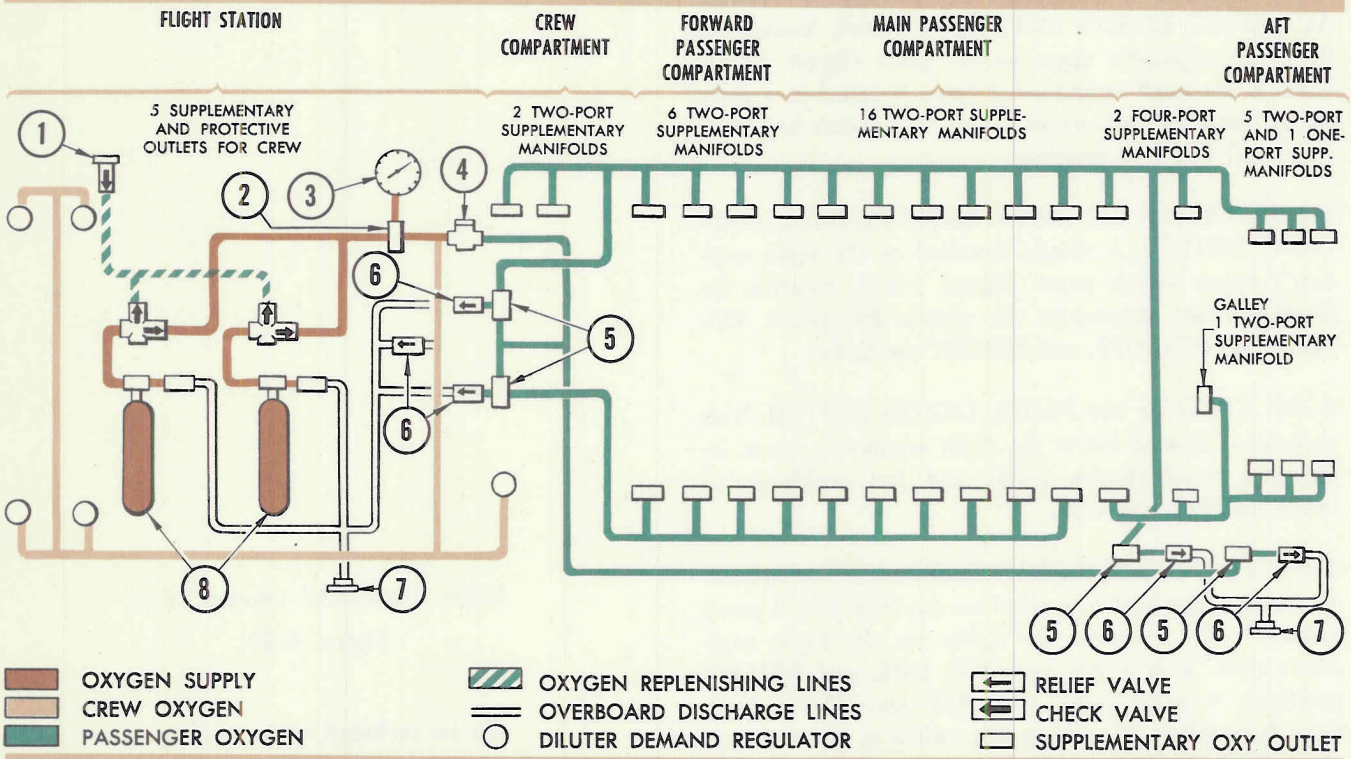
4–502. CABIN ATTENDANT CONTROL PANEL LIGHT. A switch with OFF, DIM, and BRIGHT positions to control floodlighting of the cabin attendants' control panel is located on that panel (figure 4–24).

Cabin Attendants' Control Panel
Figure 4–24

To be included when available.

oxygen system

LAC Serials 4501 Through 4509



1. Filler check valve
2. Pressure reducer
3. High pressure gage
4. Line shut-off valve
5. Continuous flow pressure regulators
6. Relief valves
7. Overboard discharge indicator
8. Oxygen supply cylinders

figure 4-25

4–503. OVERHEAD CABIN LIGHTS SWITCHES. Four switches with BRIGHT, DIM, and OFF positions are located on the cabin attendants' switch panel (figure 4–24) in the cabin, and are used to turn the cabin overhead lights on or off. These switches are labelled GALLEY, FWD., MAIN, and AFT.

4–504. NIGHT LIGHTS SWITCH. White night lights, installed in the ceiling of the cabin, provide subdued illumination when the main overhead lighting is not required. The lights are controlled by a switch installed on the cabin attendants' switch panel (figure 4–24) with ON and OFF positions.

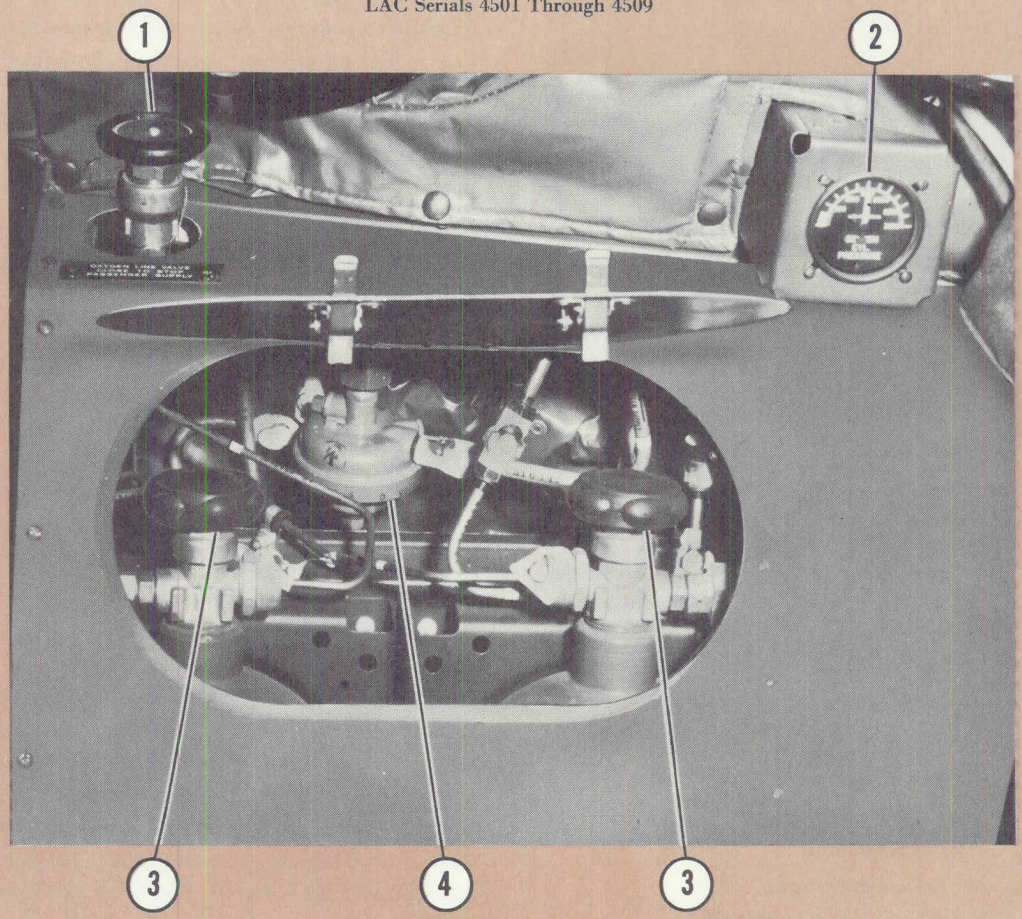
4–505. CREW COMPARTMENT LIGHTS SWITCH. A switch, located on the aft side of the station 260 bulkhead, controls the crew compartment ceiling lights. The switch has labelled OFF, DIM, and BRIGHT positions.

4–506. LAVATORY LIGHTS SWITCH. A switch that controls the general illumination in the lavatories is installed on the cabin attendants' switch panel (figure 4–24). The switch has NIGHT, OFF, and DAY positions.

4–507. READING LIGHTS SWITCHES. Individually controlled spotlight type reading lights are located above the passenger seats in the overhead racks. Each light is controlled by a push-button switch.

oxygen system controls

LAC Serials 4501 Through 4509



1. Oxygen line shut-off valve
2. High pressure oxygen gage
3. Oxygen cylinder shut-off valves
4. Oxygen pressure reducer

figure 4-26

4–508. OXYGEN SYSTEM (LAC Serials 4501 through 4509).

4–509. The aircraft is equipped with a high-pressure oxygen system. Either supplemental or protective oxygen can be selected from the diluter demand oxygen regulators installed in the pilot's, copilot's, flight engineer's, radio operator's, and navigator's stations. Supplemental oxygen is also available through continuous flow plug-in outlets to four relief crew members, two cabin attendants, and fifty-nine passengers. The plug-in outlets for the oxygen masks are distributed as shown on figure 4–25.

4–510. Oxygen is supplied by two high pressure oxygen cylinders, each having a capacity of 63.7 cu. ft. at a pressure of 1800 psi. Both of the cylinders are mounted in brackets installed on the left sidewall just above the floor and outboard of the radio operator's seat. An external filler check valve is installed in the fuselage skin forward of the crew door. Two emergency discharge outlets are installed in the fuselage skin on the left side of the aircraft. One is located near the oxygen cylinders and the other is located near the trailing edge of the wing. An oxygen pressure reducer automatically controls the pressure that is directed to the active crew member diluter-demand regulators and the passenger oxygen pres-

LAC Serials 4501 Through 4509

1. Oxygen supply control lever
2. Regulator pressure gage
3. Flow indicator
4. Air valve control lever
5. Safety pressure control lever

figure 4-27

sure regulators. There are four of these regulators that control the flow of oxygen to the passengers.

4–511. A high pressure gage is connected to the oxygen pressure supply lines to indicate the pressure in the oxygen supply cylinder. This pressure can be used to calculate the oxygen duration from the oxygen duration chart. (Refer to figure 4–28.)

4–512. PORTABLE OXYGEN BOTTLES. One portable pressure-demand oxygen cylinder is mounted in a bracket located on the left sidewall of the flight station.

4–513. OXYGEN CONTROLS.

4–514. OXYGEN CYLINDER SHUT-OFF VALVES. A shut-off valve is mounted on top of each oxygen cylinder (figure 4–26) to turn the oxygen supply on or off.

4–515. OXYGEN LINE SHUT-OFF VALVE. This valve is located on the left sidewall of the flight station above the aft oxygen cylinder (figure 4–26) and when closed, directs oxygen to only the active crew member diluter demand regulators. When open it permits a flow of oxygen to the passenger portion of the oxygen system.

4–516. DILUTER DEMAND REGULATOR OXYGEN SUPPLY CONTROL LEVER. This lever is located on the top of each diluter demand regulator (figure 4–27) and is used to shut off the oxygen supply to the regulator. The oxygen supply lever should be left in the OFF position when oxygen is not being used.

4–517. DILUTER DEMAND REGULATOR AIR VALVE CONTROL LEVER. The air valve lever, mounted on the oxygen regulator dial (figure 4–27), can be set to NORMAL OXYGEN or 100% OXYGEN. When the valve is in the NORMAL OXYGEN position, a mixture of air and oxygen, whose proportions are determined by altitude, is delivered to the face mask. When the valve is in the 100% OXYGEN position, a supply of undiluted oxygen is delivered to the mask.

4–518. DILUTER DEMAND REGULATOR SAFETY PRESSURE CONTROL LEVER. This lever is located on the face of each regulator (figure 4–27) and has OFF and ON positions. When the lever is placed in the ON position, oxygen is delivered at a slight positive pressure, thus permitting a pressure accumulation in the mask and eliminating leakage. The OFF position is the normal position.

4–519. OXYGEN INDICATORS.

4–520. HIGH PRESSURE GAGE. A high pressure gage is located above the forward oxygen cylinder (figure 4–26) and is connected to the oxygen supply line. This gage indicates the pressure in the oxygen supply cylinders from which the oxygen duration can be computed.

4–521. DILUTER DEMAND REGULATOR FLOW INDICATOR. A blinker is installed on the face of each regulator (figure 4–27) to indicate a positive flow of oxygen. At sea level the blinker may not operate since the amount of added oxygen is very small.

4–522. OXYGEN SYSTEM OPERATION.

4–523. NORMAL OPERATING INSTRUCTIONS.

a. Oxygen cylinder shut-off valves—open slowly.

b. Oxygen line shut-off valve—open slowly.

oxygen duration chart

LAC Serials 4501 Through 4509

SUPPLEMENTAL OXYGEN

CREW AND PASSENGER OXYGEN DURATION—HOURS

CABIN ALTITUDE FEET	GAGE PRESSURE—PSI						
	1800	1500	1200	900	600	300	50
25,000	.21	.17	.14	.10	.07	.03	EMERGENCY — DESCEND TO ALTITUDE NOT REQUIRING OXYGEN.
20,000	.25	.22	.17	.12	.09	.04	
15,000	.32	.28	.21	.15	.10	.04	
10,000	.48	.41	.32	.24	.15	.07	

ABOVE DURATION BASED UPON: 5 CREW MEMBERS USING OXYGEN FROM DILUTER DEMAND REGULATORS; 4 RELIEF CREW MEMBERS, 2 CABIN ATTENDANTS, AND 59 PASSENGERS USING OXYGEN FROM CONTINUOUS FLOW OXYGEN REGULATORS.

PROTECTIVE OXYGEN

5 ACTIVE CREW MEMBERS

1800 PSI CYLINDER PRESSURE — 350 LITERS AVAILABLE PER CREW MEMBER
1550 PSI CYLINDER PRESSURE — 300 LITERS AVAILABLE PER CREW MEMBER

figure 4-28

c. Oxygen high pressure gage—check for reading of approximately 1800 psi or check pressure against oxygen-duration chart to make certain that sufficient oxygen is available.

d. Diluter demand regulator oxygen supply control levers—ON.

e. Diluter demand regulator air valve control lever —NORMAL OXYGEN for all normal flight conditions.

f. Put on face mask. Fully engage mating portions of disconnect couplings of mask and regulator breathing tubes.

g. Check mask fit by squeezing mask tube and inhaling lightly. If the mask does not leak, it will adhere tightly to your face and a definite resistance to inhalation will be noticed.

h. While on oxygen, frequently check the cylinder pressure gage for oxygen supply, the oxygen flow indicator for flow of oxygen through the regulator, the mask for leak tightness, and the disconnect coupling to insure that it is fully engaged.

4–524. EMERGENCY OPERATING INSTRUCTIONS.

a. Should the symptoms, suggestive of the onset of hypoxia occur, or the regulator become inoperative, immediately turn the air valve lever to 100% OXYGEN and descend below 10,000 feet.

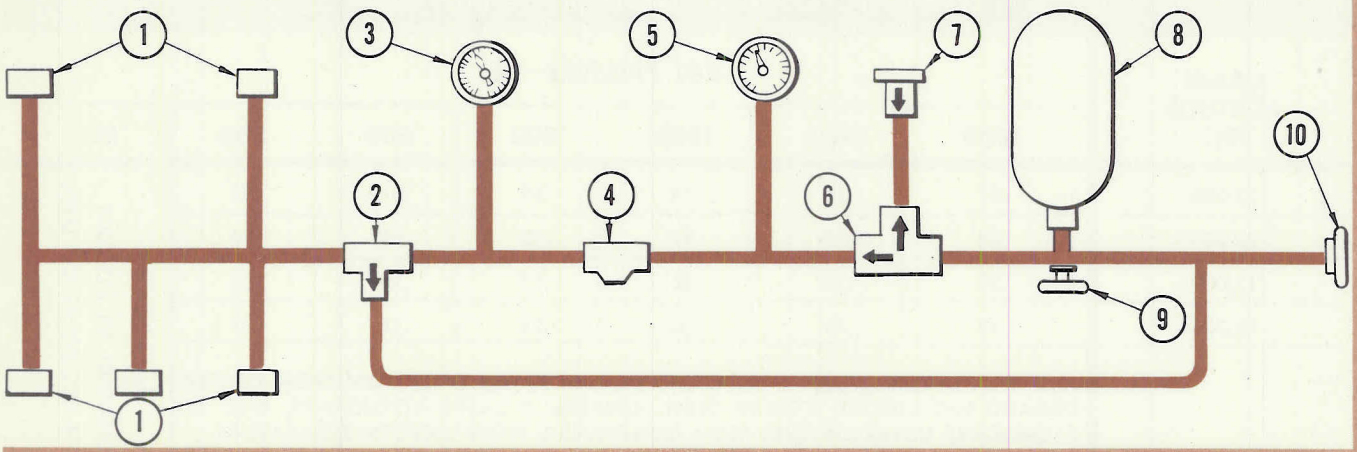
b. Whenever excessive carbon monoxide or other noxious or irritating gas is present or suspected, then regardless of the altitude, set the air valve at 100% OXYGEN until the danger has passed.

4–525. OXYGEN SYSTEM (LAC Serials 4510 through 4519).

4–526. The aircraft is equipped with a high-pressure oxygen system that provides 100% oxygen to each of the active crew members. The oxygen flows from the high pressure oxygen cylinder to a pressure reducer that automatically reduces the pressure to 60-65 psi and then it flows to the pressure demand regulators located at the pilot's, copilot's, flight engineer's, radio operator's, and navigator's stations. Refer to figure 4–29.

oxygen system

LAC Serials 4510 Through 4519



1	CREW PRESSURE DEMAND REGULATOR	6	TEE CHECK VALVE
2	OXYGEN PRESSURE RELIEF VALVE	7	OXYGEN FILLER CHECK VALVE
3	LOW PRESSURE OXYGEN GAGE	8	OXYGEN SUPPLY CYLINDER
4	PRESSURE REDUCER	9	OXYGEN SUPPLY CYLINDER SHUT-OFF VALVE
5	HIGH PRESSURE OXYGEN GAGE	10	OXYGEN DISCHARGE INDICATOR (OVERBOARD)

figure 4-29

4–527. The oxygen supply cylinder has a capacity of 107 cu. ft. at 1800 psi and is mounted in a bracket attached to the left sidewall of the flight station outboard of the radio operator's seat. The cylinder is provided with a shut-off valve and it can be refilled through the filler check valve located in the fuselage skin forward of the crew door. A line is also routed from the cylinder to an overboard discharge outlet, which includes a discharge indicator, in the left side of the flight station fuselage skin, just above the floor level.

4–528. Scott pressure-demand type regulators are provided at each active flight crew member's station and provide 100% oxygen to each member as he breathes through his mask.

4–529. A high pressure gage is installed in the oxygen supply lines to indicate the pressure in the oxygen supply cylinder and provides a basis for computing oxygen duration from the oxygen duration chart. (Refer to figure 4–31.) A low pressure gage is installed downstream of the pressure reducer to show that the pressure reducer is operating and to indicate the pressure of the oxygen delivered to the oxygen regulators.

4–530. PORTABLE OXYGEN BOTTLES. Five portable oxygen cylinders are installed. Two are pressure-demand types. One of these is located on the left sidewall of the flight station behind the pilot and the other is mounted on the right forward partition of the lounge. The other three are continuous flow types. One is located in each of the following places: In the left forward coat closet, on the right forward partition of the lounge, and in the left aft passenger coat closet.

4–531. OXYGEN CONTROLS AND INDICATORS.

4–532. OXYGEN CYLINDER SHUT-OFF VALVE. The shut-off valve on top of the oxygen cylinder (figure 4–30) is used to turn on or shut off the oxygen supply.

Oxygen System Controls
LAC Serials 4510 Through 4519
Figure 4–30

To be included when available.

4–533. OXYGEN HIGH PRESSURE GAGE. The high pressure gage located above the oxygen supply cylinder (figure 4–30) is connected to the oxygen high pressure supply line and indicates the pressure in the oxygen supply cylinder from which the oxygen duration can be computed.

4–534. OXYGEN LOW PRESSURE GAGE. This pressure gage is located near the high pressure gage above the oxygen supply cylinder (figure 4–30) and is installed in the oxygen supply line downstream of the pressure reducer. The purpose of this gage is to indicate that the pressure reducer is operating properly.

4–535. OXYGEN SYSTEM OPERATION.

4–536. NORMAL PROCEDURES.

a. Oxygen cylinder shut-off valve—open slowly.

b. Oxygen high pressure gage—check for a reading of 1800 psi or check pressure against oxygen duration chart to make certain that sufficient oxygen is available.

c. Oxygen low pressure gage—check for a reading of 60-65 psi.

oxygen duration chart

LAC Serials 4510 Through 4519

SUPPLEMENTAL OXYGEN

CREW OXYGEN DURATION—HOURS

CABIN ALTITUDE FEET	GAGE PRESSURE—PSI						
	1800	1500	1200	900	600	300	50
25,000	1.9	1.57	1.25	.92	.60	.27	EMERGENCY— DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
20,000	1.53	1.27	1.00	.74	.49	.22	
15,000	1.25	1.03	.82	.61	.39	.18	
10,000	1.02	.84	.67	.49	.32	.15	

ABOVE DURATION BASED UPON 5 CREW MEMBERS ON PRESSURE DEMAND FLOW.

PROTECTIVE OXYGEN

5 ACTIVE CREW MEMBERS

1800 PSI CYLINDER PRESSURE—600 LITERS AVAILABLE PER CREW MEMBER.
950 PSI CYLINDER PRESSURE—300 LITERS AVAILABLE PER CREW MEMBER.

figure 4-31

d. Put on face mask. Fully engage mating portions of disconnect couplings of mask and regulator breathing tubes.

e. Check mask fit by squeezing mask tube and inhaling lightly. If the mask does not leak, it will adhere tightly to your face and a definite resistance to inhalation will be noticed.

f. While on oxygen, frequently check the cylinder pressure indicators for correct low pressure and adequate oxygen supply.

4–537. AUTOMATIC PILOT.

4–538. The PB-10 automatic pilot installed in the aircraft is an electrically operated system that requires alternating current, which is supplied by the inverter system, and direct current, which is supplied by the main d.c. bus. The automatic pilot establishes references for automatic control of the aircraft. Whenever there are any deviations in the attitude of the aircraft from these flight references, the system senses these deviations electronically and operates the rudders, ailerons, and elevators through the normal flight control system, accordingly.

4–539. Fundamentally, the automatic pilot is made up of nine components. Of these the gyro Flux Gate transmitter, the amplifier signal generator, the three main servos, and the elevator trim tab servo, comprise the working units of the system. The remaining three components, the master direction indicator, the three-axis trim indicator, and the controller provide indications and operating controls for the pilots. In addition, switches are provided to control the various functions of the equipment.

4–540. An elevator trim tab servo eliminates the need for manual nose up or nose down trimming when the automatic pilot is being used, because the elevator trim tab servo is controlled directly by the elevator servo signal. When the elevator servo is required to sustain a force for a period of time to hold an elevator position,

the elevator trim tab servo will be automatically actuated and will position the trim tab to provide aerodynamic balance. The manual trim tab wheel will move very slowly and the tab position indicator will show the position of the tab.

4–541. A safety circuit in the amplifier causes disengagement of the automatic pilot servo clutches in case of a.c. power failure. The automatic pilot clutches are also automatically disengaged in case of d.c. power failure.

4–542. FLIGHT PATH CONTROL SYSTEM.

4–543. Provisions are made for the future installation of a flight path control system. This system will enable the aircraft to follow a fixed flight path derived from the VHF radio navigation system, and to automatically approach a landing field through the use of existing ILS facilities. Radio directional signals are supplied from a VOR receiver and a glide slope receiver. Where dual installations for these receivers are made, the pilot selects either the No. 1 or No. 2 receiver with the ILS transfer switch on the overhead radio control panel. The same signals which are sent to the deviation indicators or the Zero Reader indicator are also sent to the flight path computer. The information from the flight path computer is then used to operate the surface controls through the automatic pilot system. Included in the flight path control system is the throttle servo equipment. The function of the throttle servo is to maintain an essentially constant airspeed during aircraft descent along an ILS glide path.

4–544. The necessary controls for operation of the flight path control system are on the pilots' control stand. The DIRECTION switch is used when flight path control is connected to localizer radio signals. With the direction switch at BLUE RIGHT the aircraft flies toward the ground station on the inbound course. Raising the guard and placing the switch at BLUE LEFT reverses the deviation signal in the computer, and the aircraft heads away from the station. The primary control in the flight path control system is the sequence switch on the pilots' control stand. This switch has four positions labelled OFF, VHF RANGE, LOCALIZER, and LOCALIZER AND GLIDE PATH. When this switch is OFF the aircraft is not directed by the flight path control and returns to automatic pilot operation. If the flight path control system is disconnected for any reason, such as moving the controller handle from its detent, the sequence switch must be returned to OFF before any of the flight path control functions can be selected.

4–545. Three red warning lights, one for the automatic pilot, one for the glide path, and the last for the localizer, are on the pilot's instrument panel. The automatic pilot light monitors the amplifier plate voltage† and also indicates that the clutch switch is disengaged.* If either of these power supplies is inoperative, the light is energized. The localizer and the glide path alarm circuits in the flight path computer ground the circuits to the localizer and glide path lights, warning of improper operation in the flight path computer. When either of these lights is on, the flight path control system is automatically disconnected from the automatic pilot. Until the flight path computer is installed, the localizer and glide path warning lights are inoperative, except for the "depress-to-test" circuits when the sequence switch is positioned to select the function corresponding to the light.

4–546. Space provisions are made behind the flight engineer's control quadrant for automatic throttle control equipment. Future incorporation of the throttle servo, servo engage actuator (geneva actuator), follow up autosyn, throttle clutch assembly, and a throttle servo engage interlock microswitch can be made in this area. The throttles will be clutched so that they can be overridden manually by either the pilot or the flight engineer with the clutch engaged. Mechanical disconnect levers to engage or release the throttle clutch will also be provided for the pilot and the flight engineer for use as a throttle lock because of decrease in throttle friction.

4–547. AUTOMATIC PILOT CONTROLS.

4–548. INVERTER SWITCH AND CIRCUIT BREAKERS. When the inverter switch, located on the MJB No. 1 switch panel (figure 1–58), is turned on, and the circuit breakers, two labelled AUTO PILOT Aϕ and Cϕ, and one labelled D.C., located on the MJB No. 2A switch panel, are pushed in, both alternating current and direct current are directed to the system.

4–549. SERVO EMERGENCY DISCONNECT LEVERS. These three levers, located on the lower aft side of the center control stand (figure 4–32), operate mechanical clutches in each of the servos. Raising any one lever completely disengages the corresponding servo pulley from the servo drive shaft so that the pulley is free to turn with control cable movement. The servo disconnect levers also operate interlock switches at the beginning of their travel which interrupt the d.c. power to the clutch switch and prohibit its engagement before the actual mechanical engagement.

*LAC Serials 4501 through 4509. †LAC Serials 4510 through 4519.

4–550. AUTOMATIC PILOT CAGING SWITCH. This momentary contact switch, located on the center control stand (figure 4–32) and to the left of the clutch switch, provides a means for expediting the erection of the gyro in the gyro Flux Gate transmitter and the automatic pilot vertical flight gyro. When the caging switch is placed in the on (up) position and then released, the caging motors are energized to drive and lock the gimbal rings of the gyros so that the gyros are caged; then the gyros are automatically released (uncaged) and the caging motors are stopped. The caging circuit to the automatic pilot and Flux Gate compass also includes an interlock so that in case the caging switch is closed, while the automatic pilot is engaged, the clutch-switch holding solenoid is de-energized. This releases the clutch switch, allowing it to pop out, disengaging the automatic pilot.

4–551. CLUTCH SWITCH. This switch is located on the center control stand (figure 4–32), directly above the caging switch, and when pressed in, operates an electric clutch in each of the servos and the master direction indicator to engage the automatic pilot, provided a.c. and d.c. power have been on approximately 2 minutes; servo disconnect levers are in the ON position; altitude control switch is OFF; and gyros are uncaged. A clutch time delay relay prevents engagement of the clutch for approximately 2 minutes after the automatic pilot is turned on. The delay set in by the relay allows time for the amplifier tubes to warm up, the gyros to reach operating speed, and the servos to turn to cancel the net channel signal before the automatic pilot takes control of the aircraft. During this delay period, the clutch switch, when pressed, will not hold and will not operate the servo clutches. The trim tab functions with the automatic pilot clutch switch. With the clutch switch out and the automatic pilot not engaged, a clutch inside the trim tab servo disengages to free the servo. A pulley friction release, mounted on the servo shaft, permits overpowering the trim tab servo.

4–552. ALTITUDE CONTROL SWITCH. This switch, which is mounted on top of the controller (figure 4–32), energizes a clutch which connects the altitude control autosyn to its sensing aneroid. Any deviation from the altitude at which this clutch is engaged will cause a signal to be generated for automatic control of the elevator, which will hold the aircraft at any pressure altitude up to 30,000 feet, provided airspeed and altitude are stabilized at the time it is turned on. Regardless of the amount the aircraft is displaced in altitude, the maximum pitch change that the unit can set in to return the aircraft to its original altitude is ±8°. The switch is electrically interlocked with the clutch switch to prevent engagement of the automatic pilot while the altitude control switch is ON. Also, when the altitude control switch is ON, a guard covers the pitch trim knob, making it inaccessible.

4–553. CONTROLLER. The controller, mounted on the center control stand (figure 4–32), is installed to permit maneuvering the aircraft through the automatic pilot to make coordinated turns, climbs, descents, climbing turns, or descending turns. The three controls and their functions are:

a. The pistol grip turn handle (figure 4–32) incorporates two cut-out switches; one operated automatically whenever the handle is displaced 4 degrees maximum in either direction from the center position and the other operated manually by a trigger switch on the pistol grip. The switches are normally closed and are connected in series with the clutch solenoid in the master direction indicator. When either switch is opened, the course autosyn is disengaged, thus allowing the selection of a new heading by use of the turn handle. If neither of these switches is opened while maneuvering the aircraft with the controller, the aircraft will return to its original heading when the turn handle is returned to the detent.

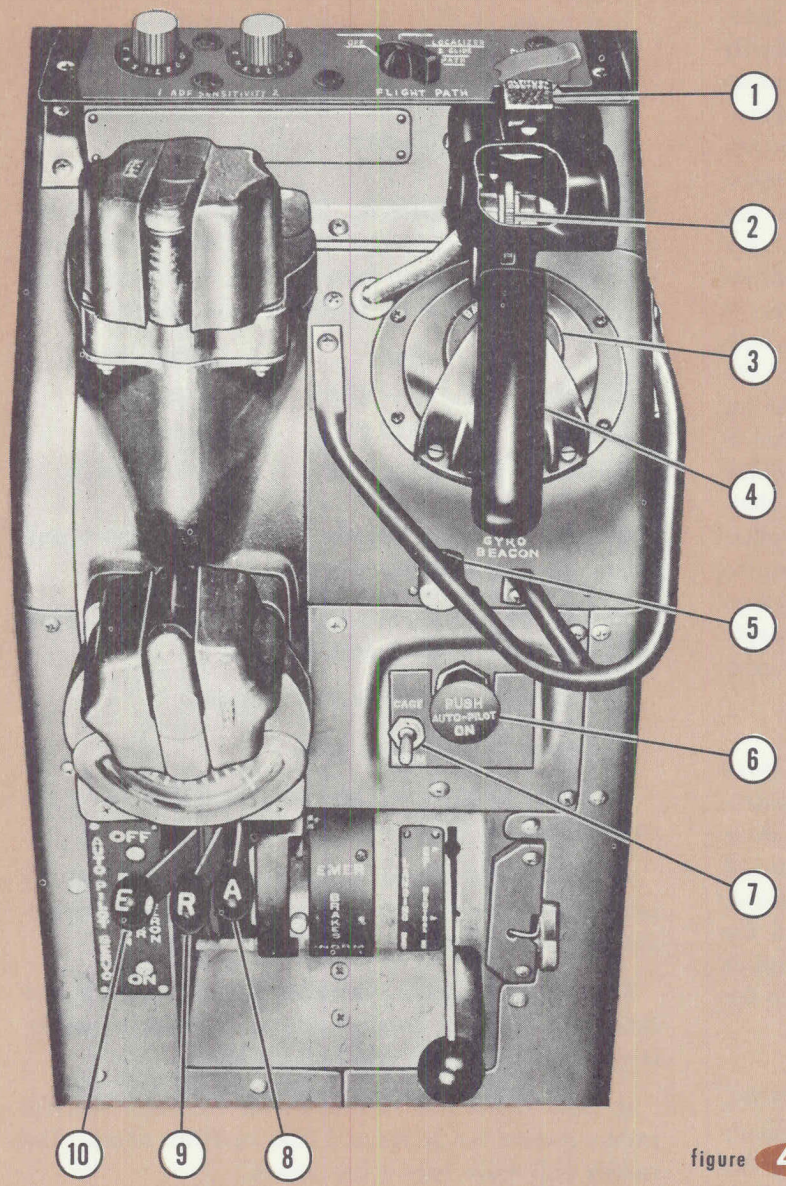
b. The bank trim knob (figure 4–32) may be used to adjust bank attitude after squeezing the pistol grip trigger switch. (See paragraph on CRUISE procedure.)

c. The pitch trim knob (figure 4–32) may be used to bias the elevator channel for any desired angle of climb or descent. This control is not accessible with the altitude control switch ON.

4–554. PILOTS' CLUTCH DISCONNECT SWITCHES. These switches, mounted on the pilot's left hand and the copilot's right hand control wheel grip, provide a means for disengaging the automatic pilot. When pressed, either of these switches will electrically disconnect the automatic pilot system and the clutch switch will pop out. When this occurs, the clutches in the servos and in the direction indicator are disengaged, preventing automatic control from being applied to the aircraft control surfaces.

4–555. FLUX GATE SENSITIVITY CONTROL. This control, located on the lower right corner of the automatic pilot amplifier-signal generator, under a removable cover, is used for adjusting Flux Gate compass sensitivity. For latitudes approximating that of the Continental

automatic pilot controls



1. Altitude control switch
2. Pitch trim knob
3. Bank trim knob
4. Pistol grip turn handle and trigger switch
5. Gyro beacon light
6. Clutch switch
7. Automatic pilot Flux-Gate caging switch
8. Aileron servo disconnect lever
9. Rudder servo disconnect lever
10. Elevator servo disconnect lever

figure 4-32

United States, this adjustment can be full counterclockwise. For those latitudes nearer the poles where the horizontal component of the earth's flux is weaker, increased sensitivity will probably be preferred. A setting which is too high results in oscillation of the master direction indicator and of the aileron servo. Sluggish movement of the direction indicator occurs when the setting is too low.

4–556. AUTOMATIC PILOT SWITCH. This is a guarded switch (figure 1–52) located on the pilot's switch panel and is normally left in the ON position. In an emergency this switch is used to shut off the a.c. and d.c. power supply to the automatic pilot and the Flux Gate compass.

4–557. AUTOMATIC PILOT INDICATORS.

4–558. GYRO BEACON LIGHT. The gyro beacon light (figure 4–32), located on the center control stand, directly above the automatic pilot clutch switch, indicates the erect position and the approximate rotating speed of the flight gyro. This beacon light is energized through a photo-electric tube positioned so that the light reflected from a mirror surface on the flight gyro erector, strikes the photo-electric tube, and causes the neon bulb to glow. When the gyro is properly erected and running at correct speed, and the aircraft is not in a bank or steep climb, the neon bulb glows approximately 35-45 times per minute.

4–559. MASTER DIRECTION INDICATOR (FLUX GATE). The Flux Gate master direction indicator, located on the copilot's instrument panel (figure 1–49), indicates the magnetic heading of the aircraft whether the automatic pilot is engaged or disengaged. The dial is directly connected through gears and linkages to an induction motor which operates both directionally and proportionally to changes of the magnetic heading of the aircraft. When the heading changes, the gyro Flux Gate transmitter, mounted in the left wing, electrically senses this change due to its change of position in the earth's magnetic field, and transmits a signal to the Flux Gate direction indicator. Here this signal serves three purposes; it is used to drive the dial of the Flux Gate direction indicator, to provide heading information to the radio VOR navigation system, and to originate a course signal for automatic control of the ailerons. The course signal is then transmitted to the amplifier where it is amplified and modified to become a working signal with the characteristics necessary for application of power to the aileron servo motor. When this working signal energizes the servo motor, which is tied into the aileron control system of the aircraft, it drives in the proper direction to apply corrective force for holding the aircraft on a desired magnetic heading.

4–560. THREE AXIS TRIM INDICATOR. The three axis trim indicator, mounted on the pilot's center instrument panel (figure 1–49), is connected across all three amplifier channels and indicates trim condition in all three axes. A sustained displacement of the indicator hand indicates a servo is putting out torque and the direction indicated. This out-of-trim condition requires manual correction by use of the trim tab controls in the same direction.

4–561. PB-10 (AUTOMATIC PILOT) WARNING LIGHT.* This red warning light is located on the pilot's instrument panel (figure 1–49) and is on any time the automatic pilot switch is OFF, or whenever the plate supply monitor has switched the servo power off.

4–562. NORMAL OPERATING PROCEDURES.

a. To engage the automatic pilot for ground check:

1. Circuit breakers—in.

2. Inverter switch—ON.

3. Automatic pilot switch—ON.

4. Servo disconnect levers—ON.

5. Gyros—caged (after the inverter has been operating at least two minutes). Allow about 30 seconds for completion of the caging cycle.

Note

The gyro beacon light indicates that the flight gyro is erect and up to speed when it flashes at a rate of 35 to 45 times per minute.

6. Altitude control switch—OFF.

7. Clutch switch—press.

4–563. GROUND CHECK. The forces tabulated below refer to: Elevator force applied on the center of the control wheel hub; aileron force applied at the rim of the wheel; and rudder force applied on the rudder.

	Stall	Overpower
Elevator	30 + 0 — 10 lb.	50 ± 10 lb.
Rudder	95 + 0 — 28 lb.	175 ± 30 lb.
Aileron	169 ± 34 in. lb.	350 ± 70 in. lb.

4–564. To determine that the values of the above stall forces are approximately correct:

a. With the engines running and with boost on, operate the surface controls several times.

b. Neutralize (center) surface controls.

c. Engage the automatic pilot.

d. By use of the pitch and turn controller, move the surface controls each way.

e. Operate the turn controller and determine that the rotation of the control wheel can be stopped with moderate effort of one hand.

f. Operate the pitch controller forward and aft and determine that the control column movement can be stopped with moderate effort of one hand.

g. Operate the turn controller and determine that the rudder motion can be stopped with moderate effort. (The rudder will move only a few inches.)

4–565. To check the overpowering forces, proceed as follows:

a. With the turn and pitch controller in the neutral position, operate each of the surface controls against the power of the automatic pilot.

b. Using two hands on the wheel, the pilot should be able to turn or move it forward and aft.

c. By applying considerable effort on the rudders, the pilot should be able to move the pedals each way.

Note

The above checks must not be performed in flight.

*LAC Serials 4501 through 4509.

4–566. The above checks give the pilot an approximation of the forces that the automatic pilot can produce. If it requires maximum effort with two hands to stall the elevator, the pilot is sure that the automatic pilot is capable of producing excessive force. If the pilot can overpower the ailerons easily with one hand, he knows that the aileron servo is not putting out sufficient force.

Note

Wind blowing directly on the tail may affect the required force on the controls.

4–567. BEFORE TAKE-OFF.

a. Pilot's clutch disconnect switch—press.

b. Servo disconnect levers—OFF.

4–568. CLIMB.

a. After climb power is set, the aircraft should be trimmed before the automatic pilot is used.

b. Altitude control—OFF.

CAUTION

Never turn the altitude control switch ON during a climb. If it is accidentally turned ON, trim the aircraft and disengage the automatic pilot before turning it OFF.

c. Servo disconnect levers—ON.

d. Clutch switch—push.

4–569. CRUISE. When the desired cruising altitude has been attained, proceed as follows:

a. Disengage the automatic pilot.

b. Trim the aircraft manually for straight and level cruising flight at the desired altitude with desired cruising power.

c. Set the automatic pilot trim knobs to neutral.

d. Check that the altitude control is OFF.

e. Engage the automatic pilot.

f. Altitude control—ON, if desired.

g. If the altitude control fails to hold a steady altitude, it is possible that the aircraft was slightly out of trim when the altitude control was turned ON. To correct this, repeat the above steps in this paragraph.

Note

If a major change in trim occurs, such as a power change, while using the altitude control, it will be necessary to disengage the automatic pilot, turn OFF the altitude control, and repeat the above steps. For minor changes in trim as noted on the three axis trim indicator, adjustments can be made to the aircraft trim tabs in the normal manner while on altitude control.

h. The automatic pilot now has control of all three axes of the aircraft. With the altitude control OFF, the aircraft can be maneuvered by moving various components of the controller. It is possible to adjust bank attitude by squeezing the trigger switch and using the bank trim knob, however, since the inclusion of the directional signal in the aileron channel, the bank knob is of no practical use. The automatic pilot should be engaged with the aircraft trimmed for wing level flight. If changes in bank attitude become necessary, disengage the automatic pilot and re-trim the aircraft again for level flight. Rotating the pitch trim knob aft (toward the pistol grip) will move the elevator to raise the nose. Any desired angle of descent may be obtained by rotating the pitch trim knob forward. To make a coordinated turn, move the pistol grip in the direction it is desired to turn. This operation gives the proper amount of "up" elevator to maintain altitude and the correct amount of aileron and rudder for a coordinated turn. When the turn control grip is rotated to make greater changes in heading, a switch is automatically tripped to disconnect the automatic pilot from the Flux Gate compass so that when the handle is returned to the central detent position, the aircraft will maintain the new heading. If very slight changes in heading are desired, squeeze the trigger switch under the pistol grip, which cuts out compass heading signals, and rotate the grip a small amount in the desired direction, and then return it to the detent. The aircraft will hold the new course.

4–570. DESCENT.

a. Automatic pilot—disengage.

b. Altitude control—OFF.

Note

The automatic pilot may be engaged and used for descents, when the altitude control is turned OFF, by adjusting the pitch trim knob.

Navigator's Station
LAC Serials 4501 Through 4509
Figure 4–33 Sheet 1

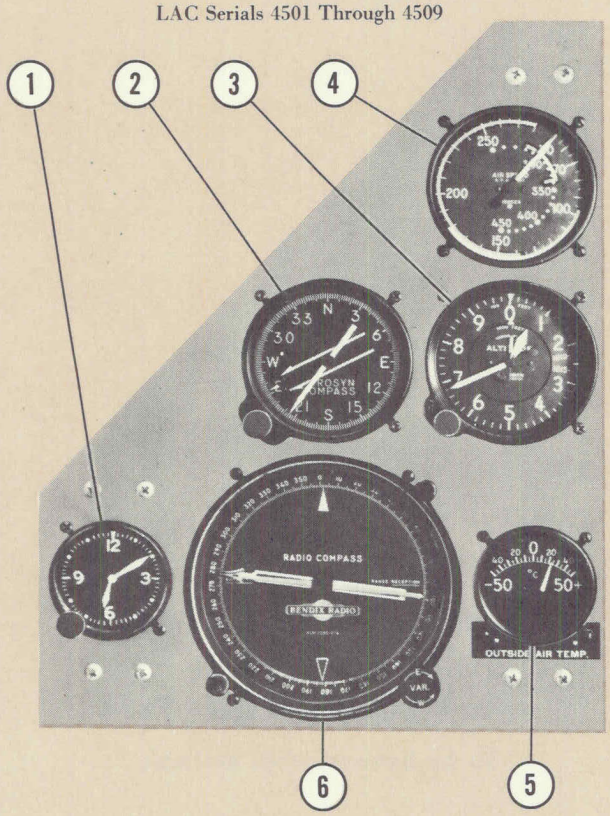
To be included when available.

Navigator's Station
LAC Serials 4510 Through 4519
Figure 4–33 Sheet 2

To be included when available.

navigator's instrument panel

LAC Serials 4501 Through 4509



1.	Clock	4.	Airspeed indicator
2.	Gyrosyn compass repeater indicator	5.	Outside air temperature indicator
3.	Altimeter	6.	ADF azimuth indicator

figure 4-34 Sheet 1

4–571. PRE-TRAFFIC PATTERN. To disengage the automatic pilot, proceed as follows:

a. Pilot's (or copilot's) clutch disconnect switch—press.

b. Servo disconnect levers—OFF.

4–572. EMERGENCY OPERATING PROCEDURES.

4–573. When using the automatic pilot, the pilot or copilot must be in his seat, with his safety belt fastened so that if any malfunction of the automatic pilot should occur, he can recover immediately.

4–574. AUTOMATIC PILOT FAILURES.

4–575. Automatic pilot failures generally will fall into one of the following categories: Continuous hard-over signals or oscillating signals. The continuous hard-over type of malfunction can result from shorting or grounding of certain circuits, and/or the failure of certain tubes. The result will be that the automatic pilot servo will develop full torque on one of the surfaces (not necessarily full deflection) and the maneuver that results will depend upon the speed, CG position, gross weight, and to a certain extent upon the type of failure that has occurred, as it is possible to get erroneous signals that do not develop full torque from the servo unit.

Navigator's Instrument Panel
LAC Serials 4510 Through 4519
Figure 4–34 Sheet 2

To be included when available.

4–576. ELEVATOR HARD NOSE-DOWN. Should the automatic pilot malfunction to give an elevator hard nose-down signal, the aircraft will pitch over quite rapidly to almost zero G., which is the critical condition. In combination with turbulence, this hard nose-down signal may produce an acceleration below zero G's which could unseat the pilot. Therefore, the pilot must have his safety belt fastened at all times.

4–577. AILERON HARD-OVER. Another type of failure is an aileron hard-over signal which produces a smooth movement of the ailerons and the aircraft will roll at a maximum rate of about six degrees per second. This is so smooth that it is quite possible that the pilot will not detect the motion at night or when on instruments, unless he is actually observing the gyro horizon or the control wheel at the time. It is possible that the aircraft can reach a very steep angle bank before the pilot detects the motion, particularly if the air is slightly turbulent, making the pilot relatively insensitive to the small acceleration produced by the aileron roll.

4–578. OSCILLATING SIGNALS. Oscillating signals can occur due to a failure in the automatic pilot follow-up circuit and will be evident by the oscillating movement of the controls. Should the automatic pilot malfunction, it should be disengaged immediately by one of the following methods:

a. Operate either the pilot's or copilot's clutch disconnect switch.

b. Pull out the clutch switch.

c. Move the servo disconnect levers to OFF (up) position.

d. Move the automatic pilot gyro caging switch to the ON (up) position and then release.

e. Automatic pilot switch—OFF.

4–579. If a malfunction occurs, the pilot must restrain the controls while disconnecting the automatic pilot to prevent a sudden jerk when it disengages. The automatic pilot will be automatically disengaged by any momentary interruption of either a.c. or d.c. current, as while switching inverters.

Note

The automatic pilot may be overpowered; however, the control forces required will be higher than when the automatic pilot is disengaged.

4–580. NAVIGATOR'S STATION.

4–581. The navigator's station is located on the left forward side of the crew compartment and is equipped with a stool, table, instrument panel, periscopic sextant with case, sextant mount, and a driftmeter and tube. Refer to figure 4–33.

4–582. The navigator's instrument panel (figure 4–34) consists of ADF controls, an outside air temperature indicator, a sensitive altimeter, an airspeed indicator, a clock, an interphone control box, a C-2 gyrosyn compass repeater indicator, and a radio magnetic indicator.

4–583. DRIFTMETER. Provisions for mounting a gyrostabilized driftmeter to aid the navigator in determining terrestrial bearings of objects relative to the heading of the aircraft, ground speed, and wind velocity are installed. The driftmeter mounts on the floor of the navigator's station. The driftmeter telescope tube extends downward through the fuselage floor and projects through a hole in the lower fuselage skin.

4–584. PERISCOPIC SEXTANT. A periscopic sextant is provided which enables the navigator to make observations from within the cabin by projecting the periscope outside of the aircraft. A permanent mount in the cabin ceiling, above the navigator's station, is provided to accommodate the sextant. A shutter, incorporated with the mount, seals the external periscope hole which is flush with the aircraft skin.

4–585. IGNITION ANALYZER.

4–586. The ignition analyzer installed in LAC Serials 4510 through 4519 provides a visual means of detecting, locating, and identifying engine ignition abnormalities. (Provisions are incorporated in LAC Serials 4501 through 4509 for installation of the ignition analyzer at a later date.) It can be used either on the ground or during flight and will reveal ignition malfunctions at high altitude that normally are not evident on the ground. Data is presented in the form of patterns on the face of the cathode ray tube indicator mounted on the flight engineer's table. The characteristic ignition patterns of each engine may be examined singularly for individual cylinders or simultaneously for all cylinders. Any ignition malfunction during engine operation will alter the characteristic pattern and change its contour. Each engine pattern can be identified with the number of the cylinder, spark plug or magneto associated with the malfunction. The basic components of the ignition analyzer system are; a synchronizing generator for each engine, a condition switch, a cycle switch, and an indicator (cathode ray tube). The condition switch and cycle switch are located on a panel inboard of the flight engineer's auxiliary control quadrant (figure 4–35). The power supply amplifier located aft of the station 260 bulkhead is supplied with a.c. power and contains the electronic circuits that provide necessary voltages to operate the cathode ray tube indicator.

4–587. SYNCHRONIZING GENERATOR. The synchronizing generator is driven by the engine auxiliary tachometer drive at one-half engine speed, and provides 3-phase voltage for timing the patterns to the angular position of the engine crankshaft. This voltage initiates and produces the horizontal base sweep across the cathode ray tube of the indicator.

4–588. IGNITION ANALYZER CONTROLS AND INDICATOR.

4–589. CYCLE SWITCH. The cycle switch (figure 4–35), located on the floor adjacent to the flight engineer's auxiliary control quadrant, consists of a fixed index ring marked off with numbers that correspond to the number of cylinders of the engine in their firing order. The inner rotatable switch dial is marked with an index line and abbreviations at specific points which indicate events occurring during a complete engine cycle. The following abbreviated positions are inoperative on this unit since vibration pick-ups are not installed: I.O. (intake opens), E.C. (exhaust closes), I.C. (intake closes), E.O. (exhaust opens). The IGN (ignition) position, however, is used. The center selector switch incorporates a push-pull knob that controls the sweep of the horizontal pattern

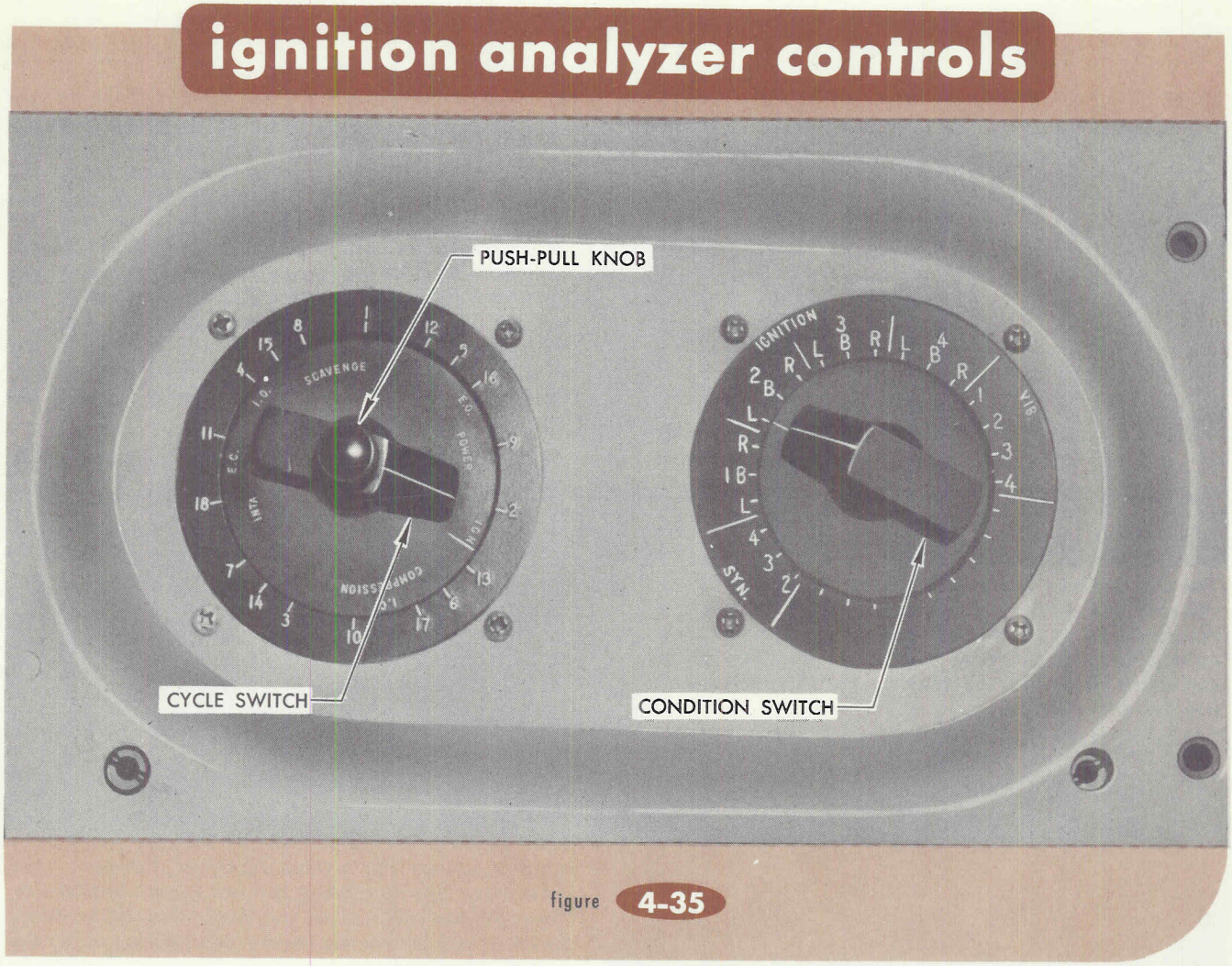


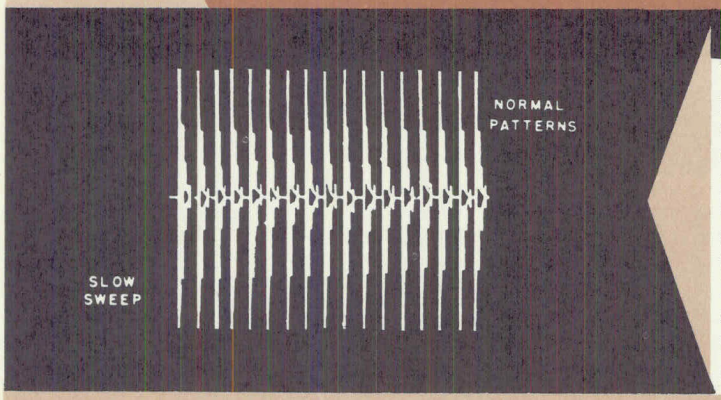
figure 4-35

on the cathode ray tube indicator. When the IGN position is aligned with any cylinder designation on the fixed ring dial, the operator may choose the pattern presentation. The number of patterns that will be seen is contingent upon the position of the push-pull knob. In the "pushed-in" position (fast sweep), two complete patterns will appear on the indicator, beginning with the ignition diagram of the cylinder on which the cycle switch is indexed, and will conclude with that of the next cylinder in firing order. In the "pulled-out" position (slow sweep), the patterns of all cylinders will appear beginning with that of the cylinder on which the IGN is indexed. Some typical patterns are illustrated on figure 4–36.

4–590. CONDITION SWITCH. The condition switch (figure 4–35), located on the floor adjacent to the flight engineer's auxiliary control quadrant, functions as a selector for a specific engine for either ignition analysis or for checking the speed synchronism between engines. Furthermore, it selects either left, right, or both magnetos for observation. The inner rotatable dial has a single index mark which is rotated to the desired indices engraved on the fixed outer ring. The fixed ring is divided into four general sections which are engraved as follows: SYN., 2, 3, and 4 for checking synchronization of respective engines with No. 1 engine; IGNITION, 1, 2, 3, and 4 for ignition analysis of the respective engines and B (both), L (left), and R (right) magnetos.

4–591. CATHODE RAY TUBE INDICATOR. The indicator assembly is a housing which encloses a 3-inch cathode ray tube. The assembly is mounted face-up in the flight engineer's table. The power supply amplifier provides the adjustments of the indicator such as, focus, length, H-centering, and intensity. However, when these controls are set they should not require frequent readjustment.

ignition analyzer patterns

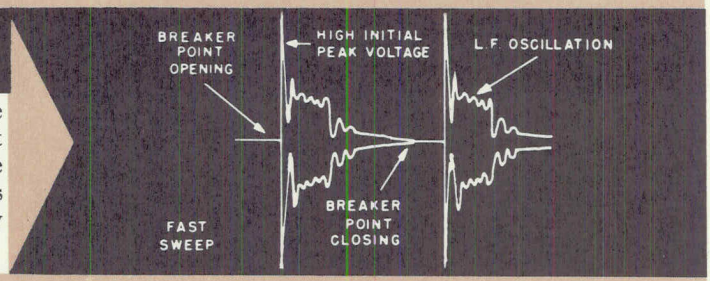


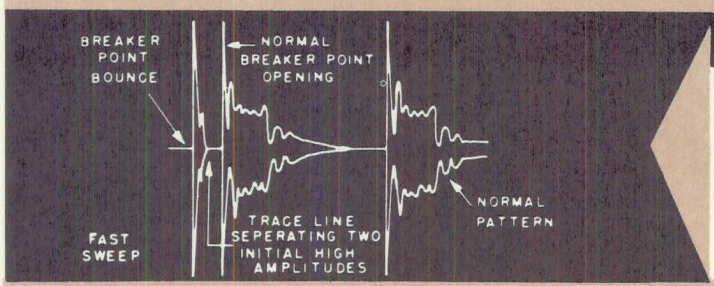
NORMAL PATTERNS – SLOW SWEEP

The picture observed presents the patterns of 18 spark plugs fired by two magnetos in one complete engine cycle, or 720 crankshaft degrees. The normal polarity reversal of consecutive firings of one magneto is indicated by patterns appearing alternately above and below the trace line. Because of the magneto arrangement of this engine, successive firings of the same plug are alternately positive and negative. The first pattern appearing from the left edge of the tube is identified as to cylinder by the selected cylinder on the cycle switch. The remaining patterns are for the remaining 17 cylinders fired by the selected magneto in firing order.

NORMAL PATTERN – FAST SWEEP

The two patterns that appear in fast sweep are for the cylinder selected by the cycle switch and for the next cylinder fired by the selected magneto. Both patterns are normal and appear above and below the trace line as successive firings of the same spark plug alternately positive and negative.



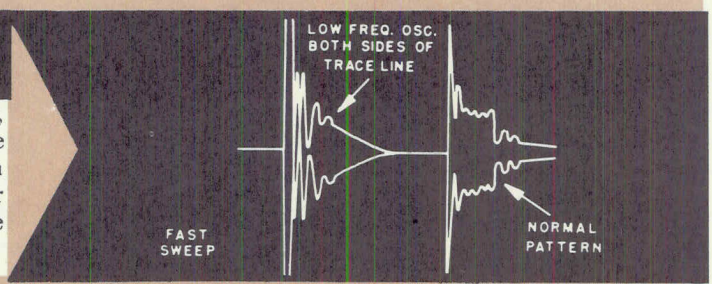


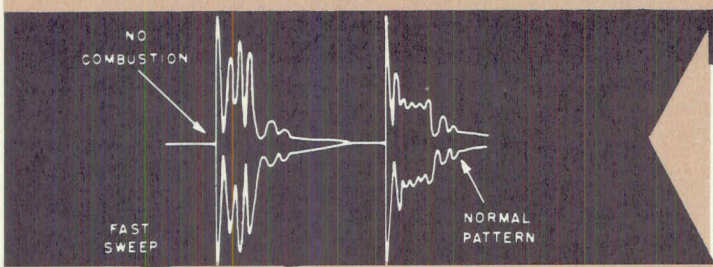
BREAKER POINT BOUNCE – FAST SWEEP

This pattern resembles that for breaker point non-synchronization. The marked difference, however, is the short trace line separating the two initial oscillations. The condition switch is set to a single magneto position. Breaker point bounce may occur both before or after the normal point opening.

OPEN PRIMARY CIRCUIT PATTERN (DISTRIBUTOR TO COIL) – FAST SWEEP

This pattern produces a very high initial peak voltage, the second excursion of the trace extends below the horizontal trace line, and the remainder of the pattern consists of low frequency oscillations until the breaker points close. This pattern will only appear for the cycle switch selected cylinder position.





NO COMBUSTION PATTERN – FAST SWEEP

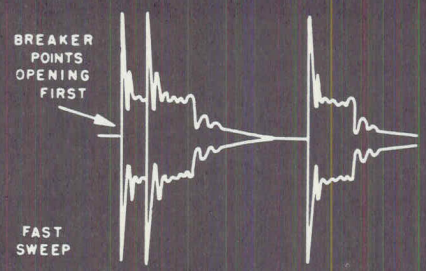
This pattern is distinctive because of the low rate of dissipation of electrical energy within the system. Low frequency, high-amplitude oscillation continues throughout the major portion of the pattern. This pattern will appear for both spark plug positions of the affected cylinder.

figure 4-36 Sheet 1

ignition analyzer patterns

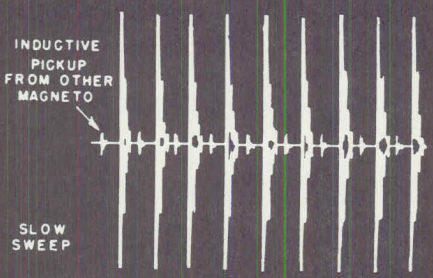
BREAKER POINT NON-SYNCHRONIZATION – FAST SWEEP

The magneto breaker point synchronization check is made to determine that both spark plugs in each cylinder are fired simultaneously. The condition switch is set to display the patterns of both the left and right magnetos superimposed upon each other. If the breaker points are not synchronized, the pattern to the left will show an opening period before the pattern to the right. By measuring the distance on the screen between the limits of breaker point opening and allowing 1/32 in. to equal one degree of crankshaft rotation, the amount of synchronization error may be determined.



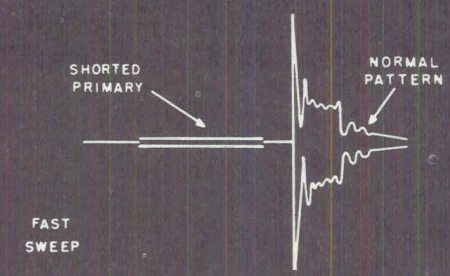
SHORTED PRIMARY CIRCUIT PATTERN – SLOW SWEEP

A completely shorted primary circuit in the grounding system or between the magneto and the distributor produces no pattern; only the horizontal trace line will be seen. Nine small pips which are inductive pickups from the other magneto are sometimes visible. All spark plugs fired by the affected magneto will display this pattern. The nine additional patterns appearing at the left are from the other magneto and are visible because of the analyzer tie-in to the magneto grounding system.



SHORTED PRIMARY CIRCUIT PATTERN (DISTRIBUTOR TO COIL) – FAST SWEEP

A shorted primary circuit between the distributor and cylinder mounted coil produces no pattern for the cycle switch selected spark plug position; only the horizontal trace line will be seen. The pattern will appear on only the selected cylinder position, but the pattern for the next cylinder to be fired by the selected magneto will generally be distorted because of the reaction of this malfunction on the system.



OPEN PRIMARY CIRCUIT PATTERN (MAGNETO TO DISTRIBUTOR) – SLOW SWEEP

This pattern can be best described as nine pips superimposed on a distorted sine wave. The pips occur at approximately the breaker point closing of the affected magneto. The nine normal patterns are for the unaffected magneto, but are generally distorted because of the malfunction present on the one magneto.

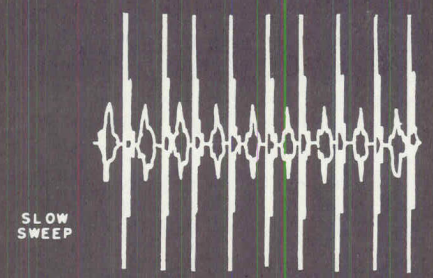
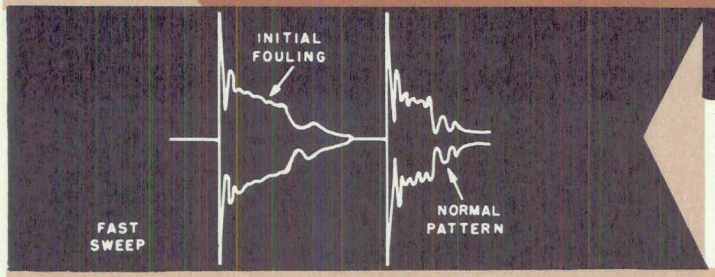


figure 4-36 Sheet 2

ignition analyzer patterns

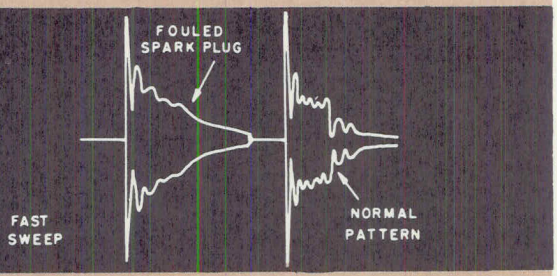


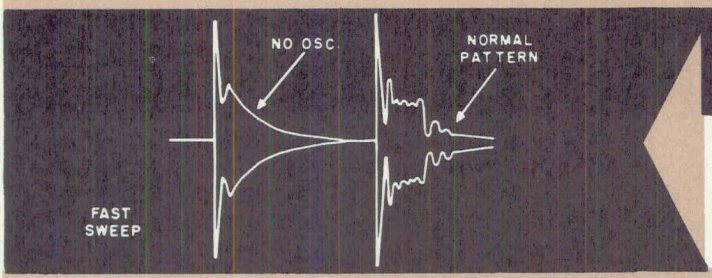
INITIAL FOULING OF SPARK PLUG – FAST SWEEP

The height of the initial oscillation is less than normal and does not return as close to the zero trace line as normal. Some combustion is indicated by the oscillation in the saddle portion of the pattern.

FOULED SPARK PLUG PATTERN – FAST SWEEP

The fouled plug pattern represents a changing resistive short due to the fouling and consequently presents a changing, dancing appearance. A pattern intermittently changing from almost normal to that of a dead short may be classified as an intermittently fouled plug. If the pattern continuously presents characteristics of a fouled plug the pattern may be classed as a badly fouled plug.



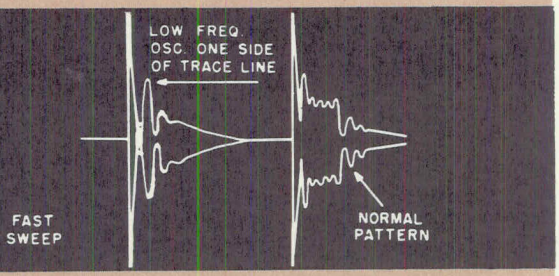


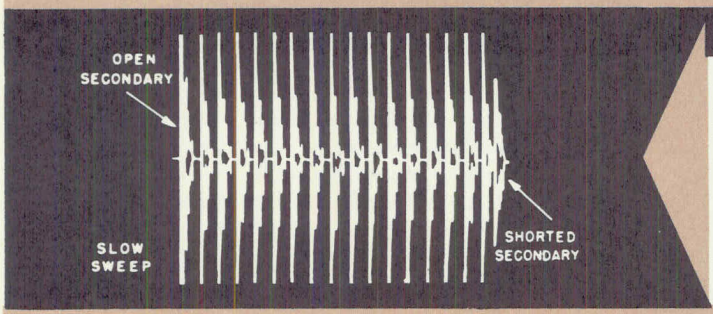
SHORTED HIGH-TENSION CIRCUIT PATTERN (SECONDARY CIRCUIT) – FAST SWEEP

On this pattern, the initial peak voltage is less than normal. The pattern tail appears as a steady curved line without high-frequency oscillation since the circuit is not dissipating energy in the presence of combustion.

OPEN HIGH-TENSION CIRCUIT (SECONDARY) – FAST SWEEP

The initial high peak voltage is higher than normal and this excursion returns to point below the horizontal trace line. Since the high tension circuit is open, the plug is not fired and the high frequency oscillation normally associated with energy flow is not present. This pattern may occur on only one or scattered cylinder positions.





MALFUNCTION PATTERNS – SLOW SWEEP

An open high tension circuit (open secondary) can be identified as a much higher than normal pattern with complete lack of high frequency oscillation. Shorted high tension circuit (shorted secondary) appears as a pattern slightly lower in height than a normal pattern with a complete lack of secondary high frequency oscillation. This appears as a bright spot on the tail of the pattern. An open secondary, a shorted secondary, and 16 normal patterns are shown.

figure 4-36 Sheet 3

4–592. IGNITION ANALYZER NORMAL OPERATING PROCEDURES.

Note

Ignition analysis is recommended prior to take-off, after the magneto check has been made, and the engine speed is at or above magneto check rpm. The cycle switch should be set on slow sweep position.

a. Turn on the amplifier power supply and allow it and the cathode-ray tube to warm up.

b. Set the index on the inner dial of the condition switch to the L index near the number 1 beneath the general caption IGNITION on the fixed ring.

c. Set the index labeled IGN on the inner dial of the cycle switch against the number 1 on the fixed ring. This setting, supplementing that of the condition switch, will present the pattern of No. 1 cylinder, left magneto, or No. 1 engine on the indicator, followed by the pattern of No. 12 cylinder, which is next in firing order.

Note

With the push-pull knob in the "pulled-out" position, in the above condition, the indicator will portray all the ignition patterns associated with the left magneto beginning with No. 1 cylinder. When the spark plug is fired on the negative pulse of the magneto, the major portion of the pattern will appear below the zero line and when fired on the positive pulse, the major portion will appear above the zero line. This condition is apparent at low rpm only.

d. Push the push-pull knob in and set the dial index of the condition switch to B, near the numeral 1 beneath the general caption IGNITION. Maintain IGN against 1 on the cycle switch. The pattern on the indicator will portray the functioning of both magnetos and both spark plugs for cylinders 1 and 12. This setting is used for checking magneto synchronization.

e. For study of the individual ignition patterns or all the ignition patterns of engines No. 2, 3, or 4, the same settings of the cycle switch as for engine No. 1 are used, but the condition switch must be switched to L, B, and R adjacent to the numerals 2, 3, and 4, respectively.

f. For engine speed synchronization check, set the dial index of the condition switch against the index 2 under the caption SYN. on the fixed ring. This setting establishes the electrical connection for the comparison of speed of engine No. 2 to that of engine No. 1. The push-pull knob should preferably be in the "pushed-in" position. To compare the speeds of engines No. 3 and 4 to engine No. 1, set the dial index on the condition switch to 3 and 4 within the captioned SYN segment of the outer ring.

Note

When making the engine synchronization check, the position of the cycle switch is of no importance.

4–593. WATER SYSTEM.

4–594. A pressure water system is installed to provide water to the lavatory wash and dental basins and to the galley sink. Refer to figure 4–37. The water supply is stored in a 60-gallon bladder-type water tank located on the left side of the rear cargo compartment. Installed in the tank is a submerged type electric-driven water pump which is automatically controlled by a pressure and a low level switch after the system is energized by the switch in the flight station. The pressure switch turns the pump on if the water pressure drops to 15 psi and turns the pump off when the pressure reaches 25 psi. The low level switch turns the pump off before the tank empties and protects the motor from burning out. A pressure dome (accumulator) tank is installed in the water pressure line to absorb line surges and reduce the number of pump operating cycles. Restrictors are installed in each lavatory supply line to control the flow of water. If the pressure switch should fail to shut off the pump, a combination pressure relief and thermal relief valve is installed to direct the excess water back to the supply tank.

4–595. A fitting is installed in the bottom of the fuselage to which a water hose can be connected to refill the water tank. A direct reading sight gage is installed in the inboard side of the supply tank and an overflow standpipe dumps water overboard when the tank is full.

4–596. When the tank is being filled, the water is routed to the top of the tank and enters a diffuser from which it flows into a partitioned section of the tank called the surge box. The surge box has a capacity of approximately 10 gallons and includes a flapper check valve to permit flow of water from the larger section of the tank into the surge box but prevents flow in the opposite direction. This design helps to prevent uncovering of the pump when the aircraft is climbing, particularly when the water supply is low.

4–597. When the aircraft is parked where the temperature is below freezing, the water system must be drained

water system

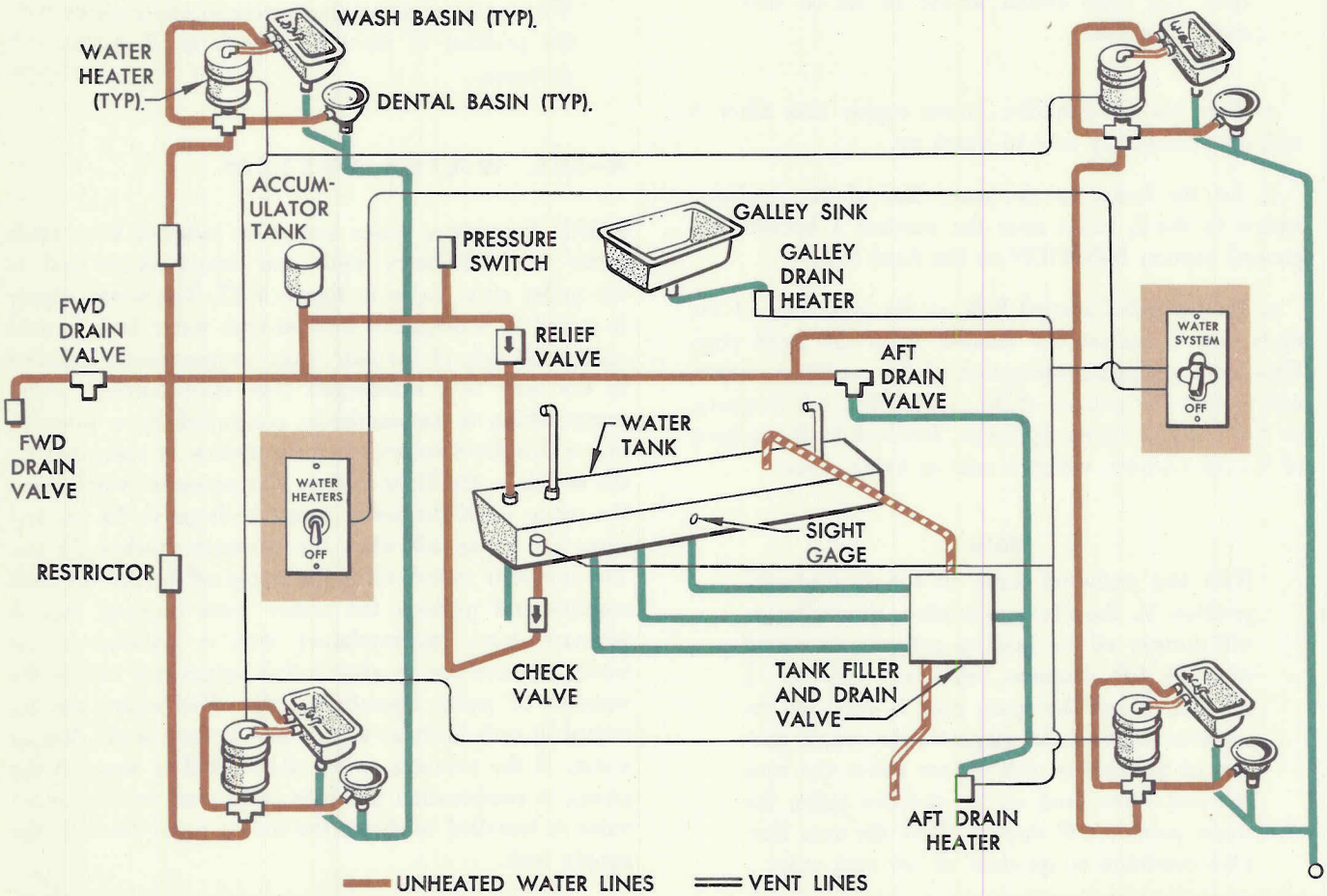


figure 4-37

and three drain valves are provided. The forward system drain valve is located in the left underside of the fuselage and is accessible through the left sidewall of the forward cargo compartment. The aft system and the supply tank drain valves are located beneath an access panel in the underside of the fuselage approximately beneath the aft passenger compartment.

4–598. All of the water taps and basin drains in the lavatories are spring-loaded and should normally be in the closed positions to prevent loss of cabin pressure. However, when the water system is being drained the hot water taps must be locked open to provide a vent in the supply lines.

4–599. Waste water from the wash and dental basins in the two forward and the two aft lavatories tee into common lines that drain overboard through heated outlets. The drain from the galley sink is also provided with a heated outlet. Those heaters are connected through the

left main landing gear scissors switch so that they will operate only when the aircraft is airborne.

4–600. Thermostatically controlled electric water heaters are installed in insulated 1½ gallon tanks in each of the four lavatory hot water lines. If the heater thermostat should fail to turn the heater off at the proper temperature, an overheat thermostat mounted on the tank will interrupt the circuit to the heater. The external thermostat is equipped for manual resetting. However, this should not be done unless the cause of the interruption has been corrected and the tank has been examined for damage.

4–601. WATER SYSTEM CONTROLS.

4–602. DRAIN-FILL VALVE. This valve is on the left underside of the fuselage and is beneath an access cover located approximately beneath the aft passenger compartment. The valve has three marked positions: OPEN, FILL, and CLOSE. The OPEN position is used to drain the water supply tank. The FILL position is selected when the supply tank is being replenished and the CLOSE position is the normal position during flight.

4–603. AFT WATER SYSTEM DRAIN VALVE. This valve is located adjacent to the DRAIN-FILL valve and is used to drain the aft lavatory water supply lines.

4–604. FORWARD WATER SYSTEM DRAIN VALVE. This valve is located behind the left side liner of the forward cargo compartment and is used to drain the forward lavatory water supply lines.

4–605. WATER SYSTEM SWITCH. This is a switch type circuit breaker located on the station 260 switch panel (figure 1–44). The switch is on in the up position and off in the down position. When this switch is on it energizes the water system control circuits, turns on the electric hot water heaters, and turns off the overboard drain heaters when the aircraft is on the ground. The water heater switch can be used to turn off the water heaters.

4–606. WATER HEATER SWITCH. This switch has ON (up) and OFF (down) positions and is located on the station 260 switch panel (figure 1–44). It is used to turn the four hot water tank heaters on or off, but is effective only if the water system switch is on.

4–607. INTERIOR CONFIGURATION.

4–608. The aircraft are designated Model 1049C-55-81. The aircraft model is 1049C; -55 indicates the power plant; and the -81 indicates the basic interior arrangement. The -81 basic configuration provides for an active crew of 7, consisting of pilot, copilot, flight engineer, radio operator, navigator, 2 cabin attendants, 4 relief crew members; and provisions for 59 passengers (plus seats for 8 in the lounge). The -81 basic configuration is designed to provide for two additional passenger seating arrangements: the siesta and the high density. The siesta arrangement has provisions for 7 active crew members, 4 relief crew members, and 43 passengers. The high density arrangement has provisions for 7 active crew members, 4 relief crew members, and 82 passengers. Refer to figure 4–38.

4–609. PASSENGER SEATS. All passenger seats on LAC Serials 4501 through 4509 for the basic configuration, except the seats in the lounge, are full reclining seats with removable center arm rests. The settee type seats in the left side of the lounge compartment have fixed backs. A safety belt is provided for each passenger and lounge seat including each cabin attendant seat. All passenger seats on LAC Serials 4510 through 4519 are to be furnished and installed by the customer after delivery of the aircraft.

Note

The cabin attendant seat located near the main passenger door is not to be used during take-off or landing.

4–610. Flush tracks that run fore and aft are installed in the floor to permit installation of alternate arrangements with the standard type seats, siesta type seats, and the high density type seats.

4–611. BERTHS. Structural provisions only, are made for the installation of six upper berths, one on each side of the lounge compartment and four on the right side of the main passenger compartment.

4–612. MISCELLANEOUS EQUIPMENT.

4–613. PASSENGER SEATS. The passenger seats are anchored to tracks which extend the full length of the cabin and permit the seat positions and spacing to be readily changed to conform to any one of the passenger configurations. A finger-tip button that controls the seat position is mounted on the forward end of each fixed arm rest. Slight pressure on the button allows the seat back to recline to 38 degrees from the vertical, or any intermediate position. Each passenger seat incorporates food serving tray holders and a pocket in the seat back provides a storage space for a food serving tray.

interior arrangements

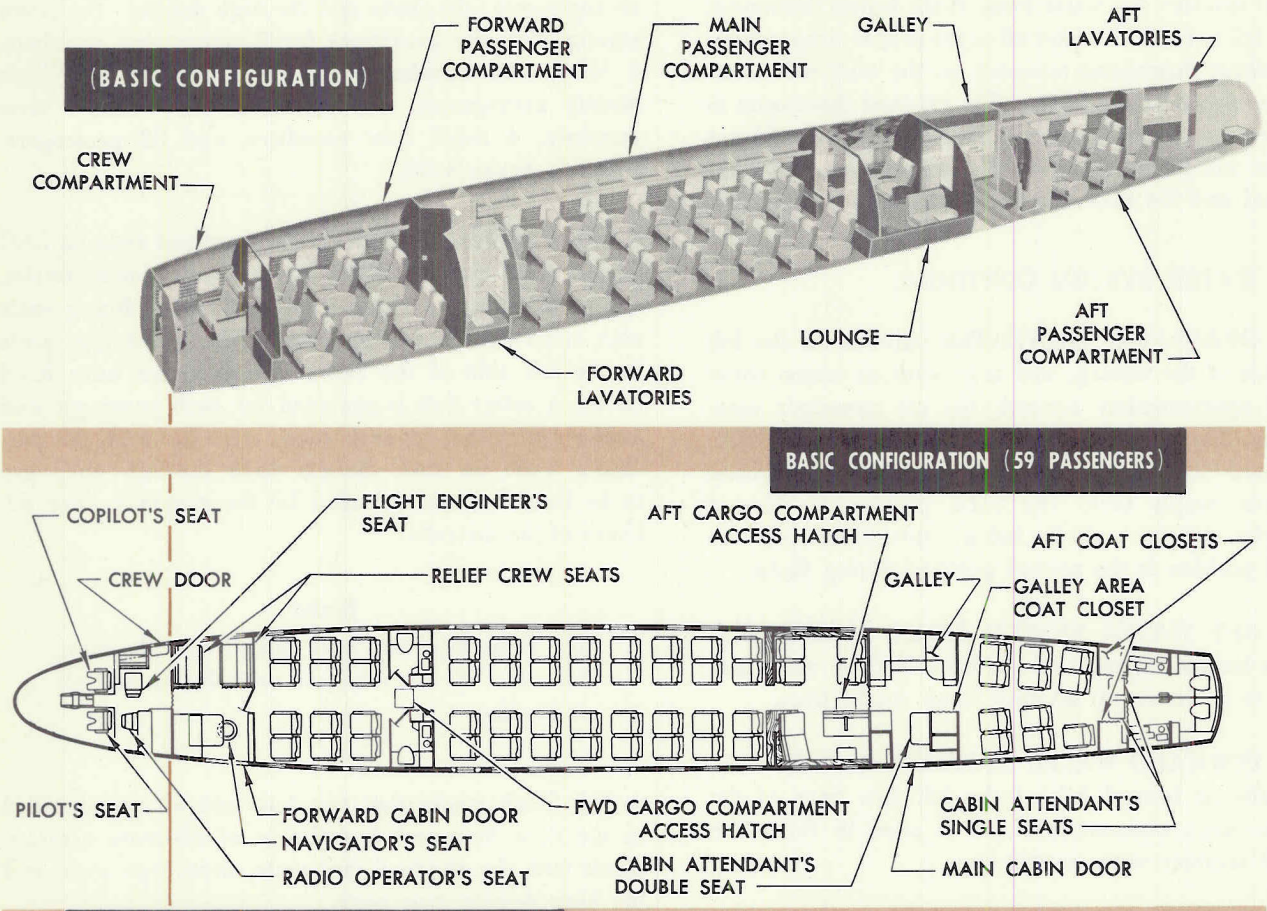


figure 4-38

4–614. GALLEY. Space provisions are made for the galley on the right side of the fuselage opposite the main cabin door and provisions are made for facilities that will help with preparation of the trays, and that will maintain food at the desired temperature until used. Utensils can be stowed in a cabinet on the left side directly forward of the main cabin door. When not in use, the galley is hidden by a pull-down curtain.

4–615. LAVATORIES AND TOILETS. Two aft toilet and lavatory compartments are located in the aft end of the cabin. One is for ladies and the other is for gentlemen. Two forward toilet and lavatory compartments are also located between the forward passenger compartment and the main passenger compartment. Each lavatory is equipped with mirrors, towel dispensers, holders for air sickness containers, and waste containers. The doors have latch switches that operate occupancy lights that show whether the lavatory is occupied.

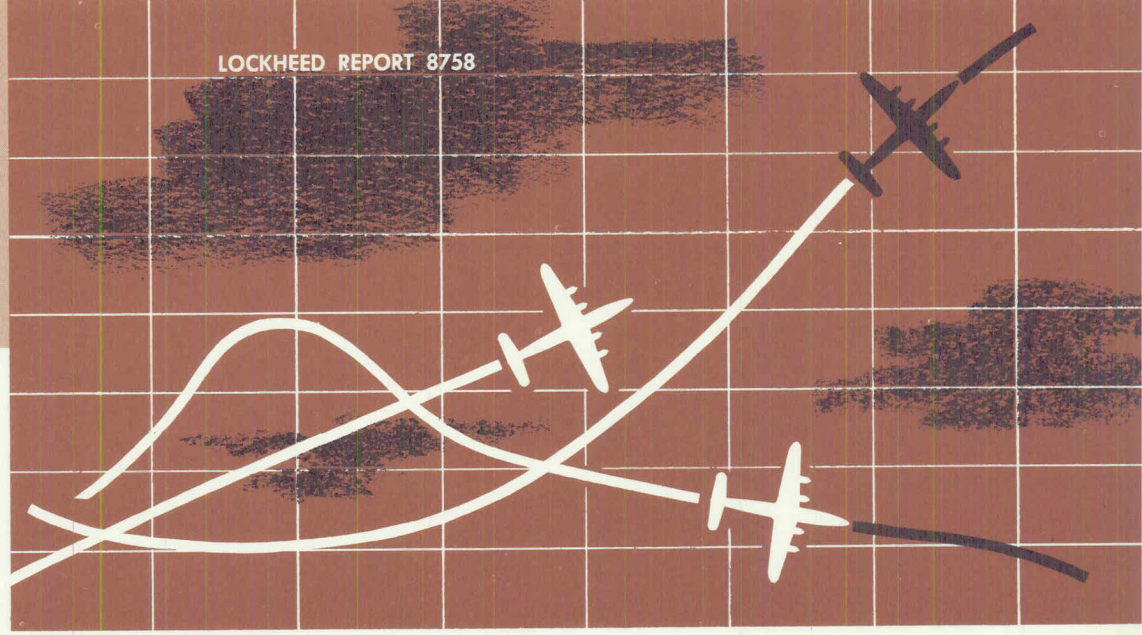
4–616. DRINKING WATER. A 6-quart container that holds dry-ice chilled drinking water is installed in each lavatory.

4–617. NIGHT FLYING CURTAIN. A flame-proof, light-tight curtain is provided behind the pilots for protection against light reflections.

4–618. FOLDING HOOKS. Articles of clothing may be hung on folding hooks provided for each crew member in the flight station and folding hooks in the crew compartment are for use of the navigator and relief crew members.

4–619. REFUSE CONTAINERS. One refuse container is provided in the flight station and one at the navigator's station. Ash trays are provided at each active crew member station. Waste rag containers are provided for the flight engineer, navigator, and each pilot.

4–620. LOOSE EQUIPMENT. The following items are stowed in the cargo compartments: Maintenance Instruction Manual, miscellaneous service and operating instruction handbooks, jack pads, auxiliary ground fire extinguisher coupling, sleeve and bag assembly for wing and nose tie down cables, and miscellaneous equipment. The log books, Crew Operating Manual, and C.A.A. Approved Flight Manual are stowed in the flight engineer's desk.



Section V

operating limitations

PART I

Refer to the C.A.A. APPROVED OPERATING FLIGHT MANUAL for the aircraft limitations. Limitations information contained in that manual will be included in this section at a later date.

PART II

5–1. The limitation and settings given below are in addition to the limitations imposed by the C.A.A. and given in the C.A.A. APPROVED OPERATING FLIGHT MANUAL.

5–2. BRAKE SYSTEM.

Accumulator air pressure 1000 (±50) psi.

Normal hydraulic pressure 1700 (+25) psi.

Debooster and lockout debooster cylinders reduce pressure to 700 ±25 psi.

5–3. PNEUMATIC DE-ICING SYSTEM.

Normal suction	5-7 inches Hg.
Minimum suction	4 inches Hg.
Normal pressure	18-22 psi.
Maximum pressure	25 (+0, —5) psi.
Vacuum pump warning light	On when suction is less than 4 (+ 25, —0) psi.

5–4. ELECTRICAL SYSTEMS.

D.C. SYSTEM.

Normal operation	27.5 volts.
Max. operation	30 (+.6, —.4) volts.
Generators	30 volts. Ground rating—150 amp. max. continuous. Flight rating—350 amp. max. continuous.
Voltage regulators	Set to govern to 27.5 volts.
Reverse current relay	Differential relay closes when difference between generator feeder and bus is +.25 to +.35 volts. Relay opens when generator draws reverse current in excess of 30 amps. Potential relay closes at 20-24 volts, opens at 18 volts or less.

Minimum Permissible Fuel for Individual Tanks during Flight
Figure 5-1

To be included when available.

Voltage applied to aircraft from external power source.	
Normal	26-29 volts.
Minimum	20 volts at peak surges.

A.C. SYSTEM (LAC Serials 4501 through 4509).

Inverters (5)

Two single phase regulated to 115 volts.

Three two phase—115 volts.

One phase of each regulated to 115 volts.

Other two phases—variable.

A.C. SYSTEM (LAC Serials 4510 through 4519).

Inverters (3)

One single phase regulated to 115 volts.

Two three phase—115 volts.

One phase of each regulated to 115 volts.

Other two phases—variable.

Alternators (2)

Variable frequency—variable voltage.

Continuous duty—2000 rpm and above.

center of gravity limits

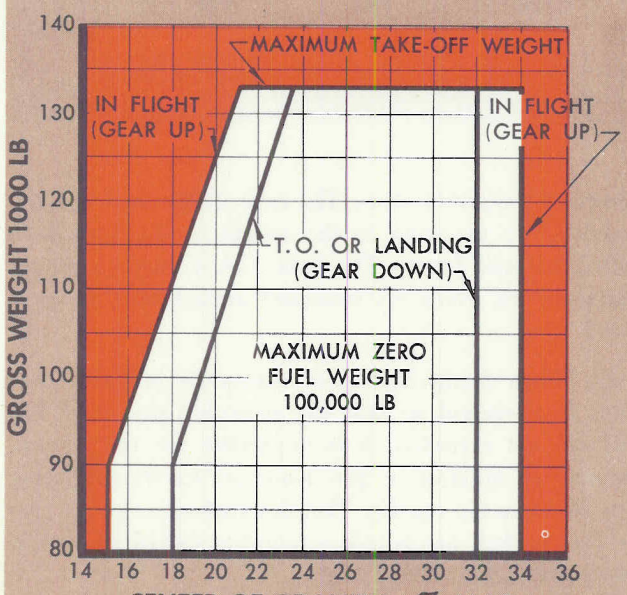


figure 5-2

5–5. ENGINE OIL SYSTEM.

Oil low pressure warning light	Comes on at 55 ±5 psi.
Oil cooler surge valve	Opens 60 psi (fully open at 100 psi). Closes at 40 psi.
Bypass valve	Opens at 40 (+3) psi. Closes at 37 ±3 psi.

5–6. FUEL SYSTEM.

Low fuel pressure warning light	Comes on at 20 ±5 psi.
Auxiliary fuel pumps (with engine driven fuel pumps operating)	HIGH setting, 25-27 psi. (normal) max. allowable 35 psi. LOW setting, 24-26 psi.
Fuel crossfeed relief valve	Opens at 40 ±1 psi. Closes at 32 psi.
Overboard thermal relief valve	Opens at 55 (±5) psi.
Fuel filter relief valve	Opens at 3-4 psi differential pressure.

5–7. HYDRAULIC SYSTEM.

Primary System Normal pressure	1700 (+0, —25) psi.
Secondary System Normal pressure	1700 (+0, —25) psi.
Pump control valve	Opens at 1800 psi. Max. pressure 2050 psi. Reseats at 1750 psi.
Low pressure warning light	On at 1325 (±50) psi. Off at 1450 (±50) psi.
Thermal relief valve	Begins to bypass at 235°-245°F. Closes at 230°-220°F.
Reservoir relief valve (air)	Opens at 30 (+0, —5) psi. Closes at 23 psi.
Crossover check valve	Opens at 300-400 psi differential pressure between primary and secondary hydraulic systems.

aircraft flight strength diagram

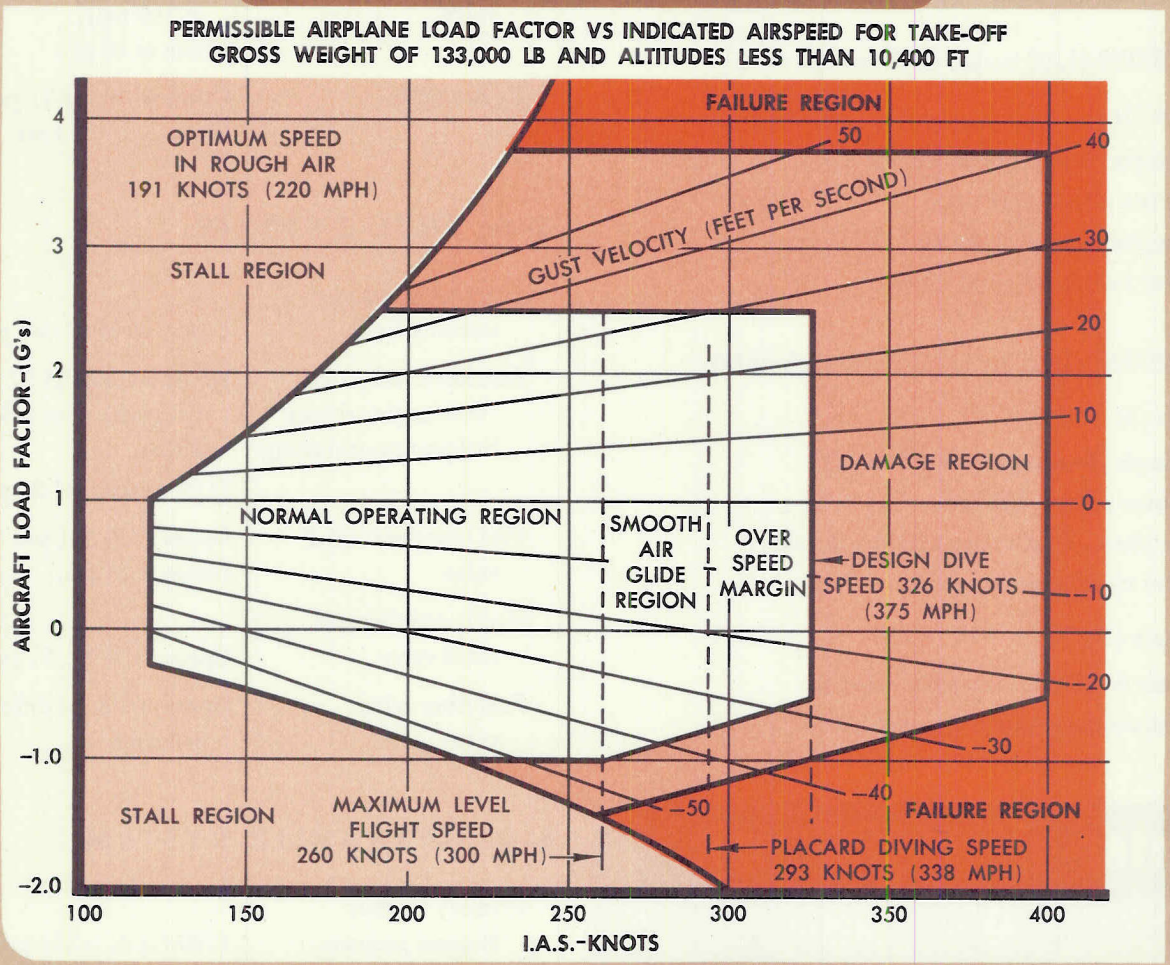


figure 5-3

5–8. STRUCTURAL LIMITATIONS.

5–9. Flight of any aircraft through turbulent atmospheric conditions imposes loads on the structure in excess of those encountered in normal operation. These load conditions were taken into consideration during the design of the aircraft; however, it is possible to reduce the stresses imposed by turbulence and gusts, and improve passenger comfort, by observing certain techniques and precautions.

5–10. In normal level flight the wing supports a load equal to the aircraft's weight. When acceleration is applied to the aircraft, however (through maneuvers such as pull-ups, push-overs, turns, or by atmospheric disturbances such as gusts), the load on the wing becomes greater or less than the aircraft's weight depending on the nature of the acceleration. The ratio of the load actually sustained by the wing to the weight of the aircraft is called the load factor. The basic C.A.A. load factor requirement to which all transport aircraft are designed is 2.5.

5–11. When flying high-speed transports in gusts, care must be exercised so that the allowable gust load factors are not exceeded. It is impossible for the pilot to prevent the build-up of gust loads on the wing, because they build up too rapidly. Therefore, when rough air cannot be avoided, one simple precaution should be kept in mind: REDUCE AIRSPEED.

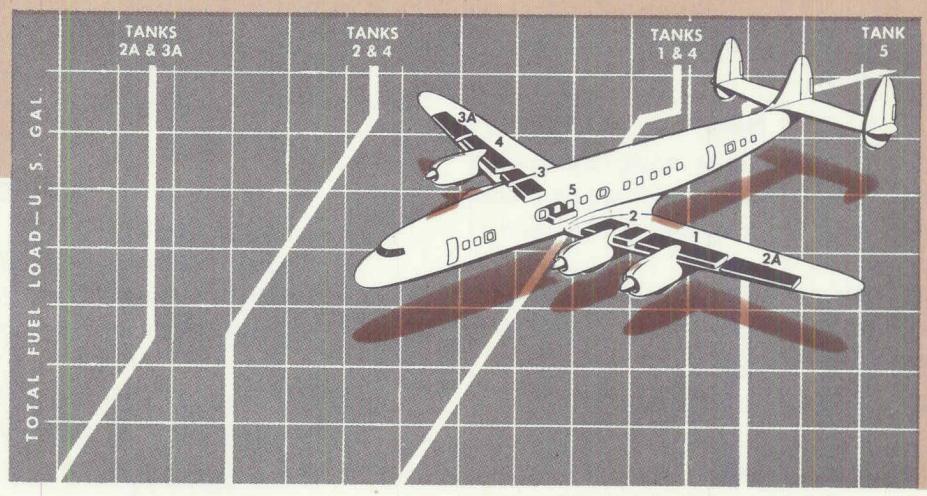
5–12. The reason for this precaution is explained by the fact that for an aircraft entering a gust, the additional load imposed by the gust is directly proportional to the

aircraft's speed. Although for a given gust velocity, the change in wing angle of attack to the relative wind decreases as the aircraft speed increases, the load produced by the change in angle increases as the square of the speed.

5–13. Because of these factors, it is apparent that it is advantageous from the standpoint of aircraft strength to reduce airspeed in rough air. If this is carried too far, however, the danger of stalling the wing by a gust is increased.

5–14. An up-gust has the same effect as a sudden increase in the wing angle of attack: Hence, if the aircraft is flying at close to maximum lift (low speed), the gust can precipitate a stall. It is, therefore, necessary to use discretion in the selection of airspeed for flying in rough air.

5–15. Analysis of the structural and aerodynamic capabilities of the Constellation aircraft indicates that at about 191 knots (220 mph) indicated airspeed, the optimum compromise of allowable gust velocities and speed margin above stall is obtained. At this speed, a 43-foot-per-second gust can be sustained without incurring damage to the structure. A margin of about 70 knots (93 mph) above the stall speed with gear and flaps up at 1G exists at this speed. The acceleration required to stall the aircraft is approximately 2.5G.



Section VI

systems operation

6–1. FUEL SYSTEM.

6–2. FUEL SYSTEM MANAGEMENT.

6–3. All take-offs are to be made with tanks 1, 2, 3, and 4 supplying fuel to respective engines, and all landings are to be made with tanks 1, 2A, 3A, and 4 supplying fuel to respective engines. For fuel loading, refer to figure 6–2 (Operational Fuel Loading).

6–4. Refer to figure 6–1 for the proper fuel consumption sequence for various fuel quantities. The fuel loading charts and fuel usage procedures are presented in both pounds and gallons. The fuel usage procedures are established by the fuel load at take-off. Therefore, enter the applicable (gallons or pounds) chart at the left top and read down the applicable column to the number 1. Then read the procedure at the right of the number 1 and adjust the fuel feed as shown. Continue that feed until instructions of the note are completed. Then return to the originally selected vertical column and complete the fuel usage procedures in numerical sequence as shown. The various routes of fuel flow from the fuel tanks to the engines are also shown on figure 6–1.

6–5. REFUELING WITH PASSENGERS ABOARD. During refueling operations with passengers aboard, the following precautionary measures must be taken:

a. A crew member must be assigned to prevent passengers from smoking in the aircraft or in the vicinity until refueling is completed.

b. Passenger loading stairways must be in position at the entrances and the doors must be kept open.

c. During daytime refueling, the battery switch must be turned OFF.

d. During night refueling, the battery switch may be left on to provide cabin lighting. The exterior lights switch may either be turned OFF or left at the STEADY position, if required by the airport. All radio equipment, inverters, motors, and similar electrical equipment, must be off. No switches are to be operated after refueling is started.

e. The auxiliary ground power source must be shut down and moved clear of the aircraft unless it is explosion-proof.

6–6. CARBURETOR ICING. When visible atmospheric moisture is encountered, with free air temperatures below 10°C (50°F) carburetor icing should be anticipated and the following steps be taken:

a. Mixture control levers—AUTO RICH.

b. Carburetor air temperature—raise to 25-30°C (77-86°F).

c. Mixture control levers—reset for cruising.

d. Monitor fuel flow and BMEP in order to detect first evidence of instability.

Note

Impending loss of power is usually indicated by intermittent fluctuations of fuel flow and BMEP, or gradual decrease or increase in fuel flow.

6–7. In case icing conditions are encountered without warning, and there is a BMEP drop, fuel flow loss, or rpm surging, perform the following:

a. Mixture control levers—AUTO RICH.

Note

If fuel flow indicates that mixture is excessively rich, manually lean with mixture control to maintain smooth engine operation.

b. Apply carburetor alcohol for 3 to 5 seconds, release and observe whether stable power is regained. Continue intermittent application of alcohol until power is stabilized.

c. Mixture control levers—reset for cruising.

d. Leave carburetor heat on approximately 5 minutes after leaving icing conditions. Then reduce heat in progressive increments to assure that ice is melted.

e. Be alert for further power loss and reapply above procedure if instability occurs.

Note

If sufficient fuel flow cannot be obtained in AUTO RICH after the above procedures have been applied, operate the primer for short periods until stable engine operation is resumed.

6–8. The above procedures have been shown to be effective under all normal conditions where ice is likely to be encountered at altitudes below 20,000 feet and temperatures between 10 and –25°C (50 and –13°F). At altitudes above 20,000 feet, extremely high carburetor air temperatures may cause excessive leaning of the mixture and resultant engine instability. If such a condition occurs, the mixture should be enriched and/or carburetor heat reduced. It may be necessary to use alcohol more frequently.

6–9. MANUAL LEANING.

6–10. The engine fuel metering is designed to give the best economy in the AUTO LEAN mixture position. However, variables such as atmospheric conditions, induction configuration (carburetor air source) or carburetor malfunctioning may exist for which automatic compensation cannot be provided. Manual mixture control may be used to obtain best economy fuel flows under such conditions in accordance with the procedures outlined as follows:

CAUTION

Manual mixture control should not be used outside the normal AUTO LEAN cruise power settings as outlined in the operating instructions issued by the engine manufacturer.

6–11. The manual leaning procedure, *when using maximum cruise BMEP*, is as follows:

a. Set desired rpm.

b. Mixture control lever—AUTO RICH.

c. Set desired BMEP.

d. Lean with mixture control manually until BMEP rises to its maximum or shows no rise and begins to drop.

Note

This rise will normally be from 0 to 3 BMEP.

e. Throttle lever—reset to obtain desired BMEP.

f. Lean mixture control manually for 10% BMEP drop.

g. Throttle lever—open to originally desired BMEP.

6–12. The manual leaning procedure, *when using 90% maximum cruise BMEP or less*, is as follows:

a. Set desired rpm and 10% above desired BMEP in AUTO RICH.

b. Lean with mixture control until BMEP rises to its maximum or shows no rise and begins to drop.

c. Throttle lever—reset to obtain 10% above desired BMEP as in step a.

d. Lean with mixture control until BMEP drops to the desired cruise value.

6–13. FILLING MAIN OR EMERGENCY HYDRAULIC RESERVOIR IN FLIGHT.

6–14. Emergency hydraulic fluid may be used to replenish either the main hydraulic reservoir or the emergency extension and brake reservoir by the following method:

a. Hydraulic reservoir selector (figure 6–3)—set to reservoir to which fluid is to be transferred.

b. Operate hydraulic reservoir filler wobble pump handle.

fuel system management

FUEL LOAD					FUEL USAGE PROCEDURE (DO NOT TAKE OFF WITH LESS THAN 150 GALLONS IN EACH OF TANKS 1, 2, 3 AND 4)					
TO AND INCLUDING 5420 GAL. (32,520 LB)	OVER 5420 GAL. (32,520 LB) TO AND INCLUDING 5820 GAL. (34,920 LB)	OVER 5820 GAL. (34,920 LB) TO 6220 GAL. (37,320 LB)	6220 GAL. (37,320 LB) (400 GAL. (2400 LB) IN TANK 5)	OVER 6220 GAL. (37,320 LB)	ENG	1	2	3	4	
1	1				TANK	1	2	3	4	Take-off, climb and cruise until tanks 2 and 3 are empty.* Refer to 1, figure 6-1.
		1	1	1	TANK	1	2	3	4	Take-off and climb until cruise altitude is reached. Refer to 1, figure 6-1.
				2	TANK	1	5	5	4	Until 400 gallons (2400 lb) +1/2 the excess over 400 gallons (2400 lb) is used out of tank 5. Refer to 2, figure 6-1.
		2	2		TANK	1	5	5	4	Until tank 5 is empty. Refer to 2, figure 6-1.
				3	TANK	5	2	3	5	Until tank 5 is empty. Refer to 3, figure 6-1.
		3	3	4	TANK	1	2	3	4	Until tanks 2 and 3 are empty.* Refer to 1, figure 6-1.
	2	4			TANK	1	1	3a	4	Until the quantity of fuel in tank 1 is equal to that in tank 2a. Refer to 4, figure 6-1.
	3	5			TANK	1	2a	4	4	Until the quantity of fuel in tank 4 is equal to that in tank 3a. Refer to 5, figure 6-1.
2	4	6	4	5	TANK	1	2a	3a	4	To end of flight and landing. Refer to 6, figure 6-1.

* Momentarily required if crossfeed is to be established after tanks 2 and 3 are empty.

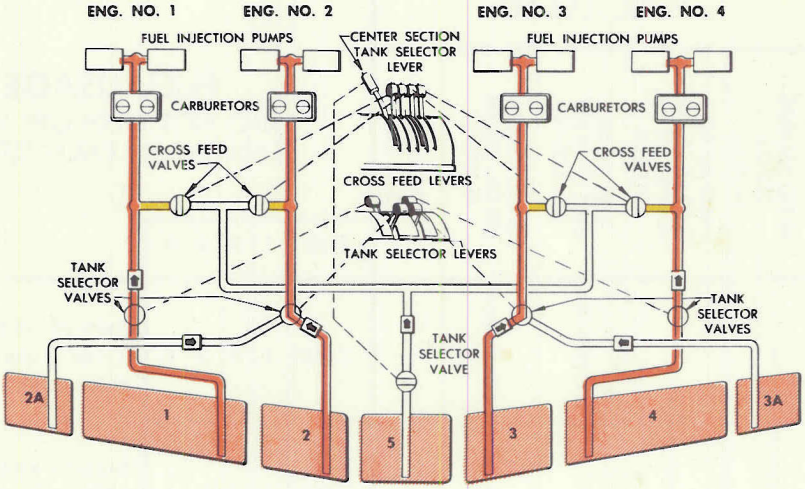
ENG	1	2	3	4
TANK	1	2a	3a	4

figure 6-1 Sheet 1 of 3

fuel system management

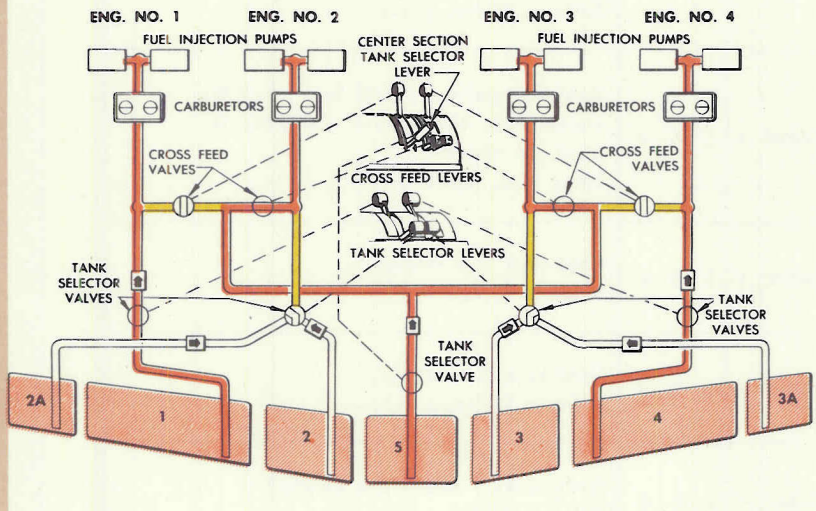
1

TANK-TO-ENGINE OPERATION FROM TANKS 1, 2, 3, AND 4.



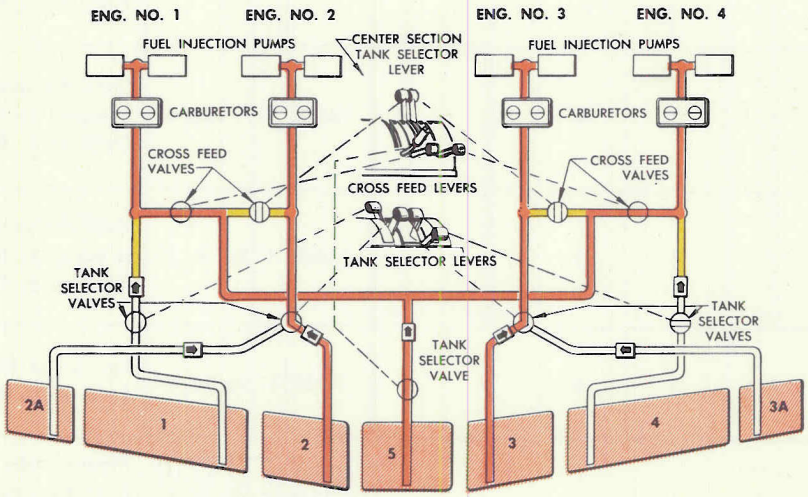
2

CROSSFEED TO ENGINES 2 AND 3 FROM TANK 5. TANK-TO-ENGINE OPERATION FROM TANKS 1 AND 4.



3

CROSSFEED TO ENGINES 1 AND 4 FROM TANK 5. TANK-TO-ENGINE OPERATION FROM TANKS 2 AND 3.

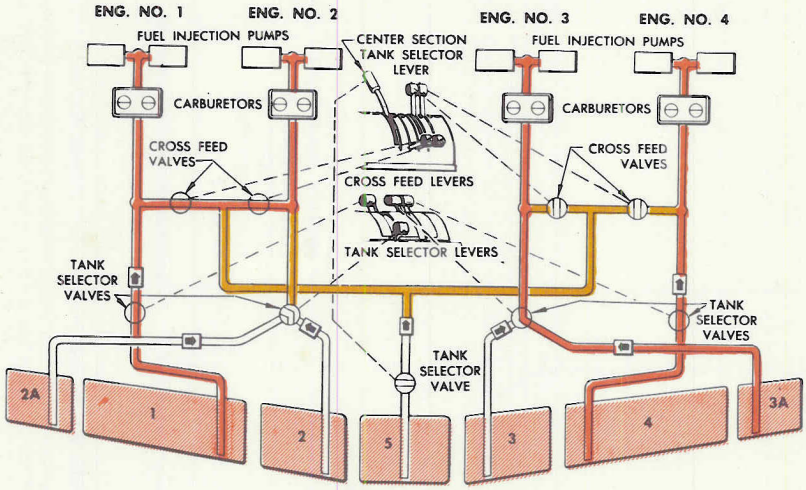


FUEL FLOW

STATIC FUEL

figure 6-1 Sheet 2 of 3

fuel system management

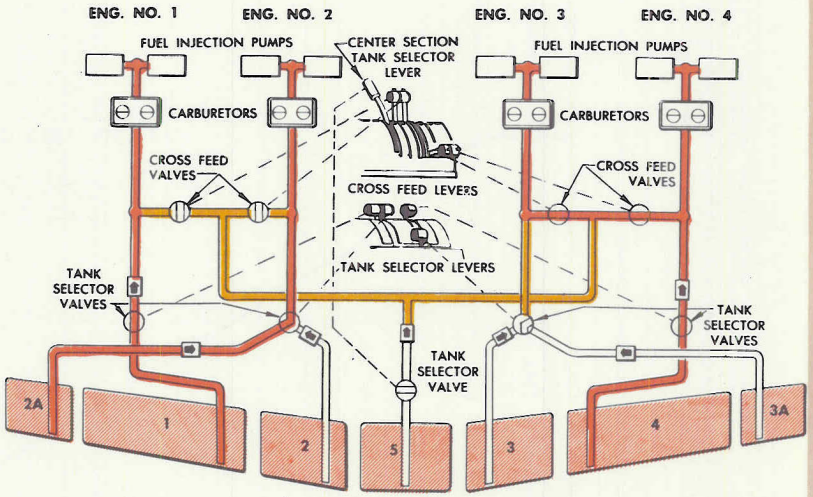


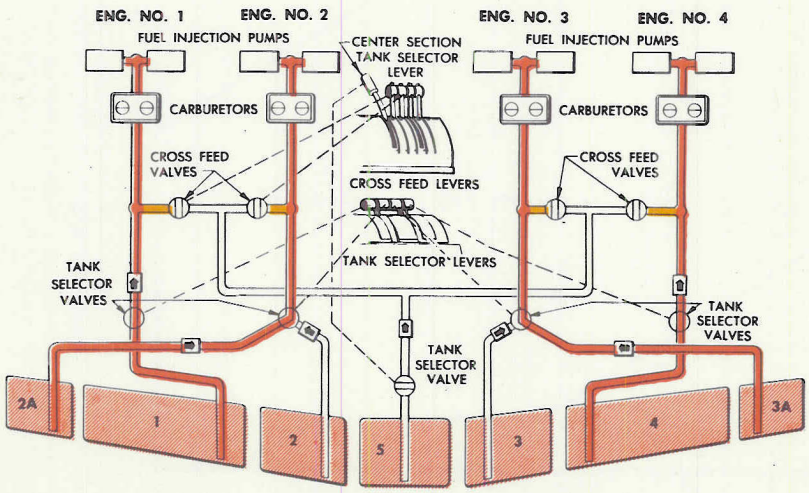
4

CROSSFEED TO ENGINES 1 AND 2 FROM TANK 1. TANK-TO-ENGINE OPERATION FROM TANKS 3A AND 4.

5

CROSSFEEED TO ENGINES 3 AND 4 FROM TANK 4. TANK-TO-ENGINE OPERATION FROM TANKS 1 AND 2A.





6

TANKS TO ENGINE OPERATION FROM TANKS 1, 2A, 3A, AND 4.

FUEL FLOW
STATIC FUEL

figure 6-1 Sheet 3 of 3

operational fuel loading — gallons

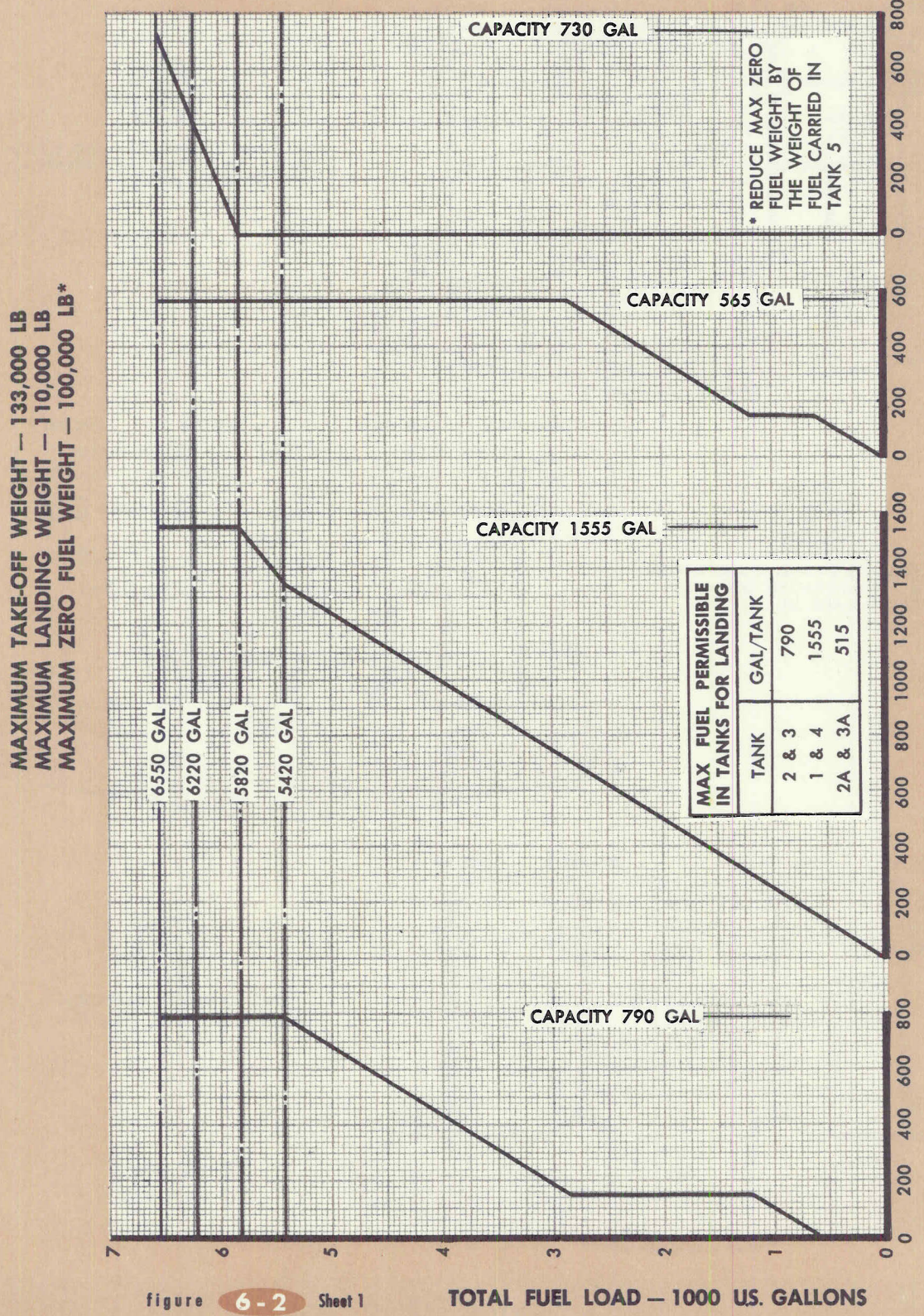
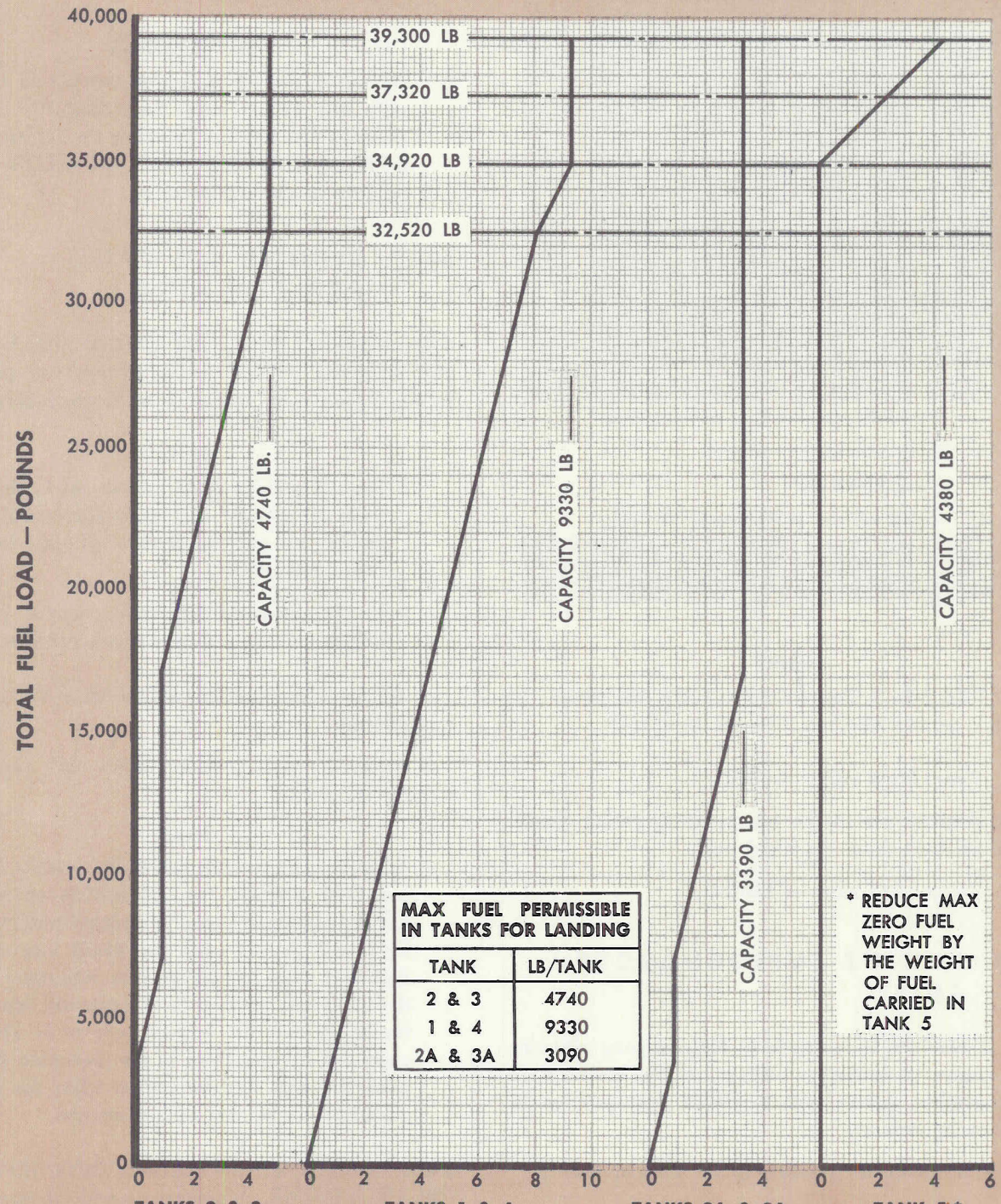


figure 6-2 Sheet 1

operational fuel loading—pounds

MAXIMUM TAKE-OFF WEIGHT — 133,000 LB
MAXIMUM LANDING WEIGHT — 110,000 LB
MAXIMUM ZERO FUEL WEIGHT — 100,000 LB*

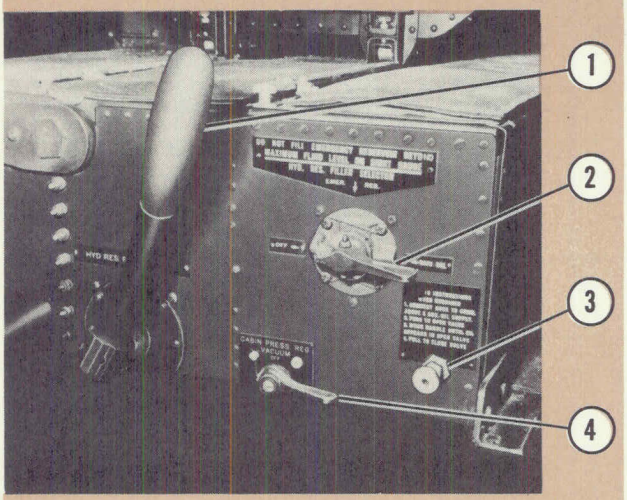


MAX FUEL PERMISSIBLE IN TANKS FOR LANDING	
TANK	LB/TANK
2 & 3	4740
1 & 4	9330
2A & 3A	3090

* REDUCE MAX ZERO FUEL WEIGHT BY THE WEIGHT OF FUEL CARRIED IN TANK 5

figure 6-2 Sheet 2

hydraulic reservoir replenishing controls



1. Hydraulic reservoir filler wobble pump
2. Hydraulic reservoir selector
3. Pump bleed valve
4. Cabin outflow valves vacuum shut-off

figure 6-3

Note

If fluid fails to flow from the pump, the pump may require bleeding. Proceed as follows:

1. Pump bleed valve—OPEN.

2. Disperse air in the pump, by operating handle until fluid flows from the bleed port.

3. Pump bleed valve—CLOSED.

6–15. ENGINE SUPERCHARGER SHIFT.

6–16. If climb is to be made to high cruising altitudes where engine supercharger shift is required to maintain adequate climb power, shift to HIGH ratio position in the following manner:

a. Reduce manifold pressure to 20″ Hg., or less.

b. Reduce engine speed to 1600 rpm.

c. Shift supercharger control to HIGH position. (Make all shifts as smoothly and rapidly as possible.)

d. After manifold pressure increases, indicating shift has been made, reset throttles to obtain the required climb power.

Note

The shift to HIGH position during climb-cruise power should be made at the altitude at which the BMEP drops to approximately 170 (from 188) with 2400 rpm.

WARNING

Do not exceed 38 inches of mercury in LOW ratio and do not make more than two shifts within a five minute interval or the engine may be damaged. Shifting from HIGH to LOW may be done at any engine speed.

6–17. ENGINE OIL TANK REPLENISHING.

6–18. NORMAL IN FLIGHT ENGINE OIL TANK REPLENISHING PROCEDURE. Operational procedures for adding oil to the engine oil tanks are as follows:

Note

- During interior flight station check, the reserve oil transfer circuit breaker should be pushed in, and the reserve oil tank heater switch turned ON.
- In the event of hydraulic transfer pump failure, use manual emergency procedure.

a. Rotate engine tank selector switch to tank requiring replenishing.

b. Press the start transfer button and check pump transferring light.

Note

When the engine tank maximum quantity limit has been reached, the transferring operation will automatically stop, the pump transferring light will go out, and the pump evacuating light will show for 60 seconds, indicating that the pump has reversed to evacuate the lines. In the event that the engine tank is to be replenished but not filled to the maximum limit, press the stop transfer button when the fluid quantity reaches the desired amount.

6–19. EMERGENCY ENGINE OIL TANK REPLENISHING PROCEDURE. A manual reserve oil transfer procedure is provided for operation of the system in the event of electrical power failure. The sequence of steps is as follows:

CAUTION

Open the reserve oil system circuit breaker on the station 260 upper switch panel before operating the manual controls.

a. Rotate engine oil tank selector to END position, then return to OFF position.

b. Select engine oil tank by rotating the handle from OFF to the desired engine tank position. Do not rotate handle backward while selecting engine tank.

c. Rotate auxiliary oil tank handle to OPEN position.

d. Set hydraulic pump transfer handle to PUMP position. Time pump operation to determine quantity of oil to be transferred. Transfer rate is approximately 3 gallons per minute.

e. After the desired quantity of oil has been transferred, set pump transfer handle to EVACUATE position and allow to operate for approximately 60 seconds.

f. Return hydraulic pump transfer handle to OFF position.

g. Rotate auxiliary oil tank handle to CLOSED position, then return to NEUTRAL position.

h. Rotate engine oil tank selector handle to END position, then return to OFF.

Note

For each engine oil tank replenished, the above procedure is to be followed.

i. When not in use, the handles must be in the following positions:

1. Engine oil tank selector—OFF.
2. Hydraulic pump transfer—OFF.
3. Auxiliary oil tank shut-off—NEUTRAL.

Section VII

trouble shooting

7–1. TROUBLE SHOOTING.

7–2. This section describes various troubles which may be encountered, their possible causes, and the recommended action to be taken. When continued operation of any malfunctioning system is considered imperative in the interest of safety of the aircraft, the passengers, and the crew, such operation shall be at the discretion of the responsible crew member.

7–3. ENGINE MALFUNCTION.

7–4. It is not practical to attempt to correct serious engine malfunction in flight. Efforts to do so may cause more serious damage. Reference to the engine manufacturer's handbooks and bulletins is recommended for more detailed information about engine malfunction, causes, effects, and methods of correction in flight.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
7–5. FUEL SYSTEM.			
Low fuel pressure (auxiliary fuel pumps on HIGH or LOW).	Improper tank selection. Faulty fuel pressure indicator. Leak in fuel lines. Low voltage.	Cross check warning lights and fuel pressure indicator; check fuel tank selector levers, and fuel tank level.	If on crossfeed, switch to tank-to-engine operation from main tanks, or, if on direct, switch to crossfeed.
7–6. INDUCTION SYSTEM.			
Carburetor air temperature high without heat on.	Induction leak. Faulty indicator.	Check carburetor air switches in COLD position. Cross check manifold and BMEP gages for drop (rpm constant) to determine that temperature actually is high.	If checks indicate trouble is not the result of instrument malfunction, and if temperature continues to increase or remains high and cannot be corrected, feather the propeller and shut down the affected engine.
7–7. PROPELLER MALFUNCTION — Curtiss Electric Propellers (LAC Serials 4501 through 4509).			
Feathering switch inoperative.	Faulty feathering switch circuit or voltage booster contacts.	Hold propeller selector switch in DEC. RPM position (feather switch—NORMAL). Check booster circuit breaker.	Place feather switch to NORMAL position and complete engine shutdown procedure. Refer to paragraph 3–7.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
PROPELLER MALFUNCTION—(Continued)			
Failure of all engines to reach take-off rpm (AUTO RPM position).	Synchronizer motor not adjusted properly.		
All propellers hunting or surging simultaneously.	Synchronizer motor not operating properly.	Place propeller selector switches in fixed pitch position.	If hunting or surging stops place master control lever to full DEC RPM position. Match engine speeds to desired rpm with the propeller selector switches, then return to fixed pitch position. If hunting or surging continues, it will indicate engine malfunction. Return selector switches to AUTO RPM position.
One propeller hunting or surging.	Contactors malfunctioning or loose power unit motor brake.	Place selector switch to fixed pitch position.	If hunting or surging continues, the cause is not in the propeller system and the selector switch should be returned to AUTO RPM position. If the hunting or surging stops, control the propeller by selective fixed pitch. If a steady increase in rpm is noted, it will indicate a loose brake in the motor unit and the selector switch should be returned to AUTO RPM position. If hunting or surging continues violently, feather the affected engine.
Propeller overspeeds in flight.		Refer to Section III.	

7—8. PROPELLER MALFUNCTION — Hamilton Standard Propellers (LAC Serials 4510 through 4519).

Propeller overspeeds during take-off.	Governor malfunction.	Toggle propeller governor control switch to decrease rpm.	If rpm cannot be reduced with the toggle switch, reduce power, and maintain a minimum safe airspeed. If overspeeding persists with toggling, momentarily engage feathering button to bring the engine speed within operating range. If rpm continues out of control, feather the propeller and shut down the affected engine.
Propeller overspeeds in flight.	Governor malfunction.	Promptly reduce airspeed and power.	Feather propeller and shut down engine if overspeeding persists.
Propeller will not feather.	Circuit malfunction.	Pull power off and toggle to decrease rpm.	Land as soon as possible.
Overspeeding propeller which will not feather.	Insufficient oil pressure to propeller. Circuit malfunction.	Reduce airspeed as much as safety permits and reduce power of affected engine.	Shut off ignition and all fluid to the engine except oil. If propeller cannot be feathered after airspeed has been reduced, stand by the engine fire extinguisher. Land as soon as possible. **Note** Observe RAPID DESCENT procedure.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
PROPELLER MALFUNCTION—(Continued)			
Propeller will not synchronize (hunting or surging).	Circuit malfunction.	Select other master engine.	If propellers continue out of synchronization, synchronize manually.
No master rpm lever control with synchronizer ON.	Circuit malfunction.	Move master engine selector switch to OFF and use individual propeller governor switches.	Check synchronizer toggle circuit breaker on engineer's control quadrant circuit breaker panel to be sure it is in the ON position.
Erratic or backward propeller governor action (synchronizer action only).	One phase open to step motor head.	Turn synchronizer OFF and operate manually.	If action continues to be erroneous, make no further attempt to adjust rpm. Feather propeller if necessary.
Erratic or backward governor action (all conditions).	One phase open in any circuit to step motor head.	Operate manually.	Establish rpm by positioning step motor head with governor control toggle switch, moving it to INC. RPM or DEC. RPM as necessary. **Note** Use toggle switch carefully to avoid overspeeding propeller. Once in safe operating range, leave it.
Tachometer fluctuates.	Broken wire at the tachometer generator. Instrument malfunction. Faulty indicator.	Cross check pilots' and flight engineer's tachometers.	If malfunction is in the tachometer, it may be ignored. Synchronize manually, using engine analyzer as synchroscope.

7—9. HYDRAULIC POWER SYSTEM MALFUNCTION.

7—10. SECONDARY HYDRAULIC SYSTEM FAILURE DURING CRUISE.

Loss of secondary system pressure during flight.	Multiple pump failure. Line stoppage; air lock in line between reservoir and pump. Leak resulting in empty secondary system side of reservoir. Failure of pressure indicators.	Move No. 3 and No. 4 emergency shut-off valve levers to HYD. OIL OFF positions. Shut off secondary heat exchanger fan motor.	**Note** There is no demand for secondary system pressure during normal cruise operation. In some cases, a leak resulting in loss of secondary system fluid can be located and isolated, thus permitting the use of components not affected. If pressure loss was detected during the operation of any secondary system component, isolate that component, and prepare to operate it when necessary, in accordance with applicable emergency procedures. Refer to paragraph 3—137. To determine if secondary side of main hydraulic reservoir is empty as a result of leakage in the system: 1. Check the hydraulic fluid quantity indicator on the flight engineer's upper instrument panel. A reading above 5/8 full should indicate the presence of fluid in the secondary side of the reservoir. Prove this by adding a small amount of fluid

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS

SECONDARY HYDRAULIC SYSTEM—(Continued)

which should show as an increased reading on the quantity indicator.

2. A reading of less than 5/8 full may indicate reservoir empty on secondary side. Check by adding fluid. If the quantity indicator fails to show an increase after fluid has been added, it may be assumed that a leak has occurred in the secondary system and that the secondary side of the main hydraulic reservoir is empty.

To isolate a hydraulic leak between pump control valve and check valve to pressure manifold, check pumps individually as follows:

1. Add fluid to main reservoir until secondary side is filled to normal level (the point at which the quantity indicator registers an increase above 5/8 full).

Note

Three gallons of fluid may be required if secondary side of the reservoir is completely empty.

2. Turn on No. 3 pump. Watch pressure indicator and fluid quantity indicator. If pressure and fluid quantity drop, turn off No. 3 pump and repeat test with No. 4 pump. If pressure and fluid quantity drop with this pump in operation also, leak may be assumed to be in the pressure system. If pressure remains normal, and reservoir level remains constant during either test, while dropping during the other test, the leak may be assumed to be in the pumping or supply system of the failed pump.

Note

Tank level may drop slightly due to empty lines.

WARNING

If leak cannot be located and isolated so that partial use of the secondary hydraulic system is available, or if failure is due to any indeterminate or irreparable cause, prepare for emergency operation of flaps, landing gear, and brakes for the next landing.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
SECONDARY HYDRAULIC SYSTEM—(Continued)			
			Note If secondary system fails, it will be impossible to operate the reserve engine oil system, to dump fuel from tanks No. 2A and 3A, and nose wheel steering will be inoperative. In event of primary system failure, also, there will be no cross-over back-up from secondary system to operate primary system components.
7—11. PRIMARY HYDRAULIC SYSTEM FAILURE.			
Loss of primary system pressure (secondary system normal).	Leak in primary pumping system or primary supply system.	Notify pilot. Move No. 1 and No. 2 emergency shutoff valve levers to HYD. OIL OFF positions. Refer to paragraph 3—109.	Before starting trouble shooting procedures, set boost controls to manual for all three surfaces. This procedure is necessary to prevent loss of primary fluid during tests. 1. Determine that the secondary system is operating satisfactorily. 2. To isolate a hydraulic leak in the primary supply system: a. Add fluid to the main hydraulic reservoir until fluid quantity indicator begins to register an increase. **Note** Quantity indicator should begin to register when 1 or 2 gallons have been added. b. Stop filling operation and watch fluid quantity indicator for a decrease in reservoir level. If fluid level drops, leak is in the supply system. 3. To isolate a hydraulic leak in the pumping system: If fluid level remains stationary during step 2b, above: a. Turn on No. 1 pump. Watch quantity and pressure indicators. If pressure builds up and fluid level does not drop, the No. 1 pumping system is normal. If the pressure does not build up, and/or the reservoir fluid level drops, the leak may be assumed to be in the No. 1 pumping system. b. Turn off pump No. 1, and repeat step 3a, above, for pump No. 2. If leak is located, isolate the bad pump-

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
PRIMARY HYDRAULIC SYSTEM—(Continued)			
			ing system or systems, and continue operation. 4. If the trouble cannot be located, the probable cause is a slow leak. Leave No. 1 and No. 2 pumps turned off as a precautionary measure, and monitor the system during the remainder of the flight. **Note** Systems normally supplied by the secondary hydraulic system may operate more slowly.
Loss of primary pressure and primary hydraulic fluid (No. 1 and No. 2 pressure warning lights on), followed by loss of secondary pressure (No. 3 and No. 4 warning lights on).	Leak in one or more primary units.	Do not attempt to trouble shoot.	Refer to emergency procedures. Check emergency boost and brakes before entering the landing pattern.
Landing gear will not lock up.	Uplocks or uplock pins do not engage. Pressure in the emergency extension line. Drag struts out of adjustment.	Lower and raise the gear several times.	Check position of the hand pump selector. It should be in the EMER. BRAKE position. Place gear control lever in the DOWN position; then move it to the UP position. If landing gear still will not lock in the UP position, return to the airport and land.
Landing gear comes up, but red UNLOCKED light does not go out.	Circuit malfunction.	Leave landing gear control lever in UP position.	Establish satisfactory flight conditions with airspeed at or below the established landing gear operating speed (V_{LO}). Move landing gear control lever to NEUTRAL. If the gear does not extend partially, it may be assumed that the switch or position indicating system circuit is not functioning properly, and normal operation may be continued. If the gear partially extends when the lever is positioned at NEUTRAL, perform the check outlined for "landing gear will not lock up."
Landing gear red unlocked light on; one or more of green gear down and locked lights off, with landing gear control lever in DOWN position.	Downlock not properly engaged. Malfunctioning switch or circuit.	Check position of hand pump selector lever (it should be in the EMER. BRAKE position). Check hydraulic fluid quantity and pressure. Raise and lower the gear several times.	If the malfunction continues, follow the emergency gear extension procedure. Apply hand-pump pressure to the maximum value. **Note** If only the nose gear fails to lock in the down position, inspect the extension and locking action visually through the forward cargo loading door to confirm indicators. If the emergency procedures fail to produce the desired result, isolate emergency pressure so that it

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
PRIMARY HYDRAULIC SYSTEM – (Continued)			
			may be directed entirely to the nose gear by "pinching off" the emergency line to the main gear. This line, located on the left forward side of the forward cargo compartment, can be reached by removing the forward section of the compartment lining. It is marked L.G.EMERG.EXT. When the line has been closed off, apply hand-pump pressure to the maximum value, which should extend and lock the nose gear.
Landing gear will not come up.	Gear safety pins not out.	Return to field and land.	
Landing gear red unlocked light on, all gear down and locked lights on, with landing gear extended.	Circuit malfunction.	Retract gear and check red unlocked light in gear UP position. Return landing gear control lever to DOWN position.	Use emergency gear extension procedure if necessary.
7–12. ELECTRICAL POWER SYSTEM MALFUNCTION.			
7–13. D.C. ELECTRICAL SYSTEM.			
Generator overheat light comes on.	Generator overheating.	Isolate affected generator by turning generator switch OFF and pulling the generator field circuit breaker. Reduce electrical load if total is greater than the rating of the remaining operating generators.	If overheat light remains on a total of 10 minutes, including isolation and cooling period, feather the propeller and shut down the affected engine. If the generator is operated for more than 10 minutes after the overheat warning light comes on, it will be necessary to remove and replace the generator.
Generator field relay trips.	Overvoltage or reversed generator polarity.	Open generator switch and close it momentarily on the reset contacts.	If the reversed polarity or the overvoltage condition has been removed, the warning lights will go out and the circuit may be restored to normal operation. If the cause of the tripped condition persists, the field relay will immediately trip, as indicated by the blinking of the warning light. Turn generator switch OFF.
Generator trips during taxiing or on landing.	Overvoltage control panel set too low or voltage regulator set too high.	Turn generator switch OFF.	Report for correction by ground maintenance crew.
Voltage, but no amperage.	1. Defective or incorrectly adjusted reverse current relay, voltage regulator, or equalizer circuit.	1. Turn on additional loads. If no results, turn OFF generator and pull field circuit breaker.	1. Report for correction by ground maintenance crew.
	2. Defective ammeter or ammeter circuit.	2. None.	2. Report for correction by ground maintenance crew.
Generator trips and cannot be reset by switch.	Feeder fault.	Turn generator switch OFF.	Report for correction by ground maintenance crew.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
ELECTRICAL POWER SYSTEM—(Continued)			
			WARNING Under no circumstances should any attempt be made to reset the fault protection relay in flight.
No voltage or amperage from generator.	1. Field relay open.	1. Reset field relay.	
	2. Mechanical or electrical failure.	2. None.	2. Report for correction by ground maintenance crew.
Generator trips due to over-voltage.	1. Transient voltage.	1. Reset with generator switch.	
	2. Voltage regulator set too high.	2. Turn generator switch OFF, and pull field circuit breaker.	2. If generator is needed, adjust voltage regulator. Reset field circuit breaker and check generator voltage. If voltage is satisfactory, turn generator switch ON.
7—14. A.C. ELECTRICAL SYSTEM.			
Inverter inoperative with inverter switch on.	Inverter circuit breaker OFF (located on the station 260 upper panel).	Reset circuit breaker.	
Inverter not producing 115 volts.	Voltage regulator not functioning properly.	Switch to No. 2 or spare inverter.	Report for correction by ground maintenance crew.
Low voltage on one inverter phase.	1. Faulty inverter.	1. Cross check with No. 2 or spare inverter. If voltage on all phases is normal, the NORMAL or No. 1 inverter has failed.	Switch to No. 2 or SPARE inverter. Report for correction by ground maintenance crew.
	2. Excess load on circuit.	2. Reduce load on affected phase.	2. Locate cause of overloading, and isolate if possible.
Inverter voltage drops below 115 volts on phases 2 and 3; inverter out warning light fails to light.	Failure in affected phases.	Switch to SPARE or No. 2 inverter.	Report for correction by ground maintenance crew.
Loss of a.c. power to either left or right engine instruments with inverter out warning light not on.	1. Two-amp. engine instrument fuse burned out.	1. Replace fuse. Check left and right engine instrument voltage.	1. Two fuses; one in lead from A phase for right engine instrument transformer; one in line from C phase for left engine instrument transformer (located on main power relay panel in forward cargo compartment). Four fuses; one for instruments of each engine (located on lower MJB station 212 panel).
	2. Defective transformer or broken lead.	2. Control engines with inoperative instruments by positioning controls approximately the same as controls for symmetrical engines.	2. Report for correction by ground maintenance crew.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
7–15. AIR CONDITIONING SYSTEM MALFUNCTION.			
Cabin supercharger oil temperature rises and oil temperature warning light lights during ground operation.	Insufficient oil cooling.	Check other supercharger instruments to be sure operation is otherwise normal; then reduce throttle setting to 1,000 rpm or less.	After oil temperature warning light goes out, increase engine rpm not to exceed 1,200. **Note** Right hand cabin supercharger operates at a lower temperature than the left.
Door warning light lights.	One or more doors unlatched.	Instruct navigator to fasten seat belt.	Lower cabin differential. Descend to safe low altitude.
Cabin supercharger oil temperature rises and oil temperature warning light lights in flight.	Cabin supercharger internal failure.	If temperature reaches 110°C, disconnect cabin supercharger.	Report for correction by ground maintenance crew.
Cabin supercharger low oil pressure warning light on.	Cabin supercharger internal failure.	If pressure falls below 50 psi, disconnect cabin supercharger.	Report for correction by ground maintenance crew.
Cabin supercharger low oil pressure warning light comes on and cabin supercharger discharge pressure falls to zero.	Inadvertent cabin supercharger disconnect.	Disconnect supercharger drive shaft and make the necessary checks to be sure the drive shaft is actually disconnected.	Report for correction by ground maintenance crew.
Cabin supercharger drive shaft rear bearing temperature increases.	Disconnect bearing failure.	Verify by checking other cabin supercharger instrumentation. Disconnect cabin supercharger if temperature reaches 150°C.	Report for correction by ground maintenance crew.
Cabin supercharger fails, and drive shaft disconnect fails to operate.	Malfunctioning drive shaft disconnect.	Feather propeller and shut down engine.	Report for correction by ground maintenance crew.
Cabin supercharger discharge pressure registers zero; temperature and oil pressure remain normal.	Reactor pump failure.	Disconnect cabin supercharger.	Report for correction by ground maintenance crew.
Fluctuating cabin supercharger discharge pressure.	Pressure ratio limiter valve or water separator anti-icer valve opening.	Check other cabin supercharger instrumentation for indications of supercharger failure.	Reduce cabin pressure enough to take the cabin supercharger out of the governing range.
Cabin pressure surge with panel set for automatic operation.	Malfunctioning of the automatic circuit.	Switch to manual pressurization control. (Refer to paragraph 4–110.)	
No change in refrigeration discharge duct temperature when cabin air (paddle) switches are repositioned.	Primary heat exchanger scoops immobilized by ice. Circuit malfunction.	Move refrigerator override switch to EMER. position.	With the refrigerator override switch in the EMER. position, the cabin air switch will reposition the air mixing and selector valve without changing the position of the primary heat exchanger scoops.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
AIR CONDITIONING SYSTEM—(Continued)			
One cabin heater fails to function when energized by cabin temperature selector rheostat.	Heaters out of balance or faulty temperature control circuit.	Check air conditioning control panel controls and indicators to verify correct positioning.	Move cabin heater emergency override switch to OVERRIDE position.
One cabin heater fails to function with heater emergency override switch in either NORMAL or OVERRIDE positions.	Faulty heater ignition.	Move affected cabin heater emergency ignition switch to the EMERGENCY position.	Report for correction by the ground maintenance crew.
One cabin heater fails to function under any condition.	Heater failure.	If ambient air temperature is low, close the key-operated hot wall shut-off valve on that side of the fuselage on which the inoperative heater is located.	Report for correction by the ground maintenance crew.
Cabin heaters fail to function in icing conditions.	Combustion air inlet iced up.	Turn combustion air blower override switch ON.	
Cabin heater overheat light lights.	Faulty temperature control circuit.	Turn cabin heater switch OFF.	Allow heater to cool, then turn cabin heater switch ON. Adjust cabin air temperature selector switch to a lower value. If the heater overheat light comes on again, turn heater OFF. Do not attempt to re-start it. Report for correction by the ground maintenance crew.
Pilots' aux. heater overheat warning light lights.	Insufficient air flow over heater.	Check position of mixing valve. Open pilots' face and foot outlets to allow more air flow over auxiliary heater.	Turn heater switch OFF, then back ON. **Note** Pilots' auxiliary heater is usually required only in very cold weather to supplement air conditioning system heater output. It is not intended for use as an individual heater.
7—16. PNEUMATIC DE-ICER SYSTEM AND VACUUM SYSTEM MALFUNCTION.			
Uneven build-up of ice on wings.	1. Low de-icer boot pressure due to faulty regulator setting.	1. Move de-icer boot timer pneumatic control to EXTENDED CYCLE.	
	2. Low de-icer boot pressure due to faulty pump.	2. Move one de-icer air pump selector valve switch from VAC. to DE-ICER PRES.	2. Operate segment switch manually. If pressure still is insufficient, move second de-icer air pump selector valve to DE-ICER PRES.
	3. Faulty timing or circuit.	3. Inflate the ineffective boot section manually with the appropriate segment switch located at the bottom of the de-icer boot timer.	3. Try manual operation.

NATURE	POSSIBLE CAUSES	IMMEDIATE ACTION	FOLLOW-UP ACTION AND REMARKS
PNEUMATIC DE-ICER SYSTEM AND VACUUM SYSTEM MALFUNCTION — (Continued)			
Boots separate from leading edge.		Reduce airspeed.	
Low air pressure in boot system.	Failure of de-icer pump. Sheared shaft.	Move one de-icer air pump selector valve switch from VAC. to DE-ICER PRES.	Report for correction by ground maintenance crew.
De-icer pump warning light comes on.	Vacuum pump failure.	Shut off unessential vacuum operated equipment, to conserve suction for essential equipment.	Report for correction by ground maintenance crew. **Note** The cabin pressure regulator valve isolates the air conditioning system cabin outflow valve controls; the driftmeter shut-off valve will isolate the driftmeter vacuum defogging system; and the motor-driven shut-off valve, controlled by the de-icer vacuum switch aft of the electronic de-icer timer, isolates the de-icer boots, thus directing greater suction to the vacuum-driven flight instruments on those airplanes so equipped.
De-icer pump warning light comes on when de-icer boot timer pneumatic control is turned on.	1. No vacuum to de-icer boots. Both de-icer air pump selector valve switches are turned to DE-ICER PRES.	1. Move switch to VAC. position.	
	2. Leak in system.	2. Shut off system to conserve vacuum for instruments.	

THE INDEX WILL BE SUPPLIED WHEN AVAILABLE