REPORT NO. 7786

Super Constellation

Model *1049* Series

CREW OPERATING MANUAL

LOCKHEED

LOCKHEED AIRCRAFT CORPORATION
BURBANK, CALIFORNIA

LOCKHEED REPORT 7786

CREW OPERATING MANUAL FOR LOCKHEED MODEL 1049 *Super Constellation* AIRPLANES

Revision Notice . . . . REVISED PAGES SUPERSEDE AND REPLACE PAGES OF SIMILAR NUMBER. Insert revised pages in basic manual. Remove and destroy superseded pages.

NOVEMBER 30, 1951
REVISED MAY 1, 1952

1000 COPIES

First Printing Dated November 30, 1951

Revision No. 1 Dated February 15, 1952

Revision No. 2 Dated May 1, 1952

LOG OF REVISIONS

PAGES REVISED	PAGES REVISED	PAGES REVISED	PAGES REVISED
Revision 1	Sect. III	176	37
Dated 2/15/52	Divider	178	38
1	115	179	38A
2	116	180	38B
9	117	181	39
10	118	182	40
13	119	184	41§
14	120	185	42
20	121	188	43
21	122	189	44
22	123	190	44A
23	124	191	44B
25	125	193	45
26	126	194	46
28	127	195	47
33	128	196	48
34	129	197	49§
35	130	198	50
36	131	199	52
37	132	200	53
38	133	201	54
54	134	202	54A & 54B
62	134A	203	55
64	134B	204	56
66	135	204A	57
70	136		58§
71	138		59
72	140	Revision 2	60§
73	141	Dated 5/1/52	61
82	142	Sect. I	62
88	143	Divider	62A
89	145	1	62B
90	147	2	63
91	148	6	64
92	149	7 & 8	66
93	150	9	67§
Sect. II	151	10§	71
Divider	152	11§	72
99	153	12	72A
100	154	13	72B
101	155	14	73
102	156	14A	76
103	157	14B§	78
104	158	16	79
105	160	17	83
106	161	24	84
107	162	26	85
108	162A	27	86
109	162B	28	87
110	163	29	88
111	166	30	88A
112	168	32	88B
113	170	33	89
114	171	34	90
114A	173	35	91
114B	174	36	92

§Text and/or figure repositioned, or minor typographical correction.

LOG OF REVISIONS (Continued)

PAGES REVISED	PAGES REVISED	PAGES REVISED	PAGES REVISED
93	173	219	
94	176	220	
95	178	221	
96	180	222	
96A	180A		
96B§	180B		
97	180C		
98	180D		
99	180E		
100	180F		
101	180G		
102	180H		
103	180J		
104	180K		
109	180L		
110	180M		
111	180N		
112	180P		
113	181		
114	182		
114A	183		
114B	184		
114C	184A		
115	184B		
116	184C		
117	184D		
118	185		
119	186		
120	186A		
121	186B		
122	186D		
123	187		
124§	188		
125	189		
126	190		
127	191		
128	192		
129	193		
131	194		
132	195		
133	196		
134	198		
134B	199		
161	201		
162	202		
162A	203		
163	204		
164	204A		
165	204B§		
166	Section VII		
167	Insert		
168	215		
170	216		
171	217		
172	218		

§Text and/or figure repositioned, or minor typographical correction.

FOREWORD

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

SECTION I — DESCRIPTION

Describes the airplane systems and controls that are required to fly the airplane.

SECTION II — NORMAL OPERATING PROCEDURES

Details procedures used to operate the airplane and its systems under normal conditions.

SECTION III — EMERGENCY OPERATING PROCEDURES

Outlines basic emergency procedures and the use of emergency systems and facilities.

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 airplane, 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.

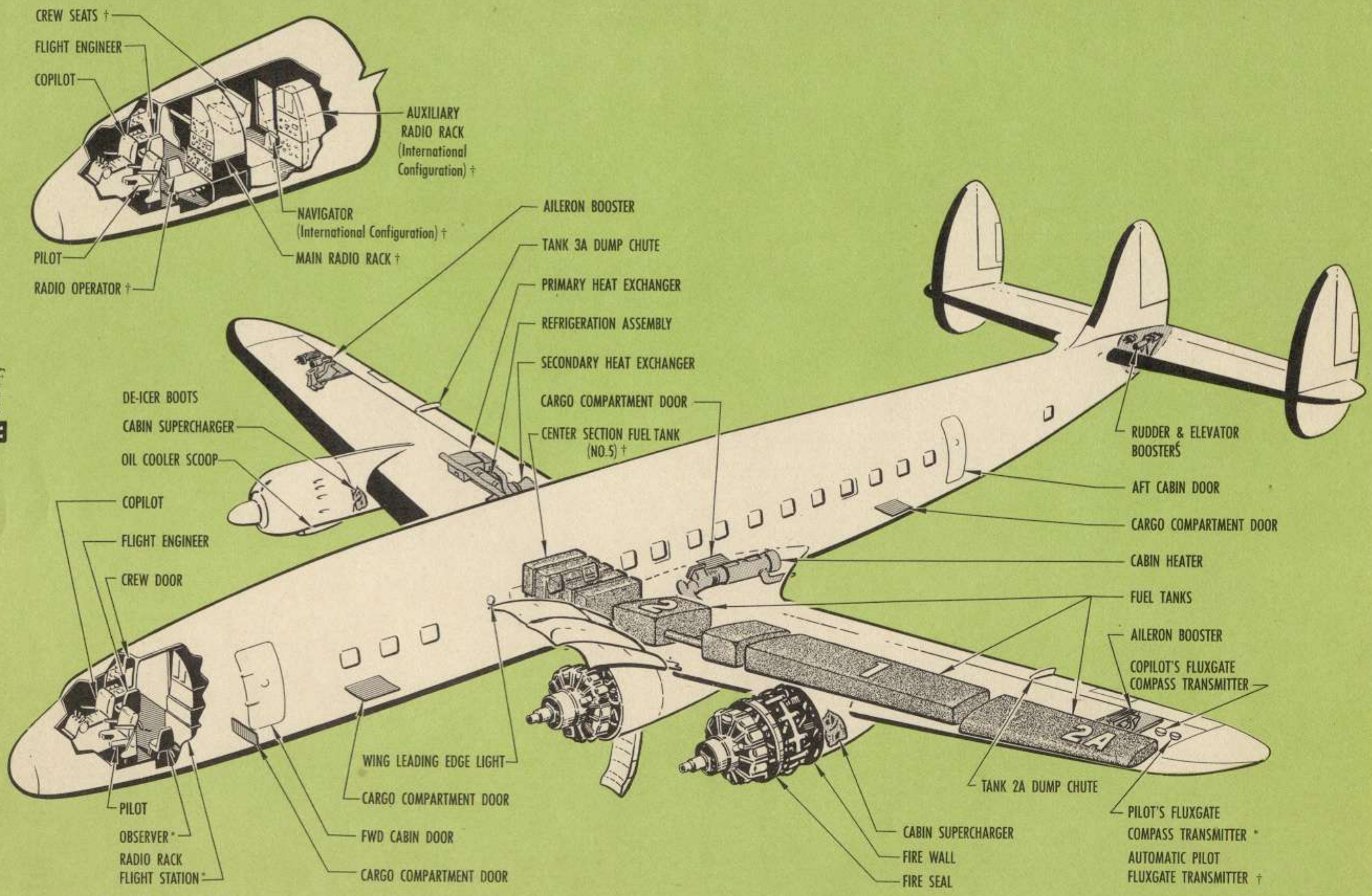
Cruise control, performance information, weight and balance data, maintenance instructions and structural repair information are not included in this manual, but are published in separate reports. These reports are identified as follows:

SUBJECT	LOCKHEED REPORT NO.
Cruise Control	8482*
Performance—CAA Flight Manual	7787
Weight and Balance	8098§
Maintenance Instructions Manual	7788* or 7963†
Structural Repair	7789

§ L.A.C. Aircraft serial number is listed as a dash number following the report number.

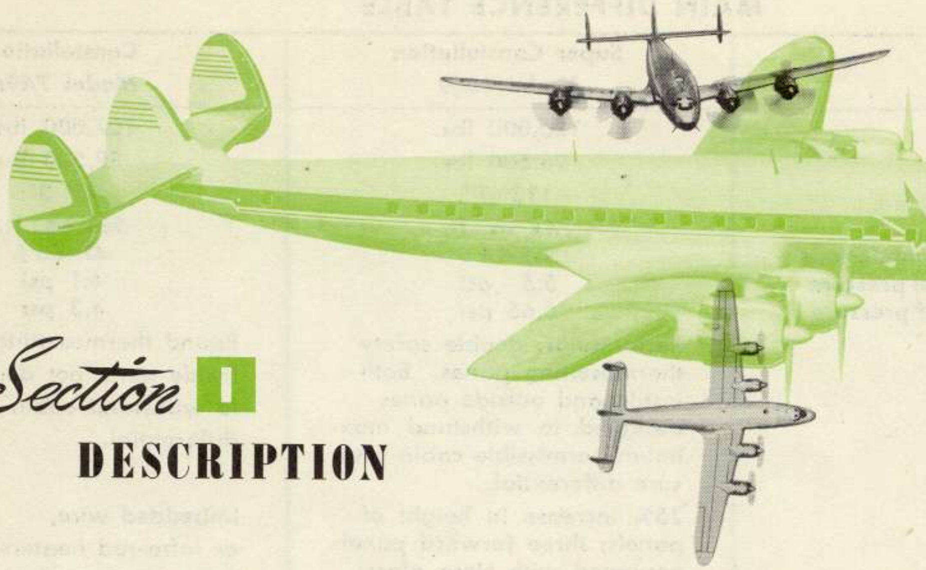
IMPORTANT! ... Descriptions or illustrations that are not applicable to all Model 1049 airplanes are serialized or footnoted. Asterisks (*) are used to designate differences exclusive to LAC Serials 4001 through 4014, and daggers (†) are used for LAC Serials 4015 through 4024.

GENERAL ARRANGEMENT DIAGRAM



* LAC Serials 4001-4014 † LAC Serials 4015-4024

figure 1-1



Section I
DESCRIPTION

1-1. THE AIRPLANE

1-2. GENERAL. The Lockheed Super Constellation, Model 1049, is a modified, improved development of the 749A Constellation series. It is an all-metal, low-wing monoplane, powered by four Wright Cyclone engines, designed for high-speed, long-range commercial transportation. Capacity, seating arrangement, and crew required are varied to suit operators' requirements.

1-3. DIMENSIONS AND DIFFERENCES. Four internal configurations of the Model 1049 are described in this report. LAC Serials 4001 through 4014 are discussed as a single group, and three configuration variations, two domestic and one international, are described in the discussion of LAC Serials 4015 through 4024. Essential dimensional data and main differences between Model 1049 and Model 749A Constellations are presented on Pages 2 and 3.

1-4. FUSELAGE. The semi-monocoque fuselage is circular in cross section, and is sealed for pressurization between the forward bulkhead, which is located approximately one foot aft of the tip of the nose, and the aft bulkhead, which is the rear wall of the lounge. Doors on the lower sides and bottom of the fuselage are equipped with additional sealing to minimize water leakage if it becomes necessary to ditch the airplane.

1-5. Two cargo compartments, separated by the wing center section, are located below the cabin floor. The cabin is divided by partitions into sections for the flight station, galley and passenger compartments, the size and arrangement of which are varied to meet operators' service requirements. (See figures 4-31 and 4-31A.)

1-6. FLIGHT STATION.* Stations for pilot, copilot, and flight engineer, and a seat for an observer are provided in the flight station.

1-6A. 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 airplanes equipped for international service. Seats for the relief crew are installed on the right side opposite the navigator's station. In domestic service airplanes, passenger seats are installed in this compartment. (Refer to figure 4-31A.)

1-7. 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. A forward-opening door in the station 260 partition provides access to compartments aft of the flight station.

1-8. Two 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.

1-9. The seven panel, wide angle windshield is equipped with anti-icing, de-icing and de-fogging devices. The three forward panels are equipped with Nesa anti-icing glass; the five forward panels are equipped for fluid de-icing; and the four aft panels (two on each side) are equipped with heated air de-fogging jets. The second panels from the rear on each side are in low pressure areas, and may be opened for clear vision without exposing the pilots to wind and rain. (Refer to figure 4-23.)

1-10. GALLEY COMPARTMENT.* The galley and two storage closets are located in a seven foot long compartment immediately aft of the flight station. The galley installation is on the right side. The forward passenger

*LAC Serials 4001–4014 †LAC Serials 4015–4024

MAIN DIFFERENCE TABLE

	Super Constellation Model 1049	Constellation Model 749A
Take-off weight limits	120,000 lbs.	107,000 lbs.
Landing weight limits	98,500 lbs.	89,500 lbs.
Fuselage length	113′ 7″	95′ 3″
Usable cabin floor area	744 sq. ft.	561 sq. ft.
Passenger and crew accommodations	76–94 §	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; three forward panels equipped with Nesa glass; five forward panels equipped with alcohol anti-icing facilities; two aft panels on each side equipped with hot air defoggers.	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	Four. Two in each compartment (4 interior access hatches, two of which are equipped with wide angle inspection lenses).	Two. One in each compartment (2 interior access hatches).
Engines	Wright 956C18CA1 * ; Wright 975C18CB1 †	Wright 749C18BD1
Propellers	Hamilton Standard 43E60/6901A with autofeathering	Hamilton Standard 43E60/6869A without autofeathering
Governor		
Direction of drive	clockwise	counterclockwise
Drive ratio	.857: 1	.879 : 1
Propeller blade angles — High	81.5° approx	81.5° (feather)
Low	12.0°	13.0°
Reverse	−21.5°	−20.5°
Fuel tanks	6 with provision for center section tank*; 7 including center section tank †	6
Fuel tank standpipes	Tanks 1, 2A, 3A, & 4	Tanks 1, 2, 3, & 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
Cowl flap chord (centerline)	15.9″	17.9″
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 elevator with up spring on elevator.	Up and down spring on control column.
Brakes	Goodyear single disc spot type	Goodyear multi-disc

*LAC Serials 4001–4014 †LAC Serials 4015–4024

§ 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 baggage compartment doors:
Forward baggage compartment:
Forward loading door (in nose wheel well) . . . . 7′ 5″ approx
Aft loading door (in fuselage skin, lower right side) . . . . . . 8′ 3″ approx
Aft baggage compartment:
Forward loading door (in fuselage skin, lower right side) . . 8′ 4″ approx
Aft loading door (in fuselage skin, lower right side) . . . . . . 8′ 8″ approx
Minimum ground clearance, nose gear door open . . . . 7′ 0″ approx
Minimum ground clearance, main gear doors open . . . . 6′ 2″ approx
Height to aft passenger door sill . . . . 9′ 4″ approx
Height to forward passenger door sill 11′ 2″ approx
Height to flight station door sill . . . . . 10′ 7″ approx
Stabilizer span . . . . 50′ 0″
Diameter of propeller disc . . . . 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) 9.4″
Clearance between adjacent propeller planes . . . . 18.5″
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° 14′
Horizontal stabilizer area (including 67.38 sq. ft. of fuselage area) . . . . . . 356.78 sq. ft.
Elevator area (including 10.86 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°
Let 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 fin area (not including rudders) . . . . 312 sq. ft.
Vertical stabilizer area . . . . 210.8 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°

STATIONS DIAGRAM

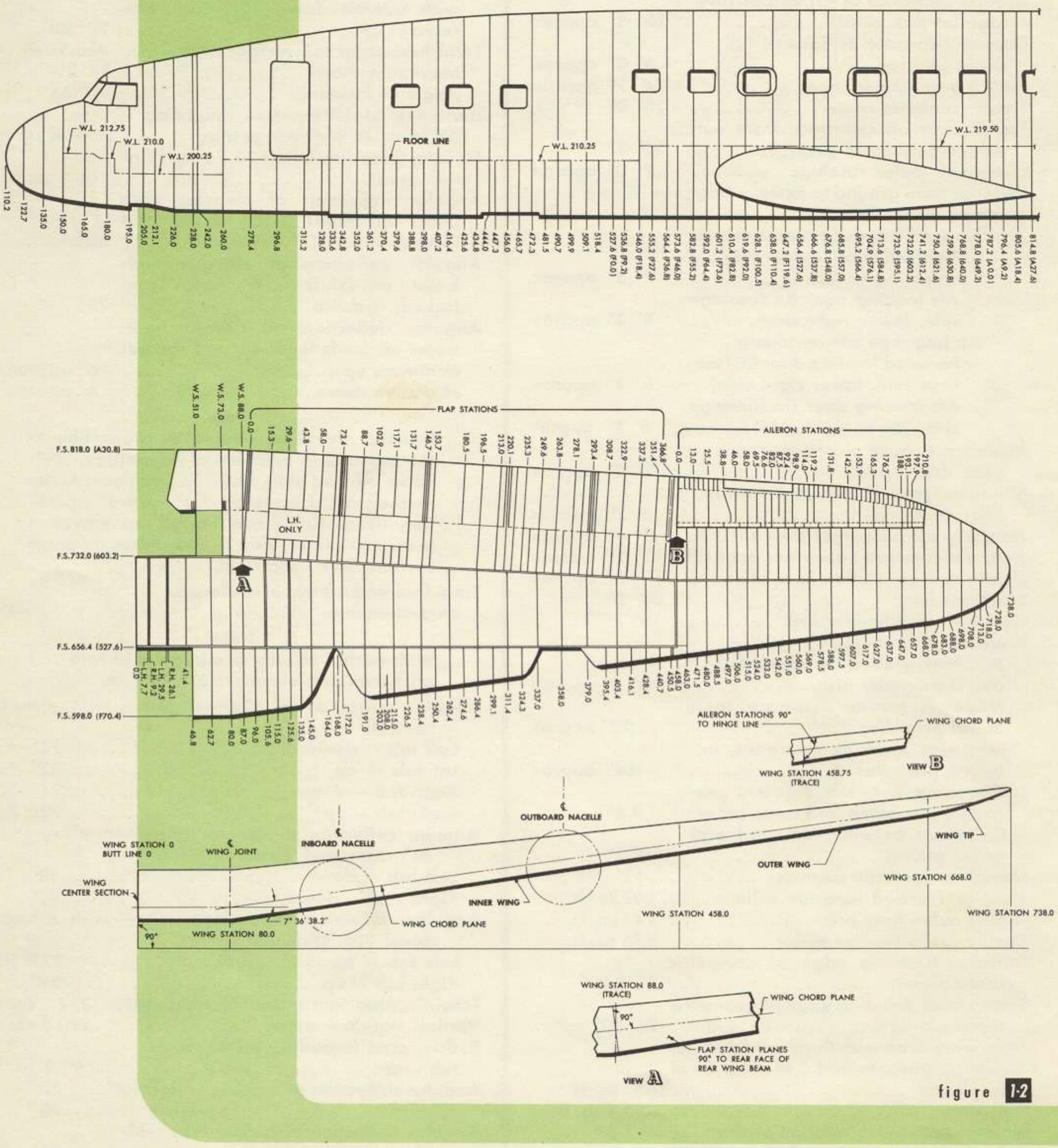
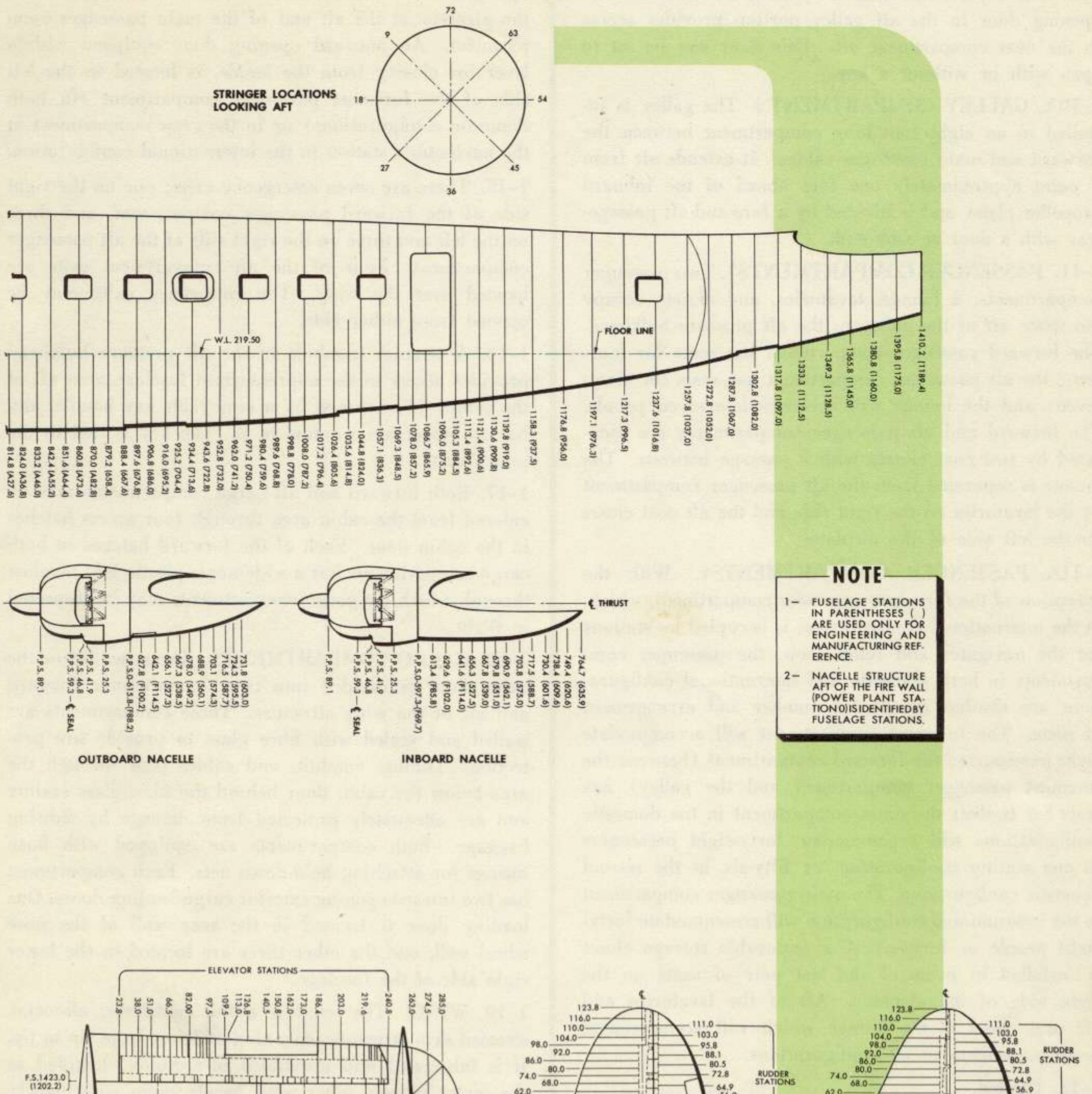


figure 1-2



NOTE

1— FUSELAGE STATIONS IN PARENTHESES ( ) ARE USED ONLY FOR ENGINEERING AND MANUFACTURING REFERENCE.

2— NACELLE STRUCTURE AFT OF THE FIRE WALL (POWER PLANT STATION 0) IS IDENTIFIED BY FUSELAGE STATIONS.

door is in the left side flanked by the closets. A forward-opening door in the aft galley portion provides access to the next compartment aft. This door can be set to open with or without a key.

1-10A. GALLEY COMPARTMENT.† The galley is installed in an eight foot long compartment between the forward and main passenger cabins. It extends aft from a point approximately one foot ahead of the inboard propeller plane, and is divided by a fore-and-aft passageway with a door at each end.

1-11. PASSENGER COMPARTMENTS*. Two passenger compartments, a lounge, lavatories, and closets occupy the space aft of the galley to the aft pressure bulkhead. The forward passenger compartment has seats for fourteen; the aft passenger compartment has seats for sixty-seven; and the lounge will accommodate seven people. The forward and aft passenger compartments are separated by two coat closets with a passage between. The lounge is separated from the aft passenger compartment by the lavatories on the right side and the aft coat closet on the left side of the airplane.

1-11A. PASSENGER COMPARTMENTS†. With the exception of the foremost passenger compartment, which, in the international configuration, is occupied by stations for the navigator and relief crew, the passenger compartments in both domestic and international configurations are similar, except for number and arrangement of seats. The foremost compartment will accommodate eight passengers; the forward compartment (between the foremost passenger compartment and the galley) has seats for twelve; the main compartment in the domestic configurations will accommodate forty-eight passengers in one seating configuration, or fifty-six in the second domestic configuration. The main passenger compartment in the international configuration will accommodate forty-eight people or forty-six if a removable storage closet is installed in place of the last pair of seats on the right side of the airplane. Aft of the lavatories and aft coat closet is the lounge which will accommodate seven passengers in all configurations.

1-12. Deleted.

1-13. WINDOWS, DOORS, EMERGENCY EXITS, ACCESS HATCHES. Rectangular, double windows are located adjacent to each outboard passenger seat.

1-14. On LAC Serials 4001 through 4014 the two passenger entrance doors are located in the left side of the airplane. They may be opened from either side. Each has a six-inch circular window, and is equipped with a safety bar. The forward door opens outward has a lever mounted on the inside by means of which it can be closed. The rear door slides aft on tracks.

1-14A. On LAC Serials 4015 through 4024 the main passenger entrance, which is closed by a sliding door, openable from either side, is located in the left side of the airplane at the aft end of the main passenger compartment. An outward opening door equipped with a lever for closing from the inside, is located in the left side of the foremost passenger compartment (in both domestic configurations) or in the crew compartment at the navigator's station in the international configuration.

1-15. There are seven emergency exits; one on the right side of the forward passenger compartment, and three on the left and three on the right side of the aft passenger compartment. Four of the aft compartment exits are located over the wing. The emergency exits may be opened from either side.

1-16. 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.

1-17. Both forward and aft cargo compartments may be entered from the cabin area through four access hatches in the cabin floor. Each of the forward hatches in both cargo compartments has a wide angle plastic lens window through which the cargo compartments may be inspected in flight.

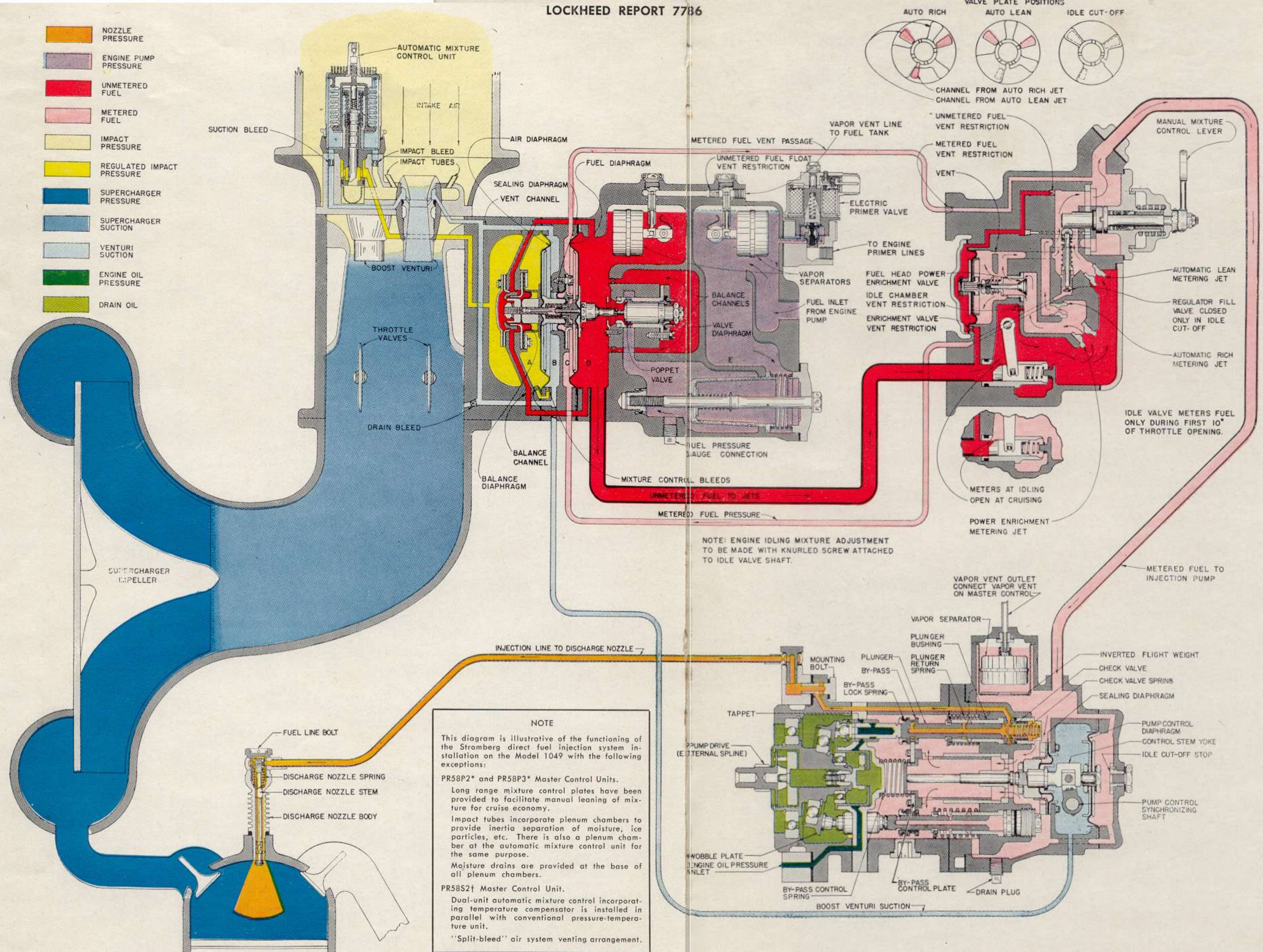
1-18. CARGO COMPARTMENTS. The space below the cabin floor is divided into two compartments forward and aft of the wing structure. These compartments are walled and sealed with fibre glass to provide fire protection. Tubing, conduit, and cables pass through the area below the cabin floor behind the fibre glass sealing and are adequately protected from damage by shifting baggage. Both compartments are equipped with flush fittings for attaching hold-down nets. Each 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 three are located in the lower right side of the fuselage.

1-19. 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, and outer tips. The outer wing panels and tips are removable for overhaul and inspection.

1-20. CENTER SECTION. The stub wing or center section is an integral part of the fuselage structure, faired to the skin with fillets. It extends from the airplane's longitudinal centerline right and left to wing stations 80, where it provides attachment for the inner wing panel.

1-21. 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

*LAC Serials 4001–4014 †LAC Serials 4015–4024



NOTE

This diagram is illustrative of the functioning of the Stromberg direct fuel injection system installation on the Model 1049 with the following exceptions:

PR58P2* and PR58P3* Master Control Units.

Long range mixture control plates have been provided to facilitate manual leaning of mixture for cruise economy.

Impact tubes incorporate plenum chambers to provide inertia separation of moisture, ice particles, etc. There is also a plenum chamber at the automatic mixture control unit for the same purpose.

Moisture drains are provided at the base of all plenum chambers.

PR58S2† Master Control Unit.

Dual-unit automatic mixture control incorporating temperature compensator is installed in parallel with conventional pressure-temperature unit.

"Split-bleed" air system venting arrangement.

FIGURE 1-3 SCHEMATIC DIAGRAM OF STROMBERG DIRECT FUEL INJECTION SYSTEM

*LAC Serials 4001–4014 †LAC Serials 4015–4024

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.

1–22. 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.

1–23. 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.

1–24. 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.

1–25. 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.

1–26. 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.

1–27. 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.

1–28. STABILIZER. The horizontal stabilizer extends twenty-five feet to the right and left of the airplane's longitudinal centerline. It has removable leading edges.

1–29. 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.

1–30. 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 fares into the underfaring 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 horizontal plane, and extend approximately four feet below it.

1–31. RUDDERS. The all-metal structural framework 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.

1–32. ENGINES.

1–33. GENERAL. The 1049 airplane is powered by four Wright 956C18CA1* or Wright 975C18CB1† air cooled, twin row, radial engines, of 3350 cubic inch displacement, incorporating torquemeters, Scintilla low tension ignition systems (with automatic spark advance), Bendix Stromberg direct fuel injection systems, jet exhaust stacks, and two-speed superchargers.

1–34. THROTTLES. Throttle controls are located on the center control stand (4 and 5, fig. 1-18), and on the flight engineer's control quadrant (3 fig. 1-51) and are numbered from left to right. Both sets of throttles are mechanically interconnected. A swinging arm at the fire wall supports the throttle pulley to which two push rods are attached. The other end of these push rods attach at the carburetor to a special arm on the butterfly shaft. The engine controls (throttles, mixture and blowers) have been designed so that their rigging need not be disturbed when removing an engine.

1–35. MIXTURE CONTROLS. Each mixture control lever (8 fig. 1-51) on the flight engineer's control quadrant is mechanically linked to the respective carburetor mixture lever. The linkage is designed so that engine motion will not affect mixture setting. The settings marked are: AUTO RICH, AUTO LEAN and OFF.

1–36. LONG RANGE MIXTURE CONTROL PLATES. In order to provide improved control of mixtures during manual leaning procedures, a "long range" mixture con-

*LAC Serials 4001–4014 †LAC Serials 4015–4024

trol plate has been incorporated in the carburetor. The new plates will permit a gradual leaning of mixtures as soon as the mixture control lever is moved from the detent position toward OFF.

1–37. CARBURETOR. (Master Fuel Control Unit). Each engine utilizes a Stromberg direct fuel injection system which consists of a carburetor, two injection pumps, and a nozzle for each cylinder. It meters the correct proportion of fuel for the amount of air passing through the unit. The injection nozzles begin to open at 450 psi and are fully open at 550 psi.

1–38. INJECTION PUMPS. The fuel injection cycle is complete when the piston is 60° before top center. Two injection pumps distribute fuel in proper sequence to the correct cylinders at pressures up to 2000 psi. The right injection pump supplies the front cylinders and the left pump supplies the rear cylinders. The pump assembly having a parts list number ending in an odd digit is a left hand pump, and an even digit is a right hand pump.

1–39. CARBURETOR AIR. Hot or cold air may be directed to each carburetor by means of its hot air door, which is operated by one of the four toggle switches (1, fig. 1-51) located on the flight engineer's switch panel. Operation of these switches allows the door to be opened to any intermediate position. Each switch has three positions: COLD (steady), OFF, and HOT (momentary). When the switches are in the COLD position, air entering the cold air duct flows directly to the carburetor. When the switches are in the HOT position, the hot air door is open and the air is taken into the carburetor, after it has been heated by flowing around the hot cylinders, and around the exhaust manifold. The carburetor air temperature is registered by a bulb in the upper deck of each carburetor.

1–40. BLOWERS. Each blower lever (5 fig. 1-51) on the flight engineer's control quadrant is connected by cables to a transfer pulley on the aft face of the fire wall. A single cable is connected from the transfer pulley to the control on the engine. The engine control is spring-loaded to the LOW blower position. The engine blower control also operates the cabin supercharger drive shaft disconnect in nacelles No. 1 and No. 4. These controls have a third position on each of the two outboard engine-driven blower controls. Lifting the lever and moving the blower control through and beyond the LOW blower position disconnects the cabin supercharger.

1–41. COWL FLAPS. Two cowl flaps, one on either side of each nacelle, regulate the quantity of cooling air flowing over the engine cylinders. Each flap is operated by an electric actuator. These actuators are controlled by four paddle type switches (17, fig. 1-51) located on the flight engineer's control quadrant. Both actuators in each nacelle are connected by a flexible shaft to maintain synchronism between the actuators. Should one of the cowl flap actuators fail, the other has sufficient power to operate both sets of flaps. However, the operation will be slower. The position of the flaps is indicated on two dual indicators mounted on the flight engineer's lower instrument panel.

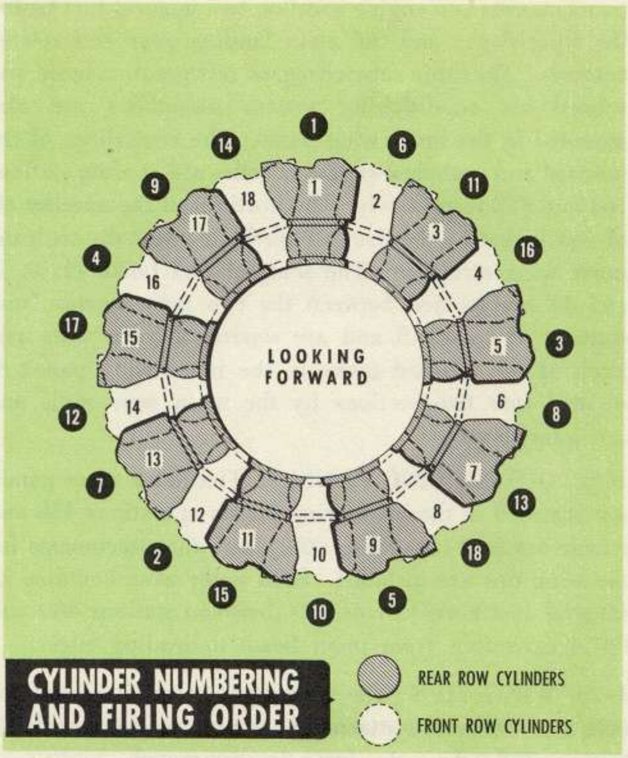


figure 1-4

1–42. JET STACKS. The engines are equipped with jet exhaust stacks. Added air flow, because of the augmentive effect created by these stacks, improves the cooling of the engine. The thrust of the jet stacks adds to the performance of the airplane, but varies with power setting, cowl flap setting, weight, and free air temperature.

1–43. STARTER AND ENGINE SELECTOR. (Refer to Fig. 1-32). A momentary contact switch, for energizing the starter, and the engine selector switch, are located on the upper panel of the master junction box. When the engine selector switch is turned to any of the four engines, the starter selector warning light, located to the left of the priming switch on the upper MJB panel, will glow. The starter is of the direct cranking type and incorporates a clutch which is set to release at 850 to 900 foot pounds torque to prevent damage to the engine should a hydraulic lock exist when turning the propellers through.

1–44. IGNITION SYSTEM. (Refer to Fig. 1-6.) These engines use a low-tension, high-altitude ignition system.

ENGINE STARTER CIRCUIT

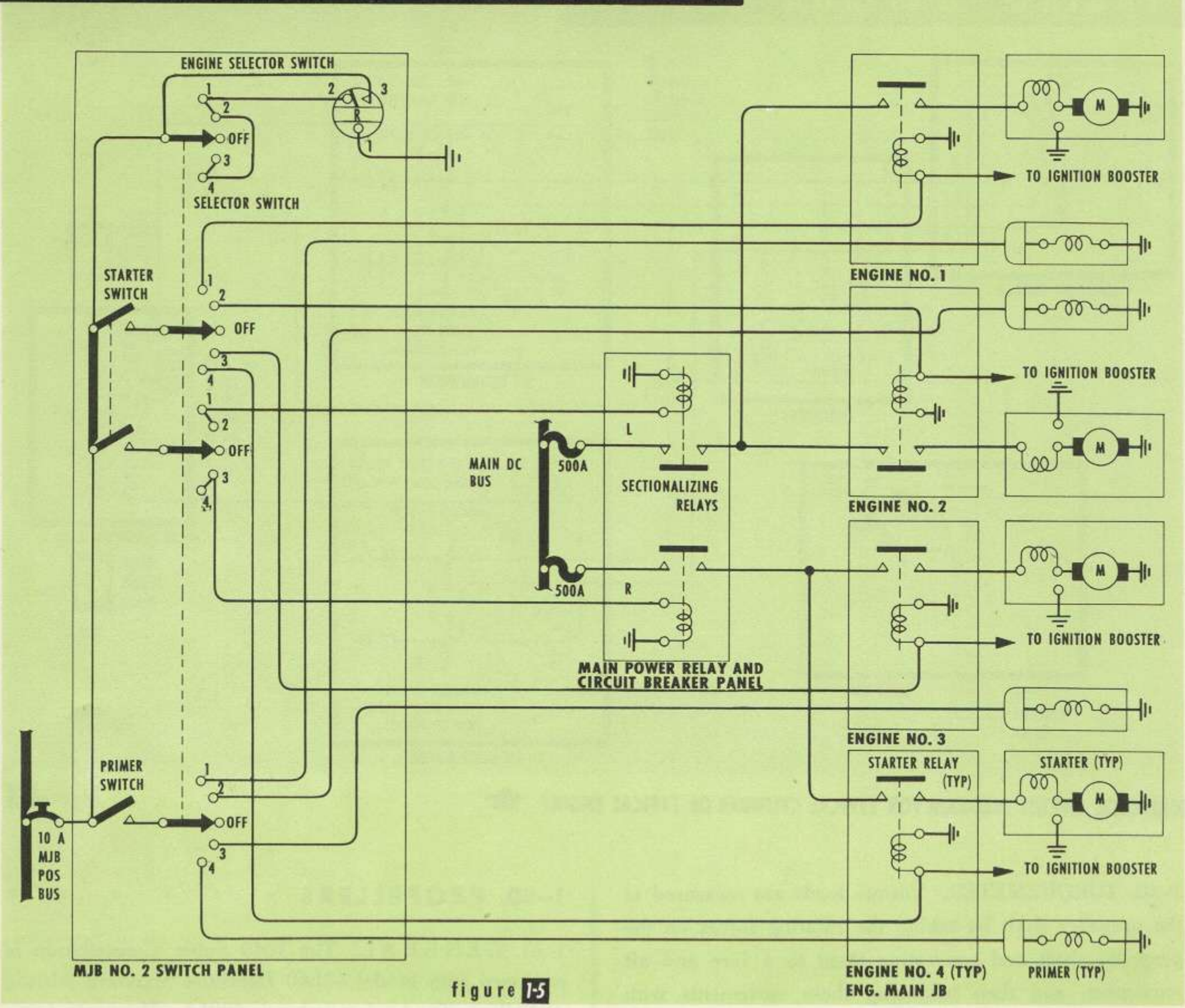


figure 1-5

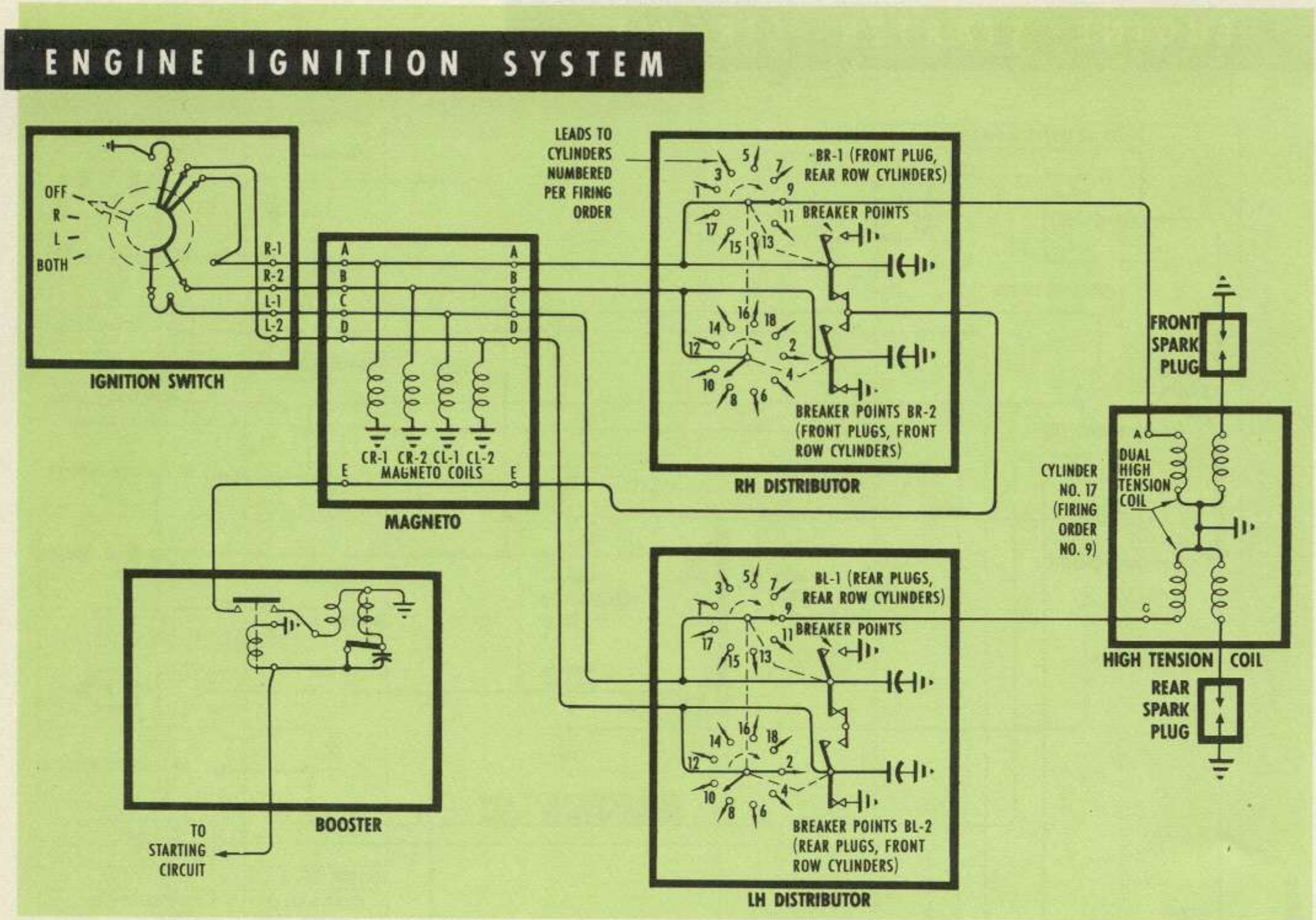
One low tension, quadruple magneto is installed on the rear accessories section of each engine, and produces a low voltage spark timed to right and left dual distributors on the nose section. The right distributor directs low voltage, timed in proper sequence, to the high tension coils that fire all front plugs in both rows, in all cylinders. The left distributor directs low voltage, timed in proper sequence, to the high tension coils, that fire all rear plugs in all the cylinders.

1–45. The high tension coils, located at each cylinder, convert low voltage to high voltage in order to fire the two spark plugs in each cylinder.

1–46. IGNITION BOOSTER. A booster coil is employed to provide the hot spark that is required for engine starting at engine speeds below the coming-in speed of the magneto. The booster coil unit is located forward of the fire wall in each nacelle. The booster fires through a trail finger in the right distributor, firing the front plugs of all cylinders at starting.

1–47. AUTOMATIC SPARK ADVANCE. The automatic spark advance mechanism is set to operate from 1150-1350 and from 2350-2550 rpm. It will advance the spark to 35° before top center. (See fig. 1-7.) This mechanism is inoperative on EAL airplanes.

ENGINE IGNITION SYSTEM



SCHEMATIC CIRCUIT DIAGRAM FOR TYPICAL CYLINDER OF TYPICAL ENGINE

figure 1-6

1-48. TORQUEMETER. Torque loads are measured at the propeller shaft by taking the rotating forces on the propeller shaft and converting them to a fore and aft movement, and then balancing these movements with boosted oil pressure against torque from the propeller shaft. The oil pressure required to stabilize the torque meter is directed through internal passages in the engine to a transmitter in the accessory section through which the oil pressure forces are electrically transmitted to the flight station and operate the two dual BMEP gages located on the flight engineer's lower instrument panel. To eliminate false readings caused by oil congealing, torque oil is conducted to an outlet in the supercharger front housing through internal passages and tubes.

1-49. HORSE POWER ENGINE FORMULA. The horse power formula for either engine is:

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

1-50. PROPELLERS

1-51. GENERAL. The 1049 Super Constellation is equipped with Model 43E60 Hamilton Standard 3-blade propellers. The blade number is 6901A. The control system provides for constant speed, synchronization, individual selective controls, a master control for changing rpm of all engines simultaneously, manual and automatic

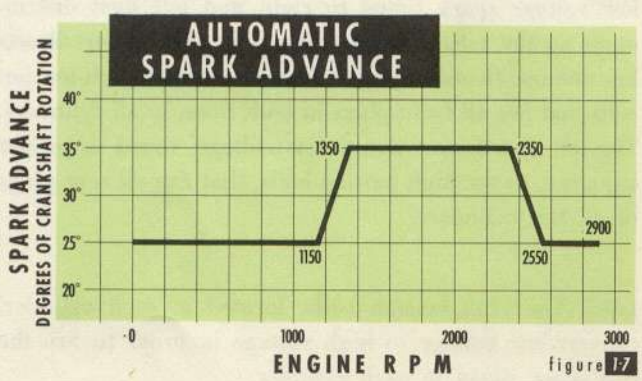


figure 1-7

ENGINE — AFT VIEW

REF	ACCESSORY	RPM RATIO TO CRANKSHAFT
1.	FUEL INJECTION PUMP	0.5:1
2.	MAGNETO	1.125:1
3.	HYDRAULIC PUMP	1.4:1
4.	ENGINES NO. 1 AND NO. 4, CABIN SUPERCHARGER DRIVE SHAFT	3.11:1
	ENGINES NO. 2 AND NO. 3, COVERED	
5.	PROPELLER SYNCHRONIZER GENERATOR	0.5:1
6.	TACHOMETER GENERATOR	0.5:1
7.	ENGINES NO. 1 AND NO. 4, EMERGENCY FLIGHT INSTRUMENT ALTERNATOR	1.4:1
	ENGINES NO. 2 AND NO. 3, COVERED	
8.	DIRECT CURRENT GENERATOR	3.11:1
9.	STARTER	1:1
10.	VACUUM PUMP	1.4:1
11.	FUEL PUMP	1:1

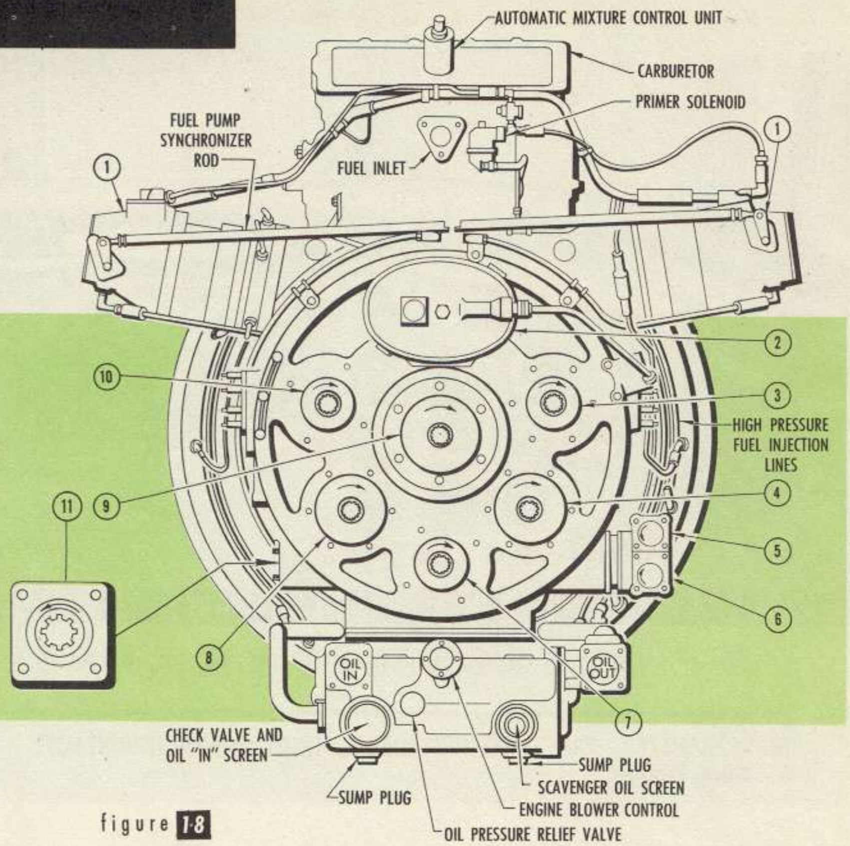


figure 1-8

feathering, and reversing. The propellers are 15′ 2″ in diameter.

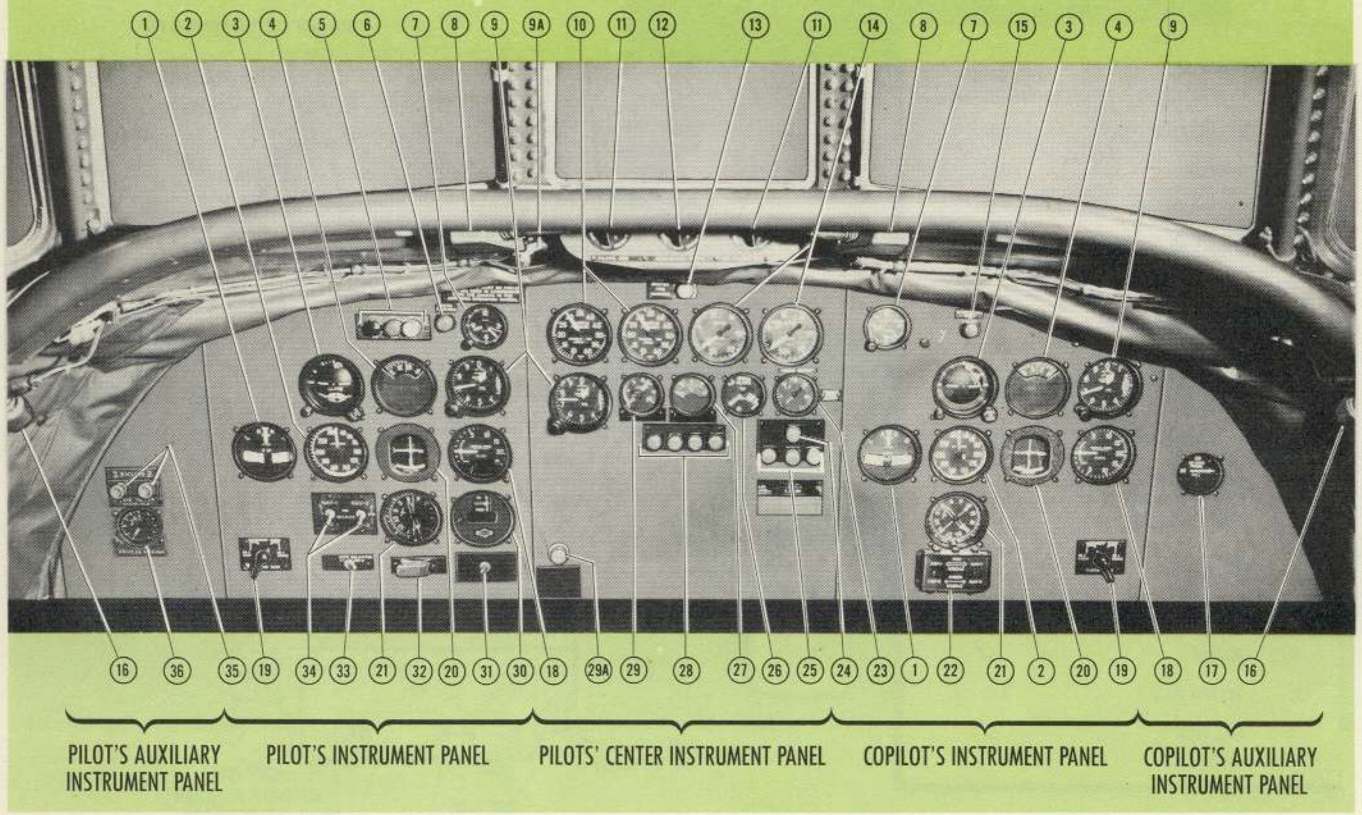
1–52. PRINCIPLES OF OPERATION. (Fig. 1-10.) The propeller control forces are centrifugal twisting moment, governor oil, and propeller return oil. The centrifugal force acting on each blade of a rotating propeller tends at all times to move the blade toward approximately zero pitch (flat pitch). Governor pump output oil is directed by the governor to either side of the propeller piston. The oil, on the side of the piston opposite the governor pressure oil, returns to the intake side of the governor pump and is re-used. Engine oil at engine supply pressure does not enter the propeller directly, but is supplied to the governor pump only.

1–53. During constant speed operation, the double-acting governor sends pressure oil to whichever side of the piston requires it, so that the blades can be positioned to maintain a selected rpm.

1–54. FEATHERING. When feathering the propeller (fig. 1-10, sheet 4), an auxiliary (feathering) pump is energized, and the auxiliary oil is directed through the base of the governor and then through the propeller shaft to the outboard side of the piston in the dome, turning the blades toward high pitch. A holding coil holds the feathering button in the depressed position. When the propeller is feathered, the feathering button must be pulled out manually.

1–55. UNREVERSING. When unreversing (fig. 1-10, sheet 3), high pressure oil is directed through the propeller shaft and the oil transfer tube to the forward side of the piston, forcing the oil aft, and turning the blades to a positive angle. Unreversing will continue until the blade switch on the butt of the No. 1 blade stops the feathering pump. This occurs when the blade angle reaches a point 5° ±1° above the low pitch stop setting, and then constant speed control will take over.

1–56. In unfeathering and unreversing, the blade switch turns off the auxiliary pump and stops the action at a blade angle in the constant speed range. The blade switch is located in the spinner bulkhead and actuated by a cam on No. 1 blade.



1. Turn and bank indicator
2. Airspeed indicator
3. Gyro horizon indicator
4. Fluxgate compass
5. Marker beacon lights
6. Auto feathering "armed" indicator light
7. Clock
8. Instrument panel direct red light
9. Altimeters

9A. Windshield wiper switch

10. Manifold pressure gages
11. Red instrument light rheostat switch
12. Emergency white lights rheostat switch
13. Master fire warning light and bell test
14. Tachometers
15. Interphone call light
16. Emergency white light
17. De-icing pressure gage
18. Rate of climb indicator
19. Instrument static selector switch
20. Deviation indicator
21. Radio magnetic indicator (RMI)
22. RMI enunciator lights
23. Hydraulic system pressure gage
24. Gear "unsafe" warning light
25. Gear "down and locked" indicator lights
26. Wing flap position indicator
27. Outside air temperature gage
28. Propeller reverse pitch indicator lights
29. Emergency brake pressure gage

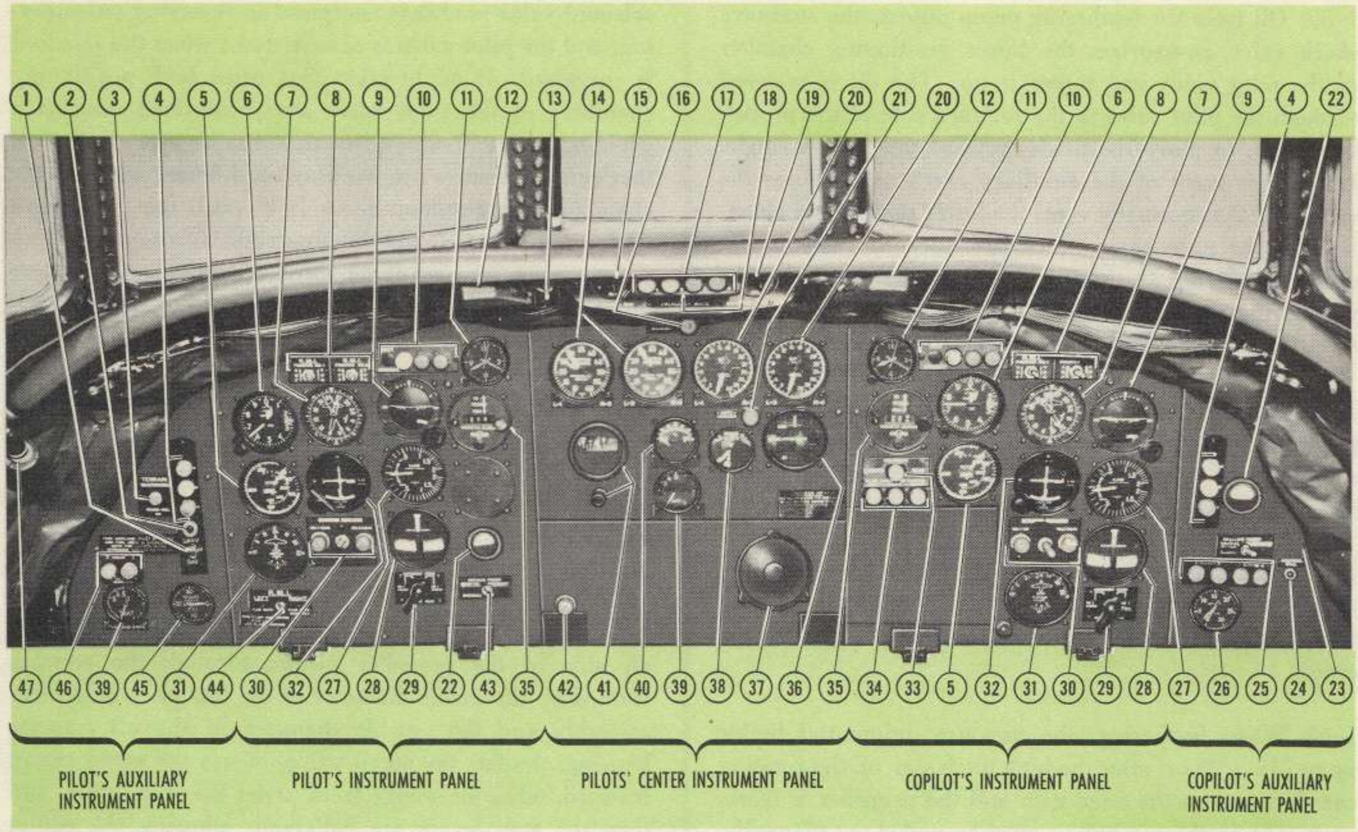
29A. Parking brake warning light

30. Omni-bearing selector
31. Localizer heading computer (LHC) test switch
32. LHC ON-OFF switch
33. Fluxgate compass selector switch
34. RMI pointers selector switches
35. De-icer pump warning lights
36. De-icer vacuum gage

PILOTS' INSTRUMENT PANELS*

figure 1-9

*LAC Serials 4001–4014



1. Terrain warning altitude selector switch
2. Terrain warning test switch
3. Terrain warning system light
4. Terrain warning indicator lights
5. Airspeed indicator
6. Altimeter
7. Radio magnetic indicator (RMI)
8. RMI pointers selector switches
9. Gyro horizon indicator
10. Marker beacon lights
11. Clock
12. Instrument panel direct red light
13. Windshield wiper switch
14. Manifold pressure gages
15. Pilot's instrument panel red light rheostat switch
16. Pilot's master fire warning light
17. Propeller reverse pitch indicator lights
18. Emergency white light rheostat switch
19. Copilot's instrument panel red light rheostat switch
20. Tachometers
21. Automatic feathering "armed" indicator light
22. Horizon power failure indicator
23. Horizon power (inverter—alternator) selector switch
24. Flight attendant call light
25. Hydraulic pump pressure warning lights
26. Hydraulic systems pressure gage
27. Rate of climb indicator
28. Turn and bank indicator
29. Instrument static selector switch
30. Deviation indicator VOR selector switch and indicator lights
31. Master direction indicator
32. Deviation indicator
33. Landing gear "unsafe" warning light
34. Landing gear position lights
35. Omni bearing selector
36. Three axis trim indicator
37. Terrain warning gong
38. Wing flap position indicator
39. Vacuum gage
40. Outside air temperature indicator
41. Directional gyro and caging knob
42. Parking brake warning light
43. Gyro horizon power selector switch
44. RMI Flux Gate selector switch
45. De-icer pressure gage
46. De-icer pump warning lights
47. Emergency white light

figure 1-9A

PILOTS' INSTRUMENT PANELS†

1–57. Oil from the feathering pump unseats the auxiliary check valve, pressurizes the lower positioning chamber of the pilot valve and forces it up. The oil is metered through the pilot valve to the forward side of the propeller piston, to move the blades toward the feather angle. Initial movement of the auxiliary check valve closes the vent line (that normally vents the lower positioning chamber) to the nose case. Since the solenoid valve is not energized during feathering and unreversing, the upper positioning chamber is still vented to the nose case, through the solenoid valve and the fly-weight cup.

1–58. During the feathering-unreversing condition, the governor fly-weights are in an overspeed condition, because the oil pressure in the lower positioning chamber has overcome the force exerted by the speeder spring.

1–59. Maximum oil pressure during the feathering-unreversing condition is limited to 775 ±25 psi differential pressure by the high pressure relief valve in the governor.

1–60. When feathering, the pressure differential builds up to 775 ±25 psi after the high pitch stop on the rotating cam bottoms on the fixed cam and the propeller is feathered. The feathering button must be pulled out manually. The feathering pressure switch is inactive on this installation.

1–61. UNFEATHERING. When unfeathering (fig. 1-10 sheet 5), the auxiliary pump and reversing solenoid are energized and auxiliary oil is directed to the inboard side of the piston in the dome, turning the blades toward low pitch. Unfeathering may be continued until blade angle is low enough to provide enough rpm for governor control. If the switch is held out, the No. 1 blade switch will open the circuit at some high blade angle in the constant speed range. This function is a safety feature and should not be used normally.

1–62. REVERSING. When reversing (fig. 1-10, sheet 2), the auxiliary pump and governor solenoid valve are energized which sends high pressure auxiliary oil through the governor base, the propeller shaft, around the oil transfer tube, opens the servo valve and releases the low pitch stop levers. Thus, the propeller piston is forced forward, turning the blades to the reverse stop.

1–63. The feathering pump and the solenoid valve are energized at the same time. Pressure oil from the feathering pump unseats the auxiliary check valve, which allows the oil to enter the governor body. The lower positioning chamber of the pilot valve is pressurized, as in feathering-unreversing, and because the solenoid valve is energized, the upper positioning chamber is also pressurized. The solenoid valve is always energized in reversing-unfeathering, and the pilot valve is always down when the solenoid is energized. It might seem that when both positioning chambers of the pilot valve are pressurized, the valve could not move in either direction, but because of the fact that equal pressures are working on different areas in the chambers, the resultant force is to push the pilot valve down. This overcomes the fly-weight force, and forces the governor into an under-speed condition, as it meters oil to the aft side of the propeller piston to decrease the blade angle.

1–64. During unfeathering, the blade angle is decreased until the propeller windmills at about 600 rpm in flight, and on the ground the feathering button is held out until the action stops. As soon as the light in the feathering button goes out the button should be released to avoid cycling the system rapidly.

1–65. During reversing, pressure oil that is metered to the aft side of the propeller piston, through the annulus formed by the inside diameter of the low pitch stop lever assembly and the outside diameter of the oil transfer housing, unseats the servo valve, moves the servo piston forward, takes the wedge from under the stop levers, and then the stop levers are collapsed, allowing the piston to move forward of the low pitch stop levers. This additional movement of the piston causes the blade angle to be decreased through zero pitch and into the reverse angle. The action of the pump is stopped by the No. 2 blade switch at 5° ±1° above the reverse pitch stop. The No. 2 blade switch also operates a light on the pilot's panel indicating propeller is in reverse pitch.

1–66. During reversing, the solenoid valve in the governor is energized. Since the governor pump will have a pressure out-put (after the feathering pump is stopped), this pressure will be limited by the position of the dump valve and stop lever assembly to that necessary to counteract centrifugal twisting moment by action of the dump valve. Governor pump pressure, through the energized solenoid and into the upper positioning chamber of the pitot valve, will keep the pilot valve down, and the governor will continue to meter the oil to the aft side of the propeller piston, and hold the propeller in full reverse pitch.

1–67. The reversing feature permits the blade angle to be decreased below the normal low pitch setting, through zero blade angle, to a fixed reverse (negative) blade angle by pulling the reverse throttles aft of the idle stop. A mechanical stop, operated by a rotary actuator, will prevent moving the reversing throttles unless the airplane is on the ground and the left main gear strut is depressed, or the reverse lock override flag is pushed out of sight.

PROPELLER OPERATING SYSTEM

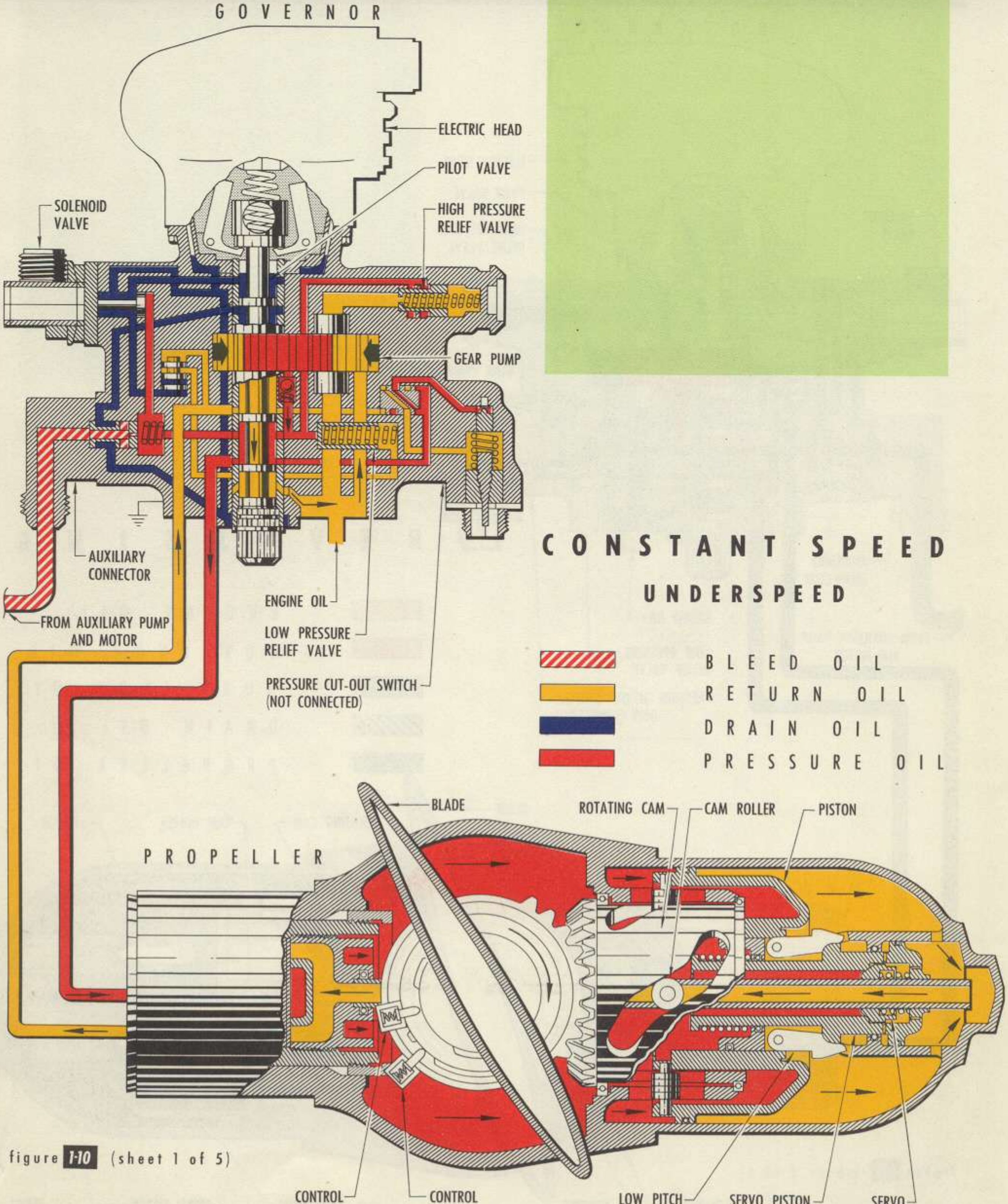


figure 1-10 (sheet 1 of 5)

PROPELLER OPERATING SYSTEM

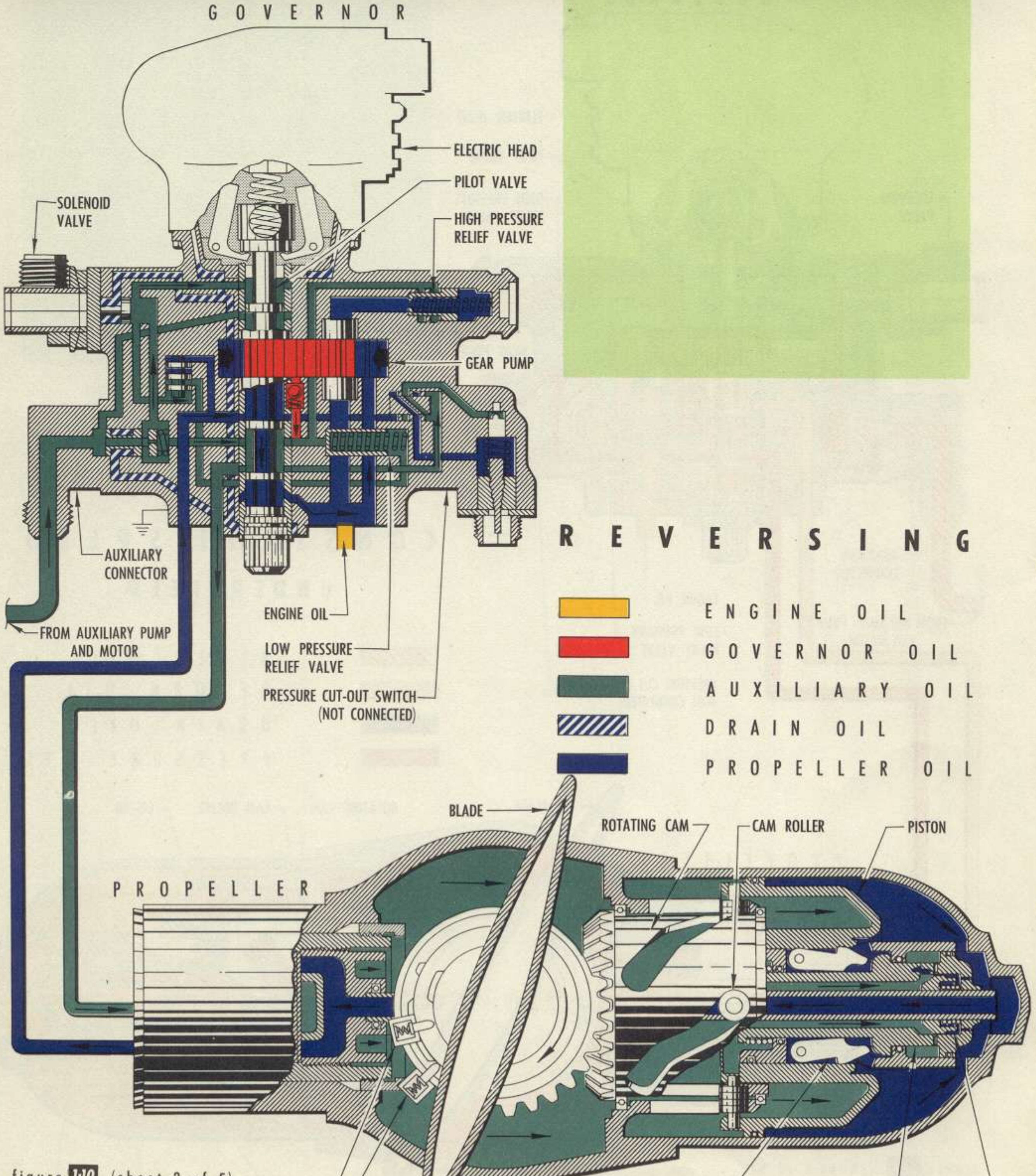


figure 1·10 (sheet 2 of 5)

PROPELLER OPERATING SYSTEM

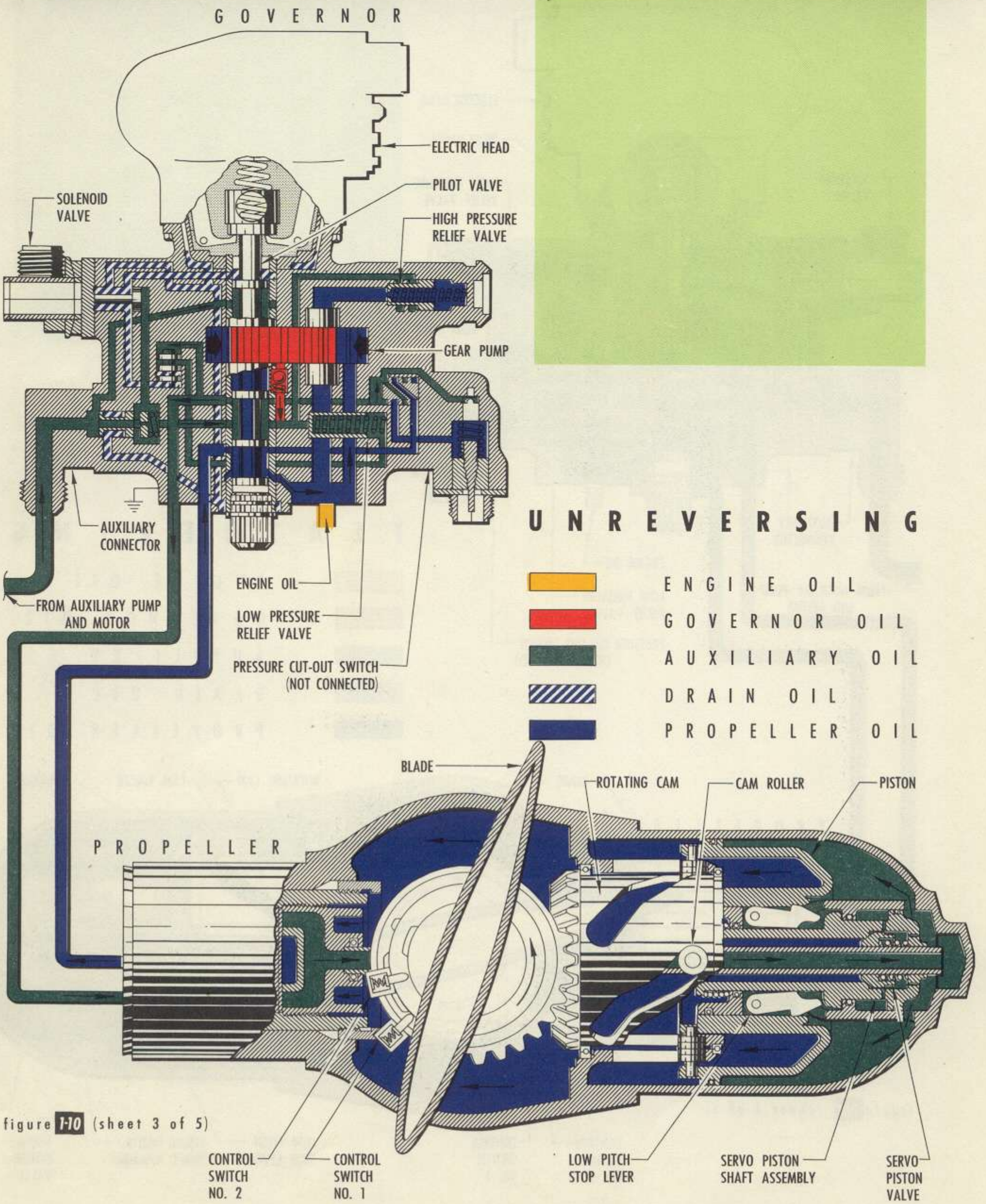


figure 1-10 (sheet 3 of 5)

PROPELLER OPERATING SYSTEM

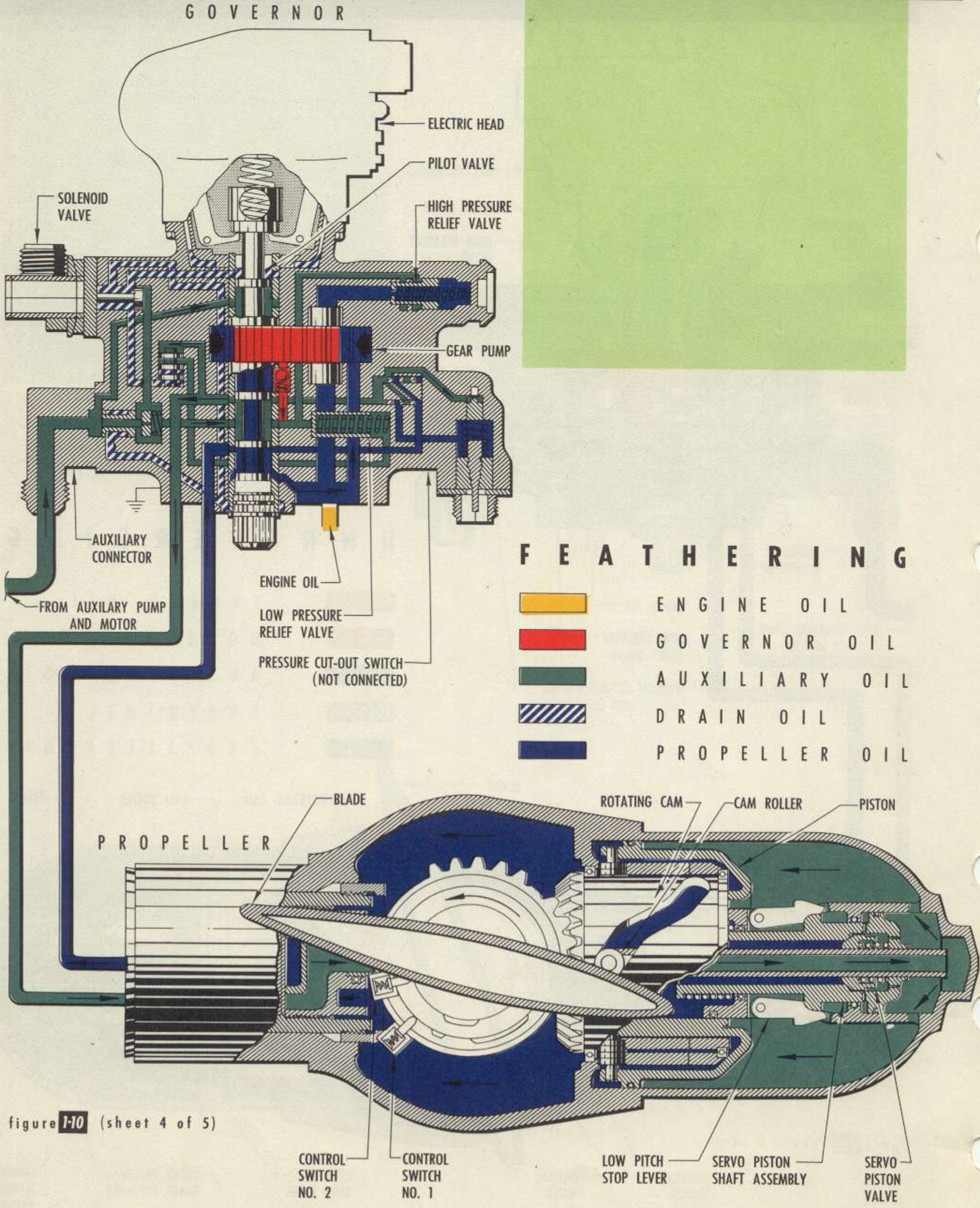


figure 1-10 (sheet 4 of 5)

PROPELLER OPERATING SYSTEM

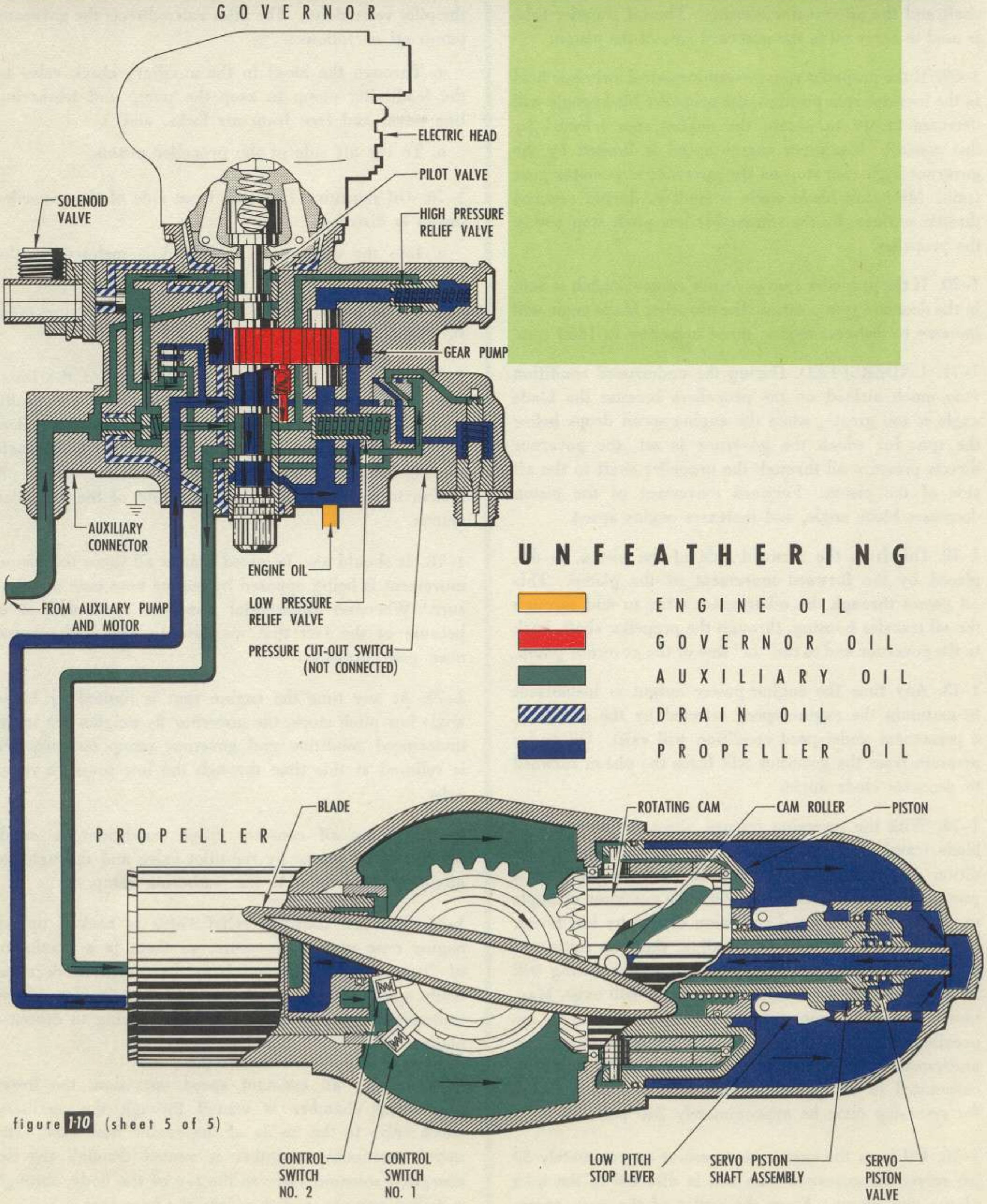


figure 1-10 (sheet 5 of 5)

1–68. CONSTANT SPEED. Constant speed operation (fig. 1-10, sheet 1) of the propeller is controlled by an engine-mounted double-acting governor which meters oil to both sides of the propeller piston through the propeller shaft and the oil transfer housing. The oil transfer tube is used to carry oil to the outboard side of the piston.

1–69. If the propeller rpm governor control switch is held in the increase rpm position, the propeller blade angle will decrease to try to obtain the engine rpm selected by this control. Maximum engine speed is limited by the governor high rpm stop on the governor step motor gear train. Minimum blade angle is limited, during reduced throttle settings, by the retractable low pitch stop within the propeller.

1–70. If the propeller rpm governor control switch is held in the decrease rpm position, the propeller blade angle will increase to decrease engine speed to as low as 1350 rpm.

1–71. UNDERSPEED. During the underspeed condition (too much airload on the propellers because the blade angle is too great), when the engine speed drops below the rpm for which the governor is set, the governor directs pressure oil through the propeller shaft to the aft side of the piston. Forward movement of the piston decreases blade angle, and increases engine speed.

1–72. Oil, from the forward side of the piston, is displaced by the forward movement of the piston. This oil passes through the oil transfer tube, to and through the oil transfer housing, through the propeller shaft, back to the governor and to the "in" line of the governor pump.

1–73. Any time the engine power output is insufficient to maintain the engine speed selected by the governor, a permanent underspeed condition will exist. Oil under pressure from the governor will force the piston forward to decrease blade angle.

1–74. With the reversing feature, since the direction of blade travel is the same to correct an underspeed condition as to reverse, the low pitch stop assembly must prevent inadvertent reversing when the governor attempts to correct an underspeed condition caused by low power settings, as on landing. On landing, the rpm setting of the governor will be at high rpm, the power setting will be low, so the above-mentioned condition will exist. Maximum governor pump output pressure is limited to approximately 70 – 90 psi differential pressure during an underspeed condition by a low-pressure relief valve incorporated in the governor, and minimum oil pressure for reversing must be approximately 240 psi.

1–75. Oil from the engine nose case at approximately 50 psi enters the governor base and is directed to the inlet of the gear pump. From the outlet of the gear pump, the oil flows through the outlet check valve to the front side of the high pressure relief valve, low pressure relief valve, and into the drive gear shaft. Because an underspeed condition exists, the speeder spring has forced the pilot valve down. The pilot valve directs the governor pump oil as follows:

a. Through the bleed in the auxiliary check valve to the feathering pump to keep the pump and feathering line warm and free from air locks, and

b. To the aft side of the propeller piston.

1–76. Oil returning from the front side of the propeller piston is directed:

a. Into the drive gear shaft and is metered by the pilot valve into the governor base.

b. To the selector valve to the aft side of the low pressure relief valve.

1–77. From this it will be noted that, when the lines, dome, and the governor are filled with oil, theoretically no oil is taken from the engine nose case during underspeed. However, due to leakage by the propeller shaft transfer rings, enough oil is taken from the engine oil system to make up for the leakage out of the propeller system.

1–78. It should also be noted that at all times the piston movement is being opposed by engine nose case oil pressure. Whenever differential pressures are noted, it is because of the fact that we have to deal with engine nose case pressure.

1–79. At any time the engine rpm is limited by blade angle low pitch stops, the governor fly-weights are in an underspeed condition and governor pump out pressure is relieved at this time through the low pressure relief valve.

1–80. During all constant speed conditions, a small amount of oil passes by the pilot valve and through the auxiliary check valve to the feathering pump.

1–81. The low pressure relief valve is backed up by engine nose case oil pressure, so there is a maximum of 70 to 90 psi differential on the piston to decrease blade angle. This is more than sufficient in view of the centrifugal force on the blade that is trying to decrease blade angle.

1–82. During all constant speed operation, the lower positioning chamber is vented through the auxiliary check valve to the inside of the engine nose case. The upper positioning chamber is vented through the de-energized solenoid valve to the top of the body, through a drilled passage, and then into the nose case.

1–83. OVERSPEED. During an overspeed condition, when the engine speed is in excess of the governor rpm setting, the governor directs pressure oil through the propeller shaft and to the forward side of the piston. This piston moves aft and the blade angle increases, thereby increasing the airload on the propellers and decreasing engine rpm. This brings the engine back to the selected rpm. Oil displaced from the aft side of the piston moves back through the governor to the "in" side of the governor pump.

1–84. Preventing inadvertent feathering is not as critical as the prevention of inadvertent reversing, for obvious reasons, and because a sustained overspeed condition is not likely to occur. However, in the event of governor malfunctioning of a type which simulates an overspeed condition, while the propeller is in reverse, the propeller would full feather, if sufficient power exists to keep the engine running.

1–85. The fly-weight force is now considerably above speeder spring pressure, so that the pilot valve will be raised. Pressure oil will be directed:

a. To and through the selector valve to back up the low pressure relief valve and render it inoperative, and

b. To the forward side of the propeller piston to increase the blade angle. Increasing of the blade angle will increase the airload on the blades and correct the overspeed.

1–86. ON-SPEED. During the on-speed condition, the main mass of the fly-weights move slightly outward from the pivot point. This causes the pilot valve to be raised slightly from the neutral position. The pilot valve meters pressure oil through the upper opening of the drive gear shaft to the selector valve and to the forward side of the propeller piston. This will exert a force that will tend to increase the blade angle. On the aft side of the piston there will be oil at engine nose case pressure that will exert a force to try and decrease blade angle. The nose case oil pressure on the aft side of the piston, plus centrifugal twisting force on the blades, equals the force exerted on the forward side of the piston by pressure oil, and holds the blades in an on-speed condition.

1–87. DESCRIPTION OF PARTS:

a. Gear Pump — This conventional, positive displacement type, spur gear pump is capable of operating in either direction of rotation. The drive gear is driven .857 times engine crankshaft speed. It turns clockwise when viewing the engine governor drive pad.

b. Pump Output Check Valve — A pump output check valve is provided to prevent the propeller blade angle from decreasing too rapidly in the event of a governor drive shaft failure and to prevent loss of auxiliary oil pressure when governor pump speed is low or engine is stopped, or if pump output check valve should stick in an open position.

c. Low Pressure Relief Valve — A low pressure relief valve is provided to limit the governor pump pressure, applied to the aft side of the propeller piston, during the underspeed condition of the governor.

d. Pilot Valve — The pilot valve directs the oil from the governor gear pump and the feathering pump to the selected side of the propeller piston. The pilot valve also meters engine nose case oil. The pilot valve is controlled during constant speed conditions by the governor head, and during feathering-unreversing and unfeathering-reversing by auxiliary pump oil.

e. Governor Head — The governor head consists of a set of fly-weights, a speeder spring, a speeder spring adjusting rack and a control or step motor. The fly-weights set up a force which increases with engine speed. The force of the fly-weights acts to raise the pilot valve to meter pressure oil to the forward side of the propeller piston for increasing blade angle. The force of the fly-weights is opposed by the speeder spring. The downward force of the speeder spring may be altered by changing the position of the speeder spring adjusting rack through operation of the rpm control switch and step motor.

f. High Pressure Relief Valve — The high pressure relief valve limits the maximum pressure that may be transmitted to the propeller under any normal condition.

g. Shuttle Valve — The shuttle valve directs nose case oil to the back side of the pressure cut-out switch and pressure oil to the "to open" side of the pressure cut-out switch.

h. Deleted.

i. Auxiliary Check Valve — The auxiliary check valve, when seated, allows a small amount of governor oil to flow through the line and feathering pump during constant speed operation. This keeps the pump and line warm, and keeps the line full of oil. Also, when seated, it opens a drain line to keep the lower positioning chamber of the pilot valve from having oil trapped in it. When unseated, the auxiliary check valve directs oil from the feathering pump during feathering, unfeathering, reversing, and unreversing to the pilot valve, which positions and diverts the oil to the proper side of the propeller piston.

PROPELLER HUB

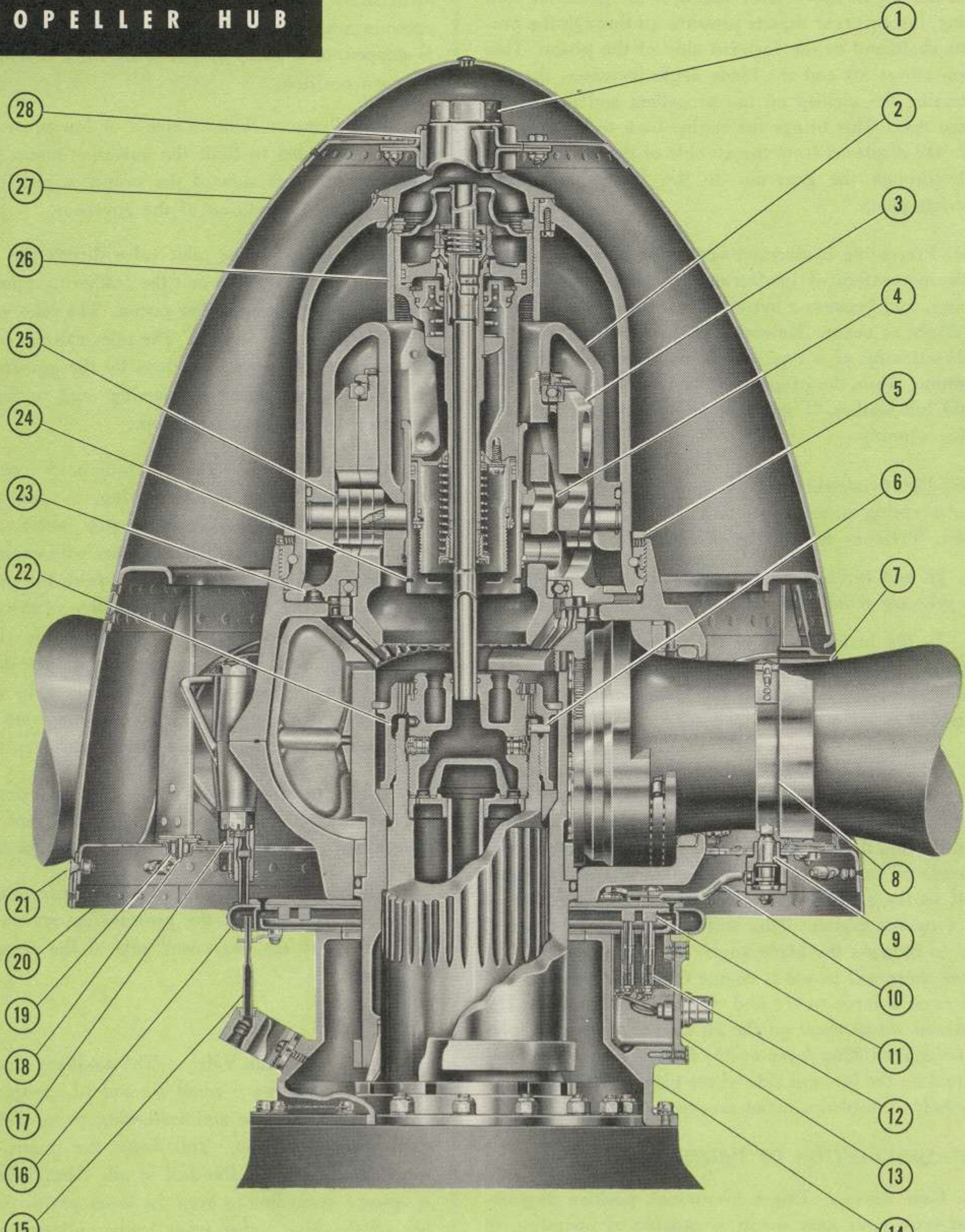


figure 1-11

PROPELLER HUB ASSEMBLY

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

j. Selector Valve — The selector valve controls the oil to the back side of the low pressure relief valve, so that during underspeed the low pressure relief valve can open. During all other conditions the low pressure relief valve can regulate oil pressure as required.

k. Solenoid Valve — The solenoid valve is an electrically operated valve that is energized during unfeathering and reversing. Its purpose is to allow feathering pump and/or governor pump oil to pressurize the upper positioning chamber of the pilot valve and force it down, and to back up the low pressure relief valve with high pressure oil. When the pilot valve is forced down, it meters oil to the aft side of the propeller piston so it will move the blades toward a negative angle.

1–88. SYNCHRONIZER OPERATION. (Refer to Fig. 1-12.) The synchronizer system provides a means for controlling and synchronizing the speed of all engines, throughout the entire operating range, by use of either master control lever, located on the pilot's and flight engineer's control stands, or individual governor control switches at flight engineer's station. Synchronization is accomplished by pushing and releasing the resynchronize button, located on the flight engineer's control quadrant. Full range synchronization by ± 3% increments of existing rpm of the particular engine, may be accomplished by pushing and releasing this button until synchronization is reached. However, it is recommended that the button not be used indiscriminately, especially in rough weather when the engines may be "hunting" excessively. It is more convenient to approach synchronization by means of the governor control switches to bring the engine rpm within ±3% of the existing rpm registered on the master engine tachometer, before using the resynchronize button. Separate adjustment of each propeller governor may be made by use of its respective governor control switch, located on the flight engineer's lower switch panel.

Note

When the master lever is advanced to take-off rpm position, all governors are set to their positive high speed stops, regardless of their initial settings, and synchronization is eliminated.

1–89. The speed settings of the governors may be individually controlled by the use of their respective governor control switches. These switches override both the synchronizer and the master control lever, and constant speed is retained if a complete failure of the synchronizer system should occur.

1–90. Because of a mechanical device on the connection between the differential motor and commutator switch, which limits synchronization with ±3% of the existing rpm on the master engine tachometer, a decrease in speed, or even failure of the master engine cannot drag the speed of the slave engines down more than 3%.

1–91. AUTOMATIC FEATHERING. Basically, the auto feathering system consists of a means of determining that a take-off condition exists; a means of determining loss of power of the engine, and a means of feathering the failed engine.

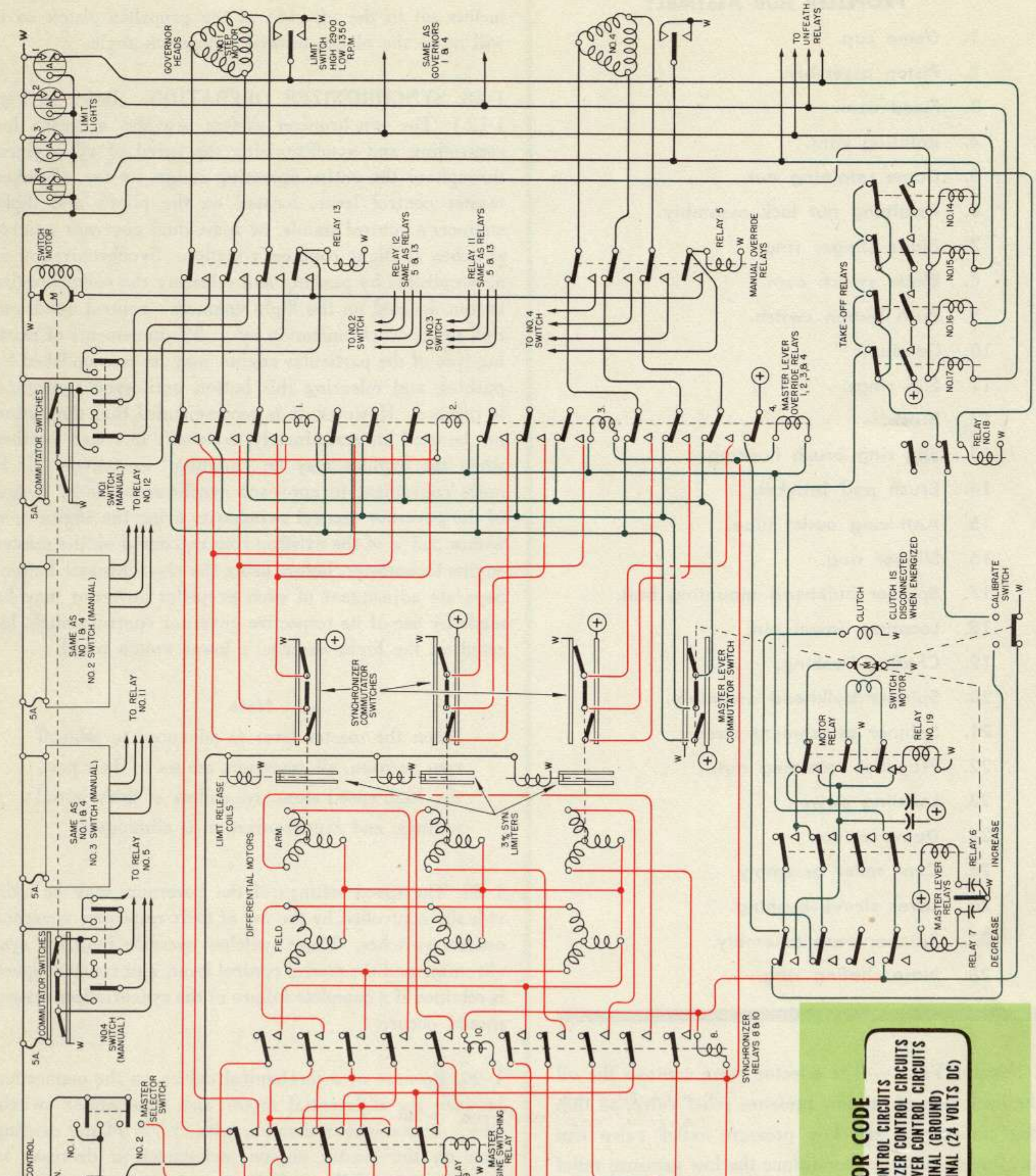
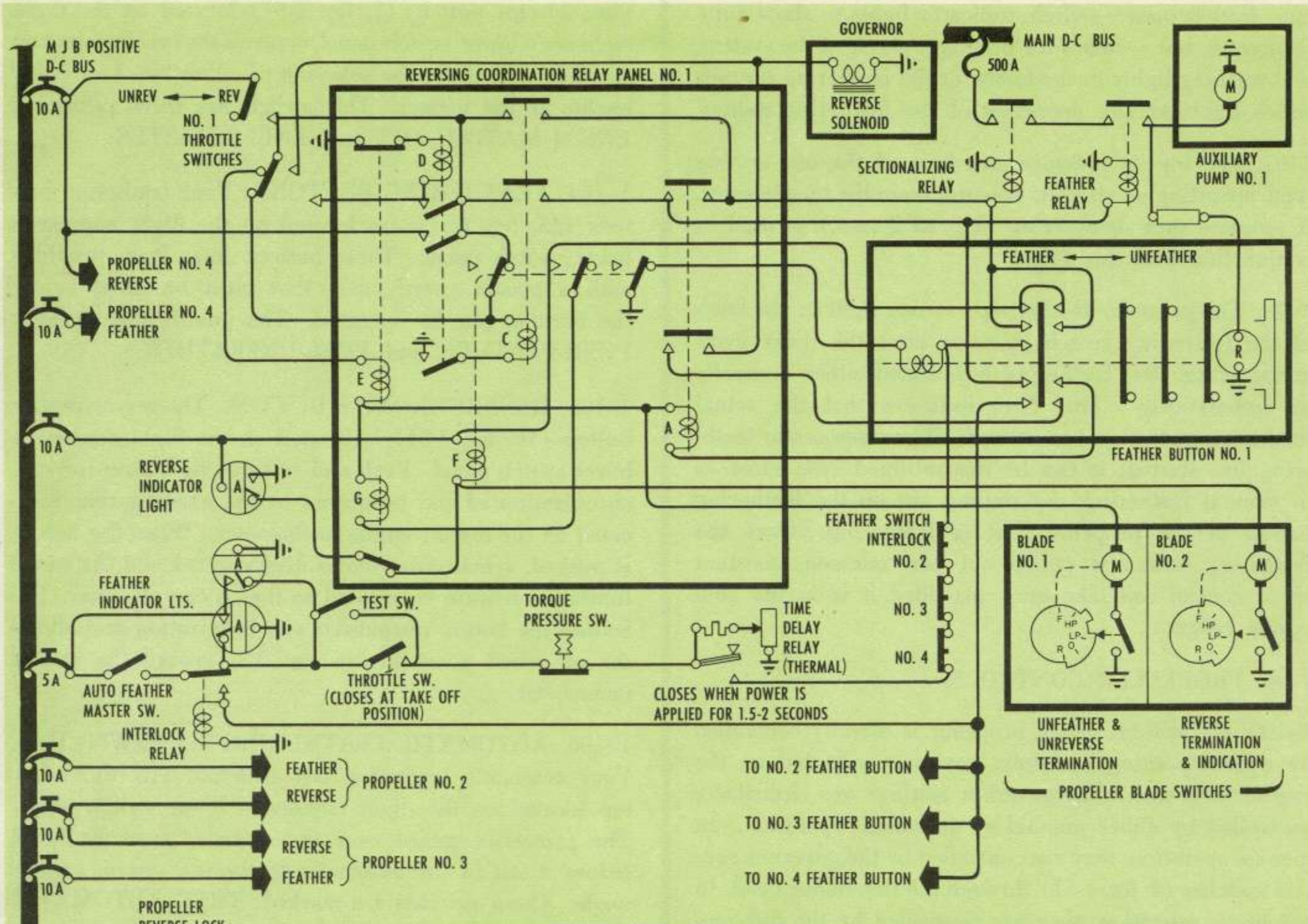
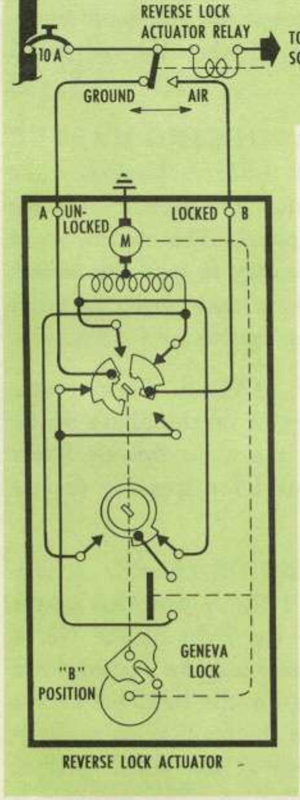

COLOR CODE
MANUAL CONTROL CIRCUITS
SYNCHRONIZER CONTROL CIRCUITS
MASTER LEVER CONTROL CIRCUITS
"W" TERMINAL (GROUND)
+ TERMINAL (24 VOLTS DC)
LIMIT LIGHTS
GOVERNOR HEADS
NO.1 STEP MOTOR
LIMIT SWITCH HIGH 2900 LOW 1350 R.P.M.
SAME AS GOVERNORS 1 & 4
NO.4
TO UNFEATH RELAYS
SWITCH MOTOR
RELAY 13
RELAY 12 SAME AS RELAYS 5 & 13
RELAY 11 SAME AS RELAYS 5 & 13
TO NO.2 SWITCH
TO NO.3 SWITCH
TO NO.4 SWITCH
RELAY 5
MANUAL OVERRIDE RELAYS
TAKE-OFF RELAYS
MASTER LEVER OVERRIDE RELAYS 1, 2, 3 & 4
RELAY NO.18
COMMUTATOR SWITCHES
NO1 SWITCH (MANUAL)
TO RELAY NO.12
SAME AS NO.1 & 4 NO.2 SWITCH (MANUAL)
TO RELAY NO.11
SAME AS NO.1 & 4 NO.3 SWITCH (MANUAL)
TO RELAY NO.5
NO4 SWITCH (MANUAL)
SYNCHRONIZER COMMUTATOR SWITCHES
MASTER LEVER COMMUTATOR SWITCH
CLUTCH
CLUTCH IS DISCONNECTED WHEN ENERGIZED
CALIBRATE SWITCH
SWITCH MOTOR
MOTOR RELAY
RELAY NO.19
LIMIT RELEASE COILS
3% SYN. LIMITERS
DIFFERENTIAL MOTORS
ARM.
FIELD
RELAY 6
INCREASE
MASTER LEVER RELAYS
RELAY 7
DECREASE
SYNCHRONIZER RELAYS 8 & 10
MASTER SELECTOR SWITCH
RELAY 9
MASTER ENGINE SWITCHING RELAY
MANUAL CONTROL
PROP. SYN.
RE-SYN. SWITCH
M J B POSITIVE DC BUS
PROPELLER SYNCHRONIZING GENERATORS
NO.1
NO.2
NO.3
NO.4

figure 1·12





PROPELLER FEATHERING & REVERSING CIRCUIT

figure 1-13

1–92. The take-off condition is determined by means of throttle operated arming switches, which close only when the throttles are in the normal take-off range. (65% or more open.)

1–93. Loss of power is detected by a torque pressure switch connected to the BMEP line on the engine. When the BMEP drops to within a range of from 82 to 72 and stays there from 1½ to 2 seconds, the normal feathering circuit will be energized automatically.

1–94. Feathering is accomplished manually through the normally controlled facilities, modified so that the holding coil in the feathering switch will energize the feathering contacts, when the signal is received from the auto feathering circuit. In addition, time delay is introduced into the system to prevent auto feathering in event of momentary losses of power due to back fires, etc. and to prevent auto feathering if the throttle is advanced rapidly enough to close the throttle switch before the BMEP has risen above its torque pressure switch setting.

1–95. Two means are provided to prevent auto feathering of more than one propeller. The operation of any feathering switch will interrupt the auto feathering circuits of the other three propellers, and a blocking relay is provided to disconnect the entire auto feathering circuit when one propeller has feathered automatically.

1–96. The remaining elements of the system are: an auto feather master switch, indicator lights to show auto-feather on, test switches for pre-flight check of the system, and warning lights in the knobs of the feathering buttons which light for any operation of the feathering pumps.

1–97. The torque pressure switch is of the non-arming type, operating on straight pressure from the torquemeter. A separate time delay relay (1½ to 2 secs.) is used in conjunction with this unit.

1–98. The propeller feathering warning light in the knob of the feathering switch operates after the delay cycle at the actual time feathering is initiated either manually or automatically. This light indicates that the actual feathering operation has started. When automatic feathering has started, it can be discontinued (the same as in manual feathering) by pulling out on the feathering button of the propeller that is feathering. Once the feathering button is pulled out and released, constant speed control can take over, provided it is in the governing range.

1–99. PROPELLER CONTROLS.

1–100. GENERAL. Each propeller is directly controlled by a double-acting hydraulic governor mounted on the engine nose case. The governor settings are electrically controlled by either manual or automatic operation. In manual operation, they are controlled by the governor control switches (4, fig. 1-51) through the step motor head. In automatic operation, they are controlled by the differential motors, or the master motor, which are incorporated in the synchronizer and operate through the step motorhead. During automatic operation, changes in rpm of the engines are controlled by the master control lever, (2, fig. 1-51) through the master motor. Constant speed synchronization (in automatic operation) is accomplished by selecting either engine No. 1 or No. 2 as the master, and matching the rpm of the other three slave engines to it by means of differential motors. The propellers are feathered, unfeathered, reversed and unreversed, by auxiliary oil pressure, and engine oil pressure.

1–101. MASTER CONTROL LEVER. A master control lever (8, fig. 1-18) is provided on the pilot's center control stand and on the flight engineer's control quadrant (2, fig. 1-51). These levers are linked together by a cable and pulley system. The lever is used in conjunction with the synchronizer system and controls the speed of all engines throughout the full operating range.

1–102. PROPELLER GOVERNOR CONTROL SWITCHES. Four governor control switches (4, fig. 1-51) are located on the flight engineer's lower switch panel. The switches are marked INC. RPM, OFF, and DEC. RPM.

1–103. MASTER ENGINE SELECTOR. A master engine selector switch, (7, fig. 1-51) located on the flight engineer's lower switch panel, controls the synchronization function and allows the selection of either No. 1 or No. 2 engine as the master. This switch has three positions: ENG. 1 MASTER, OFF, and ENG. 2 MASTER.

1–104. FEATHERING BUTTONS. Four feathering buttons (15, fig. 1-51) are located on the flight engineer's lower switch panel. These buttons have been provided with a plastic guard cover that must be lifted before the buttons can be operated. The guards are marked: PUSH-FEATHER and PULL-UNFEATHER.

1–105. RESYNCHRONIZE BUTTON. The resynchronize button (16, fig. 1-51) is located on the flight engineer's lower switch panel. Push and release this button for synchronization of the propellers to the existing rpm indicated on the master engine tachometer. When the button is pushed, synchronization is disconnected and the range limitation feature is released so that it can re-center. Releasing the button re-connects synchronization and allows the off speed governors to run 3% toward the master tachometer.

1–106. AUTOMATIC FEATHERING TEST SWITCHES. Four automatic feathering test switches, (13, fig. 1-51) are located on the flight engineer's lower switch panel. The protective guard over the switches must be lifted before a test of the automatic feathering system can be made. These switches are marked: TEST, AUTOMATIC FEATHERING and are used to test the automatic feathering system. The switches are off when the red guard covers are down.

1–107. AUTOMATIC FEATHERING MASTER SWITCH. This switch (14, fig. 1-51) is located to the left of the automatic feathering test switches on the flight engineer's lower switch panel. The switch has a protective red guard. It is necessary to turn this switch on and have the throttles 65% or more open in order to arm the automatic feathering system.

1–108. REVERSE THROTTLE LEVERS. Four reverse throttle levers (5, fig. 1-18) located on the pilot's center control stand, are attached to the main throttle levers (2, fig. 1-18) and provide control for applying reverse thrust.

1–109. REVERSE LOCK OVERRIDE LEVER. A visible, guarded flag lever (6, fig. 1-18) is provided on the pilot's center control stand to the right of the No. 4 main throttle lever. This flag lever may be pushed down to manually release the reverse throttle lock, before the full weight of the airplane is on the landing gear, allowing reverse power to be applied at the initial part of the landing, when it is most effective. This actuator is

PILOTS' OVERHEAD PANEL

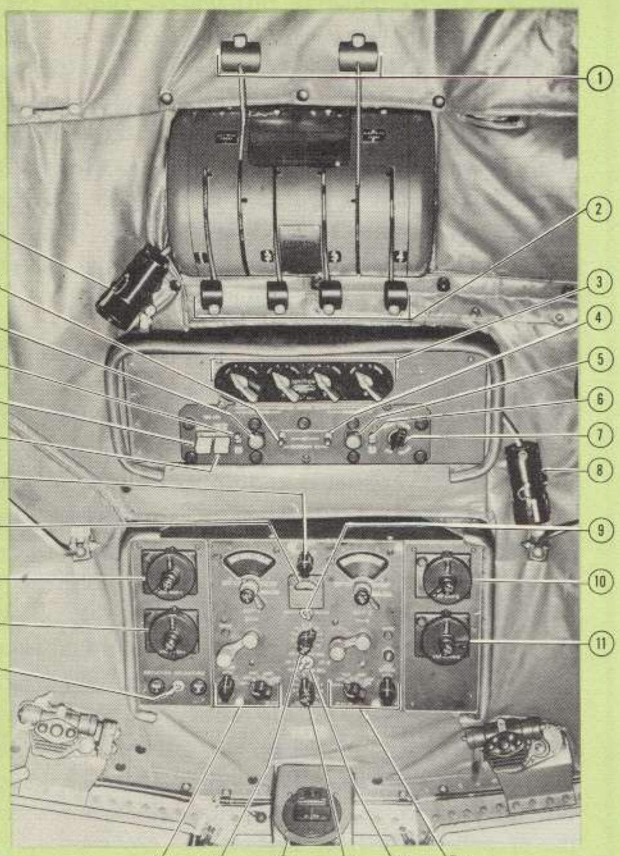


figure 1-14

LAC Serials 4001 Through 4014

1. Fuel dump valve levers, tanks 1, 2, 3 and 4
2. Firewall shut-off valve levers
3. Ignition switches
4. Auxiliary rudder booster control switch
5. Auxiliary rudder booster indicator light
6. Auxiliary rudder booster circuit breaker switch
7. Panel lights switch
8. Spot light
9. ADF tuning meter selector switch
10. VHF NAV-2 receiver controls
11. VHF COMM-2 transmitter-receiver controls
12. ADF-2 Control panel
13. HF transmitter-receiver selector switch
14. HF-2 transmitter-receiver channel selector switch
15. Standby compass
16. HF-1 transmitter-receiver controls
17. ADF-1 Control panel
18. Deviation indicator selector switch
19. VHF COMM-1 transmitter-receiver controls
20. VHF NAV-1 receiver controls
21. ADF tuning meter
22. Marker beacon switch (inoperative*)
23. Ordinance light (fasten belt) switch
24. Ordinance light (no smoking) switch
25. Auxiliary elevator booster circuit breaker switch
26. Auxiliary elevator booster indicator light
27. Auxiliary elevator booster control switch
28. HF COMM-2 transmitter-receiver controls
29. Tone-phase switch (inoperative)
30. VOR-2 receiver controls
31. CW-PHONE switch
32. VOR-1 receiver controls
33. HF COMM-1 transmitter-receiver controls
34. Landing lights lamp switches
35. Landing lights extend-retract switches

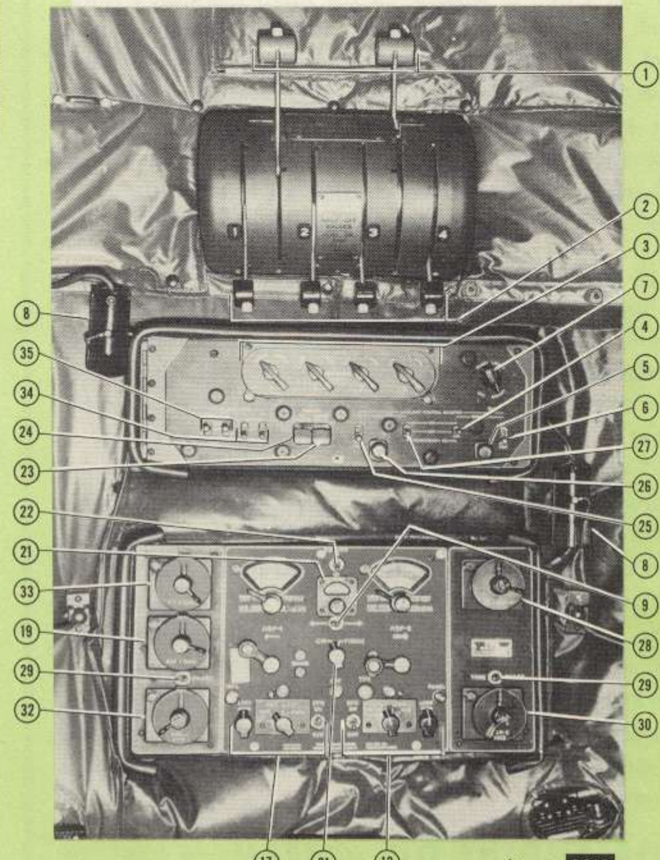


figure 1-14A

LAC Serials 4015 Through 4024

connected by cables to the reverse locking bar, which, when turning to the open position, lowers the flag lever, allowing the throttles to be pulled aft for reverse power.

1–110. PROPELLER INDICATORS.

1–111. REVERSE PITCH INDICATOR LIGHTS. Four reverse pitch indicator lights are located on the pilot's instrument panel, forward of the throttle levers. These lights are set to come on 5° before the reverse pitch stops are reached, and to go out when unreversing is initiated.

1–112. PROPELLER GOVERNOR HIGH AND LOW PITCH POSITION INDICATOR LIGHTS. Four indicator lights are located on the flight engineer's lower instrument panel. These lights indicate that the respective governors are set to their limit settings, either 2900 or 1350 rpm.

1–113. FEATHERING BUTTON LIGHTS (15, fig. 1-51). The lights, incorporated in the feathering buttons, will come on whenever the auxiliary pump circuits are energized.

1–114. AUTOMATIC FEATHERING ARMING LIGHTS. One of the automatic feathering arming lights (14, fig. 1-51) is located on the flight engineer's lower switch panel, and one is located on the pilot's instrument panel. They are set to glow when the system is armed. When the feathering system is energized manually, the light in the feathering button will come on, and the automatic feathering arming light will go out. When feathering is started automatically, all lights will go out when the feathering button is pulled out.

1–115. SYNCHROSCOPE. The synchroscope, located on the flight engineer's lower instrument panel, provides indications for synchronizing the four propellers. It is an electrical beat-frequency indicator that shows the frequency difference between the tachometer generator output of the No. 1 engine, and the output of Nos. 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 Nos. 2, 3, and 4 in relation to No. 1. They rotate either clockwise or counter-clockwise, depending on whether the engine speed is faster (clockwise) or slower (counter-clockwise) than the No. 1 engine. When the speed of the Nos. 2, 3, and 4 engines is synchronized with No. 1 engine rpm, the needles will be stationary.

1–116. ENGINE OIL SYSTEM • • •
(Refer to Fig. 1-15.)

1–117. GENERAL. Completely separate oil systems, located within each engine nacelle, provide lubrication for each engine. Oil flows through the standpipe in the engine oil tank, through a cable-operated shut-off valve, to the rear engine pump, which pumps oil through the engine. After circulating through the engine, the oil is returned by the scavenger pump to the oil cooler for cooling. From the oil cooler, the oil flows through the return line and back into the top of the engine oil tank, where it is discharged into the top of the swirl tube. A drain valve is located in the oil line adjacent to the shut-off valve and is provided to drain the oil from the system, except that trapped in the tank sump, engine sump, and in the oil cooler. The trapped oil may be removed through other drains.

1–118. OIL TANK.* (Refer to Figure 1-15.) The oil tanks are located on the right sides of the engine nacelles, just forward of the firewalls. Total capacity of each tank is 65.9 U.S. gallons; oil capacity (to the lip of the filler well) is 57 gallons; and filling capacity is placarded on the dip stick at 49 gallons. The difference between filling capacity and total capacity is air space necessary to accommodate oil foaming, which otherwise might result in excessive back pressures in the oil system. Direct-lift, float-type transmitters activate dual liquidometer oil quantity indicators on the flight engineer's instrument panel. The dip stick (fig. 1-16) mounted in the filler well, measures the oil level from the top of the standpipe, and does not include 2.6 gallons of oil contained below the standpipe, which is reserved for the propeller feathering system.

1–118A. OIL TANK.† The main oil tanks are located on the right sides of the engine nacelles, immediately forward of the firewalls, and each tank has an auxiliary tank clamped to its upper rear section. The auxiliary tank extends aft of the firewall (fig. 1-15). Total capacity of each main oil tank and its auxiliary tank is 74.3 gallons; oil capacity (to the lip of the filler well) is 59.6 gallons, and filling capacity is placarded on the dip stick at 55 gallons. The difference between filling capacity and total capacity is the air space necessary to accommodate oil foaming, which otherwise might cause excessive back pressure in the oil system. Direct-lift, float type transmitters activate dual liquidometer oil quantity indicators on the flight engineer's instrument panel. The dip stick (fig. 1-16), mounted in the filler well measures the oil level from the top of the standpipe and does not include 2.6 gallons of oil contained below the standpipe, which is reserved for the propeller feathering system.

1–119. The cable-operated oil shut-off valve is an integral part of the oil tank sump section. There are two oil outlets at the sump; one through the shut-off valve, which is fed by the standpipe; the other feeds from the side of the sump directly to the propeller feathering system. The feath-

*LAC Serials 4001–4014 †LAC Serials 4015–4024

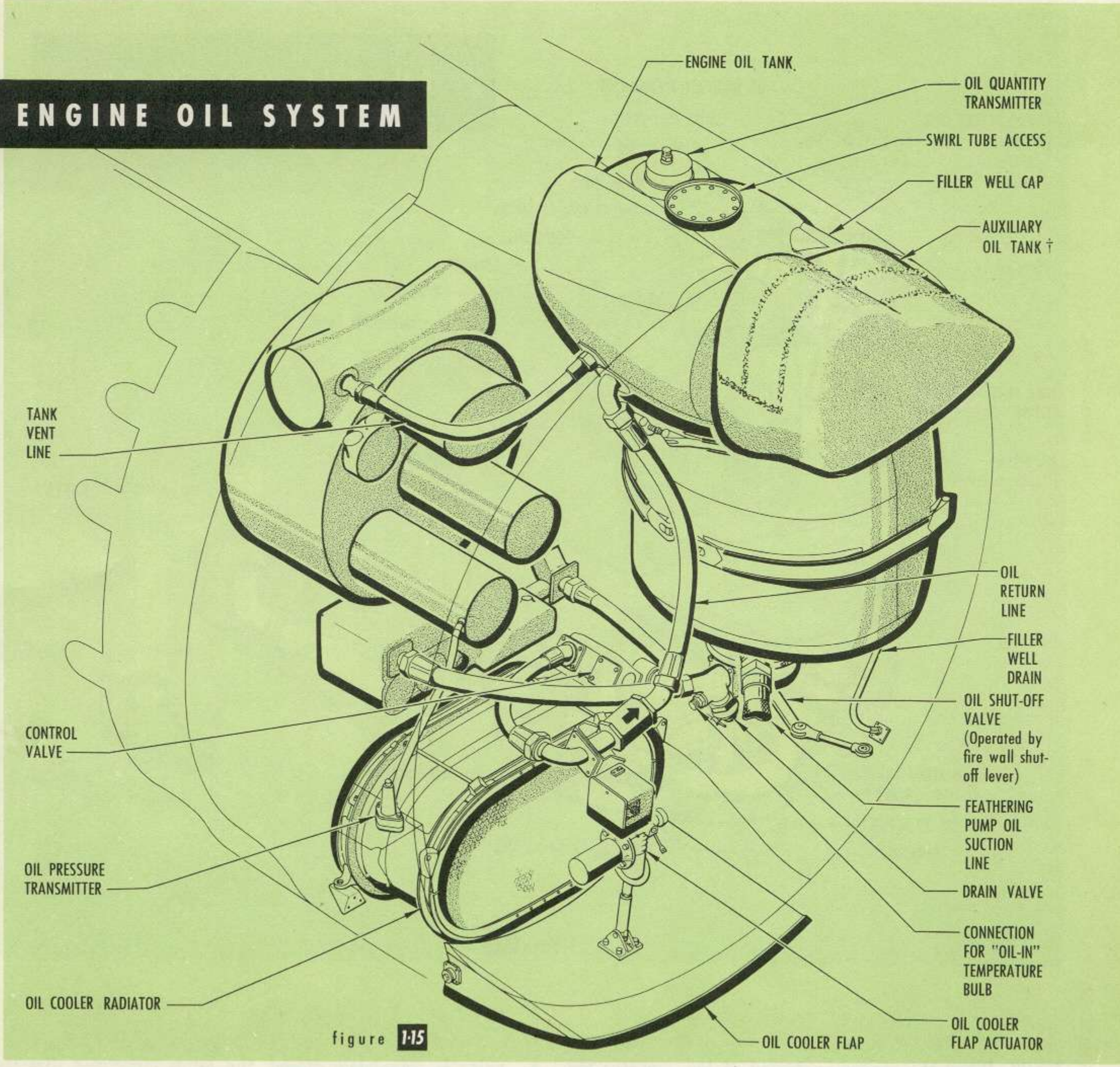


figure 1·15

ering supply of 2.6 US gallons, minimum, is available, regardless of the position of the shut-off valve. A casting for the oil supply to the engine is located at the sump and incorporates the system drain plug and oil-in temperature bulb fitting.

1–120. The tank is provided with a vent line and a filler well drain. The oil tank is vented to the rear crankcase of the engine so that the pressures in the tank and engine will be the same. The filler well drain is provided for draining oil overboard, in the event that the oil tank is overfilled.

1–121. OPERATION OF CONTROL VALVE. (Refer to Fig. 1-17.) The control valve, mounted on the oil radiator, has five ports. The porting of the oil through the control valve is as follows:

a. The oil can be ported straight through the valve bypassing the radiator.

b. Around the jacket of the oil cooler.

c. Through the core of the oil cooler radiator.

No matter which way the oil flows through the control valve and oil cooler, it exits through the same port.

†LAC Serials 4015–4024

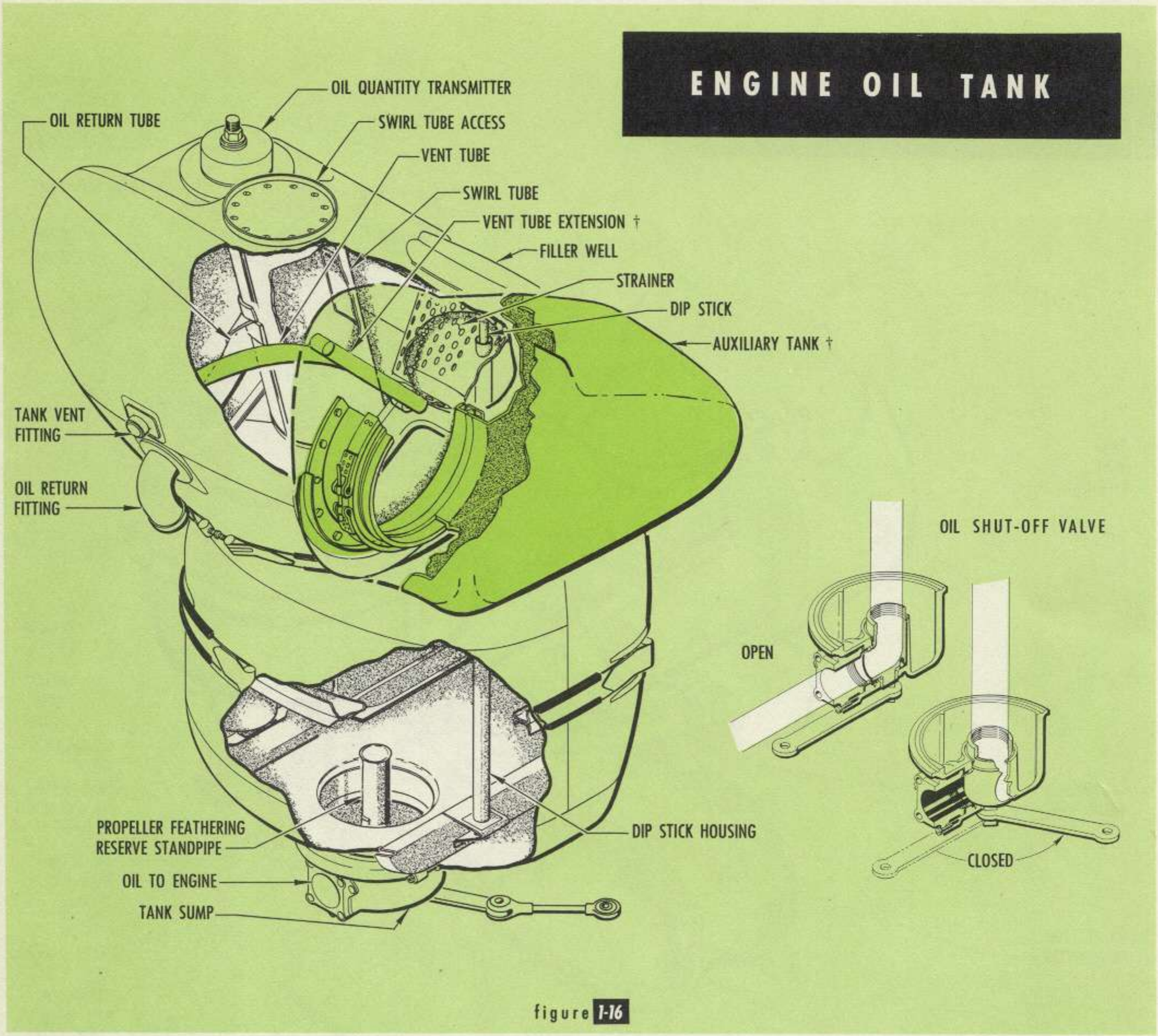


figure 1-16

1–122. When the engine is started at low ambient temperature, the oil in the oil cooler radiator is highly viscous and flow of oil through the oil cooler radiator is prevented by the high viscosity of the oil. 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 oil cooler 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 it becomes more fluid until the rate of oil flow is increased and the pressure drops below the closing pressure point of the bypass valve. When the bypass valve is completely closed, the oil is circulated directly through the core of the oil cooler radiator and back into the control valve, and then out through the exit port to the oil tank return line.

1–123. ENGINE OIL SYSTEM CONTROLS.

1–124. OIL COOLER FLAP SWITCHES. The oil cooler flap switches (11, fig. 1-51) are located on the extreme right side of the flight engineer's control quadrant just above the desk top. The switch is spring-loaded to OFF, and the flap is moved to the desired position by holding the switch in either the OPEN or CLOSE position. Thus the flap can be stopped in any position.

†LAC Serials 4015–4024

ENGINE OIL FLOW CONTROL VALVE

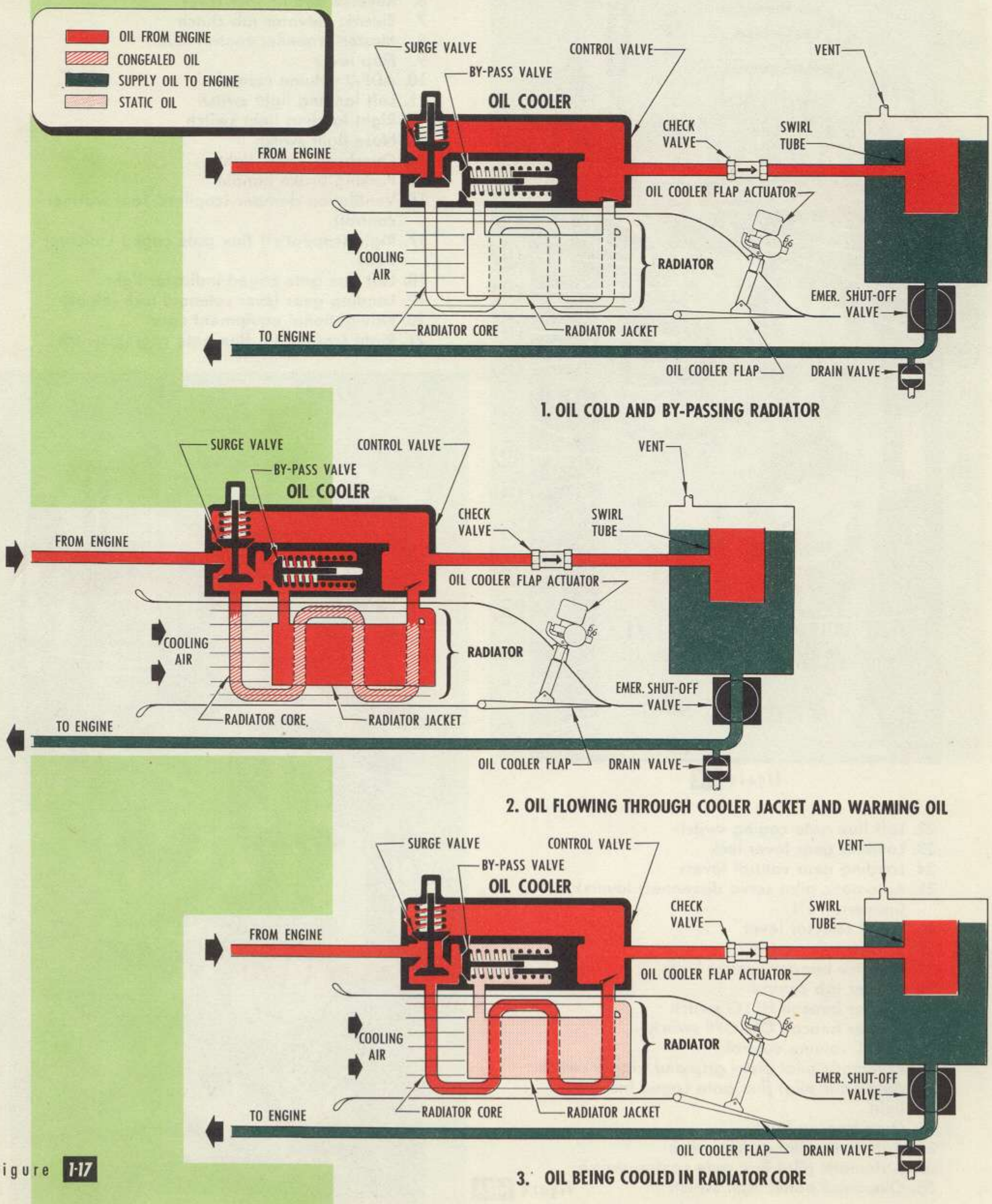


figure 1-17

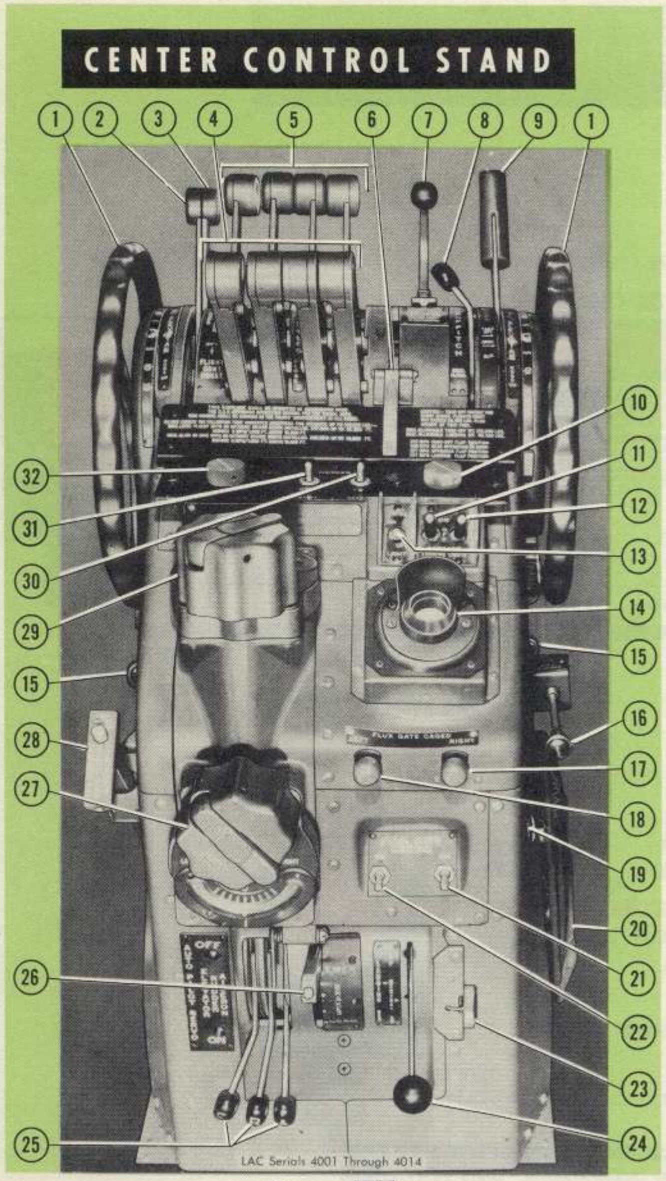


figure 1-18

1. Elevator tab control wheel
2. Rudder booster control lever
3. Aileron booster control lever
4. Main throttle levers
5. Reverse throttle levers
6. Reverse throttle lock lever
7. Electric elevator tab clutch
8. Master propeller control lever
9. Flap lever
10. ADF-2 volume control
11. Left landing light switch
12. Right landing light switch
13. Nose light switch
14. Overhead panel light
15. Parking brake handle
16. Ventilation damper (copilots' foot warmer control)
17. Right (copilot's†) flux gate caged indicator light
18. Left flux gate caged indicator light
19. Landing gear lever solenoid lock release
20. Navigational equipment case
21. Right (copilot's†) flux gate caging switch
22. Left flux gate caging switch
23. Landing gear lever lock
24. Landing gear control levers
25. Automatic pilot servo disconnect levers† (inoperative*)
26. Brake selector lever
27. Aileron tab control
28. Elevator booster control lever
29. Rudder tab control
30. Marker beacon HI-LO switch
31. Marker beacon ON-OFF switch
32. ADF-1 volume control
33. Automatic pilot pistol grip and trigger switch
34. Automatic pilot flux gate caged indicator light
35. Gyro beacon light
36. Automatic pilot clutch switch
37. Automatic pilot flux gate caging switch
38. Overhead panel light switch

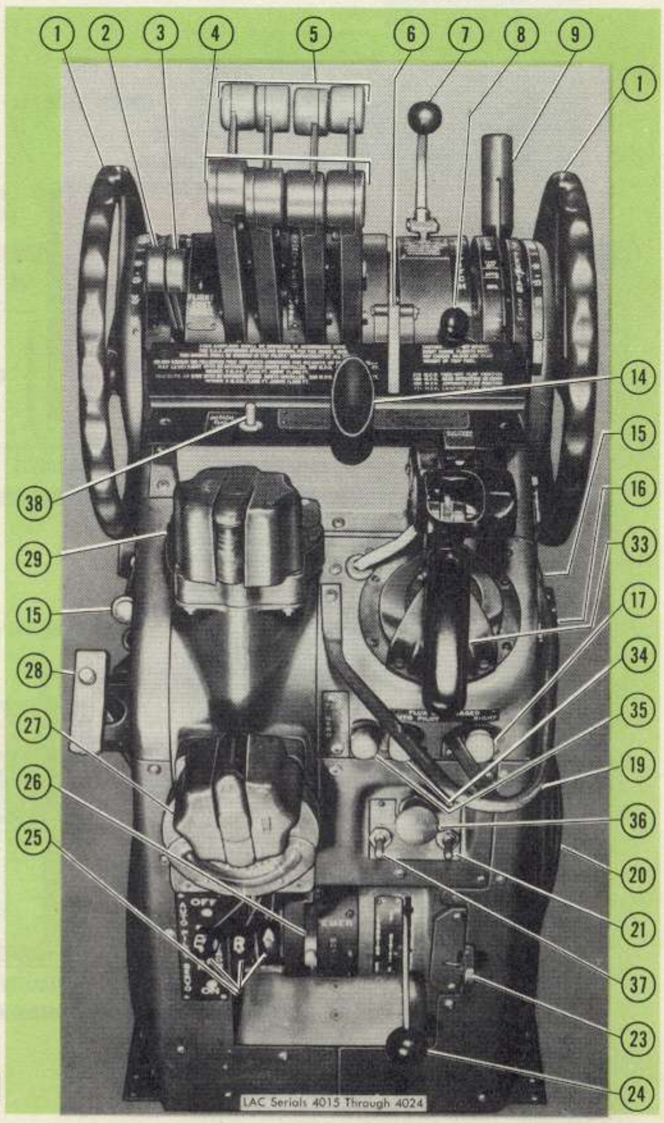


figure 1-18A

*LAC Serials 4001–4014 †LAC Serials 4015–4024

1–125. FIREWALL SHUT-OFF LEVERS. The firewall shut-off levers (2, fig. 1-14) are located on the cockpit overhead panel. There is one lever for each engine. When the lever is pulled to the aft position, it actuates the following:

a. It shuts off the engine oil to the engine.

b. It shuts off the hydraulic oil to the engine at the firewall.

c. A micro-switch actuated by a cam on the hydraulic shut-off, operates an electric motor that shuts off the emergency fuel valve at the firewall.

d. It closes a butterfly valve in the cooling air supply duct to the engine accessories.

1–126. ENGINE OIL SYSTEM INDICATORS.

1–127. OIL COOLER FLAP POSITION INDICATORS. Two dual oil cooler flap position indicators are located on the lower center of the flight engineer's middle instrument panel. The indicators are calibrated in percentage of full open position, which is 100%.

1–128. OIL INLET TEMPERATURE INDICATORS. Two dual oil inlet temperature gages are located on the top center of the flight engineer's middle instrument panel and are calibrated in degrees Centigrade. The oil temperature bulbs are located in the drain valve castings of each engine oil tank. Signals are transmitted electrically to the temperature gages.

1–128A. OIL OUTLET TEMPERATURE INDICATORS. Two dual oil outlet temperature indicators calibrated in degrees Centigrade are located on the flight engineer's middle instrument panel below the two oil outlet temperature indicators. The oil temperature bulbs are located at the forward end of the rear sump outlet boss of each engine.

1–128B. OIL QUANTITY INDICATORS. Two dual liquidometer type oil quantity indicators are located on the flight engineer's middle instrument panel. Range is from 4.2 to 58 gallons.

1–129. OIL PRESSURE GAGES. Two dual pressure gages are mounted on the right side of the flight engineer's lower instrument panel. Beneath the pressure gages are four low oil pressure warning lights. The oil pressure transmitter is mounted on the left side of the engine nacelle, looking forward. The oil line take-off is attached to the rear engine oil pump and terminates at the oil pressure transmitter. The pressure transmitter is set so that the warning light will come on when the engine oil pressure drops to the minimum allowable.

1–130. FUEL SYSTEM.

(Refer to Fig. 1-19.)

1–131. GENERAL. Fuel is supplied to the engines from six integral wing tanks, and a bladder-type, five-cell center section tank (No. 5)†. All the tanks are interconnected by the cross feed system, thereby allowing fuel to be supplied from any tank to any engine. Fuel tanks 1 and 4 normally supply engines 1 and 4, and fuel tanks 2A and 3A (main tanks for engines 2 and 3) normally supply engines 2 and 3. Fuel conforming to Specification AMS 3036A, Grade 115/145 must be used. For fuel system management refer to Section VI.

1–132. TANKS. The capacity of each tank is stenciled on the wing, adjacent to the tank filler cap. The approximate fuel tank capacities are as follows:

No. 2A	565 gallons
No. 3A	565 gallons
No. 1	1555 gallons
No. 4	1555 gallons
No. 2	790 gallons
No. 3	790 gallons
No. 5†	750 gallons §
Total *	5820 gallons
Total†	6570 gallons §

1–133. SURGE BOXES. A surge box, located in the inboard aft corner of each tank, provides a steady supply of fuel to the submerged booster pump. A synthetic rubber flapper valve, installed on the inside of the outboard wall of the surge box, traps fuel when the attitude of the airplane tends to empty the surge box. Tank No. 5 does not contain a surge box assembly.† The fuel inlet to the booster pump is enclosed by a screen to prevent foreign matter from entering the pump and fuel lines.

1–134. WATER DRAINS. Spring-loaded water drain valves are located at the low points in the fuel system for removing water.

1–135. FILLER WELLS AND DIP STICKS. Each tank has an individual filler well in the upper surface of the wing. The filler contains a filler screen which serves the double purpose of straining the fuel and flame-proofing the filler well. Two fuel measuring dip sticks are stowed in the flight compartment on the forward right side of the station 260 bulkhead. One dip stick is calibrated for use on tanks 1, 2, 3 and 4, and one for use on tanks 2A and 3A. These dip sticks are used in the tank filler wells, and conesquently will not record low fuel levels. In addition to the standard dip sticks, integral dip sticks are provided at the aft inboard ends of tanks 1, 2A, 3A and 4. The integral dip sticks will measure fuel levels too low to register on the standard dip sticks. They are screwed into the upper surface of the wing, and may be recognized by the slotted screw head.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

§ Approximate values; exact values to be submitted when available.

FUEL SYSTEM DIAGRAM

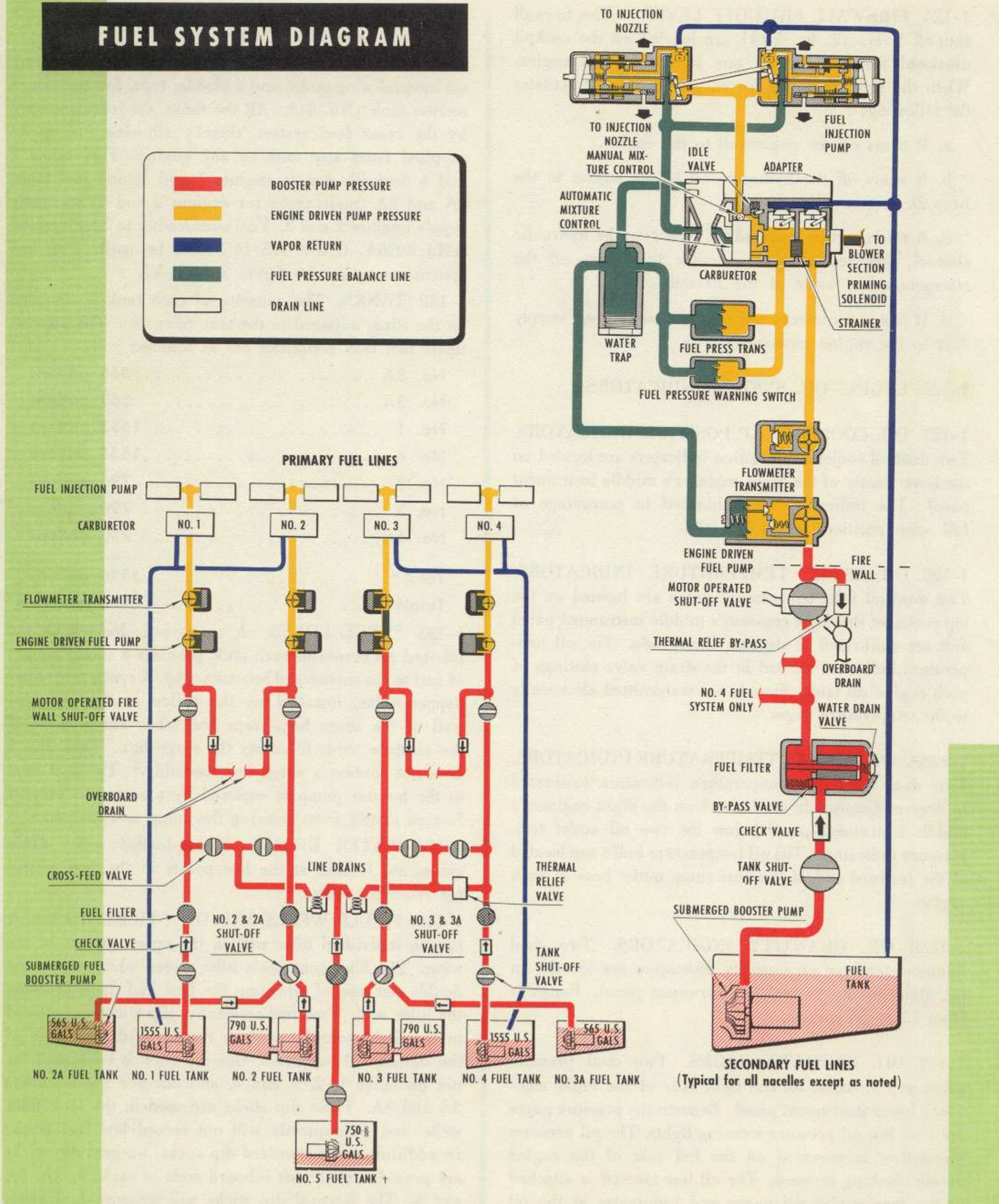


figure 1-19 (sheet 1 of 2)

†LAC Serials 4015–4024

§Approximate value; exact value to be submitted when available.

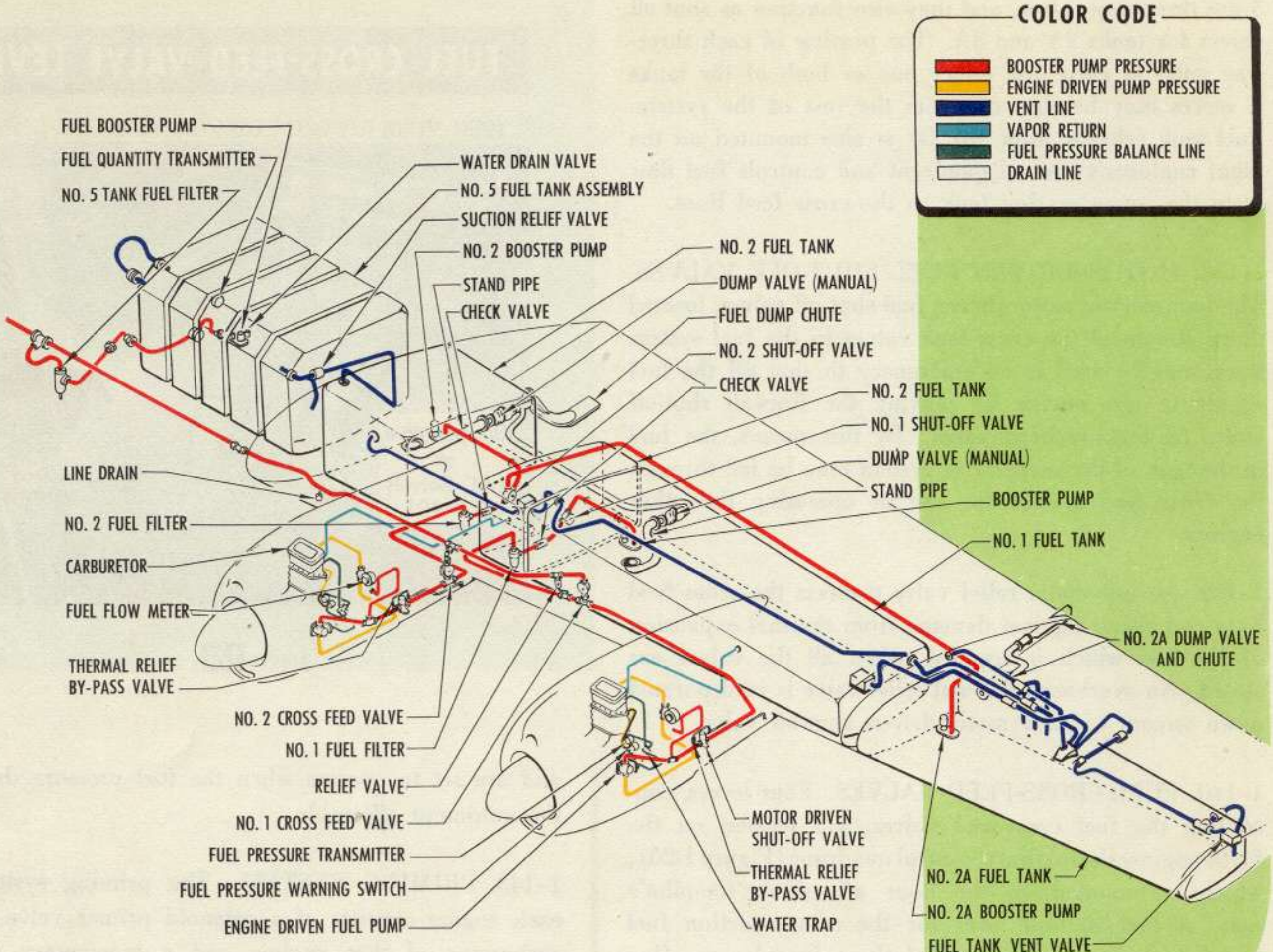


figure 1-19 (sheet 2 of 2)

WARNING

When checking fuel levels, loosen the integral dip sticks slowly. If any fuel seepage occurs, do not remove the dip stick. It is possible to have fuel levels which will not register on the normal dip stick, but which are above the top of the integral dip stick. If the integral dip stick is removed under such circumstances, large quantities of fuel will be discharged on the wing surface, and will constitute a serious fire and accident hazard. Take all readings with the dip stick unscrewed.

1–136. FUEL GAGES. Tanks 1, 2, 3, 4, and 5† are equipped with liquidometer type fuel quantity gages. Tanks 2A and 3A are equipped with capacitance type fuel quantity gages. The fuel quantity gages are mounted on the flight engineer's overhead instrument panel. Fuel flow transmitters, installed in the fuel line between the fuel pump and the booster control inlet connection, indicate the rate of flow of fuel in pounds per hour and transmit the indication electrically to fuel flow indicators, mounted on the flight engineer's lower instrument panel.

1–137. FUEL TANK SELECTOR VALVES. Four fuel tank selector levers, (9, fig. 1-51) mounted on the right end of the flight engineer's control quadrant, operate the fuel tank selector valves, installed near the outlet of each inner wing tank. The valves serving tanks 1 and 4 are simple two-way valves. Those serving tanks 2 and

3 are three-way valves, and they also function as shut-off valves for tanks 2A and 3A. The porting of each three-way valve is such that either one or both of the tanks it serves may be shut off from the rest of the system. Fuel tank selector lever No. 5† is also mounted on the flight engineer's control quadrant and controls fuel flow from the center section tank to the cross feed lines.

1–138. MOTOR DRIVEN FUEL SHUT-OFF VALVES. The four electric motor-driven fuel shut-off valves, located down stream of the cross feed valves in the fuel system lines, may be used in an emergency to shut off the fuel supply to any engine by moving the firewall shut-off levers on the overhead panel. By this means, the fuel in the tank of the inoperative system may be fed through the cross feed system for use in operating the other engines.

1–139. An automatic relief valve protects the cross feed lines and valves against damage from thermal expansion of the fuel which is trapped, when all the valves are closed. An overboard thermal relief valve is incorporated down stream of each motor-driven shut-off valve.

1–140. FUEL CROSS-FEED VALVES. Four levers, controlling the fuel cross-feed valves, are located on the flight engineer's auxiliary control quadrant (Figure 1-20), which is mounted on the floor aft of the co-pilot's seat. A fuel shut-off lever for the center section fuel tank † is located to the left of these four levers. One fuel cross-feed valve is provided for each engine control system. The valves are numbered to correspond to the engine position numbers. Thus, if fuel cross-feed valves 1 and 3 are opened, the fuel systems for engines 1 and 3 are interconnected. The valves are cable operated and are OPEN when they are positioned aft.

1–141. SUBMERGED FUEL BOOSTER PUMPS. Each fuel tank contains an electrically operated submerged fuel booster pump. These pumps provide relatively vapor-free fuel under pressure to the engine-driven fuel pumps provided that the fuel booster pump switch, located on the flight engineer's lower switch panel, is positioned at HIGH or LOW.

1–142. FUEL PRESSURE. A Magnesyn fuel pressure transmitter and pressure warning switch measures the fuel pressure at the carburetor. A pressure balance line connects the pressure transmitter, pressure warning switch, and engine-operated fuel pump relief valve chamber to the carburetor. Thus, the differential between fuel pressure and ram air pressure remains constant, regardless of altitude. Four fuel pressure warning lights are located on the flight engineer's lower instrument panel,

FUEL CROSS-FEED VALVE LEVERS

figure 1-20

and are set to operate when the fuel pressure drops to the minimum allowable.

1–143. PRIMING SYSTEM. The priming system for each engine consists of a solenoid primer valve in the carburetor of that engine, and a momentary contact switch is located adjacent to the engine starter switch on the master junction box panel. Priming fuel is discharged from the master control fuel inlet chamber to the engine supercharger (blower) section. Fuel booster pumps must be turned ON to supply pressure when priming.

1–144. VAPOR RETURN. The vapor return lines from engines 1 and 2 return to tank 1 and the vapor return lines from engines 3 and 4 return to tank 4.

1–145. FUEL TANK VENT LINES. Fuel is vented from each wing tank through the vent lines to a common flush type vent in the lower part of the outer wing panel. Separate overboard lines are teed into the outer wing fuel tank vent lines. These overboard lines incorporate pressure and suction relief check valves to prevent any possibility of positive or negative pressure existing in the outer wing tanks, should icing occur during either ascent or descent.

1–146. FUEL DUMP SYSTEM. Fuel may be dumped from tanks 1, 2, 3 and 4 by two independent systems.

†LAC Serials 4015—4024

TANKS 2A & 3A FUEL DUMP HYDRAULIC SYSTEM

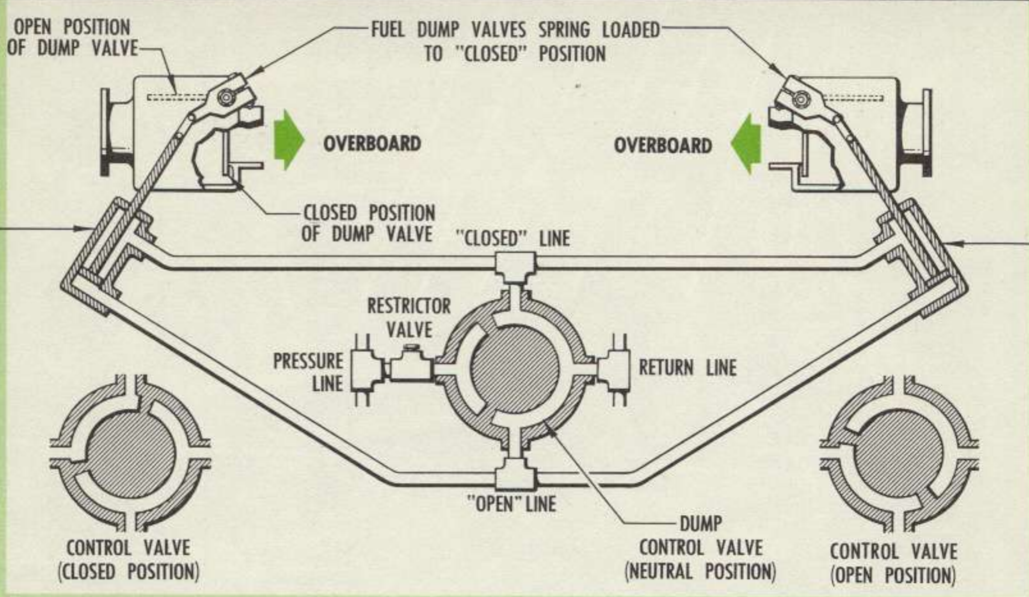


figure 1-21

One serves tanks 1 and 2 in the left-hand inner wing; the other serves tanks 3 and 4 in the right-hand inner wing. Each system consists of individual valves for each of the two tanks in that wing, and a common dump chute. Each dump system is cable-operated by a lever on the pilot's overhead control panel. Initial movement of the lever extends the retractable dump chute. Further movement opens the shut-off valve in each tank as the dump chute continues to extend.

1–147. Fuel is dumped from tanks 2A and 3A by means of a fuel dump valve and fuel dump chute for each tank. Secondary hydraulic pressure (fig. 1-21) is necessary to operate these dump valves. The dump valves are operated by a hydraulic 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 compartment to the forward passenger compartment. Operation of the selector valve causes both tanks 2A and 3A to be dumped simultaneously. The dump valve has three positions: OFF, NEUTRAL and ON.

1–148. No provision is made for dumping fuel from tank No. 5.†

1–149. Standpipes, installed in fuel tanks 1, 2A, 3A, and 4, limit the amount of fuel that can be dumped. The fuel remaining in each tank is shown in the following table:

FUEL IN U.S. GALLONS

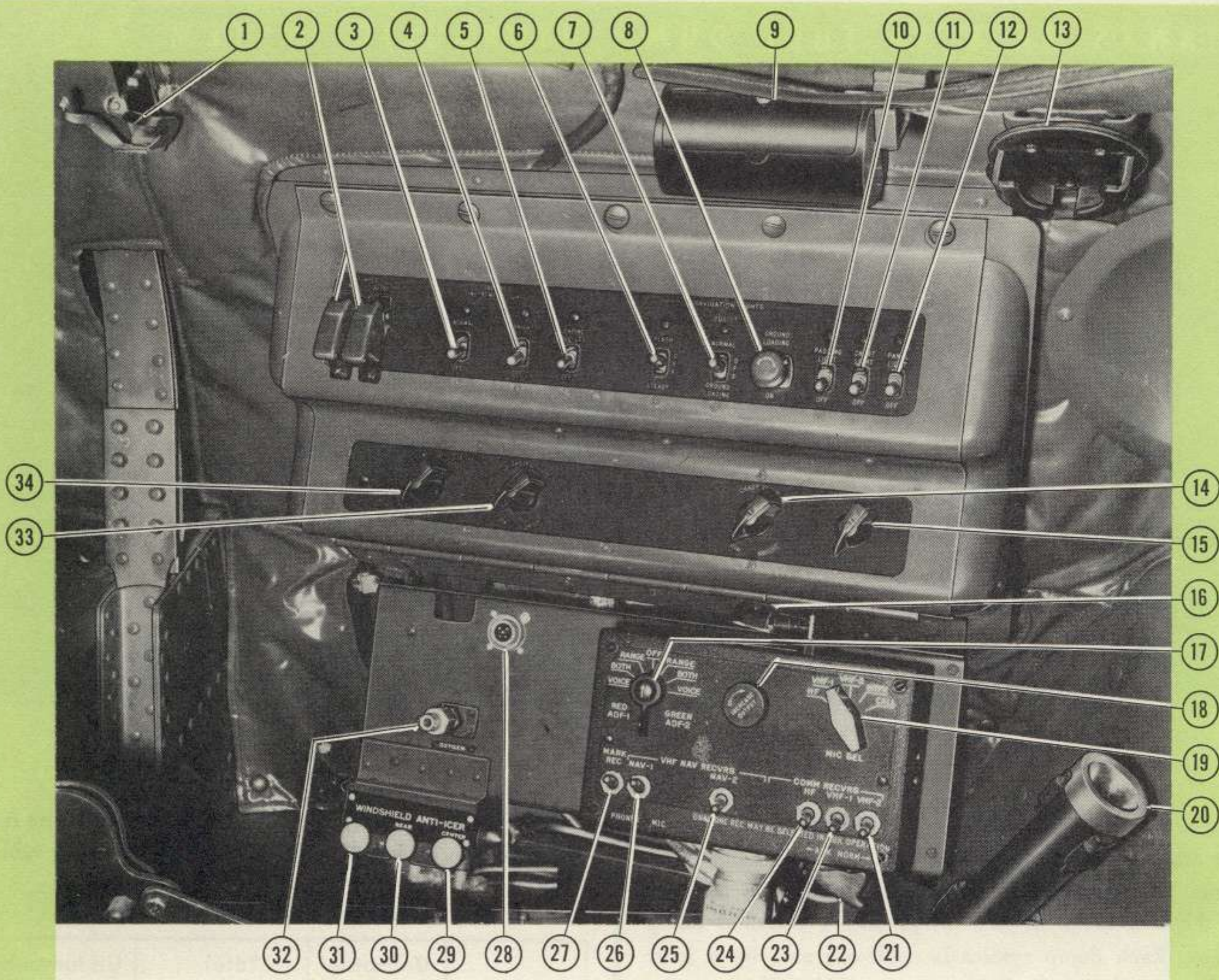
Tanks	Unusable Fuel	Total Undumpable	Undumpable but Usable
1 and 4 (each)	3	139	136
2 and 3 (each)	16	45	29
2A and 3A (each)	3	152	149
5†	20§	750§	730§

1–150. FUEL FILTERS. There are two Purolator type fuel filters in each wheel well. The outboard filters serve tanks 1 and 4, and the inboard filters serve tanks 2, 3, 2A and 3A. An additional filter in the right stub wing serves tank No. 5.†

1–151. The fuel filters have an element made of specially treated cellulose and incorporate a relief valve in the body which will open to by-pass fuel if the filter becomes clogged. A spring-loaded valve is provided to drain water from the filter.

†LAC Serials 4015–4024

§ Approximate values; exact values to be submitted when determined.

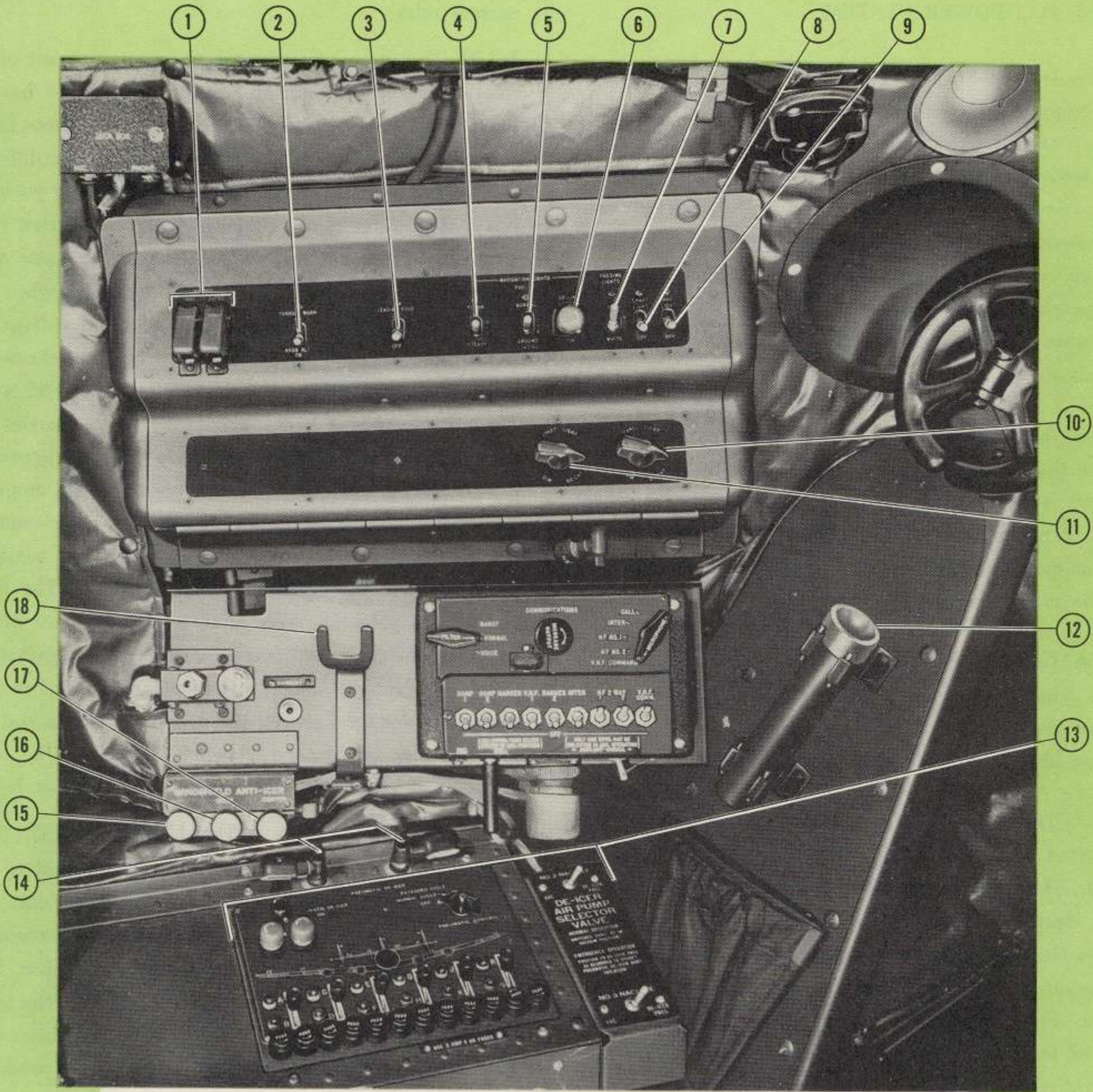


1. Public address microphone holder
2. Flare release switches (Inboard and Outboard)
3. Indirect instrument lights switch — normal
4. Indirect instrument lights switch — bright
5. Leading edge lights switch
6. Navigation lights switch
7. Ground loading light switch
8. Ground loading indicator light
9. Ash receptacle
10. Passing light switch
11. Chart light switch
12. Panel light switch
13. Microphone holder
14. Chart light rheostat switch
15. Panel light rheostat switch
16. Radio remote control panel light
17. Filter switch
18. Remote volume control
19. Microphone selector
20. Flashlight
21. VHF-2 communication receiver switch
22. Auxiliary receiver switch
23. VHF-1 communication receiver switch
24. HF communication receiver switch
25. VHF NAV-2 receiver switch
26. VHF NAV-1 receiver switch
27. Marker receiver switch
28. Pilot's public address microphone plug
29. Center windshield panel anti-icer fluid valve
30. Rear windshield panel anti-icer fluid valve
31. Inoperative
32. Continuous flow oxygen plug
33. Center panel instrument lights rheostat switch
34. Left panel instrument lights rheostat switch

figure 1-22

PILOT'S SIDE PANEL*

*LAC Serials 4001–4014



1. Flare release switches
2. Terrain warning—radio altimeter switch
3. Leading edge light switch
4. Navigation light switch
5. Ground loading light switch
6. Ground loading indicator light
7. Passing—taxi light switch
8. Chart light switch
9. Panel light switch
10. Panel light rheostat switch
11. Chart light rheostat switch
12. Flashlight and holder
13. Pneumatic de-icer boot panel
14. Pneumatic de-icer boot panel lights with integral switches
15. Inoperative
16. Rear windshield panel anti-icer fluid valve
17. Center windshield panel anti-icer fluid valve
18. Microphone holder

PILOT'S SIDE PANEL†

figure 1-22A

1–152. ELECTRICAL POWER SYSTEM.

1–153. D.C. POWER SYSTEM.

1–154. GENERAL. The Model 1049 Super Constellation is equipped with an electrical d.c. power system that incorporates reversed polarity, undervoltage, overvoltage, and feeder-fault protection. The d.c. power supply equipment consists of four generators and two storage batteries. A generator is mounted on an accessory pad of each engine, and all four generators are electrically connected for parallel operation with the batteries. The d.c. system furnishes power for distribution as shown on figure 1-23 and is shown schematically on figure 1-24.

1–155. A three-prong, polarity protected receptacle for connecting an external d.c. power supply to the airplane system is installed in the right side of the nose wheel well. A manually operated switch at the flight engineer's station connects either the batteries or the external supply to the main power bus.

1–156. Carbon pile voltage regulators are connected to each generator and are mounted beneath the floor, just aft of the pilot's and copilot's seats. Two a.c. motor-driven blowers provide cooling for the regulators.

1–157. The main d.c. bus is located in an isolated and insulated box in the lower forward baggage compartment. This box also contains four auxiliary contactors, four ammeter shunts, and four feeder fault protection relays (incorporating reverse current protection and main contactors) that are mounted on the main power relay panel. Four forward current relays are mounted to the left of the main power relay panel. Four over-voltage control relay panels, one for each generator, are installed between the right keelsons forward of the copilot's station. In addition to the overvoltage sensing relays, these panels also incorporate latching field relays, overvoltage selector relays, equalizer switching relays, field relay reset lockout relays, resistors, electrolytic capacitors, and a rectifier.

1–158. HARTMAN A726 REVERSE CURRENT AND FAULT SENSING RELAY CONTACTOR (Referred to as "Fault Protection" relay for brevity.) This relay assembly incorporates the differential current fault sensing relays, the differential voltage and reverse current pilot relay, a potential relay and a contactor in one unit which replaces the conventional generator control reverse current relay.

1–159. The reverse current relay-contactor circuit of the relay assembly performs the same function and has the same circuit elements as a standard reverse current relay-contactor. It consists of the main contactor, the differential voltage and reverse current pilot relay, and potential relay. The differential voltage and reverse current relay is polarized and has two coils wound on the same magnetic circuit. One coil has many turns of wire and closes the relay when there is a differential voltage between the generator feeder and the bus. It closes the relay when the differential is +0.25 to +0.35 volts. The other coil is a heavy copper strap that carries the generator current and opens the relay when the generator draws reverse current in excess of about 30 amperes. In series with the generator switch, the relay contacts energize the coils of the main contactor, the auxiliary contactor, and the equalizer switching relay. The function of the potential relay is to protect the coil of the differential voltage and reverse current relay against excessive differential voltage. It is polarized, and its coil senses the voltage between the generator feeder and the ground when the generator switch is closed. The relay closes at 20 to 24 volts and opens at 18 volts or below.

1–160. THE HARTMAN A712 AUXILIARY CONTACTOR. This is a heavy duty contactor identical to the main contactor in the Hartman A726 relay unit. Its contacts are connected in series, and its coil is connected in parallel with those of the main contactor. Thus, four breaks disconnect the feeder from the bus, and the interrupting ability at elevated voltages is thereby increased. This is necessary in the event that overvoltage is produced by a short circuit between the generator armature positive and the shunt field positive at high generator speed. The armature shorting relay which is tripped by the field relay, reduces generator voltage to nearly zero even under these conditions. Under all other conditions which produce overvoltage, the generator field is de-energized by operation of the field relay before the main and auxiliary contactors open, so the contactors do not interrupt sustained excessive voltage.

1–161. THE HARTMAN AVR735 FORWARD CURRENT RELAY. The forward current relay is a polarized, toggling type relay, which can be reset only by means

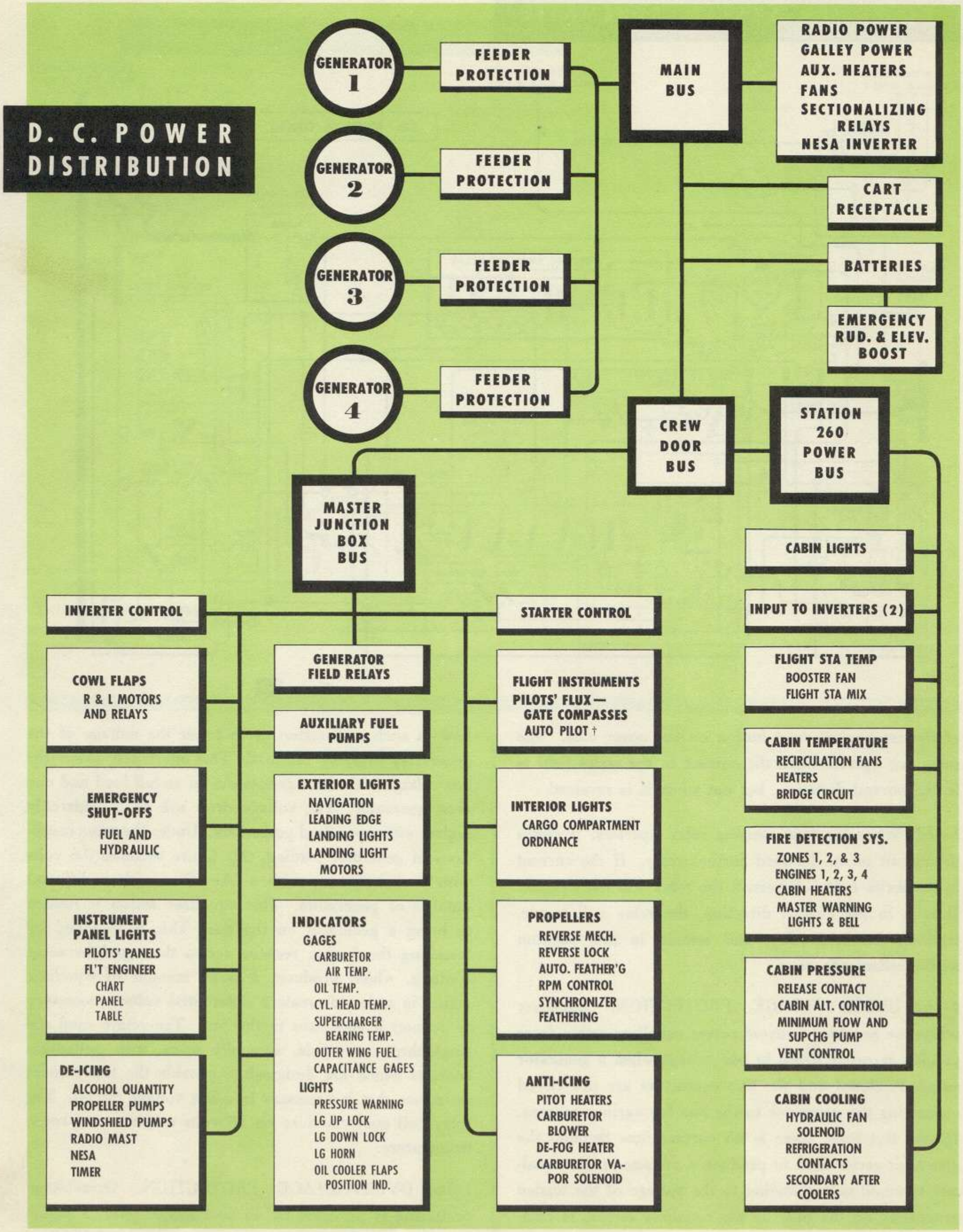


figure 1-23

†LAC Serials 4015–4024

D.C. POWER SYSTEM SCHEMATIC

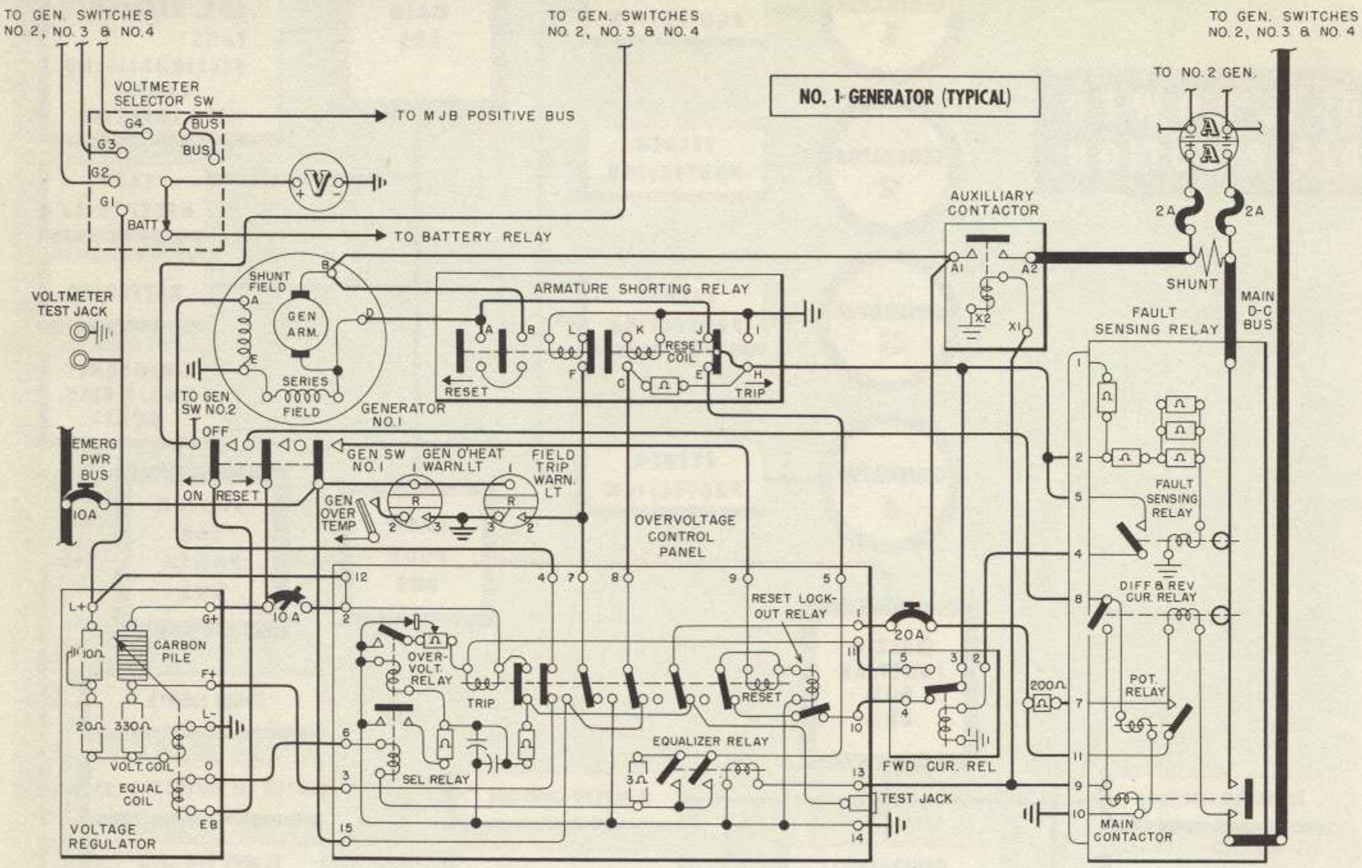


figure 1-24

of the mechanical reset button on the cover case. The relay can operate when the current in the series field is in the normal direction, but not when it is reversed.

1–162. When the fault sensing relay operates, it closes the circuit to the forward current relay. If the current in the series field is reversed, the relay will not operate. If it is in the normal direction, the relay will toggle, tripping the field relay, and remain in this position until mechanically reset.

1–163. UNDERVOLTAGE PROTECTION. Equalizer relays are provided to avoid severe equalizer action from causing excessive drops in bus voltage when a generator switch is closed and the line contactors are not closed connecting the generator to the bus for various reasons. During this time, there is no current flow through the generator series field to produce a voltage at the equalizer terminal corresponding to the voltage of the loaded generators on the bus. If the equalizer circuit is complete during this time, a heavy equalizing current will flow in such a direction as to lower the voltage of the generators carrying the load. This effect may lower the bus voltage with three generators on at full load and one dead generator. The voltage drop will be considerably higher with more dead generators. Under the same conditions of generator loading, this figure becomes 0.6 volts with 5 ohm resistor with a like effect with a different number of generators. This equalizer action is needed to bring a generator on the bus. This is provided by installing the 5 ohm resistor across the equalizer relay contacts, which produces a small amount of equalizer action in order to create a differential voltage necessary to connect a generator to the bus. The relays used are single-throw, two-pole, normally open, with palladium contacts which are designed to provide the low contact resistance that is necessary in a low voltage circuit. The relay coil contacts close on 18 volts maximum at room temperature.

1–164. OVERVOLTAGE PROTECTION. Overvoltage protection is provided by an overvoltage relay, a polarized selector relay, plus resistors and capacitors for time

ELECTRICAL POWER SYSTEM LOCATIONS

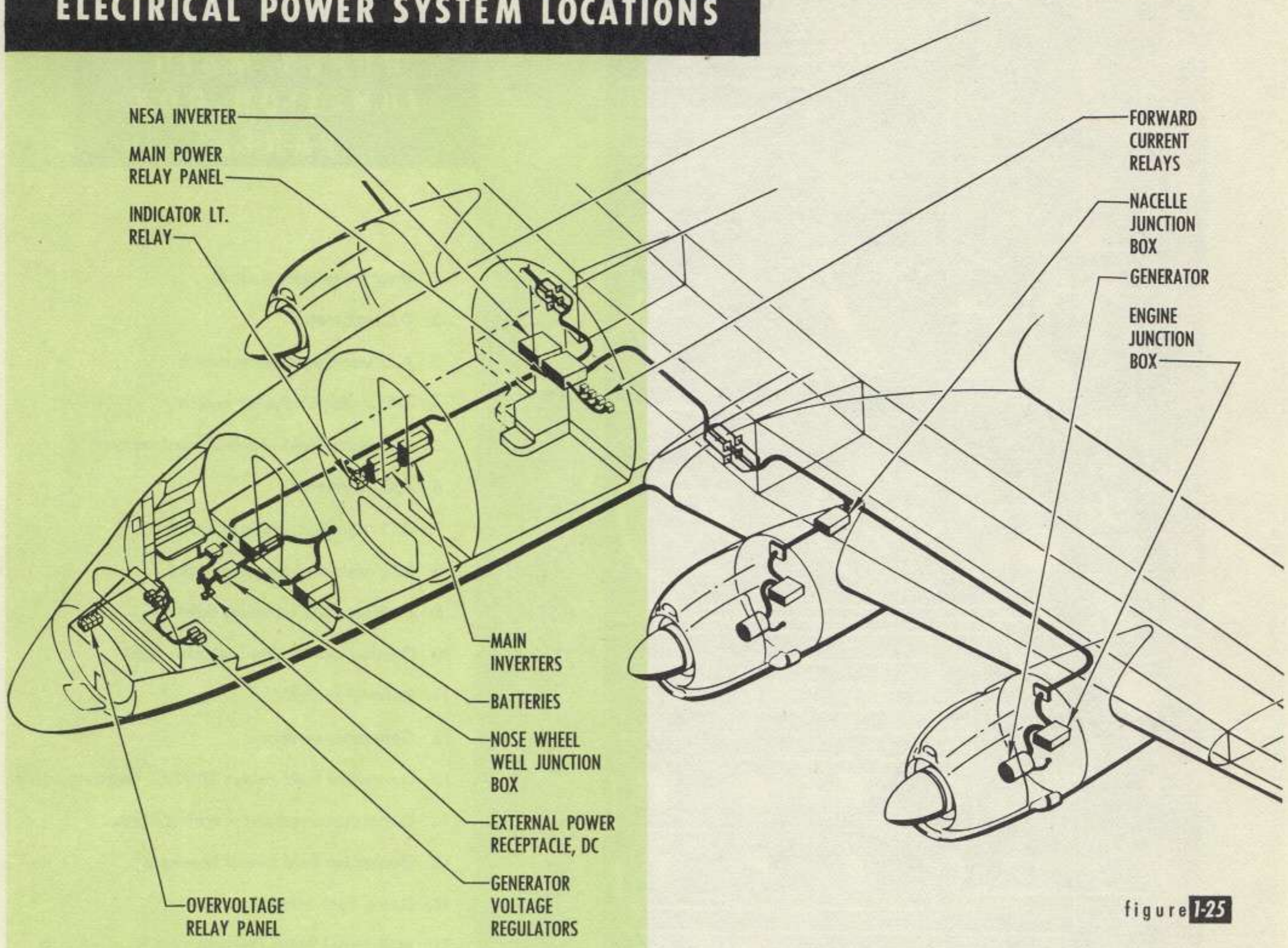
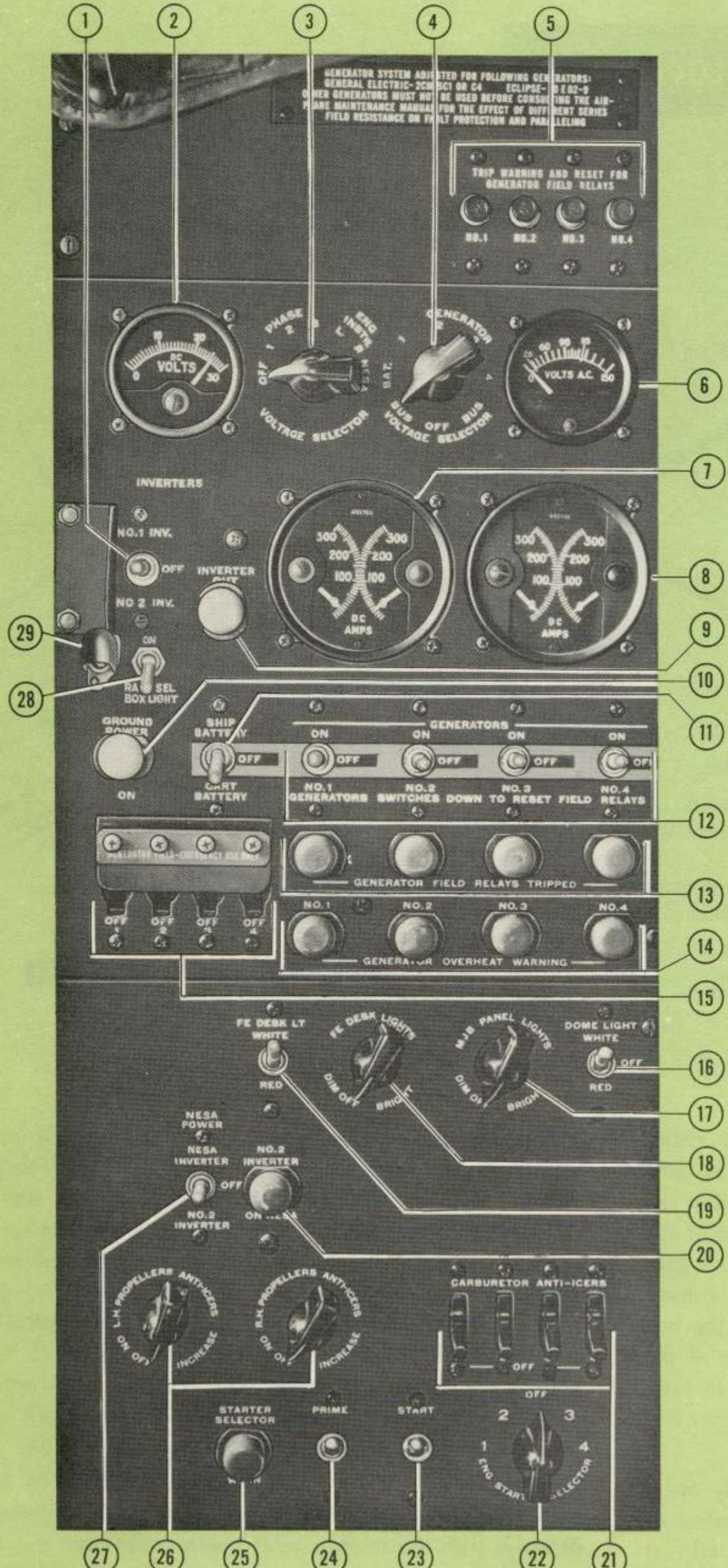


figure 1-25

delay. A latching field relay that is tripped by either the overvoltage relay or fault protection relay is used to de-energize the generator. The voltage is sensed at the generator side of the auxiliary contactor, and part of the lead to the overvoltage relay is common with the generator field and contactor coil circuits, so the voltage at the relay may be as much as 0.5 volt below the bus voltage, but is essentially the same as the voltage at the regulator. With generators parallel, the voltage to each overvoltage relay and regulator is the same.

1–165. The overvoltage relay is a sealed, normally open, sensitive relay, shock mounted to minimize the effect of vibration and jolts. The relay is calibrated to trip at 30 $+.6$, $-.4$ volts across its coil circuit including the resistors and capacitors. The normally open contacts of the relay are connected in series with the field relay trip coil through a current limiting resistor.

1–166. The polarized selector relay is a normally open sensitive relay. The coil is connected in series with the voltage regulator equalizer coil in such a way that it closes when the equalizer signal is in the direction to raise the voltage of the generator it is associated with, but its polarization prevents closing when the signal is in the opposite direction. With the generators operating in parallel, all selector relays, except the one for a high voltage generator, will close. The relay contacts are in parallel with the overvoltage relay coil so that the coil is short circuited and thus made inoperative when the selector relay is closed. This ensures that only the generator causing the overvoltage will be tripped. A resistor in series with the selector relay contacts prevents damage to the contacts by discharge of the capacitors. When only one generator is operating, there will be no equalizer current, so the selector relay will remain open and the overvoltage protection will remain functional. When



UPPER MAIN JUNCTION BOX PANEL

1. Inverter selector switch
2. D.C. voltmeter
3. A.C. voltage selector switch
4. D.C. voltage selector switch
5. Generator field trip and reset relays
6. A.C. voltmeter
7. D.C. ammeter, engines 1 and 2
8. D.C. ammeter, engines 3 and 4
9. Inverter OUT warning light
10. Ground power ON indicator light
11. Battery switch
12. Generator switches
13. Generator field relays TRIPPED warning lights
14. Generator overheat warning lights
15. Generator field circuit breakers
16. Dome light selector switch
17. MJB panel lights rheostat switch
18. Flight engineer's desk lights rheostat switch
19. Flight engineer's desk light selector switch
20. No. 2 inverter on Nesa indicator light
21. Carburetor anti-icer switches
22. Engine starter selector switch
23. Starter switch
24. Primer switch
25. Starter selector switch warning light
26. Propeller anti-icer rheostats
27. Nesa power selector switch
28. Radio selector box light switch†
29. Radio selector box light†

figure 1-26

†LAC Serials 4015–4024

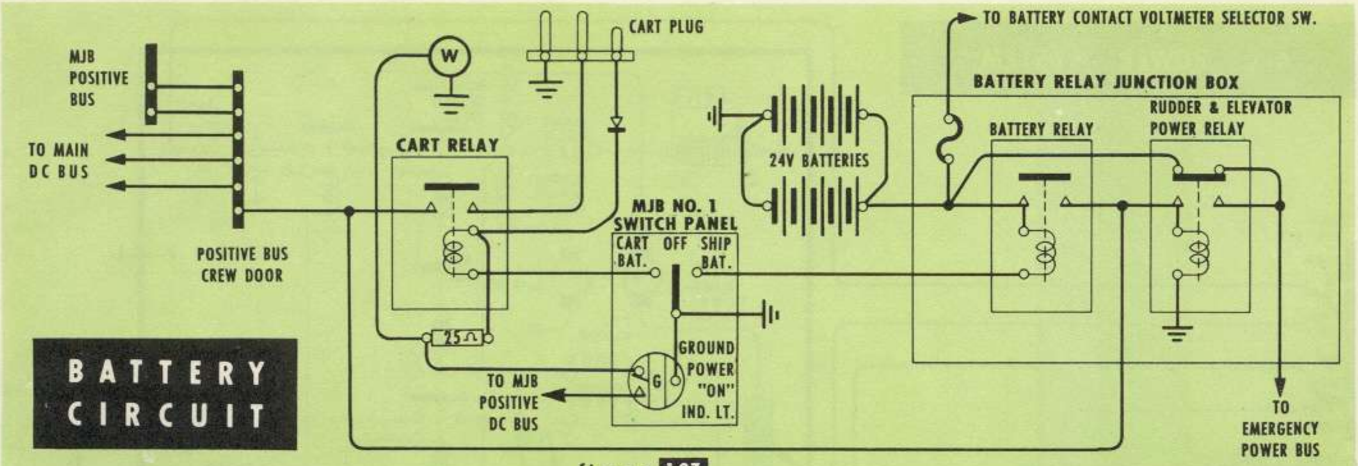


figure 1·27

any generator is off the bus, only its overvoltage relay will sense that generator's voltage and its selector relay will not close.

1–167. The high value of the series resistor limits the current when the selector relay is closed. It also limits the rate of charge of the capacitors, which must be charged before sufficient voltage to trip the relay will be applied to the overvoltage coil. This provides the necessary time delay to prevent tripping on voltage transients.

1–168. The field latching relay is effectively two relays with a mechanical interlock between their armatures. Five sets of single-throw contacts, which are closed when the relay is reset, are actuated by the reset coil. Three sets of double-throw contacts are operated by the trip coil. When an open armature is actuated by its coil, it closes and mechanically actuates the other armature. Either armature will latch and remain in the position to which it was last actuated until the open armature is actuated. The trip coil operates on about four (4) volts and the reset coil requires about 14 volts. If generator polarity should be reversed, the trip coil will be energized directly from generator voltage through a rectifier. The overvoltage relay need not trip. The five sets of contacts on the reset armature are connected in series in the generator field circuit. Their location in the circuit is such that all possible control circuits from the generator positive terminal are open when the field relay is tripped. One set of contacts on the trip armature is in the reset coil circuit. These contacts close when the relay is tripped. Another set of contacts operates the trip indicator light, and the armature shorting relay. Thus, overvoltage protection of the d.c. bus is provided for all overvoltage faults, including a short circuit between the generator and field positive terminals.

1–169. FEEDER FAULT PROTECTION. The feeder fault protection system provides the necessary safeguards to ensure tripping of the faulted generator only, with no false trips due to reverse current or system transients. The basic principle employed to provide this protection is that current at the negative terminal of the generator will be equal to the current supplied to the bus, unless some load or fault is applied between them. Since these two points are remote from each other, it is not practical to directly compare the currents. Accordingly, the voltage drop across the generator series field is used as a measure of the current in the series field. This voltage can be conducted by relatively small wires to the area where the current entering the center bus is measured directly, and these two compared.

1–170. The fault sensing relay is polarized and has two coils on a common magnetic circuit. One coil is a single turn of heavy copper which is connected in series with the feeder at the center bus. The other coil consists of many turns of small wire and is connected in parallel with the generator series field. In series with this coil are temperature compensating resistors which reduce the effects of temperature changes on this coil.

1–171. It is not practical to provide temperature compensating resistors in the generator; therefore, it is necessary to consider the effect of temperature change on the series field. Since the resistance of this field is approximately 2½ times as great at 185°C as it is at —55°C, the voltage from the generator series field at the relay shunt coil will vary by this ratio for a constant current, being higher at the higher temperature.

1–172. The calibrating resistor in series with the shunt coil is set at such a value that the ampere turns in the shunt coil balance those of the series coil when the temperature of the series field is 185°C. At this temperature a fault above 70 amperes will permit the ampere turns of the shunt coil to exceed those of the series coil by enough that the net flux closes the relay contacts.

A. C. POWER SYSTEM *

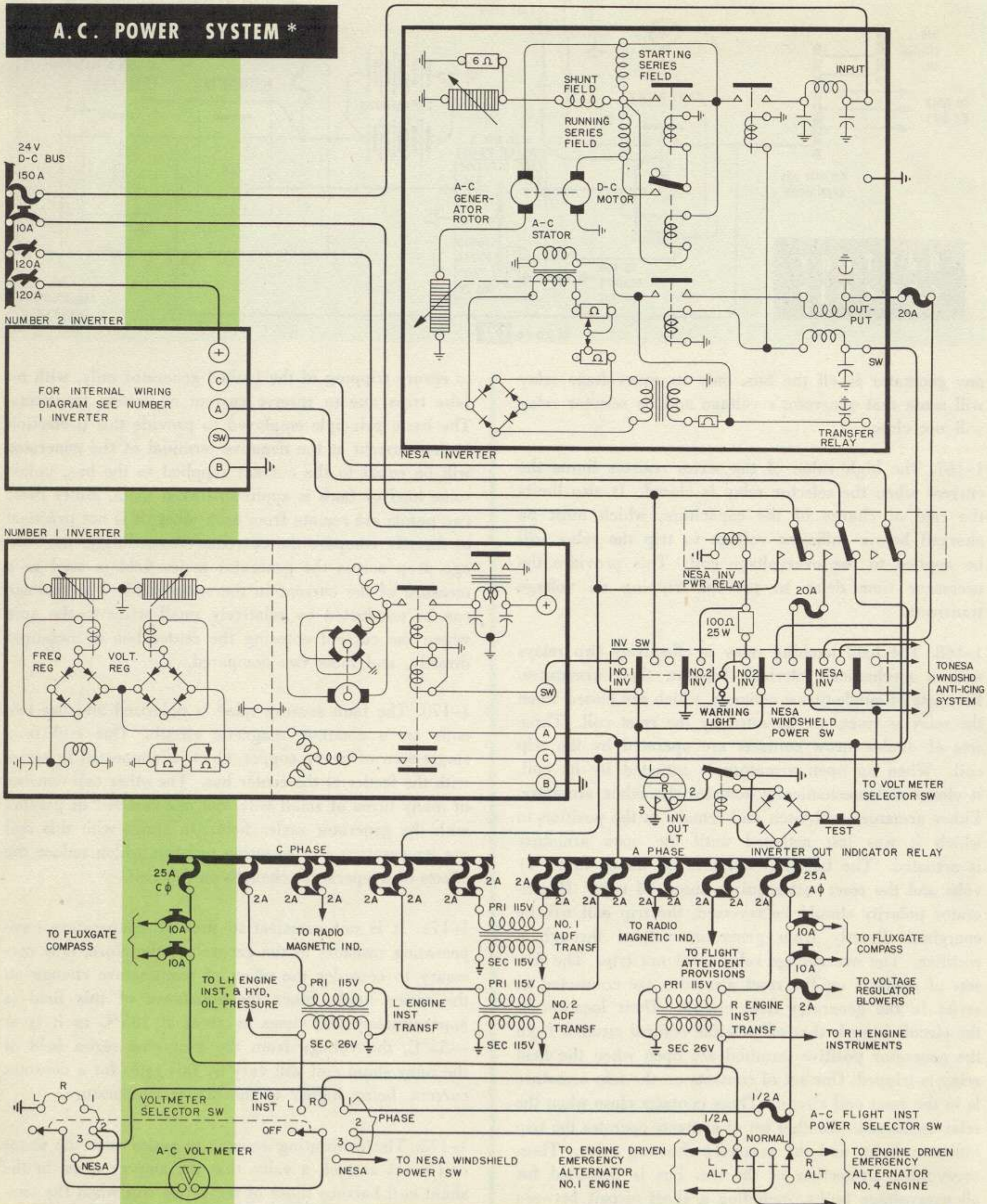


figure 1·28

*LAC Serials 4001–4014

A.C. POWER SYSTEM†

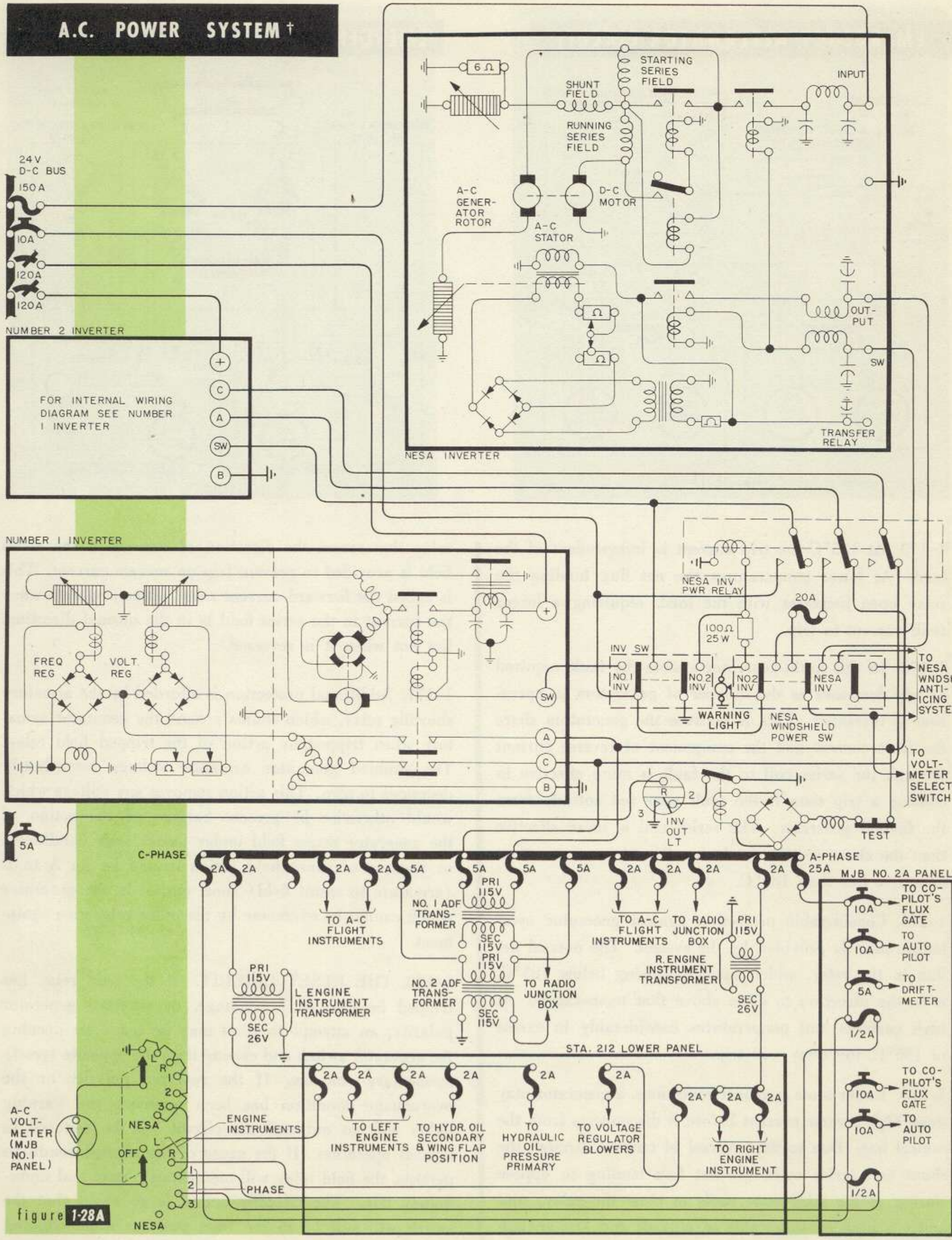


figure 1-28A

EMERGENCY ALTERNATOR CIRCUIT*

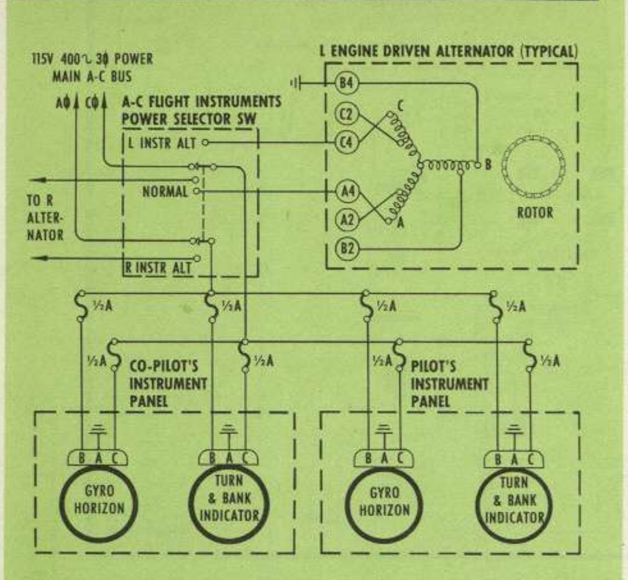


figure 1-29

EMERGENCY ALTERNATOR CIRCUIT†

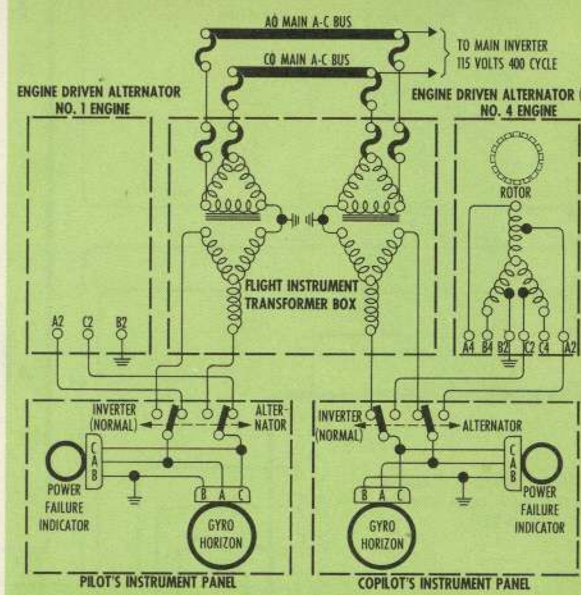


figure 1-29A

1–173. At 185°C the trip current is independent of the load. At lower temperatures the net flux holding the relay open increases with the load, requiring a larger fault current to trip.

1–174. In this multi-generator system the fault required to trip decreases as the number of generators in operation is increased. This is because the generators share the fault current and the component of reverse current through the series coil to the fault is more effective in causing a trip than if the fault were fed entirely from the faulted generator. The series coil is more effective than the shunt coil in producing trip at generator temperatures less than 185°C.

1–175. Considerable protection against generator overtemperature is provided by the system. The normal net flux in the relay, which opposes closing below 185°C, is in the direction to close above that temperature. At high currents and temperatures considerably in excess of 185°C, the relay will trip.

1–176. Under some transient conditions, a generator may draw high reverse current before it disconnects from the central bus. Due to the reversal of current through the shunt and series coils, the net flux tending to oppose closing of the relay now tends to close the relay; and under a high enough value of current and low enough generator temperature, it will close. For this reason, a relay that senses the direction of current in the series field is provided to prevent trip on reverse current. This is called the forward current relay. It can operate when the current in the series field is in the normal direction, but not when it is reversed.

1–177. Additional protection is afforded by the armature shorting relay, which shunts around the generator armature when tripped by action of the tripped field relay. The shunted generator armature voltage immediately decreases to zero. This action removes any voltage which would otherwise be present because of the action of the generator series field under feeder fault conditions, or because of shunt field action caused by an A to B (armature to shunt field) short circuit in the generator which cannot be overcome by the other protective equipment.

1–178. THE RESET CIRCUIT. If the field relay has tripped because of overvoltage, or reversed generator polarity, an attempt to reset may be made by opening the generator switch and closing it on the opposite (reset) momentary contacts. If the reversed polarity or the overvoltage condition has been removed, the warning lights will go out and the circuit will be restored to normal operation. If the cause of the tripped condition persists, the field relay will momentarily reset and immediately trip. The tripping action is so rapid that the switch will still be in the reset position when tripping is complete. The generator trip warning light will blink

*LAC Serials 4001–4014 †LAC Serials 4015–4024

ELECTRICAL LOAD TABLE*

NOTES	LOAD ITEMS		UNITS PER SHIP	AMPS PER UNIT	UNITS IN USE	AMPS PER ITEM
			APPROX. DESIGN LOAD			
289 AMPS @ 900 FT. LBS. MAX. TORQUE	**STARTERS & BOOSTERS (AT 10°F.)**		4	178.6	1	178.6
NORMAL CHARGE	**BATTERIES**		2	10.0	2	20.0
52% EFFICIENCY	**INVERTER NO. 1**		1	75.0	1	75.0
EMER. LOAD — NESA WINDSHIELD	**INVERTER NO. 2**		1	100.0	1	100.0
	INVERTER (NESA WINDSHIELD)		1	130.0	1	130.0
	LIGHTS					
	CABIN OVERHEAD (BRIGHT) 4 & STEP LT. 4	△4	80		80	63.5
	CABIN OVERHEAD (DIM) 4 & STEP LT. 4	△4	80		80	21.6
	CABIN OVERHEAD — NIGHT (DIM)		4	.8	4	3.2
10% ON	WARNING (ALL CIRCUITS)		54		5	.5
	LANDING GEAR		3	.8	3	2.4
	CARGO COMPT. & ENTRANCE		13		13	10.4
10% MAX. ON INTERM.	CALL SYSTEM		43	.04	4	.16
FLT. STA. GENERAL LTS. & PANEL LTS.	INSTRUMENT & PANEL (NORMAL)		125		125	39.1
DURING LIGHTNING	INSTRUMENT & PANEL (EMERGENCY)		4		4	3.2
	ORDINANCE		30	.17	30	5.1
	PILOTS CHART & COMPASS		3		3	.5
PASSING LT. 1.95 AMPS. WHEN USED	TAXI & PASSING		1	16.0	1	16.0
	LANDING		2	21.8	2	43.6
	POSITION (AVERAGE WITH T. & B. LTS.)	△3	6		3	2.85
	GALLEY & LAVATORY (ON BRIGHT)	△4	12	.8	12	9.6
	LEADING EDGE		2	2.8	2	4.0
50% READING ON	READING	△4	90	.75	45	33.75
	POWER PLANT					
EMER. ONLY	AUXILIARY FUEL PUMPS (HIGH)		6	23.0	4	92.0
	AUXILARY FUEL PUMPS (LOW)		6	10.5	4	42.0
	ANTI-ICER PUMPS (PROP.)		2	1.5	2	3.0
EMER. ONLY	FUEL & HYD. SHUT-OFF VALVE		8	2.5	2	5.0
	ENGINE FLAP MOTORS		12		3	30.0
	PROPELLERS					
	GOVERNOR CONTROL (STEP MOTOR)		4	1.5	4	6.0
	FEATHERING CONTROL	△1 △2	4	150.0	1	150.0
	AIRPLANE CONTROLS					
	ELEV. & RUD. BOOSTERS (AVERAGE)	△6 △5	2	30.4	2	60.8
	ELEV. TAB. MOTOR		1	13.2	1	13.2
	AUTOMATIC PILOT (D.C.)	△7	1	3.5	1	3.5
ON WITH GEAR DOWN IN FLIGHT	LDG. GEAR LOCK SOLENOID		1	.5	1	.5
WHEN TRANSMITTING WITH	**RADIO**					
RTA-1B ADD 15.4 AMPS	STANDBY LOAD CONTINUOUS					58.2
440-A ADD 19.0 AMPS						
	MISCELLANEOUS					
	AIR CONDITIONER	△4				237.0
	FLT. STA. AUX. HEATER					133.0
	INSTRUMENTS (D.C.)					5.5
	WING & EMP. ELECT. DE-ICING	△6	1	26.1	1	26.1
	FLUXGATE COMPASS		2	1.0	2	2.0
	WINDSHIELD DEFOG. (FAN & HTR.)	△6	1	75.7	1	75.7
	WINDSHIELD WIPER MOTOR		1	9.0	1	9.0
	FLARE RELEASE SOLENOID		2	12.5	1	12.5
	GALLEY (MAX.)	△4				143.0
	ANTI-ICER PUMPS (CARB.)		4	2.3	4	9.2
	CARB. PRE-HEAT & IND. AIR		4	3.5	1	3.5
	PITOT HEATERS & LTS.		2	3.5	2	7.0
	ANT. MAST HEATER		1		1	32.2
	NESA WINDSHIELD (CONTROL)					1.0
	ANTI-ICER PUMPS (WINDSHIELD)		2	2.3	2	4.6

SOURCE OF POWER

FOUR GENERATORS (3.11 DRIVE)

ECLIPSE 30 E 02-9 (30 VOLT)

GROUND RATING 150 AMP. MAX. CONTINUOUS

FLIGHT RATING 300 AMP. CONTINUOUS

TWO BATTERIES (IN PARALLEL)

AN 3150-A 24 VOLT

14 AMP. TOTAL FOR 5 HOURS AT 80°F BATTERY TEMPERATURE

25 AMP. TOTAL FOR 2 HOURS AT 80°F BATTERY TEMPERATURE

RATING REDUCED APPROX. 60% AT ABOVE VALUES AT 0°F BATTERY TEMPERATURE

△7 WIRING PROVISIONS ONLY.

△6 CYCLING LOAD.

△5 PUMPING LOAD 35 AMPS; IDLING LOAD 25 AMPS PER UNIT

△4 ITEMS MARKED EQUIPPED WITH TOGGLE TYPE BREAKERS FOR MONITORING IN CASE OF EMERGENCIES, TOTAL POWER MONITORED 487 AMPS.

△3 AVERAGE POWER FOR POS. LTS. FLASHING WITH T. & B. WHITE LTS.
FLASHING WITHOUT T. & B. LTS. 1.80 AMPS
STEADY WITHOUT T. & B. LTS. 2.55 AMPS
ADD 2.5 AMPS FOR WHEEL WELL LTS. IF LANDING GEAR IS DOWN.

△2 FOR REVERSE PITCH LANDING ADD 93.3 AMPS PER PROP REVERSED APPROX. 2 SEC. DURATION DEPENDING ON SYNCH. SETTING

△1 93.3 AMPS TO UNFEATHER.

figure 1-30

*LAC Serials 4001–4014

ELECTRICAL LOAD TABLE†

APPROX. DESIGN LOAD

NOTES	LOAD ITEMS	UNITS PER SHIP	AMPS PER UNIT	UNITS IN USE	AMPS PER ITEM
289 AMPS @ 900 FT. LBS. MAX. TORQUE	**STARTERS & BOOSTERS (AT 10°F.)**	4	178.6	1	178.6
NORMAL CHARGE	**BATTERIES**	2	10.0	2	20.0
52% EFFICIENCY	**INVERTER NO. 1**	1	75.0	1	75.0
EMER. LOAD — NESA WINDSHIELD	**INVERTER NO. 2**	1	100.0	1	100.0
	INVERTER (NESA WINDSHIELD)	1	130.0	1	130.0
	LIGHTS				
	FLIGHT STATION DOME & FLIGHT ENGINEERS DESK	6		3	1.9
	CABIN OVERHEAD (BRIGHT) △4	72		72	54.7
	CABIN OVERHEAD (DIM) △4	72		72	20.2
	CABIN OVERHEAD — NIGHT	4	.3	4	1.2
10% ON	WARNING (ALL CIRCUITS)	77	.2	8	1.4
	LANDING GEAR	3	.8	3	2.4
	CARGO COMPT. & ENTRANCE	13		13	10.4
10% MAX. ON INTERM.	CALL SYSTEM	50	.04	5	.2
FLT. STA. GENERAL LTS. & PANEL LTS.	INSTRUMENT & PANEL (NORMAL)	73		73	12.4
DURING LIGHTNING	INSTRUMENT & PANEL (EMERGENCY)	4	.8	4	3.2
	ORDINANCE	36	.17	36	6.1
	PILOTS CHART, PEDESTAL & COMPASS	4		4	.8
PASSING LT. 1.95 AMPS. WHEN USED	TAXI & PASSING	1	16.0	1	16.0
	LANDING	2	21.8	2	43.5
	POSITION (AVERAGE WITH T. & B. LTS.) △3	6		3	2.9
LAMP LOADS ON BRIGHT	GALLEY, CREW COMPT., FLT. ATT. & LAV. △4	26	.8	26	20.8
	LEADING EDGE	2	2.0	2	3.9
50% READING ON	READING △4	86	.75	43	32.3
	POWER PLANT				
EMER. ONLY	AUXILIARY FUEL PUMPS (HIGH)	7	23.0	4	92.0
	AUXILARY FUEL PUMPS (LOW)	7	10.5	4	42.0
	ANTI-ICER PUMPS (PROP.)	2	1.5	2	3.0
EMER. ONLY	CARB. VAPOR SOLENOID	4	.3	4	1.3
EMER. ONLY	FUEL & HYD. SHUT-OFF VALVE	8	2.5	2	5.0
	ENGINE FLAP MOTORS	12		3	30.0
	PROPELLERS				
	GOVERNOR CONTROL (STEP MOTOR)	4	1.5	4	6.0
	FEATHERING CONTROL △1 △2	4	150.0	1	150.0
	AIRPLANE CONTROLS				
	ELEV. & RUD. BOOSTERS (AVERAGE) △6 △5	2	30.4	2	60.8
	ELEV. TAB. MOTOR	1	13.2	1	13.2
	AUTOMATIC PILOT (D.C.)	1	3.5	1	3.5
ON WITH GEAR DOWN IN FLIGHT	LDG. GEAR LOCK SOLENOID	1	.5	1	.5
WHEN TRANSMITTING WITH	**RADIO**				
ART-13 ADD 24 AMPS	STANDBY LOAD CONTINUOUS				50.3
18S-3 ADD 33 AMPS					
ARC-1 ADD 12.7 AMPS					
	MISCELLANEOUS				
	AIR CONDITIONING △4				237.0
	FLT. STA. AUX. HEATER & BOOST FAN				133.0
	INSTRUMENTS (D.C.)				5.5
	WING & EMP. PNEUM. DE-ICING SYS. △6	1	4.0	1	4.0
	FLUXGATE COMPASS	1	1.0	1	1.0
	WINDSHIELD DEFOG. (FAN & HTR.)	1	75.7	1	75.7
	WINDSHIELD WIPER MOTOR	1	9.0	1	9.0
	FLARE RELEASE SOLENOID	2	12.5	1	12.5
	GALLEY (MAX.) △4				394.0
	ANTI-ICER PUMPS (CARB.)	4	2.3	4	9.0
	CARB. PRE-HEAT & IND. AIR	4	3.5	1	3.5
	PITOT HEATERS & LTS.	2	3.5	2	7.0
	ANT. MAST HEATER	1	32.2	1	32.2
	NESA WINDSHIELD (CONTROL)				1.0
	ANTI-ICER PUMPS (WINDSHIELD)	2	2.3	2	4.6

SOURCE OF POWER

FOUR GENERATORS (3.11 DRIVE)

ECLIPSE 30E02-11(30 VOLT)

GROUND RATING 150 AMP. MAX. CONTINUOUS

FLIGHT RATING 300 AMP. CONTINUOUS

TWO BATTERIES (IN PARALLEL)

AN3150-A 24 VOLT

14 AMP. TOTAL FOR 5 HOURS AT 80°F BATTERY TEMPERATURE

25 AMP. TOTAL FOR 2 HOURS AT 80°F BATTERY TEMPERATURE

RATING REDUCED APPROX. 60% AT ABOVE VALUES AT 0°F BATTERY TEMPERATURE

△6 CYCLING LOAD.

△5 PUMPING LOAD 35 AMPS; IDLING LOAD 25 AMPS PER UNIT

△4 ITEMS MARKED EQUIPPED WITH TOGGLE TYPE BREAKERS FOR MONITORING IN CASE OF EMERGENCIES, TOTAL POWER MONITORED 759 AMPS.

△3 AVERAGE POWER FOR POS. LTS. FLASHING WITH T. & B. WHITE LTS.
FLASHING WITHOUT T. & B. LTS. 1.80 AMPS
STEADY WITHOUT T. & B. LTS. 2.55 AMPS
ADD 2.5 AMPS FOR WHEEL WELL LTS. IF LANDING GEAR IS DOWN.

△2 FOR REVERSE PITCH LANDING ADD 93.3 AMPS PER PROP REVERSED APPROX. 2 SEC. DURATION DEPENDING ON SYNCH. SETTING

△1 93.3 AMPS TO UNFEATHER.

figure 1-30A

†LAC Serials 4015–4024

CONTROL QUADRANT CIRCUIT BREAKER PANEL

LAC Serials 4001 Through 4014

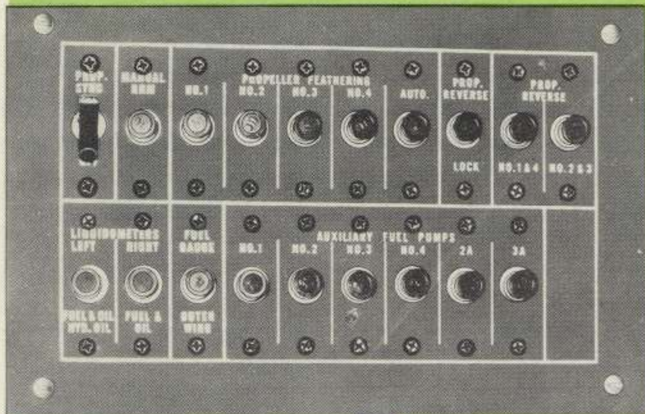


figure 1-31

LAC Serials 4015 Through 4024

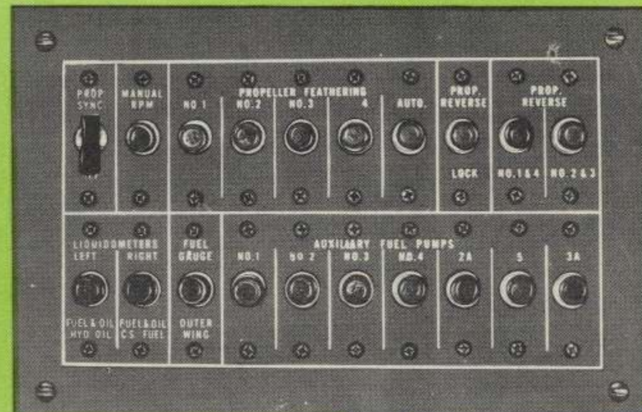


figure 1-31A

off, then on again for this condition. The circuit is prevented from cycling while the reset switch is held closed by the action of the reset lockout relay.

1–179. Because it is too hazardous to attempt a reset after a feeder fault in flight, the forward current relay is connected to open the reset circuit when it operates. Resetting the fault protection relay is purposely made difficult to accomplish in flight because the fault should be located and corrected before a reset is attempted. After the fault is corrected, reset is accomplished by pressing the reset button on the forward current relay and then operating the field relay reset switch.

1–180. PARALLELING OF GENERATORS. Generator paralleling potentiometers are eliminated from this system so the full differential voltage of the generator series fields is sensed by the equalizer circuit.

1–181. Without potentiometers, paralleling is directly affected by the uniformity of the generator series field resistance and generators of different series field resistances should not be operated in parallel.

1–182. There is no adjustment for equalizing the loads between the generators. The voltage potentiometer on the regulators is retained, but must only be used to obtain the correct initial voltage setting, using precision test equipment. The variation in series field resistance for any one type of generator used on Super Constellation airplanes is within plus or minus 5 percent which results in fewer discrepancies in paralleling than the uncontrolled factors in the previous system of equalizer adjustment. The use of generators of different types is not approved. Although a maximum spread of 20 amperes from the average is specified in the "Generator System Checkout" procedure, it should be understood that a much higher spread is allowable under many operating conditions.

1–183. The allowable spread of plus or minus 20 amperes from the average of shared currents is an initial setting, made at equal temperatures, and allows for greater divergence with temperature differences or wear. The requirement for load sharing between generators is that no generator carry an overload during any operating extreme of total load. Therefore, a spread of generator currents up to about 100 amperes between high and low connected generators is not cause for readjustment under normal load demands. This allowance need be decreased only if normal, plus emergency, total load is increased, approaching closer to the time-load ratings of the generator.

1–184. CIRCUIT BREAKERS. The branch circuits of the electrical system are protected against sustained overloads by thermal type automatic circuit breakers. The four types of circuit breakers that are used in this airplane are manual-push to reset, remote controlled, switch type, and push-pull. When the manual push-type circuit breakers have been tripped (circuit opened) they may be reset after the overload is removed by pushing the button until it clicks. The remote controlled breakers are located near the unit or line they protect and are reset by a remote switch convenient to the pilots or flight engineer. The switch type circuit breakers may be used to open the circuit by reversing the position of the toggle. However, push-pull breakers are not designed for use as switches and should be left in the closed position except for emergency conditions or occasional maintenance checks. Circuit breakers of the trip free type cannot be held closed if overload conditions exist. Breakers of the non trip free type can be held closed, regardless of the amount of overload, if necessary.

1–185. D.C. POWER SYSTEM UNITS. (Figure 1-25.)

Unit	Location	Remarks
GENERATORS (4)	Accessory pad of each engine (3.11 to 1 drive)	Ground Rating—150 amp. maximum continuous. Flight Rating — 300 amp. continuous.
VOLTAGE REGULATORS (4)	Beneath floor aft of pilots.	Set to 27.5 volts on initial flight using precision equipment. Additional flight adjustment should not be required.
BATTERIES (2) (24-volt in parallel)	Nose wheel well, forward end.	14 amp. total for 5 hours at 27°C (80°F) battery temp. 25 amp. total for 2 hours at 27°C (80°F) battery temp. Ratings reduced to approximately 60% of above at −18°C (0°F) battery temp.
BATTERY RELAY (1)	Nose wheel well, forward end.	Connects batteries to the MJB positive bus and crew door positive bus. Battery switch grounds relay coil. Voltmeter connects through a fuse in the relay case. NOTE: With battery switch OFF, battery power will be supplied to emergency bus if main bus is dead.
CART RECEPTACLE (1)	Right side of nose wheel well.	Three-prong receptacle for ground power source. Short prong provides power for white light on receptacle case, actuates cart relay when battery switch is in CART BATTERY position, and lights green light to the left of switch when external power is available.
CART RELAY (1)	Right side lower fuselage forward of nose wheel well.	Actuated by short prong when switch is in CART BATTERY position. Rectifier on cart relay lead prevents connecting reversed polarity cart to ship's bus.
FAULT PROTECTION RELAY (main contactor)	Main power relay panel. Lower forward baggage compartment.	Connects generator to main bus. Energized by differential voltage and reverse current relay contact. Pick-up voltage is 16 volt max. and dropout voltage is 3.5 volt. max.
Diff. and Reverse Current Relay—Polarized	Part of fault protection relay assembly.	Relay is closed when differential voltage between generator feeder and bus is .25 to .35 volts. Opens when generator draws reverse current of 30 amperes or more.

Unit	Location	Remarks
Potential Relay — Polarized	Part of fault protection relay assembly.	When potential from 10 amp. generator field circuit breaker reaches 20–24 volts it connects coil of diff. and rev. current relay between main bus and generator.
Fault Sensing Relay	Part of fault protection relay assembly.	Utilizes voltage drop across the generator series field as a measure of current in the series field and compares it to the current supplied to the bus. Relay contacts close with fault above 70 amp. at 185°C generator temperature. At lower temperature a larger fault is required to tip relay.
AUXILIARY CONTACTOR	Main power relay panel. Lower forward baggage compartment.	Connects generator to main bus. Energized by differential voltage and reverse current relay contact. Coil in parallel with coil of main contactor. Contacts in series with contacts of main contactor.
FORWARD CURRENT RELAY	To left of main relay panel in lower forward baggage compartment.	Closes and trips field relay only if fault sensing relay closes and current in generator series field is in normal direction. If tripped, must be mechanically reset.
OVERVOLTAGE CONTROL RELAY PANEL	Between right keelsons forward of co-pilot's seat.	See text and items below. Overvoltage protection is provided for each generator.
Overvoltage Relay	Part of overvoltage control relay panel.	Sealed, normally open, sensitive shock-mounted. Coil resistance 1000 ohms connected in series with 750 ohm fixed resistor and 500 ohm adjustable resistor. Calibrated to trip at 30 +.6 —.4-volt across coil circuit including resistors and capacitors.
Equalizer Relay	Part of overvoltage control relay panel.	Some equalizer action is necessary to bring generator on bus. Relay coil resistance is 235 ohms and contacts close on 18 volts max. Serves to avoid severe equalizer action from causing excessive drops in bus voltage when generator switch is closed but generators are not, for some reason, connected to bus.
Field Latching Relay (Mechanically latched)	Part of overvoltage control relay panel.	Two mechanically latching relays with mechanical interlock between their armatures. Trip on about 4 volts. One relay trips when forward current relay is tripped or through the action of overvoltage relay or reverse generator polarity. Other relay resets combination when actuated by the momentary contact on generator switch. If overvoltage or reverse polarity causes have been removed, the circuit will be restored to normal. Tripping of the field relay opens coil

Unit	Location	Remarks
		circuits of main and auxiliary contactors, the overvoltage relay, the potential relay, and the equalizer relay, as well as isolating the voltage regulator to open the generator shunt field circuit.
Selector Relay (Polarized)	Part of overvoltage control relay panel.	Connected in series with the voltage regulator equalizer coil. Closed when the generator is in a low voltage condition as compared to other operating generators. Open at all other times to allow operation of the overvoltage relay. This allows only the generator producing overvoltage to trip off.
Reset Lockout Relay	Part of overvoltage control relay panel.	Prevents reset circuit from cycling while reset switch is held closed.
AMMETER SHUNT	Main power relay panel.	Calibrated for 300 ampere full scale reading of ammeter.
ARMATURE SHORTING RELAY	Each nacelle junction box.	Magnetic latching type. Tripped or reset by energy from essential bus through contacts or latched field relay. When field relay trips, it causes armature shorting relay to trip. This action shunts generator armature through total circuit resistance of about 0.02 ohm to reduce generator terminal voltage to zero, after first isolating from each other the lead to the negative armature terminal D, and leads to equalizer and fault sensing circuits. This isolation is required to avoid undesirable effects of transients in these circuits.

1–186. D.C. POWER SYSTEM CONTROLS.

1–187. GENERATOR SWITCHES. Each generator is controlled by a four-pole, double-throw type switch (12, fig. 1-26), located on the upper MJB panel. The three positions provided are ON, OFF, and GENERATOR SWITCHES DOWN TO RESET FIELD RELAYS. When a generator switch is placed ON, power from the generator field circuit-breaker passing through a contact on the reverse current relay, will energize and close the main and auxiliary contactors to connect the generator to the bus. The GENERATOR SWITCHES DOWN TO RESET FIELD RELAY position is a momentary contact position, which will reset the field relay if it has been tripped by overvoltage or by reversed generator polarity, or has been inadvertently left in the tripped position. If the relay has been tripped by a feeder fault, it cannot be reset until the fault sensing relay has been reset. This cannot be done until the fault has been located and cleared. In the OFF position the generator is disconnected from the bus, but the field is not de-energized.

1–188. GENERATOR FIELD CIRCUIT BREAKERS. Each generator is provided with a switch type circuit breaker for emergency use only. These circuit breakers (15, fig. 1-26) are located on the upper MJB panel, and are guarded in the ON position. These circuit breakers should be placed in the OFF position only when necessary to de-energize the generators completely, as in an emergency landing, or in the event of the malfunction of the protection system. They should not be used as generator switches and should be opened or closed only with the associated generator switch in the OFF position.

1–189. BATTERY SWITCH. A three-position switch is located on the upper MJB panel, just forward of

UNDER DESK CIRCUIT BREAKER PANEL

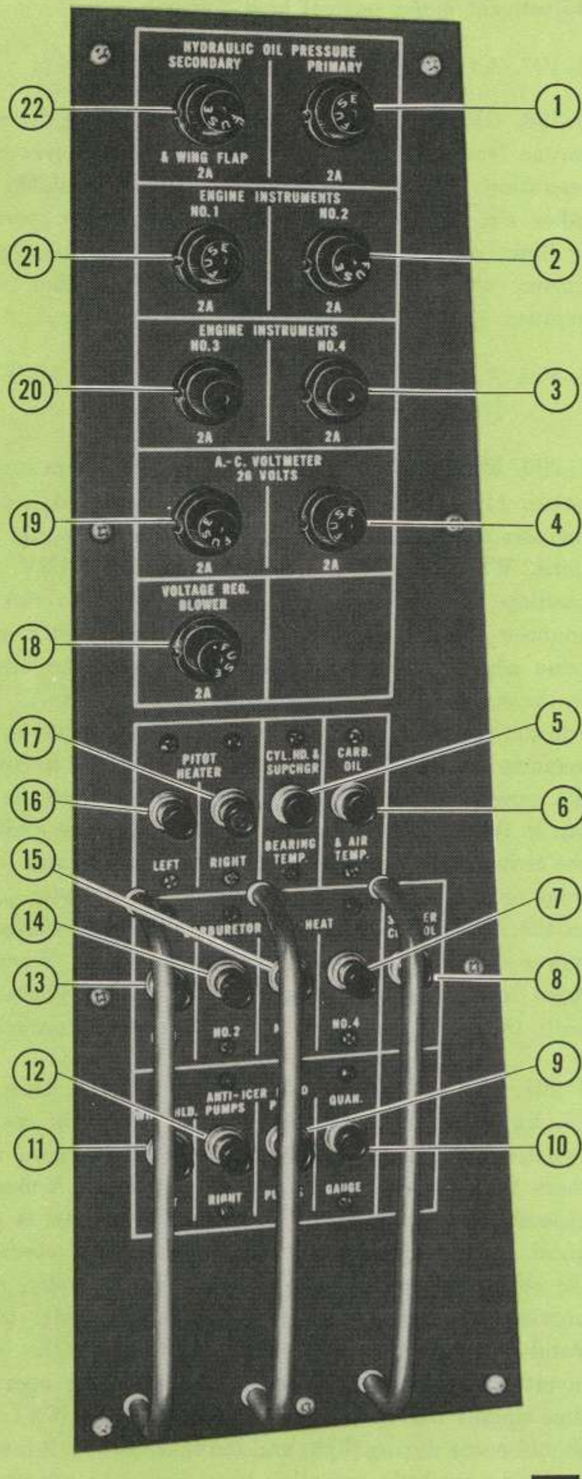


figure 1·32

1. Hyraulic System (Primary) Pressure Gages Fuse
2. No. 2 Engine Instruments Fuse
3. No. 4 Engine Instruments Fuse
4. A.C. Voltmeter Fuse
5. Cylinder Head and Supercharger Bearing Temperature Gages Circuit Breaker
6. Carburetor Air, Oil, and Free Air Temperature Gages Circuit Breaker
7. No. 4 Engine Carburetor Pre-Heat Circuit Breaker
8. Starter Control Circuit Breaker
9. Propeller Anti-Icer Fluid Pump Circuit Breaker
10. Anti-Icer Fluid Quantity Gage Circuit Breaker
11. Windshield (Left) Anti-Icer Fluid Pump Circuit Breaker
12. Windshield (Right) Anti-Icer Fluid Pump Circuit Breaker
13. No. 1 Engine Carburetor Pre-Heat Circuit Breaker
14. No. 2 Engine Carburetor Pre-Heat Circuit Breaker
15. No. 3 Engine Carburetor Pre-Heat Circuit Breaker
16. Pitot Heater (Left) Circuit Breaker
17. Pitot Heater (Right) Circuit Breaker
18. Voltage Regulator Blower Fuse
19. A. C. Voltmeter Fuse
20. No. 3 Engine Instruments Fuse
21. No. 1 Engine Instruments Fuse
22. Hydraulic System (Secondary) Pressure Gages Fuse

the generator switches (11, fig. 1-26) and controls the selection of either the batteries or the external d.c. supply as shown on figure 1-27. In the SHIP BATTERY (up) position, the coil of the battery relay is grounded by the switch and connects the battery to the d.c. main bus. In the CART BATTERY (down) position, the battery switch grounds the coil of the cart relay which is connected to the short prong of the cart plug receptacle, and closes the cart relay, provided cart polarity is correct, thus connecting cart power to the ship's bus.

1–190. D.C. POWER SYSTEM INDICATORS.

1–191. GENERATOR FIELD RELAYS TRIPPED WARNING LIGHTS. Beneath each of the four generator switches, located on the upper MJB panel, is a red warning light (13, fig. 1-26) which is set to glow when a generator field relay has been tripped. The light goes out when the field relay is reset by moving the generator switch from the ON (up) to the RESET (down) position, provided the cause of overvoltage or reversed polarity has been corrected.

1–192. GENERATOR OVERHEAT WARNING LIGHT. Beneath each generator switch and field relay warning light is a red generator overheat warning light (14, fig. 1-26). The overheating 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, 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.

1–193. D.C. VOLTMETER. A d.c. voltmeter (2, fig. 1-26), calibrated from 0 to 30 volts, is provided to indicate the generators, batteries, and bus voltages.

1–194. D.C. VOLTMETER SELECTOR SWITCH. An eight-position switch (4, fig. 1-26) provides selection of generators 1, 2, 3, 4, BAT, two bus positions, and OFF. Due to the parallel operation of the generators and batteries to a common bus, they must be disconnected from all other power sources to indicate the voltage of any one generator or battery.

1–195. GROUND POWER INDICATOR LIGHT. This green light is provided on the upper MJB panel (10, fig. 1-26) forward of the battery switch and indicates when ground power is connected to the airplane even though the battery switch may be OFF.

1–196. D.C. AMMETERS. Two dual type ammeters reading from 0 to 300 amperes (7, 8, fig. 1-26) are installed near the top of the upper MJB panel. The ammeters indicate the direct load on each generator. A spread of generator currents up to approximately 100 ampere, between high and low connected generators, is not cause for readjustment under normal load demands.

1–197. A.C. POWER SYSTEM.

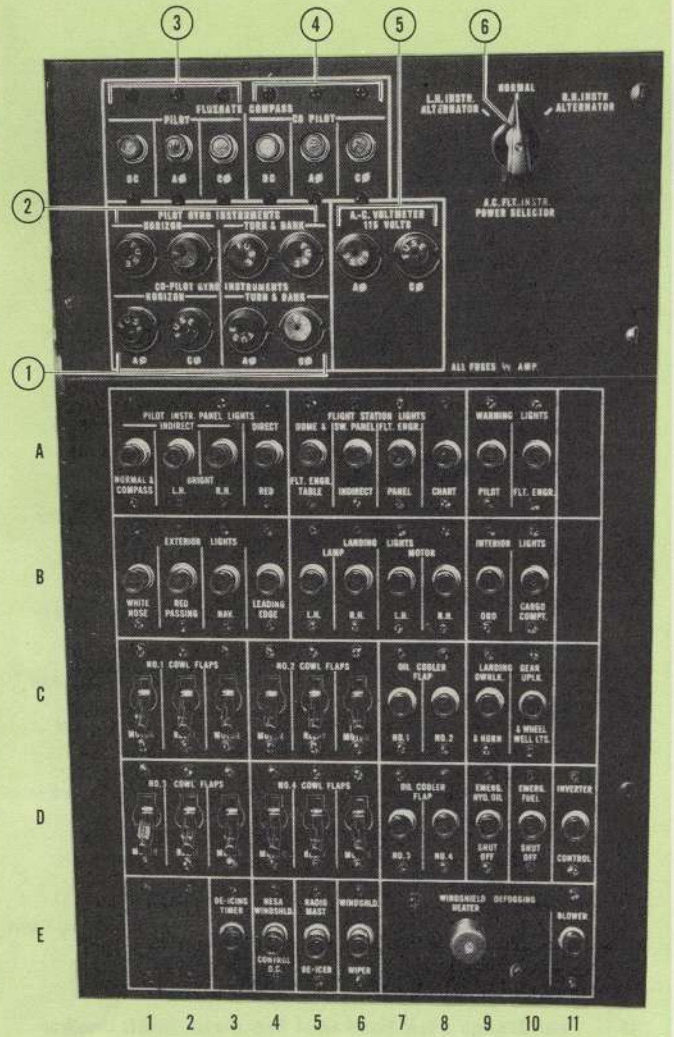
1–198. GENERAL. Three inverters, which are driven by power from the main d.c. bus, supply a.c. power for operation of radio, instruments, Nesa windshield and other a.c. equipment. Power for emergency operation of flight instruments is obtained from two variable frequency alternators mounted on the No. 1 and No. 4 engines.

1–199. A.C. POWER SYSTEM CONTROLS AND INDICATORS.

1–200. MAIN INVERTER SWITCH. The main inverter switch (1, fig. 1-26), mounted on the upper MJB panel, includes the No. 1 inverter, OFF, and No. 2 inverter positions. When the switch is placed in the No. 1 INV. (up) position, it actuates the control relay in the inverter that connects d.c. power to the No. 1 inverter motor and a relay which connects a.c. power output of the inverter to the a.c. bus. When the switch is in the No. 2 INV. (down) position, it de-energizes the No. 1 inverter and actuates the control relays in the No. 2 inverter to connect d.c. power to that inverter motor, and connects its output to the a.c. bus. Also, in the No. 2 inverter position, the switch shorts out the coil of the Nesa inverter power relay, preventing application of No. 2 inverter power to the Nesa windshield system, if the Nesa windshield power switch is in the No. 2 INV. position. When the main inverter switch is in the OFF (center) position, both inverters and their motors are disconnected.

1–201. INVERTER OUT WARNING LIGHT. This light (9, fig. 1-26) is located just aft of the main inverter switch on the upper MJB panel. The light is on when there is no power on the a.c. bus or if the voltage is excessively low, provided that the d.c. system is energized. If the light comes on during normal operation, the other inverter must be switched on manually, as no provision is incorporated for automatic transfer to the stand-by inverter. It is good practice to use the No. 1 inverter continuously rather than divide the operating time equally between the two inverters. Then, if a failure should occur during flight and the spare or No. 2 inverter has had very little operating time, it can be expected to function satisfactorily.

1–202. NESA POWER SELECTOR SWITCH. The Nesa power selector switch (27, fig. 1-26) is located on the upper MJB panel. This is a three-position switch, ALT.



1. Fuses for copilot's gyro instruments
2. Fuses for pilot's gyro instruments
3. Outboard flux gate compass circuit breakers
4. Inboard flux gate compass circuit breakers
5. A.C. voltmeter fuses
6. A.C. flight instruments power selector switch

A-1. Pilots' instrument panel normal (dim) indirect lights and compass light circuit breaker
A-2. Pilots' instrument panel left hand bright indirect light circuit breaker
A-3. Pilots' instrument panel right hand bright indirect light circuit breaker
A-4. Pilots' instrument panel direct red light circuit breaker
A-5. Flight station dome light and flight engineer's table light circuit breaker
A-6. Pilot's side panel indirect light circuit breaker
A-7. Flight engineer's instrument panel light circuit breaker
A-8. Chart light circuit breaker
A-9. Pilot's warning lights circuit breaker
  Circuits protected:
    Pilot's hydraulic pressure warning light
    De-icer pumps warning lights
    Master fire warning light and bell test
A-10. Flight engineer's warning lights circuit breaker
  Circuits protected:
    Flight engineer's hydraulic pressure warning light
    De-icer pumps warning lights
    Fuel pressure warning lights
    Oil pressure warning lights
    Master fire warning light and bell test
    Ground power ON indicator light
B-1. White nose light circuit breaker
B-2. Red passing light warning light circuit breaker
B-3. Navigation lights circuit breaker
B-4. Leading edge (wing) inspection lights circuit breaker
B-5. Left hand landing light lamp circuit breaker
B-6. Right hand landing light lamp circuit breaker
B-7. Left hand landing light actuating motor circuit breaker
B-8. Right hand landing light actuating motor circuit breaker
B-9. Ordinance lights circuit breaker
B-10. Cargo compartment lights circuit breaker
C-1. No. 1 engine left hand cowl flap motor circuit breaker switch
C-2. No. 1 engine cowl flap relay circuit breaker switch
C-3. No. 1 engine right hand cowl flap motor circuit breaker switch
C-4. No. 2 engine left hand cowl flap motor circuit breaker switch
C-5. No. 2 engine cowl flap relay circuit breaker switch
C-6. No. 2 engine right hand cowl flap motor circuit breaker switch
C-7. No. 1 engine oil cooler flap actuating motor circuit breaker
C-8. No. 2 engine oil cooler flap actuating motor circuit breaker
C-9. Landing gear DOWN lock indicator lights and horn circuit breaker
C-10. Landing gear UP indicator lights and wheel well lights circuit breaker
D-1. No. 3 engine left hand cowl flap motor circuit breaker switch
D-2. No. 3 engine cowl flap relay circuit breaker switch
D-3. No. 3 engine right hand cowl flap motor circuit breaker switch
D-4. No. 4 engine left hand cowl flap motor circuit breaker switch
D-5. No. 4 engine cowl flap relay circuit breaker switch
D-6. No. 4 engine right hand cowl flap motor circuit breaker switch
D-7. No. 3 engine oil cooler flap actuating motor circuit breaker
D-8. No. 4 engine oil cooler flap actuating motor circuit breaker
D-9. Emergency hydraulic oil shut-off valve circuit breaker (hydraulic suction shut-off valve switches)
D-10. Emergency fuel shut-off valve circuit breaker (motor-driven shut-off valves)
D-11. Inverter control (main inverter switch and Nesa power selector switch) circuit breaker
E-3. De-icing timer (electronic de-icer timer) circuit breaker
E-4. Nesa windshield control circuit breaker (D.C.)
E-5. Radio mast de-icer boot circuit breaker
E-6. Windshield wiper circuit breaker
E-7-10. Windshield heater circuit breaker
E-11. Windshield heater blower circuit breaker

figure 1-33 **LOWER MAIN JUNCTION BOX CIRCUIT BREAKER PANEL***

LOWER MAIN JUNCTION BOX CIRCUIT BREAKER PANEL†

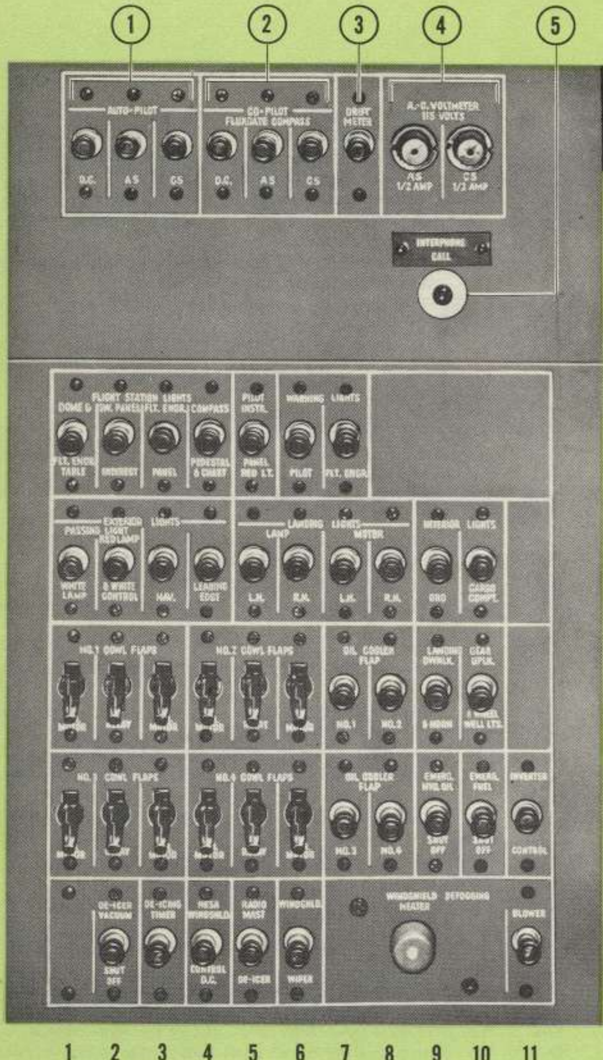


figure 1-33A

1. Automatic pilot flux gate circuit breakers
2. Copilot's flux gate circuit breakers
3. Drift meter circuit breaker
4. A.C. voltmeter fuses
5. Interphone call button

A-1. Flight station dome light and flight engineer's table light circuit breaker
A-2. Pilots' side panels indirect light circuit breaker
A-3. Flight engineer's instrument panel lights circuit breaker
A-4. Compass light, pedestal rear light and chart light circuit breaker
A-5. Pilots' instrument panel red lights circuit breaker
A-6. Pilots' warning lights circuit breaker
Circuits protected:
Pilots' master fire warning light
De-icer pumps warning lights
Hydraulic pump pressure warning lights
A-7. Flight engineer's warning lights circuit breaker
Circuits protected:
Flight engineer's master fire warning light
De-icer pumps warning lights
Hydraulic pump pressure warning lights
Fuel low pressure warning lights
Oil pressure warning lights
Ground power ON indicator light

B-1. Passing light white lamp circuit breaker
B-2. Passing light red lamp and white control circuit breaker
B-3. Navigation lights circuit breaker
B-4. Leading edge inspection lights circuit breaker
B-5. Left hand landing light lamp circuit breaker
B-6. Right hand landing light lamp circuit breaker
B-7. Left hand landing light actuating motor circuit breaker
B-8. Right hand landing light actuating motor circuit breaker
B-9. Ordinance lights circuit breaker
B-10. Cargo compartment lights circuit breaker

C-1. No. 1. engine left hand cowl flap motor circuit breaker switch
C-2. No. 1. engine cowl flap relay circuit breaker switch
C-3. No. 1. engine right hand cowl flap motor circuit breaker switch
C-4. No. 2 engine left hand cowl flap motor circuit breaker switch
C-5. No. 2. engine cowl flap relay circuit breaker switch
C-6. No. 2. engine right hand cowl flap motor circuit breaker switch
C-7. No. 1. engine oil cooler flap actuating motor circuit breaker
C-8. No. 2. engine oil cooler flap actuating motor circuit breaker
C-9. Landing gear downlock indicator lights and warning horn circuit breaker
C-10. Landing gear uplock indicator lights and wheel well lights circuit breaker

D-1. No. 3. engine left hand cowl flap motor circuit breaker switch
D-2. No. 3. engine cowl flap relay circuit breaker switch
D-3. No. 3. engine right hand cowl flap motor circuit breaker switch
D-4. No. 4. engine left hand cowl flap motor circuit breaker switch
D-5. No. 4. engine cowl flap relay circuit breaker switch
D-6. No. 4. engine right hand cowl flap motor circuit breaker switch
D-7. No. 3. engine oil cooler flap actuating motor circuit breaker
D-8. No. 4. engine oil cooler flap actuating motor circuit breaker
D-9. Emergency hydraulic oil shut-off valve circuit breaker (hydraulic suction shut-off valve switches)
D-10. Emergency fuel shut-off valve circuit breaker (motor-driven fuel shut-off valves)
D-11. Inverter control (main inverter switch and Nesa power selector switch) circuit breaker

E-2. De-icer vacuum shut-off valve (de-icer vacuum selector valve) circuit breaker
E-3. De-icing timer (electronic de-icer timer) circuit breaker
E-4. Nesa windshield control (d.c.) circuit breaker
E-5. Radio mast de-icer circuit breaker
E-6. Windshield wipers circuit breaker
E-7-10. Windshield defogging heater circuit breaker
E-11. Windshield defogging blower circuit breaker

†LAC Serials 4015–4024

HYDRAULIC SYSTEM

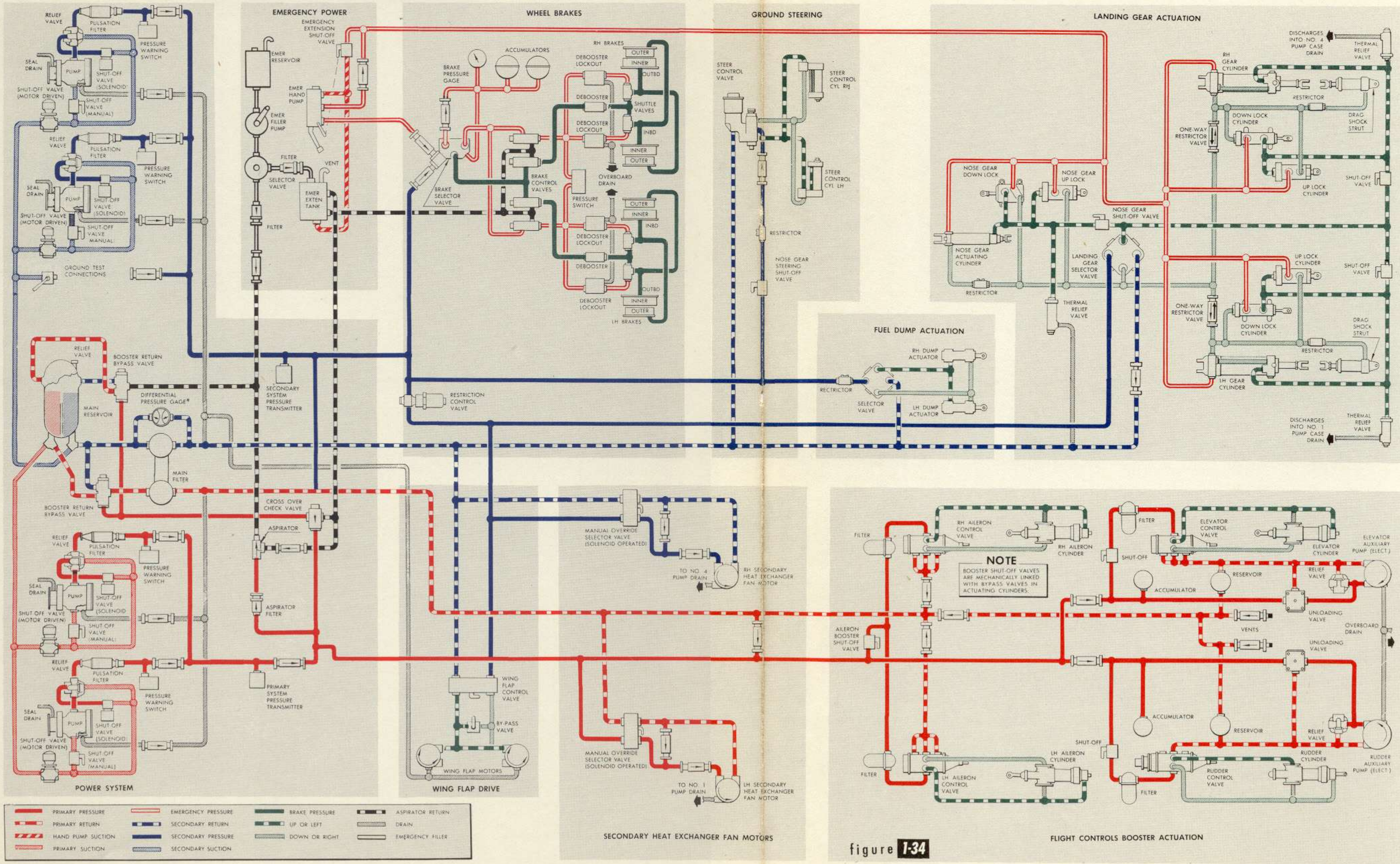


figure 1-34

*LAC Serials 4001–4014

(up), OFF (center), and No. 2 INVERTER (down) positions. In the up position the Nesa inverter power relay is energized furnishing d.c. power to the Nesa inverter. In position NO. 2 INV. the Nesa inverter is OFF and power is supplied by the No. 2 inverter, but only when the main inverter switch is not also in the NO. 2 INV. position.

1–203. NO. 2 INVERTER ON NESA INDICATOR LIGHT. An amber indicator light (20, fig. 1-26), located adjacent to the Nesa power switch, glows when the switch is in the No. 2 INVERTER position.

1–204. A.C. VOLTMETER AND SELECTOR SWITCH. An a.c. voltmeter reading from 0 to 150 volts (6, fig. 1-26) is located at the top of the upper MJB panel. A selector switch (3, fig. 1-26) is provided to select any phase of the three-phase, 115-volt a.c. bus, the Nesa power supply, or the output voltage from the left and right 26-volt, single-phase engine instrument alternators. The selector switch also has an OFF position.

1–205. A.C. FLIGHT INSTRUMENTS POWER SELECTOR SWITCH*. A three-position switch (6, fig. 1-33) is located on the lower MJB panel to select the power source for the electrically-driven gyro horizons and turn and bank indicators. The L.H. INSTR. ALTERNATOR (forward) position connects the pilot's and copilot's gyro horizons and the turn and bank indicators to the left-hand (No. 1 engine) alternator. The NORMAL (center) position connects the gyro horizons and turn and bank indicators to the 115-volt, 400-cycle, three-phase power from the main a.c. bus. In the R.H. INSTR. ALTERNATOR (aft) position, the above instruments are connected to the right-hand (No. 4 engine) alternator.

1–205A. GYRO HORIZON POWER SELECTOR SWITCHES.† Two double-pole, double-throw switches (42 and 22, fig. 1-9A) are provided to select the power source for the gyro horizons. One is located on the pilot's instrument panel, the other on the copilot's auxiliary panel. When either switch is in the INVERTER position (left) the gyro horizon on that side is connected to the inverter through transformers. In the ALTERNATOR (right) position, the gyro horizons are connected to the engine driven alternator on their respective sides. The pilot's gyro horizon, in the ALTERNATOR position, receives power from the alternator mounted on the No. 1 engine while the copilot's gyro horizon is connected to the alternator on the No. 4 engine when the switch is in the ALTERNATOR position. The switches are independent of each other and either pilot can switch to either source at any time.

1–205B. POWER FAILURE INDICATORS.† A power failure indicator (21, fig. 1-9A) is mounted on each pilot's instrument panel to monitor the power supplied to each gyro horizon. The indicator provides a warning of low system voltage or failure of a.c. power from inverters or alternators. The indicator consists of a small induction torque motor which is restrained by a calibrated torque spring and limited to 180° travel. A cup-shaped card is attached to the forward end of the rotor shaft. One half of this card is black and the other half is fluorescent. A glass cover fits over the indicator housing and encloses the moving card. Under normal operating conditions, the face of the failure indicator appears completely black, and in case of power failure the fluorescent half of the card appears and gives warning of faulty power supplied to its respective gyro horizon.

1–206. ELECTRICAL LOAD TABLES. The electrical load table (Figs. 1-30 & 1-30A) show the approximate d.c. design loads of the various units of the electrical system.

1–207. HYDRAULIC POWER SYSTEMS. (See Fig. 1-34.)

1–208. GENERAL. Four engine-driven variable displacement hydraulic pumps, one on each engine, provide operating power at pressures up to 1700 psi for the various hydraulic units and system. No system accumulators are necessary in this installation as the normal accumulator function is performed by the variable displacement pumps and pulsations are minimized by pulsation filters. However, accumulators are used in the brake and booster systems. The hydraulic power is divided into a primary and a secondary hydraulic system. Both systems obtain fluid from the main hydraulic reservoir, which is divided into two compartments up to about ⅔ the height and is pressurized to approximately 30 psi by means of an aspirator. The primary and secondary hydraulic 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 failure of the primary system. A hand pump system, with its own reservoir, is provided for braking and emergency extension of the landing gear. An emergency filler reservoir supplies fluid to replenish the main reservoir or emergency extension reservoir in flight by means of a wobble pump and selector valve. The emergency filler reservoirs will not be installed in LAC Serials 4015 through 4024 when the airplanes are delivered.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

EMERGENCY EXTENSION RESERVOIR

figure 1-35

1–209. PRIMARY HYDRAULIC SYSTEM. The primary hydraulic system supplies pressure for operation of the surface control boosters, the aspirator (which scavenges the crossover check valve and the emergency extension reservoir to the MAX. FLUID LEVEL) and the left wing secondary heat exchanger fan motor. The hydraulic pumps on left-hand engines, No. 1 and 2, furnish the volume and pressure required for the primary system. Pressure warning switches are installed in each pump pressure line to operate warning lights on the flight engineer's middle instrument panel. A line from the primary system manifold directs pressure through the aspirator filter and aspirator, and another line directs pressure to the left wing secondary heat exchanger fan motor. The primary system pressure transmitter is connected into the primary manifold and furnishes pressure indications to hydraulic pressure indicators, located at the flight engineer's and co-pilot's stations. Another line directs primary pressure to the surface control boosters. A connecting line, between the primary system return line from the surface control boosters and the pressure line to the boosters, allows replenishment of displaced fluid in the pressure line when the surface controls are moved without hydraulic pressure on the airplane. A check valve in this connecting line prevents pressure flow into the return line.

1–210. The primary pressure manifold is connected to the cross-over check valve. Internal passages through this valve allow primary pressure to enter a balancing or positioning line to the booster return bypass valves. This action positions the return bypass valves so that during normal operation, fluid from the aspirator and booster systems will be returned to the primary side of the main hydraulic reservoir. The primary return lines from all primary units manifold into a common return line through the main filter and the booster return bypass valve to the primary return port of the main hydraulic reservoir.

1–211. SECONDARY HYDRAULIC SYSTEM. The secondary hydraulic system supplies pressure for the operation of landing gear, brakes, nose gear steering, wing flaps, outer wing fuel dump valves, and the right wing secondary heat exchanger fan motor. Power for the secondary system is furnished by the hydraulic pumps, mounted on right hand engines No. 3 and 4. Pressure warning switches are installed in each pump pressure line to operate warning lights at the flight engineer's station. A pressure transmitter is "teed" into the common pressure line from both pumps to furnish secondary system pressure indications on the flight engineer's and co-pilot's indicators. A line joins the secondary pressure line to the cross-over check valve, and enables the secondary system pressure to assist or replace the primary system, if necessary. Secondary pressure lines direct fluid to the brakes, nose gear steering mechanism and outer wing fuel dump valve actuators. The pressure take-off for these items is located upstream of the restriction control valve, which acts as a fluid volume control during cross-over operation. It limits the secondary hydraulic systems (brakes, nose gear steering, and outer wing fuel dump systems excepted) to 1½ gallons per minute, when the pressure in the secondary system is 1150 psi or less. With the pressure in the secondary system 1300 psi or more, the valve will open sufficiently to pass the amount of fluid required. A dual type pressure gage* indicates differential pressure on either side of the secondary system main filter in the return line. This gage* determines

*LAC Serials 4001–4014

EMERGENCY FILLER RESERVOIR & TRANSFER SYSTEM

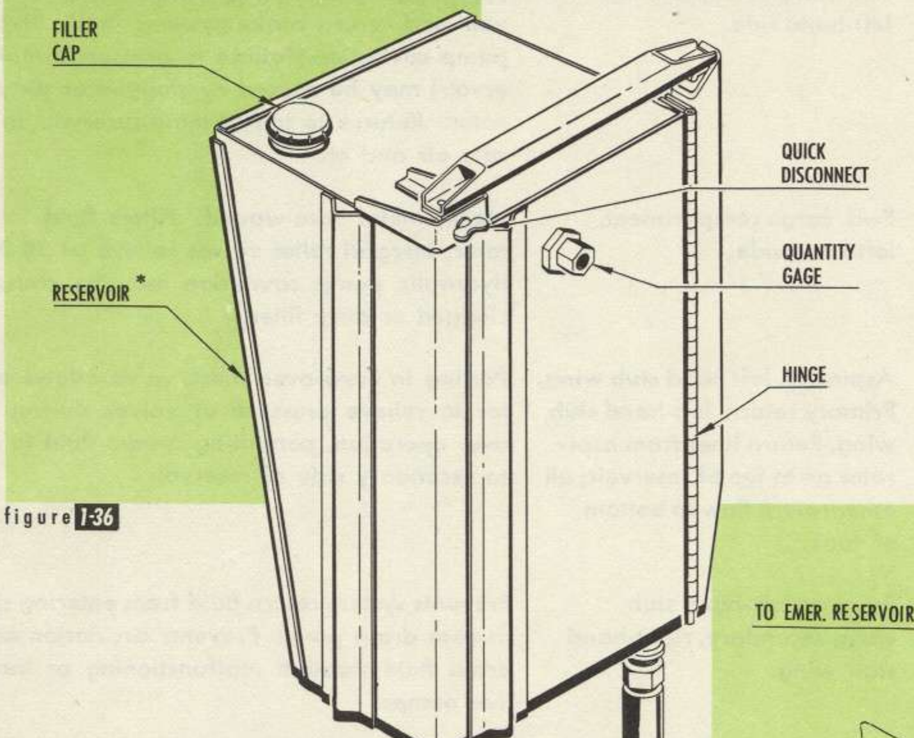
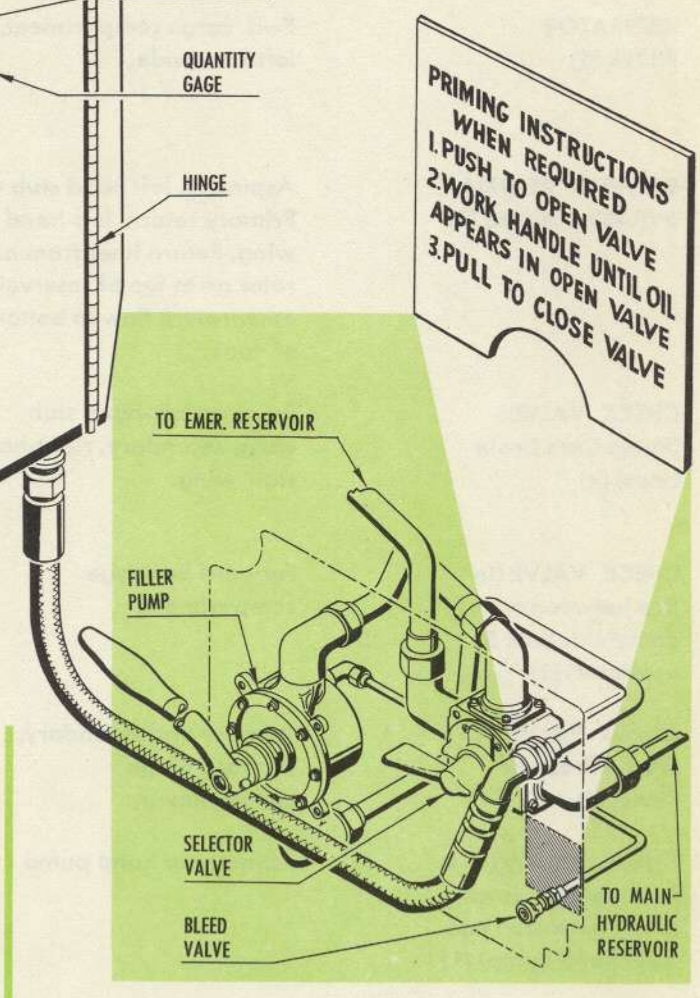


figure 1-36



when it is necessary to change filters due to contamination and also provides a means of reading aspirator pressure for the main system reservoir.

1–212. CROSS-OVER SYSTEM. If the pressure in the primary system becomes 300 to 400 psi less than that in the secondary system, the cross-over check valve will open. This allows the secondary system to assist the primary system, or in case of primary system failure, supplies the primary system. The checking feature prevents primary pressure from entering the secondary system. During cross-over operation, the booster return bypass valves direct return fluid from the aspirator and surface control booster systems to the secondary side of the main hydraulic reservoir. The balance-line pressure (primary system), which normally positions the booster return bypass valves, is now connected through the cross-over check valve to aspirator suction. This loss of pressure permits spring tension in the individual booster return bypass valves to position the poppets, so that return fluid through them is now directed to the secondary side of the main hydraulic reservoir. The action of these valves, during cross-over operation, results in return fluid from all hydraulic systems and units being directed to the secondary side of the main hydraulic reservoir.

1–213. HYDRAULIC PUMP BYPASS SYSTEM. The vent outlet of each relief valve is connected to each pump suction line and a solenoid operated shut-off valve is installed in each line. When the main motor-driven hydraulic shut-off valve, in any suction line to the hydraulic reservoir, is CLOSED (off) a relay energizes the solenoid shut-off valve (normally closed) in the bypass line, opening it and allowing the fluid in the pump pressure line to travel through the relief valve vent line into the pump suction line, and back to the pump.

*LAC Serials 4001–4014

1–214. HYDRAULIC SYSTEM UNITS.

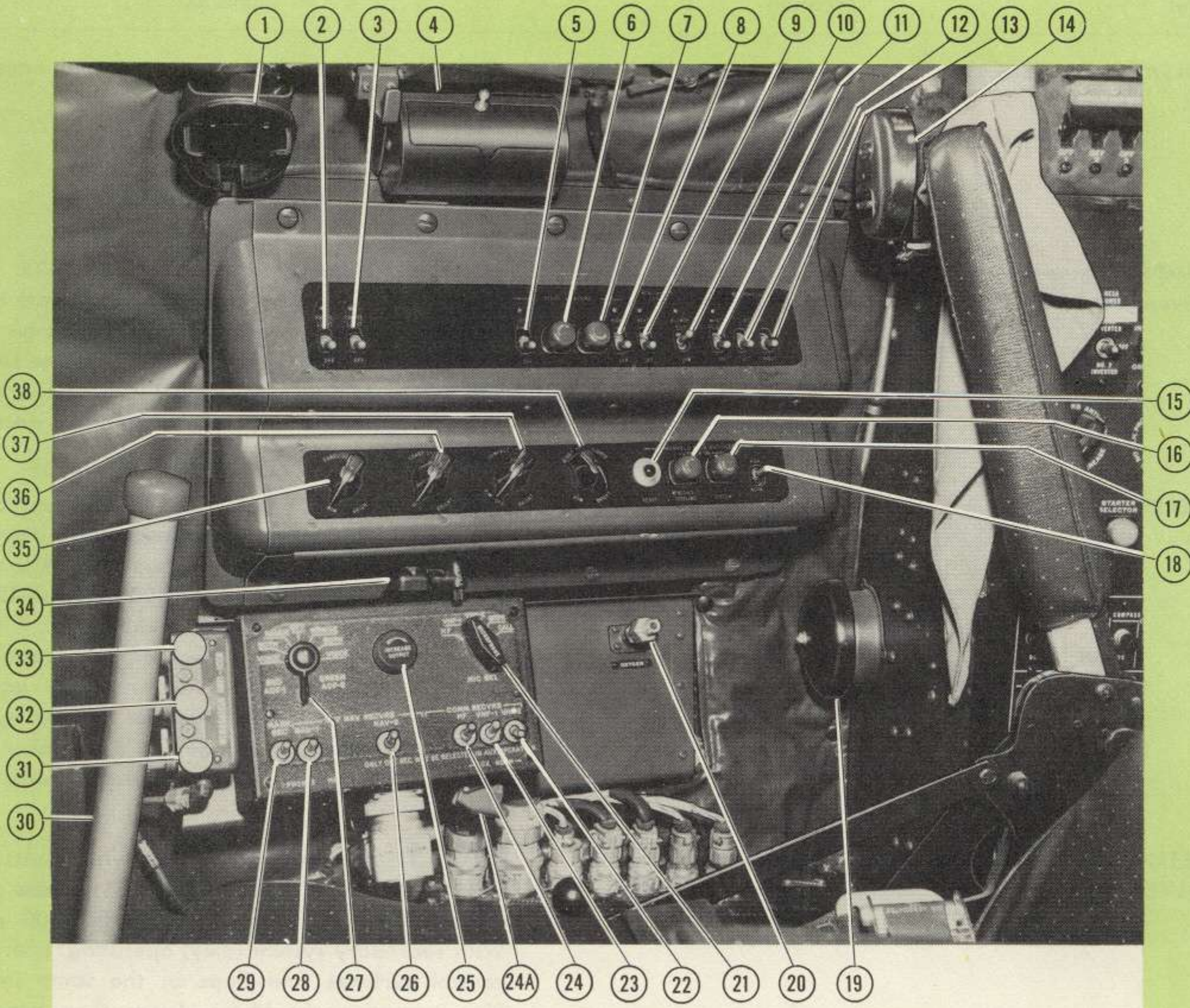
Unit	Location	Remarks
ASPIRATOR (1)	Fwd. cargo compartment left-hand side.	1/32-inch jet pressurizing medium for main reservoir and return brake systems fluid. Hydraulic pump cavitation (failure to pressurize main reservoir) may be caused by clogged or dirty aspirator. Returns to top of main reservoir to separate air and oil.
ASPIRATOR FILTER (1)	Fwd. cargo compartment, left-hand side.	Monel metal wire-wound. Filters fluid for aspirator. Integral relief valves relieve at 28-30 psi. Hydraulic pump cavitation may be caused by clogged or dirty filter.
BOOSTER RETURN BYPASS VALVES (2)	Aspirator, left hand stub wing, Primary return, left-hand stub wing. Return lines from aspirator go to top of reservoir; all other return flow to bottom of tank.	Porting in cross-over check valve allows aspirator to relieve pressure at valves during cross-over operation, permitting system fluid to return to secondary side of reservoir.
CHECK VALVES (Pump Case Drain Lines) (4)	Primary, left-hand stub wing; secondary, right-hand stub wing.	Prevents system return fluid from entering pumps at case drain ports. Prevents circulation of case drain fluid through malfunctioning or inoperative pumps.
CHECK VALVE (In line between emergency ext. tank & aspirator) (1)	Forward baggage compartment.	Prevents fluid from return system or pressure system entering emergency extension tank in event of malfunctioning aspirator.
CHECK VALVES (Pump Pressure Lines) (4)	Primary and secondary, forward cargo compartment.	Prevent circulation of fluid through malfunctioning or inoperative pumps.
CHECK VALVE (In landing gear emergency extension line from hand pump) (1)	Adjacent to hand pump.	Prevents return fluid from emergency extension system entering hand pump.
CHECK VALVE (between primary pressure & primary return manifolds) (1)	Fwd. cargo compartment adjacent to primary relief valve.	Allows fluid from return side of boost system to replenish displaced fluid in pressure side of boost system, when controls are moved without pressure being applied from engine pumps or test gig. Reversed or malfunctioning valve can result in failure of primary and secondary systems (through cross-over operation) to build up hydraulic pressure.
CHECK VALVE (In line between emergency filler selector valve and main reservoir (1)	Fwd. baggage compartment	Prevents return fluid from aspirator entering emergency filler system.

Unit	Location	Remarks
CROSS-OVER CHECK VALVE (1)	Fwd. cargo compartment left-hand side.	Opens at 300-400 psi differential pressure to allow secondary system fluid to enter primary manifold. Primary fluid cannot enter secondary manifold at any time through valve. With secondary pumps (only) operating, return fluid from systems should be entering secondary side of reservoir. With primary pumps (only) operating, no pressure indication should be noted on secondary pressure gages at the co-pilot's and flight engineer's stations. Check booster operation when secondary pumps are operating to be sure valve has opened.
EMERGENCY EXTENSION TANK (1)	Nose of airplane.	Total capacity of 4.58 gallons. Operating level of 3.27 gallons. Includes sight gage for fluid level check. Vented to cabin air. Overboard drain shut-off valve from filler scupper should be safetied in closed position (possible source of cabin pressure leak). Be sure vent is open, as it is source of air for main reservoir pressurization through aspirator.
EMERGENCY FILLER RESERVOIR*	Flight station, aft of pilot's seat.	The emergency filler reservoir, located on the left side of the flight station, has a capacity of 5 U.S. gallons (4.16 IMP.). The reservoir has a sight gage and is connected by a flexible hose to the emergency filler pump. The reservoir is used during flight under emergency conditions, to add hydraulic fluid to either the main reservoir or the emergency extension and hydraulic brake tank.
EMERGENCY FILLER PUMP (1)	Flight station, aft of pilot's seat.	Used to fill either main or emergency extension tank from emergency filler reservoir. Use of manually operated bleed valve adjacent to pump dispels air from pump in the event the pump fails to deliver fluid.
EMERGENCY FILLER SELECTOR VALVE (1)	Flight station, aft of pilot's seat.	Directs fluid from emergency filler pump to either main or emergency extension tank. When replenishing reservoirs on ground by means of emergency filler pump, fluid quantity indicator for reservoir selected must show amount of fluid being added. Sight gage on emergency extension tank. Electric power must be on to get indicator reading for main system reservoir, including inverter.
EMERGENCY HAND PUMP (1)	At copilot's station, right-hand side.	Provides source of pressure for emergency brake and/or emergency gear extension. Integral selector is safetied in brake (forward) position. With brake selector valve in emergency position and hand pump selector forward, it should be possible, by operating hand pump, to obtain

*LAC Serials 4001–4014

Unit	Location	Remarks
		pressure indication at brake pressure gage of approximately 1700 psi. The pump capacity is about 1 cubic inch per stroke.
EMERGENCY EXTENSION SHUT-OFF VALVE (1)	Operated by mechanical linkage from integral selector on hand pump.	Valve is open when hand pump is in BRAKE position; closed when hand pump is in EMER. EXT. position (selector handle aft). After landing gear emergency extension operation, pressure in emergency lines and at emergency side of units will not relieve unless integral selector at hand pump is in BRAKE position. This position also allows thermally expanded fluid in emergency landing gear system to return to the emergency extension tank.
FILTER (Emergency filler line) (2)	One in fwd. cargo compartment; one in nose section.	Filters fluid from emergency filler pump before it enters main reservoir or emergency extension tank.
FILTERS (Main System) (2)	Primary and secondary, fwd. cargo compartment. (Located in return side of system.)	Micronic paper element type. Integral relief valve opens between 22 & 28 psi differential pressure.
GROUND TEST CONNECTION (Pressure) (2)	Left-hand stub wing.	Direct fluid from pressure side of test gig into secondary manifold. Must be safetied in CLOSED position.
GROUND TEST CONNECTION (Suction) (1)	Left-hand stub wing.	Attachment point for ground test gig (secondary side of reservoir). Must be safetied in closed position.
PRESSURE TRANSMITTERS (2)	Primary, fwd. cargo compartment; secondary, fwd. cargo compartment.	Dual type gages at flight engineer's and copilot's stations. Primary transmitter isolated by check valve to give true indication of primary pressure. When secondary pumps are put into into operation at initial engine start, primary pressure gage will not give indication of pressure due to transmitter isolation by check valve. At 1000 rpm of engines or more (1400 rpm of pump) all systems inoperative, primary gage will read approximately 1650 psi; secondary gage approximately 1700 psi.
PRESSURE WARNING SWITCHES (4)	No. 1 & No. 2 in leading edge of wing inboard of No. 2 nacelle. No. 3 & No. 4 in leading edge of wing inboard of No. 3 nacelle.	Warning lights at flight engineer's and copilot's stations open at 1450 ±50 psi (increasing pressure). Close at 1325 ±50 (decreasing pressure). Warning light gives indication of individual pump output, provides flight engineer with clue as to proper pump shut-down procedure during flight.

Unit	Location	Remarks
PULSATION FILTERS (4)	For Nos. 1, 2, and 4 pumps in pump pressure line immediately aft of fire wall. For No. 3 pump just inboard of No. 3 nacelle in leading edge of wing.	Reduces vibration and noise in plumbing lines.
PUMPS (Engine Driven) (4)	On each engine accessory section	Variable volume adjusted to 1700 −25 +0 psi (recommended bench adjustment). Note that individual pump pressure warning lights go out as respective engines are started. Engine starting sequence (secondary side) provides immediate pressure for brakes and steering system. Pump relief pressure 2000 psi.
RESERVOIR, MAIN (1)	Left-hand stub wing.	Total capacity 10.1 gal. Fluid level (operating) 7.1 gal. Liquidometer in primary side; dipstick in secondary side. When filling, be sure brake accumulators are charged to 1600 psi (with 1200 psi pressure in air side before charging). Fill to full mark on dip stick. Check dip stick reading against flight engineer's fluid quantity gage. Filler and dip stick caps must not be over-tightened. Red mark on plunger at sump must be visible. Drain shut-off valve must be safetied closed.
RESTRICTION CONTROL VALVE (1)	Fwd. cargo compartment in secondary manifold.	Allows 1½ gal. per minute flow when pressure in secondary is 1150 psi. Allows 11 gallons per minute minimum when pressure is 1300 psi. With secondary system (only) operating, operate control surfaces and flaps at the same time. Flap operation should be slower than normal during this time, due to restriction control valve starving off flow to the flap system.
SHUT-OFF VALVES (Motor-driven) (4)	No. 1, left-hand stub wing; No. 2, left-hand stub wing; No. 3, fwd. cargo compartment right-hand side; No. 4, fwd. cargo compartment. Right-hand side.	Controlled by flight engineer to shut off fluid supply to individual pumps. With master electrical switch ON, operate electrical shut-off valves and return them to OPEN position. Have mechanic stationed at valve to be sure it has operated.
SHUT-OFF VALVES (Manual) (4)	One in each engine pump suction line aft of fire wall.	Rigged to operate with emergency fuel and oil shut-off valves. Operate from control at pilot's overhead panel. Hydraulic valve must operate switch to close fuel motor-driven shut-off valve.
SHUT-OFF VALVES (Solenoid) (4)	Each nacelle.	Opens when motor driven valves are closed. Isolates pump into closed system in case of malfunctioning pump.
PUMP RELIEF VALVES (4)	1 each nacelle, aft of fire wall.	Adjusted to crack at 1800 −0, +50 psi.

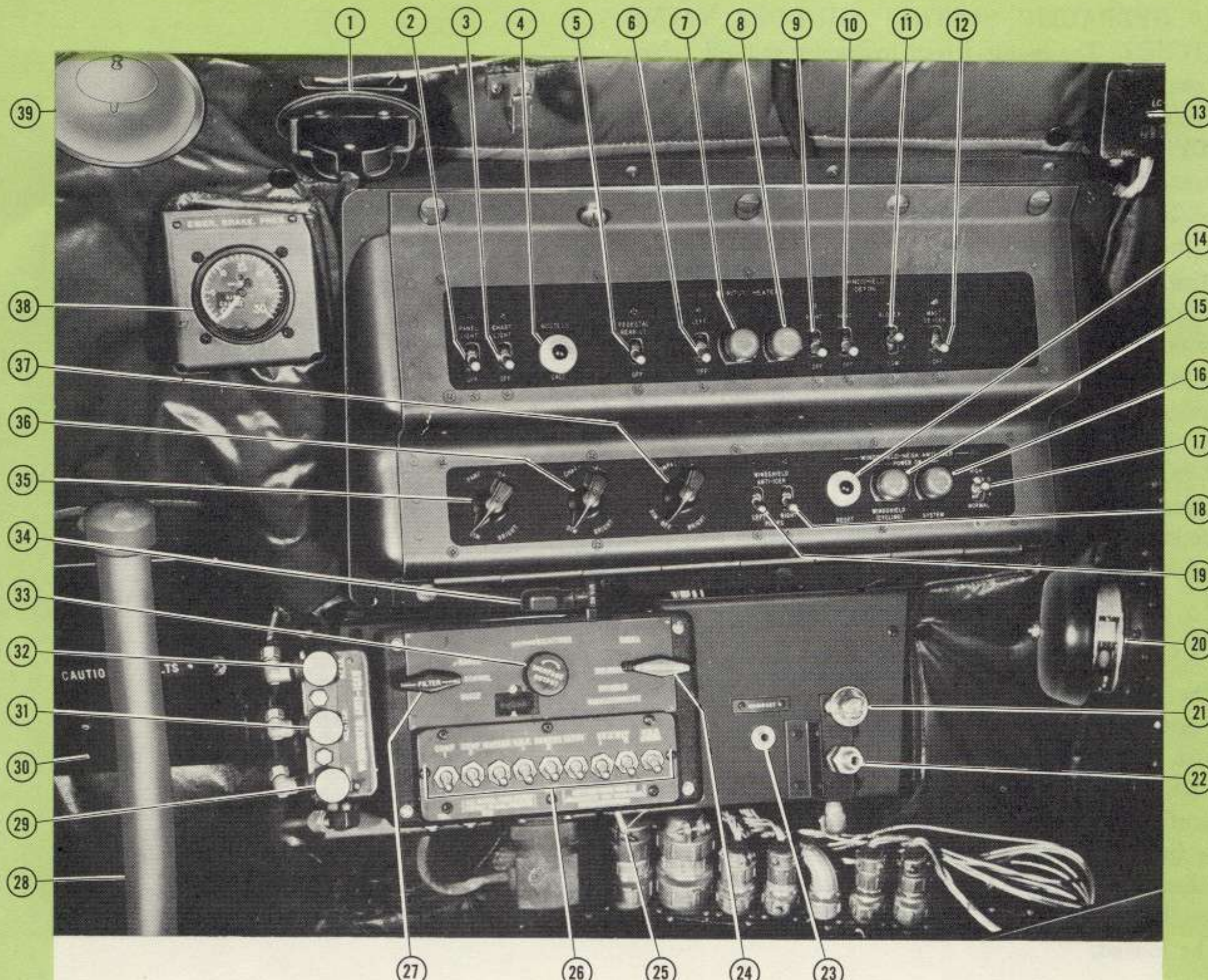


1. Microphone holder
2. Panel light switch
3. Chart light switch
4. Ash receptacle
5. Left pitot heater switch
6. Left pitot heater ON warning light
7. Right pitot heater ON warning light
8. Right pitot heater switch
9. Windshield de-fogger heat switch
10. Windshield de-fogger blower switch
11. Radio mast de-icer switch
12. Left windshield panel anti-icer pump switch
13. Right windshield panel anti-icer pump switch
14. Diluter-demand oxygen regulator
15. Nesa reset switch
16. Nesa cycling light
17. Nesa system power ON light
18. Nesa system power switch
19. Fire warning bell
20. Continuous flow oxygen outlet
21. Microphone selector switch
22. VHF-2 communication receiver switch
23. VHF-1 communication receiver switch
24. HF communication receiver switch
24A. Isolation amplifier by-pass switch
25. Remote volume control
26. VHF NAV-2 receiver switch
27. Filter switch
28. VHF NAV-1 receiver switch
29. Marker receiver switch
30. Emergency hand pump
31. Front windshield anti-icer fluid valve
32. Center windshield anti-icer fluid valve
33. Rear windshield anti-icer fluid valve
34. Radio remote control selector box
35. Panel light rheostat switch
36. Chart light rheostat switch
37. Compass light rheostat switch
38. Right panel instrument lights rheostat switch

COPILOT'S SIDE PANEL*

figure 1-37

*LAC Serials 4001–4014



1.	Microphone holder	21.	Supplemental oxygen outlet
2.	Panel light switch	22.	Protective oxygen outlet
3.	Chart light switch	23.	Public address handset jack
4.	Cabin attendant call button	24.	Microphone selector switch
5.	Pedestal rear light switch	25.	Isolation amplifier by-pass switch
6.	Left pitot heater switch	26.	Receiver selector switches
7.	Left pitot heater ON warning light	27.	Filter switch
8.	Right pitot heater ON warning light	28.	Emergency hand pump
9.	Right pitot heater switch	29.	Front windshield anti-icer fluid valve
10.	Windshield de-fogger heat switch	30.	Flight instrument transformer box
11.	Windshield de-fogger blower switch	31.	Center windshield anti-icer fluid valve
12.	Radio mast de-icer switch	32.	Rear windshield anti-icer fluid valve
13.	Microphone and headset jack box	33.	Radio remote volume control
14.	Windshield Nesa anti-icer reset switch	34.	Radio remote control selector box light
15.	Nesa cycling light	35.	Panel light rheostat
16.	Nesa system power ON light	36.	Chart light rheostat
17.	Nesa system power switch	37.	Compass light rheostat switch
18.	Right windshield anti-icer pump switch	38.	Emergency brake pressure gage
19.	Left windshield anti-icer pump switch	39.	Ash receptacle
20.	Fire warning bell		

COPILOT'S SIDE PANEL†

figure 1-37A

†LAC Serials 4015–4024

1–215. HYDRAULIC POWER SYSTEM CONTROLS AND INDICATORS.

1–216. HYDRAULIC SUCTION SHUT-OFF VALVE SWITCHES. The motor-driven hydraulic shut-off valves are controlled by four switches located on the flight engineer's upper panel. These switches are guarded to the OPEN (or OFF) position. When in the CLOSED position, d.c. power, through a single 10-amp. push-pull circuit breaker located on the M.J.B. circuit breaker panel, runs the motor-driven valve to the CLOSED position shutting off the flow of fluid from the main hydraulic reservoir to the pump. When the motor-driven valve is operated to the CLOSED position the hydraulic bypass relay is de-energized allowing the contacts to close and power is applied to open the hydraulic solenoid shut-off valve which is normally closed. This permits the trapped fluid in the pump to circulate through the relief valve, the open solenoid valve in the bypass line and return to the suction side of the pump. This prevents overheating of a shut-off pump.

1–217. FIREWALL SHUT-OFF VALVE LEVERS (2, fig. 1-14.) The firewall shut-off valve levers, located on the ceiling of the flight station, are used during emergency shut-down of an engine to prevent the flow of fuel, oil and hydraulic fluid forward of the nacelle firewall. They are connected by cables to the manual hydraulic suction shut-off valves. These levers are normally in the OPEN (forward) position and when pulled aft close the valves. The levers are equipped with a button lock which must be depressed before the lever can be moved.

1–218. EMERGENCY HAND PUMP SELECTOR LEVER. The hand pump incorporates a selector lever to select either brakes or landing gear extension functions. The lever is normally latched in the BRAKE position.

When the latch is manually released the lever can be moved aft to the EMER. EXT. position, as the emergency extension bypass valve is mechanically linked to this lever.

1–219. EMERGENCY HYDRAULIC SUPPLY FILLER SELECTOR VALVE HANDLE. This handle, (fig. 1-36) controls the three-way valve which allows the emergency supply of hydraulic fluid to replenish either the emergency extension tank, or the main hydraulic reservoir. It is located on the floor behind the pilot's seat. In the EMER. RES. position fluid from the hand wobble pump is directed to the emergency extension tank; in the MAIN RES. position fluid will be pumped to the main hydraulic reservoir. In OFF position there is no flow through the valve.

1–220. HYDRAULIC FLUID QUANTITY INDICATOR. This indicator, located on the Flight Engineer's middle panel, indicates the amount of fluid in the main hydraulic reservoir. It is marked in increments of E, 1/4, 1/2, 3/4, and F. A red arc extends from 1/2 to E; above 1/2 to F the arc is green. When the hydraulic reservoir is below 5/8 full or thereabouts, the indicator is only indicating the level of the primary side as this is below the level of the primary-secondary divider and the fluid level transmitter is located on the primary side of the reservoir.

1–221. HYDRAULIC SYSTEM PRESSURE INDICATORS. Two dual remote pressure indicators, indicate the pressure of the primary and secondary hydraulic systems. One indicator is located on the flight engineer's middle panel, directly below the hydraulic fluid quantity indicator. The other is on the pilot's middle instrument panel. Each indicator has two needles, one marked P, the other S, and indicate the respective pressure of the primary and secondary systems as transmitted from the pressure transmitters, located in the system pressure lines. The indicators are calibrated from 0 to 30 in hundreds of psi.

1–222. HYDRAULIC PUMP WARNING LIGHTS. The four hydraulic pump warning lights are located below the pressure indicators on the flight engineer's middle panel. They will light when the individual pump hydraulic pressure drops below 1325 +50 psi as reflected by the pressure switch in each pump pressure line. When lighted and pressure reaches 1450 +50 psi, the lights will go off.

1–223. HYDRAULIC RETURN LINE SECONDARY FILTER DIFFERENTIAL PRESSURE GAGE.* This gage is a dual indicating type with two needles. It is located on the upper outboard side of the station 260 panel. The gage indicates from 0 to 70 psi, with a red arc from 0 to 20 psi and green arc from 20 to 25 psi. One needle indicates the secondary system return line pressure upstream of the main filter and the other needle indicates the pressure on the downstream side of the same filter. If the pressure differential is greater than 12 psi during a high flow condition (wing flaps operating) both system filters should be changed. The 12 psi differential on the ground is equivalent to 20 psi differential in flight. This 20 psi differential pressure approaches the 22-28 psi relief valve setting of the filters. The primary system has no peak high flow condition similar to the secondary system, so differential pressure on the secondary system is the more critical. Aspirator pressure may also be read by taking the lower reading of the gage while the system is not in a high flow condition. This pressure should be 30 +0, —5 psi with two or more engines running.

1–224. EMERGENCY HYDRAULIC FLUID RESERVOIR SIGHT GAGE. The emergency hydraulic tank, located forward of the pilot, is equipped with a sight gage (visible from the flight engineer's station) to indicate the level of fluid in the tank. Maximum and minimum markings are labeled on the gage.

1–225. SURFACE CONTROLS.

1–226. GENERAL. The ailerons, rudders, and elevators are actuated by systems of cables with hydraulic booster units built into the cable system. As the booster units do not actuate, but merely assist in the movement of the surfaces, "feel" is present in the flight station controls. The aileron, elevator, and rudder cable systems incorporate tension regulators that automatically maintain constant tension of the cable systems.

1–227. SURFACE CONTROL BOOSTERS. Hydraulic pressure for the boosters is normally supplied by the primary hydraulic system. However, if primary system pressure drops 300 to 400 psi below secondary system pressure, the cross-over check valve will transfer booster operation to the secondary system. The pressure demands of the boosters will be met at the expense of the components normally served by the secondary system.

1–228. Each booster unit incorporates an actuating cylinder and a four-way control valve that regulates the speed and direction of the motion of the cylinder piston. Any movement of the cockpit controls opens the control valve which directs hydraulic pressure to the actuating cylinder. When the control movement is discontinued, the

*LAC Serials 4001–4014

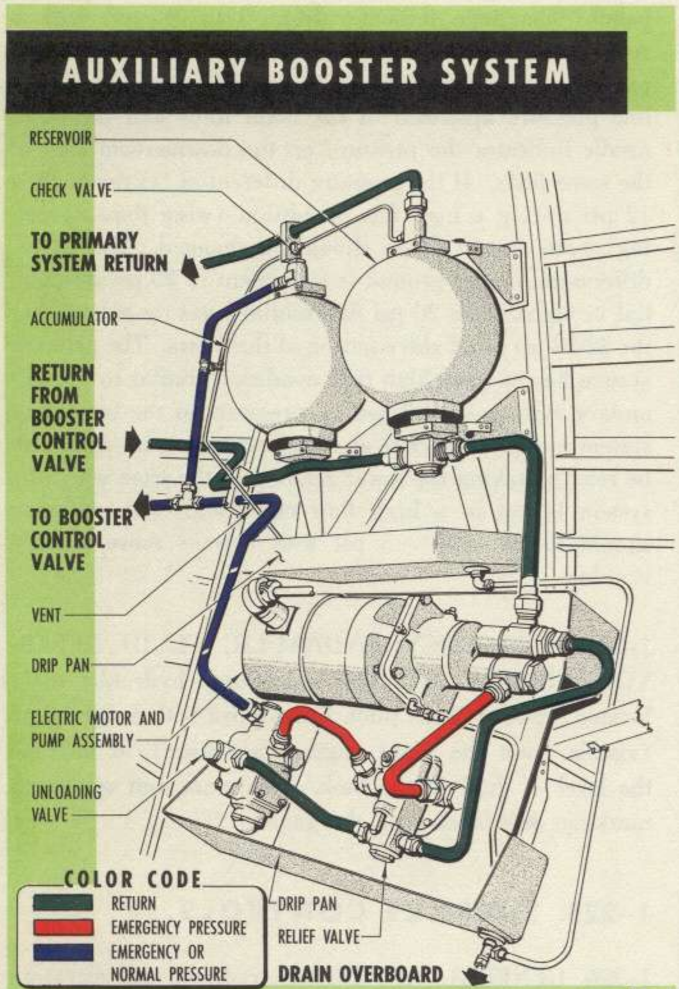


figure 1-38

valve is closed by the actuating cylinder through a parallelogram follow-up linkage. The follow-up linkage is limited in its travel, so that the cables actuate the control surfaces directly without assistance of the hydraulic boosters, when the hydraulic pressure is shut off. A cable operated shut-off valve is installed in the pressure line so that the booster unit may be turned off. In addition, a bypass valve is cam operated by the shut-off valve, so that the fluid is positively by-passed from one side of the actuating cylinder to the other when the shut-off valve is off, thus eliminating all possibility of hydraulically locking the booster unit.

1–229. A filter is installed upstream of each booster control valve to prevent foreign matter from interfering with the proper functioning of the booster mechanism.

1–230. The actuating cylinder of each booster unit has a piston of equal areas on both sides. Two spring-loaded by-pass valves are incorporated in the cylinder housing and connect the chambers on each side of the piston. One of these bypass valves is also opened by a cam, which is operated manually in conjunction with the shut-off valve. Both bypass valves are set to open when the pressure differential between the piston chambers is 1475 ± 100 psi.

1–231. CONTROL VALVE. The booster control valve directs the hydraulic pressure for operating the booster actuating cylinder in the direction and at the rate set by the parallelogram linkage, which is in direct proportion to the movement of the controls in the cockpit.

1–232. FILTERS. The hydraulic fluid is cleaned, prior to its entry into the booster unit, by means of paper-element filters. Two non-adjustable relief valves provide for continuous fluid flow, in the event that the filter element is fouled and stopped.

1–233. AUXILIARY BOOSTERS. A complete, self-contained power unit supplies fluid to the elevator and rudder booster systems, in the event of primary and secondary hydraulic system failure. Pressure is supplied by two electric-driven, gear-type pumps.

Note

The rudder and elevator booster controls, located on the center control stand, must be ON in order that the rudder and elevator booster systems may be operated from auxiliary boost pressure.

1–234. CONTROL LOCK. The effect of control locks is achieved by leaving the control boosters engaged while the airplane is parked. In this condition there is sufficient resistance in the system to prevent the surfaces from swinging excessively.

1–235. AILERON BOOSTER CONTROL LEVER. The aileron booster control lever (3, fig. 1-18), located on the center control stand, turns the aileron boosters ON and OFF.

1–236. AILERON BOOSTER RATIO. The aileron booster ratio varies from 26½ to 1 full up to 7.64 to 1 in neutral and 3.16 to 1 in full down position.

1–237. AILERON TABS. The aileron tabs are mechanically controlled through a cable system by a hand crank (26, fig. 1-18), located on the center control stand. Internal stops limit the number of turns of the crank handle to approximately nine (9) in each direction from the neutral position. Tab position is shown by two indicators located adjacent to the hand crank. The travel ratio of the pointer of the indicator located immediately forward of the crank is slight, and is only indicative of relative tab position. The travel ratio of the pointer of the second indicator, located below the hand crank, is approximately 5 times greater, and its travel arc is graduated to show the degree of deflection of the tabs.

AILERON CONTROL SYSTEM

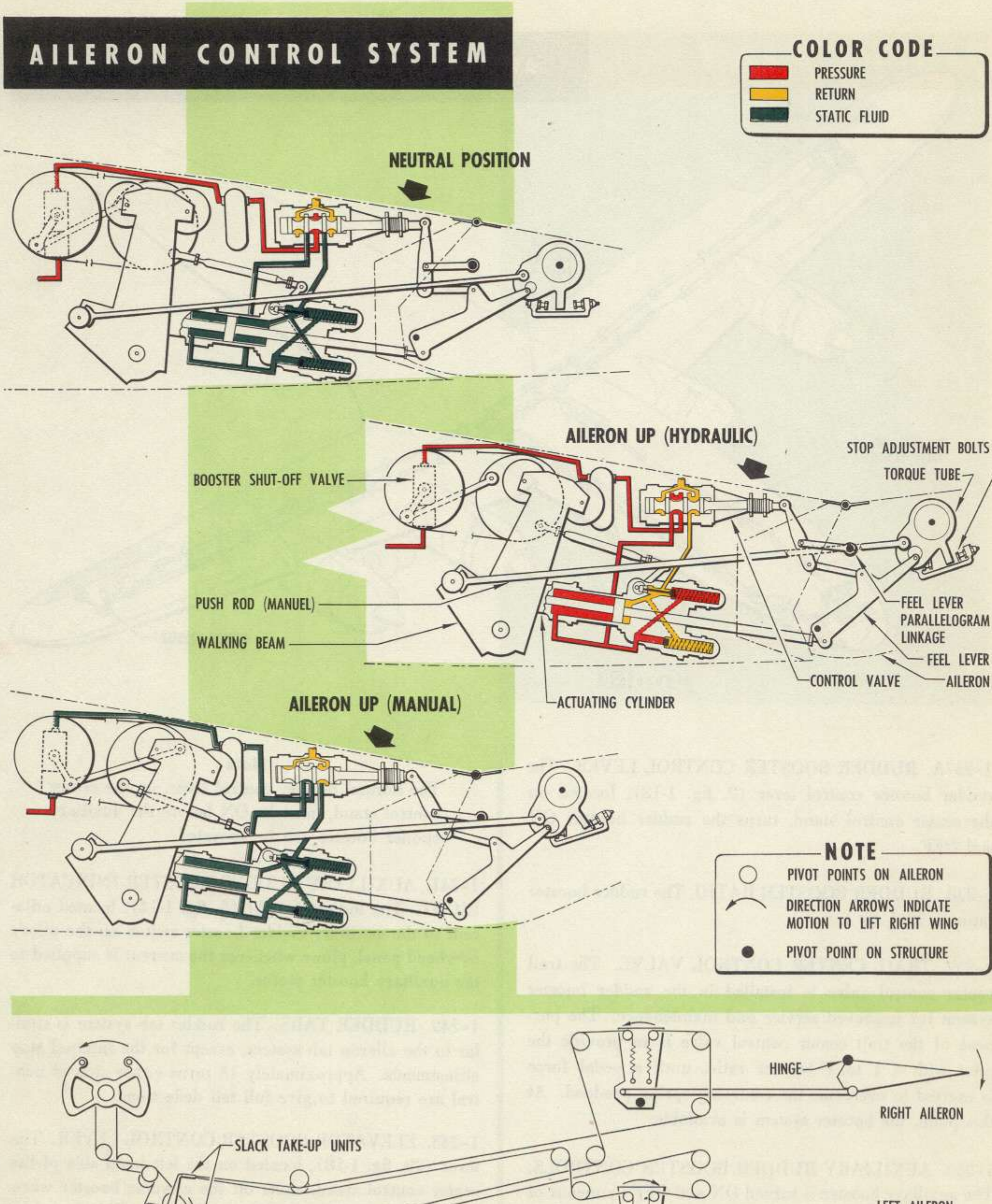


figure 1-39

AILERON CABLE CONTROL SYSTEM

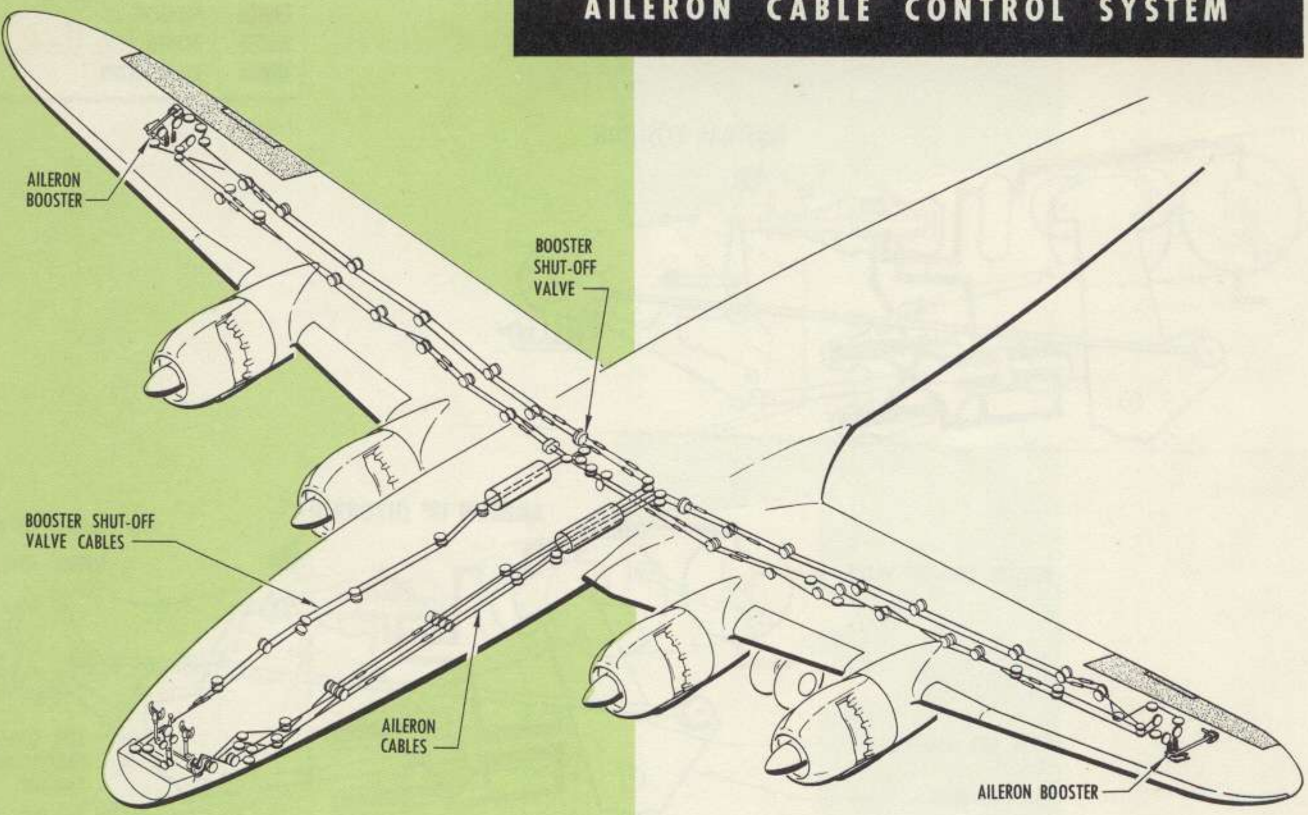


figure 1-40

1–237A. RUDDER BOOSTER CONTROL LEVER. The rudder booster control lever (2, fig. 1-18), located on the center control stand, turns the rudder booster ON and OFF.

1–238. RUDDER BOOSTER RATIO. The rudder booster ratio is 22½ to 1.

1–239. TRAIL CENTER CONTROL VALVE. The trail center control valve is installed in the rudder booster system for improved service and maintenance. The purpose of the trail center control valve is to provide the pilot with a 1 to 1 booster ratio, until a pedal force is exerted to overcome the centering spring pre-load. At this point, the booster system is available.

1–240. AUXILIARY RUDDER BOOSTER CONTROLS. The auxiliary booster is turned ON and OFF by means of a three-position switch (4, fig. 1-14), located on the pilot's overhead control panel. In addition to ON and OFF positions, a third position, EMERGENCY ON, is provided to bypass the circuit breaker and battery switch and connect the auxiliary booster motor directly to the batteries.

Note

The normal booster control lever, on the center control stand, must be ON before the auxiliary rudder booster can be operated.

1–241. AUXILIARY RUDDER BOOSTER INDICATOR LIGHT. The indicator light (5, fig. 1-14), located adjacent to the auxiliary rudder booster switch on the pilot's overhead panel, glows whenever the current is supplied to the auxiliary booster motor.

1–242. RUDDER TABS. The rudder tab system is similar to the aileron tab system, except for the internal stop adjustments. Approximately 13 turns either side of neutral are required to give full tab deflections.

1–243. ELEVATOR BOOSTER CONTROL LEVER. The lever (29, fig. 1-18), located on the left hand side of the center control stand, shuts off the elevator booster when pulled out. At the same time, it shifts the linkage in the elevator control system to give the pilot a 3 to 1 mechanical advantage. In giving the pilot a 3 to 1 mechanical advantage, the shift reduces the elevator travel to 16° up and 6° down.

RUDDER CONTROL SYSTEM

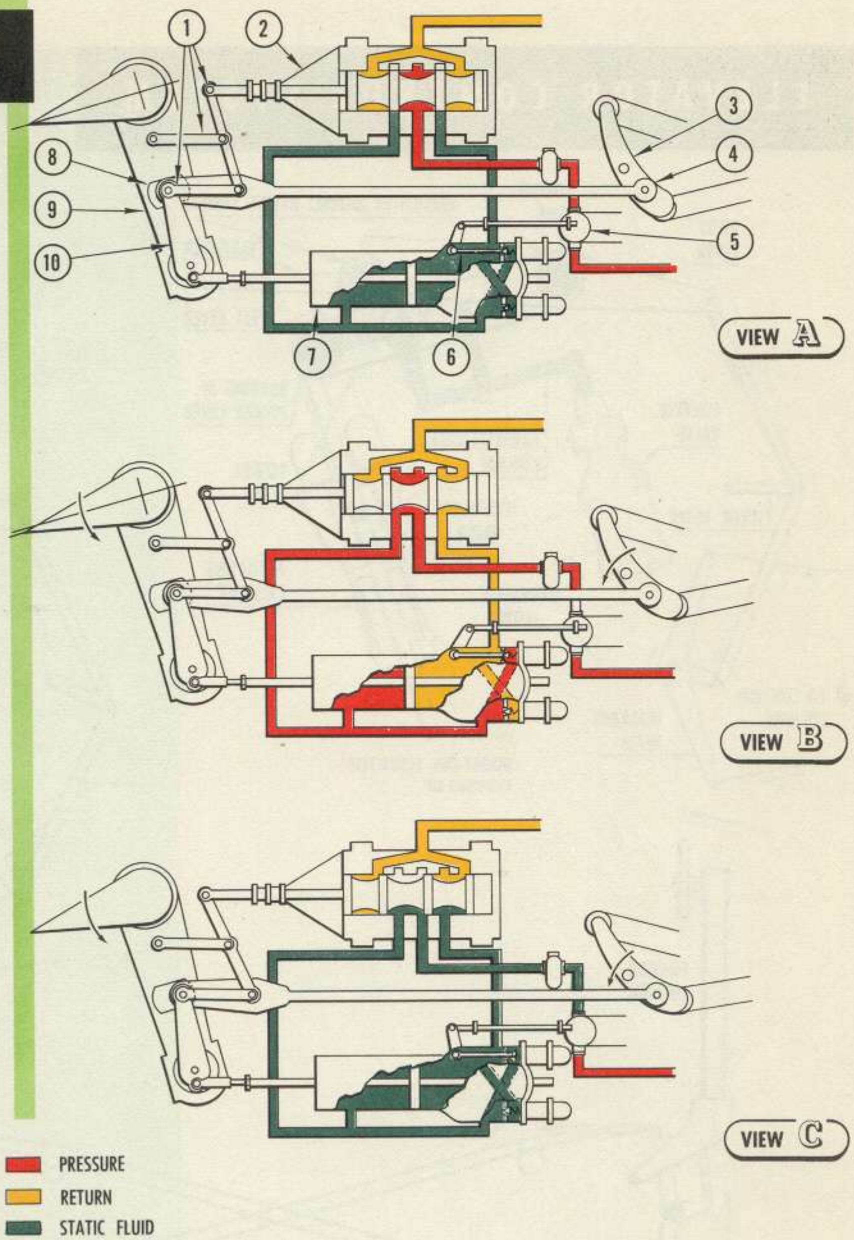
VIEW A illustrates the rudder booster mechanism with the rudder approximately 15 degrees to right. The parallelogram linkage (1) is positioned to hold control valve (2) in neutral. Any movement of lever (8) from alignment with rudder-operating arm (9) will open the control valve.

VIEW B illustrates opening of the control valve by force initiated by the pilot. The control cables have rotated walking beam (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 walking beam 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 walking beam 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 walking beam 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.



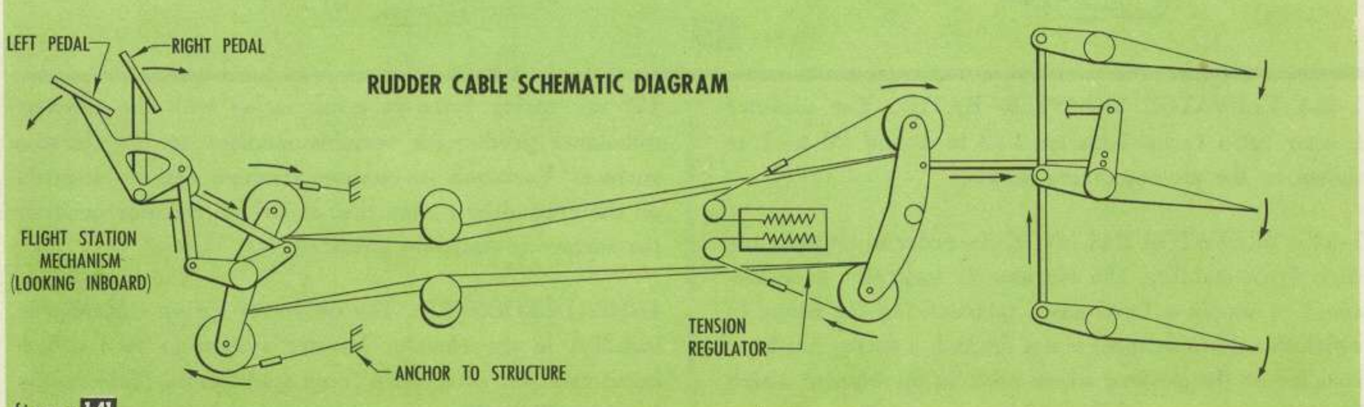


figure 1-41

ELEVATOR CONTROL SYSTEM

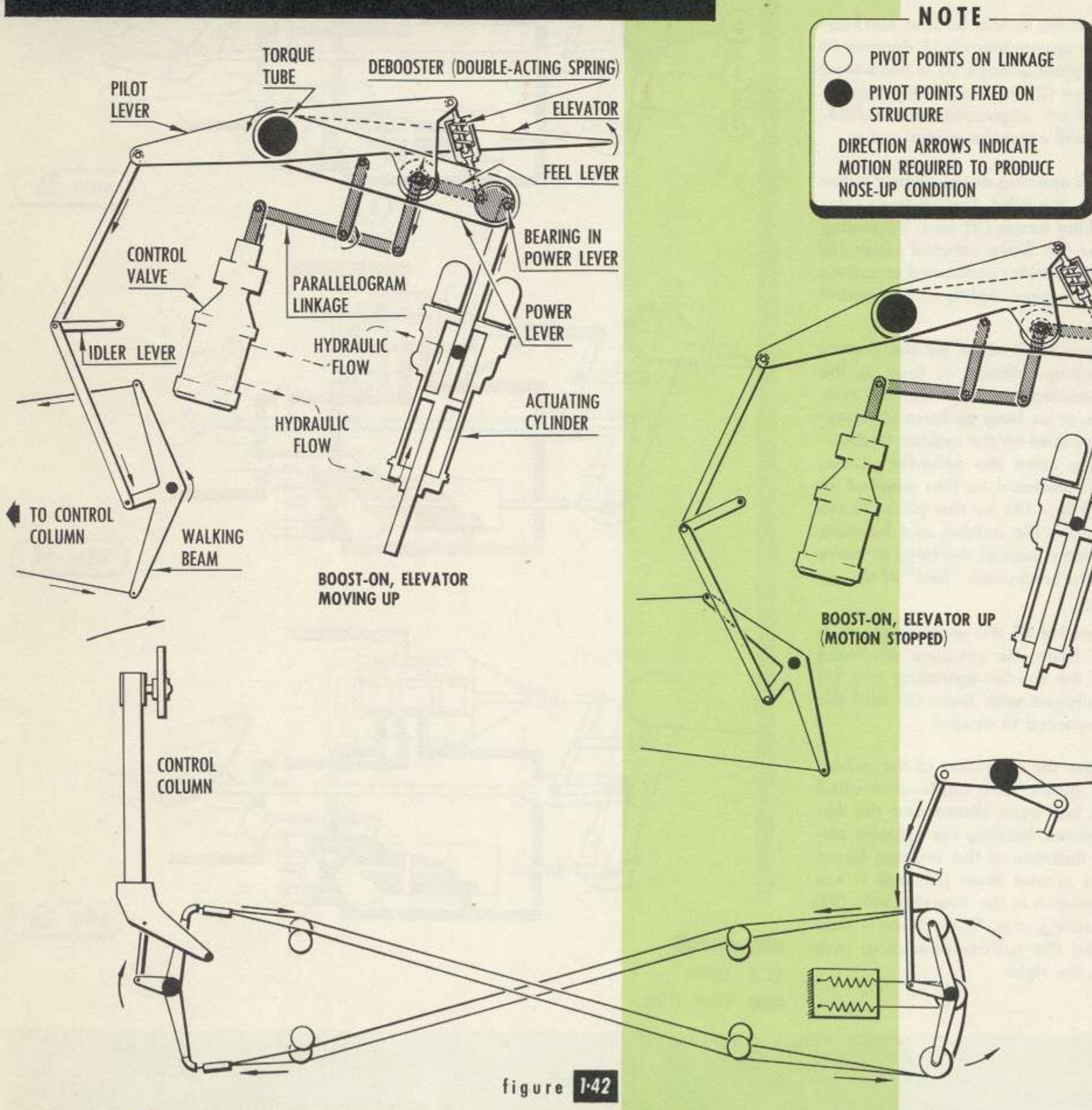
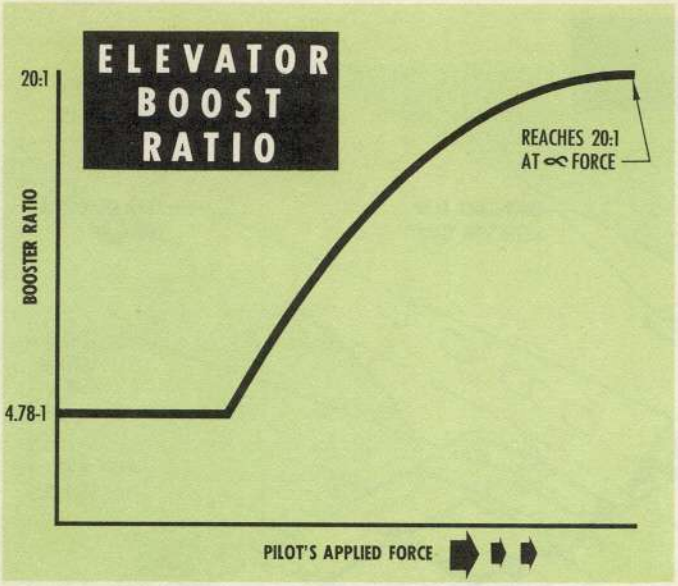


figure 1·42

1–244. ELEVATOR BOOSTER RATIO. The elevator booster ratio varies between 4.78 to 1 and 20 to 1 as shown on the accompanying sketch.

1–245. ELEVATOR BALANCE. In order to improve the stick force stability, the elevator is statically underbalanced to supply a fixed down moment. In the range in which this down moment is not desired, a spring has been installed on the elevator which adds an up moment which is relatively constant from 15° up to the full up elevator position (the range used for landing). From 2° up to 15° up, spring force in combination with the elevator unbalance produces a variable moment on the elevator surface. Variation in elevator moment can be detected on the ground by noting that at 10° up elevator position the surface is statically balanced.

1–246. DEBOOSTER. The debooster spring cartridge is installed in the elevator booster system to give a low boost ratio for small stick force application. This results in better flight characteristics at or near the trim condition.



1–247. ELEVATOR AUXILIARY BOOSTER CONTROLS. The elevator auxiliary booster controls consist of a switch (27, fig. 1-14) and a circuit-breaker (25, fig. 1-14), located on the pilot's overhead panel. The switch has three positions; OFF, ON and EMERGENCY ON. It is spring-loaded from the EMERGENCY ON position to OFF, and when held in the EMERGENCY ON position, bypasses the circuit breaker and battery switch and connects the auxiliary booster motor to the batteries.

1–248. AUXILIARY ELEVATOR BOOSTER INDICATOR LIGHT. An indicator light (26, fig. 1-14), located adjacent to the switch, glows whenever the auxiliary booster motor is in operation.

1–249. ELEVATOR TABS. The elevator tabs can be controlled either manually by control wheels on the pilot's center control stand (1, fig. 1-18), or electrically by push buttons on the pilot's control wheel. Three turns of the tab control wheel give full deflection in either direction.

1–250. ELEVATOR ELECTRIC TAB. For electric operation of the elevator tabs, an electric motor actuator (in the center control stand) drives the cable drum through a chain and sprocket. A multiple jaw clutch is engaged by a solenoid when either the nose down or nose up switch on the pilot's wheel is depressed. In an emergency, the electric motor can be disengaged from the cable drum by pushing the release lever (7, fig. 1-18) forward.

1–251. When the aft button on the pilot's control wheel is depressed, nose-down trim results; when the forward button is depressed, nose-up trim results. If both buttons are depressed simultaneously, nose-up trim will result. If either of the buttons is released after both have been depressed simultaneously, nose-up trim will result.

1–252. WING FLAPS

1–253. GENERAL. Lockheed modified Fowler wing flaps are installed in the trailing edge of the wing.

1–254. Flaps are actuated by a mechanical-hydraulic system including a cable system. Hydraulic pressure for the flap motors is supplied by the secondary hydraulic system. Two hydraulic motors, mounted on the aft side of the main wing beam, actuate a gear train that drives a torque tube extending to the right and left drive units, which are connected in series. A chain-and-cable drive connects all carriages to drive units actuated by the main drive shaft extending through the wing center section into each inner wing.

1–255. In the event of failure of the hydraulic system, the control cables, or the control mechanism, the flaps may be extended manually by means of a hand crank and shaft-and-gear mechanism. Access to the emergency actuating drive is through the flap emergency access door, located in the aisle of the aft passenger compartment approximately one foot aft of the emergency exit which is located closest to the trailing edge of the wing. The carpet covers the access door and is easily lifted by unfastening and rolling back to the left side of the airplane. The access door is held in place by four fasteners located in each corner. The door is lifted out of the floor to gain access to the bypass valve and emergency flap lowering shaft. The hand crank for emergency flap lowering is stowed on the forward partition of the forward left clothes closet. Before the hand crank is used, the bypass valve, located near the aft edge of the access door, must be turned to the OPEN position (counterclockwise), so that the hydraulic fluid can be circulated through the hydraulic flap motors, thus preventing a hydraulic lock.

WARNING

Make sure secondary suction shut-off valves are OFF before operating flaps manually as hydraulic pressure may be applied to the flap motors, causing the drive shaft to turn, thus spinning the hand crank which may possibly cause injury to personnel.

1–256. WING FLAP CARRIAGE DRIVE. Carriages are driven through chains-and-cables by sprockets on the intermediate drive units. These are two chain-and-cable assemblies on each end of the wing flap carriages and spring units on the chain-and-cable assembly take up slack on the loose side of the chain to prevent jamming. Fourteen intermediate drive units, bolted to the track ribs and to brackets on the wing rear beam, actuate the wing flaps;

WING FLAPS

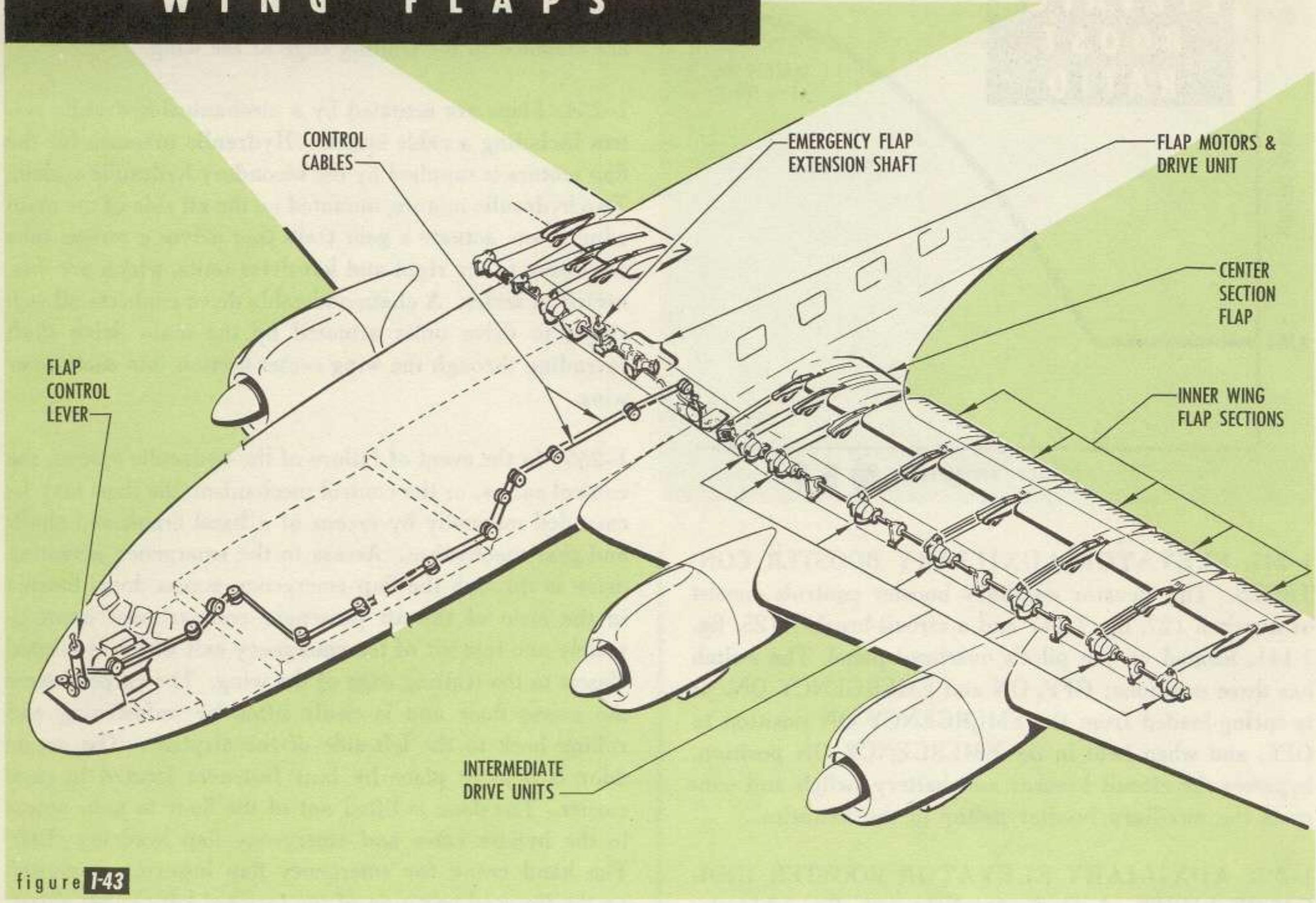


figure 1-43

six intermediate drive units actuate each inner wing flap and one actuates the center section flaps.

1–257. WING FLAP CONTROL UNIT AND SELECTOR VALVE. The control unit consists of a selector valve operated by a follow-up mechanism, which allows pre-positioning of the flaps and permits changing the direction of flap movement at any time without completing the cycle. During operation of the flaps, hydraulic pressure to the right secondary heat exchanger fan motor is automatically shut off, since there is an insufficient supply of fluid to operate the flaps efficiently when the fan is operating. When flap movement stops, pressure is automatically restored to the fan.

1–258. WING FLAP CONTROLS. The flap lever (9, fig. 1-18) is located on the top right side of the center control stand. Four positions of the flap lever are marked. When the lever is full forward, the flaps are fully retracted. Moving the flap lever aft, the other marked positions are as follows:

Take-off .... 60% extension.
Approach .... 66% extension.
80% .... 80% extension.
Landing ....100% extension.

Note

There is no detent at the APPR (66%) position, but lever will remain at this position.

1–259. WING FLAP INDICATORS. The flap position indicator is located on the pilot's center panel and indicates flap positions. The flap position indicator is a 26-volt, ac, 400 cycle, magnesyn indicator. The indicator needle is slaved to the position transmitter (magnesyn), located beneath the selector valve.

1–260. LANDING GEAR

1–261. GENERAL. The hydraulically actuated, retractable landing gear incorporates a steerable nose gear. When the gears retract, the nose gear pivots aft into the underside of the fuselage and the main gears pivot forward into the inboard nacelles. The landing gear doors are mechanically operated by action of the oleo-pneumatic shock struts and lie flush with the airplane contour when closed.

WING FLAPS EMERGENCY EXTENSION BY-PASS VALVE & HANDCRANK SOCKET

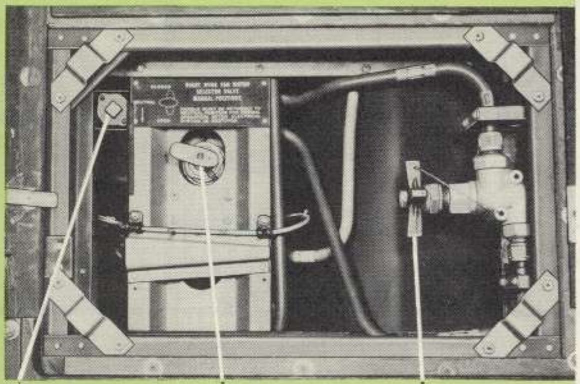


figure 1·44

Dual wheels are mounted on each of the landing gear shock struts.

1–262. LANDING GEAR HYDRAULIC SYSTEM. The secondary hydraulic system provides the hydraulic pressure to operate the uplocks, downlocks, and actuating cylinders which retract and extend the landing gear. Each main gear actuating cylinder has a runaround valve which allows the hydraulic fluid to pass from one side of the actuating cylinder piston to the other while extending the gear without returning to the hydraulic fluid reservoir, thus reducing operation time. The lower drag strut on each main gear is a hydraulic cylinder designed to absorb shock loads of landing and taxiing by the combined damping action of internal springs and metering orifices. There is no circulation of fluid through the strut, but pressure from the secondary hydraulic system is used to return the piston to its normal position.

1–262A. The right secondary heat exchanger fan motor also receives its hydraulic fluid from the secondary hydraulic system. Normally, it is shut off by the landing gear scissors switch during retraction of the gear. In the event of failure of this switch, landing gear operation time may be excessive, since the fluid flow to the fan motor will tend to starve the landing gear.

1–263. The nose gear and main gears are locked in the extended and retracted position, by hydraulically-operated mechanical uplocks and downlocks.

1–264. LANDING GEAR ELECTRICAL SYSTEM. Uplock switches energized by the 24-28 volt d.c. electrical system are provided on each gear, near the uplock latching mechanism, to control the red landing gear UNLOCKED warning light and the wheel well flood lights. The indicating system is so designed that all three gear uplock latches must be closed, and the uplock cylinders must be in the locked position before the switches open to turn the red UNLOCKED light out.

1–265. Downlock switches are located in the inboard nacelles and on the nose gear strut. They are actuated by mechanical linkages coupled to the downlocks. As each gear extends and locks, the corresponding green landing gear indicator light will come on. When all three gears are down and locked, the red UNLOCKED light will go out.

1–266. 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 airplane is on the gear. The solenoid lock is operated by a series circuit through both main gear scissors switches. Airplane weight on either main gear will lock the control lever if it is in the DOWN position.

1–267. The solenoid is spring-loaded to the locked position and when energized, retracts the pin to unlock the landing gear control lever. When the gear is locked up, the series circuit (through the normally closed position of the main and nose gear uplock switches) is broken, and the solenoid is de-energized. The scissor switches are closed by cams on the scissor pins when the weight of the airplane is off the gears.

1–268. The solenoid lock may be manually released by depressing the landing gear lock override pin accessible through a hole (19, fig. 1-18) in the right side of the center control stand.

1–269. A landing gear warning horn is operated by four throttle switches connected in parallel and the unlock contacts of the downlock switches which are also connected in parallel. The horn will sound if one or more of the throttles is retarded beyond a critical setting and all gears are not down and locked. The critical setting of the throttle switches is made to conform to 16 inches of mercury manifold pressure at 5000 feet altitude and 2400 rpm. On LAC Serials 4015 through 4020 the warning horn can be silenced by raising the horn release lever located on the left side of the center control stand. The horn release lever is not installed on any other

FLAP CONTROL VALVE

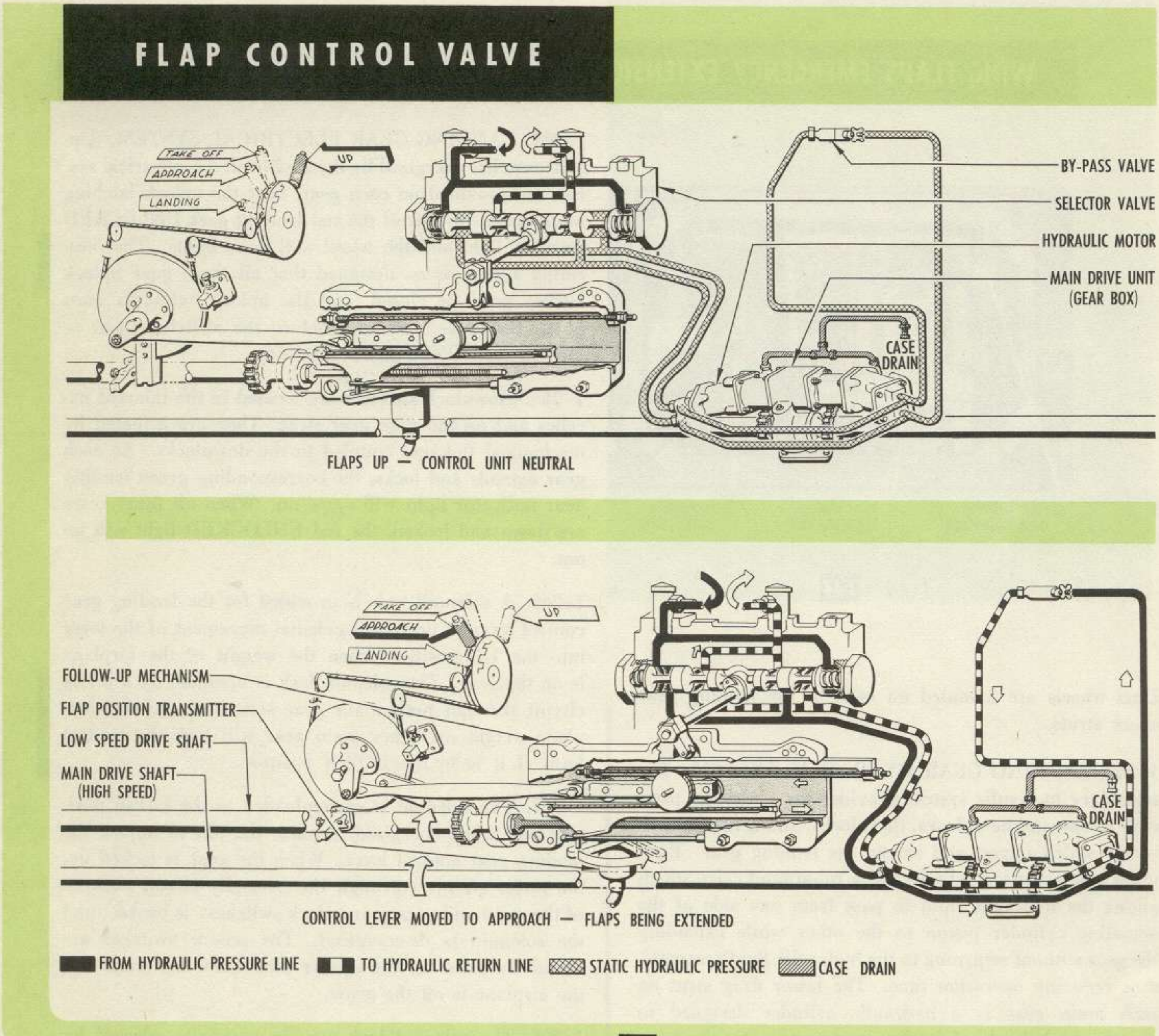


figure 1-45

airplanes, but the warning horn can be silenced either by locking the landing gear down or by advancing the throttles.

1-270. LANDING GEAR CONTROLS.

1-271. LANDING GEAR CONTROL LEVER. The landing gear control lever (24, fig. 1-18) is located on the right aft face of the center control stand and actuates the landing gear selector valve by control cables. The lever is moved to the UP position to retract the landing gear, and to the DOWN position to extend it. There is a detent in the NEUTRAL position (midway between the UP and DOWN positions) and the landing gear control lever must be pulled out when passing through that position. Also, when moving the landing gear control lever to the UP position, the trigger to the right of the control lever must also be held toward the control lever. After the landing gear has been retracted, the control lever should be moved to the NEUTRAL position to reduce the amount of circulating hydraulic fluid, thereby lessening the load on the hydraulic pumps. The uplocks are sufficient to hold the landing gear in the UP position. When the landing gear is extended the control lever should be left in the DOWN position.

1–272. EMERGENCY HAND PUMP SELECTOR LEVER. This lever is located at the base of the emergency hand pump near the copilot's seat. To extend the landing gear in an emergency, release the lock lever and move the selector lever aft to the EMER GEAR position. Make certain that the landing gear control lever is in the DOWN position

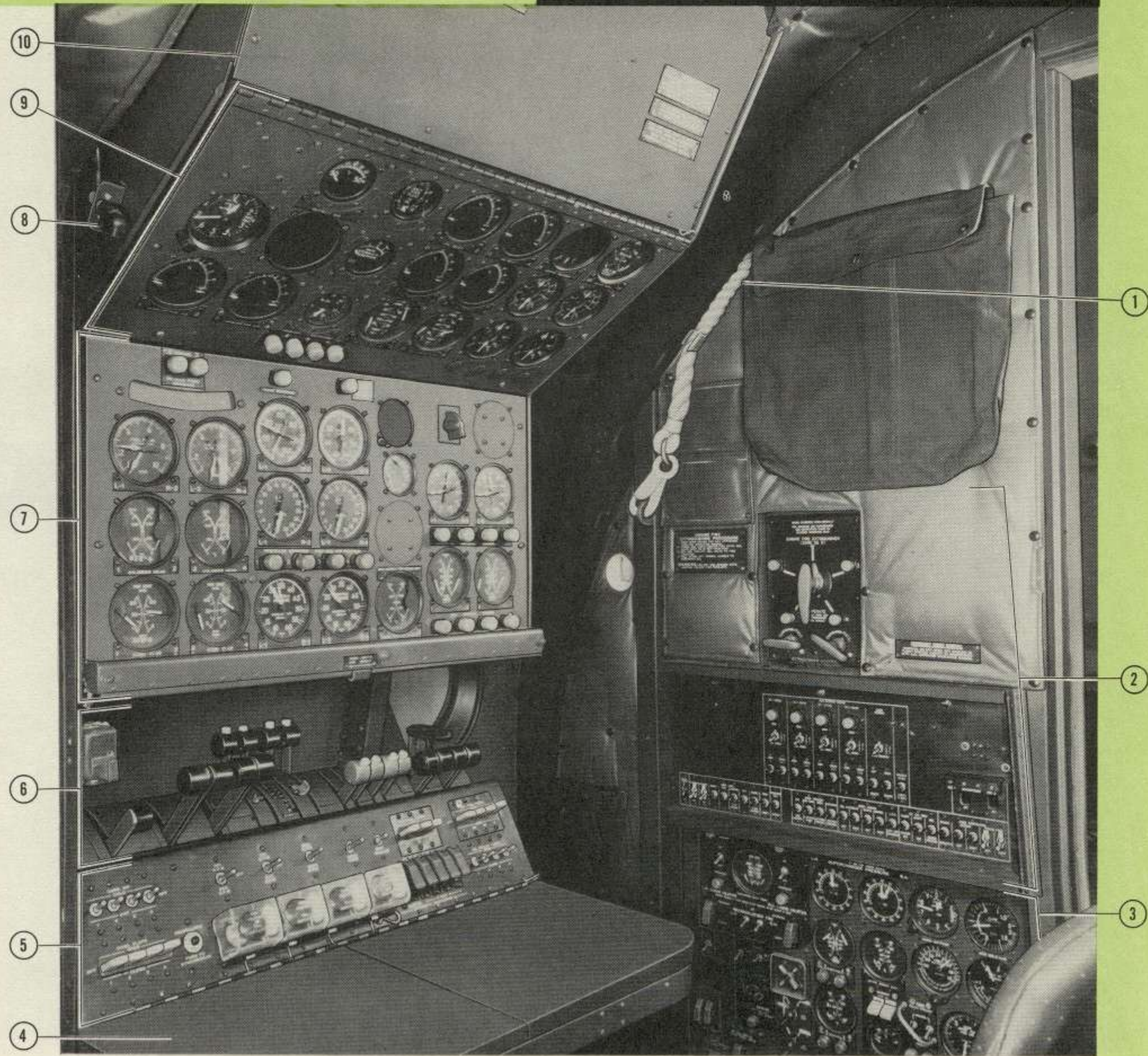
FLIGHT ENGINEER'S STATION*

1. Ditching rope
2. Station 260 upper panel
3. Fuel tank dip-stick gages
4. Air conditioning system control panel
5. Desk
6. Flight engineer's switch panel
7. Flight engineer's control quadrant
8. Lower instrument panel
9. Center instrument panel
10. Radio control box
11. Upper instrument panel
12. Windshield wiper motor

figure 1·46

*LAC Serials 4001–4014

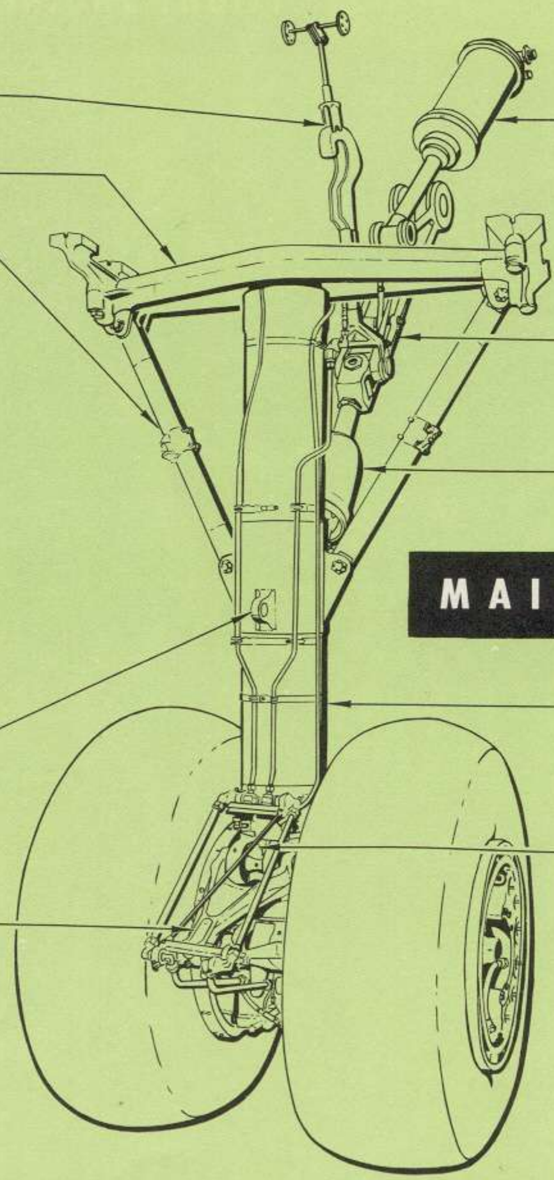
FLIGHT ENGINEER'S STATION†



1. Ditching rope
2. Station 260 upper panel
3. Air conditioning system control panel
4. Desk
5. Switch panel
6. Control quadrant
7. Lower instrument panel
8. Upper MJB panel direct red light
9. Center instrument panel
10. Upper instrument panel

figure 1-46A

†LAC Serials 4015–4024



MAIN LANDING GEAR

figure 1-47

and then operate the emergency hydraulic pump handle. This will direct hydraulic fluid to the landing gear actuating cylinders and extend the gears. No pressure reaction will be felt in the hand pump handle until it has been operated for some time. During initial operation, the pump can be operated faster from near the base of the handle. It is imperative that the operation be continued until pressure is felt on the handle and the green indicator lights show that the down and locked position has been reached. The hand pump selector should then be reset to the EMER BRAKES position. About 245 strokes of the hand pump are necessary, over a period of 2½ to 3 minutes, to extend and lock all gears.

CAUTION

Since the landing gear probably will not lock in the extended position after it falls free, the emergency extension system must be used to insure locking the gear down. Furthermore, the geometry of the landing gear is such that landing impacts will not lock it in the down position.

1-273. MAIN LANDING GEAR. Each main landing gear is equipped with two Goodyear wheels and non-skid tires (17.00 x 20). Two Goodyear spot-type disc brakes are mounted on each wheel. Scissor links keep the oleo-pneumatic shock strut piston and the shock strut cylinder in alignment.

NOSE LANDING GEAR

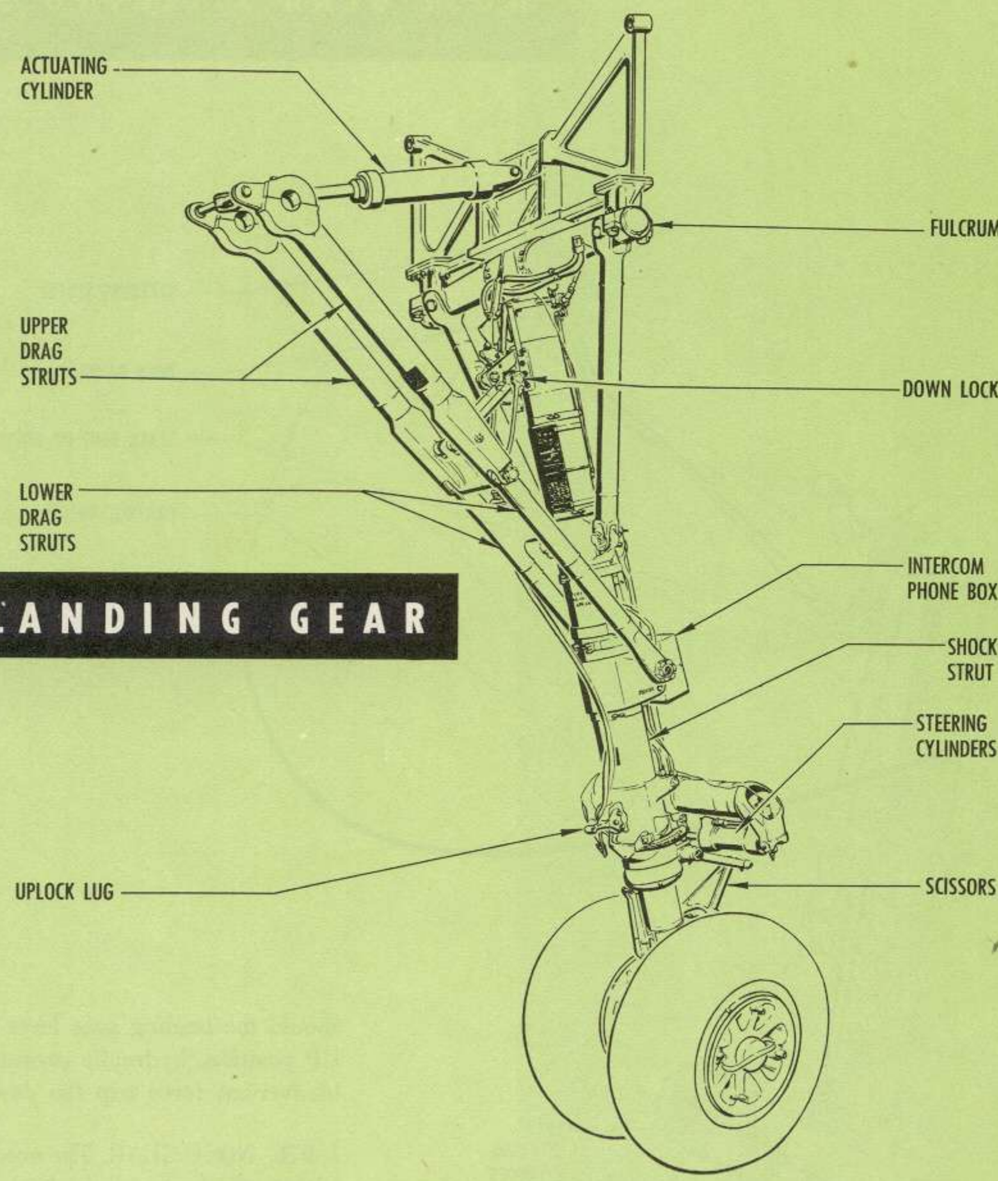


figure 1·48

1–274. The uplocks are mechanically latched by the gears which trip triggers when they are completely retracted. The double latches of the uplock assemblies close around the uplock lugs, that are welded to the bottom forward side of each cylinder of the shock strut assembly, and the latches are locked in position by wedges that are hydraulically operated and blocked against the top ends of the latches by steel balls which fit in a groove in the wedge housing. The latches are released by hydraulic pressure which releases the steel balls and then withdraws the wedges, and the latches are opened and held open by springs as the gears extend.

1–275. 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 connecting 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 the hydraulically operated main gear downlock release cylinder. When the airplane is parked, ground safety pins must be inserted through the case of the spring loaded shaft of the downlock mechanism. These pins will prevent accidental folding of the gears

NOSE GEAR STEERING SYSTEM

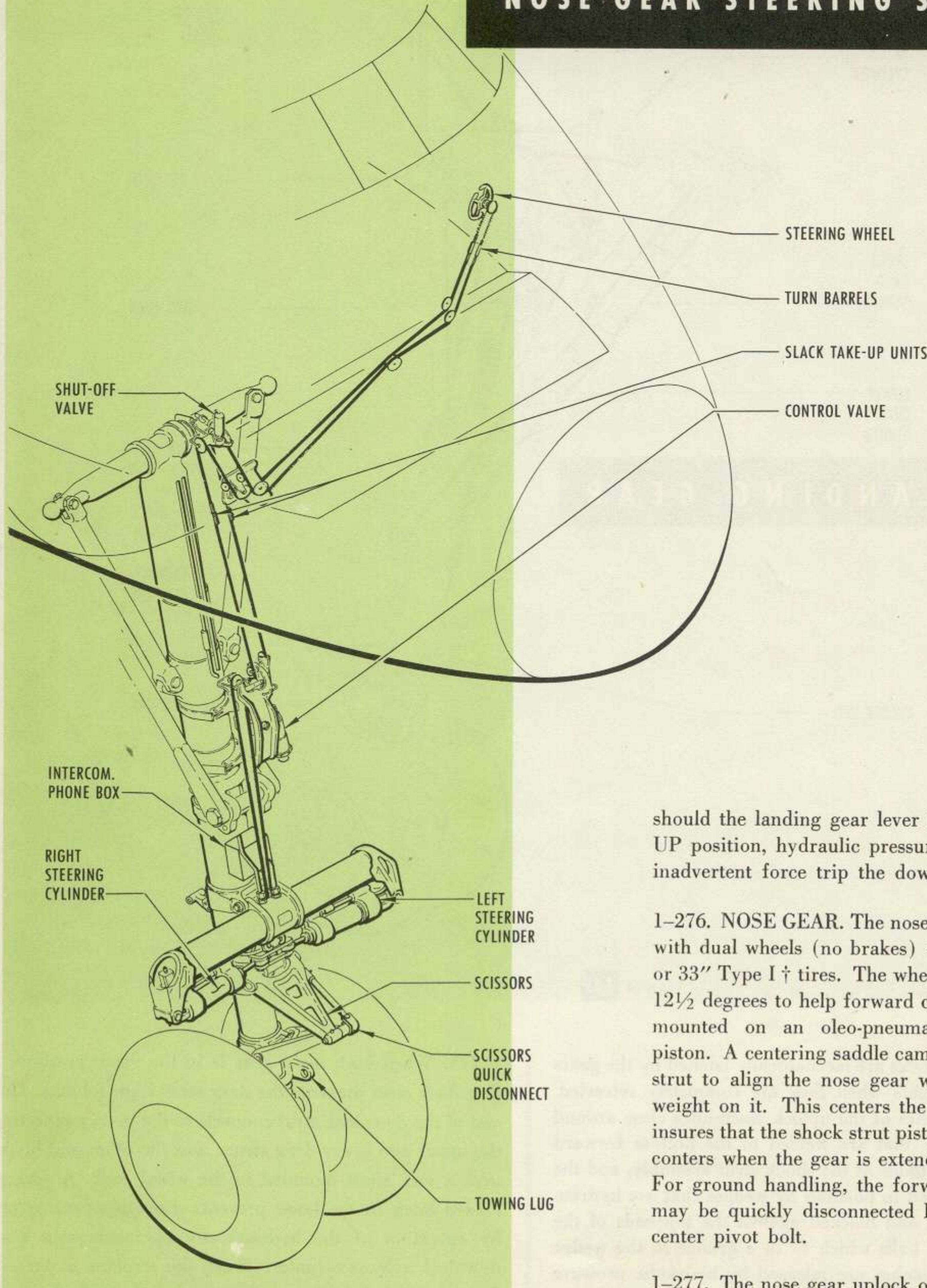


figure 1-49

should the landing gear lever be moved to the UP position, hydraulic pressure fail and some inadvertent force trip the down lock.

1–276. NOSE GEAR. The nose gear is equipped with dual wheels (no brakes) and 34″ x 9.9″* or 33″ Type I † tires. The wheels are cambered 12½ degrees to help forward castering and are mounted on an oleo-pneumatic shock strut piston. A centering saddle cam is built into the strut to align the nose gear when there is no weight on it. This centers the shock strut and insures that the shock strut piston automatically conters when the gear is extended or retracted. For ground handling, the forward scissor link may be quickly disconnected by removing the center pivot bolt.

1–277. The nose gear uplock operation is similar to that of the main gear uplocks. The downlock is a mechanical cam that locks the drag strut in the extended position. The gear cannot

*LAC Serials 4001–4014 †LAC Serials 4015–4024

NOSE GEAR STEERING HYDRAULIC SYSTEM

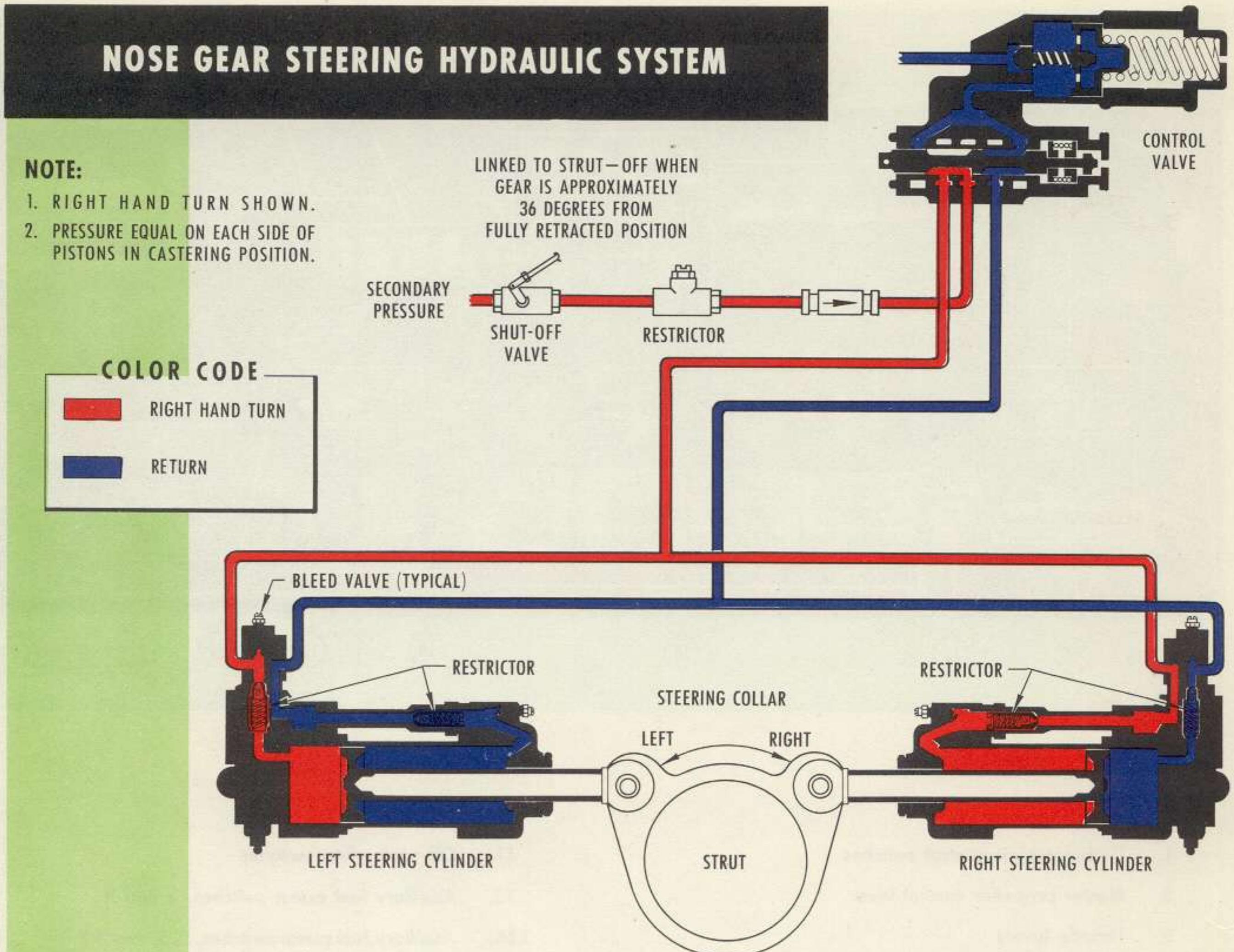
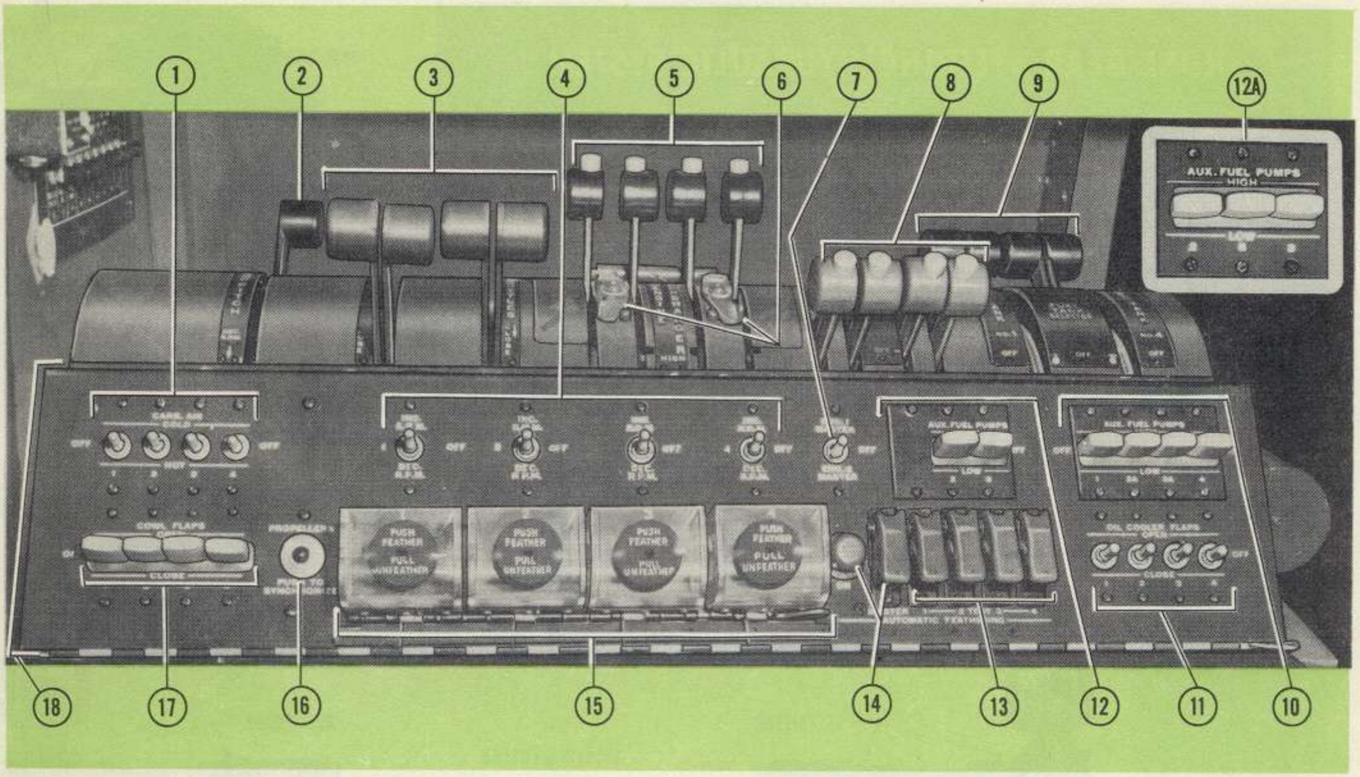


figure 1-50

retract until the cam is released by the hydraulically operated nose gear down lock release cylinder.

1-278. NOSE GEAR STEERING. The nose gear is steered by the small control wheel, located below the pilot's left instrument panel. Turning the control wheel operates the control cables which actuate the steering control valve and directs secondary hydraulic pressure to the left or right steering control actuating cylinder and turns the nose gear. The control wheel must be held to keep the nose gear turned; when the wheel is releasd, the nose gear will return to the neutral (center) 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 damped by orifices in the steering control actuating cylinders that restrict the flow of hydraulic fluid. These cylinders also serve as shimmy dampers when the nose gear is in the neutral position. The control wheel folds, along a diameter, so that it will clear full forward movement of the pilot's control column.



1. Carburetor air control switches
2. Master propeller control lever
3. Throttle levers
4. Propeller govenor control switches
5. Engine blower control levers
6. Cabin supercharger drive shaft disconnect locks
7. Master engine selector switch
8. Mixture control levers
9. Fuel tank selector levers

9A. Control quadrant

10. Auxiliary fuel pump switches, 1, 2A, 3A, and 4
11. Oil cooler flap switches
12. Auxiliary fuel pump switches, 2 and 3

12A. Auxiliary fuel pump switches, 2, 5, and 3 †

13. Automatic feathering test switches
14. Automatic feathering master switch and automatic feathering "armed" indicator light
15. Feathering buttons
16. Propeller synchronizer button
17. Cowl flap switches
18. Lower switch panel

FLIGHT ENGINEER'S CONTROL QUADRANT AND LOWER SWITCH PANEL*

figure 1-51

*LAC Serials 4001–4014 †LAC Serials 4015–4024

BRAKES

four sets are connected in pairs (the inner brake of one wheel to the outer brake of the other wheel). The outer brake assemblies are slightly different in design than the inner brakes, but are functionally similar. Each individual brake assembly consists of a steel disc attached

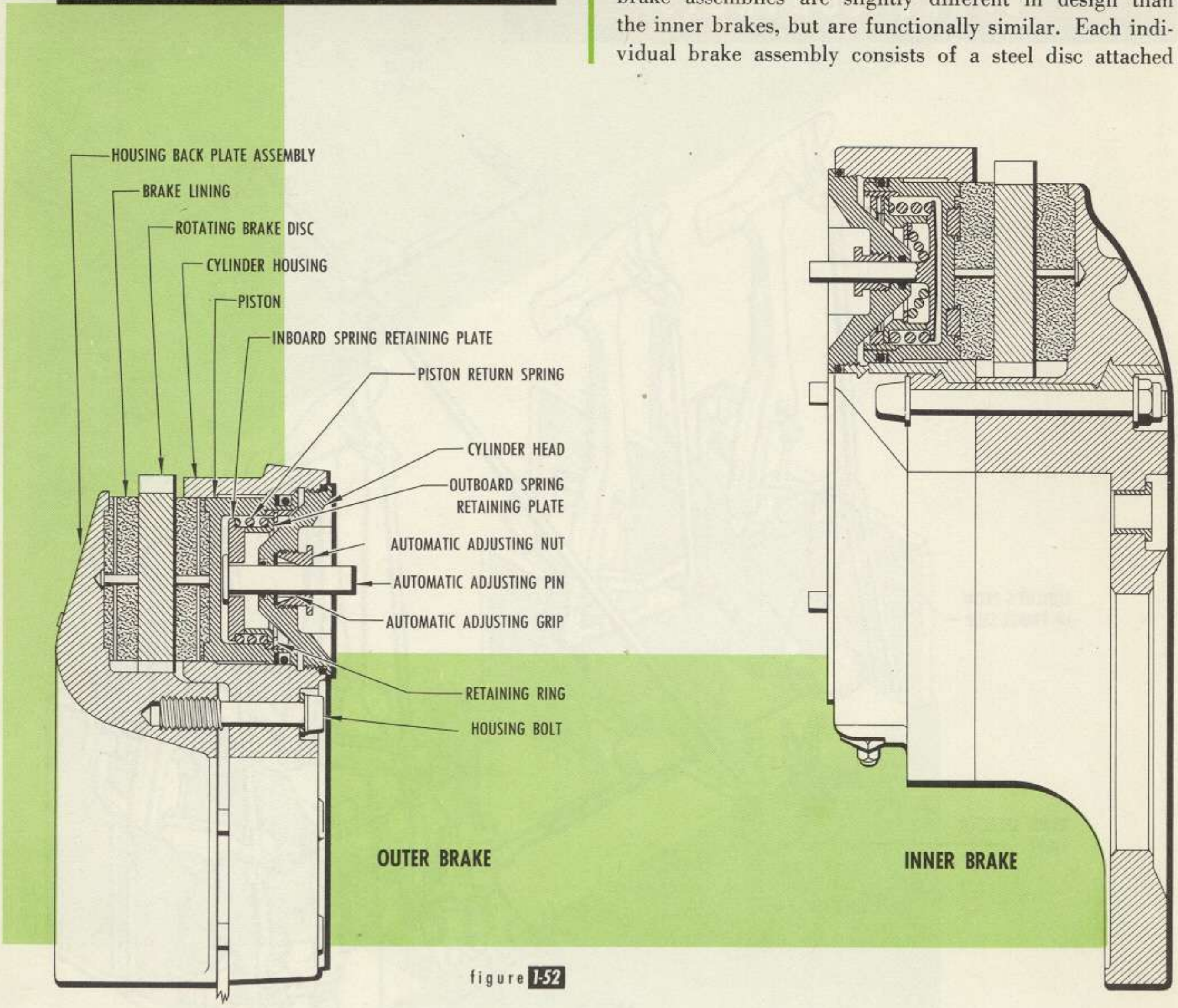


figure 1-52

1-279. BRAKE SYSTEM

1-280. GENERAL. Each main landing gear is equipped with two sets of power boosted hydraulic brakes. Both sets function together on pressure from the secondary hydraulic system, or accumulator and hand pump pressure. Hydraulic pressure enters the brake selector valve and is directed to the brake control valves. When the toe pedals are depressed, pressure is metered to the deboosters or debooster lockouts, as determined by the position of the brake selector valve. The pressure is then transmitted through the shuttle valves to the brake pistons.

1-281. BRAKES. Each main landing gear is equipped with four Goodyear single disc type brakes. The to the wheel and six cylinder and lining assemblies. They are arranged so that the steel disc is squeezed between the circular spots of brake lining when pressure is applied to the cylinder pistons. As the piston moves, the automatic adjusting pin is pulled through the automatic adjusting grip. Then, when the pressure on the piston is released, the spring returns the piston only as far as the head of the automatic adjusting pin is extended. Thus, the proper brake clearances are automatically and continuously maintained.

1-282. BRAKE SELECTOR VALVE LEVER. This lever (25, fig. 1-18) is located on the aft face of the center control stand, and has two positions: NORM (down) and

BRAKE CONTROLS

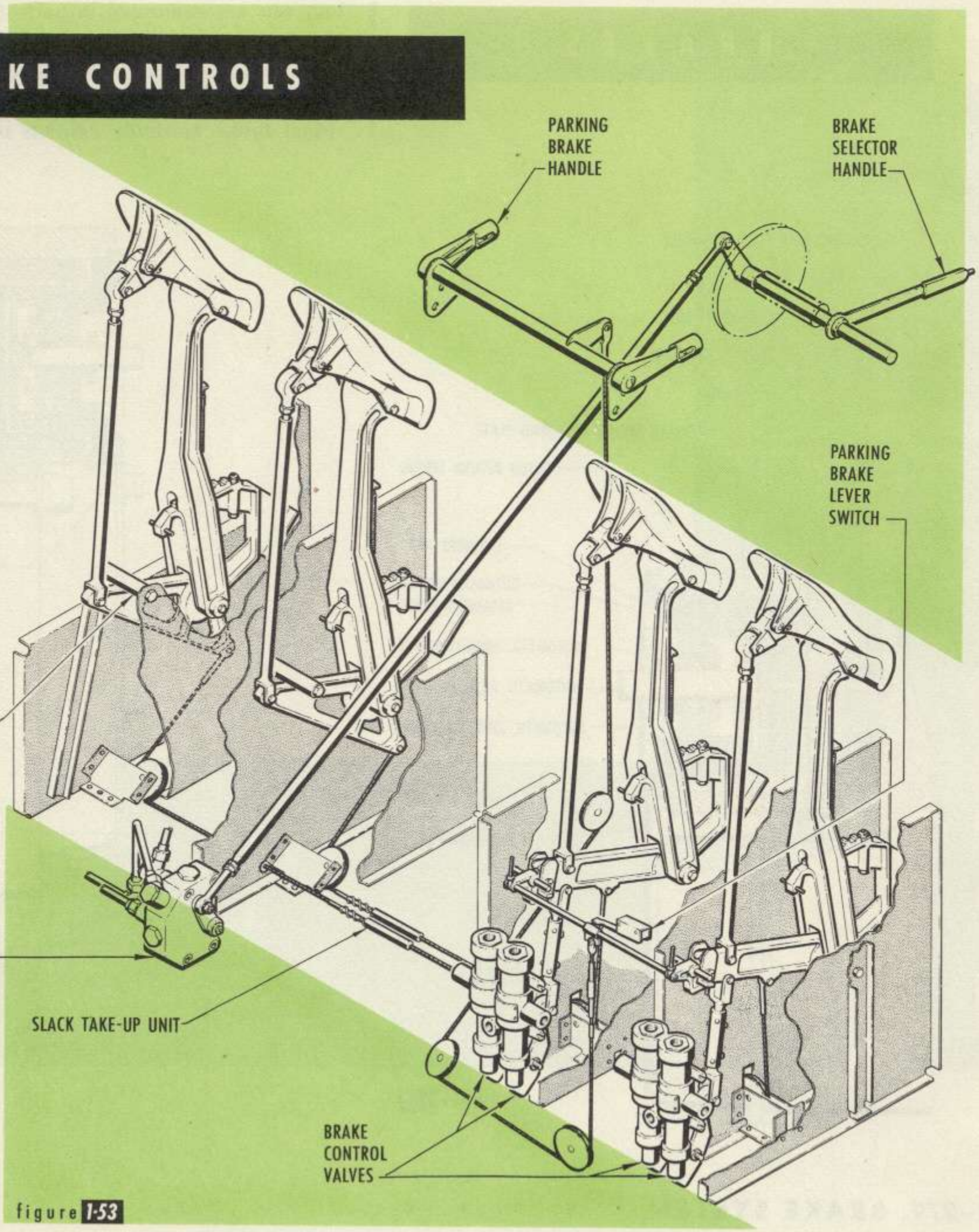


figure 1-53

EMER (up). When in the NORM position, it directs secondary system pressure to the normal side of the brake control valves, or, when secondary system pressure is not available the pressure from the hand pump is routed directly to the brake control valves, provided that the hand pump selector is in the EMER BRAKE position. When the brake selector is in the EMER position, secondary system pressure will operate the brakes and also fill the accumulators. If secondary pressure is not available, handpump pressure may be used to fill the accumulators when the hand pump selector is in the EMER BRAKE position.

1–283. BRAKE CONTROL VALVE. The brakes are controlled by two dual valves located on the bulkhead just forward of the rudder pedals. One side of the valve controls the fluid flow when the brake selector is in NORM and the other when it is in EMER position. The brake control valves are actuated by the rudder toe pedals in such a manner that the pedals can be depressed 5° before pressure is fed to the brakes. As the pedals are depressed

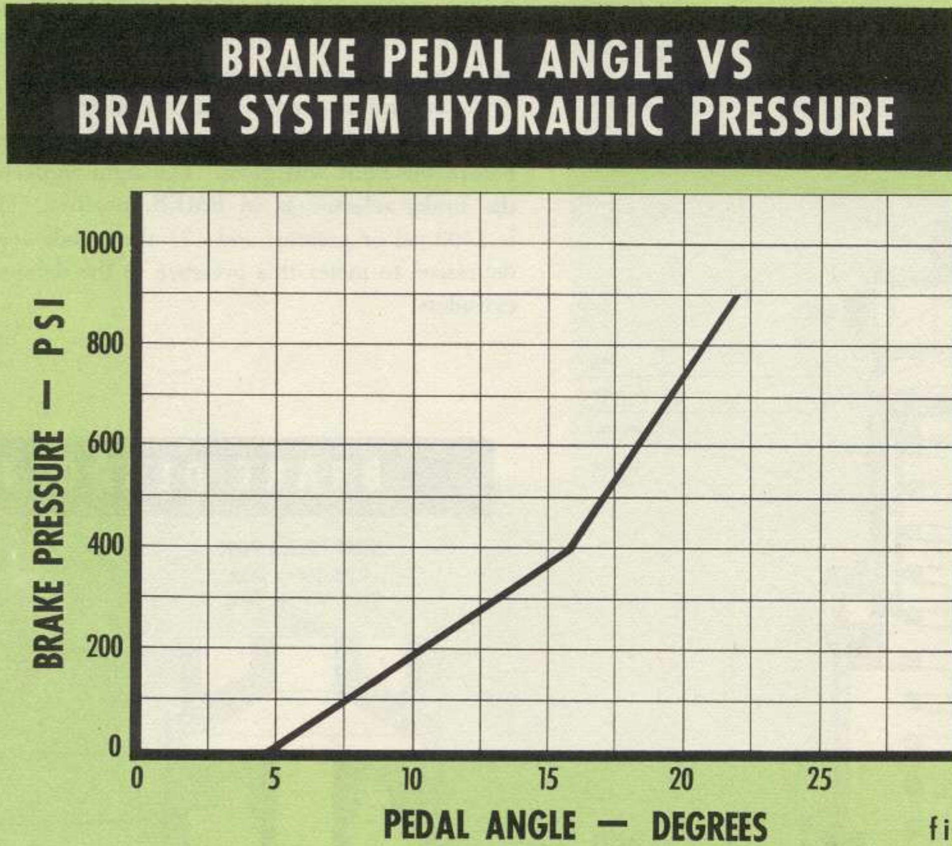


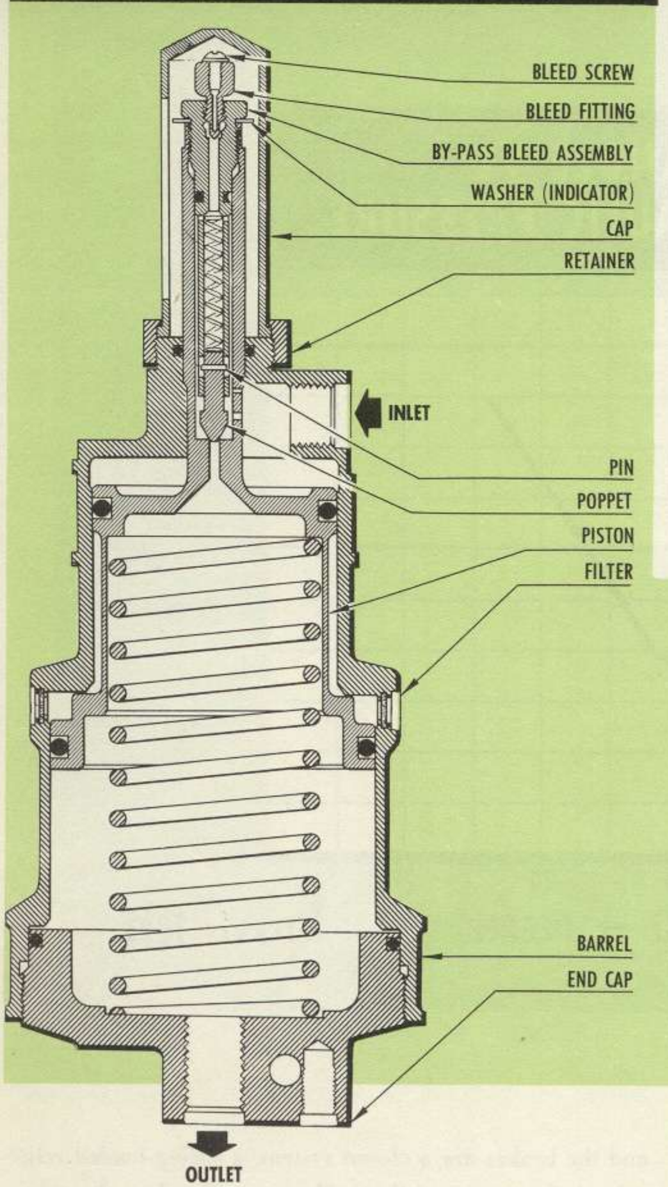
figure 1-54

beyond 5° the pressure increases in the relationship shown on Fig. 1-54. In addition, this valve serves to trap fluid in the brake lines when the parking brake lever is engaged. The design of the valve assures constant pressure in the brake lines while parked (with the brake selector in EMER), regardless of fluid expansion or contraction resulting from temperature changes. Fully charged accumulators maintain pressure to the brakes and provide safe parking for about 24 hours.

1–284. DEBOOSTER. The debooster cylinders are connected to the normal brake lines and reduce the secondary hydraulic system pressure from 1675 +25 —150 to 900 ±25 psi. Since the hydraulic lines between the debooster and the brakes are a closed system, a spring-loaded relief valve is incorporated that will open and reduce the excessive pressure resulting from thermal expansion of the fluid. In addition, an upset screw is installed in the debooster head to open the relief valve whenever the piston bottoms due to insufficient fluid. When the relief valve opens, the supply of fluid is replenished automatically.

1–285. DEBOOSTER LOCKOUT. The debooster lockout cylinders are connected into the emergency brake lines to reduce system pressure in the same manner as the normal brake system deboosters. The lockout cylinders, however, do not have provisions for automatically replenishing the fluid supply that is trapped between the lockout and

BRAKE DEBOOSTER LOCKOUT



the brakes. The relief valve, connected to an overboard drain, has been installed to dissipate excessive pressure.

1–286. SHUTTLE VALVES. Four shuttle valves are installed (two for each main gear). They route pressure from either the normal or emergency system to the brakes, depending upon which system is in use, and are positioned automatically by system pressure.

1–287. PARKING BRAKES. The brakes are applied for parking by depressing the toe pedals to position the brake control valves and raising the parking brake handle to lock the valves.

Note

The brake selector must be in EMER when using the parking brakes without secondary system pressure, so that the accumulators will be connected to supply pressure.

1–288. PARKING BRAKE INDICATOR LIGHT. A parking brake ON indicator light is connected to two switches in series. One switch is operated by the parking brake control mechanism and the other by pressure in the emergency brake lines. Both switches must be closed, before the light will glow. The light indicates that (1) the brake selector is in EMER. position, (2) pressure is 1400 psi or greater, and (3) the pedals are sufficiently depressed to meter this pressure to the debooster lockout cylinders.

BRAKE DEBOOSTER

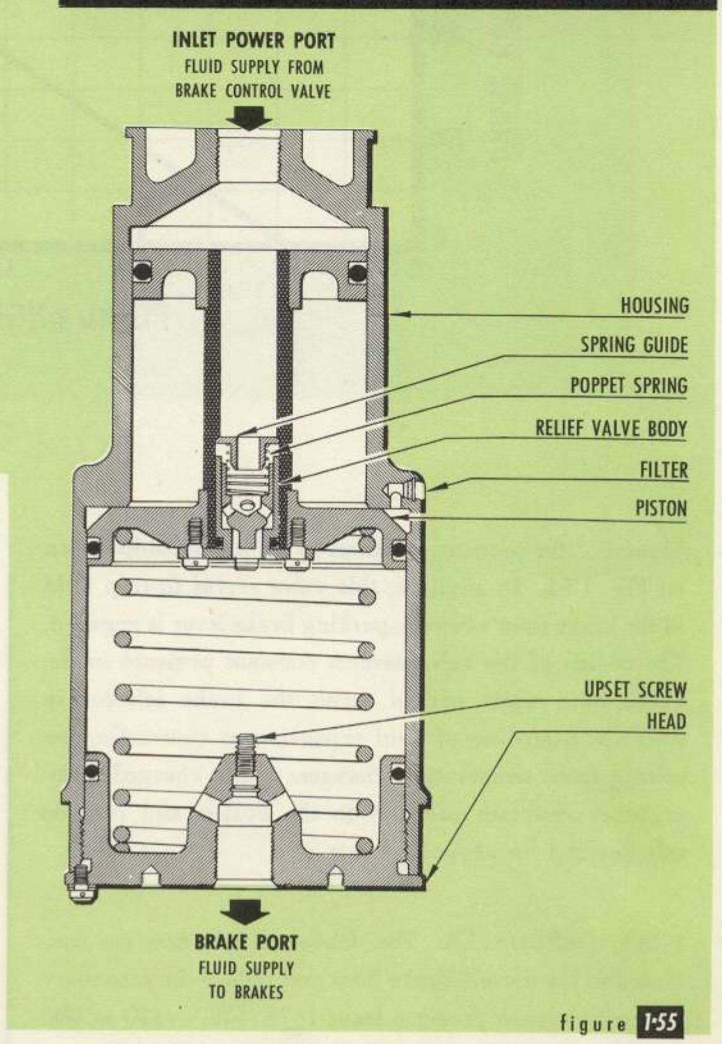


figure 1-55

1–289. INSTRUMENTS

1–290. GENERAL. The instruments are conventional electrically driven, vacuum operated, differential pressure and direct reading types, mounted in shock-absorbing panels which may be lighted with either direct or indirect lighting. In the following tabulations, instruments are grouped according to power sources.

1–291. 24-VOLT DIRECT CURRENT INSTRUMENTS.

1–292. The following instruments operate by direct current and are connected to the airplane d.c. power sources.

Instrument	Number	Location	Remarks
DC Voltmeter	1	MJB Panel.	Selector switch permits voltage readings for each of four generators, two batteries, and d.c. bus.
DC Ammeter	2 Dual	MJB Panel.	Continuous readings of current output for each of four generators.
Cylinder head temperature indicators.	2 Dual	Flight engineer's lower instrument panel.	Resistance bulb mounted on cylinders 1 and 2 of each engine. Selector switch permits temperature readings of front or rear row cylinders. Pointers return to zero when power is interrupted. (Reads full scale if power to bulb is interrupted.)
Supercharger drive-shaft bearing temperature indicator.	1 Dual	Flight engineer's lower instrument panel.	Measures temperature of rear bearings. Pointers return to zero when the power is interrupted.
Oil inlet temperature indicators.	2 Dual	Flight engineer's middle instrument panel.	Energized through resistance bulbs, mounted in outlet port of oil tank sump. Pointers return to zero when power is interrupted.
Oil outlet temperature indicators.	2 Dual	Flight engineer's middle instrument panel.	Resistant bulbs mounted at engine oil "out" port. Calibrated in half degrees. Pointers return to lower limits when power is interrupted.
Supercharger oil temperature indicator.	1 Dual	260 station panel.	Resistance bulb mounted in the oil "in" line. Pointers return to zero when power is interrupted.
Carburetor air temperature indicators.	2 Dual	Flight engineer's middle instrument panel.	Indicate induction air temperature at carburetor deck. Pointers return to lower limits of dials when power is interrupted.
Heater discharge duct temperature indicator.	1 Dual	260 station panel.	Resistance bulbs mounted in heater discharge duct. Indicator pointers return to lower limits when power is interrupted.
Refrigerator discharge duct temperature indicator.	1 Dual	260 station panel.	Resistance bulbs mounted in refrigerator discharge duct. Indicator pointers return to lower limits of dial when power is interrupted.
Anti-icer fluid tank quantity indicator.	1 Dual	Flight engineer's middle instrument panel.	Liquidometer. Indicates fluid in system's two tanks. Pointers return to zero when power is interrupted.
Fuel quantity indicators.	3 * 4 † Dual	Flight engineer's middle instrument panel.	Two types. Fuel in outer wing panel tanks is indicated on dual capacitor gage (placarded 2A and 3A). Fuel in inner wing tanks (tanks 1, 2, 3 and 4) is indicated on two dual liquidometer gages.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

Instrument	Number	Location	Remarks
			Fuel in center section tank† (tank 5) is indicated on a single liquidometer gage.† The capacitor gages indicate fuel in pounds; the liquidometers in U.S. gallons. The needles on the capacitor gages return to zero when the power is interrupted. The pointers on the liquidometer gages position themselves vertically when the power is interrupted.
Oil quantity indicators.	2 Dual	Flight engineer's middle instrument panel.	Liquidometers. Pointers position themselves vertically when power is interrupted.
Hydraulic fluid tank quantity gage.	1	Flight engineer's middle instrument panel.	Liquidometer. Float type. Pointer swings to left limit when current is interrupted.
Tachometers	4 Dual	Pilots' center and flight engineer's lower instrument panel.	Remote reading generator type. Operate independently of ship's electric system whenever engines are running. Without power, pointers return to zero.
Synchroscope	1 Triple	Flight engineer's lower instrument panel.	Operates on power from tachometers independently of ship's electric system. Operates whenever engines are operating. Indicators stop at any angle when power is interrupted.

1–293. POLYPHASE INSTRUMENTS.

1–293A. Several of the indicators in the flight station are components of electronic navigational instruments which require both direct and alternating current. The dual fluxgate compass installation requires 24-volt, direct current to energize the amplifier tubes, 115-volt 3-phase input from which is derived the 26-volt, alternating current to drive the gyros, and the other voltages necessary for system components. Alternating current to energize the remote indicators is supplied separately.

1–293B. FLUXGATE SYSTEM. Two fluxgate transmitters are installed in the left outer wing. The transmitters contain vertical-seeking gyro fluxgate elements that sense the heading of the airplane with relation to the earth's magnetic field, and transmit an electrical signal to two fluxgate amplifiers installed in the radio rack which provide signal amplification for two master direction indicators. The master direction indicators, which show the magnetic heading of the airplane, are mounted one on the pilot's and one on the copilot's instrument panels.

1–293C. On LAC Serials 4015 through 4024 the left fluxgate system is connected to the automatic pilot and on airplanes equipped for international usage the navigator's repeater indicator is connected to the copilot's master direction indicator transmitter magnesyn. The repeater indicator on the navigator's instrument panel must have the same heading as the copilot's master direction indicator within $\pm$ 2°.

1–293D. CAGING SWITCHES AND CAGING LIGHTS. Momentary type caging switches (21, 22, fig. 1-18) located on the front face of the center control stand are used to cage the gyros. When either switch is held in the up position, and released, a caging motor is energized. When the caging cycle is approximately 50% complete, the corresponding caging indicator light, (17, 18, fig. 1-18) located directly above the switch will glow and continue to glow until the caging cycle is complete. When the light goes out the gyros are uncaged, however they are not erected. It may require several minutes for the gyros to erect to gravity, depending on the attitude of the airplane. The nearer the airplane is to level, the sooner the gyros will erect.

1–293E. The dual VOR installation, dual ADF installation, dual VHF command installation, dual HF command installation, and the marker beacon receiver are components of the radio installation and are energized through that source. The deviation selector switch on the pilot's overhead panel permits the selection of either NAV. 1*, NAV. 2*, VOR 1† or VOR 2† as a signal source for the flight station indicators.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

Instrument	Number	Location	Remarks
Fluxgate master indicators.	2	Pilot's and copilot's instrument panels.	No ON-OFF switches. Energized whenever a.c. and d.c. busses are energized. Indicators stop where they are when power is interrupted.
Fluxgate compass repeater.†	1	Navigator's instrument panel.	Slaved to copilot's master direction indicator magnesyn.
ILS deviation indicators.	2 in parallel	Pilot's and copilot's instrument panels.	Receives signals from VHF navigation receivers when tuned to ILS and VOR frequencies. However, only the localizer needle functions in the VOR range. OFF flag shows over needle when either is not energized.
ADF indicator †	1	Navigator's instrument panel.	Operated by ADF-2 (green) radio system.
RMI (Radio Magnetic Indicators).	2	Pilot's and copilot's instrument panels.	Receives signals from the VHF navigation receivers when the receivers are tuned to a frequency within the VOR range. Signals are eliminated when the receivers are tuned to ILS frequency.
OBS (Omni-Bearing Selectors).	1 * 2 †	Pilot's and copilot's † instrument panels.	Receive signals from the VHF navigation receivers when the receivers are tuned to a frequency within the VOR range.

1–294. ALTERNATING CURRENT INSTRUMENTS.

1–294A. The following instruments operate on alternating current.

Instrument	Number	Location	Remarks
A.C. voltmeter	1	MJB panel.	Selector switch permits voltage readings for each phase of the 115-volt a.c. system and the 26-volt a.c. system.
115-volt 3-phase alternating current instruments.			
Gyro horizons.	2	Pilot's and copilot's instrument panels.	Will not tumble in any direction. Erected by spring-loaded, pull knob. Warning flag on dial appears when power is interrupted.*
Turn and bank indicators.*	2	Pilot's and copilot's instrument panels.	No ON-OFF switch. Power from inverter or alternators. Two fuses each. Pointers remain stationary in vertical position when current is interrupted.
Outside air temperature indicators.	2 * 3 †	Pilot's, flight engineer's middle, and navigator's † instrument panels.	Calibrated from —40°C to +40°C. Pointers return to bottom of scale when power is interrupted.
Power failure indicators †	2	Pilot's and copilot's instrument panels.	Fluorescent half of indicator appears when faulty power is supplied to gyro horizon.
26-volt alternating current instruments.			
B.M.E.P. gages (torquemeters).	2 Dual	Flight engineer's lower instrument panel.	Measure shaft output of each engine. Autosyn numbered pointers stop where they may be when power is interrupted.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

Instrument	Number	Location	Remarks
Manifold pressure indicators.	4 Dual	Pilots' center and flight engineer's lower instrument panel.	Indicates intake manifold pressure in inches of mercury. Magnesyn. Pointers stop where they are when power is interrupted.
Wing flap position indicator.	1	Pilots' center instrument panel.	Placarded for positions: UP, TAKE-OFF, APPROACH, 80% and LAND. Flap control lever has detents at these positions. Magnesyn instrument. Pointers remain where they are when power is interrupted.
Cowl flap position indicators.	2 Dual	Flight engineer's lower instrument panel.	Calibrated in percent from SHUT to 100% OPEN. Magnesyn instruments. Pointers stop where they are when power is interrupted.
Oil cooler flap position indicators.	2 Dual	Flight engineer's middle instrument panel.	Calibrated in percent from SHUT to 100% OPEN. Magnesyn instruments. Pointers remain where they are when power is interrupted.
Fuel pressure indicators.	2 Dual	Flight engineer's lower instrument panel.	Indicate pressure at carburetor. Magnesyn instruments, calibrated in psi. Pointers remain where they are when power is interrupted.
Hydraulic fluid pressure indicators.	2 Dual	Pilots' center instrument panel* or copilot's auxiliary instrument panel † and flight engineer's middle instrument panel.	Indicate pressure in psi x 100 in primary and secondary hydraulic systems. Magnesyn instruments. Pointers remain where they are when power is interrupted.
Rear pump oil pressure indicators.	2 Dual	Flight engineer's lower instrument panel.	Calibrated from zero to 200 psi with normal operating range indicated. Magnesyn instruments. Pointers remain where they are when power is interrupted.
Supercharger oil pressure indicator.	1 Dual	260 station panel.	Indicates pressure at oil inlet. Magnesyn instrument. Pointers remain in operating range when power is interrupted.
Fuel flow indicators.	2 Dual	Flight engineer's lower instrument panel.	Calibrated in pounds per hour. Mcgnesyn instruments. Pointers stop where they are when power is interrupted.

1–295. DIRECT READING INSTRUMENTS.

1–295A. The direct reading instruments are energized directly from the systems of which they are a part, or are self-energized. They are as follows:

Instrument	Number	Location	Remarks
Vacuum Gage	1 * 2 †	Pilot's auxiliary and pilots' center† instrument panel.	Indicates vacuum in airplane's system in inches of mercury. Two warning lights mounted above gage with two in parallel on flight engineer's lower instrument panel (placarded DE-ICER PUMP WARNING), light when vacuum drops to 4 inches of mercury at the pumps.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

Instrument	Number	Location	Remarks
Emergency brake pressure indicator.	1	Pilots' center instrument panel.* Copilot's side panel.†	Indicates hydraulic pressure in accumulators when selector valve is in NORMAL position, and pressure in system for emergency use when selector is in EMERGENCY position.
Inclinometer.*	1	Flight engineer's lower instrument panel.	Ball-in-liquid pitch indicator. Indicates nose up and nose down angle from 0° to 10°.
Clocks.	3 * 5 †	Pilot's, copilot's, flight engineer's lower, radio operator's † and navigator's † instrument panels.	Spring-powered, 8-day, 12-hour, minute-marked dials with sweep second hand.
De-icer pressure gage.	1	Copilot's auxiliary instrument panel.* Pilot's auxiliary instrument panel.†	Indicates de-icer system pressure in psi.
Supercharger air pressure indicators.	2 Dual	260 station panel.	Indicates pressure in inches of mercury at inlet and outlet of both superchargers. Indications are variable with demand. Ratio not to exceed 1.9 to 1.
Cabin air temperature indicator.	1	260 station panel.	Indicates cabin air temperature in degrees from —40° to +40°C.

1–295B. VACUUM OPERATED INSTRUMENTS.†

1–295C. The instruments listed below are vacuum operated.

Instrument	Number	Location	Remarks
Vacuum gages.†	2	Pilot's auxiliary and pilots' center instrument panels.	Gages indicate the amount of suction available to operate de-icing boots, cabin pressure relief valve, turn and bank instruments, and directional gyro. Vacuum is supplied by de-icer pumps on engines Nos. 2 and 3.
Turn and bank indicators.†	2	Pilot's and copilot's instrument panels.	No ON-OFF switch. Indicators operate when vacuum is available.
Directional gyro.†	1	Pilots' center instrument panel.	Gyro operates when vacuum is available and gyro is uncaged. The caging knob is also used to set the initial magnetic heading.

1–296. DIFFERENTIAL PRESSURE INSTRUMENTS.

1–296A. The differential pressure instruments receive their energy through the pitot-static system (see para. 1–298) or from sources within the systems of which they are a part.

Instrument	Number	Location	Remarks
Cabin differential pressure gage.	1	260 station panel.	Connected to flush static line on one side and vented to the cabin on the other side of the diaphragm. Measures differential pressure between cabin and outside air.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

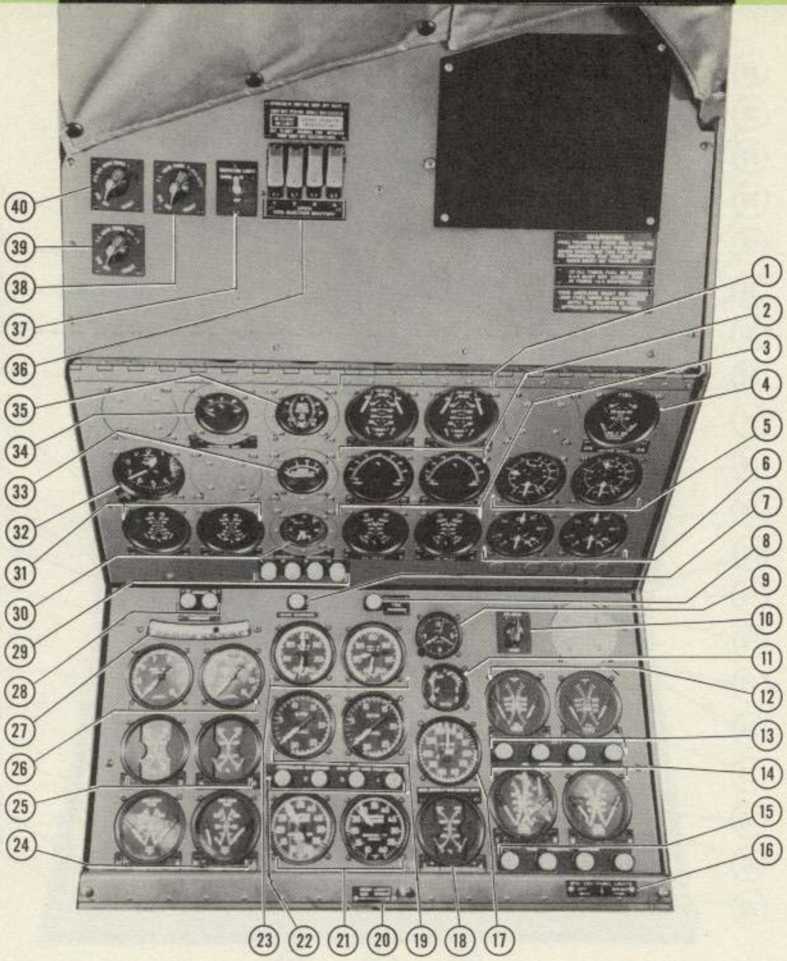
Instrument	Number	Location	Remarks
Hydraulic return line secondary filter differential pressure gage.*	1 Dual	Station 260 bulkhead.	Measures differential pressure across filtering element.
Rate of climb indicators.	3	Pilot's and copilot's instrument panels, and station 260 panel.	Pilot's indicator is connected to pilot's flush static source; copilot's to copilot's flush static source. Indicator on the station 260 panel is vented to cabin and indicates rate of change in cabin pressure.
Altimeters.	4	Pilot's instrument panel, pilots' center instrument panel*, navigator's instrument panel,† copilot's instrument panel and flight engineer's middle instrument panel.	The two altimeters on pilot's instrument panels* or the pilot's and navigator's altimeter† are connected to the pilot's flush static pick-up source; the instruments on the copilot's and flight engineer's instrument panels are connected to the copilot's flush static pick-up source. Aneroid instruments.
Cabin altitude indicator.	1	260 station panel.	Altimeter, vented to cabin pressure.
Airspeed indicators.	3 * 4 †	Pilot's, copilot's, flight engineer's lower, and navigator's † instrument panels.	Pilot's and navigator's† indicators are connected to pilot's pitot head and flush static pick-up source; copilot's and flight engineer's indicators are connected to the copilot's pitot head and static pick-up source. Placarded speed limitations are indicated on dials.

1-297. MISCELLANEOUS INDICATORS.

Instrument	Number	Location	Remarks
Standby compass.	1	Above pilots' center instrument panel.	Magnetic compass.
CO_2 bottle discharge indicators.	8	Lower right side of fuselage forward of the wing.	Red seals. When ruptured, indicate thermal relief valves have discharged CO_2 bottle.
Oxygen bottle discharge indicator.	1	Left side of fuselage near forward door.	Red seal. When ruptured, indicates thermal relief discharge.
Wash water tank gage.	1	Aisle side of men's lavatory partition.	Float type, direct reading quantity gage, calibrated in quarters.
Terrain warning indicator lights.†	2	Pilot's and copilot's auxiliary instrument panels.	Three lights, one will glow at 500, the second at 1000, and the third at 2000 feet altitudes if selected. Copilot's lights are inoperative.
Three axis trim indicator.†	1	Pilot's center instrument panel.	Operated by elevator, aileron and rudder servo amplifier channels and indicates relative torque and direction in which the torque is exerted. Indicator operates when automatic pilot is turned on.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

FLIGHT ENGINEER'S INSTRUMENT PANELS*

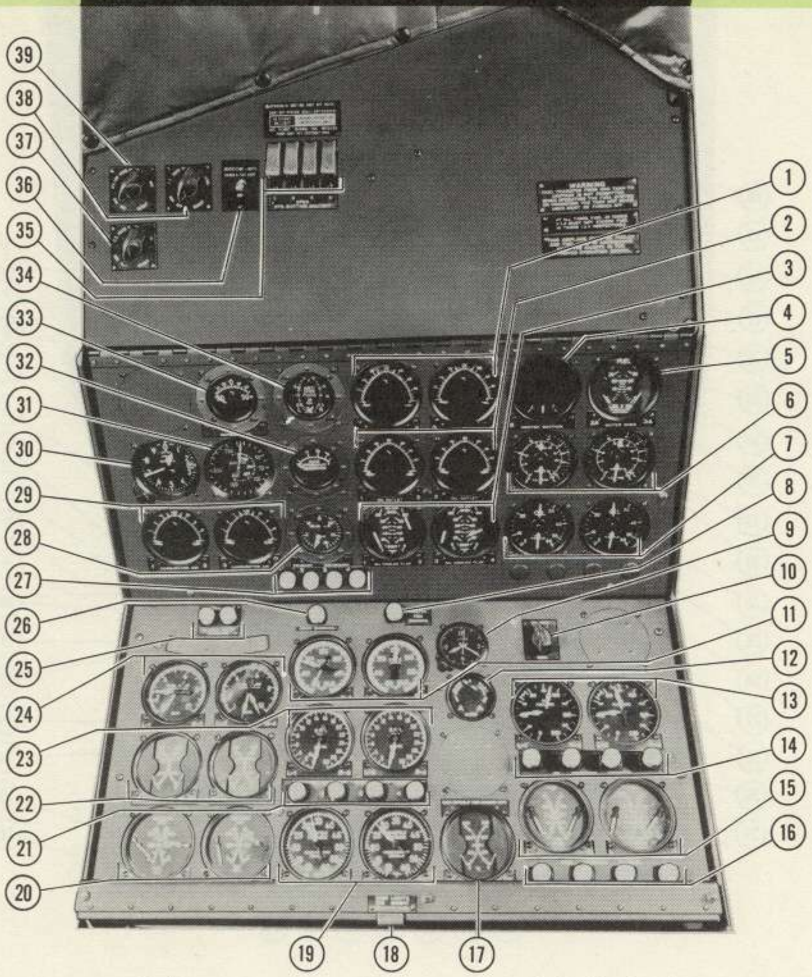


1. Oil cooler flap position indicators
2. Oil outlet temperature indicators
3. Oil inlet temperature indicators
4. Tanks 2A and 3A—fuel quantity indicator
5. Tanks 1, 2, 3, and 4—fuel quantity indicators
6. Engine oil quantity indicators
7. Door warning light
8. Master fire warning light
9. Clock
10. Cylinder head temperature selector switch
11. Synchroscope
12. Engine rear pump oil pressure indicators
13. Oil low pressure warning lights
14. Fuel pressure indicators
15. Fuel low pressure warning lights
16. Station 260 panel lights switch
17. Airspeed indicator
18. Supercharger drive shaft rear bearing temperature indicator
19. Tachometers
20. Desk lights switch
21. Manifold pressure indicators
22. Propeller governor high and low pitch position indicator lights
23. B.M.E.P. gages
24. Cowl flap position indicators
25. Cylinder head temperature indicators
26. Fuel flow indicators
27. Inclinometer
28. De-icer pump warning lights
29. Hydraulic pump low pressure warning lights
30. Hydraulic systems pressure indicator
31. Carburetor air temperature indicators
32. Altimeter
33. Main hydraulic reservoir quantity indicator
34. Outside air temperature indicator
35. Anti-icer fluid tank quantity indicator
36. Hydraulic suction shut-off valve switches
37. Cargo compartment and tail section inspection lights switch
38. Flight engineer's instrument panel floodlights switch
39. Flight engineer's instrument panel auxiliary lights switch
40. Station 260 panel floodlights switch

figure 1-56

*LAC Serials 4001–4014

FLIGHT ENGINEER'S INSTRUMENT PANELS †



1. Oil inlet temperature indicators
2. Oil outlet temperature indicators
3. Oil cooler flap position indicators
4. Center section tank (tank #5) fuel quantity indicator
5. Tanks 2A and 3A—fuel quantity indicator
6. Tanks 1, 2, 3, and 4 fuel quantity indicators
7. Engine oil quantity indicators
8. Master fire warning light
9. Clock
10. Cylinder head temperature selector switch
11. B.M.E.P. gages
12. Synchroscope
13. Oil pressure indicators
14. Oil low pressure warning lights
15. Fuel pressure indicators
16. Fuel low pressure warning lights
17. Supercharger drive shaft rear bearing temperature indicator
18. Desk lights switch
19. Manifold pressure indicators
20. Cowl flap position indicators
21. Propeller governor high and low pitch position indicator lights
22. Cylinder head temperature indicators
23. Tachometers
24. Fuel flow indicators
25. De-icer pump warning lights
26. Door warning light
27. Hydraulic pump low pressure warning lights
28. Hydraulic systems pressure indicator
29. Carburetor air temperature indicators
30. Altimeter
31. Air speed indicator
32. Main hydraulic reservoir quantity indicator
33. Outside air temperature indicator
34. Anti-icer fluid tank quantity indicator
35. Hydraulic suction shut-off valve switches
36. Cargo compartment and tail section inspection lights switch
37. Flight engineer's instrument panel auxiliary lights switch
38. Flight engineer's instrument panel floodlights switch
39. Station 260 panel floodlights switch

figure 1-56A

†LAC Serials 4015–4024

1–298. PITOT-STATIC SYSTEM

1–299. GENERAL. The pitot-static system includes: the pitot system through which impact air is transmitted to the airspeed indicators, and the flush static system through which outside air pressure (static) is transmitted to the altimeters, airspeed indicators, rate of climb indicators, the cabin differential pressure gage, pressure switch and to the altitude control† of the automatic pilot.

1–300. PITOT SYSTEM. Two separate pitot systems are provided. (See Fig. 1-57.) The two pitot heads are mounted two inches to the right and left of the airplane centerline on the underside of the forward end of the fuselage at station 160. Two small holes in the lower sides of the pitot heads permit water to drain out of the heads. The built-in electric heating elements in each head, which prevent the formation of ice in the impact air tubes, operate from the airplane's 24-volt d.c. system. The heaters are controlled by switches mounted on the copilot's side panel. Heaters automatically increase power for low temperatures and decrease power when temperature rises. Indicator lights adjacent to the switches indicate power ON, and will go out if circuit is interrupted or heaters fail.

CAUTION

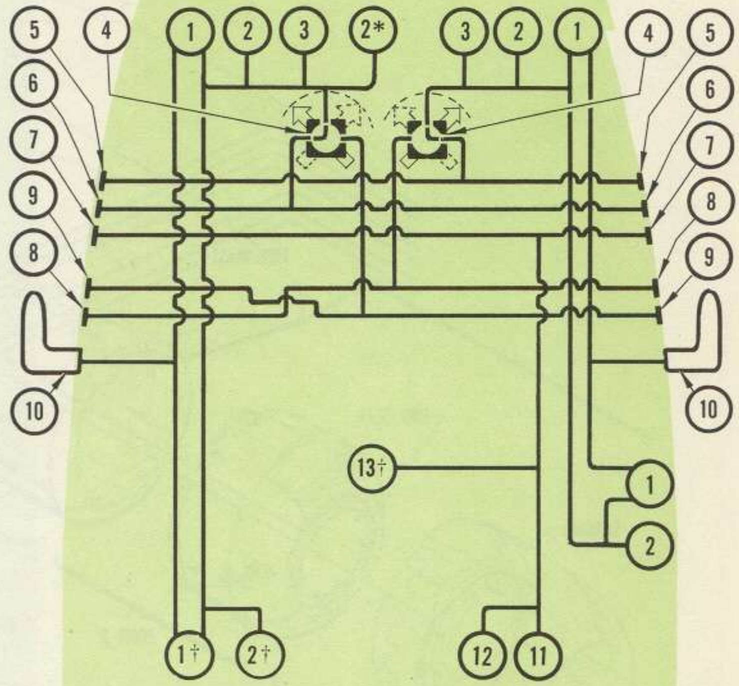
Always cover pitot heads to keep foreign matter out of tubes when the airplane is on the ground.

1–301. The pilot's and navigator's† airspeed indicators are connected to the left hand pitot head; the copilot's and flight engineer's airspeed indicators are connected to the right hand pitot head.

1–302. FLUSH STATIC SYSTEM. Static outside air pressure is transmitted from flush vents in the fuselage skin to the differential pressure flight instruments. Ten flush static vents are provided, five on each side of the fuselage. Opposing vents are interconnected to equalize the pressure between the two sources. (See Fig. 1-57.)

1–303. PITOT-STATIC SYSTEM INDICATORS. The pilot's airspeed indicator, two altimeters,* and rate of climb indicator, are teed to both the pilot's No. 1 and No. 2 flush

PITOT-STATIC SYSTEM



1	AIRSPEED INDICATOR
2	ALTIMETER
3	RATE OF CLIMB INDICATOR
4	FLUSH STATIC SELECTOR VALVE
5	COPILOT'S STATIC NO. 2 PICK-UP SOURCE
6	PILOT'S STATIC NO. 2 PICK-UP SOURCE
7	STATION 260 PANEL FLUSH STATIC PICK-UP SOURCE
8	COPILOT'S STATIC NO. 1 PICK-UP SOURCE
9	PILOT'S STATIC NO. 1 PICK-UP SOURCE
10	PITOT HEAD
11	CABIN DIFFERENTIAL PRESSURE GAGE
12	PRESSURE SWITCH
13	ALTITUDE CONTROL

figure 1-57

*LAC Serials 4001–4014 †LAC Serials 4015–4024

FIRE DETECTION SYSTEM

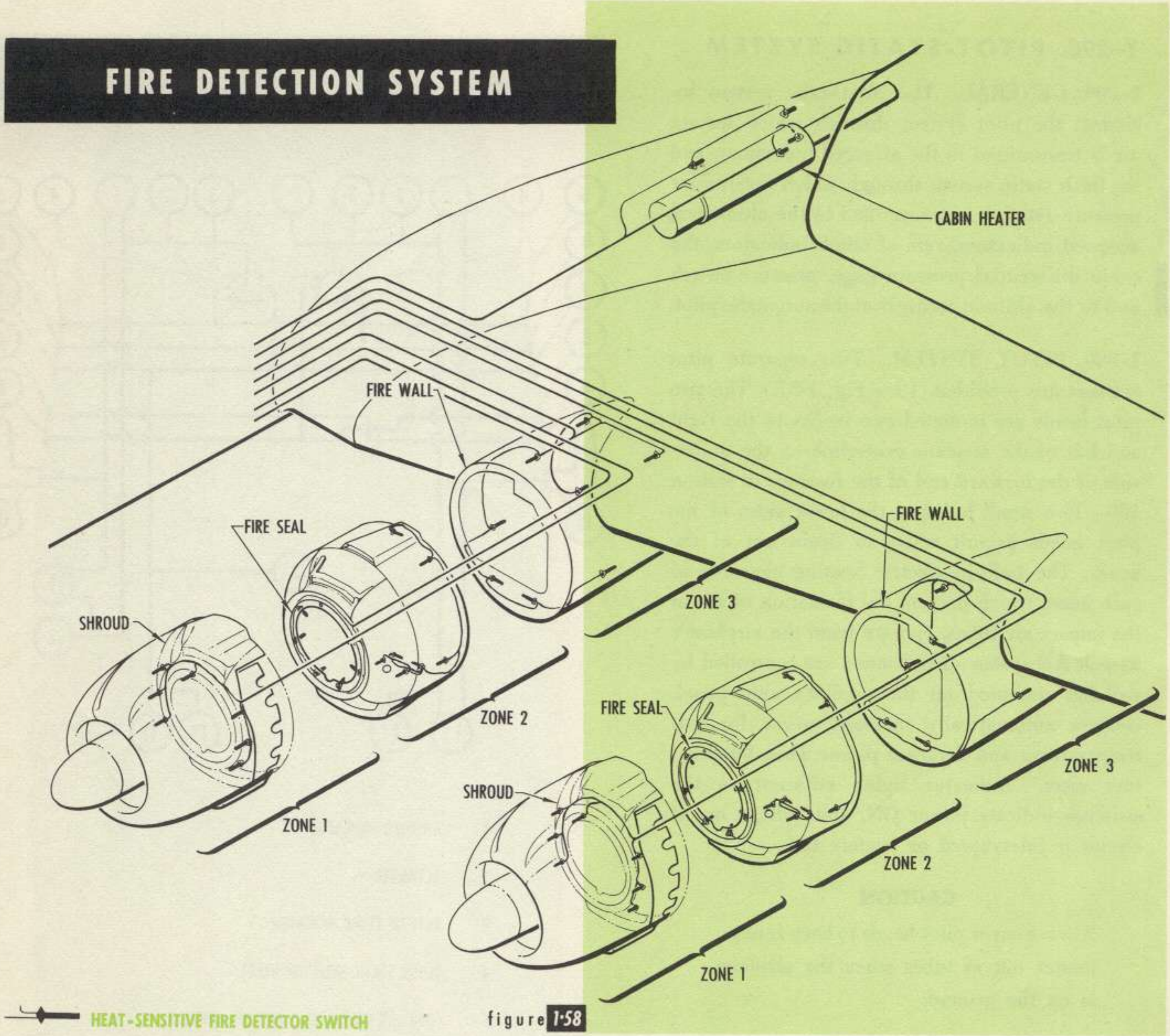


figure 1-58

static sources, with a selector valve located on the pilot's instrument panel. The copilot's airspeed indicator, altimeter, and rate of climb indicator, and the flight engineer's airspeed indicator and altimeter are teed to both the copilot's No. 1 and No. 2 alternate flush static sources with a selector valve located on the copilot's instrument panel. The cabin differential pressure gage and pressure switch are connected to the third flush static source. There is no alternate source for these instruments.

1–304. VACUUM SYSTEM

1–305. GENERAL. Two engine-driven pumps, one mounted on each inboard engine, supply vacuum to the de-icer air pump selector valve and the cabin pressure regulator (outflow) valves and through a solenoid, to the rear pressure bulkhead outflow valve. In LAC Serials 4001 through 4014, they serve no other function and they are discussed in connection with ice elimination and prevention in Section IV. In LAC Serials 4015 through 4024, the turn and bank and directional gyro indicators on the pilots' instrument panel are vacuum operated and the suction is provided by the inboard engine de-icing pumps. The de-icer vacuum selector valve is located on the off-set in the flight station floor behind the pilot's seat. In an emergency, the vacuum to the de-icer boots and cabin pressurization controls may be shut off by placing that valve in the OFF position so that maximum suction will be available for the vacuum operated instruments.

1–306. CREW SEATS

1–307. GENERAL. In LAC Serials 4001 through 4014 seats are provided for pilot, copilot, flight engineer, flight observer, and three flight attendants. Airplanes equipped

FIRE EXTINGUISHING SYSTEM

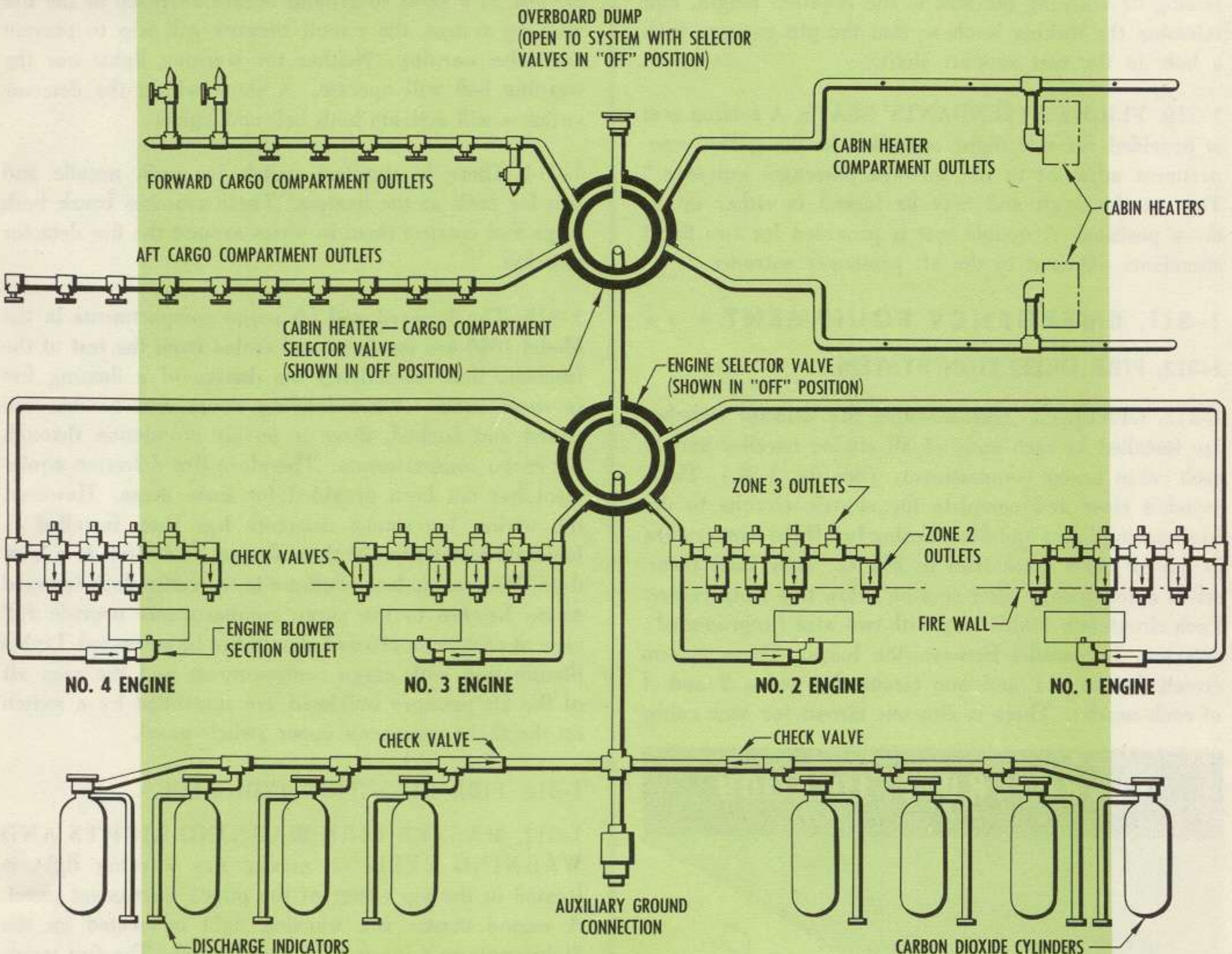


figure 1-59

for international service in LAC Serials 4015 through 4024, seats are provided for pilot, copilot, flight engineer, radio operator, navigator and two flight attendants.

1–308. PILOTS' SEATS. The pilot's and copilot's seats have tilting backs and are adjustable for height and for fore and aft position with the occupant seated. Levers for tilting the back rests and for raising or lowering the seats are located on the outboard sides of both seats. The handles for adjusting and locking the seats in fore and aft postion are on the inboard sides near the floor. Both seats slide on tracks. The pilot's seat may be removed by releasing the fore and aft control lever and sliding it aft and off the tracks. The tracks must be removed to remove the copilot's seat. Arm rests are hinged so that they may be raised out of the way when not required.

1–309. FLIGHT ENGINEER'S SEAT. The flight engineer's seat is adjustable for position and is arranged to swivel. It does not have a tilting back and is not adjustable for height. The control levers for locking the seat in any spanwise position are located on both sides of the seat near the floor, and the lever for locking the seat in any rotational position is underneath at the left center.

1–309A. OBSERVER'S SEAT*. An observer's seat is mounted on spanwise tracks aft of the pilot's seat on the left side of the flight station. It is adjustable for position, and swivels within the limits of adjacent equipment. The back does not tilt, nor is it adjustable for height.

1–309B. RADIO OPERATOR'S SEAT.† The radio operator's seat is similar to the flight engineer's seat.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

1–309C. NAVIGATOR'S SEAT.† The navigator's seat is a stool with a back rest. The height of the stool may be adjusted through a range of 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.

1–310. FLIGHT ATTENDANTS' SEATS. A folding seat is provided for one flight attendant in the galley compartment adjacent to the forward passenger entrance.* The seat faces aft and may be locked in either up or down position. A double seat is provided for two flight attendants adjacent to the aft passenger entrance.

1–311. EMERGENCY EQUIPMENT

1–312. FIRE DETECTION SYSTEM.

1–313. GENERAL. Heat-sensitive fire detector switches are installed in each zone of all engine nacelles and in each cabin heater compartment. (See fig. 1-58.) These switches close and complete the electric circuits to the fire warning lights and fire warning bell if the temperature in any of these areas rises to 232°C. 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. 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 master relay coil open circuit. If a short to ground occurs anyplace 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 within the detector switches will activate both bell and lights.

FLARE CHUTE LOCATION

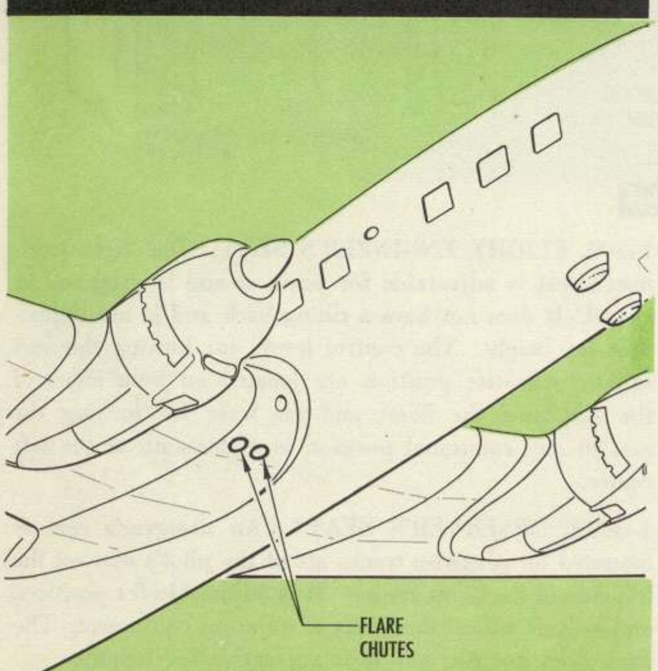


figure 1-60

1–314. 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.

1–315. The forward and aft cargo compartments in the Model 1049 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 no air circulation through the cargo compartments. Therefore fire detection equipment has not been provided for these areas. However, the wiring for smoke detectors has been installed to facilitate installation of these devices if desired at a later date. Wide angle lens windows in the cabin floor forward access hatches to the cargo compartments provide full view of each compartment should fire be suspected. 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.

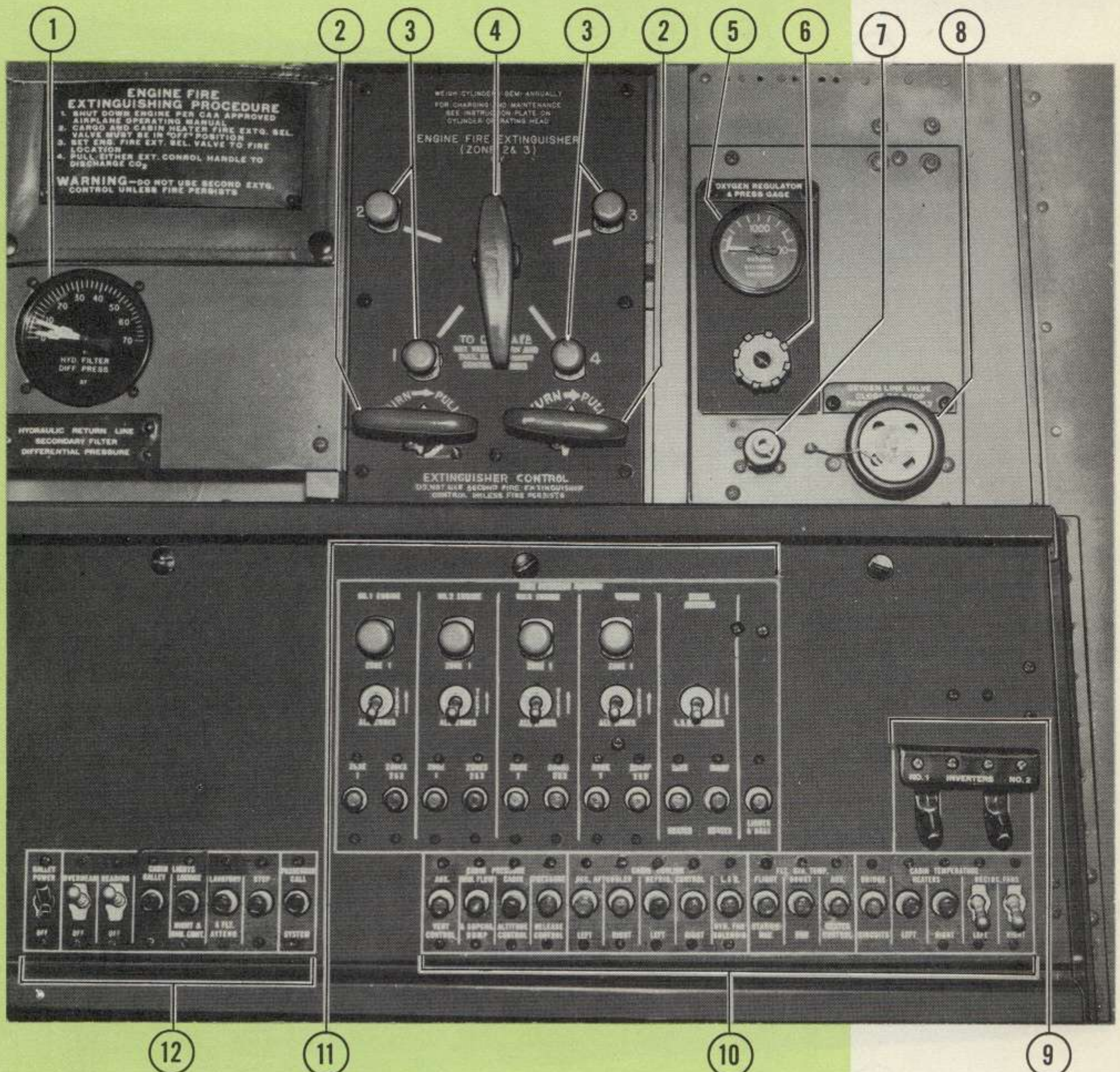
1–316. FIRE DETECTION INDICATORS.

1–317. MASTER FIRE WARNING LIGHTS AND WARNING BELL. A master fire warning light is located in the top center of the pilot's instrument panel. A second master fire warning light is located on the flight engineer's lower instrument panel. 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.

1–318. 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 on the station 260 bulkhead. The zone 1 engine fire warning lights are located on the station 260 circuit breaker panel. Fire warning lights for the left and right cabin heater compartments are located adjacent to the cabin heater and cargo compartment 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

†LAC Serials 4015–4024

STATION 260 UPPER PANEL*

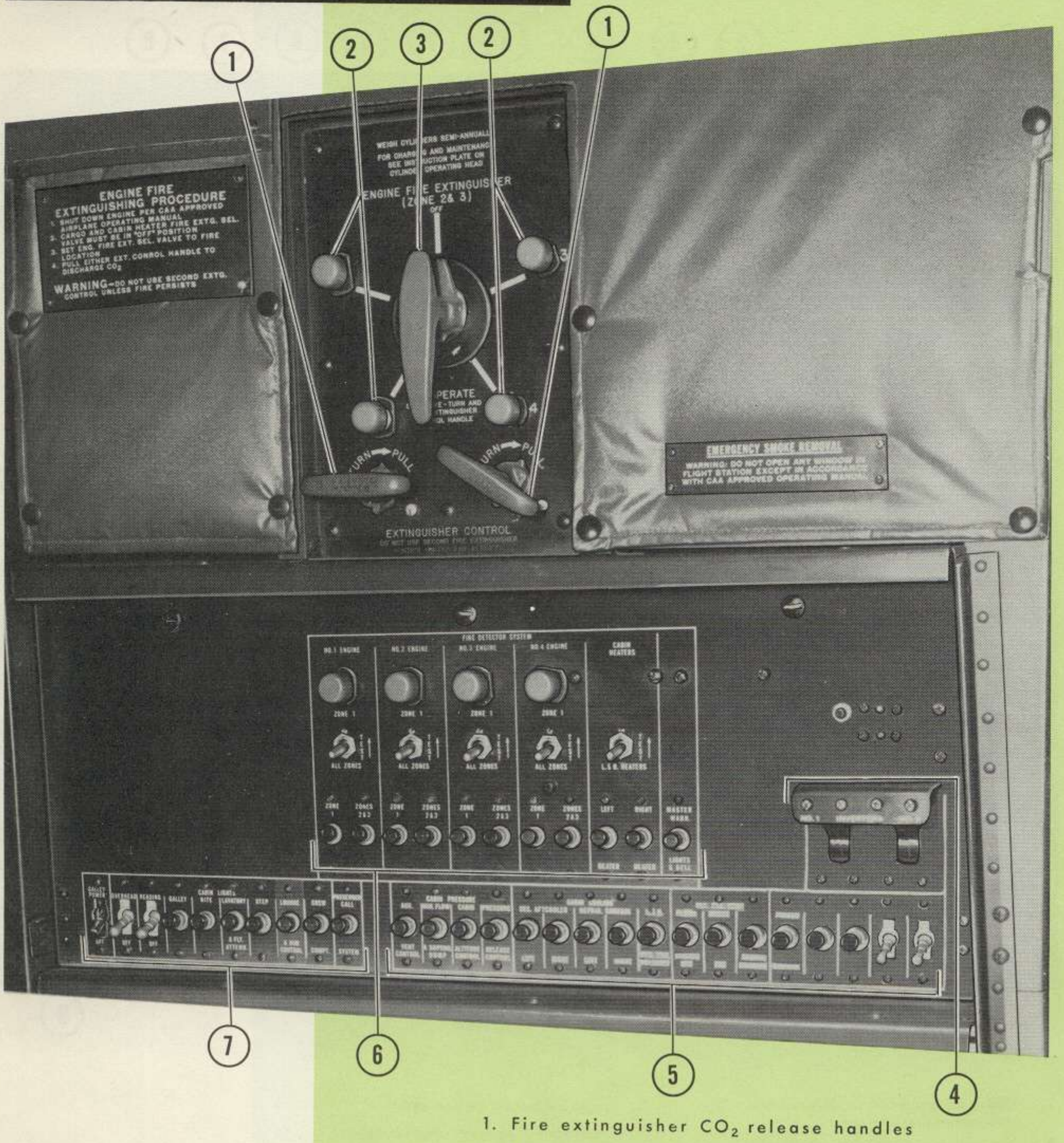


1. Hydraulic return line secondary filter differential pressure gage
2. Fire extinguisher CO_2 release handles
3. Engine fire indicator lights
4. Fire extinguisher engine selector
5. Oxygen system pressure gage
6. Oxygen flow control knob
7. Flight engineer's oxygen outlet
8. Passenger oxygen line shut-off valve
9. Inverter circuit breakers
10. Air conditioning system circuit breakers
11. Engine fire detector control panel
12. Passenger compartment circuit breakers

figure 1·61

*LAC Serials 4001–4014

STATION 260 UPPER PANEL†



1. Fire extinguisher CO_2 release handles
2. Engine fire indicator lights
3. Fire extinguisher engine selector
4. Inverter circuit breakers
5. Air conditioning system circuit breakers
6. Engine fire detector control panel
7. Passenger compartment circuit breakers

figure 1-61A

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

1–319. FIRE EXTINGUISHING SYSTEM.

1–320. GENERAL. A two shot fire extinguishing system (fig. 1-59) is installed to extinguish fires in engine zones No. 2 and No. 3, forward and aft cargo compartments, and cabin heater compartments. In addition to this system, three portable hand-operated carbon dioxide fire extinguishers are provided. One is located at each of the cabin attendant's stations and the other is located in the flight station.

1–321. The fire extinguishing system consists of two separately controlled groups of four 12.5 pound cylinders of carbon dioxide, operating heads, two selector valves, cable controls, and a distribution system.

1–322. The carbon dioxide cylinders are mounted on the right side of the forward baggage compartment. Gas is released from each group of four cylinders when the seal of the master cylinder is broken. Pulling the fire extinguisher control handle on the station 260 panel 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 three cylinders. Once the control handle has been pulled and the gas charge in the master cylinder has been released, the charges in all of the cylinders in that group are released.

Note

The selector valves are connected in series and the engine fire extinguisher handle must be in the OFF position to extinguish a cabin heater or cargo compartment fire.

1–323. An auxiliary ground connection is located on the right wall of the nose wheel well.

1–324. 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 port is directed outside of the airplane and 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.

1–325. FIRE EXTINGUISHING SYSTEM CONTROLS.

1–326. ENGINE FIRE EXTINGUISHER SELECTOR HANDLE. The handle, located above the station 260 circuit breaker panel, 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 part is piped to a distributing tube mounted on the aft face of the fire wall in each nacelle. Nozzles are attached to the tube to direct the carbon dioxide gas forward through the fire wall into zone No. 2, and aft of the fire wall into zone No. 3. An additional line is routed forward through the fire wall and carries the carbon dioxide gas forward to the engine where it is injected into the blower section. There are no provisions for spraying carbon dioxide in zone No. 1.

1–327. CABIN HEATER AND CARGO COMPARTMENT FIRE EXTINGUISHER SELECTOR HANDLE. The handle is located on the station 260 panel near the floor and has the following five positions: LEFT CABIN HEATER, RIGHT CABIN HEATER, AFT CARGO COMPT., FWD. CARGO COMPARTMENT, and OFF.

1–328. FIRE EXTINGUISHER CONTROL HANDLES. Two fire extinguisher control handles are located on the station 260 panel below the engine fire extinguisher selector handle. Each fire extinguisher selector handle releases one of the two carbon dioxide charges available. If one charge, consisting of four bottles, is insufficient to smother the fire, the second shot may be released by turning and pulling the other handle.

Note

- Do not release the second charge until it is certain the first has failed to put out the fire.
- Do not attempt to divide one charge between fires in two locations.

1–328A. PORTABLE FIRE EXTINGUISHERS.* Five portable carbon dioxide fire extinguishers are installed in the airplane. One is strapped to the base frame of the flight engineer's seat, the second is strapped to a bracket in the stowage closet located adjacent to the forward passenger door, the third is on the aft wall of the aft coat closet, the fourth and the fifth are strapped to the forward wall of the forward coat closets.

1–328B. PORTABLE FIRE EXTINGUISHERS.† Five portable carbon dioxide fire extinguishers are installed in the airplane. One is stowed above the radio operator's table, the second is located on the face of the foremost passenger compartment rear wall, the third is located in the galley, the fourth and the fifth are located in the aft coat closet.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

REPLENISHING DIAGRAM

figure 162

REF.	PART	NO. OF POINTS	CAPACITY	REPLENISH WITH:	REMARKS
	FUEL SYSTEM				
20.	Fuel tanks 1 and 4	1 ea.	1555 U.S. Gals. 1291 Imp. Gals.	AMS 3036A Grade 115/145	
22.	Fuel tanks 2 and 3	1 ea.	790 U.S. Gals. 657 Imp. Gals.	AMS 3036A Grade 115/145	
17.	Fuel tanks 2A and 3A	1 ea.	565 U.S. Gals. 470 Imp. Gals.	AMS 3036A Grade 115/145	
10.	Fuel tank No. 5†	1	750 U.S. Gals. ‡ 624 Imp. Gals. ‡	AMS 3036A Grade 115/145	
	ENGINE OIL SYSTEM				
13.	Engine oil tank	4	49 U.S. Gals.* 40.4 Imp. Gals.*	MIL-O-6082 and WAC 5815, Grade 120	See placarded capacity note near filler cap.
	Engine oil tank	4	55 U.S. Gals.† 45.81 Imp. Gals.†	MIL-0-6082 and WAC 5815, Grade 120	See placarded capacity note near filler cap.
	HYDRAULIC SYSTEM				
28.	Main hydraulic reservoir	1	7.1 U.S. Gals. 5.9 Imp. Gals.	MIL-O-5606 (AN-O-366)	
33.	Emergency filler hydraulic reservoir	1	5 U.S. Gals.* 4.16 Imp. Gals.*	MIL-O-5606 (AN-O-366)	Use to replenish main or emergency extension tanks in flight. Located aft of pilot's seat in flight station.
	Emergency filler hydraulic reservoir §		4.5 U.S. Gals.† 3.7 Imp. Gals.†	MIL-0-5606 (AN-0-366)	Use to replenish main or emergency extension tanks in flight.
34.	Emergency extension hydraulic reservoir	1	3.27 U.S. Gals. 2.72 Imp. Gals.	MIL-O-5606 (AN-O-366)	
3.	Brake accumulators	2	1200 psi	Air	Charge with no hydraulic pressure.
25.	Rudder auxiliary booster system accumulator	1	600 psi	Air	Charge with no hydraulic pressure.
26.	Elevator auxiliary booster system accumulator	1	600 psi	Air	Charge with no hydraulic pressure.
	LANDING GEAR				
1.	Nose gear strut	1	Fill to bleed holes	MIL-O-5606 (AN-O-366) Air	See instructions for servicing with oil as placarded on strut. See placarded instructions for inflation or refer to inflation chart in Lockheed report No. 7788* or 7963†
2.	Nose gear tires	2		Air	Refer to inflation chart in Lockheed report No. 7788* or 7963†
12.	Main gear shock struts	2	Fill to bleed holes	MIL-O-5606 (AN-O-366) Air	See instructions for servicing with oil as placarded on strut. See placarded instructions for inflation or refer to inflation chart in Lockheed report No. 7788* or 7963†
11.	Main gear tires	4		Air	Refer to gross weight curve in Lockheed report No. 7788* or 7963†
	AIR CONDITIONING SYSTEM				
15.	Cabin supercharger oil tank	2	2 U.S. Gals. 1.66 Imp. Gals.	Aeroshell 1 AC	Preflight check for proper oil level. Oil change not required more often than every 200 hours nor less than 400 hours of supercharger operation.
16.	Cabin supercharger drive shaft disconnect housing	2	690 cc approx.	Aeroshell 1 AC	Preflight check and replenish at 160±50 hours. Fill to plug level.
19.	Secondary heat exchanger hydraulic motor and fan	2	450 cc approx.	Aeroshell 1 AC	Preflight check oil level at sight gage. Maintain level at "F." Approximately 50 cc remain when level is at "L."
18.	Refrigeration unit sump	2	500 cc approx.	Aeroshell 1 AC	Preflight check for proper oil Level. Drain and re-fill at 500 hours.
	ANTI-ICING SYSTEM				
21.	Anti-icing fluid tank	2	20 U.S. Gals. 16.7 Imp. Gals.	MIL-F-5566	
	OXYGEN SYSTEM				
32.	Oxygen system supply cylinder	1*	48.3 cu. ft.	Oxygen	Replace with pre-charged cylinder.
32.	Oxygen system supply cylinders	3†	107 cu. ft. ea.	Oxygen	Replace with pre-charged cylinder.
29.	Portable oxygen cylinder with demand regulator	1*	3.8 cu. ft.	Oxygen	Replace with pre-charged cylinder.
14.	Portable oxygen cylinders with demand regulators	2†	7.8 cu. ft. ea.	Oxygen	Replace with pre-charged cylinder.
30.	Portable oxygen cylinders (Continuous flow)	6*	7.13 cu. ft. ea.	Oxygen	Replace with pre-charged cylinders.
31.	Indicator, oxygen overboard discharge	1		Celluloid port seal disc	Replace when ruptured.
	FIRE EXTINGUISHING SYSTEM				
8.	CO_2 cylinder—fixed fire extinguishing system	8	12.5 pounds ea.	Carbon dioxide	Replace with charged, vertically mounted CO_2 cylinders. (Placarded with black circles on cylinder bases.)
4.	CO_2 cylinder—portable	3	8 pounds ea.	Carbon dioxide	Replace with charged cylinders.
7.	Indicator, CO_2 overboard safety discharge	8		Celluloid port seal discs	Replace when ruptured. Note that ruptured seal indicates discharged cylinder.
	WATER SYSTEMS				
23.	Wash water	1	25.5 U.S. Gals. 21.25 Imp. Gals.	Water	Placarded connection, lower right side of fuselage.
27.	Drinking water	2*	6 quarts	Drinking water	Thermos tanks located in the fore and aft closets.
	Drinking water	1†	6 quarts	Drinking water	Thermos tank located in the aft closet.
	MISCELLANEOUS				
5.	Battery	2		Distilled water	
24.	Toilet	2	28.5 U.S. Gals. 23.7 Imp. Gals.	Water	
9.	Landing flare	2		Pioneer SA-8	
6.	Station 260 bulkhead	(REF.)			

*LAC Serials 4001–4014 †LAC Serials 4015–4024
§When installed

1–329. LANDING FLARES.

1–330. GENERAL. 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.

1–331. The release and triggering provisions consists 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.

1–332. The flare will not ignite, nor will the parachute be ejected, if the release switch is inadvertently closed when the plane 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 airplane before the parachute is ejected and the flare is ignited.

1–333. CONTROLS. Flare release switches are located near the top and aft end of the pilot's side panel. 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 250 mph indicated airspeed.

MODEL 1049 COCKPIT CHECK LIST

BEFORE STARTING ENGINES

1 CP Landing Gear Lever . . . . DOWN
2 CP Ignition Switches . . . . OFF
3 PCPE Circuit Breakers & Switches . . . . SET
4 CP Hand Pump Selector . . . . BRAKE
5 P Brake Selector Valve . . . . EMER
6 P Parking Brake . . . . SET
7 P Electric Tab . . . . CHECKED
8 P Aileron & Rudder Booster . . . . ON
9 P Elevator Shift . . . . CHECKED, ON
10 P Aux. Boosters . . . . CHECKED, OFF
11 P Ordinance Lights . . . . ON
12 E Dump Valves . . . . CLOSED
13 E Fire Wall Shut-off Valves . . . . OPEN
14 E Battery Voltage . . . . ______ VOLTS
15 E Inverters . . . . CHECKED, ON 1
16 E Generators . . . . OFF
17 PCPE De-Icers & Anti-Icers . . . . OFF
18 E Crossfeed Valves . . . . CLOSED
*19 E Center Section Fuel Valve . . . . OFF
20 E Vacuum Shut-off Valve . . . . OPEN
21 E Master RPM Control . . . . FULL INC. RPM
22 E Blowers . . . . LOW
23 E Fuel Tank Selectors 1, 2A, 3A, 4 . . . . ON
24 E Cowl Flaps . . . . OPEN
25 E Carburetor Air . . . . COLD
26 E Master Eng. Selector . . . . ON (1 or 2)
27 E Oil Cooler Flaps . . . . OPEN
28 E Air Conditioning POSITION A & PANEL SET
29 E Tanks 2A, 3A Dump Lever . . . . NEUTRAL
30 E Anti-Icer Fluid . . . . ____________ GALS.
31 P E Hydraulic Fluid, Main, Reserve, Emergency . . . . . ____________ FULL
32 E Fuel Quantity ________ Lbs. __________ GALS.
33 E Engine Oil Quantity . . . . . . ____________ GALS.
34 E Gross Weight & CG __________ Lbs. _____%
35 E Oxygen & Masks . . . . CHECKED
36 P E Fire Warning System . . . . CHECKED
37 E Start Engines . . . .
38 P Control Boosters . . . . CHECKED
*39 P Auto Pilot . . . . CHECKED
and Servo Disconnect Levers . . . . OFF

DURING WARM-UP

1 PCP Horizons & Fluxgate Compasses . . . . UNCAGED & ERECTED
2 E Pitot Covers & Gear Pins . . . . ABOARD
3 E Battery Cart . . . . REMOVED
4 E Batteries & Generators . . . . ON
5 E Alternate Instrument Power . . . . . . CHECKED

TAXIING

1 P Brake Selector Valve . . . . NORM
2 PCP All Turn Indicators . . . . CHECKED
3 P Propeller Reversing . . . . CHECKED
4 PCPE Clocks & Altimeters . . . . SET

BEFORE TAKE-OFF

1 E Run-up (Propellers, Blowers and Magnetos) . . . . COMPLETED
2 P Trim Tabs . . . . CHECKED
3 CP Flaps . . . . TAKE-OFF
4 CP Aux. Boosters . . . . ON
5 E Propeller Controls SET FOR TAKE-OFF
6 E Mixtures . . . . AUTO RICH
7 E Air Conditioning . . . . PANEL SET
8 E Fuel Pumps 1, 2A, 3A, 4 . . . . . HIGH
9 E Oil Cooler Flaps 50%

TAKE-OFF CLEARANCE

10 E Cowl Flaps 20%
11 P Controls . . . . FREE

* When Installed and Operative.

CLIMB

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

PRE-TRAFFIC PATTERN

*1 P Auto Pilot Servo Disconnect Levers . . . . . OFF
2 P Brakes . . . . CHECKED
3 P Ordinance Lights . . . . ON
4 CP Altimeter Setting . . . . SET
5 E Blowers . . . . LOW
6 E Fuel Tank Selectors 1, 2A, 3A, 4 . . . . ON
7 E Crossfeeds . . . . CLOSED
*8 E Center Section Fuel Valve . . . . OFF
9 E Cabin Pressure . . . . SET FOR LANDING

TRAFFIC PATTERN

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 E Propellers . . . . 2600 RPM
6 CP Aux. Boosters . . . . ON
7 CP Landing Gear . . . . DOWN & LOCKED

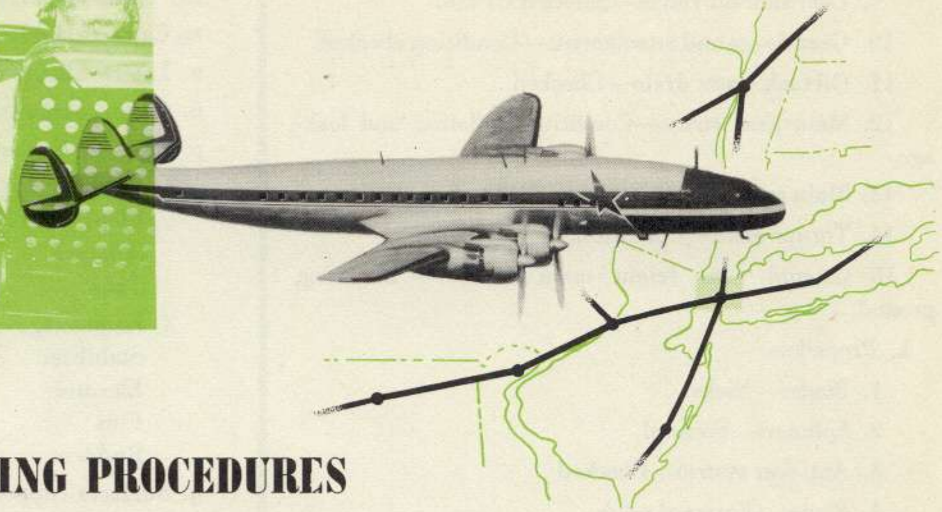
AFTER LANDING

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. Boosters . . . . OFF
6 CP Flaps . . . . UP

PARKING

1 P Brake Selector . . . . EMER
2 PCPE All Unnecessary Switches . . . . OFF

Revised February 1, 1952



Section II

NORMAL OPERATING PROCEDURES

2–1. BEFORE ENTERING THE AIRPLANE

2–2. FLIGHT RESTRICTIONS.

Note

Refer to Section V for Operating Limitations.

2–3. EXTERIOR INSPECTION.

Note

Check airplane status with Crew Chief. Check any items affecting operation or safety of airplane which have not been worked.

a. Taxi and passing light—Glass intact and clean.

b. Pitot heads—Condition, covers removed and holes open.

c. Nose access inspection door—Secured.

d. Nose gear and nose wheel well—

1. Nose wheel tires—Condition, slippage and proper inflation.

2. Nose wheel dust covers—Secured.

3. Nose gear strut—Condition, inflation, leakage.

4. Nose gear steering—Leakage, bleed plugs and ports, control mechanism, torsion link bolt assembly.

5. Nose gear safety pin—Installed and secured.

6. Gear position light switch arms—Checked.

7. Batteries—Secured.

8. Acid traps—Empty.

9. Gear uplock—OPEN.

10. "X" bar—Properly attached.

11. Nose gear shut-off valve—Safetied OPEN.

12. Nacelle doors and attachments—Checked.

e. Radio loop housings and antenna masts—Clean and intact.

f. Cabin pressure regulators and outflow valves — Checked.

g. CO_2 overboard safety discharge discs—Intact.

h. Landing flare chute covers—Intact.

i. Fuel Tanks—

1. Exteriors—No leaks.

2. Sumps—Drain water.

3. Vents—Clear.

j. Main gear and main wheel wells—

1. Tires—Condition, slippage and proper inflation.

2. Brakes — Fittings, discs, adjustment pins and bleed plugs—Checked.

3. Debooster rack—

(a) Indicators—Checked.

(b) Plunger on lock-outs — Positioned above the BLEED BRAKE mark (with brakes set).

(c) Fittings and leakage—Checked.

4. Door carriage hooks—Full down.

5. Uplocks—OPEN.

6. Firewall doors—Secured.

7. Gear drag struts—Condition and leakage.

8. Rear nacelle section—Fuel leakage and fumes.

9. Gear shut-off valves—Safetied OPEN.

10. Gear doors and attachments—Condition checked.

11. Oil tank water drain—Checked.

12. Main gear struts—Condition, inflation and leakage.

13. Main gear safety pins—Installed and secured.

14. Torque arms—Condition.

15. Ground wire (right main gear) — Touching ground.

k. Propellers—

1. Blades—Nicks.
2. Spinners—Secured.
3. Anti-icer system—Checked.
4. Blades—Forward pitch.

l. Power Plant section—

1. Cowling—Condition and security.
2. Breather lines and vents—Open.
3. Exhaust system—Condition and security.
4. Cowl and oil cooler flaps—Positioned and attached.
5. Scoop covers—Removed.
6. Fuel and oil system — Check for evidence of leakage.
7. Ignition wiring — Check for loose connections and cracked insulation.

lA. Cabin supercharger oil tanks—Quantity checked.

m. Cabin superchargers access doors—Secure.

n. Exterior lights—Condition and operation.

o. Cargo compartment doors—Secured.

p. Surfaces (lower side)—Condition.

1. Wing
   Flaps
   Ailerons
   Tabs
2. Empennage
   Stabilizer
   Elevators
   Fins
   Rudders

q. Surfaces (upper side)—Condition.

r. Cabin emergency exits—Inspect.

s. Antennae and masts—Condition.

t. De-icer boots—Condition.

u. Fuel and oil—Quantity, caps, dipsticks, access doors secured.

v. Main hydraulic reservoir—Quantity, cap, dipstick, drain valve, access door secured.

w. Alcohol tanks—Quantity, caps secured.

x. All exterior access covers (upper and lower surfaces) —Secured.

2–4. ON ENTERING THE AIRPLANE

2–5. CABIN INSPECTION.

PILOTS

ENGINEER

a. Wash water system and drains—functioning.

b. Emergency equipment—in place.

1. First aid kits.
2. Fire extinguishers.
3. Life rafts.
4. Ropes.
5. Ladder.
6. Flashlights.
7. Portable oxygen bottles.

c. Emergency exits—secure.

d. Cabin doors—condition.

e. Windows—condition, crazing.

f. Emergency flap extension by-pass valve—close.

g. Hydraulic fan valves—check, safetied.

h. Furnishings—condition.

i. Emergency flap extension crank—secure in place.

j. Emergency flood light—switch safetied.*

jA. Ditching light—batteries checked.†

*LAC Serials 4001–4014 †LAC Serials 4015–4024

PILOTS

2-6. FLIGHT STATION.

a. CP—Landing gear lever—DOWN.

b. CP—Ignition switches—OFF.

c. P—Side panel—set.

1. Flare release switches
1A. Terrain warning—radio alt. switch.†
2. Indirect instrument lights switches.*
3. Leading edge lights switch
4. Navigation lights switch
5. Ground loading light switch
6. Passing light switch
7. Chart light switch
8. Panel light switch
9. Chart light rheostat switch
10. Panel light rheostat switch
11. Radio selector box
12. Center windshield panel anti-icer fluid valve
13. Rear windshield panel anti-icer fluid valve
14. De-icer boots panel
15. Center panel instrument lights rheostat switch*
16. Left panel instrument lights rheostat switch*

d. CP—Side panel—set.

1. Panel light switch
2. Chart light switch
2A. Pedestal rear light switch†
3. Left pitot heater switch
4. Right pitot heater switch
5. Windshield heat de-fogger switch*
6. Windshield blower switch
7. Radio mast de-icer switch
8. Left windshield panel anti-icer pump switch*
9. Right windshield panel anti-icer pump switch*
10. Nesa system power switch
11. Radio selector box
12. Front windshield anti-icer fluid valve

ENGINEER

a. Forms, logs, check lists and handbooks—aboard and check.

b. Spare fuses and bulbs—aboard.

c. Windshield—clean.

d. Escape rope and axe—in place.

e. Emergency hydraulic refill selector valve—off.

f. Circuit breakers and switches—set.

Note

For panel locations refer to figures 1-26, 1-26A, 1-33, 1-33A, 1-31, 1-31A, 1-32, 4-17, 4-26, 4-26A, 1-46, and 1-46A.

g. Battery switch—CART BATTERY.

Note

If an external power source is not available, it is permissible to place battery switch to SHIP BATTERY position to accomplish the check list, return the switch to OFF to conserve the battery until ready to start engines.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

PILOTS

13. Center windshield anti-icer fluid valve
14. Rear windshield anti-icer fluid valve
15. Panel light rheostat switch
16. Chart light rheostat switch
17. Standby compass light rheostat switch
17A. Left windshield panel anti-icer pump switch†
17B. Right windshield panel anti-icer pump switch†
18. Right panel instrument lights rheostat switch*

e. CP—Hand pump selector—BRAKE.

f. P —Brake selector valve—EMER.

g. P —Parking brake—set and light on.

h. CP—Brake pressure—check.

Note

Improper operation of the brakes, when the brake selector is in EMER. and with engine driven pumps inoperative, may cause the emergency extension tank to overflow. Refer to Section VI.

i. CP—Landing lights—OFF.

j. CP—Taxi light—OFF.*

k. P —Electric elevator tab—check.

Note

To check the electric elevator tab disengaging mechanism, start the tab operating with either button, and push the disengaging lever forward and see that the manual controls cease rotating. Then depress the nose-up (forward) button and see that manual control rotates to give nose-up trim. Depress the nose-down (aft) button and see that the manual control rotates to give nose-down trim. Depress both buttons and check to see that the manual control rotates to give nose-up trim. Release either button, but continue holding the other depressed; this also gives nose-up trim.

l. P—Aileron and rudder boost—ON.

m. P—Elevator shift—check and push control lever in and lock.

Note

- To check elevator shift, center control column; pull out and lock the elevator shift lever; test mechanical advantage by moving control column through full fore and aft range. Return control column to center position; push in shift lever and lock.
- The elevator and rudder boost controls must be ON to utilize the auxiliary elevator and rudder boost system.

ENGINEER

h. Wheels—chocked (safety position).

Note

When chocks are used, they should be placed approximately 3 inches ahead of the tires to prevent wedging.

i. Dump valve levers (1, 2, 3, 4)—CLOSE (safetied).

j. Hydraulic suction shut-off valves—OPEN.

Note

Do not close the hydraulic suction shut-off valves during ground operation except in an emergency to prevent loss of fluid as the pumps will be damaged due to continued cavitation and rapid heat rise which occurs during ground operation. If a pressure check of the pump is desired, each engine should be operated individually. If the pressure line is broken and the valve is closed, the pump will operate indefinitely without damage.

k. Firewall shut-off valve levers—OPEN.

l. Battery voltage— ———volts.

m. Inverters—check No. 2 and return to No. 1.

Note

A switch on the master junction box allows the No. 2 inverter to be checked, at which time a warning light comes on indicating No. 1 is out. Switch should be returned to No. 1 for normal operation. The No. 1 inverter should be used continuously until it fails rather than dividing time equally between the two inverters. By using the No. 1 inverter until it fails, and reserving the No. 2 inverter for emergency use only, an alternate source of fixed-frequency a.c. power can be counted on to supply power for as long

*LAC Serials 4001–4014 †LAC Serials 4015–4024

PILOTS

n. P—Auxiliary elevator and rudder boost circuit breakers—check.

o. P—Auxiliary elevator and rudder boost—check and then turn switch OFF.

Note

Ease of operation of elevator and rudder should be checked with auxiliary boost switches ON; then switches should be turned OFF until ready for take-off.

p. P—Ordinance light switches—ON.

q. PCP—De-icers and anti-icers—OFF.

ENGINEER

as it may be needed. If operating time is divided equally between the two inverters, both inverters can be expected to fail at approximately the same time with the result that a complete loss of fixed-frequency a.c. power may be experienced.

n. Generators—OFF.

o. Anti-icers—OFF.

1. Propeller anti-icers
2. Carburetor anti-icers

p. Fuel crossfeed valves—CLOSE.

pA. Center section fuel valve†—closed.

q. De-icer vacuum distributor—ON.

r. Master rpm control—full INC. RPM.

s. Blowers—LOW.

t. Fuel tank selectors (1, 2A, 3A, 4)—ON.

Note

These tanks are ON when the levers are in the full forward position.

u. Cowl flaps—OPEN.

v. Carburetor air—COLD.

w. Master engine selector—on No. 1 or No. 2.

x. Auxiliary fuel pump switches—OFF.

y. Oil cooler flaps—OPEN.

z. Air conditioning—position A and panel set. (Refer to Section IV.)

aa. Emergency cabin pressure release door—check.

ab. CO_2 selectors—OFF.

ac. Outer wing fuel dump lever (2A and 3A) —NEUTRAL.

ad. Anti-icer fluid— _______ gallons.

ae. Hydraulic fluid; main, reserve* and emergency— _______ full.

Note

Check the hydraulic reservoirs and report the quantity in each.

af. Fuel quantity— _______ pounds _______ gallons.

Note

The fuel in tanks 1, 2, 3, 4, and 5† is indicated in gallons and the fuel in tanks 2A and 3A is indicated in pounds.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

PILOTS

r. P—Fire warning system—check.

Note

The pilot will check to see that his master fire warning light glows when the flight engineer checks the fire warning system.

s. P—Radio—check.

t. PCP—Warning lights—check.

u. PCP—Indicator lights—check.

Note

Check the indicator and warning lights that should be on at this time. Test the others by pushing.

v. PCP—Manifold pressure gages—check.

ENGINEER

ag. Engine oil quantity— _______ gallons.

ah. Gross weight and CG— _______ pounds, _______ percent.

ai. Oxygen pressure and masks—check.

Note

See that masks are aboard and that pressure is adequate.

aj. Fire warning system—check.

Note

Check the fire warning system by pushing the master fire warning light which should glow. The fire warning bell should ring and the pilots' master fire warning light should also glow.

ak. Warning lights—check.

al. Indicator lights—check.

Note

Check the indicator and warning lights that should be on at this time. Test the others by pushing.

am. Manifold pressure gages—check.

Note

Remember this pressure reading for the blower and magneto check.

2–7. BEFORE STARTING ENGINES

2–8.

The engines should be turned over a minimum of six propeller blades with the starters whenever they have been shut off for more than ten minutes. This is necessary because of the possibility of a liquid lock which may damage the engines. Should a liquid lock exist, remove the spark plugs of the lower cylinders and pull the propeller through to remove the oil from the cylinders before starting the engines.

WARNING

- Do not attempt to clear a liquid lock by reversing engine rotation. Liquid forced into the intake pipes will be drawn into the cylinders again when normal rotation is resumed, and serious damage to the engine may result.
- Do not under any circumstances pull the propeller through manually. In addition to the possibility of doing mechanical damage if a liquid lock exists, a hot engine, under certain conditions, could fire by auto-ignition.

PILOTS | ENGINEER

2-9. STARTING ENGINES

2-10.

Engine starting order is: 3, 4, 2 and 1. The engines are started in this order to prevent ground personnel from having to pass a moving propeller for fire guard or fire control.

2-11.

Obtain propeller clearance from the ramp mechanic.

a. Auxiliary fuel pump switches—LOW (tanks being used, others—OFF).

b. Throttles—set for 1200 rpm.

Note

- Avoid moving the throttle until after the engine is running smoothly.
- Do not exceed 1400 rpm on start.

c. Starter—engage.

Note

- Pilot or copilot will turn ignition switch on BOTH after propeller has turned six blades.
- Priming will only be necessary during cold weather starts. Under these conditions operate the starter and primer switches simultaneously.

a. CP—Ignition switch—BOTH.

Note

Coordinate with the engineer after propeller has been turned six blades.

b. P—Flight control boosters—check.

Note

Immediately after starting engines 3 and 4, the crossover system from the secondary hydraulic system to the primary should be checked for operation. Normal control loads under this condition indicate satisfactory operation.

Automatic pilot—Check.†

Note

Check the forces required to overpower the automatic pilot as described in Section IV.

Automatic servo disconnect levers—OFF.†

c. P—De-icer warning lights—out.

d. Mixture control—move from OFF to AUTO RICH.

Note

- When starting a hot engine, or an engine which tends to load-up, move the mixture control to OFF momentarily, then back to AUTO RICH.
- Should the engine fail to start within 30 seconds, let the starter cool and then repeat the starting procedure.
- When starting the engines for the first time after an airplane has been overhauled or after work has been done on the landing gear or center control stand, check to see that the landing gear pins can be removed. This must be done immediately after starting the No. 3 engine. If the pins cannot be removed, it is evident that the landing gear control valve is improperly rigged or the landing gear control lever is in the UP position.

CAUTION

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

PILOTS

ENGINEER

- The cabin superchargers are operated by engines No. 1 and No. 4. If the supercharger oil pressure does not indicate 40 psi after starting, the engines must be shut down immediately.

2–12. ENGINE GROUND OPERATION

2–13. Head the airplane into the wind when ground operation for an extended period of time is anticipated.

a. Gyro horizons—cage and release.

b. Fluxgate compasses—cage and uncage.

Note

Check fluxgate compasses again in approximately 5 minutes, some error may be expected until gyros erect to gravity.

Note †

Turn the alternate instrument power switches to the ALTERNATOR position when the power failure indicators show that the gyro horizons are not receiving power. Return the switches to the INVERTER (NORMAL) position after noting that the gyro horizons are receiving normal power from the alternators.

a. Pitot covers and gear pins—removed.

CAUTION

Remove pins only after full secondary hydraulic system pressure has been obtained.

b. Battery cart—removed.

c. Battery switch—SHIP BATTERY.

d. Generators—ON.

Note

When it is necessary to start the engines on SHIP BATTERY, it is recommended that as soon as one engine is started the generator on that engine should be turned ON and the engine speed set to 1200 rpm before starting the second engine. As each successive engine is started (and brought up to speed) its generator should be turned on. The engine should be started on SHIP BATTERY only in an emergency and cannot be expected to succeed in cold weather unless engines are warm.

e. Alternate instrument power—check.

Note *

To check the alternate instrument power: move the switch to a point half way between NORMAL and L.H. INSTR. ALTERNATOR. In this position, a flag in the pilots' gyro horizons will appear, indicating these instruments and the turn and bank indicators are not receiving power. Movement of the switch to the full L.H. INSTR. ALTERNATOR position directs the alternator power to the instruments and the flag should disappear. Repeat this procedure for the R.H. INSTR. ALTERNATOR.

Note †

Coordinate this check with the pilots by turning the inverter to the OFF position. Return the switch to No. 1 INV. position after the pilots have checked the alternators.

f. Thoroughly warm-up the engines at approximately 1200–1400 rpm before making any performance checks or before taxiing to take-off position.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

ENGINEER

g. Continue the warm-up until the oil pressure stabilizes. Control the oil cooler flaps to maintain the oil temperature below the maximum operating limit.

CAUTION

In order to prevent excessive oil tank pressures, when operating with full tanks, engine oil inlet temperature must be warmed up to at least 50°C (122°F) prior to take-off.

h. Open the throttle to obtain not more than 30″ Hg manifold pressure. If the oil pressure drops or fluctuates as engine speed is increased, extend the warm-up period.

2–14. TAXIING

PILOTS

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

Note

With the engines running, secondary hydraulic system pressure has been applied to the accumulators with the selector in EMER. Movement of the selector to NORM. then directs secondary pressure directly to the brakes and allows the emergency system to be blocked off. Move to NORM. only after brakes are released.

b. Set rpm for taxiing.

c. Use nose-wheel steering in preference to brakes.

d. Check brakes on EMER. and NORM.

e. Check for proper functioning of all turn indicators while taxiing.

f. Propeller reversing—check.

Note

This check should be made on all four engines simultaneously. It is suggested that very little power be applied in reverse and that the propellers be unreversed quickly to minimize blowing fumes and dust into the flight station. (This check should be required only once per day unless training and familiarization are desired.) It is also suggested that this check be made while taxiing to the run-up area, when the airplane is in motion, in order to avoid rocking on the main landing gear.

g. Flaps—test and UP.

h. Altimeters—set.

ENGINEER

a. Altimeters—set.

LANDING PATTERN

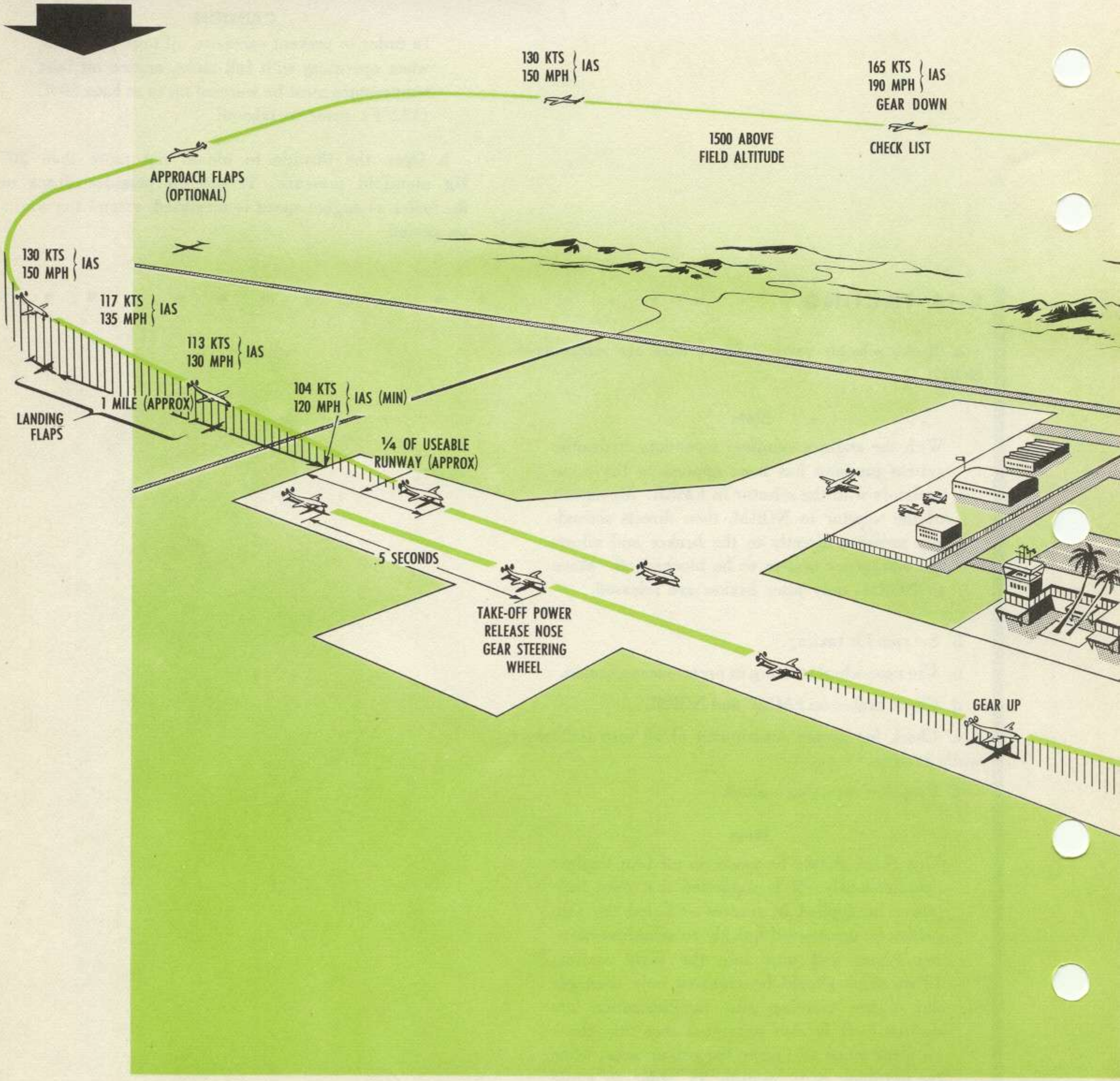
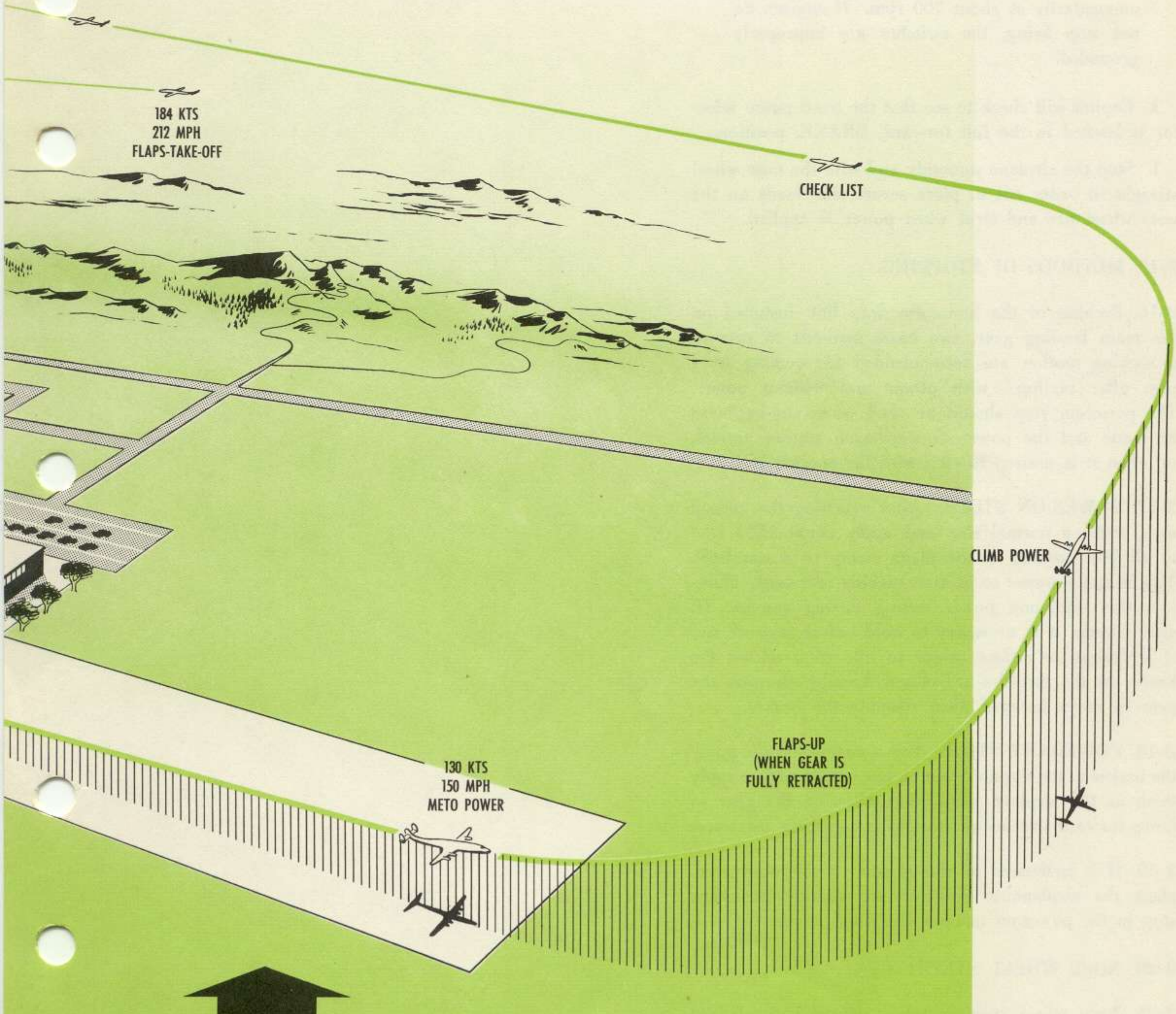


figure 2-1



TAKE - OFF PATTERN

PILOTS

i. Clocks—wind and set.

j. Ignition switch—check.

Note

Check the OFF position of the ignition switches momentarily at about 700 rpm. If engines do not stop firing, the switches are improperly grounded.

k. Copilot will check to see that the hand pump selector is latched in the full forward, BRAKE, position.

l. Stop the airplane smoothly and with the nose wheel straight in order not to place severe side loads on the nose wheel tire and strut when power is applied.

2–15. METHODS OF STOPPING.

2–16. Because of the hydraulic drag link installed on the main landing gear, two basic methods to prevent a rocking motion are recommended for coming to a stop after taxiing: with power and without power. 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 desired to stop with the engines idling.

2–17. POWER-ON STOPS. After reaching the run-up area, make a normal stop and apply about 1500 rpm to all four engines as the plane comes to a standstill. This is ample power to prevent rocking rearward. Maintain this minimum power setting during run-up. If, after run-up, 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.

2–18. POWER-OFF STOPS. For a no-power stop, apply the brakes in the normal manner, but release and re-apply them as the airplane stops, thus allowing the gear to move forward instead of the airplane rocking rearward.

2–19. If it is desired to run-up after a no-power stop, allow the airplane to roll forward slightly and then stop in the power-on manner described above.

2–20. NOSE WHEEL STEERING.

2–21. Nose wheel steering turns should be restricted to keep the main gear that is on the inside of the turn, outside of a circle of 12 foot radius. This radius represents the minimum and applies only at very low speed. As speed is increased, greater turning radii are required as the airplane tends to resist the turn due to inertia forces which induce side skidding of the nose wheel.

ENGINEER

b. Clock—wind and set.

PILOTS

ENGINEER

Augmentation of the normal turn side loads by high skidding loads can impose excessive forces on the inside nose wheel tire, strut components, and airplane structure. Side loads may prove sufficient at high speeds to pull the inside tire off the wheel. This radius should be increased by two or three times when taxiing over rough or frozen ground.

2–22. Use the steering system and minimum engine rpm. Only use brakes and asymmetrical power when necessary.

CAUTION

With the nose wheel fully deflected in either direction, even power should be applied until the airplane starts rolling before using nose wheel steering.

2–23. BEFORE TAKE-OFF

2–24. PRE-FLIGHT ENGINE CHECK.

2–25.

GENERATORS AND PROPELLERS. Check the generators and propellers as follows: place the master rpm control lever at full INC. RPM and set the throttles for 1600 rpm on each engine. At this point the amperage and voltage output of the generators should be checked with all generators ON. The master rpm control lever may then be moved to full DEC. RPM. The propeller governor limit indicator lights should light and remain on and the rpm should drop to 1350 and stabilize. Return the lever to full INC. RPM. The indicator lights should go out, then come on again and stay lighted, and the rpm should increase to the original setting of 1600 and stabilize. Repeat the test with the propeller governor control switches.

2–26.

The following checks should be made prior to take-off, to assure that the propellers are in forward pitch position:

a. Set all four engines at 1500 to 1700 rpm with the master rpm control in full INC. RPM position.

b. Run all four governors to full DEC. RPM as indicated by glowing of the propeller governor limit indicator lights. RPM should reduce quickly to minimum setting of the governors.

c. Engage the feathering button on each engine momentarily. If the rpm increases, the blades are in reverse pitch and take-off should not be attempted.

Note

On airplanes equipped with reverse pitch indicator lights that are readily visible to all three crew members, step c above may be omitted. Check that these lights are out.

PILOTS	ENGINEER

2–27.

BLOWERS. Check the blowers as follows:

a. Set the engine speed to 1600 rpm with the throttles.

b. Move the blower controls to the HIGH position with a quick movement and lock.

c. Open the throttles to obtain 32" Hg MAP at sea level. (On fields at altitude, set MAP 2" Hg greater than existing barometric pressure, noted on the manifold pressure gages before starting engines.)

d. Move the blower control levers to the LOW position and lock. A sudden decrease in manifold pressure indicates that the two-speed mechanism is working properly. Do not make more than two blower checks on one engine within a five minute interval.

2–28.

a. The copilot will coordinate movement of the ignition switch with the flight engineer when checking the magnetos.

MAGNETOS.

a. At sea level, check the magnetos at 30" Hg MAP. (On fields at altitude, check magnetos at field barometric pressure.)

b. Place the ignition switch in the LEFT position and observe the rpm.

c. Return the switch to BOTH in order to stabilize engine speed.

d. Repeat this procedure for the RIGHT position.

CAUTION

A variation of greater than two inches spread in manifold pressure between engines, at the same rpm, should be investigated immediately.

Note

Atmospheric conditions will influence the readings obtained; however, a drop of 75 rpm or less is considered satisfactory provided no engine roughness is encountered.

2–29.

AUTO FEATHERING. Check the auto feathering system as follows:

a. Place auto feathering master switch ON.

b. Open throttle to 100 BMEP.

c. Place corresponding test switch ON.

d. Retard throttle slowly to 72 BMEP. After approximately 2 seconds the light in the feathering button should come on and rpm drop. (The auto feathering pressure switch is set to actuate between 72 to 82 BMEP.)

PILOTS | ENGINEER

e. Pull feathering button to neutral; light in button and master lights should go out and rpm should rise.

Note

The flight engineer should be prepared to pull the feathering button to neutral when rpm drop is noted or the propeller will feather completely.

CAUTION

The feathering button must be pulled out as soon as possible after a propeller feathers to relieve the feathering motor of an overload condition or the motor may be damaged.

2–30. PRE-FLIGHT AIRPLANE CHECK

PILOTS

Note

Refer to Section V for power settings and operating limits.

a. Trim tabs—check.

b. Flaps—TAKE-OFF.

c. Auxiliary elevator and rudder boost—ON.

d. Take-off clearance—received.

e. Controls—free.

f. Doors and windows—closed.

ENGINEER

a. Propeller controls—set for take-off.

b. Mixture controls—AUTO RICH.

c. Air conditioning—panel set.

d. Auxiliary fuel pump switches 1, 2A, 3A, 4—HIGH. (Others—OFF.)

e. Oil cooler flaps—50%.

f. Cowl flaps—20%.

g. Temperatures and pressures—normal.

h. Doors and windows—closed and door warning light out.

2–31. TAKE-OFF

(Refer to fig. 2-1.)

PILOTS

2–32. The pilot will advance the throttles to 35″ Hg or more and then call, "Take-off power."

2–33. The copilot should stand by on take-off to push the reverse throttle lock flag out of sight to override the scissors switch so reverse thrust will be available immediately in the event it becomes necessary to discontinue take-off.

2–34. Use the steering system to hold the airplane on a straight course during take-off until a speed of about 50 mph is reached. Use the rudders above this speed.

Note

- Although it is not a structural limitation, it is not recommended that nose wheel steering be used at speeds above 50 mph on take-off as the rudders become effective when this speed is reached.

ENGINEER

When the pilot calls for take-off power, the flight engineer will advance and trim the throttles accordingly. Take-off manifold pressure should be reached in approximately 5 seconds after starting to open throttles.

PILOTS | ENGINEER

Note

- Pressure should be applied in order to ease the nose wheel off the ground as take-off speed is approached.
- When taking off from snow or slush covered runways, lift the nose gear as soon as possible to reduce the amount of snow or slush thrown back into the nose wheel well.

CAUTION

If an engine fails on take-off, do not use nose wheel steering. At high speeds, this may result in nose wheel chatter, which may lead to further trouble.

2–35. AFTER TAKE-OFF

PILOTS:

a. Landing gear lever—UP.

CAUTION

The inertia loads induced by sudden application of the brakes during retraction of the gear, are sometimes excessive. If it is desired to stop wheel rotation after breaking ground, the brakes should be applied while the gear is still in the DOWN and locked position.

b. Request METO power.

ENGINEER:

a. METO power—set.

PILOTS:

c. Flaps—UP (after gear is fully retracted).

d. Landing lights—RETRACT and OFF.

CAUTION

Landing lights are usually turned OFF after the first power reduction. This is left to the pilot's discretion. A light that is not retracted will create turbulence and may cause damage to the trailing edge of the ailerons.

2–36. CLIMB

2–37.

ENGINEER:

If climb is to be made where high blowers are required to maintain adequate climb power, shift to high blower by reducing manifold pressure to 20″ Hg or less, and engine speed to 1600 rpm with the throttles and by placing controls in HIGH blower position. After manifold pressure increases indicating the shift has been made, reset the throttles to obtain the required climb power. The blower shift should be made at the altitude at which full throttle gives 148 BMEP at 2400 rpm. (Do not exceed 35″ Hg).

PILOTS:

a. Request climb power, (after flaps are up).

ENGINEER:

a. Climb power—set.

PILOTS

b. Ordinance light switches—OFF.

c. Auxiliary elevator and rudder boost—OFF.

d. Landing gear lever—NEUTRAL.

CAUTION

Never use NEUTRAL position on the ground.

ENGINEER

b. Auxiliary fuel pump switches—LOW (tanks being used, others—OFF).

c. Oil cooler flaps—as required to maintain temperature within limits.

d. Pressures and temperatures—normal.

e. Auto feathering master switch—OFF.

Note

It is advisable to turn the auto feathering system off in the climb because it serves no useful purpose after the airplane is safely airborne.

f. Cowl flaps—set for climb.

2–38. SYSTEMS OPERATION

2–39. Refer to Section VI for information regarding the operation of the various systems.

2–40. DESCENT

2–41. Descent should be regulated according to weather, wind, and traffic conditions. Normal rate of descent with pressurized cabin is about 1000 ft. per minute. For maximum IAS in descent refer to Section V.

2–42. Reduce speed for approach to that shown on figure 2-1.

2–43. Refer to Section V for IAS at which flaps may be lowered.

2–44. PRE-TRAFFIC PATTERN CHECK LIST

PILOTS

a. Automatic Pilot servo disconnect levers—OFF.†

aA. Brake selector valve — check EMER. and select NORM.

Note

- Check that the hand pump selector is in full forward, BRAKE, position.
- With the brake selector in the EMER. position, check the toe brakes.
- With the brake selector in NORM. position, check the toe brakes.

b. Emergency brake pressure—check.

ENGINEER

a. Blowers—LOW.

b. Fuel valves (1, 2A, 3A, 4)—ON.

c. Crossfeed valves—OFF.

cA. Center section fuel valve—closed.†

d. Cabin pressure—set for landing.

e. Pressures and temperatures—normal.

†LAC Serials 4015–4024

PILOTS

Note

If the emergency brake pressure is below normal, the selector valve should be moved to EMER. long enough to charge the accumulators to system pressure and then returned to NORM.

c. Ordinance light switches—ON.

d. Altimeter setting—set.

e. De-icers and anti-icers—as required.

ENGINEER

2–45. TRAFFIC PATTERN CHECK LIST

PILOTS

a. De-icer boots—off.

b. Auxiliary elevator and rudder boost—ON.

c. Flaps—TAKE-OFF.

d. Landing gear—DOWN and locked (indicator lights on).

Note

The nose gear steering wheel turns through more than 360 degrees to obtain full deflection of the nose gear. Therefore it is possible for the steering wheel in the cockpit to appear to be centered for landing when the nose gear is actually turned approximately 50 degrees from forward. This condition will occur only in cases of malfunction since the nose wheel is automatically centered when the strut is extended and there is no torque on the steering wheel. If, however there is any doubt about the position of the nose wheel, a thorough check may be made as follows after the gear has been extended:

1. Turn the steering wheel to the full left position and release.

2. Turn to the full right position and release.

3. If the proper centering action does not occur, locate the center as being half-way between the full left and full right positions and hold the wheel in centered position during landing. Hold the nose wheel off the ground as long as possible after landing. Do not turn the steering wheel when the gear is retracted.

e. Landing lights—as required.

Note

Refer to figure 2-1 for information regarding approach and landing patterns.

ENGINEER

a. Mixture controls—AUTO RICH.

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

c. Carburetor air—COLD.

d. Propellers—2600 rpm.

e. Cowl flaps—as required.

PILOTS

2–46. LANDING

2–47. Do not use the nose wheel steering when the nose wheel is off the ground, as the system has sufficient power to override the saddle cam and turn the nose wheels off center.

CAUTION

- When landing on a wet runway, 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 travel may be used, but the applications must continue to be intermittent. It should be remembered that when most of the weight is on the gear, the tires tend to flatten out and force water out from under, greatly increasing the traction of the tires.
- To avoid damage to the wing trailing edge and flap retraction mechanism when landing or taxiing on airports covered with snow or slush, the wing flaps should not be retracted beyond the 30% extended position until the flap area has been inspected and cleaned of any snow or slush. The 30% extended position of the wing flaps places them in a high enough position to be protected from flying debris, which may be present on snow covered runways, and to afford adequate clearance in the wing flap well so that damage due to accumulation of snow or slush will be avoided.

a. Reverse propeller lock override flag—hold in.

Note

Upon landing, the copilot may hold the reverse propeller override flag in. This will unlock the reverse throttle levers, allowing the pilot to reverse the propellers immediately.

CAUTION

- When landing on runways covered with loose snow, avoid the use of high power in reverse pitch at low speeds. A cloud of snow may be blown ahead of the airplane and obscure the pilot's vision.
- Do not apply high power in reverse pitch until the nose wheel is on the ground and the pilot has his hand on the steering wheel.
- Propellers will reverse in approximately four seconds and the four reverse pitch indicator lights will glow. If one or more of the lights

ENGINEER

a. Aux. Vent. control—position A.

Note

Place the Aux. Vent. control to position A approximately 30 seconds before touchdown. This will minimize the possibility of engine fumes and dust entering the cabin when reverse power is applied.

PILOTS

do not come on, a malfunction is indicated and application of power to the malfunctioning propeller or propellers should be discontinued.

Note

It is recommended that not more than METO power be used in reverse. However, the amount of power applied is left to the pilot's discretion.

2-48. UNREVERSING PROCEDURES. After the desired braking effect has been obtained, the propellers may be unreversed as follows:

a. Move the throttle levers forward through the idle position to 1400—1500 rpm in forward thrust, in order to obtain assistance from the governors in changing pitch.

2-49. GO-AROUND

2-50. Apply METO power and raise flaps to TAKE-OFF. Retract the gear when the flaps are at TAKE-OFF, then use normal climb procedure.

2-51. AFTER LANDING

PILOTS

a. Auxiliary elevator and rudder boost—OFF.

b. Flaps—UP.

ENGINEER

a. Cowl flaps—OPEN.

b. Oil cooler flaps—OPEN.

c. Auxiliary fuel pump switches—OFF.

d. Master rpm control lever — full INC. RPM (indicator lights on).

2-52. POST FLIGHT ENGINE CHECK

2-53. The flight crew shall report any unsatisfactory condition on the approved form.

Note

Check the OFF position of the ignition switches momentarily at about 700 rpm. If engines do not stop, switches are improperly grounded.

2-54. STOPPING OF ENGINES

PILOTS

a. Brake selector valve—EMER.

b. Parking brake—set and light on.

c. All unnecessary switches—OFF.

ENGINEER

a. Engines—idle.

Note

Operate at 600-700 rpm for two to five minutes

PILOTS

d. Control boosters—ON.

Note

The control boosters function as control surface gust dampers when left on.

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

ENGINEER

to permit optimum crank-case scavenging and to reduce the possibility of hydraulic lock. If possible, taxiing the airplane with the engines between 600–700 rpm will consume most of the above scavenging time.

b. Oil cooler flaps—open.

c. Cowl flaps—open.

d. Radio d.c. power and a.c. power switches—OFF.

e. Mixture controls—OFF.

f. Air conditioning—as desired.

g. Generators—OFF.

h. All other unnecessary switches—Off.

Note

The battery switch and all other unnecessary switches should be off before leaving the cockpit. When cabin lights, navigation lights, etc. are required to be on, an outside power source should be obtained.

III

EMERGENCY OPER. PROC.

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

MODEL 1049 ABBREVIATED EMERGENCY PROCEDURES

ENGINE FAILURE and/or *ENGINE FIRE*

Gear .... UP

Wing Flaps .... AT CAPTAIN'S DISCRETION

1. Throttle .... CLOSED
2. Feathering Button .... PUSH
3. Mixture .... OFF
4. ***Firewall Shut-off Valve Lever ...... CLOSED***
5. Hydraulic Suction Shut-off Valve .... CLOSED
6. Fuel Tank Selectors, to Operating Engines .... NORMAL
7. Fuel Tank Selector, to Inoperative Engine .... OFF
8. Fuel Boost Pump .... OFF
9. Crossfeed Valve .... OFF
10. Cowl Flaps .... FAIRED - ***OPEN***
11. ***Propeller & Carburetor Anti-Icers ...... OFF***
12. Generator and Generator Field Circuit Breaker .... OFF
13. ***Engine Fire Extinguisher Selector .... SET (Cargo & Heater Selector OFF)***
14. ***CO_2 Release Handle (At Captain's Order) .... DISCHARGE***
15. Feathering Button .... NEUTRAL
16. Propeller Governor Switch ...... FULL DEC. RPM
17. Ignition Switch .... OFF
18. Oil Cooler Flap .... FAIRED
19. Cowl Flap (After Fire) .... FAIRED
20. Crossfeed Valves (After Fire) ..... AS REQUIRED

ENGINES No. 1 & No. 4 OUT

1. Descend to Safe Altitude
2. Auxiliary Vent .... OPEN
3. Nos. 2 & 3 Vacuum Pump Switch .... DE-ICER PRESSURE

CARGO COMPARTMENT FIRE (Pressurized Flight)

1. Execute Rapid Descent Procedure (Do not exceed placarded airspeeds)
2. Aux. Vent. Knob .... FULL OPEN
3. Cabin Pressure Control Valve .... MANUAL
4. Cabin Recirculating & Flight Station Fans .. OFF
5. Aux. Vent. Knob (At 1" Hg Cabin Pressure Differential .... POSITION B
6. Fuel Tank Selectors .... NORMAL
7. Crossfeed Valves .... OFF
8. * Hydraulic Suction Shut-off Valves ..... CLOSED
9. * Battery Switch .... OFF
10. * Generators & Generator Field Circuit Breakers .... OFF
11. Auxiliary Boost Switches .... ON
12. Determine Fire Location
13. Engine Fire Ext. Selector .... OFF
14. CO_2 Ext. Selector ...... SET TO FIRE LOCATION
15. Crew on Emer. Oxygen .... MASKS ON
16. CO_2 Release Handle (At approx. zero differential) .... DISCHARGE

WARNING

Do not use second CO_2 charge unless absolutely necessary nor sooner than 15 minutes. Avoid nose-up attitude before or after CO_2 discharge.

* Items 8, 9, & 10 should be accomplished only when evidence of hydraulic or electrical system malfunction is indicated (loss of hydraulic pressure, fluid, control boost, feeder fault tripping of generators, over-load and over-voltage on electrical instrument panel). Item 11 to normal position as soon as safety permits.

HEATER FIRE

1. Cabin Heater Switches .... OFF
2. Cabin Recirculating Fans .... OFF
3. Engine Fire Ext. Selector .... OFF
4. Cargo Compartment & Heater Ext. 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. A.C. Flight Inst. Power Selector ..... L.H. or R.H. INSTR. ALTERNATOR
2. Generator Switches .... OFF
3. Battery Switch .... OFF
4. Generator Field Circuit Breakers .... OFF
5. Master Radio Switch .... OFF
6. Use Hand CO_2 Extinguisher Only.

CABIN FIRE

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

SMOKE REMOVAL PROCEDURE

1. Execute Rapid Descent Procedure (Do not exceed placarded airspeeds)
2. Emergency Depressurize (Heater & All Fans OFF)
3. Open All Connecting Doors.
4. Reduce Airspeed to 175 knots (201 mph) or less.
5. FIRST, Open one or more emergency exits over the wings.
6. SECOND, Open crew compartment windows.

WARNING

Do not open a vent in the cockpit before there is an opening in the cabin over the wing. Do not open an emergency exit forward of the propeller plane.

GEAR EMERGENCY EXTENSION

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

BRAKES EMERGENCY

1. Hand Pump Selector .... BRAKE (FWD) POS
2. Brake Selector Valve .... EMERGENCY
3. Pump Until Pressure Develops
4. Propeller Reverse Override Flag ...... STANDBY

FUEL DUMPING PROCEDURE

1. Gear & Wing Flaps .... UP
2. Airspeed .... IAS 139-189 KNOTS (160-218 mph)
3. Heater Switches .... OFF
4. No Smoking Sign .... ON
5. Radio Bus 1 & 2 Switches .... OFF
6. Unnecessary Electrical Equipment .... OFF
7. Fuel Dump Valves (1, 2, 3, & 4) .... OPEN
8. Fuel Dump Valves (2A & 3A) .... OPEN

   Note: When 2A & 3A Valves start to dump ... RETURN TO NEUTRAL
9. Flight Path .... STRAIGHT AND LEVEL
10. After Dumping Tanks Nos. 1, 2, 3, & 4
    (a) Return Lever to "Red Line"
    (b) Then to "Intermediate" for 15-30 seconds.
    (c) Then CLOSED POSITION.
11. After Dumping Tanks Nos. 2A & 3A .... Valves CLOSED then to NEUTRAL

FEBRUARY 1, 1952

Section III
EMERGENCY OPERATING PROCEDURES

3–1. ENGINE FAILURE

3–2. ENGINE FAILURE DURING TAKE-OFF.

3–3. If an engine should fail during take-off, before reaching the optimum V_1 speed, close the throttles and stop. The optimum V_1 speeds for various conditions are given in the CAA APPROVED AIRPLANE FLIGHT MANUAL (LOCKHEED REPORT 7787).

3–4. If an engine fails after optimum V_1 speed has been reached, take-off should be continued. Feather the inoperative propeller as follows:

a. Throttle—CLOSED.

b. Feathering button—Push.

c. Mixture—OFF.

d. Landing gear—UP.

e. Firewall shut-off valve lever—CLOSE.

f. Hydraulic suction shut-off valve (of inoperative engine)—Closed.

g. Fuel tank selectors, to operating engines—NORMAL.

h. Fuel tank selector, to inoperative engine—OFF.

i. Fuel boost pump—OFF.

j. Cowl flaps—Faired.

k. Generator—OFF.

l. Generator field circuit breaker—OFF.

m. Engine fire extinguisher selector—Set to feathered engine (other selector OFF).

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

o. Propeller governor switch—full DEC. RPM.

p. Ignition switch—OFF.

q. Oil cooler flap—Faired.

r. Cowl flaps—Faired.

3–5. ENGINE FAILURE IN FLIGHT.

3–6. FAILURE OF ONE ENGINE.

3–7. GENERAL. The feathering procedure in flight is the same as in the case of engine failure during take-off except that the landing gear will have been retracted; the crossfeed valves may be open; and the propeller anti-icer may be operating. Shutting off the cross-feed valves and anti-icer fluid to the propeller of the engine to be feathered are listed in the order of their importance to the other steps in the following procedure:

a. Throttle—CLOSED.

b. Feathering button—Push.

c. Mixture—OFF.

d. Firewall shut-off valve lever—CLOSED.

e. Hydraulic suction shut-off valve—Closed.

f. Fuel tank selectors, of operating engines—NORMAL.

g. Fuel tank selector, of inoperative engine—OFF.

h. Fuel boost pump—OFF.

i. Crossfeed valve of inoperative engine—CLOSED.

j. Cowl flaps—Faired.

k. Propeller and carburetor anti-icer—OFF.

l. Generator—OFF.

m. Generator field circuit breaker—OFF.

n. Engine fire extinguisher selector valve—set to feathered engine (other selector OFF).

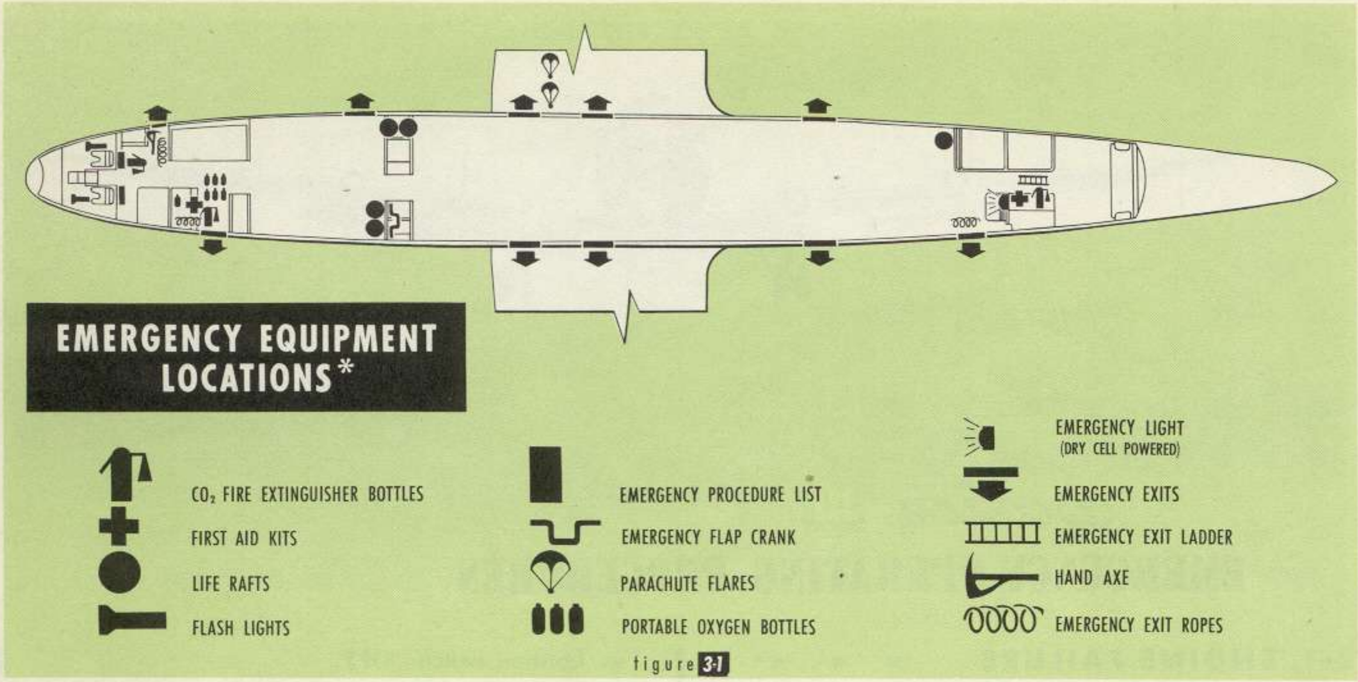


figure 3-1

o. Feathering button—NEUTRAL (after propeller has feathered).

p. Propeller governor switch—full DEC. RPM.

q. Ignition switch—OFF.

r. Oil cooler flap—Faired.

rA. Cowl flaps—Faired.

s. Set up the necessary three-engine power.

t. Re-position the cross feed valves (if it will not add to any fire hazard), to equalize fuel load.

CAUTION

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

3-8. FAILURE OF TWO ENGINES.

3-9. GENERAL. Because of the manner in which associated systems are integrated with different engines, the effects of losing various combinations of engines must be understood and anticipated. In all combinations of two engine failure, generator loading must be watched (figure 1-30). If it is too high, shut off galley and other electrical equipment as may be required to keep loading within the range of available output.

3-10. ENGINES NO. 1 AND NO. 4 OUT.

a. Feather the inoperative propellers as described in paragraph 3-7.

Note

Engines No. 1 and No. 4 drive the cabin superchargers and therefore without them pressurization is not available. It may therefore, be necessary to descend to a lower altitude.

b. When at safe altitude, aux. vent.—OPEN.

c. No. 2 and No. 3 Vacuum Pump Switches—DE-ICER PRESSURE.

Note

Engine No. 3 will supply hydraulic pressure for operation of the gear, flaps, brakes and nose wheel steering, except when the demand by the surface control boosters exceeds engine No. 2 output.

3-11. ENGINES NO. 2 AND NO. 3 OUT. Feather the propellers as described in paragraph 3-7.

Note

- With engines 2 and 3 out, vacuum system will be inoperative.
- Engine No. 4 will supply hydraulic pressure for operation of the gear, flaps, brakes and nose wheel steering, except when the demand by the boosters exceeds No. 1 output.

3-12. ENGINES NO. 3 AND NO. 4 OUT. With these engines inoperative, secondary hydraulic system pressure will not be available. Therefore the wing flaps must be operated with the hand crank and the landing gear must be extended with the hand pump. Once the gear has been extended, when secondary system pressure is not available, it cannot be retracted. In addition, nose wheel steering and the normal brake system will be inoperative and it will be impossible to dump fuel from tanks 2A and 3A.

*LAC Serials 4001–4014

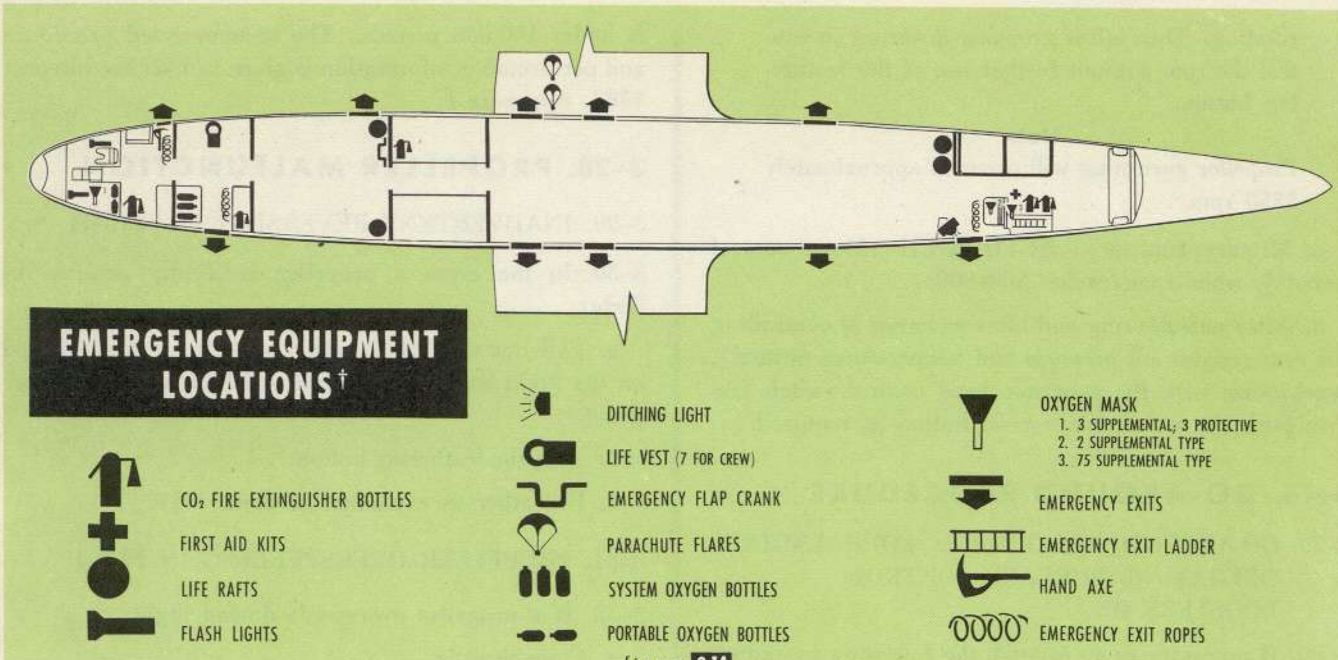


figure 3-1A

3–13. ENGINES NO. 1 AND NO. 2 OUT. With engines 1 and 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. Operating times of the landing gear and flaps may be increased somewhat since the restriction control valve in the secondary system will starve these units to provide normal surface control booster operation.

3–14. ENGINES NO. 1 AND NO. 3 OUT, OR NO. 2 AND NO. 4 OUT. With these combinations of inoperative engines hydraulic power will still be available but flow rates will be reduced. In addition, one air pressure pump and one suction pump in the de-icer system will be inoperative.

3–15. LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

3–16. LANDING WEIGHT LIMITS.

a. The maximum weight is 98,500 pounds up to an altitude of 5,750 feet unless restricted by runway length.

b. Do not land with more than the following fuel loads (in U.S. gallons):

Weight	Tanks 2 & 3	Tanks 1 & 4	Tanks 2A & 3A
98,500 or less	790	1200	515

c. Flaps—as required.

d. Landing Gear—DOWN (use emergency extension procedure if necessary).

3–17. PROPELLER UNFEATHERING PROCEDURE

The recommended unfeathering procedure is as follows:

a. Propeller governor — full DEC. RPM (Indicator light ON).

b. Propeller reverse circuit breaker—OPEN.

CAUTION

This must be done to prevent inadvertent reversing of the propeller in the event of failure of the throttle reversing switch.

c. Airspeed—Not to exceed 139 knots (160 mph).

d. Fire wall shut-off valve lever—OPEN.

e. Propeller—Turn at least six blades with starter (Ignition—OFF).

f. Throttle—CLOSED.

g. Mixture—OFF.

h. Ignition switch—ON.

i. Fuel tank selector—ON.

j. Fuel pump—ON.

k. Hydraulic suction shut-off valve—OPEN.

l. Feathering button—Pull (one second and release).

CAUTION

Do not hold the feathering button out longer than one second at a time because the blades may unfeather very quickly to the low pitch stop and cause overspeeding. Use successive momentary applications until propeller starts

†LAC Serials 4015–4024

rotating. Then allow propeller governor to control the rpm without further use of the feathering button.

Note

Propeller governing will occur at approximately 1350 rpm.

m. Mixture control — AUTO RICH (Move control smoothly when rpm reaches 500–800).

n. 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.

3–18. GO-AROUND PROCEDURE

3–19. GO-AROUND PROCEDURE: FOUR ENGINES OPERATING, SURFACE CONTROL BOOSTERS ON.

3–20. If necessary to go around, the following procedure is recommended:

a. Pilot applies power as required.

b. Wing flaps—TAKE OFF.

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

d. Set up climb power after gear is up.

e. Flaps may be left at TAKE OFF position or retracted at pilot's discretion.

3–21. GO-AROUND PROCEDURE: THREE ENGINES OPERATING, SURFACE CONTROL BOOSTERS ON.

3–22. A go-around can be accomplished if the altitude is more than 50 feet and the airspeed is more than 109 knots (125 mph). Use the procedure given in para. 3–20 preceding.

3–23. GO-AROUND PROCEDURE: TWO ENGINES OPERATING, SURFACE CONTROL BOOSTERS ON.

3–24. A go-around can be accomplished if the altitude is not less than 200 feet and the airspeed is not less than 122 knots (140 mph) and provided the inoperative engines are not 3 and 4. Use the procedure given in para. 3–20, preceding. If engines 3 and 4 are inoperative, a go-around is impossible since the landing gear cannot be retracted.

3–25. THREE ENGINE FERRYING TAKE-OFF

3–26. GENERAL.

3–27. It is possible, when circumstances warrant, to take off with one engine inoperative provided the gross weight is under 100,000 pounds. The recommended procedure and performance information is given in Lockheed Report 7787, Appendix I.

3–28. PROPELLER MALFUNCTION

3–29. INADVERTENT REVERSING IN FLIGHT.

3–30. In the event a propeller accidently reverses in flight:

a. Pull out the PROP. REV. circuit breaker, located on the flight engineer's control quadrant circuit breaker panel.

b. Push the feathering button.

c. Unfeather as explained in para. 3–17.

3–31. PROPELLER OVERSPEEDING IN FLIGHT.

3–32. If a propeller overspeeds during flight:

a. Close throttle.

b. If overspeeding cannot be controlled by throttling, attempt feathering and decrease airspeed to the minimum safe value.

c. If the overspeeding still cannot be controlled, evacuate personnel from area adjacent to plane of propeller rotation and descend to a minium safe altitude.

3–33. FIRE CONTROL

3–34. ENGINE FIRE CONTROL.

3–35. Judgment and precision are more important than 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.

3–36. ENGINE FIRE DURING START. 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. If fire continues, or spreads, stop cranking the engine.

d. Smother fire with carbon dioxide from a ground source.

3–37. ENGINE FIRE AFTER START. If the fire occurs after the engine starts:

a. Throttle—CLOSED.

b. Mixture—OFF.

c. Firewall shut-off valve lever—CLOSE.

d. Fuel tank selector—OFF.

e. Fuel booster pump—OFF.

f. Cowl flaps—OPEN.

g. Hydraulic suction shut-off valve—Closed.

h. Ignition—OFF.

i. Smother fire with carbon dioxide from a ground source.

CAUTION

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

3–38. ENGINE FIRE DURING FLIGHT. 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:

a. Throttle—CLOSED.

b. Feathering button—Push.

c. Mixture—OFF.

d. Firewall shut-off valve lever—CLOSE.

e. Hydraulic suction shut-off valve—Closed.

f. Fuel tank selector—NORMAL to operating engines.

g. Fuel tank selector—OFF to inoperative engine.

h. Fuel boost pump—OFF.

i. Crossfeed valve (of inoperative engine)—OFF.

j. Cowl flaps—full OPEN. (For failure—Faired.)

k. Propeller and carburetor anti-icers—OFF.

l. Generator—OFF.

lA. Generator field circuit breaker—OFF.

m. Engine fire extinguisher selector—Set to engine on fire—(Cargo and Heater Selector—OFF).

n. Release one CO_2 charge on captain's order—Stand by to release second charge.

o. Feathering button—NEUTRAL (after propeller has feathered).

p. Propeller governor switch—full DEC. RPM.

q. Ignition switch—OFF.

r. Oil cooler flap—Faired.

s. Cowl flap (after fire)—Faired.

t. Crossfeed valve — as required. (If no further fire hazard.)

Note

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

WARNING

Do not attempt to re-start engine.

3–39. FUSELAGE FIRE CONTROL.

3–40. Fire detectors are provided to warn of cabin heater fires. 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.

CAUTION

WHEN, IN FLIGHT AND THE CABIN IS EMPTY OF PEOPLE, ALL DOORS BETWEEN THE FLIGHT STATION AND CABIN MUST BE BLOCKED OPEN. This precaution is required to reduce the possibility of a heavy smoke accumulation in the cabin before it is detected by the fiight crew, with the possible result that the smoke would be so dense that it would be impossible for a crew member to enter the cabin to open an emergency exit.

3–41. EMERGENCY SMOKE REMOVAL

Note

In the event it becomes necessary to clear the cabin of noxious fumes or gases of any kind, the Emergency Smoke Removal 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, against the alternate danger of asphyxiation. If immediate smoke removal is felt to be necessary, the following procedure may be initiated:

Pressurized Flight	*Unpressurized Flight*
a. Close throttles and start a rapid descent, gear and flaps up.	
b. Depressurize by dumping both superchargers. (Cabin aux. vent. knob to full open, then to position A when cabin differential drops to about 1″ Hg.) §	a. Close auxiliary ventilation valves. (Aux. vent. knob to position A).§

§ Since position A supplies no ventilating air to the cockpit and cabin through the normal ventilating system, use of position A should be limited to situations when windows may be opened for ventilation.

Pressurized Flight	*Unpressurized Flight*
c. Turn recirculating and flight station fans OFF. When depressurized, remove smoke as follows:	b. Turn recirculating and flight station fans OFF. Remove smoke as follows:
(1) Block open connecting doors to provide a clear path for the air.	(1) Block open connecting doors to provide a clear path for the air.
(2) Slow down to 175 knots (200 mph) or less to facilitate opening emergency exits.	(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.	(3) FIRST open one or more of the emergency exits over the WING.

Note

If unable to open emergency exit, break window, using an axe or heavy object. Passengers and crew members should stay clear of the opening, particularly if the window is broken at full cabin pressure differential.

Pressurized Flight	*Unpressurized Flight*
(4) SECOND open the pilots' windows.	(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.

3-42. FUSELAGE FIRE EXTINGUISHING PROCEDURE.

WARNING

The crew should put on oxygen masks and goggles before releasing CO_2. Plug masks into demand* (protective†) system outlets, and set to 100% oxygen flow.

Note

The fire can best be controlled by smothering with extinguishing agent. If a fire should occur in the rear baggage compartment during pressurized flight, the cabin recirculating fans may draw some of the smoke from the baggage compartment into the cabin. It is very important, therefore, to shut off the recirculating fans immediately to minimize the smoke accumulation in the cabin and to reduce the possibility of fanning the fire.

a. Close the throttles and start a rapid descent, gear and flaps up. If it is imperative that altitude be lost at the most rapid rate, descend at V_{NE}.

b. Aux. vent. knob to—FULL OPEN.

c. FWD. and AFT cabin pressure regulators—MANUAL.

d. Cabin recirculating and flight station fans—OFF.

e. Aux. vent. knob (at 1″ Hg cabin differential pressure)—POS. B.§

f. Fuel tank selector—NORMAL.

g. Crossfeed valves—CLOSED.

Note

If it is definitely known that the hydraulic or electrical systems are not involved in the fire, steps h and i below may be omitted. (Refer to note following para. 3-44, g.)

h. Hydraulic suction shut-off valves—OFF.

i. If the fire is of an electrical origin, proceed as directed in para. 3-46.

Note

Auxiliary boost will still be available for the rudders and elevators and should be turned ON if the hydraulic system has been turned OFF. Aileron boost should be by-passed to reduce forces. The auxiliary boost motors will deplete the battery power 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 by-passed and the emergency manual elevator control pulled out and locked.

§ Position B on the aux. vent. knob dumps the cabin superchargers and puts them in minimum flow, opens the outflow valves, opens the aux. vent. inlet and exit valves partially, and closes the recirculation dampers. This configuration reduces the ventilation in the cargo compartments and supplies some ventilation for keeping the cabin and cockpit clear.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

j. If fire can be reached, extinguish it with a hand fire extinguisher.

Note

Fires due to an active short circuit cannot be extinguished until the short circuit is dead.

3–43. CARGO COMPARTMENT FIRE EXTINGUISHING PROCEDURE.

Note

The fire can best be controlled by smothering with extinguishing agent. If a fire should occur in the rear cargo compartment during pressurized flight, the cabin recirculating fans may draw some of the smoke from the cargo compartment into the cabin. It is very important, therefore, to shut off the recirculating fans immediately to minimize the smoke accumulation in the cabin and to reduce the possibility of fanning the fire.

a. Close the throttles and start a rapid descent, gear and flaps up. If it is imperative that altitude be lost at the most rapid rate, descend at V_{NE}. Refer to para. 3–58.

Note

Descent with the gear and flaps retracted will reduce the CO_2 contamination in the cockpit and increase the CO_2 retention in the cargo compartment as compared to descent with the gear and flaps extended.

b. Aux. vent knob—full OPEN.

c. FWD. and AFT cabin pressure regulators—MANUAL.

d. Cabin recirculating and flight station fans—OFF.

e. Aux. vent knob (at 1″ Hg cabin pressure differential)—POS. B. §

f. Fuel tank selectors—NORMAL.

g. Crossfeed valves—CLOSED.

Note

If there is an indication that the hydraulic or electrical systems are malfunctioning during a cargo compartment fire, such as loss of hydraulic pressure, fluid, control boost, over-voltage, feeder-fault tripping of the generators, over-load or over-voltage on the electrical panel or other obvious indications, then steps h, i, j, k should be accomplished. In addition, the airplane should be checked for good aileron trim and the aileron boost turned off and the auxiliary elevator and rudder boost turned on.

h. Hydraulic suction shut-off valves—Closed.

i. Battery switch—OFF.

j. Generator and generator field circuit breakers—OFF.

k. Auxiliary boost switches—ON.

Note

With the generators off, the auxiliary boost motors will deplete the battery power 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 or when descent is completed. To reduce control forces, the rudder boost should then be bypassed and the elevator booster control lever pulled out and locked.

l. To determine the location of the fire, turn ON the cargo compartment lights and inspect both compartments through the scanning lenses in the forward hatches of each compartment.

m. Engine extinguisher selector—OFF.

n. Cargo compartment and cabin heater fire extinguisher selector—set to compartment on fire.

o. Crew should put on demand-type* (protective†) oxygen masks with goggles and adjust selector to breathe 100% oxygen. (This should be done before CO_2 release.)

p. After cabin has depressurized to approximately zero differential, discharge only one CO_2 charge.

WARNING

- Not more than one charge (50 lbs.) of CO_2 can be discharged at once into the compartment without producing a dangerous quantity of CO_2 in the cockpit. Do not use second charge of CO_2 unless absolutely necessary and in any case, not sooner than fifteen minutes after the first charge has been released.
- Never discharge CO_2 while pressurized.
- Never discharge CO_2 in a nose-up attitude.
- Crew must use oxygen masks when discharging CO_2.

---

§ Position B of the aux. vent. knob dumps the cabin superchargers and puts them in minimum flow, opens the outflow valves, opens the aux. vent. inlet and exit valves, partially, and closes the recirculation dampers. This configuration reduces the ventilation in the cargo compartments and supplies some ventilation for keeping the cabin and cockpit clear.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

q. Block open all doors between cabin and flight station.

r. Open velocity outlets in ceiling of forward and main cabin.

s. If for any reason it becomes necessary to quickly remove CO_2 from the cockpit or cabin, follow the emergency smoke removal procedure.

t. Allow a 30-minute "soaking" period for the CO_2 to take effect.

u. After 30 minutes, examine cargo compartment for sign of smoldering "hot spot." Repeat examination every 30 minutes for remainder of flight.

v If there is a sign of smoldering fire, the best procedure is to reach the spot, if possible and use a hand extinguisher or remove and jettison the affected cargo.

WARNING

Do not enter cargo compartment without auxiliary breathing equipment. The CO_2 content will still be high.

3-44. CABIN HEATER FIRE CONTROL.

3-45. Procedure:

a. Cabin heater switches—OFF.

b. All cabin fans—OFF.

c. Engine fire extinguisher selector—OFF.

d. Cargo compartment and cabin heater fire extinguisher selector—SET (to fire location).

e. Pull either CO_2 release handle.

WARNING

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.

3-46. ELECTRICAL FIRE CONTROL.

3-47. GENERAL. Fires resulting from 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.

3-48. ELECTRICAL FIRE EXTINGUISHING PROCEDURE. If the above cannot be accomplished with a minimum loss of time, proceed as follows:

a. Engine driven emergency flight instrument alternators—LH. or RH. INST. ALT.*

aA. Horizon power switches—ALTERNATOR.†

CAUTION

To prevent damage to the instruments, operate the engine*, or engines†, that are driving the alternator*, or alternators†, supplying instrument power within the following limits:

Continuous duty—	1600–2140 engine rpm
6 hour duty--	2140–2570 engine rpm
1 hour duty—	2570–2900 engine rpm

b. Generator switches—OFF.

c. Battery switch—OFF.

d. Generator field circuit breakers—OFF.

e. D.C. radio power, and A.C. radio power switches—OFF.

f. Smother fire with hand CO_2 extinguisher.

After Fire Is Out:

g. Identify the affected circuit, if possible, and isolate it from the main bus.

h. Circuit breakers in affected circuit or circuits—OFF.

i. If affected circuit cannot be identified, all control switches and circuit breakers in the flight station—OFF.

j. Battery switch—ON.

CAUTION

- Before turning the battery switch ON, it is imperative that the scource 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.

k. Generator field circuit breakers—ON (one at a time).

l. Generators—ON (one at a time).

m. Watch for recurrence of trouble during remainder of the flight.

3-49. INOPERATIVE ITEMS. Following are the more important items that will be inoperative with the batteries and generators off:

a. Fire warning system.

b. Propeller governor controls (rpm stays at last setting).

*LAC Serials 4001–4014 †LAC Serials 4015–4024

c. De-icer boots.

d. Pitot heaters.

e. Windshield wipers.

f. Nesa windshield heat.

g. Navigation lights.

h. Landing lights.

i. Windshield de-foggers.

j. Hydraulic suction shut-off valves.

k. Pressure gages (fuel, oil, hydraulic).

l. Quantity gages.

m. Fuel boost pumps.

n. Radio.

nA. Automatic pilot.†

o. Temperature indicators, including cylinder head and supercharger drive shaft.

p. Heaters and recirculating fans (cabin pressure will remain at the value it was when electrical system was turned off unless it is changed manually at the 260 panel).

3–50. ELECTRICAL POWER SOURCES AND EFFECT OF EMERGENCY OPERATION.

3–51. The three main sources of electrical power are the four engine driven generators, the two batteries and the engine driven emergency flight instrument alternators mounted on each outboard engine.

3–52. Generator and battery power is distributed by the main bus and the essential bus.

3–53. All the heavy, unessential electrical loads are protected by switch type circuit breakers and the important, or light electrical loads are protected by push-pull type circuit breakers. If the heavy, unessential loads are not turned off when the generators are turned off, battery power will be rapidly depleted. With all four generators off, the batteries will supply the main bus with enough power to operate all the electrical equipment for a very short time. If the batteries are turned off and the generators left on, the electrical system will function normally as long as the engines are running, except for an a.c. ripple which may cause erratic ADF indication, radio noise, and affect the operation of several sensitive d.c. controls.

3–54. If all the generators and batteries are turned off, the following items may be operated from the batteries through the essential bus:

a. Cockpit instrument emergency white lights.

b. Elevator and rudder auxiliary boost.

c. Elevator electric trim tab.

d. Flares.

e. Generator field relays.

3–55. The emergency flight instrument engine driven alternator will furnish power for the pilot's and copilot's turn and bank indicators and gyro horizons if the selector switch on the MJB panel is positioned to either L.H. or R.H. INST. ALTERNATOR.*

3–55A. The emergency flight instrument engine driven alternators will furnish power for the pilot's and copilot's gyro horizons if the selector switches on the pilots' right and left instrument panels are positioned to ALTERNATOR position.†

Note *

A flag will appear on the pilots' gyro horizons if these instruments are not receiving power.

Note †

The fluorescent half of the power failure indicators on the pilot's and copilot's instrument panels will be visible if the gyro horizons are not receiving power.

3–56. Tachometers, airspeed indicators, altimeters, rate of climb indicators, brake accumulator pressure gage and the magnetic compass are not directly affected by the electrical system, and will continue to operate. The cable controlled fire wall shut-off valves may still be used to shut off engine oil and hydraulic fluid and the accessory section air blast tube valve.

3–57. EMERGENCY DEPRESSURIZATION

a. Place the auxiliary ventilation control knob in the full OPEN position and then return the knob to position A as soon as cabin differential pressure reaches 1″ Hg. The aux. vent. 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. Fan and heater switches—OFF.

c. Descend to a low, safe altitude.

3–58. RAPID DESCENT PROCEDURE

a. Gear and flaps—UP

b. Auto-pilot—OFF

c. Controls—RE-TRIM

d. Aux. boost—ON

e. Throttles—CLOSED

f. Descend at airspeeds up to V_{NE}.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

3–59. LANDING WITH GEAR RETRACTED

3–60. GENERAL. It is possible in an emergency to land a Lockheed Super Constellation with gear retracted without seriously damaging the airplane. With the exception of those procedures which are obviously peculiar to ditching, the procedures for a crash landing are very similar to those recommended for ditching. Escape routes are shown on figure 3-2. The recommended procedure is given in the following steps:

a. Notify crew of intention to crash land.

b. Notify ground stations, giving position.

c. Reduce gross weight of aircraft by dumping fuel.

d. If possible, move center of gravity to approximately 30% MAC.

e. Provide passengers with padding; show them how to brace themselves when the signal is given, and order seat belts fastened.

f. Secure or stow loose equipment.

g. Open all doors; remove and stow securely all emergency exit covers.

h. Select grass or open ground on which to land, rather than a paved runway.

i. Make a wide enough approach to permit feathering and positioning of inboard propellers before starting the down-wind leg.

j. Feather propellers Nos. 2 and 3, positioning them with one blade up. Use engine starters to position blades.

k. Firewall shut-off valve levers on feathered engines—CLOSE.

l. Ignition to feathered engines—OFF.

m. All fuel booster pumps—OFF.

n. Auxiliary booster switches—ON.

o. Wing flaps—Extend to LAND position as soon as it is certain landing area can be reached.

p. Give order to BRACE 30 seconds before contact.

q. Mixture controls, engines Nos. 1 and 4—OFF.

r. Fuel tank selectors—OFF.

s. Ignition switches—OFF.

Note

Items q, r and s above should be accomplished simultaneously just prior to contact with the ground so that engines Nos. 1 and 4 can be kept running up to the last possible moment to provide hydraulic power for control boosters.

t. Hold nose fairly high for landing.

u. Firewall shut-off valve levers—CLOSE.

v. All electrical power (batteries, generators and generator field circuit breakers)—OFF as soon as possible after contact with the ground.

w. Evacuate plane promptly.

3–61. DITCHING

3–62. GENERAL. Ditching is the term used to describe an emergency landing and abandonment of an airplane on water. No Constellation or Super Constellation airplane 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 towards a prompt and orderly abandonment of the aircraft (figure 3-3) as soon as it decelerates.

3–63. 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 airplane 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.

3–64. 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 airplanes successfully.

3–65. There are three phases of any ditching procedure:

a. Preparation for ditching.

b. Alighting.

c. Abandonment.

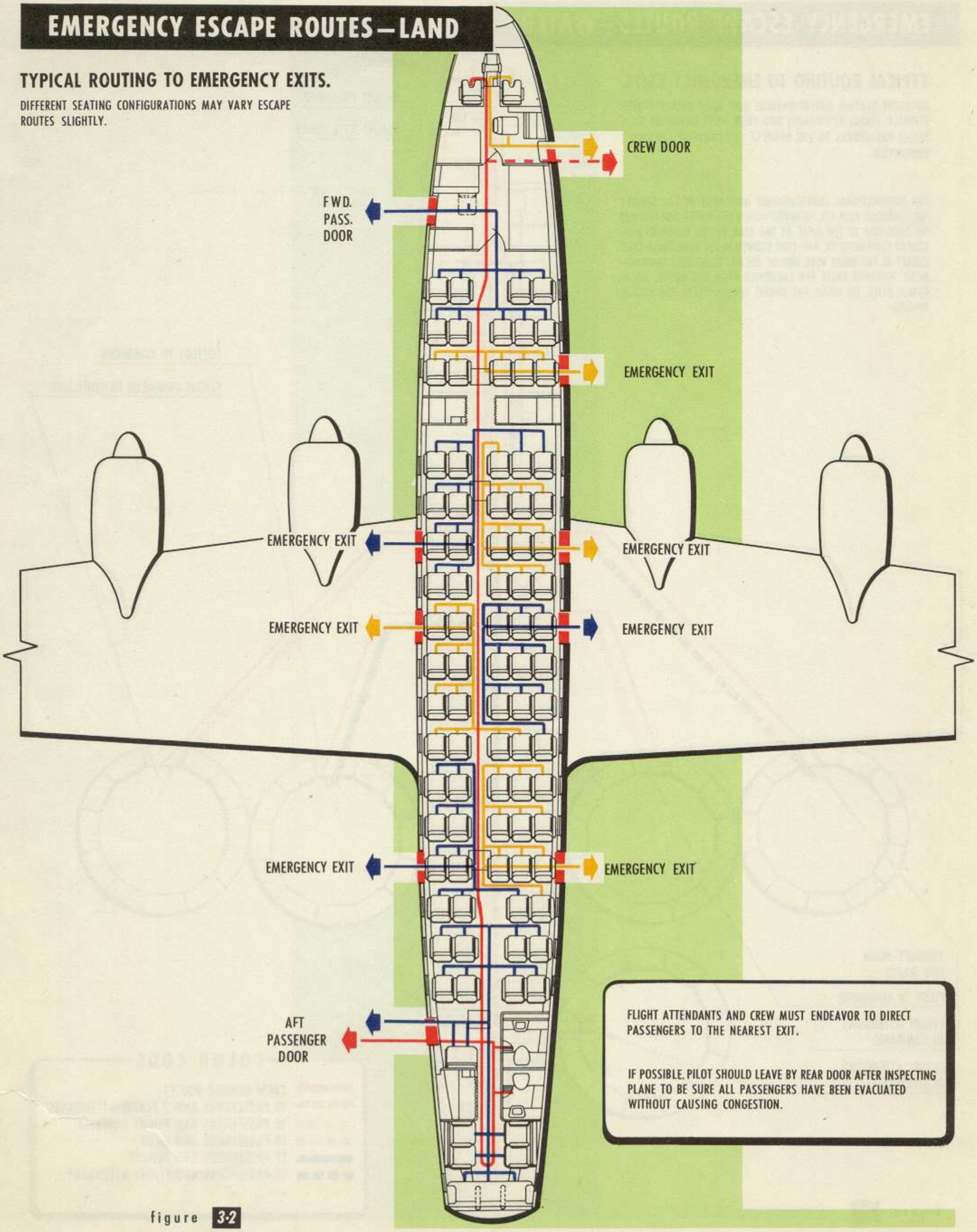
3–66. PREPARATION FOR DITCHING.

3–67. 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.

EMERGENCY ESCAPE ROUTES—LAND

TYPICAL ROUTING TO EMERGENCY EXITS.

DIFFERENT SEATING CONFIGURATIONS MAY VARY ESCAPE ROUTES SLIGHTLY.



FLIGHT ATTENDANTS AND CREW MUST ENDEAVOR TO DIRECT PASSENGERS TO THE NEAREST EXIT.

IF POSSIBLE, PILOT SHOULD LEAVE BY REAR DOOR AFTER INSPECTING PLANE TO BE SURE ALL PASSENGERS HAVE BEEN EVACUATED WITHOUT CAUSING CONGESTION.

figure 3-2

EMERGENCY ESCAPE ROUTES—WATER

TYPICAL ROUTING TO EMERGENCY EXITS.

DIFFERENT SEATING CONFIGURATIONS MAY VARY ESCAPE ROUTES SLIGHTLY. FLIGHT ATTENDANTS AND CREW MUST ENDEAVOR TO DIRECT PASSENGERS TO THE NEAREST EXIT WITHOUT CAUSING CONGESTION.

THE INTERNATIONAL CONFIGURATION AIRPLANES IN LAC SERIALS 4015 THROUGH 4024 ARE EQUIPPED WITH 4 LIFE RAFTS, ONE STOWED ON EACH SIDE OF THE AISLE AT THE REAR OF THE FORWARD PASSENGER COMPARTMENT, AND TWO STOWED IN THE REMOVABLE COAT CLOSET AT THE RIGHT REAR END OF THE AFT PASSENGER COMPARTMENT. WHETHER THESE ARE LAUNCHED FROM THE WINGS, EMERGENCY EXITS, OR FROM THE DOORS WILL DICTATE THE ESCAPE ROUTES.

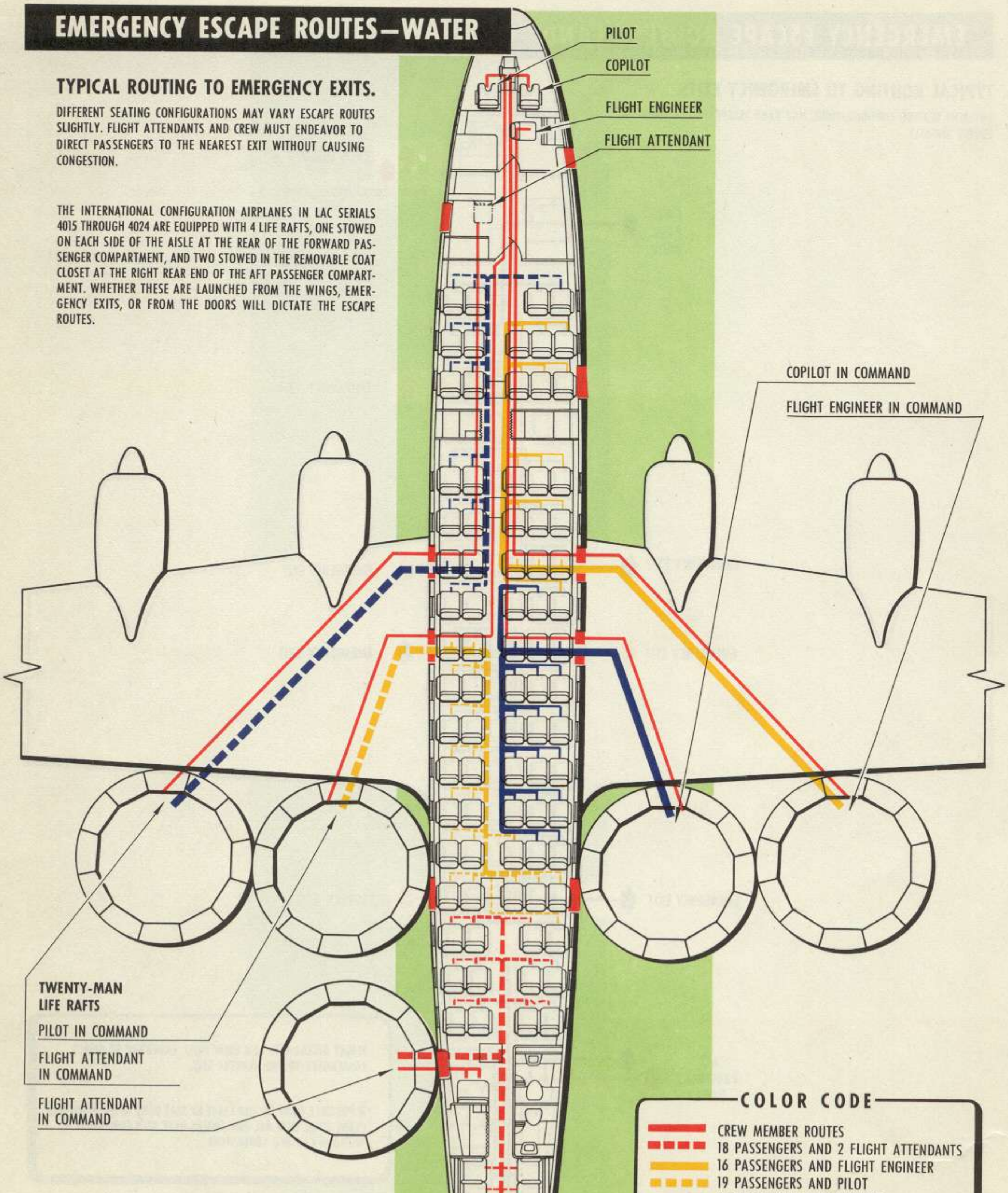


figure 3-3

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.

3–68. CREW RESPONSIBILITIES.

3–69. 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 touch down on the water with a nose-high attitude.

a. Instruct crew to prepare for ditching.

Note

If cabin attendants are not within audible range of the cockpit 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.

dA. Order fuel to be dumped.

WARNING

Do not use flares when dumping fuel.

e. Use or jettison landing flares.

f. Turn on ordinance lights and fasten own seat belt.

g. Give signal to BRACE approximately 30 seconds before contact with the water.

3–70. 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.

3–71. FLIGHT ENGINEER.

a. Dump fuel when so instructed by pilot.

b. Depressurize cabins.

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 ax through a window. Stand clear when so doing.

c. Assist flight attendants with life rafts.

d. Fasten seat belt, turn seat to face aft, and double up when ordered to brace.

3–72. FLIGHT ATTENDANTS. Passenger morale and safety are important responsibilities of the flight 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. Instruct passengers to remove life vests from backs of seats in which they are sitting* or from overhead rack.† 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 door 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.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

e. Remove the life rafts from stowage and place on the floor near the forward bulkhead of the aft (main) cabin, adjacent to the emergency exits over the wing. One raft may be positioned near the aft passenger door if this is to be used as an escape route.

CAUTION

Do not remove rafts from their carrying case inside of the airplane.

f. Tie open the doors between flight station and cabins.

Note

Secure doors so that they will not slam and jam shut when the airplane decelerates.

g. 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.

Note

Unsecured articles may fly through the cabin like projectiles at the time of impact with the water.

h. 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, fruit juices, are ready to be removed if they are available.

i. Remove and stow securely the covers from the emergency exits over the wings.

iA. Turn on ditching light at aft passenger entrance.†

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 airplane. 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.

3–73. ALIGHTING.

3–74. 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 approximately 50,000 pounds of flotation.

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 pressure regulator valve inlets.

Note

The pressure regulator valve opening can be closed after the cabin has been depressurized by setting the controls for pressurization which will automatically close the valve opening. Repressurization 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	Approximate wind speed
Few white crests	10 to 20 mph
Many white crests	20 to 30 mph
Streaks of foam from Crests	30 to 40 mph
Spray blown from tops of Waves	40 to 50 mph

e. Use power (if available) to control point of contact and to flatten approach.

†LAC Serials 4015–4024

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 by using full-up elevator.

WARNING

Keep cockpit windows closed as the airplane has a tendency to nose under as it loses forward speed on water.

3–75. NIGHT DITCHING PROCEDURE.

a. Make a downwind 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.

3–76. ABANDONMENT.

3–77. GENERAL. 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. 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.

3–78. EXITS. The crew door, fore and aft passenger doors provide the easiest means of exit; however these may be unusable because their sills may be submerged. In addition, there are seven windows which may be removed for emergency exits. One emergency exit is located on the right side of the forward passenger compartment, and six in the aft passenger compartment. Four of the aft passenger compartment emergency exits are located over the wings, two on the right and two on the left side. Their location in relation to numbered seats varies according to the seating configuration. (See fig. 3-3.) The exits over the wings are convenient for evacuating passengers, because the wings provide a pier from which passengers may enter the rafts.

WARNING

Do not open any doors if their sills are below water. Use emergency exits.

3–79. LIFE RAFTS. Four† or five* 20-man life rafts are stowed inside the cabin area. 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 jerk 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.

3–80. 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.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

3–81. TO INFLATE AND LOAD RAFTS.

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 exits, retaining firm grip on the launching line protruding from the carrying case.

Note

Launching lines should be attached to the airplane if possible.

b. After the raft is *outside* the airplane, 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 airplane sinks while raft is tied to it.

d. Launch as many rafts as possible before beginning to evacuate passengers.

CAUTION

Keep life rafts away from any damaged surfaces which might tear them.

e. Disperse passengers as evenly as possible among exits selected for evacuation so that there will be little 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 airplane.

f. Caution passengers not to jump into life rafts. Women with high heeled shoes should be particularly careful, removing shoes if necessary. Exercise caution to avoid tearing the bottom of the raft.

g. 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.

h. See that vests are inflated *after* passengers have left the airplane.

i. Place each life raft under the command of a member of the flight crew.

j. Load life rafts as equally as possible. Redistribute load if haste has resulted in overloading any of the rafts.

k. After all passengers and crew have been evacuated, move rafts out from under any part of the airplane which might strike them as it sinks.

l. Rope rafts together so that they will not drift apart, become separated and complicate rescue.

m. 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.

3–82. CREW RESPONSIBILITIES. The following distribution of crew responsibility during evacuation and abandonment of the aircraft is suggested:

3–83. PILOT.

a. Survey situation and decide which exits to use.

b. Supervise and assist in launching life rafts.

c. Make certain water, food, first aid kit, and other necessities are removed from airplane.

d. Supervise and help crew to abandon aircraft.

e. Take command of own raft; remove mooring line; rally rafts together and get them clear of the airplane.

3–84. COPILOT.

a. Launch and inflate life raft.

b. Assist with launching of other life rafts.

c. Supervise evacuation of passengers in forward passenger compartment.

d. Take command of own raft.

3–85. FLIGHT ENGINEER.

a. Assist flight attendants in opening emergency exits.

b. Assist with the launching and inflation of life rafts from the fore and aft cabin exits.

c. Remain on wing to assist with the stowing of emergency supplies, evacuation and embarkation of passengers.

d. Take command of own life raft.

3–86. FLIGHT ATTENDANTS.

a. Open emergency exits.

b. Launch and inflate life rafts, one from aft passenger door (if door still is above water), and the remaining rafts through the emergency exits over the wings.

c. Distribute and secure emergency supplies in launched life rafts.

d. Supervise and assist evacuation of passengers.

e. Take command of separate life rafts.

3–87. AIRPLANE SYSTEMS • • •

3–88. FUEL DUMPING.

3–89. Fuel is dumped by three independently controlled systems: One for tanks 3 and 4, one for tanks 1 and 2, and one system for tanks 2A and 3A. Certain definite fuel dumping precautions must be observed in the interest of safety. Following is the recommended procedure:

WARNING

In case of fire in any location, do not dump fuel until the fire is out.

a. If time permits, transmit any necessary messages, and advise ground stations that fuel is to be dumped. Radio and all unnecessary electrical equipment—OFF.

WARNING

Vaporized fuel may be ignited by arcs or sparks from the radio installation and electrical equipent. Fuel should not be dumped if static is heavy.

b. NO SMOKING sign—ON. Cabin attendants shall make certain that none of the passengers is smoking during or immediately after fuel dumping operation.

c. Wing flaps—UP. Fuel will not clear flaps when they are extended, but will splash the aft wing structure.

d. Landing gear—UP. Turbulence created by extended gear may whip dumped fuel over wing surfaces.

e. 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 functioning, fire might result.

f. Reduce airspeed to not more than 189 knots (218 mph) IAS. Fuel must not be dumped at indicated airspeeds in excess of 189 knots (218 mph). Indicated airspeeds of 139 to 148 knots (160 to 170 mph) will decrease air loads on the dump chutes and thus control loads will be lighter.

g. If conditions permit, it is recommended that the engine power be kept constant during dumping.

WARNING

Stop dumping when aircraft comes close to the surface of the earth. Static discharge between airplane and ground may ignite fuel being dumped.

h. Fuel dump valves for tanks Nos. 1, 2, 3 and 4—full OPEN. The full OPEN position of the fuel dump valves controlling the inboard and outboard tanks is necessary because of the geneva motion of the dump valve actuating mechanism. The initial movement lowers the dump chutes. The final movement opens the valves.

i. Fuel dump valves for tanks Nos. 2A and 3A—OPEN until fuel starts to dump; then NEUTRAL. Returning the control valve for tanks Nos. 2A and 3A to NEUTRAL after the fuel begins to flow from the dump chutes relieves the hydraulic pressure in the lines to the valves, thus minimizing the possibility of leaks in the hydraulic system.

After the desired quantity of fuel has been dumped:

j. Fuel dump valves for tanks Nos. 1, 2, 3 and 4:

1. Move control handles to red lines on quadrant.

2. Move back to INTERMEDIATE for 15 to 30 seconds.

3. Move to CLOSED position.

Note

Moving the control to the red lines on the quadrant shuts off the fuel; returning it to the INTERMEDIATE position permits the chutes to drain. Moving the control past the red lines to the CLOSED position causes the chutes to retract. Visually inspect the chutes to make certain that the fuel has drained out before retracting them.

k. Fuel dump valves for tanks Nos. 2A and 3A: CLOSED until valves have closed; then NEUTRAL.

l. For the fuel dumping rate refer to figure 3-4.

FUEL DUMP RATES

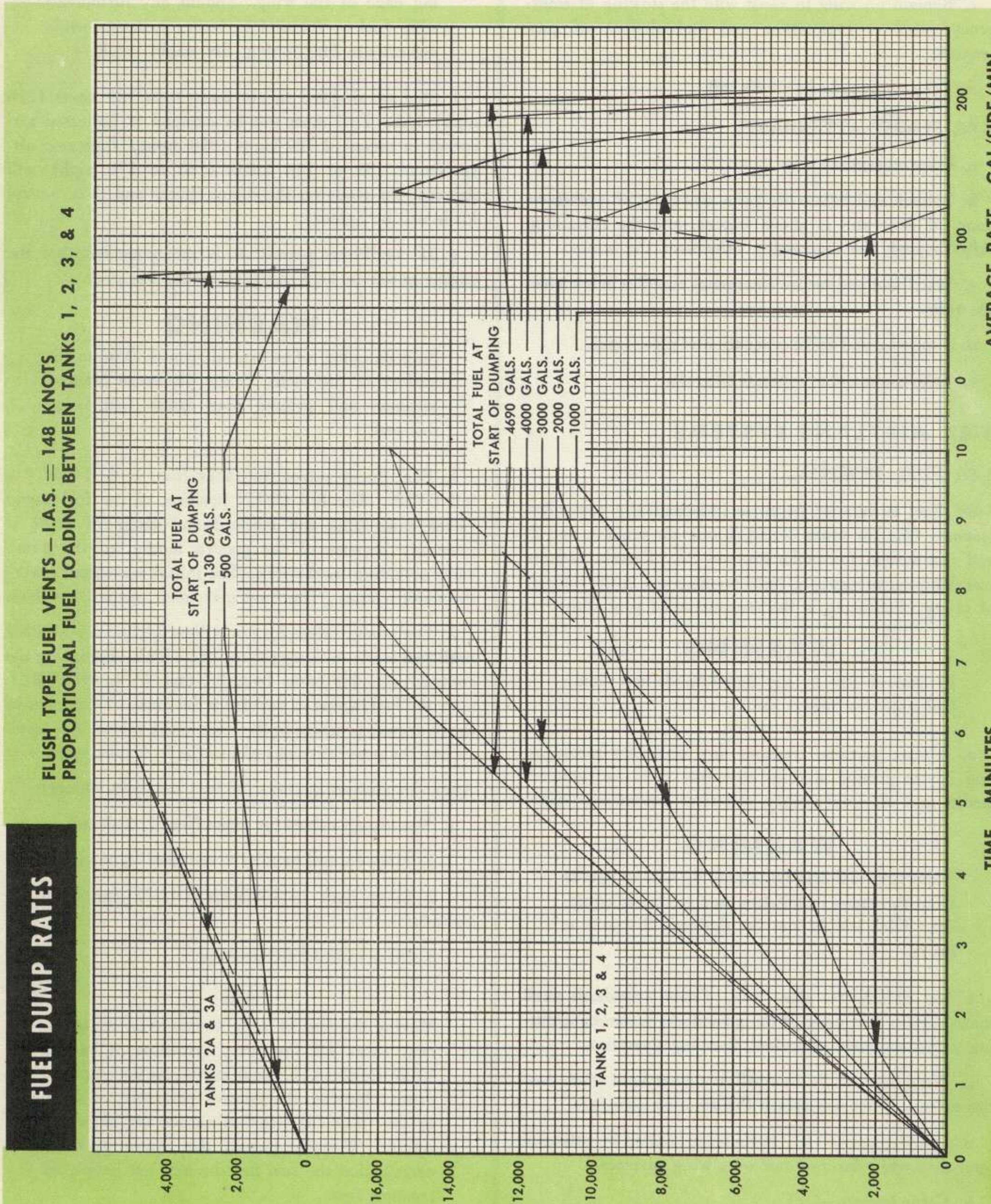


figure 3·4

3-90. HYDRAULIC POWER SYSTEM FAILURE

3-91. FAILURE OF PRIMARY PUMPS (on engines 1 and 2).

3-92. Failure of the primary hydraulic system pumps does not adversely affect the operation of the 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 services normally supplied by the secondary system may operate more slowly since priority is given to the control boosters during crossover operation.

3-93. FAILURE OF SECONDARY PUMPS (on engines 3 and 4).

3-94. Failure of these pumps makes it necessary to power the brakes with the hand pump (para. 3-112), extend the landing gear by means of the emergency system, and extend the wing flaps by means of the hand crank. In addition, the nose gear steering and the right hand secondary heat exchanger fan motor will be inoperative.

3-95. FAILURE OF PRIMARY AND SECONDARY HYDRAULIC SYSTEMS.

3-96. In addition to the hydraulic services rendered inoperative, as noted in paragraphs preceding, the normal surface control boosters and the left hand secondary heat exchanger fan motor will also become inoperative. Under these circumstances, auxiliary elevator and rudder boost may be available, depending upon the condition of the electrical system.

a. If the electrical system is functioning normally, auxiliary elevator and rudder boost will still be available. Turn auxiliary elevator and rudder boost switches ON and turn the aileron booster OFF.

b. If the generators are inoperative and the batteries are normally charged, the auxiliary elevator and rudder boosters will be available, but should be reserved for use during landing.

WARNING

Operation of the auxiliary boosters depletes the battery power very rapidly when the generators are inoperative. Hence, landing with the aid of the auxiliary boosters is not recommended when the batteries are not up to normal charge.

Note

The batteries are normally charged if the voltmeter reads 24 volts when the auxiliary boosters are off and the voltage does not drop more than 2 volts when the boosters are turned on.

1. Aileron booster control—OFF.
2. Rudder booster control—OFF.
3. Elevator booster control—OFF.
4. When on final approach:

(a) Rudder boost control—ON.

(b) Elevator boost control—ON.

(c) Auxiliary elevator and rudder boost switches —ON.

(d) Make a normal boost-on landing (aileron boost inoperative).

c. The generators and batteries are inoperative, a boost-off landing will be necessary. (See para. following.)

3-97. FLIGHT CONTROL SYSTEMS

3-98. LOSS OF BOOSTERS IN FLIGHT.

3-99. In case of complete loss of hydraulic pressure in flight, proceed as follows:

a. Re-trim for hands-off flight.

b. Elevator and rudder auxiliary booster switches—ON.

c. Aileron booster control—OFF.

WARNING

- Do not turn booster ON until any trouble has been corrected.
- In case of malfunctioning or failure of the elevator booster system *without* the simultaneous loss of hydraulic pressure, do not turn the auxiliary booster hydraulic system ON. Shift to boost-off.

3-100. BOOST-OFF LANDING.

3-101. When a boost-off landing is to be made, the following should be accomplished.

a. Arrange the load to give a gear down CG of between 27% and 30% MAC. The forward CG position is limited by inability to flare for landing because of reduced elevator travel. 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 speed in rough air.

b. When possible, reduce the weight as much as practicable.

c. Set flaps at TAKE-OFF position.

d. Approach at slightly greater speed, 130 knots (150 mph), than that normally used for boost-on landing. This must be done to counteract for the higher stalling speed with the lower flap setting, as well as to provide sufficient elevator effectiveness for the flare with the reduced elevator travel. A longer, flatter approach with more power is desirable since a minimum amount of flare and attitude change will be required than with a higher, steeper approach. If difficulty is encountered in flaring, power may be used to pull the nose up.

Note

Ailerons or differential power may be used to raise the wings. Rudders and/or differential power may be used for directional control. Turns may be made either with rudder, ailerons, or differential power.

e. If the batteries are charged sufficiently to operate the electric elevator tab motor, it is recommended that the electric tab control be used for the last part of the final approach and to flare for touch-down.

3–102. TURNING BOOSTERS OFF IN FLIGHT.

3–103. Although the booster control system is designed to be on at all times, it can be turned off in the event of malfunctioning.

a. Reduce airspeed to between 130 and 156 knots (150 and 180 mph). Although the boosters can be turned off, in an emergency, at any airspeed, it is desirable to be in this speed range, since an abrupt control surface deflection is not likely to cause as serious a change in attitude and therefore, would not put as large loads on the airplane structure as might be done at higher airspeeds.

b. Maintain sufficient altitude to permit recovery from any inadvertent attitude change.

c. Trim the airplane longitudinally, laterally, and directionally for hands-off, straight and level flight. This is important because, if the airplane is being held in trim manually by the pilot when the booster is turned off, the sudden increase in pilot force required may be beyond the strength of the pilot and may therefore result in abrupt change in attitude. An example of this would be a condition critical for the rudder boost with one or more engines inoperative at very low airspeed, when the pilot would already be applying high forces, and turning off the boost would require additional force beyond the pilot's strength to maintain directional control. Under these conditions, it would be better to increase the airspeed and obtain directional trim before turning off the boost.

d. Without applying any force to the controls, turn the boosters off slowly, one at a time.

3–104. TURNING BOOSTERS ON IN FLIGHT.

3–105. Once the boosters have been turned off, they should not be turned on again unless it is definitely known that the cause of the malfunction no longer exists. If the decision is made to turn the boosters on in flight, the following procedure must be used.

a. Maintain the airspeed between 130 and 156 knots (150 and 180 mph). With the airspeed in this range, an abrupt control surface deflection is not likely to cause a serious change in attitude and consequently will not subject the airplane structure to as large loads as would be the case at higher airspeeds.

b. Maintain sufficient altitude to permit recovery from any inadvertent attitude change.

c. Trim the airplane longitudinally, laterally, and directionally for hands-off, straight and level flight. Even though the airplane is trimmed for hands-off flight, boost off, it is possible that a boost control valve may be slightly open and when the bost is turned on, may cause an abrupt change in control surface position. For this reason the airspeed should be held within the range noted above.

d. The pilot will not apply any force to the rudders, elevators or ailerons, but will merely hold the contiols lightly. This is important since the application of pressure to any of the controls will open the booster control valve which, when the booster is turned on, will result in a large deflection of the control surface.

e. Move the booster controls, individually, to ON very slowly. Positioning of the controls slowly has the effect of turning on the hydraulic pressure slowly, which, if a booster control valve is slightly open, will preclude the possibility of an abrupt control surface deflection.

Note

- In case there is some mis-rigging between the two aileron booster units, turning the aileron booster on slowly may cause the airplane to rock slightly laterally.
- When the elevator booster is turned on, the control column may assume a new position, depending on the original elevator position.

3–106. FLAPS, EMERGENCY OPERATION.

3–107. GENERAL. If the hydraulic system fails, the wing flaps may be extended or retracted with a hand crank. Procedure for extending or retracting wing flaps manually is as follows:

a. Secondary (pumps Nos. 3 and 4) hydraulic suction shut-off valves—CLOSED.

WARNING

Do not attempt to operate any other equipment on the secondary hydraulic system while operating flaps manually. If the hydraulic flap motors were to 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.

WARNING

The bypass valve unlocks and bypasses the hydraulic motors, but is not large enough to bypass all of the flow from the secondary pumps should they still be operating.

c. Flap Control Lever—Move sufficiently UP or DOWN to determine definitely that flaps will not operate; then return to UP position.

d. Engage hand crank in drive unit.

WARNING

- Never engage hand crank unless hydraulic suction shut-off valves for pumps Nos. 3 and 4 are closed.
- Never engage hand crank unless the flap motor bypass valve is OPEN.

e. Crank flaps to desired position.

Note

- Crank counterclockwise to extend flaps; clockwise to retract.
- Approximately 360 turns will extend flaps to take-off position, the maximum recommended for emergency extension.

f. When desired flap extension has been achieved, remove hand crank.

3–108. To restore the secondary hydraulic system after shut-down for manual flap extension or retraction:

a. Flap control lever—Move to approximate position of wing flaps.

b. Flap motor bypass valve—CLOSED.

c. Secondary hydraulic suction shut-off valves—OPEN.

3–109. LANDING GEAR, EMERGENCY EXTENSION

3–110. EXTENSION PROCEDURE.

3–111. GENERAL. About 245 full strokes of the hand pump are necessary over a period of $2\frac{1}{2}$ to 3 minutes to extend and lock all the gears. Use the following procedure:

a. Place the landing gear lever in the DOWN position.

b. Place the hand pump selector in the EMER. GEAR EXT. (aft) position.

c. Use full strokes of the hand pump.

d. Return hand pump selector to BRAKE (forward) position, after gear is down and locked, as indicated by the gear position lights.

CAUTION

Since the landing gear may or may not lock in the extended position after a free fall, the emergency extension system must be used to insure locking the gear down. The design of the landing gear is such that landing loads will not lock it in the down position.

3–112. BRAKES, EMERGENCY OPERATION

3–113. GENERAL. If reaction to toe pressure and hydraulic pressure gage readings indicate brake failure:

a. With secondary pressure, charge emergency brake system by moving brake selector handle to EMER. position, then back to NORM.

b. Without secondary pressure, charge emergency brake system with the hand pump:

1. Hand pump selector handle—BRAKE position.
2. Brake selector valve—EMER. position.
3. Develop pressure with hand pump.

3–114. The brakes may be applied in the following ways:

a. On secondary hydraulic system, brake selector in NORM.

b. On secondary hydraulic system, brake selector in EMER.

c. With secondary hydraulic system inoperative, brake selector in EMER., pressure supplied by accumulators.

d. With secondary hydraulic system inoperative and no accumulators, brake selector in NORM., hand pump selector in BRAKE, pressure supplied by hand pump.

e. With secondary hydraulic system inoperative, hand pump selector in BRAKE, brake selector in EMER., brakes applied, accumulators charged and charge retained by pressure from hand pump.

f. With secondary hydraulic system inoperative, brake selector in EMER., hand pump selector in BRAKE, accumulators charged with hand pump, brakes applied after accumulators are charged.

3–115. When sight gage on emergency extension tank indicates depletion, replenish fluid from emergency hydraulic filler reservoir* behind the pilot's seat.

a. Set the emergency hydraulic filler selector valve to the BRAKE position.

b. Transfer fluid with emergency filler pump.

3–116. CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT

3–117. GENERAL. The cabin superchargers may be disconnected in the event of malfunction. The No. 1 and No. 4 engine blower control levers disconnect the superchargers when the levers are pushed beyond the LOW blower position.

Note

Indications of supercharger failure are low sump oil pressure, high oil temperature, or low discharge pressure. However, do not confuse a flowmeter reading of 10, which occurs at high air flows such as full refrigeration, with low air flow readings.

a. Release hook-type locks on the blower control lever.

b. Move control lever forward, past the LOW blower position to the end of its travel.

CAUTION

Observe blower shift precautions if disconnecting from HIGH blower position. High forces may be required to effect a complete disconnection.

c. Return lever to the desired blower position.

CAUTION

By means of one or more of the following indications, check to be sure the drive shaft is actually disconnected:

1. A drop in supercharger oil temperature. (This may require several minutes.)

2. Oil pressure warning light. (If not already lighted, it will light as soon as the drive shaft is disengaged from the engine.)

3. A zero airflow indicator reading.

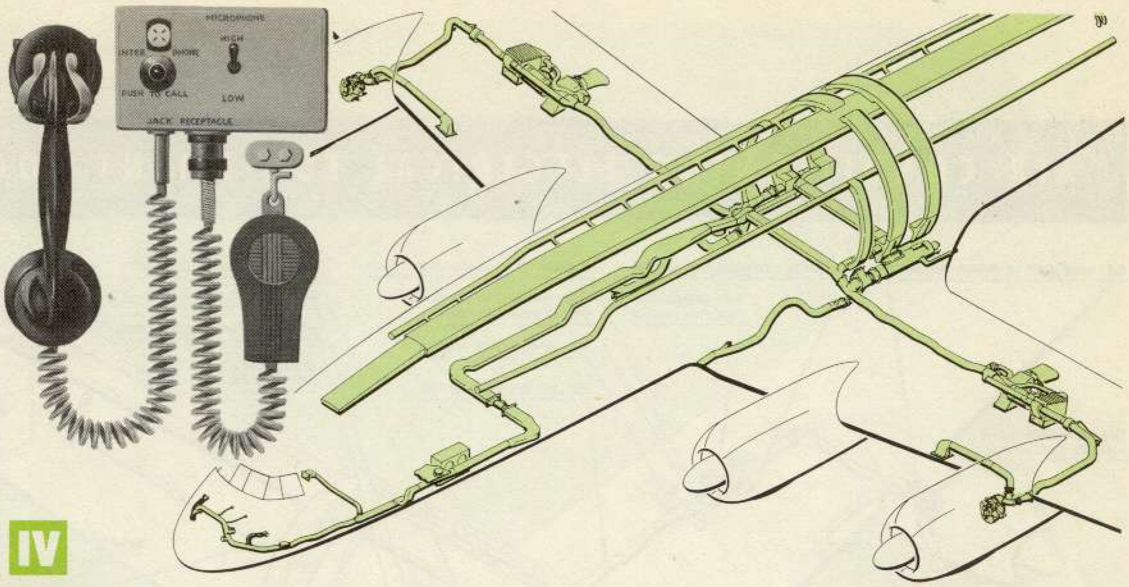
4. No pressure rise across the dual pressure gage.

d. In case the supercharger does not disconnect, feather the propeller immediately.

*LAC Serials 4001–4014

IV

AUXILIARY EQUIPMENT



Section **IV**

DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

4–1. AIR CONDITIONING SYSTEM

4–2. GENERAL. The air conditioning system provides cabin pressurization, auxiliary ventilation, heating and cooling. For pressurized operation, the air supply to the fuselage is furnished by two engine-driven compressors or 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 is provided by two internal combustion heater packages, located within the wing fillets. Supplementary heat for the flight station is provided by an electric heater located within the flight station ducting. It heats the air discharged through the pilot's and copilot's face and foot outlets.

4–3. Cooling air or refrigerated air for both the cabin and flight station is provided by two cooling units and associated heat exchangers and equipment, located within the inner wing panels.

4–4. Controls for operation of the air conditioning system are located on the panel at fuselage station 260 and are operated by the flight engineer. By proper selection of the controls, the following combinations can be obtained:

a. Normal pressurized flight with heating, cooling or refrigeration. (Figs. 4-12 and 4-13.)

b. Auxiliary ventilation in flight with or without heating. (Fig. 4-15.)

c. Ground refrigeration with engines operating. (Fig. 4-14.)

d. Ground ventilation with mixed air (fresh, recirculated, and heated, if desired).

e. Ground truck heating or cooling. (Fig. 4-16.)

4–5. MAJOR COMPONENTS OF THE AIR CONDITIONING SYSTEM (Progressive from ram-air inlets). (Refer to figures 4-1 and 4-3.)

4–6. CABIN SUPERCHARGERS. One is located in each outboard nacelle. Each supercharger assembly consists of a single-stage, variable-speed impeller, controlled by a two-speed gear train and planetary gear system. Each cabin supercharger has its own oil supply system. The superchargers are driven by a direct-coupled drive shaft from the outboard engine accessory pad at 3.11 to 1 crankshaft speed. They afford a maximum airflow of 70 lbs. per minute per supercharger (140 lbs. combined).

4–7. 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 (low impeller speed to input shaft speed) is obtained through an overriding-type clutch.

4–8. When starting, the supercharger gear system is in low ratio (plate-type clutch is disengaged). The unit remains in low ratio until the lubricating oil pressure is 25 psi, at which point the oil forces the clutch plates together to put the system in high ratio. After the oil pressure is above the minimum (25 psi) the supercharger shifts as follows:

a. High-to-low gear—1430 engine rpm (while increasing engine rpm).

b. Low-to-high gear—1130 engine rpm (while decreasing engine rpm).

The supercharger is in low-gear ratio above 1430 engine rpm. During ground operation the maximum

AIR CONDITIONING ELECTRICAL EQUIPMENT LOCATIONS

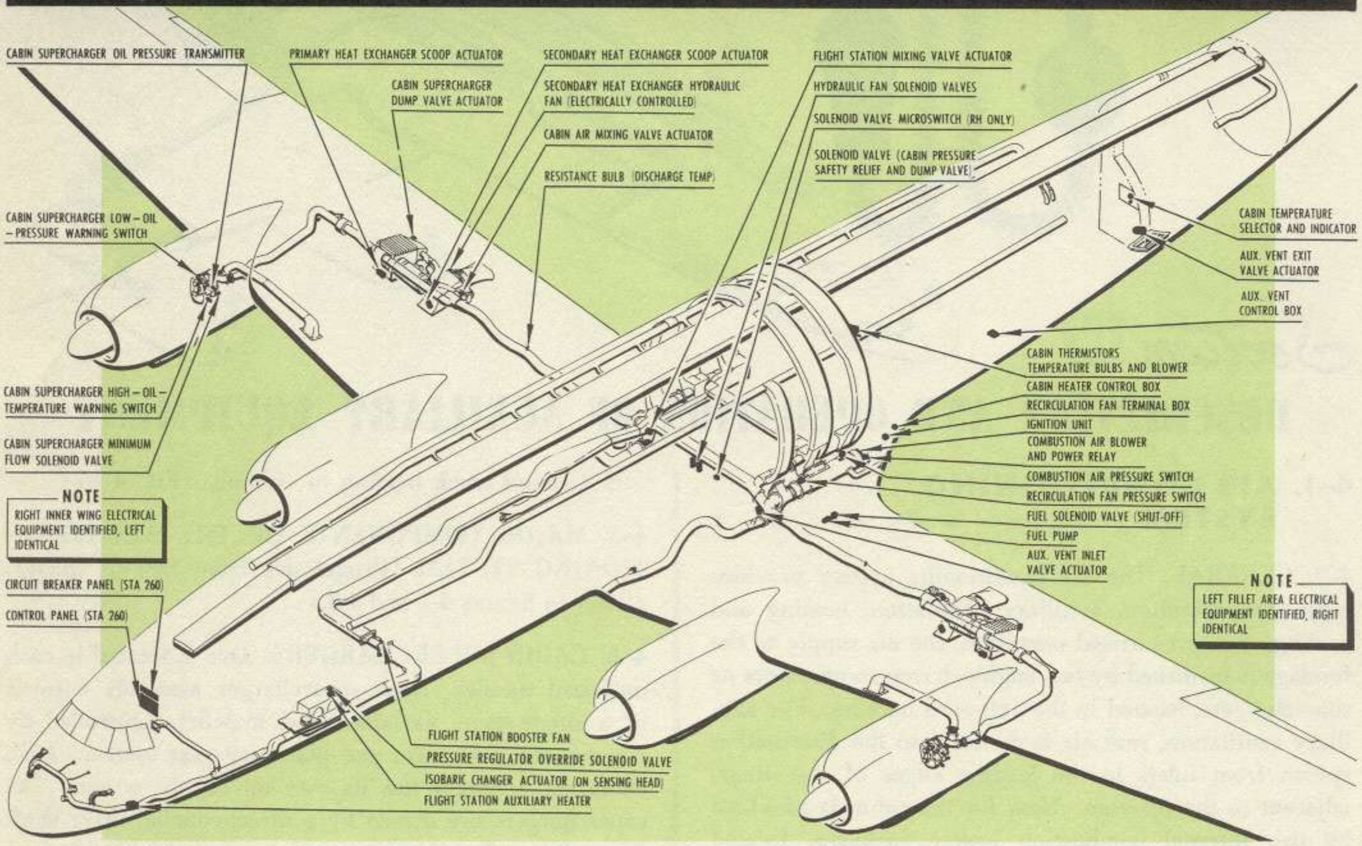


figure 4-1

supercharger output is at 1200 engine rpm (1720 engine rpm during flight).

4–9. CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT. The disconnect assembly provides a means of mechanically disconnecting the cabin superchargers from their respective engines (Nos. 1 and 4). It is located between the universal joint, at the forward end of the drive shaft, and the accessory pad at the rear of the engine. The disconnects are operated by moving the respective engine blower lever forward, past the LOW position, to the quadrant stop. Once the superchargers are disconnected, they cannot be reconnected in flight.

4–10. CABIN SUPERCHARGER PRESSURE RELIEF VALVES. One is located in the aft area of each outboard nacelle. If only one supercharger is supplying compressed air to the cabin, the air from the other supercharger is relieved through this valve, avoiding an excessive pressure build-up. This valve is controlled by the duct check valve as described in paragraph 4–11.

4–11. CABIN SUPERCHARGER DUCT CHECK VALVES. One is located immediately inboard of each outboard nacelle, downstream from the pressure relief valve. Its purpose is to prevent flow-back and resultant loss of cabin pressure through an inoperative or low output cabin supercharger. If the duct pressure becomes greater than cabin supercharger discharge pressure, the valve will close and actuate a pilot valve to open the pressure relief valve.

4–12. PRIMARY HEAT EXCHANGERS. One is located aft of the rear beam, between the nacelles. Its purpose is to remove the heat-rise-of-compression from the cabin supercharger when cabin heating is not required. The primary heat exchanger has a modulating, cooling-air scoop that works in sequence with the cabin air mixing valve (Para. 4–17) varying the degree of cooling. The scoop is electrically actuated.

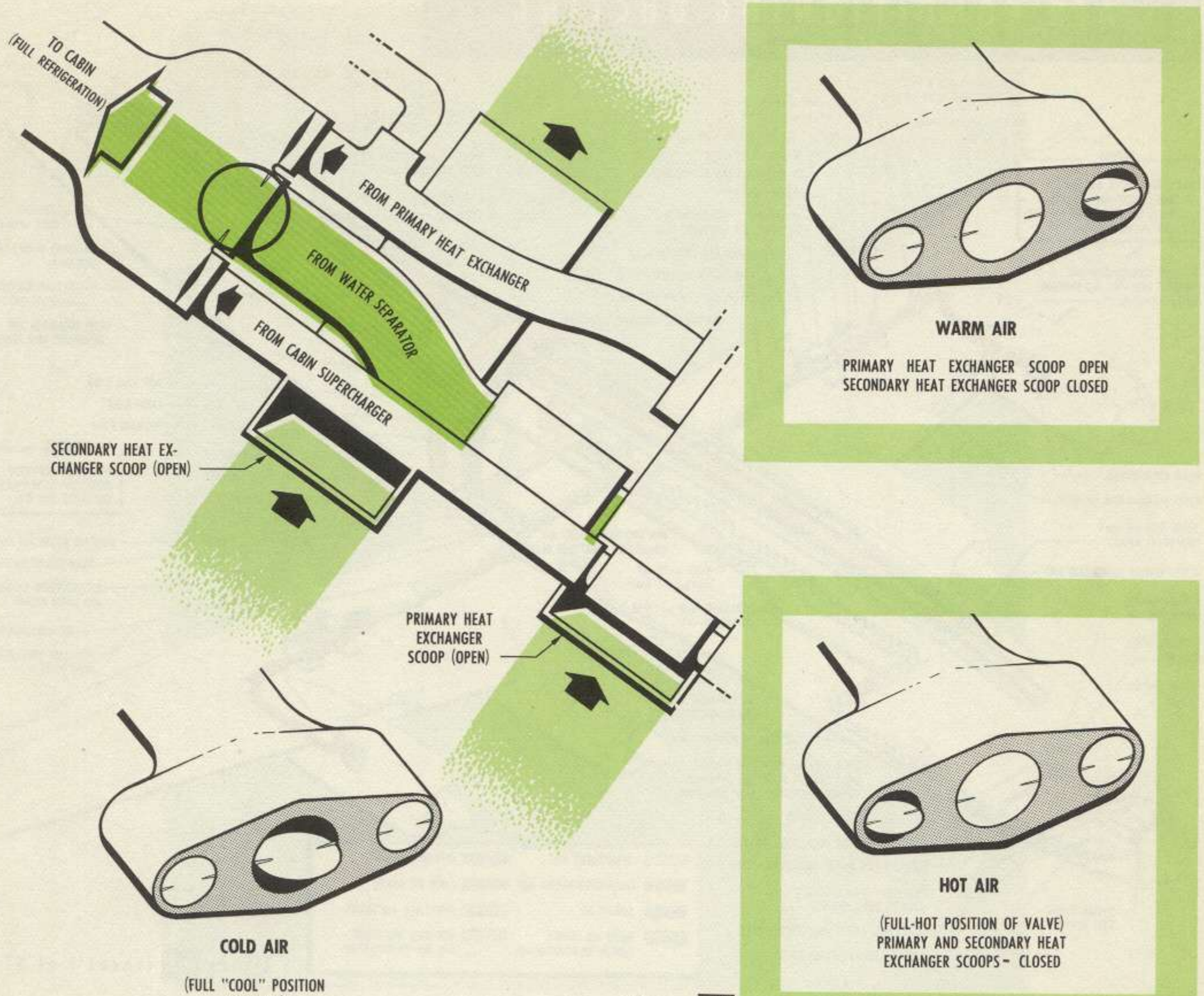


figure 4-2

CABIN AIR MIXING VALVE

4–13. CABIN SUPERCHARGER DUMP VALVES. One is located on the aft header of each primary heat exchanger. These valves automatically dump cabin supercharger air overboard whenever the system is operating on auxiliary ventilation. In the dump position, the valve closes off the outlet duct from the primary heat exchanger.

4–14. REFRIGERATION ASSEMBLIES. One is located midway between each of the inboard and outboard nacelles aft of the rear beam. The basic unit consists of a secondary compressor, secondary heat exchanger, cooling fan, and expansion turbine.

a. SECONDARY COMPRESSORS. The secondary compressors raise the cabin supercharger discharge air pressure for the cooling turbine.

b. SECONDARY HEAT EXCHANGERS. The secondary heat exchangers remove the heat resulting from the second stage of compression. The exchanger has a two-position, electrically actuated, cooling-air scoop that is open on the refrigeration phase of the control cycle.

c. SECONDARY HEAT EXCHANGER (GROUND) COOLING FANS. The hydraulically-driven fans are located on the aft cooling-air side of each secondary heat exchanger. They provide circulation of cooling air for the secondary heat exchanger when the refrigeration unit is being operated on the ground. The right fan is turned

AIR CONDITIONING DUCTING

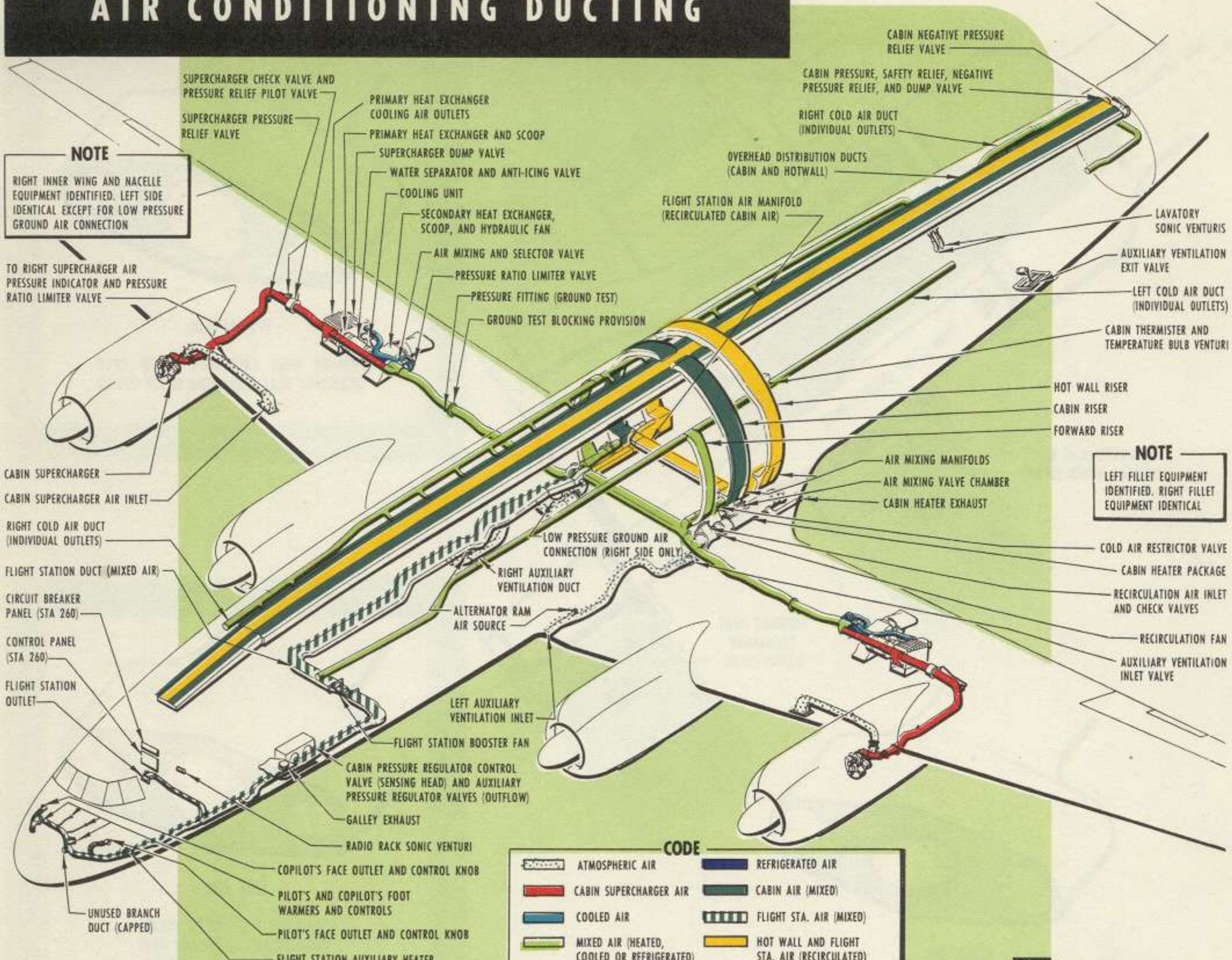


figure 4-3 (sheet 1 of 3)

off automatically during extension or retraction of the wing flaps by a microswitch on the flap pre-selector valve. Both fans are turned off by the scissors switch on take-off. In flight, cooling air is supplied by ram air.

d. EXPANSION TURBINES. These turbines expand the air for cooling and drive the secondary compressors.

4–15. WATER SEPARATORS. A water separator is located downstream of each expansion turbine. Its purpose is to remove the moisture released by cooling the air in the turbine. This is accomplished by passing the air through fiberglass condenser bags backed up with baffle tubes. The water is drained overboard through the lower surface of the wing.

4–16. WATER SEPARATOR ANTI-ICING SYSTEM. Hot air is ducted to the water separator to prevent freezing. This duct runs from the discharge side of the cabin superchargers (just upstream of the primary heat exchanger) to the duct, downstream of the expansion turbine. When the temperature at the separator reaches $1\frac{1}{2}°$ to 3°C, a thermostatic valve automatically opens allowing this hot air to mix with the cold from the expansion turbine.

4–17. CABIN AIR MIXING VALVES. (See Figure 4-2.) One is located just inboard of each refrigeration bay. These valves each consist of a four-port assembly, three ports of which contain butterfly-type valves. The fourth port discharges to the cabin duct. The three sources of air to the butterfly valves are:

a. The cabin supercharger (hot air).

AIR CONDITIONING DUCTING

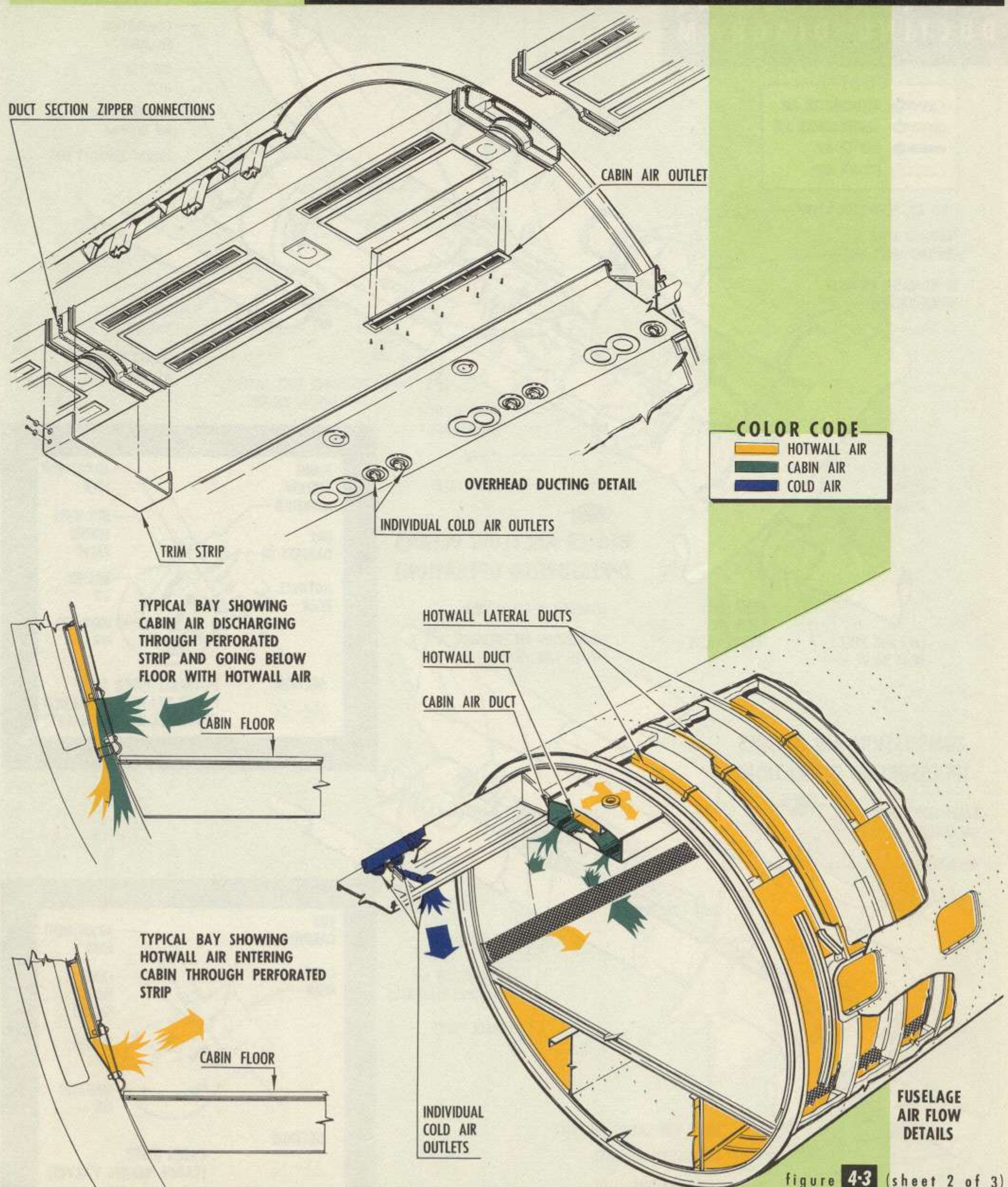


figure 4-3 (sheet 2 of 3)

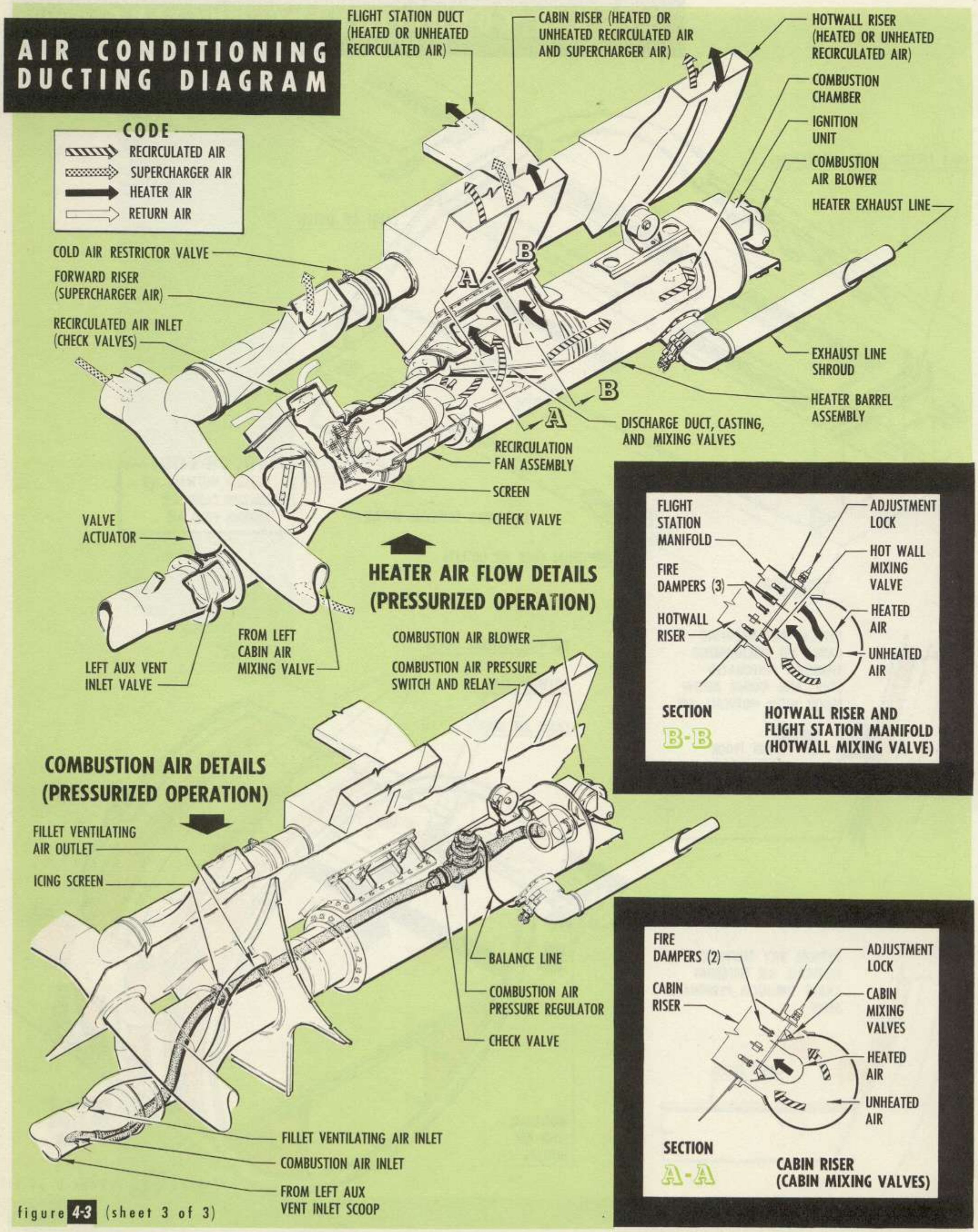


figure 4-3 (sheet 3 of 3)

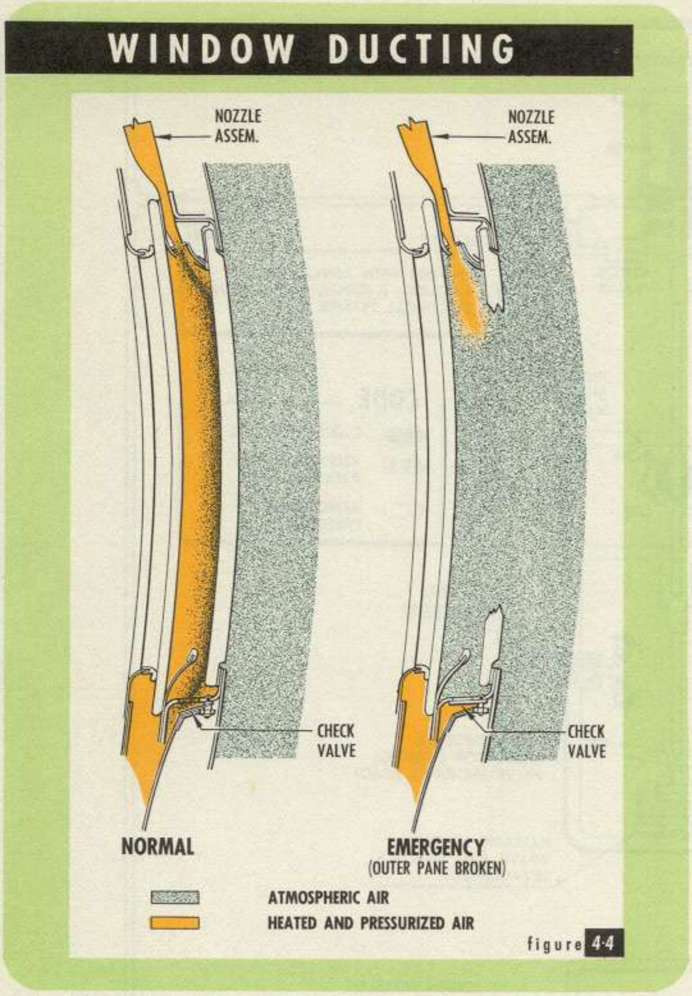


figure 4-4

b. The primary heat exchanger (warm air).

c. The refrigerator (cold air).

4–18. 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 is positioned by a cam arrangement with an electric actuator, and controlled by the WARMER and COOLER paddle-type switches on the 260 panel.

4–19. As the mixing valve moves from the full hot position (towards cool), the hot valve starts to close and the warm valve starts to open. When the hot valve is fully closed the warm valve is open. At this point, valve action stops and the primary heat exchanger scoop starts to open. When the primary heat exchanger scoop is fully open (indicated by the amber primary heat exchanger light on the station 260 panel), the warm valve starts to close, and the cold valve starts to open. As the cold valve opens, the secondary heat exchanger scoop is energized by a lock-in relay and goes to the full open position. If the airplane is on the ground, the right main gear scissors switch starts the hydraulic secondary heat exchanger (ground) cooling fans. This cycle is reversed for "cold" to "hot" operation.

4–20. PRESSURE RATIO LIMITER VALVES. These valves are pneumatically operated and controlled. In the event the cabin supercharger pressure ratio becomes excessive (refrigerator ices up, etc.) this valve will bypass the air around the mixing valve and thus protect the cabin supercharger. It is activated when the supercharger pressure ratio exceeds 1.9 to 1.

4–21. CABIN HEATER ASSEMBLIES. (See Figure 4-8.) One is located in the trailing edge of each wing fillet. Each assembly contains a 125,000 BTU Janitrol Surface Combustion Heater with its own ignition system and individual units for supplying the correct combustion ratio (fuel/air). Fuel is supplied to the heater from the fuel tanks 2 and 3.

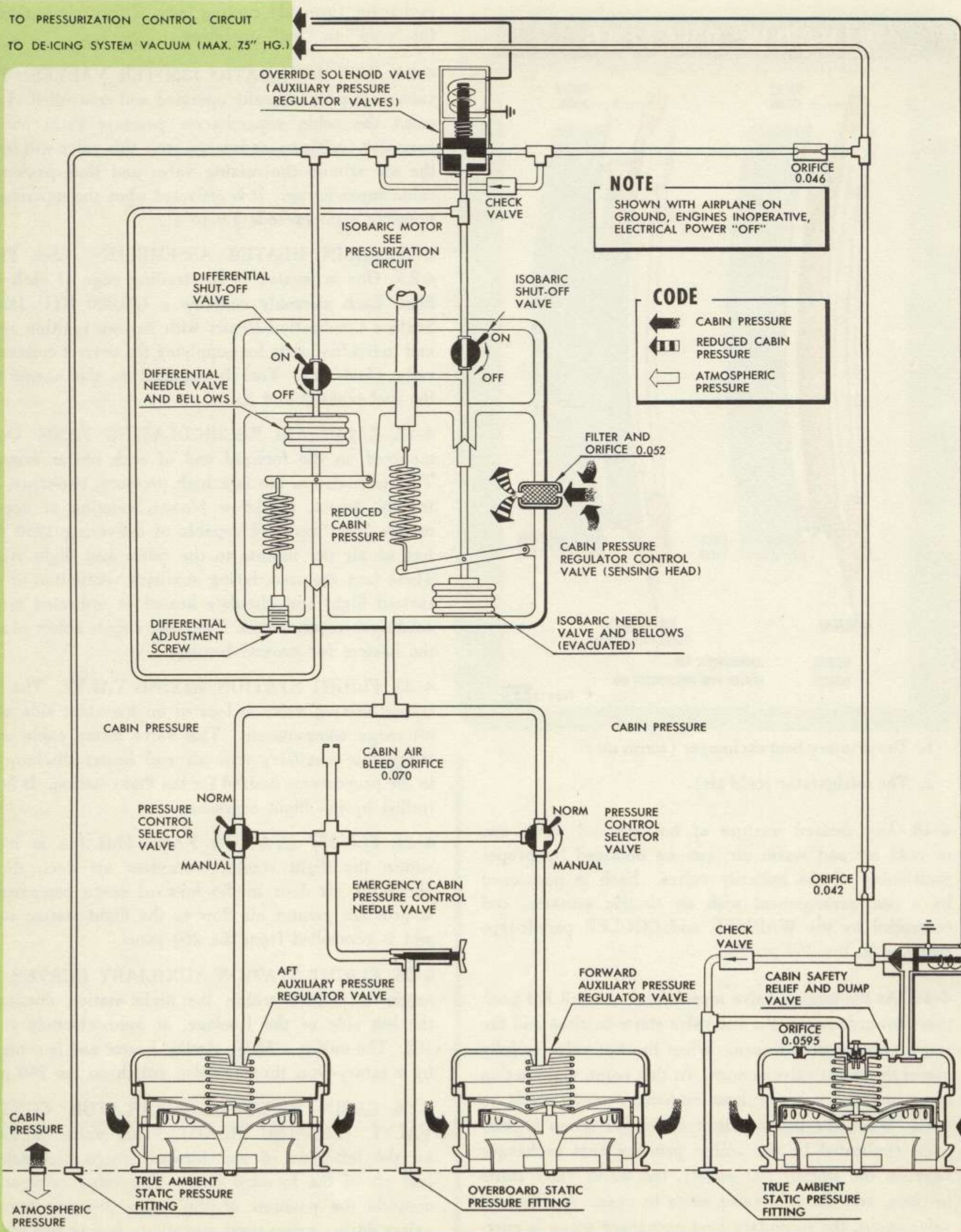
4–22. CABIN AIR RECIRCULATING FANS. One is mounted on the forward end of each heater assembly. The recirculation fan is a high pressure, two-stage, electrically driven, axial-flow blower, rotating at approximately 7500 rpm and capable of delivering 1250 cubic feet of air per minute to the cabin and flight station. These fans are used during auxiliary ventilation or pressurized flight and circulate heated or unheated air, according to requirements. They also supply a flow of air to the heaters for ground heating.

4–23. FLIGHT STATION MIXING VALVE. The flight station mixing valve is located on the right side of the aft cargo compartment. This valve mixes cabin supercharger or auxiliary ram air and heater discharge air in the proportions desired for the flight station. It is controlled by the flight engineer.

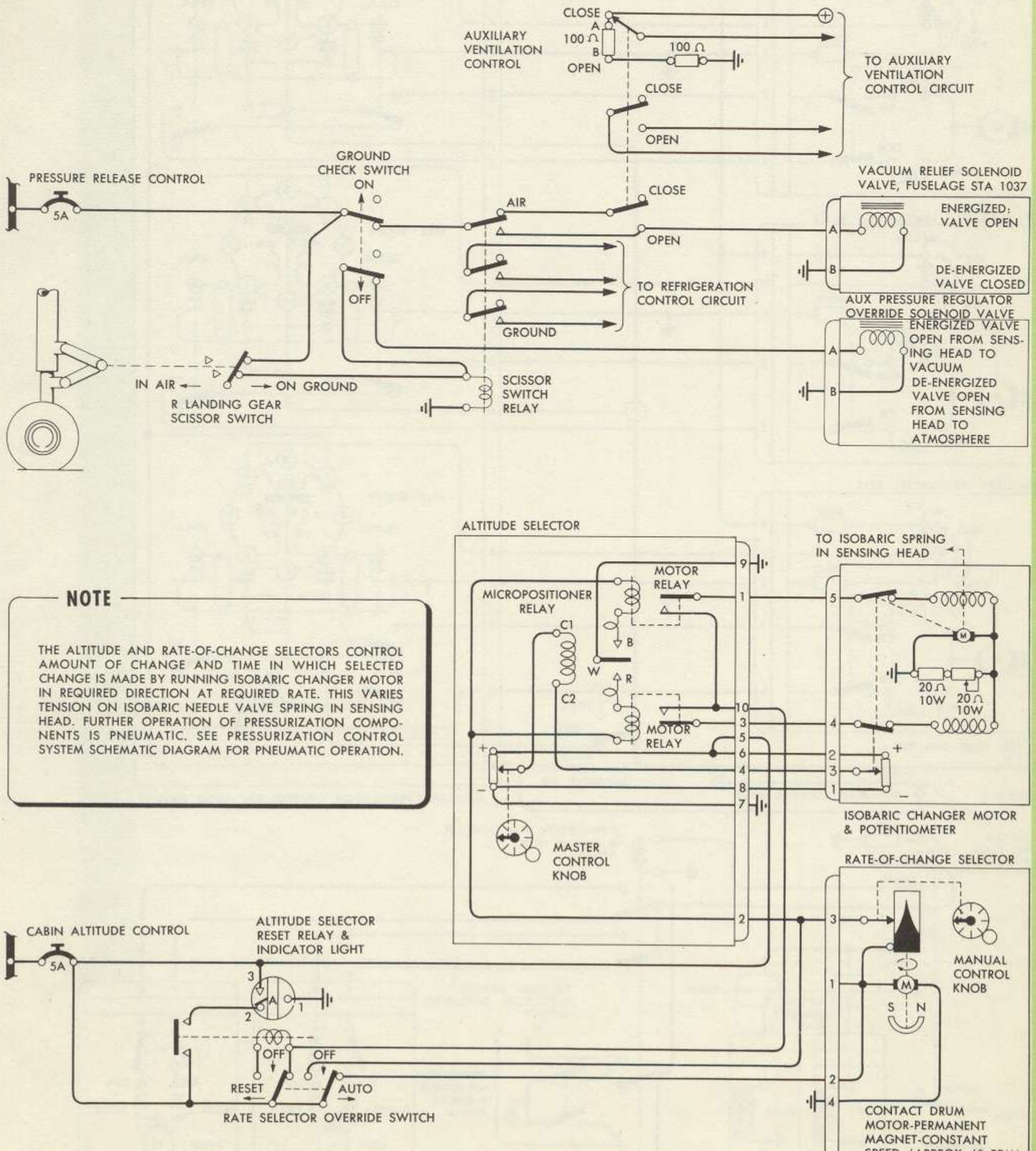
4–24. FLIGHT STATION FAN. This fan is located within the flight station transverse air duct, directly above the aft door in the forward cargo compartment. It provides greater air flow to the flight station outlets and is controlled from the 260 panel.

4–25. FLIGHT STATION AUXILIARY HEATER. The heater is located within the flight station ducting on the left side of the fuselage, at approximately station 195. The unit is a 3KW, electric heater and is controlled by a rotary-type, three-position switch on the 260 panel.

4–26. CABIN PRESSURE REGULATOR CONTROL VALVE (SENSING HEAD). This valve is located on the left side of the forward cargo compartment, just aft of the forward door. The valve automatically controls the position of the cabin pressure regulator valves during pressurized operation. It activates the auxiliary pressure regulator valves in response to the altitude and rate-of-change selectors mounted on the 260 panel.



PRESSURIZATION CONTROL SYSTEM figure 4-5



NOTE

THE ALTITUDE AND RATE-OF-CHANGE SELECTORS CONTROL AMOUNT OF CHANGE AND TIME IN WHICH SELECTED CHANGE IS MADE BY RUNNING ISOBARIC CHANGER MOTOR IN REQUIRED DIRECTION AT REQUIRED RATE. THIS VARIES TENSION ON ISOBARIC NEEDLE VALVE SPRING IN SENSING HEAD. FURTHER OPERATION OF PRESSURIZATION COMPONENTS IS PNEUMATIC. SEE PRESSURIZATION CONTROL SYSTEM SCHEMATIC DIAGRAM FOR PNEUMATIC OPERATION.

figure 4·6 **PRESSURIZATION CONTROL CIRCUIT**

AUXILIARY VENTILATION CONTROL CIRCUIT

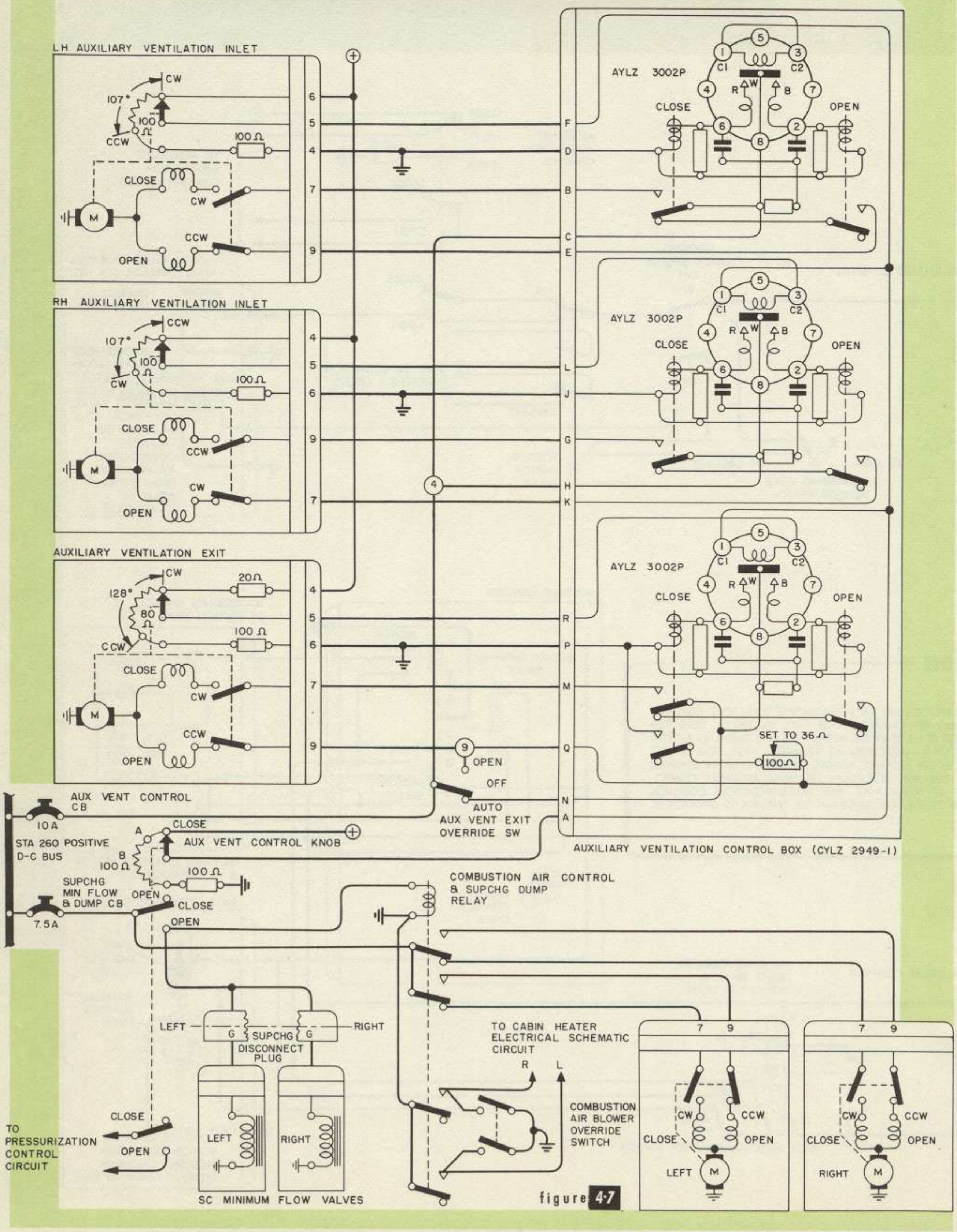


figure 4·7

CABIN HEATER SYSTEM

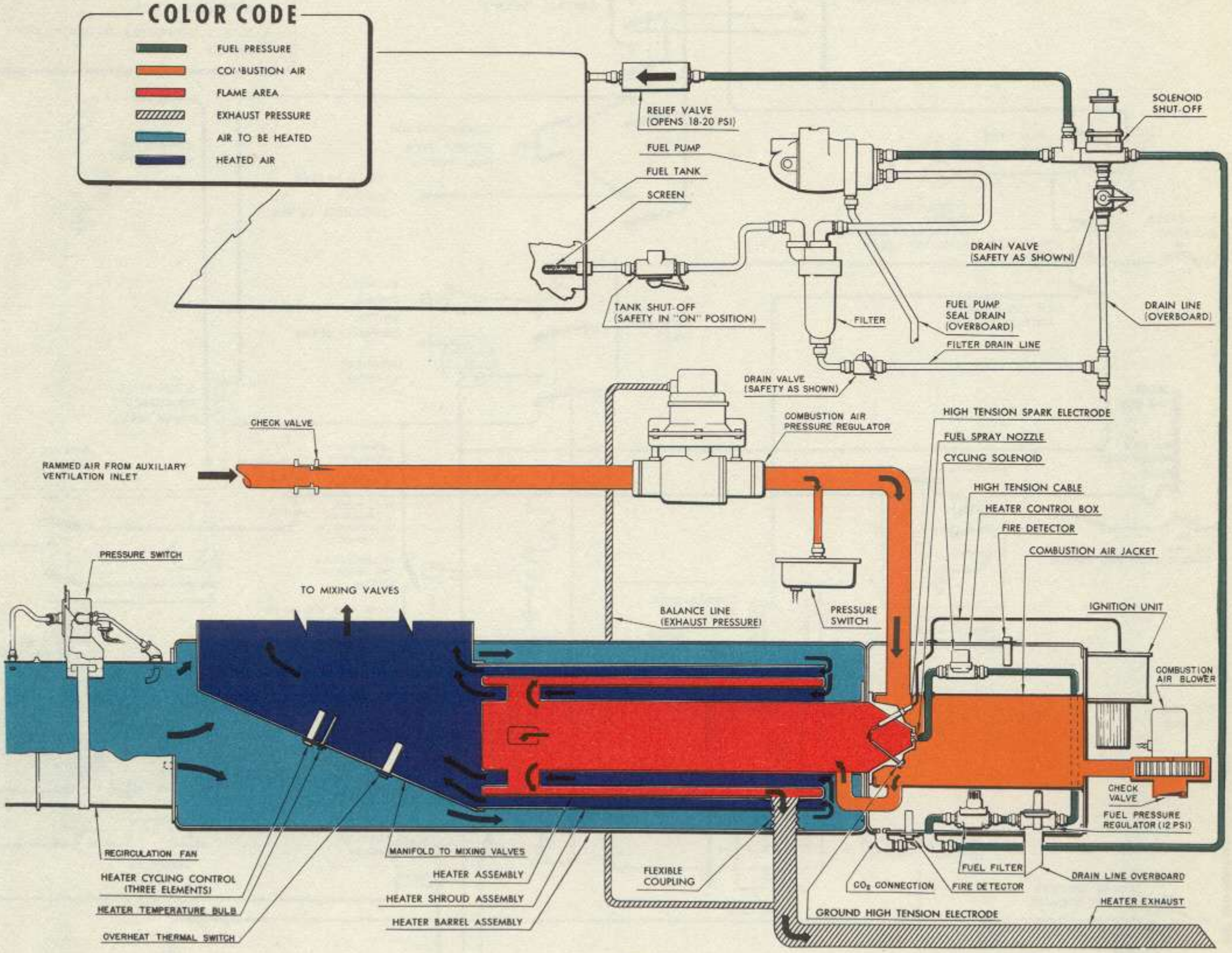


figure 4·8

4–27. CABIN PRESSURE REGULATOR VALVES (OUTFLOW). The cabin outflow valves are located on the left side of the forward cargo compartment, just aft of the forward door. These valves automatically meter the outflow of cabin air, during pressurized operation, in response to the cabin pressure regulator control valve. These valves also act as suction relief valves.

4–28. CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE. This valve is located at the top of the aft pressure bulkhead in the lounge area. It automatically prevents cabin pressure from exceeding 11.4 inches Hg by relieving excess pressure overboard. It also acts as a negative pressure relief valve when atmospheric pressure exceeds cabin pressure; as a cabin pressure dump valve during auxiliary ventilation operation; and as a dump valve in the event the airplane is inadvertently landed while pressurized.

4–29. COLD AIR RESTRICTOR VALVES. These valves, located within the ducts, that connect the left and right forward risers to the left and right cabin risers, are two cold air restrictor valves which are spring-loaded to the closed position. The valves vary their degree of opening according to the cabin air requirements and cold

CABIN HEATER CONTROL CIRCUIT

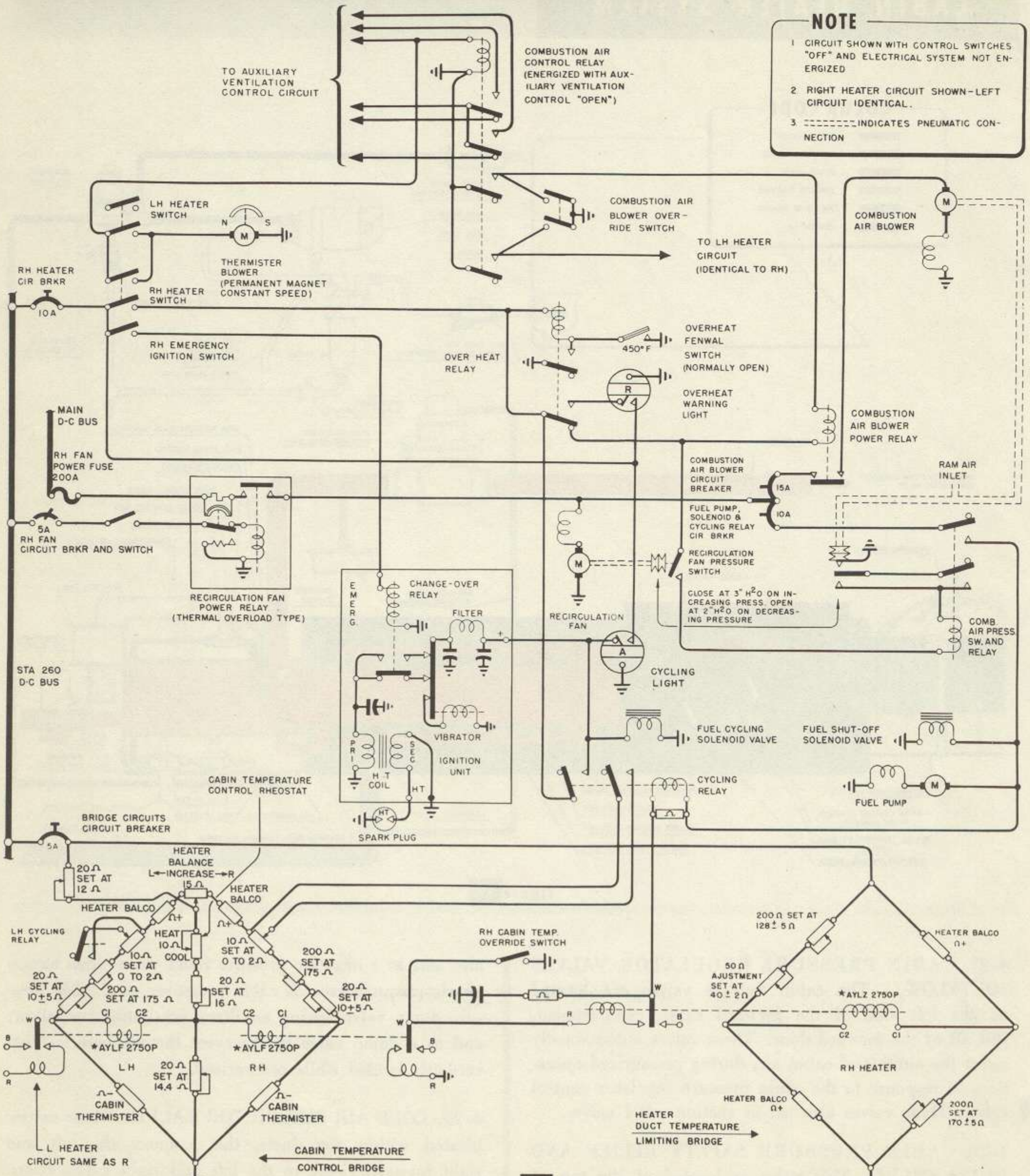


figure 4·9

FLIGHT STATION AUXILIARY HEATER CONTROL CIRCUIT

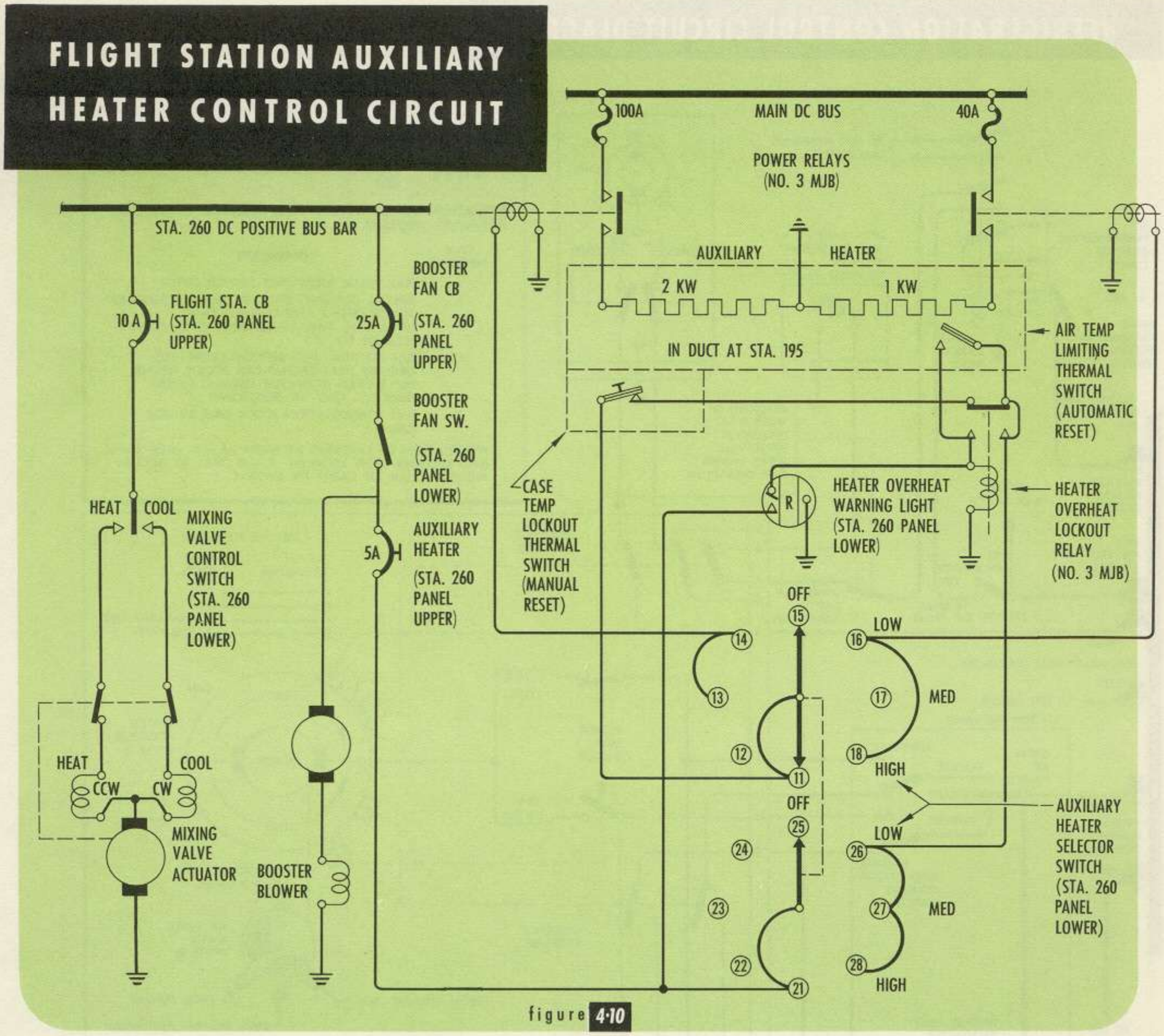


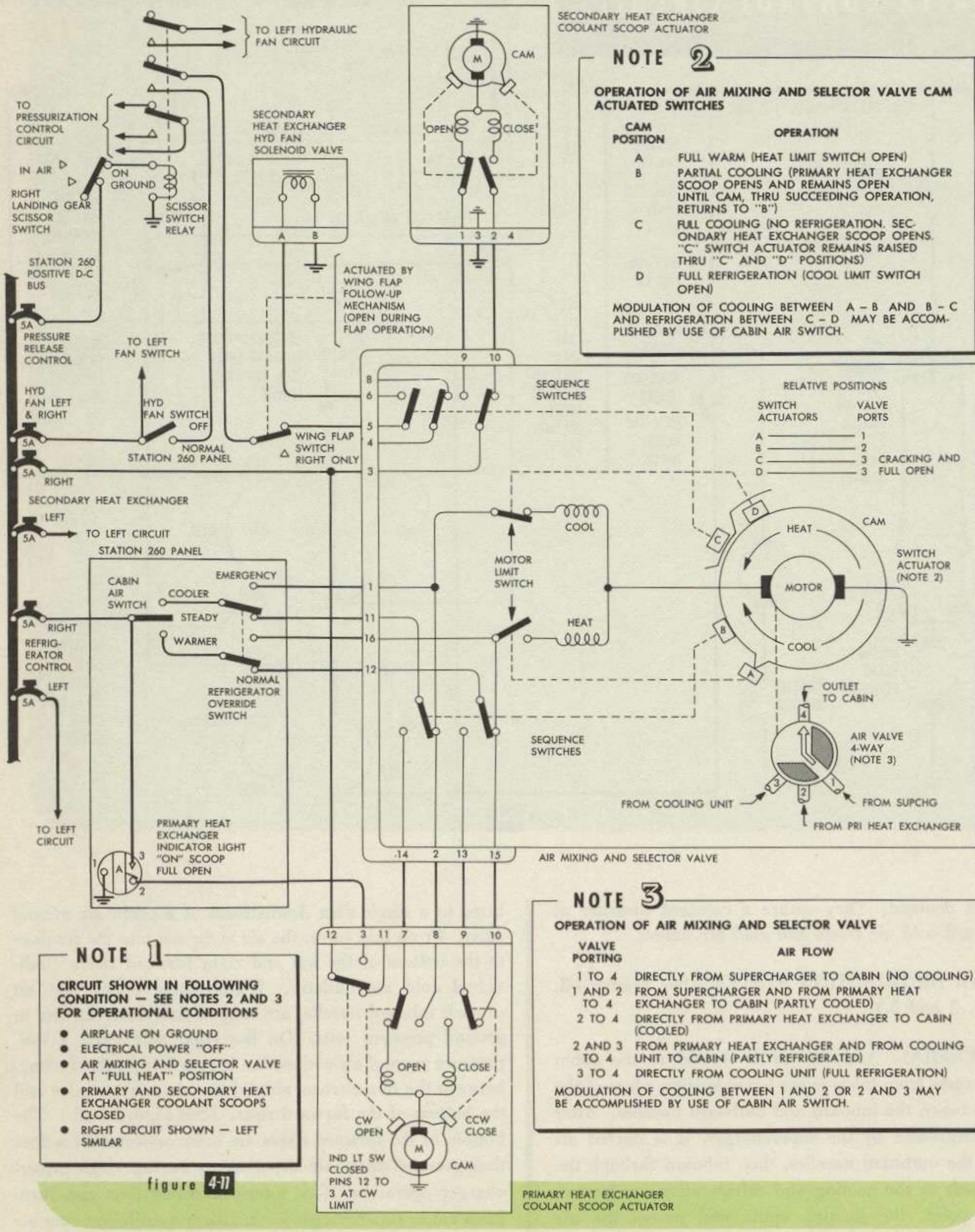
figure 4·10

air outlet demand. They assure a constant pressure at the forward cold air risers and cold air outlets.

4–30. AIR DISTRIBUTION SYSTEM (See Figure 4-3, Sheets 1, 2 and 3.)

4–31. GENERAL. 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 the 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 a cabin air mixing valve. From this valve, the air is ducted into the fuselage to the bottom of the left and right forward risers (individual cold air outlets). Within these ducts, just aft of each inboard nacelle, are capped stub ducts for use in ground pressure tests. On the right side only, a low-pressure ground air connection is provided in the ducting, between the downstream side of the air mixing valve and the bottom of the forward riser. (See Figure 4-16.) The bottom of the forward risers are interconnected by a duct that permits equal air distribution during single supercharger operation. This inter-connecting duct also furnishes cabin supercharger or auxiliary ventilation ram air to the flight station mixing valve, where it can be mixed

REFRIGERATION CONTROL CIRCUIT DIAGRAM



NOTE 1

CIRCUIT SHOWN IN FOLLOWING CONDITION — SEE NOTES 2 AND 3 FOR OPERATIONAL CONDITIONS

- AIRPLANE ON GROUND
- ELECTRICAL POWER "OFF"
- AIR MIXING AND SELECTOR VALVE AT "FULL HEAT" POSITION
- PRIMARY AND SECONDARY HEAT EXCHANGER COOLANT SCOOPS CLOSED
- RIGHT CIRCUIT SHOWN — LEFT SIMILAR

NOTE 2

OPERATION OF AIR MIXING AND SELECTOR VALVE CAM ACTUATED SWITCHES

CAM POSITION	OPERATION
A	FULL WARM (HEAT LIMIT SWITCH OPEN)
B	PARTIAL COOLING (PRIMARY HEAT EXCHANGER SCOOP OPENS AND REMAINS OPEN UNTIL CAM, THRU SUCCEEDING OPERATION, RETURNS TO "B")
C	FULL COOLING (NO REFRIGERATION. SECONDARY HEAT EXCHANGER SCOOP OPENS. "C" SWITCH ACTUATOR REMAINS RAISED THRU "C" AND "D" POSITIONS)
D	FULL REFRIGERATION (COOL LIMIT SWITCH OPEN)

MODULATION OF COOLING BETWEEN A – B AND B – C AND REFRIGERATION BETWEEN C – D MAY BE ACCOMPLISHED BY USE OF CABIN AIR SWITCH.

NOTE 3

OPERATION OF AIR MIXING AND SELECTOR VALVE

VALVE PORTING	AIR FLOW
1 TO 4	DIRECTLY FROM SUPERCHARGER TO CABIN (NO COOLING)
1 AND 2 TO 4	FROM SUPERCHARGER AND FROM PRIMARY HEAT EXCHANGER TO CABIN (PARTLY COOLED)
2 TO 4	DIRECTLY FROM PRIMARY HEAT EXCHANGER TO CABIN (COOLED)
2 AND 3 TO 4	FROM PRIMARY HEAT EXCHANGER AND FROM COOLING UNIT TO CABIN (PARTLY REFRIGERATED)
3 TO 4	DIRECTLY FROM COOLING UNIT (FULL REFRIGERATION)

MODULATION OF COOLING BETWEEN 1 AND 2 OR 2 AND 3 MAY BE ACCOMPLISHED BY USE OF CABIN AIR SWITCH.

figure 4-11

REFRIGERATION EQUIPMENT

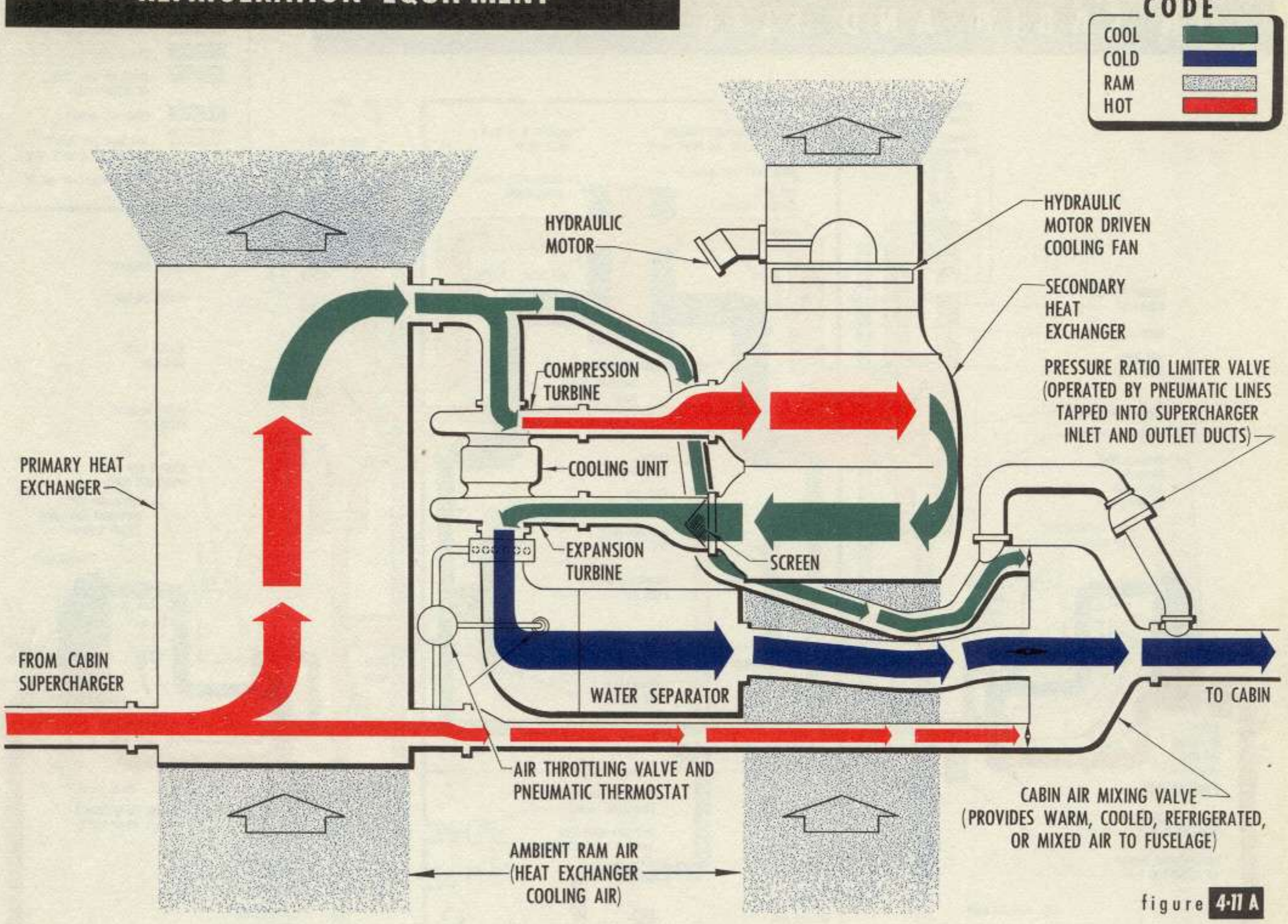


figure 4-11 A

with hot or recirculated air as required for the cockpit. Air from the bottom of the forward risers is ducted to manifolds at the bottom of the cabin risers where it is mixed with recirculated air from the cabin that may or may not be heated.

4–32. CABIN AIR DISTRIBUTION. Ducts distribute the air to the cabin according to the preset position of various mixing valves. The predetermined adjustments of these valves assure adequate heating and ventilating through the proper mixture of heated and unheated recirculated cabin air, which is then merged with fresh supercharger air in the proportions desired. The left and right forward risers supply air to ducts that extend fore and aft in the cabin at the intersection of the overhead baggage racks and the wall trim. The right duct also extends aft, around the back and along the left side of the aft lounge. These ducts are connected by tubes to outlets that may be opened or closed individually above each passenger seat. The manifolds at the bottom of the cabin risers receive air from the cabin mixing valves. This is recirculated cabin air and may or may not be heated. The risers from the manifolds are recessed into the walls and duct the air upward to supply the outer portion of the overhead duct in the cabin. Spaced at intervals along this overhead duct are outlets to permit the optimum flow of air into the cabin. The left and right hotwall risers also receive recirculated air from the mixing valves. Shut-off valves are installed within these risers, just above the level of the cabin baggage racks, and are manually controlled through the use of a special equipment key usually stored in the flight engineer's desk. The risers supply heated air to the cabin overhead duct. Through holes in the upper surface of this duct, heated air is passed into lateral ducting which is routed between the inner cabin trim and the insulation nearest the fuselage skin, down to nozzles in bays containing windows. These lateral ducts open directly into the area between the trim and the insulation in bays without windows. Air enters the void between the inner and outer

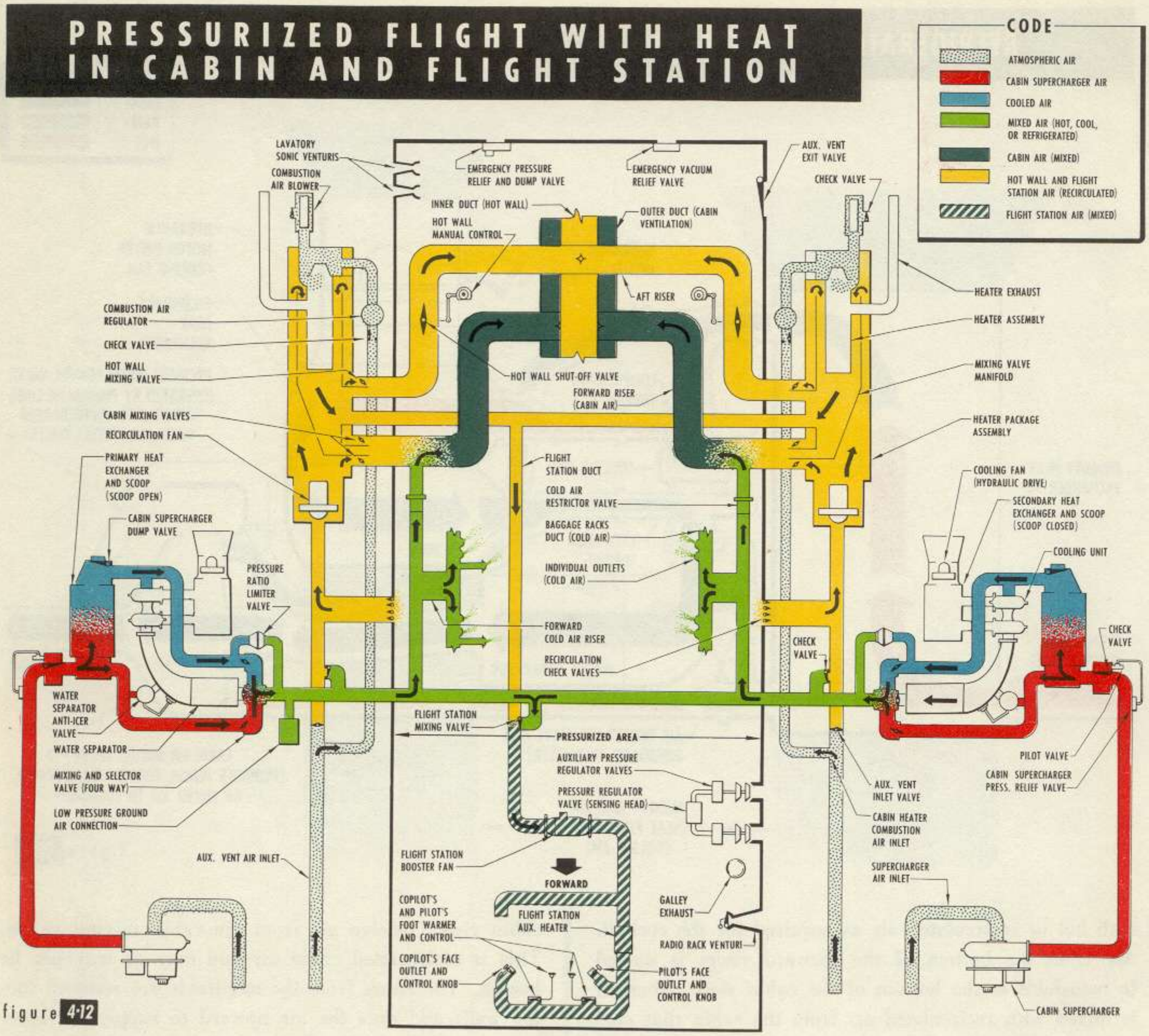


figure 4·12

panes to prevent fogging of the panels. (See Figure 4-4.) Exhaust air from the windows passes through check valves, then down into the entire bay area between the cabin trim and the fuselage skin insulation. The disc type, automatic window check valves are provided to prevent sudden depressurization of the airplane in the event of failure of the outer pressure pane of the window. They are activated when the pressurized air flow reverses towards the broken pane. From the bay area beneath the window and in bays without windows, the hotwall air enters the cabin through the perforated strip just above floor level, or, with air leaving the cabin through the perforated strip, it flows directly into the area beneath the floor and between the fuselage skin and the aft cargo compartment liner. All air entering this area during pressurized operation, circulates around the outside of the aft cargo compartment liner and enters check valves near the forward end of that area. These are the recirculated air check valves which open into the inlet side of the cabin recirculation fans. In the cabin area immediately above the forward cargo compartment, hotwall air and air leaving the cabin through the perforated strip, enters the area between the fuselage skin and the compartment liner. This air then circulates around the liner and is exhausted overboard through the auxiliary pressure regulator valves. Air entering this area is not recirculated.

PRESSURIZED FLIGHT WITH COOLING IN CABIN AND FLIGHT STATION

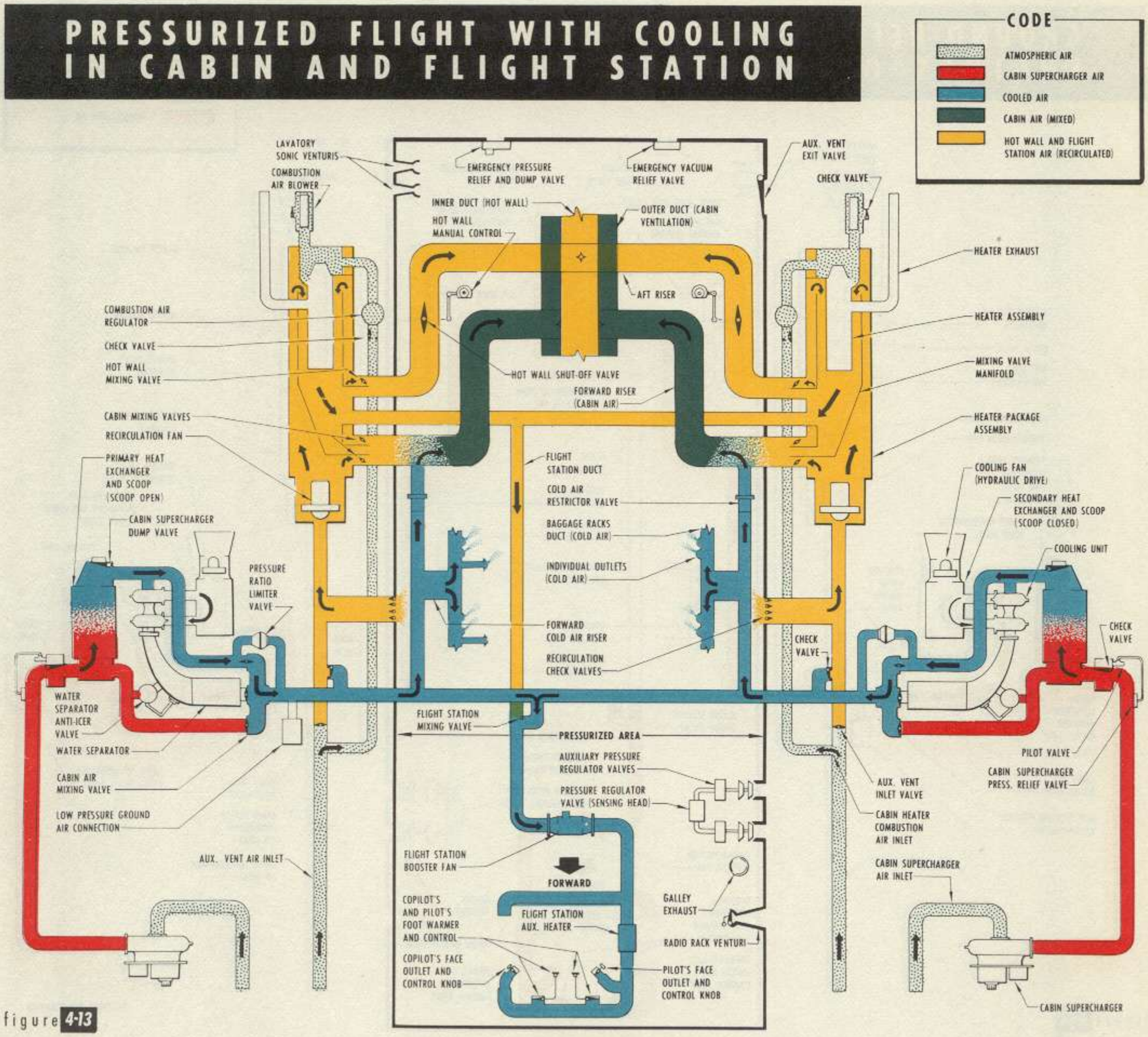


figure 4-13

4–33. FLIGHT STATION AIR DISTRIBUTION. Heating and ventilating air to the flight station is provided by an interconnecting duct between the mixing manifolds of the left and right cabin heater packages. No mixing valves are used in the manifolds to this ducting and all air passing through the duct is cabin recirculated air, with or without heating. Air at supercharger pressure, or auxiliary ventilation ram air is mixed with cabin recirculated air at the flight station mixing valve. The duct then continues forward on the right side of the airplane, running transversely through the forward cargo compartment area. Located within this section of ducting is an electric booster fan. After the duct leaves the fan, it is routed forward along the left side of the airplane to the flight station auxiliary heater which is located within the ducting. Between the booster fan and the auxiliary heater, a branch duct runs transversely through the fuselage to an air outlet, just below the station 260 panel. A duct from the outlet of the auxiliary heater continues forward to the aft side of the instrument panels, where it is divided into individual manually-controlled face and foot outlets for the pilot and co-pilot.

4–34. PRESSURIZATION SYSTEM. (See Figures 4-5 and 4-6.)

4–35. GENERAL. The pressurized portion of the airplane includes all the crew, cargo, and passenger compartments contained within the fuselage structure. The air introduced into the cabin by the cabin superchargers is used to pressurize and ventilate the cabin when the auxiliary ventilation system is closed. The mass flow of air entering the cabin during pressurized operation varies

GROUND REFRIGERATION WITH OUTBOARD ENGINES OPERATING AT 1200 RPM

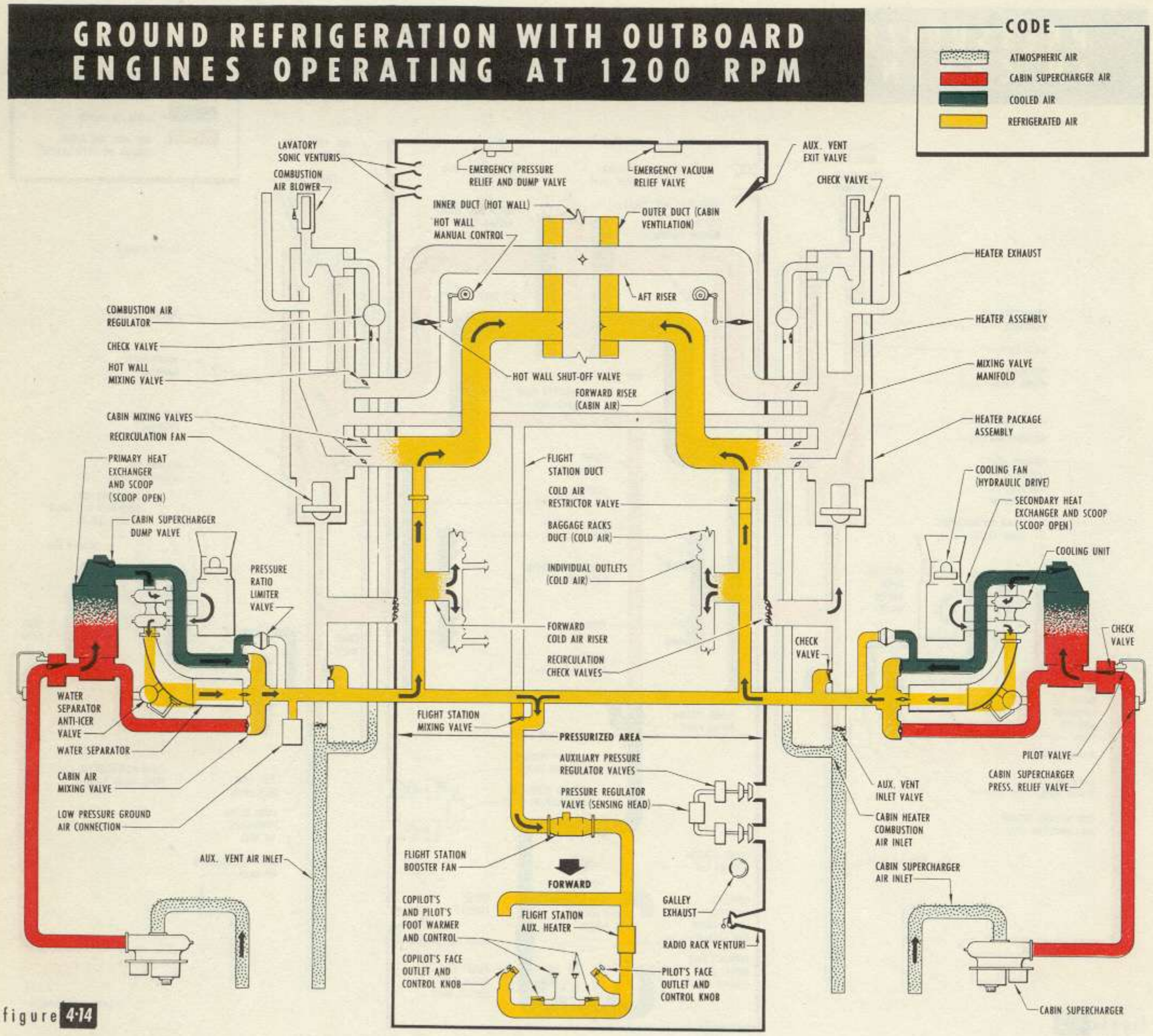


figure 4·14

with flight altitudes, air temperatures, and density. A cabin pressure equivalent to that at sea level may be maintained at flight altitudes up to 12,300 feet. At 20,000 feet flight altitude, the cabin pressure is comparable to a 5000 foot cabin altitude. At 25,000 feet, cabin pressure is comparable to 8000 foot altitude. As the flight altitude increases above 25,000 feet, the cabin pressure altitude increases at a comparable rate. The maximum allowable cabin differential pressure is 5.5 psi.

4–36. The amount and rate at which the cabin air is exhausted overboard to maintain proper cabin pressure are determined by the cabin pressure regulator valves (outflow valves) (para. 4–27), the master pressure regulator control valve (sensing head) (para. 4–26), the altitude selector, and the rate-of-change selector.

4–37. The cabin pressure regulators (outflow valves) are controlled by the master pressure regulator control valve (sensing head). The outflow valves are held in the full open position by either atmospheric static pressure or the airplane vacuum system, if the cabin altitude selector is set above the airplane altitude. The selection of atmospheric static pressure or vacuum to the isobaric section of the sensing head is automatically accomplished by a three-port, solenoid-type valve controlled by the right landing gear scissor-switch circuit. When energized, during ground operation, the valve connects the sensing head to the vacuum system. When de-energized, during flight, the valve connects atmospheric static pressure to the sensing head.

4–38. The delayed closing action (45 seconds minimum from open to close) of the cabin pressure regulator

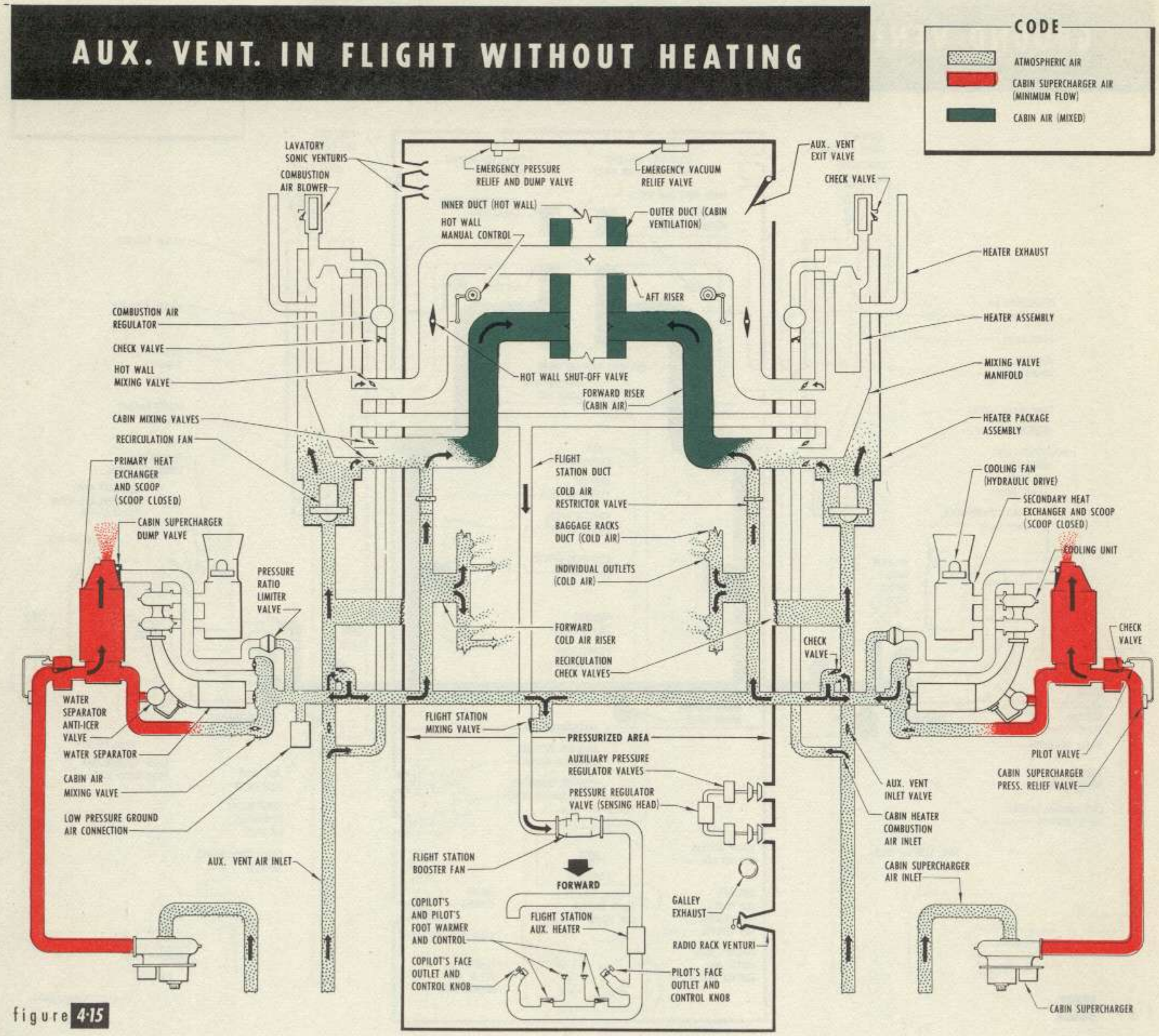


figure 4-15

valves and the cabin pressure safety relief and dump valve (para. 4–28) minimizes pressure surge when changing from auxiliary ventilation to pressurized operation.

4–39. AUXILIARY VENTILATION SYSTEM. (See Figures 4-7 and 4-15.)

4–40. GENERAL. Venturi tubes are installed for ventilation in the lavatory compartments and near the radio rack in the flight station. A venturi tube is also provided for the cabin thermister and temperature bulb box assembly to supply sensing air for these units. During unpressurized operation sensing air for these units is assured by a blower which operates when auxiliary ventilation is selected, and at least one heater switch is ON.

4–41. Auxiliary ventilation, without pressurization, is accomplished by using ram air from inlets in the leading edges of the left and right stub wing sections. The recirculation fans also draw air from these inlets during ground operation. This ram air from the inlets is ducted aft to electrically-actuated inlet valves which are open when the controls are positioned for auxiliary ventilation. Just forward of the inlet valves, a small amount of the ram air is bled off as combustion air for the cabin heaters during pressurized operation (Aux. Vent. inlet closed). A small amount of ram air is also bled off to ventilate the fillet areas around the heaters. Aft of the inlet valves, a portion of the ram air passes through a check valve and is directed to the cabin recirculating fans and heater packages. From

GROUND VENTILATION, LOW-PRESSURE TRUCK

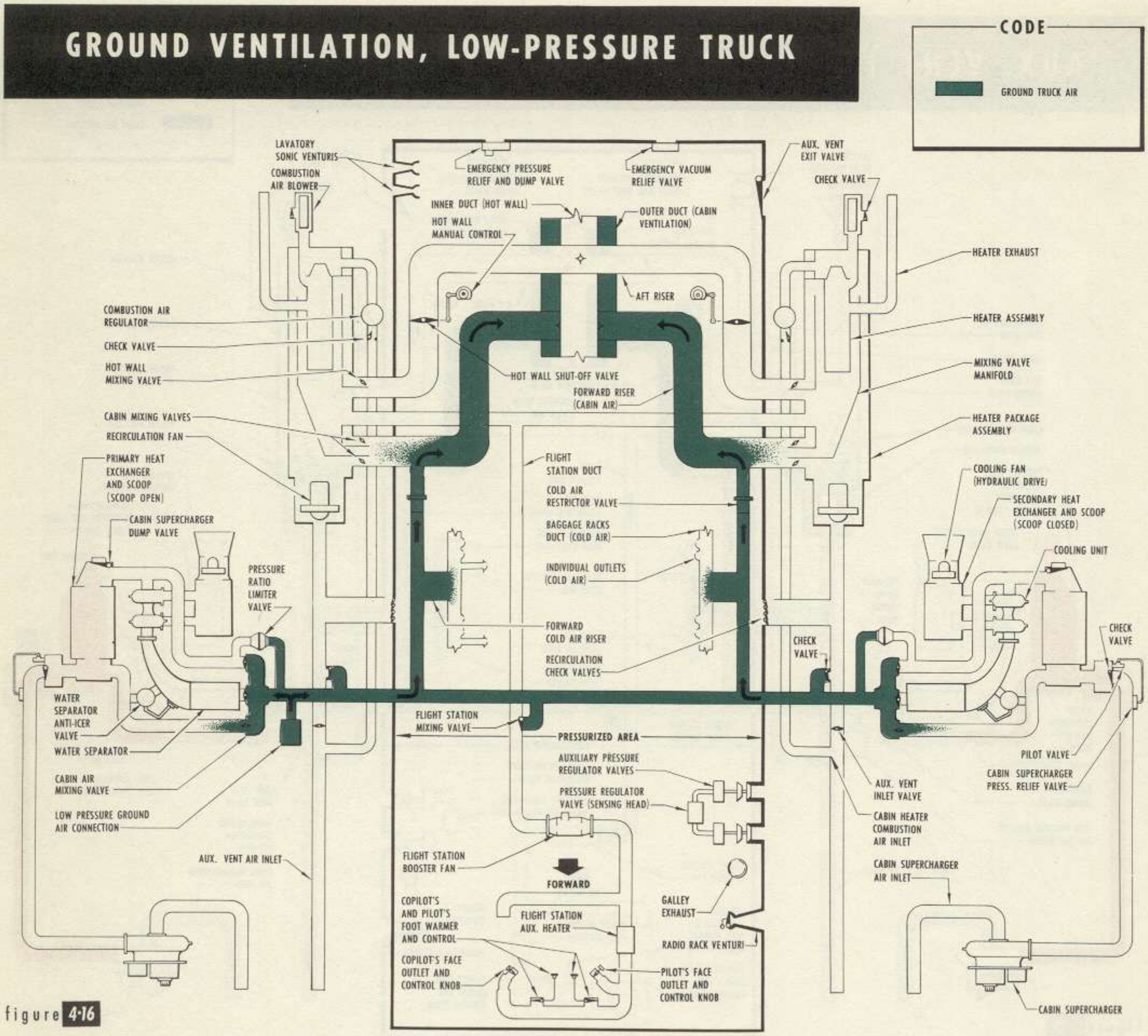


figure 4·16

the packages, the air follows the normal cabin distribution system and is exhausted overboard through the auxiliary ventilation exit valve (which opens after inlets reach the 20% open position), and cabin pressure control and dump valves. The mass flow of auxiliary ventilation air can be controlled through the amount of opening of the inlet valves and exit valve (which can be opened independently of the inlet valves). Discharge air from the cabin superchargers flows overboard through the supercharger dump valves.

4–42. HEATING. (See Figures 4-8, 4-9, and 4-12.)

4–43. CABIN HEATING. Heated air for the cabin is supplied by two 125,000 btu/hour surface combustion heaters. The heaters, during pressurized operation, utilize recirculated cabin air from the recirculation fans. 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 recirculating fans. If delivered in sufficient volume, the recirculating check valves will close. Heated air from the output side of the heaters is then mixed with fresh air from the superchargers, or ram air from the auxiliary ventilation inlets before entering the cabin distribution system.

4–44. In the event of very low atmospheric temperatures, or failure of one of the two cabin heaters, air at a higher temperature than during normal pressurized operation is available to the cabin. By proper selection of the controls, the flight engineer can position the cabin air mixing valves to bypass all cooling equipment within the wing panels. Air entering the fuselage under these conditions will be at a higher initial temperature than during normal operation. The air during normal operation is cooled after leaving the cabin superchargers to provide the desired temperature at the individual passenger cold air outlets. With the air entering the fuselage at a higher initial temperature, the load on the cabin heaters is reduced and higher cabin temperatures can be maintained.

4–45. FLIGHT STATION HEATING. (Refer to Figure 4-10.) The heated air for the flight station is recirculated cabin air from both cabin heaters. Fresh air can be mixed with this air, in the desired amount, by proper positioning of the flight station mixing valve. If, after mixing, the air is not as warm as desired, it can be further heated by operation of the pilot's auxiliary heater.

4–46. COOLING AND REFRIGERATION. (See Figure 4-11.)

4–47. COOLING AIR. (Refer to Figure 4-13.) Air that is being cooled is at supercharger discharge pressure. Due to the position of the cabin air mixing valve, this air is forced to pass 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 full open position, forces the maximum amount of ram cooling air around the tubes within the exchanger. A heat transfer from the supercharger air within the tubes is made to the cooling ram air around the tubes. Cooling air is carried away through exhaust slots in the upper surface of the wing panel.

4–48. REFRIGERATION. (See Figure 4-14.) Air being refrigerated is also at supercharger discharge pressure. In this condition, the cabin air mixing valve forces the air to pass 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 this turbine, the air passes through the secondary heat exchanger (ram air scoop open), then back into the expansion turbine of the cooling unit. From this turbine, the air flows through the water separator to the cabin air mixing valve which directs it into the fuselage duct.

4–49. Duct temperature, just downstream of the cabin air mixing valve, is continuously registered on a dual temperature indicator on the station 260 control panel. This permits the controls to be positioned for any desired discharge temperature downstream of the refrigeration equipment.

4–50. AIR CONDITIONING SYSTEM CONTROLS. (See Fig. 4-17.)

Note

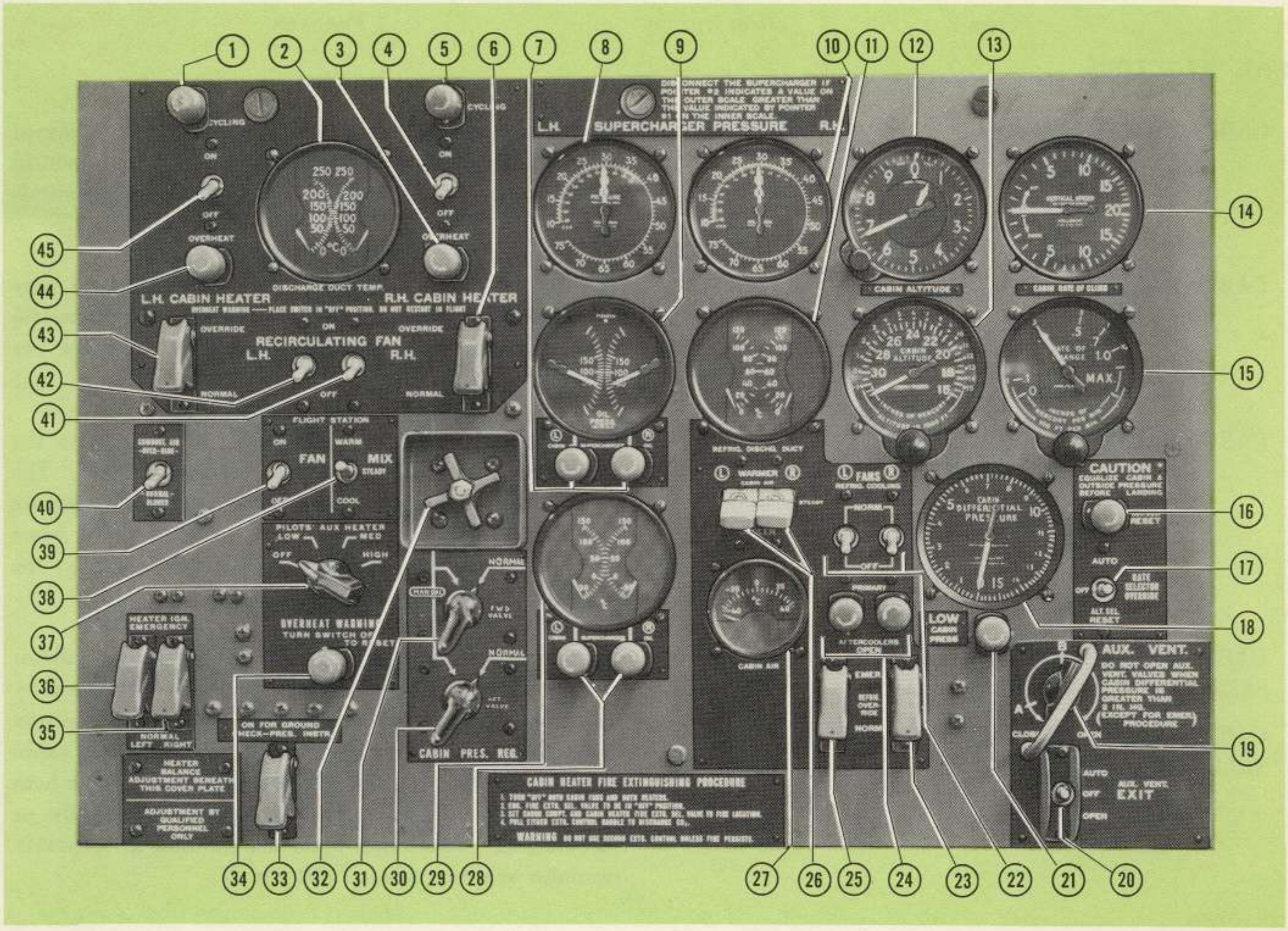
Circuit breakers for the air conditioning system are located directly above the station 260 panel. (See Fig. 1-61.)

4–51. SWITCHES.

4–52. GENERAL. Refer to Figure 4-17; items are similarly numbered in text and illustration for quick reference.

Item	*Item No.*	*Function*
RECIRCULATION FAN — L. RECIRCULATION FAN — R.	42 41	ON and OFF. These fans circulate heated or unheated air to the cabin.
CABIN HEATER — L.H. CABIN HEATER — R.H.	45 4	ON and OFF. This switch energizes the heater control circuits for operation whenever the cabin temperature is below the selected temperature.
HEATER EMERGENCY OVERRIDE — L. HEATER EMERGENCY OVERRIDE — R.	43 6	OVERRIDE and NORMAL. This is a covered switch that bypasses the cabin thermostat and allows the cabin heater to operate at maximum output.
HEATER IGNITION — L. HEATER IGNITION — R.	36 35	EMERGENCY and NORMAL. This switch selects an alternate set of ignition points for cabin heater operation.

Item	*Item No.*	*Function*
FLIGHT STATION (PILOTS) AUX. HEATER	37	This is a four-position selector switch providing OFF, LOW, MEDIUM, and HIGH control of heater output. It will not operate unless the flight station booster fan is ON.
FLIGHT STATION BOOSTER FAN	39	ON and OFF. This switch arms the flight station auxiliary heater, increases air circulation in flight station, and dissipates heat from the auxiliary flight station heater.
COMBUSTION AIR BLOWER	40	OVERRIDE and NORMAL. This switch permits blower operation under pressurized flight when ram air pressure is insufficient.
AUX. VENT. EXIT OVERRIDE	20	OPEN affords a manual means of positioning the aux. vent. exit door. In AUTO the door is controlled by the aux. vent. control knob. In the OFF position the door remains where it was positioned manually.
AUX. VENT. CONTROL KNOB	19	CLOSED, A, B, OPEN. See Fig. 4-19. This knob controls the opening and closing of the auxiliary ventilation inlets and exits in their proper sequence. It also controls the dumping of the cabin superchargers and puts them on minimum flow; it controls the opening and closing of the cabin safety, relief and dump valve; and it energizes the combustion air blowers, if cabin heating is required.
RATE SELECTOR OVERRIDE	17	A three-position switch. AUTO is the normal position for all conditions of flight. ALT SEL. RESET is used to run the isobaric changer assembly to a position corresponding to that selected on the altitude selector. OFF will stop the changer assembly at the existing position. See ALT. SELECTOR, RESET light.
GROUND TEST	33	A guarded ON and OFF switch. In the ON (up) position, it permits pressurization tests on the ground.
FLT. STA. MIXING VALVE	38	A three-position, momentary-contact switch that operates a flight station mixing valve located at a junction between hot and cold air ducts. STEADY is the normal position. Hold this switch at either WARM or COOL until the mixing valve is positioned for the desired flight station temperature.
CABIN AIR — L. CABIN AIR — R.	26 26	A three-position paddle-type switch. STEADY is the normal position. To obtain either a WARMER or COOLER cabin air duct temperature, move the switch accordingly until the required temperature is registered on the Refrigeration Discharge Duct Temperature Gage directly above the switch (11, fig. 4-17).
REFRIGERATOR OVERRIDE — L. REFRIGERATOR OVERRIDE — R.	25 23	NORM is in the down position. In EMER it bypasses the sequence switches in the cabin air mixing valve actuator and disconnects the primary heat exchanger actuator, thus supplying a direct source of current to the cabin air mixing valve.
REFRIGERATOR COOLING FANS — L. REFRIGERATOR COOLING FANS — R.	22 22	NORM and OFF. In the normal position the fan operates providing cooling air for the secondary heat exchanger (during refrigeration on ground).



1. Cabin Heater Cycling Light—L.H.
2. Discharge Duct Temperature Gage (Cabin Heater)
3. Cabin Heater Overheat Light—R.H.
4. Cabin Heater Switch—R.H.
5. Cabin Heater Cycling Light—R.H.
6. Cabin Heater Emergency Override Switch—R.H.
7. Cabin Supercharger Lo-Oil Pressure Light—L & R
8. Cabin Supercharger Air Pressure Gage—L.H.
9. Cabin Supercharger Oil Pressure Gage
10. Cabin Supercharger Air Pressure Gage—R.H.
11. Refrigeration Discharge Duct Temperature Gage
12. Cabin Altitude Indicator Gage
13. Cabin Altitude Selector
14. Cabin Rate-of-Climb Indicator Gage
15. Cabin Rate-of-Change Selector
16. Cabin Altitude Selector Reset Light
17. Cabin Rate Selector Override
18. Cabin Differential Pressure Gage
19. Aux. Vent. Control Knob
20. Aux. Vent. Exit Override Switch
21. Low Cabin Pressure Indicator Light
22. Refrigerator Cooling Fan Switch—L & R
23. Refrigerator Override Switch—R.
24. Primary Heat Exchanger Scoop Light (Aftercooler)—L & R
25. Refrigerator Override Switch—L.
26. Cabin Air (Paddle-type) Switch—L & R
27. Cabin Air Temperature Gage
28. Cabin Supercharger Hi-Oil Temperature Light—L & R
29. Cabin Supercharger Oil Temperature Gage
30. Cabin Pressure Regulator Selector Valve—Aft
31. Cabin Pressure Regulator Selector Valve—Forward
32. Cabin Pressure Regulator (Needle Valve)
33. Ground Test Switch
34. Flight Station (Pilot's) Aux. Heater Overheat Light
35. Cabin Heater Ignition Switch—Right
36. Cabin Heater Ignition Switch—Left
37. Flight Station (Pilot's) Aux. Heater Temperature Control Switch
38. Flight Station Mixing Valve
39. Flight Station Booster Fan Switch
40. Combustion Air Blower Override Switch
41. Cabin Recirculation Fan Switch—R.H.
42. Cabin Recirculation Fan Switch—L.H.
43. Cabin Heater Emergency Override Switch—L.
44. Cabin Heater Overheat Light—L.H.
45. Cabin Heater Switch—L.H.

figure 4-17 AIR CONDITIONING (STATION 260) CONTROL PANEL

Item	*Item No.*	*Function*
4–53. SELECTORS.		
CABIN ALTITUDE	13	The desired cabin pressure altitude may be obtained by selection on this instrument. Selection is by a control knob. Calibrated in inches of mercury and thousands of feet.
CABIN RATE-OF-CHANGE	15	The desired cabin pressure altitude rate-of-change may be obtained by control knob positioning on this instrument. Calibrated in inches of mercury and feet per minute.
CABIN PRESSURE REGULATOR	32	A needle-type valve meters a source of vacuum to the cabin pressure regulator valves (out-flow valves). The cabin altitude is controlled by the degree of opening (left to DEPRESSURIZE). It is effective only when the cabin pressure regulator selector valves are in the MANUAL position.
CABIN PRESSURE REGULATOR SELECTOR VALVE — FWD. CABIN PRESSURE REGULATOR SELECTOR VALVE — AFT.	31 30	In the NORMAL POSITION the cabin pressure regulator valves (outflow valves) are automatically controlled by the cabin altitude selector. In the MANUAL position the outflow valves are controlled by the emergency cabin pressure regulator on the 260 panel. Either one or both of the outflow valves may be controlled manually or automatically, depending upon the position of the cabin regulator selector valves (260 panel).
4–54. INDICATOR AND WARNING LIGHTS.		
CABIN HEATER CYCLING — L.H. CABIN HEATER CYCLING — R.H.	1 5	Amber—when cabin heaters are operating.
CABIN HEATER OVERHEAT — L.H. CABIN HEATER OVERHEAT — R.H.	44 3	Red—at 180°C. Cabin heater controls locked-out.
FLT. STA. (PILOT'S) AUX. HEATER OVERHEAT	34	Red—when flight station auxiliary heater temperature exceeds a safe value. Heater is locked-out.
CABIN SUPERCHARGER HI-OIL TEMP. — L. CABIN SUPERCHARGER HI-OIL TEMP. — R.	28 28	Red—at 110°C. Temperature taken at supercharger "oil-in" line. If red light comes on, supercharger should be disconnected.
SUPERCHARGER LO-OIL PRESS. — L. SUPERCHARGER LO-OIL PRESS. — R.	7 7	Red—at 40 psi. Pressure taken at "oil-in" line. Supercharger should be disconnected.
LOW CABIN PRESS.	21	Red—when cabin pressure altitude is 10,300 feet or above.
PRIMARY HEAT EXCHANGER SCOOP (AFTERCOOLERS) — L.	24	Amber—when the scoop is in the full-open position.
PRIMARY HEAT EXCHANGER SCOOP (AFTERCOOLERS) — R.	24	

INDICATOR LIGHTS & TEMPERATURE INDICATOR CIRCUIT

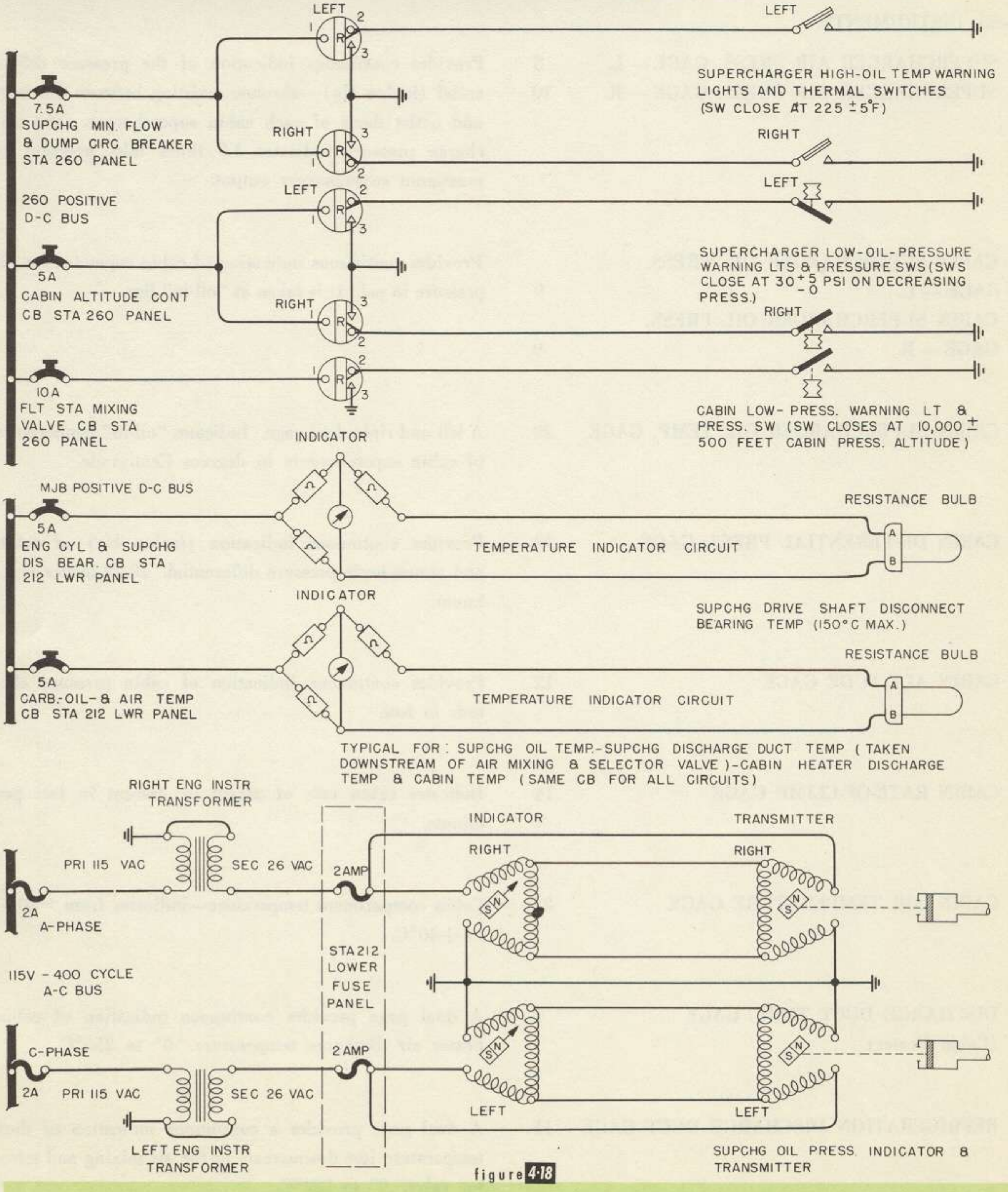


figure 4-18

Item	*Item No.*	*Function*
ALTITUDE SELECTOR RESET	16	Amber—while cabin isobaric motor is running with the rate-selector-override switch in ALT. SEL. RESET position. See Altitude Selector Reset Switch.

4-55. INSTRUMENTS.

SUPERCHARGER AIR PRESS. GAGE — L. SUPERCHARGER AIR PRESS. GAGE — R.	8 10	Provides continuous indication of the pressure differential (inches Hg)—absolute, existing between the inlet and outlet ducts of each cabin supercharger. The discharge pressure indicates 1.9 times inlet pressure at maximum supercharger output.
CABIN SUPERCHARGER OIL PRESS. GAGE — L. CABIN SUPERCHARGER OIL PRESS. GAGE — R.	9 9	Provides continuous indication of cabin supercharger oil pressure in psi. It is taken at "oil-in" line.
CABIN SUPERCHARGER OIL TEMP. GAGE	29	A left and right dual gage. Indicates "oil-in" temperature of cabin superchargers in degrees Centigrade.
CABIN DIFFERENTIAL PRESS. GAGE	18	Provides continuous indication (inches Hg) of cabin and atmospheric pressure differential. 10.92 inches maximum.
CABIN ALTITUDE GAGE	12	Provides continuous indication of cabin pressure altitude in feet.
CABIN RATE-OF-CLIMB GAGE	14	Indicates cabin rate of ascent or descent in feet per minute.
CABIN AIR TEMPERATURE GAGE	27	Cabin compartment temperature—indicates from −40°C to +40°C.
DISCHARGE DUCT TEMP. GAGE (Cabin Heater)	2	A dual gage provides continuous indication of cabin heater air discharge temperature. 0° to 250°C.
REFRIGERATION DISCHARGE DUCT GAGE	11	A dual gage provides a continuous indication of duct temperature just downstream of the air mixing and selector valve. 0° to 120°C.

4–56. NORMAL OPERATING PROCEDURES.

4–56A. GENERAL. In order to operate the air conditioning system, it is necessary to be thoroughly familiar with all the controls on the Station 260 panel. (Refer to para. 4–50 through 4–55.) The operation of the aux. vent. control knob is shown on fig. 4-19.

4–56B. GROUND-TRUCK, Heating or Cooling.

a. Attach low-pressure truck at the ground-air connection.

b. Attach electrical ground cart, energize electrical system, and position switches as follows:

1. Recirculating fan switches—OFF.

2. Aux. vent. control knob—CLOSED.

3. Cabin air mixing valve (paddle-type) switch—COOLER.

4. Cabin heater switches—OFF.

5. Flight station mixing valve—COOL.

6. Flight station fan—ON.

7. If additional flight station heat is required, switch on pilot's auxiliary heater.

4–56C. PRESSURIZED FLIGHT.

4–56D. BEFORE ENGINE START.

a. All circuit breakers—CLOSED.

b. Aux. vent. control knob—Position A.

c. Aux. vent. exit—OPEN.

d. Cabin altitude selector—500 to 700 feet above field.

e. Rate selector override—AUTO.

f. Rate of change selector—As desired (300 to 500 feet per minute recommended.)

g. Cabin pressure regulators—NORMAL.

h. Depressurize needle valve—CLOSED.

i. Fans (Refrigerator cooling)—NORMAL.

4–56E. AFTER ENGINE START (Outboard engines operating).

a. Recirculating fans—ON.

b. All windows and doors—CLOSED.

c. Aux. vent. control knob—CLOSED (After propeller-reverse-check).

d. Aux. vent. exit—AUTO.

e. Cabin air (paddle-type) switches—WARMER or COOLER as desired.

Note

- If additional heat is desired, switch heaters ON.
- When refrigeration is necessary during taxiing because of very high ambient air temperatures, operate outboard engines at 1200 rpm, with inboard engines idling. This will provide the necessary rpm for the cabin superchargers without resulting in excessive taxiing speed which would require excessive use of the brakes.

4–56F. DURING CLIMB (After cabin altitude is attained).

a. Reset cabin altitude selector for cruise altitude.

b. Cabin air (paddle-type) switches—WARMER or COOLER, as desired. Heater switches ON for additional heat.

4–56G. START OF DESCENT.

a. Reset cabin altitude selector to 500 feet above field.

b. Rate-of-change selector—As required.

Note

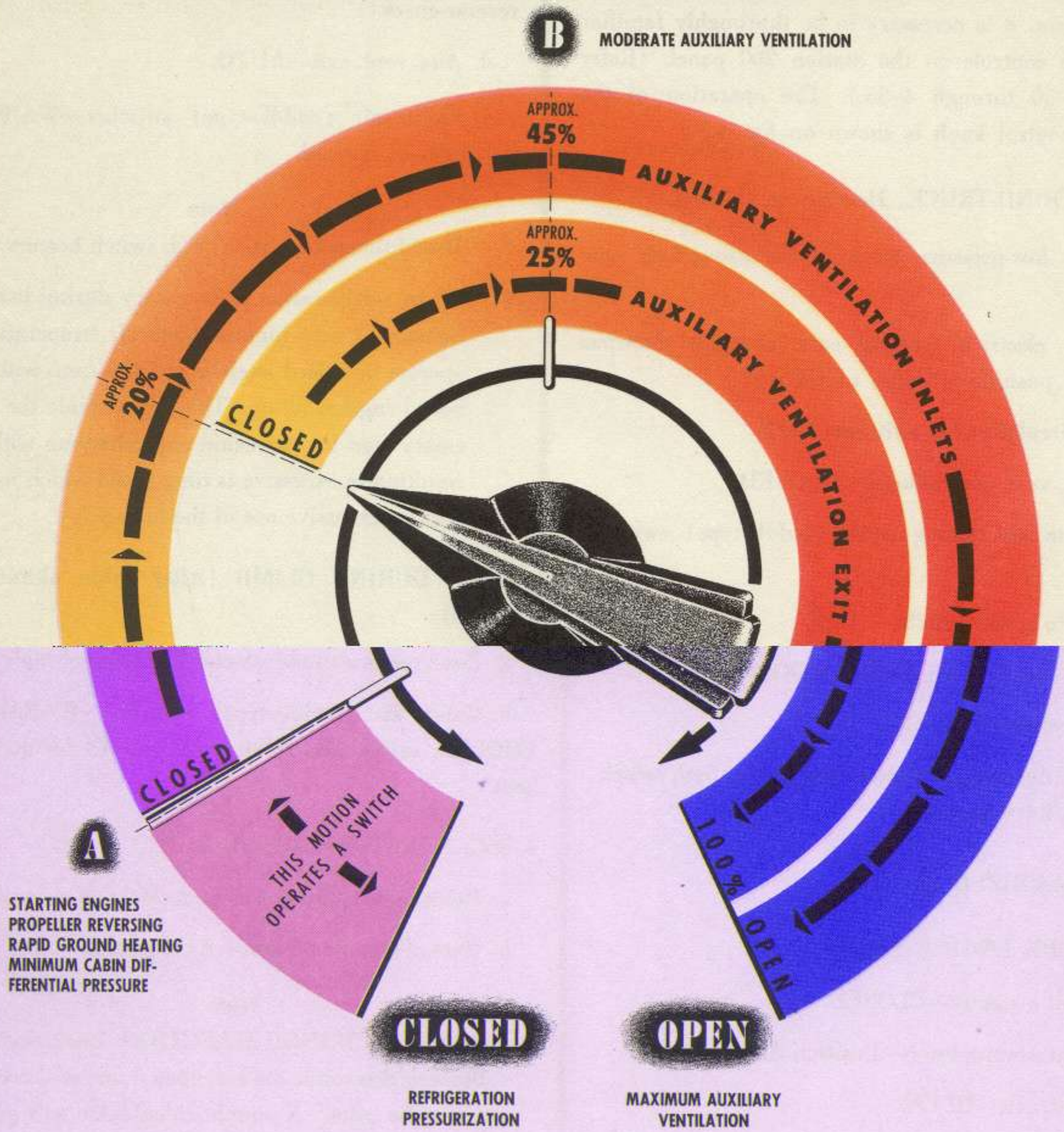
RATE OF CHANGE SELECTION. Just prior to descent, determine the anticipated rate-of-descent from the pilot. A simple calculation will give the desired rate-of-change setting. Example:

$$\text{Time to descend} = \frac{\text{Ship's Altitude } (20{,}000'-\S 500')}{\text{Rate-of-descent } (900')} = 21.7 \text{ min.}$$

$$\text{Cabin rate-of-change} = \frac{\text{Cabin Altitude } (8000'-\S 500')}{\text{Time of descent } (21.7 \text{ min.})} = 345 \text{ ft./min.}$$

§Cabin and ship altitude to meet 500′ above field. If, during descent, it appears that the cabin altitude will not reach an altitude of approximately 500′ above the field, at the same time as the airplane; then increase or decrease the cabin rate-of-change as required.

AUX. VENT. 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 4·19

4–56H. BEFORE TOUCHDOWN.

a. Aux. vent. exit—OPEN. (When cabin differential pressure is ½″ Hg or less.)

b. Heater and recirculation fan switches—OFF.

c. Aux. vent. control knob—Position A.

4–56J. AFTER LANDING.

a. Control cabin temperature by manipulating cabin air (paddle-type) switches, heaters and recirculating fans as desired. If refrigeration is desired, move the aux. vent. control knob to CLOSED before moving the cabin air (paddle type) switches to COOLER.

4–56K. PILOT'S AUXILIARY HEATER OPERATION. The flight station booster blower must be ON for operation of the pilot's auxiliary heater. The face outlets and foot warmers should be partially or fully opened to assure air flow over the heating elements.

Note

When the red overheat warning light glows, 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.

4–57. EMERGENCY OPERATING PROCEDURES.

4–57A. GENERAL. The information contained in these paragraphs is a recommended, alternate procedure for the air conditioning system. Refer to Section III, Emergency Procedures, for supercharger drive shaft disconnect, emergency depressurization, fire and smoke removal procedures.

4–57B. 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. Check setting of the cabin thermostatic control (aft cabin attendant's station). If the cabin temperature is lower than the thermostat setting, 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.

4–57C. MANUAL PRESSURIZATION CONTROL. If automatic pressurization is not properly maintained, as evidenced by a surging cabin rate-of-climb, switch to manual pressurization control as follows:

a. Place one of the cabin pressure regulators (fwd or aft) on MANUAL and simultaneously open the DEPRESSURIZE needle valve 1½ to 2 turns.

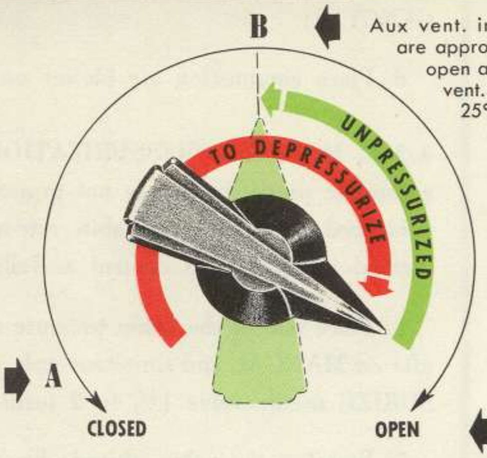
b. Stabilize the cabin altitude by opening or closing the needle valve, as required.

Note

If the depressurization needle valve is opened too far the cabin altitude will increase. If the depressurization needle valve is not opened far enough, the cabin altitude will decrease. The correct cabin altitude is dependent upon proper positioning of the DEPRESSURIZE needle valve.

c. Repeat steps a. and b. for the remaining cabin pressure regulator (forward or aft).

FIRE PROCEDURE FUSELAGE & CARGO



Aux vent. inlets are approx. 45% open and the aux vent. exits approx. 25% open.

The cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is opened; and the aux vent. inlets and exits are closed.

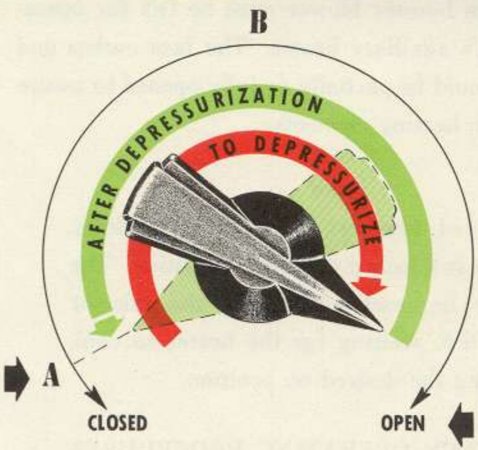
Aux vent. inlets and exits full OPEN

Rapid depressurization is accomplished by placing the aux vent. control knob to full OPEN. When depressurized (or if already depressurized) the aux vent. control knob is to be placed at position B which affords moderate ventilation without excessive air circulation that might fan the fire.

SMOKE REMOVAL

After depressurization the aux vent. control knob is placed at position A so that the auxiliary ventilation system is closed and will not circulate smoke thru the cabin or flight station.

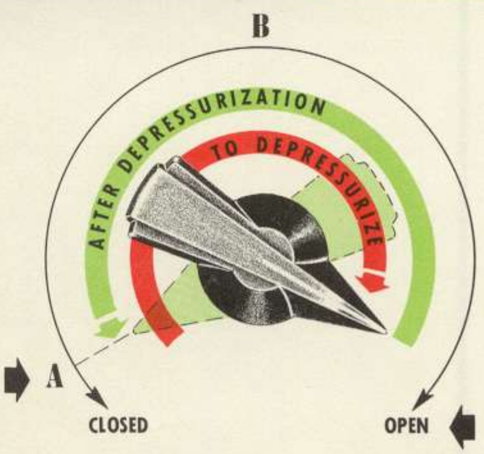
Aux vent. inlets and exits are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.



Aux vent. inlets and exits full OPEN

EMERGENCY DEPRESSURIZATION

Aux vent. inlets and exits are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.



Aux vent. inlets and exits full OPEN

After depressurization the aux vent. 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.

figure 4-20

AUX VENT. CONTROL KNOB EMERGENCY OPERATION

4–58. ANTI-ICING AND DE-ICING SYSTEMS

4–59. GENERAL. Ice accumulation on three forward windshield panels, pitot heads, and radio mast, is prevented or eliminated by electrically generated heat; it is eliminated from the windshields, propeller blades, and engine air induction system by the use of alcohol, and it is removed from the leading edges of the wing and empennage surfaces with pneumatic boots.

4–60. Defogging of the four rear windshield panels is achieved with hot air from a heater-blower, and the cabin windows are kept fog-free by warm air passing between the two panes of the double windows.

4–61. SURFACE ICE ELIMINATION. (See Fig. 4-21.)

4–62. GENERAL. Pneumatic de-icer boots provide the means for removing ice after it has formed on the leading edges of the wing and empennage surfaces. The de-icer boots are cemented to the leading edge of the wing, between and outboard of the engine nacelles, and to the leading edges of the horizontal stabilizer and fins. The boots are alternately inflated and deflated by pressure and vacuum supplied by four engine-driven de-icer pumps. Pneumatic action of the de-icer boots is controlled by an electronic timer.

4–63. DE-ICER BOOTS. The de-icer boots (1, fig. 4-21) are made in segments designed to fit the surface sections to which they are applied. Each boot segment consists of a number of small, high-pressure rubber tubes sandwiched between two layers of soft, pliable rubber. The tubes are laid parallel to each other and parallel to the leading edge of the surfaces. Each boot segment incorporates two systems of cells with independent connections to their respective distributor valves except the segments attached to the stabilizer tips and fins, each of which has one system of cells. The boots are surfaced with a conductive coating to prevent static discharges which would interfere with radio reception. They are formed to the leading edge surfaces, and firmly bonded to the skin with adhesive. They are designed to operate efficiently without inadvertent inflation up to 300 mph/IAS at 25,000 ft. altitude. When inoperative, the boots impose no restrictions on the airplane. They are designed to operate at temperatures ranging from −53° C to +71°C, and at pressures up to 30 psi.

4–64. DE-ICER PUMPS. One rotary, sliding vane, positive displacement de-icer pump is mounted on each engine. The two outboard pumps (6, fig. 4-21) supply pressure for the de-icer boots; the two inboard pumps (10, fig. 4-21) supply vacuum for the boots and for certain cabin pressurization system controls. The output sides of the vacuum pumps by pass the air regulator filter and are vented overboard except in emergency operation. Air is supplied to the pumps from the cabin supercharger. The pumps are equipped with pressure regulators, oil separators and oil filters. They are cooled by air drawn from the oil cooler scoop ahead of the radiator.

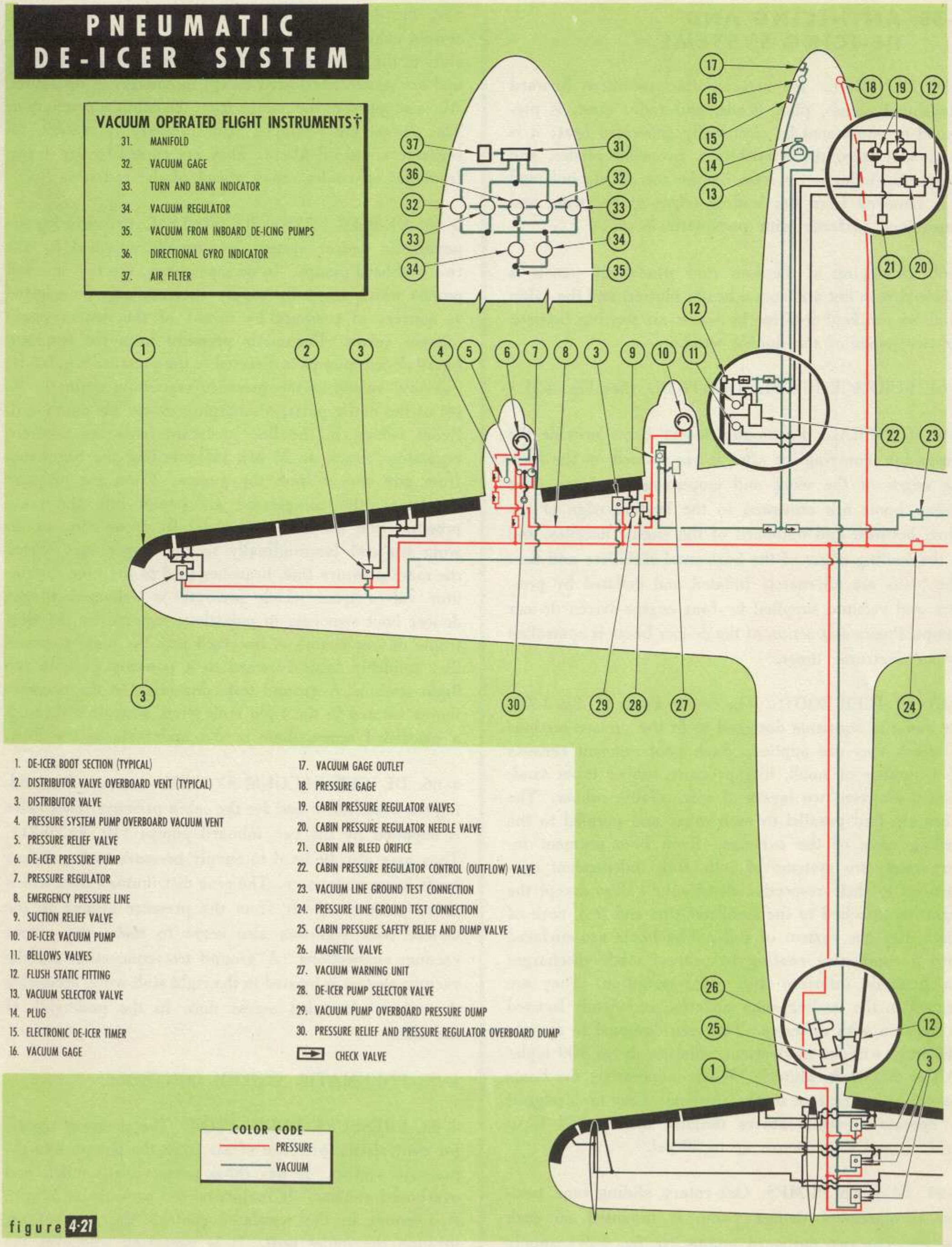
4–65. DE-ICER PRESSURE SYSTEM. Pressure for the pneumatic de-icer system is normally supplied by the two outboard pumps. In an emergency, the two inboard pumps which normally supply vacuum, may be selected as sources of pressure by means of the de-icer pump selector valves. Pneumatic pressure from the two outboard de-icer pumps is directed to the pressure regulators. Solenoid valves in the pressure regulators maintain 22 psi at the outlet ports, discharging excess air overboard. Relief valves, in the line upstream from the pressure regulators, crack at 26 psi, safeguarding the regulators from any surges from the pumps. From the pressure regulators, the compressed air passes into the main pressure line which extends laterally from wing tip to wing tip and longitudinally to the empennage. From the main pressure line, branches lead to the nine distributor valves from which pressure is delivered to the de-icer boot segments in pulsations metered by the electronic de-icer timer. A line teed into the main pressure line amidship leads forward to a pressure gage in the flight station. A ground test connection in the pressure line is located in the right stub wing, accessible through a placarded access door in the underside of the fillet.

4–66. DE-ICER VACUUM SYSTEM. Vacuum for holding the boots down and for the cabin pressure relief valve is supplied by the two inboard pumps (10, fig. 4-21). They may also be used to supply pressure to the de-icer boots in an emergency. The nine distributor valves which meter compressed air from the pressure system to the de-icer boot segments also serve to make the proper vacuum connections. A ground test connection for the vacuum system is located in the right stub wing, accessible through a placarded access door in the underside of the fillet.

4–67. PNEUMATIC SYSTEM CONTROLS.

4–68. PRESSURE REGULATOR. The pressure regulator controls the pressure of air from the pumps into the pressure system. It has three ports: inlet, outlet, and overboard exhaust. It maintains the pressure at 22 psi. A solenoid in the regulator controls the flow of air through the outlet port. It is energized whenever the pneumatic control selector switch, on the pneumatic de-

PNEUMATIC DE-ICER SYSTEM



VACUUM OPERATED FLIGHT INSTRUMENTS†

31. MANIFOLD
32. VACUUM GAGE
33. TURN AND BANK INDICATOR
34. VACUUM REGULATOR
35. VACUUM FROM INBOARD DE-ICING PUMPS
36. DIRECTIONAL GYRO INDICATOR
37. AIR FILTER

1. DE-ICER BOOT SECTION (TYPICAL)
2. DISTRIBUTOR VALVE OVERBOARD VENT (TYPICAL)
3. DISTRIBUTOR VALVE
4. PRESSURE SYSTEM PUMP OVERBOARD VACUUM VENT
5. PRESSURE RELIEF VALVE
6. DE-ICER PRESSURE PUMP
7. PRESSURE REGULATOR
8. EMERGENCY PRESSURE LINE
9. SUCTION RELIEF VALVE
10. DE-ICER VACUUM PUMP
11. BELLOWS VALVES
12. FLUSH STATIC FITTING
13. VACUUM SELECTOR VALVE
14. PLUG
15. ELECTRONIC DE-ICER TIMER
16. VACUUM GAGE
17. VACUUM GAGE OUTLET
18. PRESSURE GAGE
19. CABIN PRESSURE REGULATOR VALVES
20. CABIN PRESSURE REGULATOR NEEDLE VALVE
21. CABIN AIR BLEED ORIFICE
22. CABIN PRESSURE REGULATOR CONTROL (OUTFLOW) VALVE
23. VACUUM LINE GROUND TEST CONNECTION
24. PRESSURE LINE GROUND TEST CONNECTION
25. CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE
26. MAGNETIC VALVE
27. VACUUM WARNING UNIT
28. DE-ICER PUMP SELECTOR VALVE
29. VACUUM PUMP OVERBOARD PRESSURE DUMP
30. PRESSURE RELIEF AND PRESSURE REGULATOR OVERBOARD DUMP

CHECK VALVE

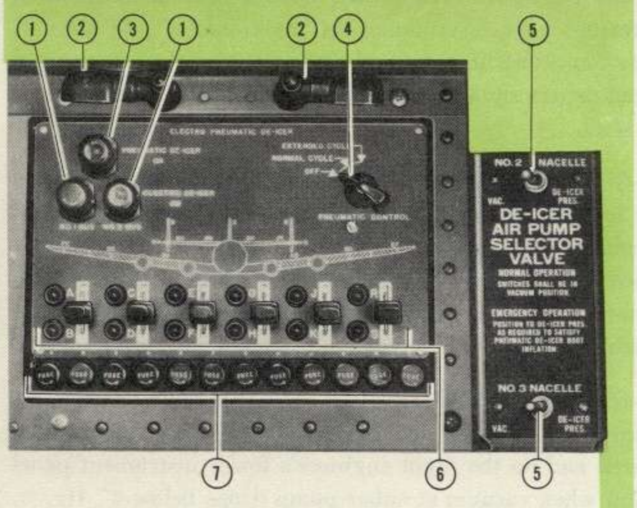
COLOR CODE

PRESSURE

VACUUM

figure 4-21

DE-ICER BOOT TIMER



1. Electric de-icer bus ON light. §
2. Panel light. Red, incandescent flood light with integral switch.
3. Pneumatic de-icer ON light.
4. Pneumatic control selector switch.
5. De-icer (vacuum) pump selector valve switch.
6. De-icer cycling lights.
7. De-icer cycle circuit fuses.

figure 4-22

icer timer (4, fig. 4-22) is placed in either the NORMAL CYCLE or EXTENDED CYCLE positions. When the solenoid is energized, air flows from the inlet port to the outlet port, with the overboard exhaust port either closed or partially open to control the pressure at the outlet port. With the solenoid de-energized, the outlet port is closed and all of the air flow is directed to the overboard exhaust port. It takes about 10 seconds after it has been energized, for the gage in the regulator which controls the flow of air at the outlet port to reach its relief setting.

4–69. PRESSURE RELIEF VALVE (5, fig. 4-21). The air pressure relief valve is set to crack at 26 psi and close at 21 psi.

4–70. DISTRIBUTOR VALVES. Nine solenoid-operated manifold de-icer distributor valves (3, fig. 4-21) deliver alternate pulsations of pressure and vacuum to the de-icer boot segments or cell systems when energized by the electronic de-icer timer. They are located behind the leading edges of the wing and empennage surfaces adjacent to the segments they serve. These units operate under 22 psi and will pass 25 cu. ft./min. of free air at sea level. Each valve is essentially two valves in one housing, serving to inflate and deflate its respective cell groups. Each unit has five ports; two inlets, one overboard vent, a d two outlet ports. One of the inlets admits pressure; suction is supplied through the other. The outlet ports serve individual boot cell systems or segments. Pressure is dumped between pulsations through the overboard vent. With the solenoid energized, the flow of air is from the pressure port to an automatically selected outlet port. When the solenoid is de-energized, pressure is relieved overboard until a pressure of approximately 1 in. Hg remains then 4 in. Hg suction is applied to evacuate the cells and flatten the boot segment against the leading edge surface.

4–71. SUCTION RELIEF VALVE. The suction relief valves (9, fig. 4-21) bleed air through screened inlets and are set to crack at 5 in. Hg and close at 7 in. Hg.

4–72. VACUUM WARNING UNIT. These units (27, fig. 4-21) energize the de-icer pump warning lights on the pilot's instrument panel and on the flight engineer's lower instrument panel.

4–73. DE-ICER VACUUM SELECTOR VALVE. Some airplanes (LAC Serials 4015 through 4024) have vacuum operated instruments, hence provisions are made to shut off the vacuum to the de-icer boots and cabin pressurization controls to insure adequate vacuum for flight instruments in case of emergency. This may be accomplished with the de-icer vacuum selector valve, the control for which is located on the off-set in the flight station floor behind the pilot's seat. The control for the valve is placarded ON and OFF, and is normally positioned ON.

4–73A. DRIFTMETER SHUT-OFF VALVE.† Located on the step below the door in the station 260 partition, the driftmeter shut-off valve provides vacuum for de-fogging the driftmeter lense. It is normally positioned CLOSED.

4–74. DE-ICER AIR PUMP SELECTOR VALVE. The de-icer pump selector valve (28, fig. 4-21) is remotely controlled and provided as a means by which pressure to the de-icer boots can be supplied by either or both of the two inboard vacuum pumps in case either or both of the outboard pressure pumps is inoperative, or if supplementary boot pressure is needed. The valves are positioned by electric motors mounted on the units themselves and are controlled by switches in the flight station to the left of the pilot's seat. The switches (5 fig. 4-22) are placarded VAC and DE-ICER PRES. The switches are normally positioned VAC, when the valves dump the pressure output of the vacuum pumps overboard, and the pumps supply vacuum to the system. When the switches are positioned at DE-ICER PRES., the overboard dump becomes an air inlet through which outside

†LAC Serials 4015–4024
§ Inoperative

air is vented into the vacuum line upstream from the pump, thereby relieving the suction load, and the output from the pressure side is bypassed around the overboard dump into the de-icer boot pressure system. In this position, the vacuum system is isolated from the pumps and is inoperative.

4–75. CABIN PRESSURE REGULATOR CONTROL OUTFLOW VALVE. During auxiliary ventilation the cabin pressure regulator valves are held in the full open position by vacuum from the de-icer vacuum system through the cabin pressure regulator control valve. (See paras. 4–26 and 4–27.)

4–76. CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE. This valve is actuated by vacuum from the de-icer pneumatic system. (See para. 4–28.)

4–77. ELECTRONIC DE-ICER TIMER. The nine solenoid-operated distributor valves are controlled by the electronic de-icer timer (fig. 4-22) located to the left of the pilot's seat. It establishes the sequence of the inflation-deflation cadence of the de-icer boots. It is designed for continuous duty in flight, and when the unit is cycling, the current drain does not exceed the current required to operate the distributor valve and regulator valves. It is energized through a 7.5 amp circuit breaker from the MJB positive bus. The boot switching circuits are protected by 5 amp fuses in the timer. The timer is controlled by a 3-position switch (4, fig. 4-22) placarded EXTENDED CYCLE, NORMAL CYCLE and OFF. No more than 20 seconds are required for the tubes to warm up after the control switch has been placed in either extended or normal cycling position. The indicator lights will flash in sequence with the inflation of the boot segments and continue without interval until the switch is turned to OFF. In normal cycle position the inflation cycle is 60 seconds; in the extended cycle position, the inflation cycle is 90 seconds in duration. The switch may be turned off at any stage of the cycling sequence and a stepper relay will click through the remaining positions and return the timer to the starting position. When the unit is turned on again, inflation will start at the beginning.

4–78. Any segment of the de-icer boots may be inflated out of sequence when the pneumatic control switch is in either cycling position by pushing the appropriate switch (7, fig. 4-22) on the lower part of the de-icer control panel. This operation does not affect the cadence of the cycle. The adjacent segment indicator light will flash to show that the individual circuit is closed and that the selected boot segment is inflated. When more than one switch is pushed, the one to the left will control. Until the controlling switch is released, switches to the right of it will have no action.

4–79. INDICATORS.

4–80. DE-ICER PRESSURE GAGE. One direct-reading pressure gage is mounted on the copilot's*, or pilot's†, auxiliary instrument panel and registers the pressure in pounds per square inch available in the de-icer pressure system.

4–81. VACUUM GAGE. One direct-reading vacuum gage is located on the pilot's auxiliary instrument panel and registers the vacuum in the de-icer vacuum system in inches of mercury. On LAC Serials 4015 through 4024 another vacuum gage is located on the pilots' center instrument panel.

4–82. DE-ICER PUMP WARNING LIGHTS. The warning lights, located on the pilot's auxiliary instrument panel and on the flight engineer's lower instrument panel glow when vacuum at either pump drops below 4″ Hg.

4–83. ELECTRO-PNEUMATIC DE-ICER INDICATOR LIGHTS. The pneumatic de-icer ON light (3, fig. 4-22) is energized whenever the switch is in either cycling position. The light may be brightened or dimmed by turning. Cycling lights, which indicate the progress of the pressure-vacuum cycle through the de-icer boot segments, are located adjacent to the segment control switches. The electric de-icer ON lights (No. 1 Bus – No. 2 Bus) are not connected in this airplane.

4–84. NORMAL OPERATING PROCEDURE FOR PNEUMATIC DE-ICER BOOTS.

4–85. GENERAL. Normally all facilities for operating the de-icer boots are available when the engines are running and the main busses are energized. When icing conditions are encountered, the best results will be obtained if initiation of the pneumatic action of the boots is delayed until ice has built up on the surface leading edges to between 1/8″ and 1/4″. The rate of ice accumulation will indicate whether NORMAL or EXTENDED cycle should be selected.

a. Before starting engines the pneumatic de-icer timer control (4, fig. 4-22) should be positioned at OFF.

b. When icing conditions are encountered and ice begins to accumulate on surface leading edges, position pneumatic control switch at NORMAL CYCLE or EXTENDED CYCLE.

Note

When the build-up of ice on the leading edges of the surfaces is slow, the EXTENDED CYCLE is the more effective means for removing it, since it allows the ice film to grow thick enough to be cracked by flexure of the de-icer boots. A thin film may be flexible.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

4–86. EMERGENCY OPERATING PROCEDURE FOR PNEUMATIC DE-ICER BOOTS.

4–87. GENERAL. The de-icer pump selector valve permits the use of the pressure side of either or both vacuum pumps as a source of de-icer boot pressure in the event of the failure of one or both pressure pumps.

a. In the event of uneven ice build-up close the appropriate switch in the bank of six segment switches on the lower part of the pneumatic de-icer switch panel.

b. In the event of failure of either or both pressure pumps, close the de-icer pump selector valve switch. This will supply pressure to the pressure side of the de-icer boot system.

Note

With both de-icer pump selector valves closed, there will be no vacuum in the system. At high speeds, boots may auto inflate. Reduce airspeed until the vacuum pumps can be returned to their normal function.

4–88. NESA WINDSHIELD ANTI-ICING SYSTEM.

4–89. GENERAL. The three center windshield panels are equipped with Nesa glass. The formation of ice on the exterior surfaces, or of fog on the interior surfaces of these panels, may be prevented or eliminated by electrically generated internal heat. Current for heating the Nesa glass is supplied by a single-phase inverter located in the forward cargo compartment and driven by power from the main d.c. bus. The No. 2, fixed-frequency, three-phase inverter can be used as an alternate source of Nesa power when its output is not connected to the main a.c. bus.

4–90. NESA GLASS. Nesa glass, as installed in Model 1049 airplanes, is an $11/16''$ thick three-ply laminated product consisting of a $1/4''$ layer of vinyl plastic sandwiched between a $3/16''$ and a $1/4''$ sheet of glass. The inner sheet of glass 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 resistance material which generates heat when an electric current is passed through it. Bus bars imbedded in the top and bottom of the panel distribute electric current uniformly to the resistance coating. Thermistors, one imbedded in the vinyl layer of each panel, are connected in parallel to regulate the electric current supplied to the panels. The thermistor in the hottest panel governs the cycling of the system.

4–91. 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

WINDSHIELD ANTI-ICING & DE-FOG

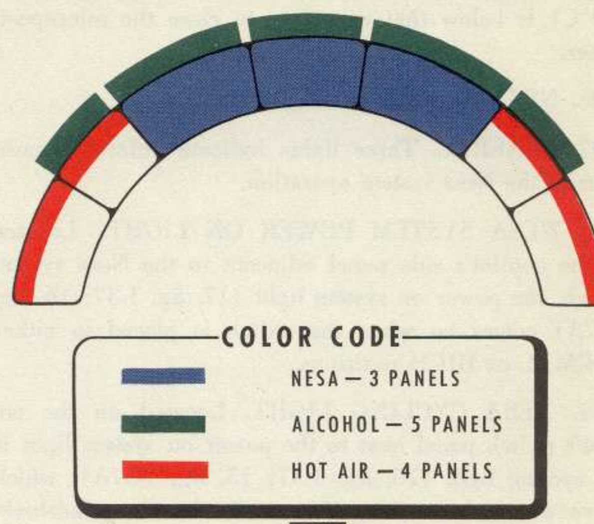


figure 4-23

that unbalances the bridge and causes the cycling action in the system.

4–92. NESA SYSTEM CONTROLS.

4–93. NESA POWER SELECTOR SWITCH. The Nesa windshield power selector switch (27, fig. 1-26) is a three-position switch located on the upper MJB panel. It permits the selection of either the NESA INVERTER (up) or the NO. 2 INVERTER (down) as a power source. The middle position is OFF.

4–94. NESA SYSTEM SWITCH. The switch which energizes the Nesa system is a three-position switch (18, fig. 1-37; 17, fig. 1-37A) located on the copilot's switch panel. It is labeled HIGH, OFF, and NORMAL. In NORMAL position, with either inverter as a power source, 0.8 KVA is delivered to the resistance material in the Nesa windshields. In the HIGH position, with the Nesa inverter as the power source, 2.0 KVA is delivered, and with the No. 2 inverter as the power source 1.49 KVA is delivered to the windshields. The latter figure is limited by the single phase rating of the No. 2 inverter. The HIGH position of the Nesa system switch provides a more rapid temperature rise in the outside lamination of glass if required by extremely low outside air temperature. The use of this position is not required for normal operation of the system.

4-95. NESA RESET SWITCH. The spring-loaded push-button Nesa reset switch (15, fig. 1-37; 14, fig. 1-37A), located on the copilot's side panel, performs two functions which are electrically separate, but mechanically combined. One function is to overcome the artificial on-off temperature differential which is built into the wheatstone bridge to prevent rapid cycling. The second function is to short across the contacts of the fail-safe micropositioner in the bridge circuit when temperature (approximately −40°C) is below that necessary to close the micropositioner.

4–96. NESA SYSTEM INDICATORS.

4–97. GENERAL. Three lights indicate different conditions of the Nesa system operation.

4–98. NESA SYSTEM POWER ON LIGHT. Located on the copilot's side panel adjacent to the Nesa system switch, the power on system light (17, fig. 1-37; 16, fig. 1-37A) comes on when the switch is placed in either NORMAL or HIGH positions.

4–99. NESA CYCLING LIGHT. Located on the copilot's switch panel next to the power on system light is the cycling light (16, fig. 1-37; 15, fig. 1-37A), which glows when the resistance material in the windshield panels is energized, and goes off when the cycling circuit interrupts the current to the panels.

4–100. No. 2 INVERTER ON NESA LIGHT. Located on the upper MJB panel, adjacent to the Nesa power selector switch, this light (20, fig. 1-26) is energized whenever the No. 2 inverter has been selected as a power source.

4-101. OPERATING PROCEDURE FOR THE NESA WINDSHIELD ANTI-ICING SYSTEM

4–102. GENERAL. The Nesa anti-icing system should be turned on in flight under most conditions to prevent the development of internal stresses in the vinyl plastic which result from very low temperatures. Approximately 10 minutes of normal operation is required before appreciable warming of the inner surfaces of the windshield panels can be detected. Use the NORMAL setting for ground and air operation except as noted.

4–103. GROUND OPERATION.

a. Use NORMAL setting to remove ice from the windshield of a stationary airplane.

Note

The HIGH power setting should be used only for established maintenance procedures.

b. Before starting engines, turn Nesa power selector switch OFF.

4–104. IN-FLIGHT OPERATION.

a. During climb, turn power selector switch to NESA INVERTER or to NO. 2 INVERTER if the No. 2 inverter is not required as a power source for the main a.c. bus.

b. Turn Nesa system switch to NORMAL.

Note

- Continuous normal operation is usually sufficient to prevent windshield icing in anticipated icing conditions. Unexpected or suddenly encountered icing can be met by immediate application of HIGH power, if necessary.

CAUTION

Use of NORMAL power for three minutes or more before moving the selector switch to HIGH diminishes thermal shock to the windshield panels resulting from the use of the HIGH setting for quick warm-up in very cold weather.

Note

- Continuous normal operation is usually sufficient to prevent fogging of the inner surfaces of the windshield panels, except in conditions of high humidity and temperature, when the dew point occurs at a temperature above the lower limit of the cycling temperature differential. Hold down the reset switch in such a circumstance. This will raise the lower cycling temperature differential limit to within 3° of the upper limit, to permit a temperature build-up in the vinyl plastic layer sufficient to raise the temperature of the inner surface of the panel to a point above the dew point of the cockpit.
- Continuous normal operation is usually sufficient to maintain the vinyl plastic layer within the temperature range (27°C to 49°C) in which it possesses its maximum resistance to shattering.
- In extremely cold weather, when the temperature falls below −40°C at the sensing point in the windshield, the current passing through the thermistor is insufficient to close the fail-safe micropositioner and start the system operating. Hold down the reset switch long enough for the panels to heat the thermistors until they draw enough current to close the fail-safe micropositioners. Normal cycling will then become automatic.

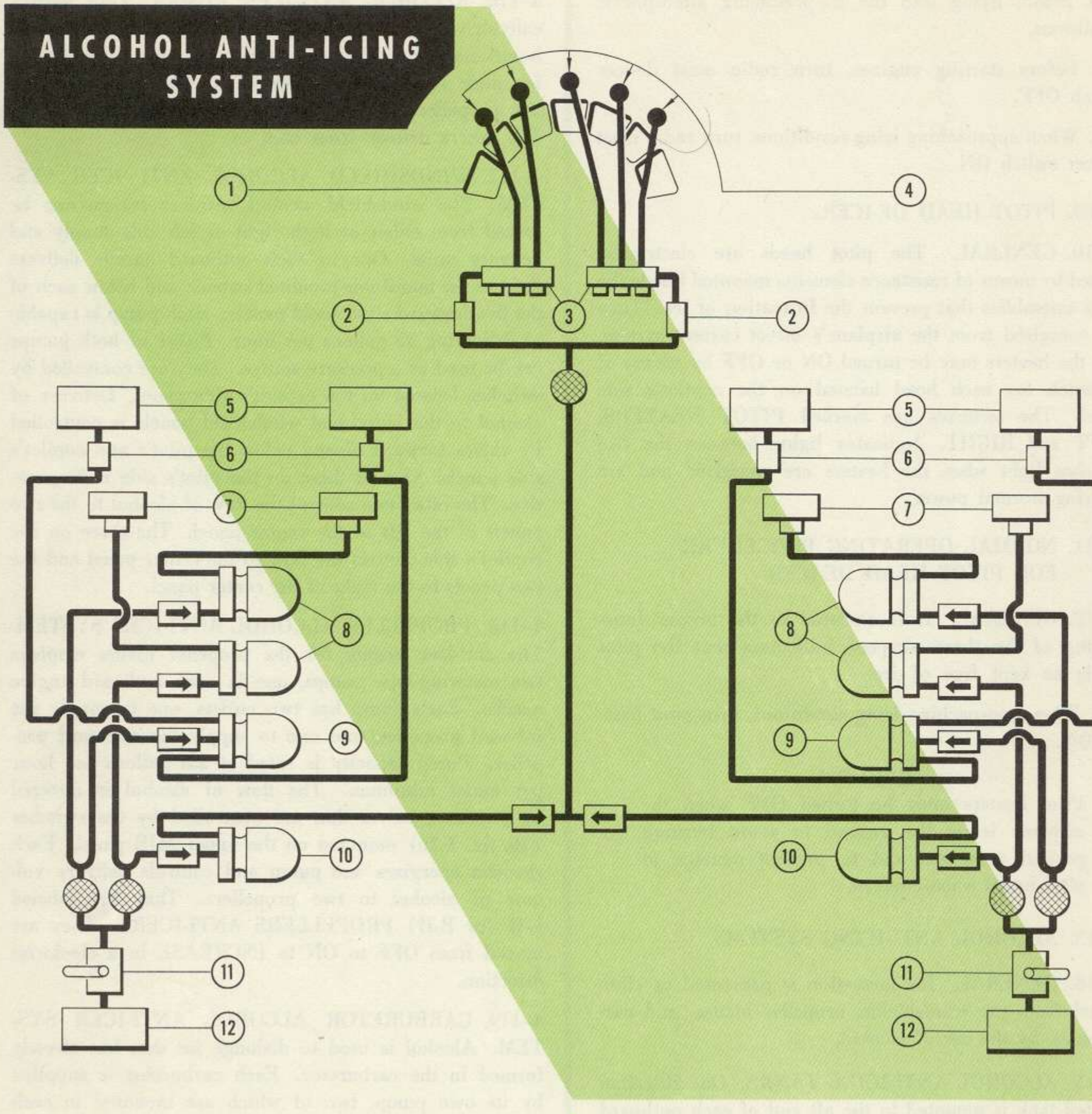
4–105. RADIO ANTENNA MAST DE-ICER.

4–106. GENERAL. An electrically heated rubber boot installed on the leading edge of the forward top radio antenna mast prevents the formation of ice on this surface. The heating element in the boot is energized by 24 volt direct current from the airplane's main d.c. bus, controlled by an ON-OFF switch located on the copilot's switch panel. The mast de-icer is automatically disconnected by the left landing gear scissors switch when the airplane is on the ground.

4–107. NORMAL OPERATING PROCEDURE FOR RADIO MAST DE-ICER.

4–108. GENERAL. Anticipate icing conditions, if possible, and energize the heating element in the mast de-icer

ALCOHOL ANTI-ICING SYSTEM



1. WINDSHIELD (SEVEN PANELS)
2. RESTRICTOR
3. SELECTOR VALVE
4. WINDSHIELD ANTI-ICER OUTLETS
5. PROPELLER ANTI-ICER
6. REGULATOR VALVE
7. CARBURETOR ANTI-ICER
8. CARBURETOR ANTI-ICER PUMP
9. PROPELLER ANTI-ICER PUMP
10. WINDSHIELD ANTI-ICER PUMP
11. SHUT-OFF VALVE
12. ANTI-ICER FLUID TANK

FLUID FILTER

CHECK VALVE

figure 4-24

boot before flying into the ice-producing atmospheric conditions.

a. Before starting engines, turn radio mast de-icer switch OFF.

b. When approaching icing conditions, turn radio mast de-icer switch ON.

4–109. PITOT HEAD DE-ICER.

4–110. GENERAL. The pitot heads are electrically heated by means of resistance elements mounted inside the head assemblies that prevent the formation of ice. They are energized from the airplane's direct current system, and the heaters may be turned ON or OFF by means of a switch for each head located on the copilot's side panel. The switches are marked PITOT HEATERS, LEFT and RIGHT. Indicator lights between the two switches light when the heaters are energized and are drawing normal power.

4–111. NORMAL OPERATING PROCEDURE FOR PITOT HEAD DE-ICER.

4–112. GENERAL. It is essential to the proper functioning of the three airspeed indicators that the pitot heads be kept free of ice.

a. When approaching icing conditions, turn pitot heaters ON.

CAUTION

Pitot heaters must be turned OFF when the airplane is on the ground to avoid burning ground personnel and to prevent damage to pitot heads when covered.

4–113. ALCOHOL ANTI-ICING SYSTEMS.

4–114. GENERAL. Ice formation is prevented or eliminated from the windshields, propeller blades, and carburetors, by the use of alcohol.

4–115. ALCOHOL ANTI-ICING TANKS. One 20-gallon alcohol tank is mounted in the aft end of each outboard engine nacelle accessible through an access door on the under side of the nacelle. Each tank has an outlet port, a vent line, a shut-off and drain valve, a fluid quantity transmitter, and a filler well located in the upper surface of the wing. The filler well has a drain leading to the lower surface of the wing. The fluid quantity transmitter is a 24-volt d.c. liquidometer type with a dual indicator mounted on the flight engineer's middle instrument panel. Alcohol can be drawn from either tank to supply the windshields, but the propellers and carburetors can be supplied only from the tank located on their respective sides of the airplane. Check valves prevent vent cross feeding from one unit to the other.

4–116. ALCOHOL ANTI-ICER PUMPS. Four electrically-driven anti-icer pumps are mounted in each outboard nacelle. They are similar to each other except for their rated delivery capacities. The pumps serving the propellers deliver alcohol from two outlet ports. The others deliver from one.

4–117. WINDSHIELD ALCOHOL ANTI-ICER SYSTEM. The windshield alcohol anti-icer system can be served from either or both right or left side supply and delivery units. One in each outboard nacelle delivers fluid to the manifolds mounted outside and below each of the five forward windshield panels. Each pump is capable of delivering 35 gallons per hour. Either or both pumps can be used as a pressure source. They are controlled by switches located on the copilot's side panel. Delivery of alcohol to the individual windshield panels is controlled by valves forward of and below the pilot's and copilot's side panels. One of these on the pilot's side is inoperative. The other two control the flow of alcohol to the two panels to the left of the center panel. The three on the copilot's side control the flow to the center panel and the two panels to the right of the center panel.

4–118. PROPELLER ALCOHOL ANTI-ICER SYSTEM. The anti-icer system for the propeller blades employs two metering-type pumps, one in each outboard engine nacelle. Each pump has two outlets, one to supply the inboard propeller, and one to supply the outboard propeller. Pump capacity is rated at 2.5 gallons per hour per outlet minimum. The flow of alcohol is metered by regulator valves that are controlled by the switches (26, fig. 1-26) mounted on the upper MJB panel. Each rheostat energizes one pump and controls delivery volume of alcohol to two propellers. They are labeled L-H (or R-H) PROPELLERS ANTI-ICERS. They are moved from OFF to ON to INCREASE in a clockwise direction.

4–119. CARBURETOR ALCOHOL ANTI-ICER SYSTEM. Alcohol is used to dislodge ice that has already formed in the carburetor. Each carburetor is supplied by its own pump, two of which are mounted in each outboard nacelle. Their delivery capacity is rated at 26 gallons per hour. The pumps are individually controlled by four spring-loaded momentary switch-type circuit breakers (21, fig. 1-26) mounted on the upper MJB panel.

4–120. OPERATING PROCEDURES FOR ALCOHOL ANTI-ICING SYSTEMS.

4–121. WINDSHIELD. To start the windshield alcohol anti-icing system:

a. Energize either or both windshield de-icer pumps by turning ON the 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.

4–122. To stop windshield alcohol anti-icing system:

a. Turn OFF windshield anti-icer valves.

b. Turn OFF windshield anti-icer pumps.

4–123. PROPELLERS. To start the propeller alcohol anti-icer system:

a. Turn propeller anti-icer rheostats clockwise to full INCREASE, then back to the desired delivery rate.

4–124. To stop propeller alcohol anti-icer system:

a. Turn propeller anti-icer rheostat counter-clockwise to OFF.

4–125. CARBURETORS. Momentary (from 3 to 5 seconds) application of alcohol is usually sufficient. If more is needed, it should be injected intermittently.

a. Close desired switch, hold momentarily, and release. The switch is spring-loaded to OFF. Refer to paragraphs 6–10 through 6–14.

4–126. WINDSHIELD DEFOGGER. (See fig. 4-23.)

4–127. GENERAL. The two aft windshield panels on both sides of the flight station (the pilot's and copilot's movable panels and the fixed panels aft of them) are equipped with distributor manifolds through which heated air may be directed upward against the glass to prevent fogging. Warm air is supplied by a heater-blower mounted forward of the instrument panel. This unit takes its air from aft of the insulating blanket and delivers it to the manifolds. The blower heater is controlled by switches on the copilot's side panel, labeled WINDSHIELD DEFOG. The blower switch has three positions: HIGH, off, and LOW. In the LOW position the fan operates at a reduced speed through an adjustable resistor located in the box with the heater relay at station 150. The heater switch has two positions: HEAT and OFF. It controls a 1750 watt heater located in the blower assembly. It contains a special low-melting alloy link which will open the relay circuit if the heater becomes overheated. In addition the heater circuit is protected by a 70 amp push-to-reset circuit breaker located on the MJB No. 3 panel, and the blower circuit is protected by a 7.5 amp push-pull circuit breaker.

4–128. NORMAL OPERATING PROCEDURES FOR WINDSHIELD DEFOGGER.

4–129. GENERAL. The windshield defogger can be operated with or without heat as circumstances warrant.

a. To start windshield defogger, move blower switch to LOW or HIGH as desired.

b. If heat is necessary, move windshield defogger heater switch to HEAT.

c. To stop windshield defogger, turn OFF defogger heater, and turn OFF blower.

4–130. WINDSHIELD SPOT DEFOGGER.

4–131. GENERAL. For spot defogging of any windshield area, a flexible hose has been provided which can be attached to either the pilot's or copilot's air duct outlets, located near the floor in the forward part of the flight station, slightly aft and outboard of the rudder pedals. By means of the flexible hose the warm air from the airplane's air conditioning system can be used for defogging. The flexible hose is coiled and stowed in a canvas sling attached to the flight station canopy immediately behind the pilot's seat.

4–132. NORMAL OPERATING PROCEDURE FOR SPOT DEFOGGING OF WINDSHIELDS.

a. Remove flexible hose from sling and attach to pilot's or copilot's air duct outlets.

b. Open butterfly valve in air duct outlet and direct air flow against area to be defogged.

c. To increase airflow and temperature, use pilots' auxiliary heater and booster. Close station 260 outlet as required.

4–133. WINDSHIELD WIPERS.

4–134. GENERAL. The pilot's and copilot's forward windshield panels are each equipped with single speed windshield wipers. They are individually driven by a d.c. motor which is controlled by an ON-OFF-PARK switch located left of the center on the underside of the instrument panel glare shield. The PARK position on the switch is a momentary contact, provided to position the blades at the sides of the panels so that they will not obstruct vision.

4–135. NORMAL OPERATING PROCEDURES FOR WINDSHIELD WIPERS.

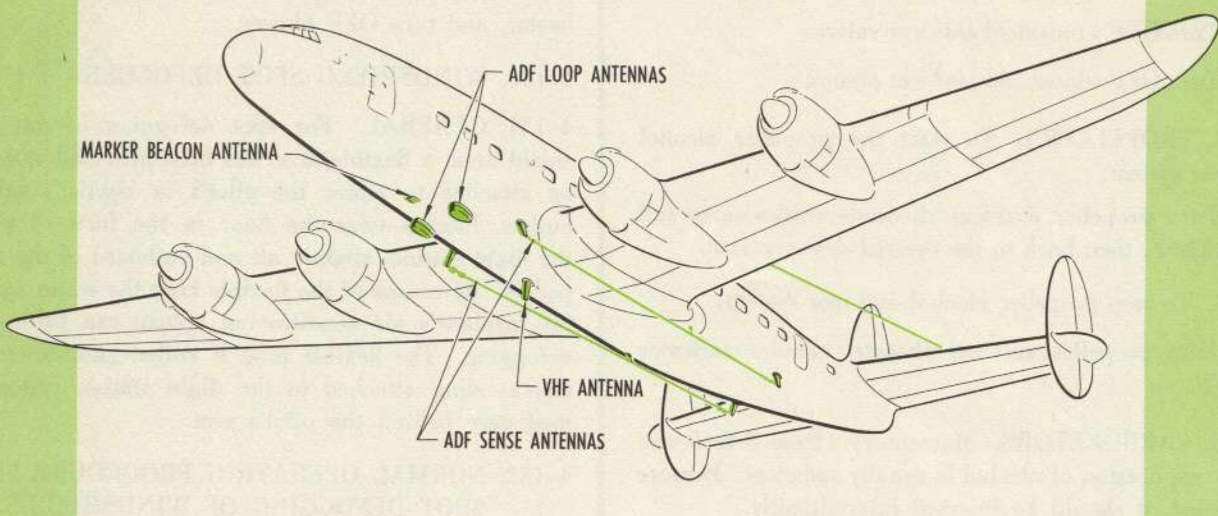
a. To start windshield wipers, move control switch to ON.

CAUTION

Do not operate windshield wipers on dry glass. Friction of blades against glass is sufficient to cause damage to the blades and glass surface if not reduced by water.

b. To stop windshield wipers, move control switch to PARK; release when blades slow down at extreme inboard travel point.

ANTENNA DIAGRAM*



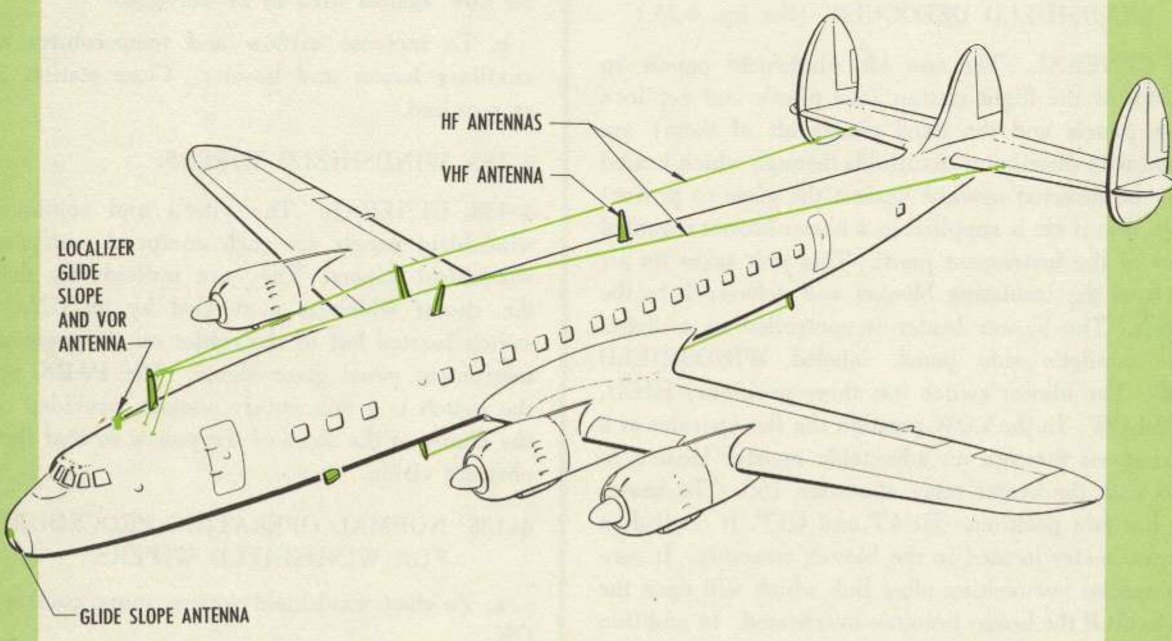


figure 4-25

*LAC Serials 4001–4014

4–136. CABIN WINDOW DEFOGGING.

4–137. GENERAL. Warm air is routed from the center overhead air conditioning system duct between the double panes of the cabin windows to prevent fogging and icing. The interior pane is removable for cleaning. (See para. 4–32 and fig. 4-4.)

4–138. COMMUNICATION AND RADIO NAVIGATION EQUIPMENT • • • • •

LAC Serials 4001 through 1014

4–139. GENERAL. The communication equipment installed in this airplane consists of an interphone system, a public address system, and dual installations of HF and VHF two-way radio sets. The radio navigation equipment consists of dual installations of automatic direction finder receivers (ADF), dual installations of VHF navigation receivers, dual installation of glide slope receivers, and a marker beacon receiver. Racks on which all of the equipment is installed are located in the flight station and in the galley section. All of the equipment is accessible while in flight.

4–140. The radio junction box containing all of the circuit breakers and master power switches controlling the radio circuits, is mounted vertically on the forward face of the radio equipment rack in the flight station. The master power switches labeled D.C. BUS 1, D.C. BUS 2, and A.C. POWER, are mounted at the top of the inboard face of the radio junction box. Radio selector boxes containing switches for aural reception of the communication and navigation receivers are provided for the pilot, copilot, and flight engineer.

4–141. All of the radio equipment with the exception of the marker beacon receiver are connected to remote controls located on the pilot's overhead panel and to the radio selector boxes. The marker beacon receiver is connected to switches located on a control panel on the center control stand.

4–142. Twenty-eight volt, direct current from the airplane d.c. bus is used to power all radio equipment. The automatic direction finder receivers also use 115-volt, 400-cycle, alternating current from the inverters. The indicators associated with the ILS and omni-range receivers use 26-volt, 400-cycle, alternating current. The master switch labeled D.C. BUS 1 supplies d.c. current to all of the radio units marked "1" and the D.C. BUS 2 switch supplies all the radio units marked "2" plus the equipment not installed in pairs, such as the marker beacon receiver, and interphone system. The switch labeled A.C. POWER supplies alternating current from the inverters to the automatic direction finder receivers, the radio magnetic indicator amplifiers, and to the rotors of the radio magnetic indicators.

4–143. The following is a complete list of the communication and radio navigation equipment installed in this airplane:

Interphone system for intra-plane communications.
Gables G-269 (mod.) public address system for general announcements to passengers.

RTA-1B HF transceivers for long-range, two-way voice communications. (Dual)

440A VHF transceivers for "line-of-sight," two-way, voice communications. (Dual)

51R-2 VHF navigation receivers for ILS, VOR, or VHF reception. (Dual)

429-A glide slope receivers. (Dual)

MN-62A radio compass receivers for automatic direction finding. (Dual)

MN-53B marker beacon receiver for the reception of 75-megacycle marker beacon signals.

4–144. The following is a list of indicators and switches associated with the radio navigation equipment:

Radio Magnetic Indicators (2) — pilot's and copilot's instrument panels.

ILS Deviation Indicators (2) — pilot's and copilot's instrument panels.

Enunciator Lights for RMI Needles — copilot's instrument panel.

Marker Beacon Lights (3) — pilot's instrument panel.

Omni-Bearing Selector (1) — pilot's instrument panel.

RMI Needle Switches (2) — pilot's instrument panel.

LHC Test Switch (1) — pilot's instrument panel.

LHC ON-OFF Switch (1)—pilot's instrument panel.

4–145. ANTENNA SYSTEM. (Figure 4-25.) The function and location of communication and navigation antennas are described in the following paragraphs:

Two $\frac{3}{32}''$ phosphor-bronze wire antennas running from the top of the fuselage at a point directly behind the flight station, through two stand-off masts, to the upper surface of each horizontal stabilizer, are installed for HF reception and transmission.

Two blade-type vertical antennas, one at the top of the fuselage at approximately the mid-point and one at the bottom of the fuselage, also at approximately the mid-point, are installed for VHF communications reception and transmission.

Two loop antennas in stream-lined housings are installed on each side of the center-line on the bottom of the fuselage, just aft of the nose wheel well, for the automatic direction finder receivers (ADF).

Two sense antennas of $\frac{3}{32}''$ phosphor-bronze wire are installed on each side of the bottom of the fuselage below the wing center-section for the automatic direction finder receivers (ADF).

One A-13 antenna for the glide slope and VOR receivers is installed on the top of the fuselage, just aft of the flight station.

One MN 92A antenna for the glide slope receivers is installed in a plexiglass housing in the nose of the fuselage.

One N 600A flush-type antenna for the marker beacon receiver is installed on the center-line of the bottom of the fuselage, just aft of the nose wheel well.

4–146. RADIO SELECTOR BOXES. A radio selector box is provided for the pilot, copilot, and flight engineer. Jacks for the headsets and microphones are provided on each of the boxes; however, a separate Bendix MS-18B microphone-headset jack box, more conveniently located just below the engine instrument panel, is provided for the flight engineer and should be used in lieu of the jacks on the radio selector box. The radio selector boxes contain switches for aural reception of the marker beacon receiver, the VHF navigation receivers, the HF communication receivers, the VHF communication receivers, and the automatic direction finder receivers (ADF). The switch labelled MIC SEL is used to connect the microphones to the transmitter circuits of the RTA-1B (HF) transceivers, or the 440A (VHF) transceivers. The interphone system is connected to both the headsets and microphone when the MIC SEL switch is moved to the INTPH position. The CALL position of the MIC SEL switch is spring-loaded and is connected to the chimes in the passenger compartment and to the signal light on the flight attendant's panel. Below the lower right hand corner of each radio selector box is a guarded switch labelled AUX and NORM. Each radio selector box is connected to a separate MI-32A isolation amplifier. In the event that the isolation amplifier fails, the guarded switch should be moved to the AUX position. When the switch is on the AUX position, the radio selector box is connected directly to a receiver selected by the individual audio switches, bypassing the isolation amplifier. However, when the guarded-switch is on the AUX position, only one receiver at a time can be monitored. In addition to the volume control located at each frequency selector switch, the volume control located in the center of each box controls the audio level of the communications receivers (HF and VHF). 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 rapidly 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.

4–147. INTERPHONE SYSTEM. An interphone system is installed to provide intra-plane communications for members of the flight crew during flight, and for maintenance personnel during airplane servicing operations. Interphone communications for the pilot, copilot, and flight engineer is controlled through the radio selector boxes provided at each of those stations. The flight attendant is provided with a handset (4, fig. 4-32) that is connected to the interphone system at the flight attendant's panel. A type 310 mechanic's interphone jack box is installed behind the firewall on the right side of each engine nacelle, the ceiling of the forward baggage compartment, the ceiling of the aft baggage compartment, and in the tail cone section. A G-256-B microphone-headset assembly is installed in a box located on the left side of the nose wheel strut, just above the nose wheel steering hydraulic cylinders. A jack box for an observer is installed on the fuselage sidewall behind the observer's seat. This jack box is controlled by the flight engineer's radio selector box. Each of the interphone stations, except the pilot's, copilot's, flight engineer's, observer's, and ramp mechanic's station, is provided with a signal button that is connected to a single signal light installed on the copilot's instrument panel. The pilot, copilot, and flight engineer are connected to the interphone system by placing the MIC SEL switch on each of the radio selector boxes on the INTPH position. The spring-loaded position of the MIC SEL switch labelled CALL is connected to chimes in the forward and aft passenger compartments and the signal light (2, Fig. 4-32) on the flight attendant's panel. The interphone amplifier, which is installed on the radio rack located in the galley section, is connected to the D.C. BUS 2 switch-type circuit breaker on the radio junction box in the flight station. Twenty-eight volt direct current is supplied to the interphone amplifier through this switch.

4–148. RTA-1B COMMUNICATIONS EQUIPMENT. Two Bendix RTA-1B HF radio transceivers are installed to provide long-range, two-way, radio communications between the airplane and ground stations or other airplanes, while in flight. The RTA-1B is a pre-set, multichannel radio with a frequency range of 2,500 to 13,000 kilocycles. The transceiver units, which are installed on the radio rack in the flight station, are remotely controlled by switches located on the pilot's overhead panel. Selection of any one of ten pre-tuned channels on each transceiver unit can be accomplished by rotating either one of the rotary selector switches (14, 16, fig. 1-14) labeled HF -1 CHAN SEL and HF -2 CHAN SEL to the desired channel number. A single toggle switch (13, fig. 1-14), located between the two rotary channel selector switches, is provided so that selection of the individual units can be made since both transceivers cannot be used simultaneously. Transmission and reception are always on the same frequency.

4–149. OPERATION. To place the RTA-1B transceivers in operation:

a. Turn on the D.C. BUS 1 and D.C. BUS 2 switches located on the radio junction box.

b. Place the transceiver selector switch (13, fig. 1-14) on either the HF -1 or HF -2 position, as desired.

c. Rotate either the HF-1 CHAN SEL or the HF-2 CHAN SEL switch, as determined by the position of the toggle switch, to the desired channel number.

d. Turn on the HF communication receiver switch located on the radio selector box.

e. To transmit, rotate the microphone selector switch on the radio selector box to the HF position and depress the microphone "press-to-talk" button.

CAUTION

Never shift frequency without first releasing the microphone button.

4–150. 440A VHF COMMUNICATIONS EQUIPMENT. Two Wilcox 440A VHF transceivers are installed to provide radio transmission and reception within the VHF frequency range of 118.1 to 135.9 Mc. The transceiver units are installed on the radio rack in the flight station and are connected to remote controls labeled VHF COMM 1 and VHF COMM 2 on the pilot's overhead panel. Aural reception is directed to the headsets by the VHF 1 and VHF 2 switches located on each of the radio selector boxes.

4–151. The frequency selector switches (11, 19, fig. 1-14) consist of two concentric knobs. The selected frequency appears in the vertical windows. Since the frequency is always expressed in the 100-mc. series of numbers, the hundreds-of-megacycles digit is always 1 and is permanently fixed. The next two digits, which indicate whole megacycles are selected by the large, outer, knob. The last digit in the frequency indicator shows tenths of a megacycle and is controlled by the small knob with the lever handle. The last knob labelled VOL acts as both an on-off switch and a volume control.

4–152. OPERATION. To place the 440A transceivers in operation, proceed as follows:

a. Turn on (up) the D.C. BUS 1 and D.C. BUS 2 switches located on the radio junction box.

b. Turn the equipment on by rotating the VOL knobs in a clockwise direction.

c. Select the frequency by rotating the frequency selector knobs until the desired frequency appears in the vertical windows.

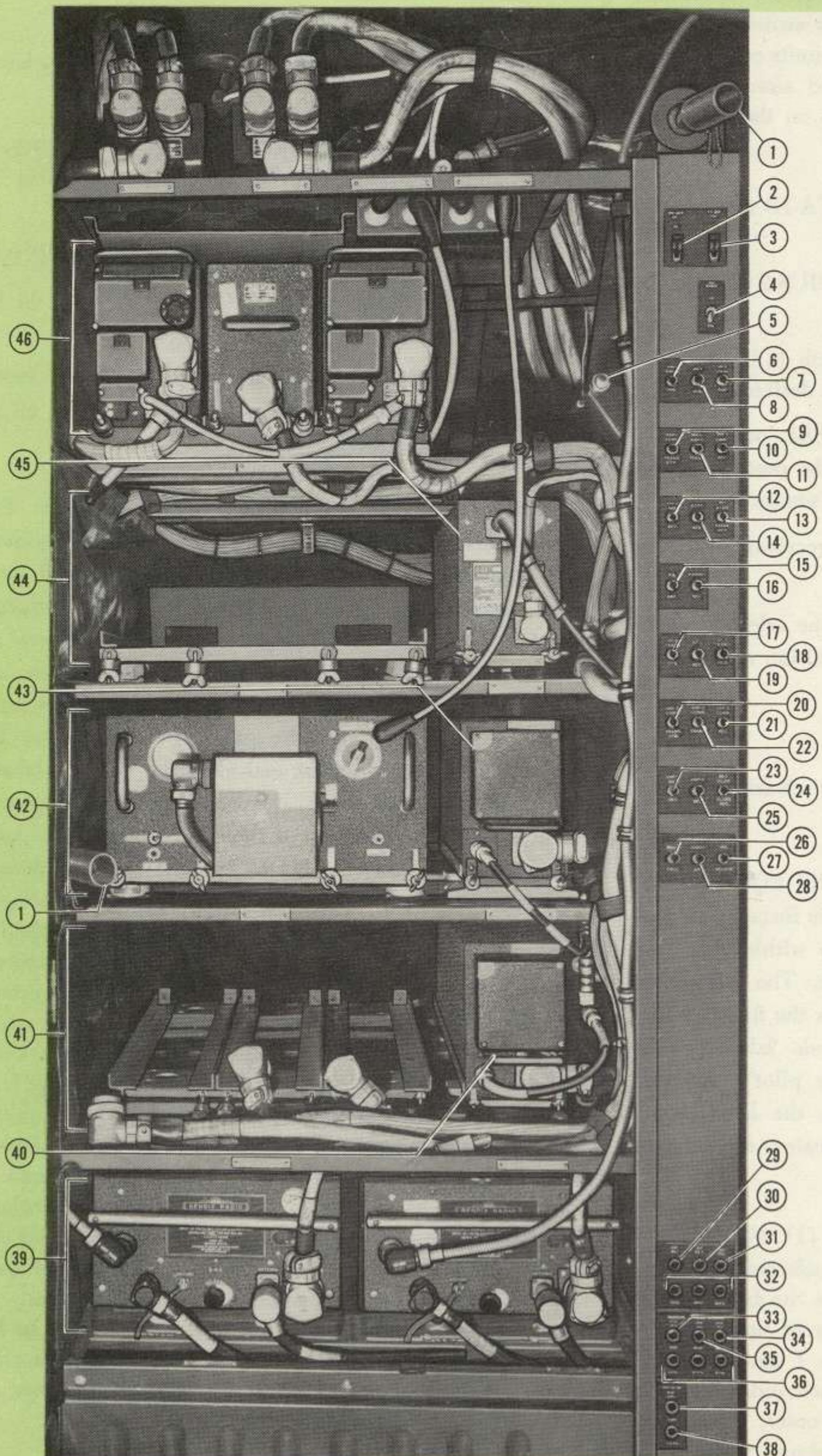
d. For aural reception, turn on (up) the COMM RECVRS switches labelled VHF 1 and VHF 2 on the radio selector boxes.

e. To transmit, place the microphone selector switch on VHF 1 or VHF 2, as desired, and depress the microphone "push-to-talk" button.

4–153. 51R-2 VHF NAVIGATION RECEIVERS. Two Collins 51R-2 navigation and communications receivers are installed to provide a means of receiving all localizer, omni-range and voice signals within a frequency range of 108 to 135.9 megacycles. The receivers are installed on the radio rack in the flight station and are connected to remote controls on the pilot's overhead panel and the radio selector boxes. The frequency selector switches (10, 20, fig. 1-14), labeled VHF NAV 1 and VHF NAV 2, consist of two concentric knobs on the front of the control panel. The large knob selects whole megacycles and the small knob with the lever handle selects tenths of megacycles. The selected frequency appears in the vertical windows. Since the frequency is always expressed in 100-mc. series of numbers, the hundreds-of-megacycles digit is always 1 and permanently fixed. The next two digits, which indicate whole megacycles, are selected by the outer concentric knob. This dial has 28 separate positions to cover the range from 108 to 135.9 megacycles. The last digit in the frequency indicator shows tenths of a megacycle and is controlled by the small knob with the lever handle. The last knob labelled VOL acts as both an ON-OFF switch and a volume control. To preclude the necessity of manually selecting the desired type of receiver operation, especially the navigation circuits, the various circuits are automatically set up as follows: ILS - 108 to 112 mc., VOR - 112.1 to 118 mc., and VHF - 118.1 to 135.9 mc. This is possible since different types of service, or ground station emission, are assigned to particular bands of frequencies.

4–154. When the receivers are tuned to a frequency within the ILS range (108 to 112 mc.), the glide path receivers are automatically turned on and the signal circuits from

RADIO EQUIPMENT RACK & JUNCTION BOX (FLIGHT STATION)*



1. Light
2. D.C. bus No. 1 circuit breaker type switch
3. D.C. bus No. 2 circuit breaker type switch
4. A.C. power switch
5. Ventilator control
6. HF-1 transmitter dynamotor circuit breaker
7. HF-1 transmitter filaments circuit breaker
8. HF-1 receiver circuit breaker
9. VHF-1 communication transmitter dynamotor circuit breaker
10. VHF-1 communication receiver circuit breaker
11. VHF-1 communication transmitter circuit breaker
12. VHF-1 navigation receiver circuit breaker
13. No. 1 glide slope receiver circuit breaker
14. ADF 1 receiver circuit breaker
15. Public address amplifier circuit breaker
16. Marker receiver circuit breaker
17. HF-2 transmitter dynamotor circuit breaker
18. HF-2 transmitter filaments circuit breaker
19. HF-2 receiver circuit breaker
20. VHF-2 communication transmitter dynamotor circuit breaker
21. VHF-2 communication receiver circuit breaker
22. VHF-2 communication transmitter circuit breaker
23. VHF-2 navigation receiver circuit breaker
24. No. 2 glide slope receiver circuit breaker
25. ADF-2 receiver circuit breaker
26. Mechanic call circuit breaker
27. Indicator relays
28. Audio amplifier circuit breaker
29. ADF No. 1 fuse
30. ADF No. 2 fuse
31. Aft cabin fuse
32. Spare fuses
33. No. 1 RMI amplifier fuse
34. Indicator rotors fuse
35. No. 2 RMI amplifier fuse
36. Spare fuses
37. Marker beacon receiver D.C. fuse
38. Spare fuse
39. Bendix MN-62 ADF receivers
40. No. 2 glide slope receiver
41. Provisions for VHF transceiver, Wilcox 440 A
42. HF transceiver RTA-1B
43. No. 1 glide slope receiver
44. Provisions for HF transceiver RTA-1B
45. Marker beacon receiver
46. VHF transceiver Wilcox 440 A

figure 4-26

the 51R-2 receivers to the radio magnetic indicators are interrupted. An ILS deviation indicator selector switch is located on the left side of the pilot's overhead panel. This switch is used to connect either the NAV 1 or NAV 2 receiver to the ILS deviation indicators on the pilot's and copilot's instrument panels.

4–155. When the receivers are tuned to a frequency within the VOR range (112.1 to 118 mc.), the signal output is connected to the magnetic bearing selector on the pilot's instrument panel, to the deviation indicator selector switch on the pilot's overhead panel, and may be connected to the radio magnetic indicators (RMI) by the RMI NEEDLE switches on the pilot's instrument panel. The red (double) needle is connected to the NAV 1 receiver, and the green (single) needle is connected to the NAV 2 receiver.

4–156. Frequencies within the VHF range (118.1 to 135.9 mc.) can be monitored when a frequency within this range is selected by the frequency selector switch. Transmissions within this range can be made only by the VHF COMM 1 or VHF COMM 2 transceivers.

4–157. Aural reception of any frequency covered by these receivers can be directed to the headsets by turning on (up) the switches labeled NAV 1 and NAV 2 located on each of the radio selector boxes.

4–158. OPERATION. To place the 51R-2 receivers in operation:

a. Turn on (up) the D.C. BUS 1 and D.C. BUS 2 switches located on the radio junction box.

b. Turn on either, or both, receivers by rotating the VOL switch on each frequency selector switch labeled NAV 1 and NAV 2 in a clockwise direction.

c. Select the desired frequency by rotating the concentric knobs until the correct frequency numbers appear in the vertical windows.

d. During ILS operation, place the ILS deviation indicator selector switch on either NAV 1 or NAV 2, as desired.

e. During VOR operation, place the ILS deviation indicator or either NAV 1 or NAV 2, and the RMI NEEDLE selector switches on NAV 1 or NAV 2, as desired.

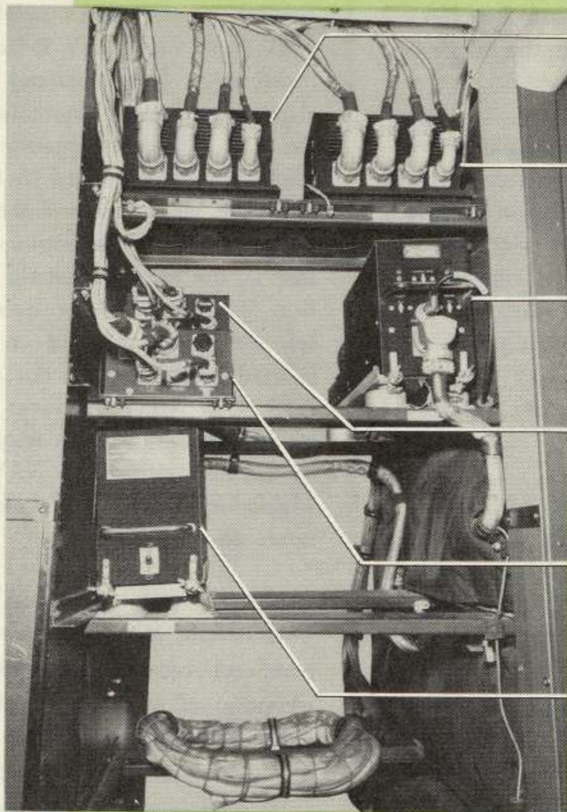
f. For aural reception, turn on (up) the VHF NAV RECVRS switches on the radio selector boxes. Adjust volume by the VOL knob on the frequency selector switches.

4–159. 429A GLIDE SLOPE RECEIVERS. Two Wilcox 429A glide slope receivers have been installed to provide vertical signals to the deviation indicators during an ILS approach. The receivers are installed on the radio rack in the flight station and are connected to remote controls on the pilot's overhead panel. When the VHF NAV 1 or VHF NAV 2 frequency selector switches are tuned to an ILS frequency (108 to 112 mc), the glide slope receivers are automatically turned on together with the 51R-2 VRF navigation receivers. The glide slope receivers are connected to the horizontal needles of the deviation indicators and the 51R-2 receivers control the vertical needles. The action of the needles are directional; that is, the airplane should be maneuvered in the direction indicated by the needles. A deviation indicator selector switch, located on the pilot's overhead panel, is used to connect the deviation indicators to either the NAV 1 or NAV 2 receiver, as desired. Aural reception of the localizer signals may be directed to the headsets by turning either the NAV 1 or the NAV 2 switch, whichever is being used, located on the radio selector boxes to on (up).

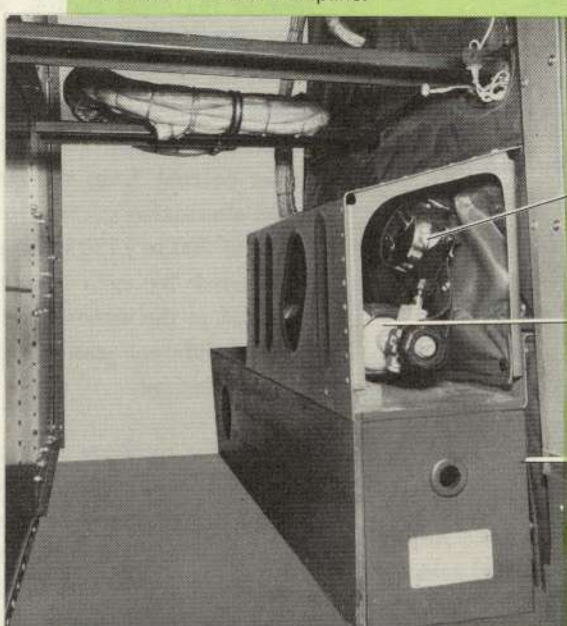
4–160. MN-62A AUTOMATIC DIRECTION FINDER. Two Bendix MN-62A automatic direction finder (radio compass) receivers are installed to provide for aural reception of modulated and unmodulated signals, using either the loop antenna or the non-directional sense antennas; for aural-null direction indications of modulated or unmodulated signals, using the loop antennas only; and for automatic bearing indication and simultaneous aural reception of the direction of modulated or unmodulated signals, using both the loop and sense antennas. The receivers, which are installed on the radio rack in the flight station, are connected to remote controls (12, 17, fig. 1-14) located on the pilot's overhead panel, the radio selector boxes, and to the radio magnetic indicators installed on both the pilot's and copilot's instrument panels. The receivers are operated on 24-volt direct current from the d.c. busses and 115-volt, 400-cycle, alternating current from the inverters. A frequency range of 200 to 1750 kilocycles, divided into three bands, is covered by each receiver. Both receivers may be operated at the same time to give simultaneous bearings on two different stations, or only one receiver may be used, if desired.

4–161. The receivers are connected to the radio magnetic indicators on the pilot's and copilot's instrument panels. Signals from the receivers are directed to the indicators when the RMI NEEDLE switches on the pilot's instrument panel are placed on the ADF 1 and ADF 2 positions. The red controls on the overhead panel and the red (double) needle on the radio magnetic indicators are connected to the ADF 1 receiver, and the green con-

RADIO RACK, GALLEY SECTION*



1. No 1 fluxgate amplifier
2. No 2 fluxgate amplifier
3. Gables G-269 (mod) public address system amplifier
4. Fluxgate No. 2 junction box
5. Fluxgate No. 1 junction box
6. Multi-channel audio amplifier



7. Demand regulator
8. Portable oxygen cylinder
9. Oxygen system supply cylinder cabinet

*LAC Serials 4001–4014

figure 4-27

trols and green (single) needles are connected to the ADF-2 receiver. The indicator lights located directly below the copilot's magnetic indicator show whether signals from the automatic direction finder receivers (ADF) or from the VHF navigation receivers (NAV) are being supplied to the copilot's indicator. Aural reception from the MN-62A receivers is directed to the headsets by a selector switch located in the upper left-hand corner of each radio selector box.

4–162. OPERATION. To place the MN-62A receivers in operation:

a. Turn on (up) the D.C. BUS 1, D.C. BUS 2, and A.C. POWER switches on the radio junction box.

b. Move the function switches located on the pilot's overhead panel from the OFF position to the desired type of operation (ADF, ANT, LOOP, or LOOP CW).

c. Rotate the frequency band selectors to the desired frequency bands on each receiver control panel.

d. Tune in the desired frequency with the tuning control. Tune each receiver for maximum strength as indicated on the tuning meter (21, fig. 1-14) located between the two frequency band selector switches. Move the tuning meter selector switch (9, fig. 1-14) in the necessary direction before attempting to tune a receiver.

e. For aural reception, move the selector switch on the radio selector box to the desired receiver and type of reception.

f. Adjust volume with the volume controls installed on the radio panel on the center control stand.

4–163. MN-53B MARKER BEACON RECEIVER. The Bendix MN-53B marker beacon receiver is a crystal-controlled, superheterodyne, receiver used to detect 75 megacycle marker beacon signals which are modulated with a 400, a 1300, or a 3000-cycle tone.

4–164. The receiver unit, which is installed on the radio rack in the flight station, is connected to remote controls (29, 30, fig. 1-18) located on the center control stand, to a switch labeled MARK REC on each of the three radio selector boxes, and to three indicator lights installed on the upper portion of the pilot's instrument panel. The HIGH-LOW switch (29, fig. 1-18) located on the center control stand provides a selection of high or low receiver sensitivity. The setting of this switch determines, under various flight conditions, the duration of the visual and aural identification signal of each marker. Normally, a longer indication will result when the switch is placed on HIGH.

4–165. The aural and visual identifications provided through the headsets and by the lights indicate the passage of the airplane over any one of three general types of markers: An airways fan-type (FM) marker, a range station cone-type ("Z") marker, and an outer-inner instrument landing system fan-type marker. Each of these markers is distinguished by its modulation tone of 400, 1300, or 3000 cycles per second as follows:

a. An airways range station "Z" marker is indicated by the white light accompanied by a 3000-cycle steady tone.

b. An airways fan (FM) marker by the white light and an on-off dash tone.

c. An instrument landing outer marker by the purple light accompanied by a 400-cycle on-off dash tone.

d. An instrument landing inner marker by the amber light accompanied by a 1300-cycle on-off dotted tone.

4–166. OPERATION. To place the marker beacon receiver in operation:

a. Turn on (up) the D.C. BUS 2 switch located on the radio junction box.

b. Move the marker beacon ON-OFF switch (30, fig. 1-18) on the center control stand to the ON position.

c. Move the HIGH-LOW switch (29, fig. 1-18) to the position that will give the desired receiver sensitivity.

d. For aural reception, turn on (up) the MARK REC switch located on the radio selector box.

Note

The switch labeled MARKER (22, fig. 1-14) on the pilot's overhead panel is inoperative.

4–167. PUBLIC ADDRESS SYSTEM. The airplane is equipped with a public address system which makes possible general announcements to the passengers from the microphone (6, fig. 4-32) located at the flight attendant's station or from the handset at the pilot's station. Loud speakers are mounted in the ceiling of the passenger compartment and the lounge.

4–168. Twenty-eight volt direct current power is supplied to the Gables G-269 (mod.) public address amplifier when the battery master switch is on. The public address system is set in operation by depressing the switch button on the microphone or handset. A high-low level switch (5, fig. 4-32) is located on the cabin attendant's interphone junction box. The switch is spring-loaded to the HIGH (normal) position. The low volume is effective only when the switch is held in the LOW position while an announcement is being made. The public address system can be operated at any time provided that the P. A. circuit breaker on the radio junction box is pushed in and the airplane batteries are connected.

4–168A. COMMUNICATION AND RADIO NAVIGATION EQUIPMENT • • • • •

LAC Serials 4015 through 4024

4–168B. GENERAL. The location and combinations of communication and navigation equipment installed in the airplanes can be changed to suit either domestic or international operations. The interphone system, public address system, dual ADF system, instrument approach system, dual VHF navigation (VOR) system, and the terrain warning system are common to both configurations. However, the domestic configuration is equipped with a H-F transmitter-receiver and a VHF transmitter-receiver (with "domestic" crystals) whereas the international configuration has dual H-F transmitter-receivers, a VHF transmitter-receiver (with "international" crystals), dual liaison transmitters, dual liaison receivers, a radio altimeter, and the navigator's ADF indicator. The major items of radio equipment are situated in the main radio rack which is located on the left side of the flight station forward of the station 260 bulkhead. On airplanes with the international configuration, another (auxiliary) radio rack is installed on the aft left side of the foremost passenger compartment, in lieu of passenger seats, to accommodate additional communication and navigation equipment.

4–168C. The radio power panel, containing all of the circuit breakers, fuses, and power switches that control the radio circuits, is mounted forward of the radio operator's table. The radio power switches that connect the radio equipment to the d.c. and a.c. buses are switch-type circuit breakers located on the inboard face of the panel and are labeled D.C. POWER-NORMAL and EMERG., and A.C. POWER. The two d.c. radio power switches (switch type circuit breakers labeled NORMAL and EMERG.) located on the radio power panel, are mechanically interlocked by a piece of steel cable so that only one of the switches can be turned on at a time. In order to ensure continuous operation of the public address, interphone, and terrain warning systems, power to these circuits does not pass through the d.c. radio power switches. Instead, a relay connects these circuits directly to the NORMAL power line as long as that line is engaged. If the NORMAL power fails, the relay automatically connects these circuits to the EMERG. power line. Individual d.c. radio equipment circuits are protected by circuit breakers also located on the radio power panel. The panel lights are controlled by a switch that has DIM, OFF, and BRIGHT positions.

4–168D. Two step-down transformers reduce 115 volts a.c. to 26 volts a.c. This lower voltage is then supplied through a two-position switch to the radio navigation instruments. The two-position radio instrument switch, located on the radio power panel, selects excitation voltage from either of the two transformers. One position of the switch is designated NORM. and the other is designated EMERG.

4–168E. All of the radio equipment except the dual T-47/ART-13 transmitters and the dual BC-348 receivers are connected to remote controls located on the pilot's overhead panel and to the radio selector boxes.

4–168F. The major communication and radio navigation equipment that is installed in these airplanes is listed below:

Interphone system for intra-plane communication.

Public address system for general announcements to passengers.

18S-4 HF transmitter-receiver (dual) for long range, two-way voice communication (international configuration only).

RT-18/ARC-1 VHF transmitter-receiver (with either domestic or international crystals) for "line-of-sight" two-way voice communications.

RTA-1B HF transmitter-receiver for long range, two-way voice communications (domestic configuration only).

T-47/ART-13 liaison transmitters (dual) for long range voice, MCW, and CW transmission (international configuration only).

BC-348 liaison receivers (dual) for long range voice, MCW, and CW reception (international configuration only).

MN-62A radio compass receivers for automatic direction finding (dual).

51R-2 VHF navigation receivers for ILS or VOR reception (dual).

51V-1 glide slope receiver.

MN-53B marker beacon receiver for the reception of 75-megacycle marker beacon signals.

ANTENNA DIAGRAM†

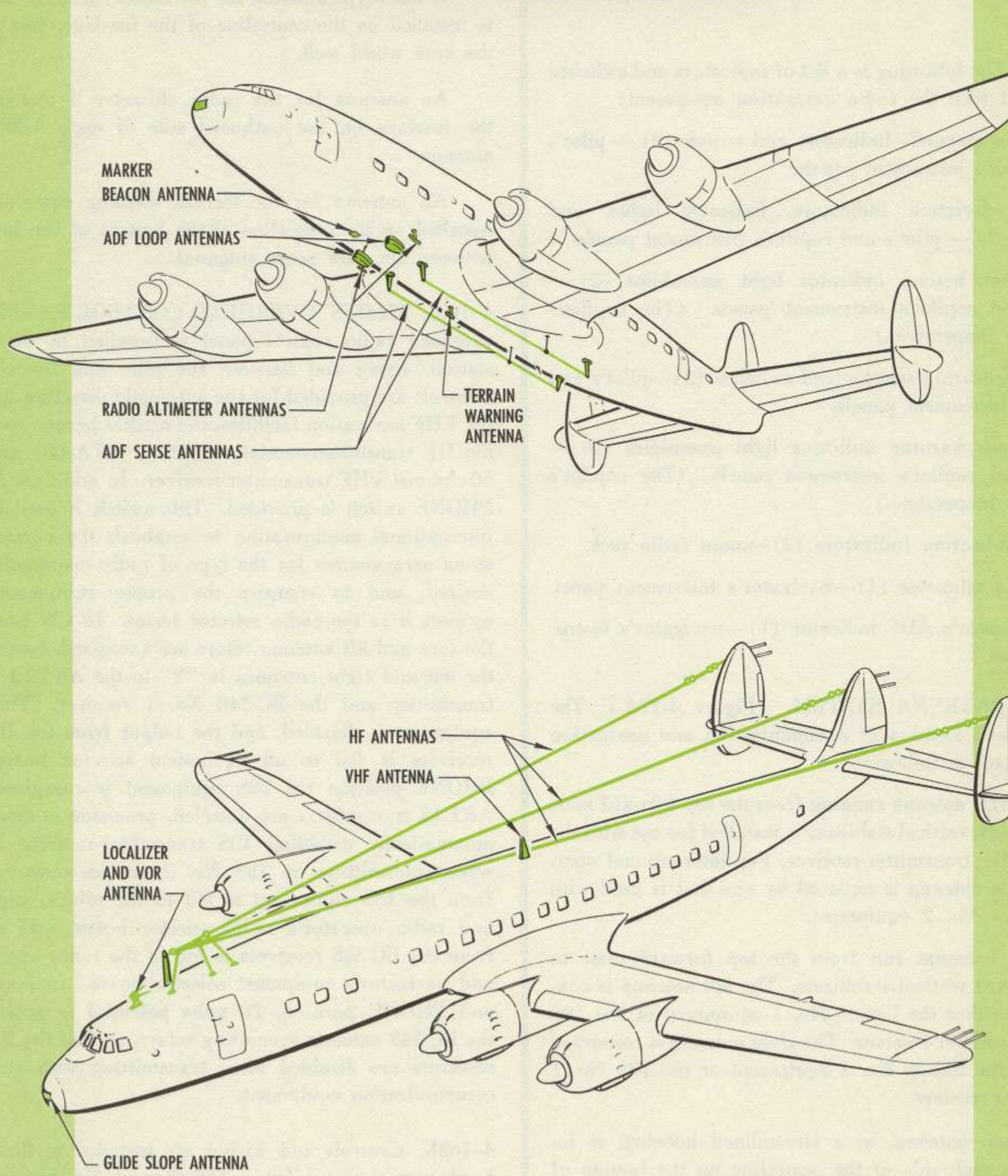


figure 4-27A

TR-XED-13A terrain warning unit with warning lights and warning gong.

AVQ-9 radio altimeter (international configuration only).

4–168G. The following is a list of indicators and switches associated with the radio navigation equipment:

Radio magnetic indicators and switch (2) — pilot's and copilot's instrument panels.

ILS deviation indicators, indicator lights, and switches (2) — pilot's and copilot's instrument panels.

Marker beacon indicator light assemblies (2) — pilot's and copilot's instrument panels. (The copilot's lights are inoperative.)

VOR bearing selector and switches (2)—pilot's and copilot's instrument panels.

Terrain warning indicator light assemblies (2) — pilot's and copilot's instrument panels. (The copilot's lights are inoperative.)

Omni-bearing Indicators (2)—main radio rack.

Radio altimeter (1)—navigator's instrument panel.

Navigator's ADF indicator (1)—navigator's instrument panel.

4–168H. ANTENNA SYSTEM. (Figure 4-27A.) The function and location of communication and navigation antennas are as follows:

A single antenna running from the top forward mast to the middle vertical stabilizer is installed for use with the RTA-1B HF transmitter-receiver. For international operations, this antenna is replaced by one that is used with the liaison No. 2 equipment.

Two antennas run from the top forward mast to the outboard vertical stabilizers. The left antenna is connected to either the liaison No. 1 equipment or the 18S No. 2 transmitter-receiver. The right antenna is connected to either the liaison No. 1 equipment or the 18S No. 1 transmitter-receiver.

A loop antenna, in a streamlined housing, is installed on each side of the centerline on the bottom of the fuselage, aft of the nose wheel well, for the automatic direction finders (ADF).

Two "T" ADF sense antennas are installed on each side of the bottom of the fuselage for the automatic direction finder receivers (ADF).

One antenna for the VOR and localizer equipment is installed on top of the fuselage just aft of the flight station.

A modified folded dipole antenna for the glide slope receivers is installed on the fuselage nose.

A flush-type antenna for the marker beacon receiver is installed on the centerline of the fuselage, just aft of the nose wheel well.

An antenna for the radio altimeter is attached to the fuselage on the outboard side of each ADF loop antenna.

An antenna for the terrain warning equipment is installed on the centerline of the bottom of the fuselage between the ADF sense antennas.

4–168J. PILOTS' OVERHEAD CONTROL PANEL. An overhead radio control panel is installed in the flight station, above and between the pilot and the copilot. Controls are provided for the automatic direction finders, the VHF navigation facilities, the marker beacon receiver, the HF transmitter-receivers (18S or RTA-1B) and the 50-channel VHF transmitter-receiver. In addition, a CW-PHONE switch is provided. This switch is used in the international configuration to establish the correct antenna arrangement for the type of radio communication desired, and to energize the proper equipment and connect it to the radio selector boxes. In CW position, the fore and aft antenna relays are energized, connecting the left and right antennas in "V" to the ART-13 No. 1 transmitter and the BC-348 No. 1 receiver. The 18S equipment is disabled, and the output from the BC-348 receivers is fed to all equipment selector boxes. In PHONE position the 18S equipment is energized, the ART-13 transmitters are disabled, provision is made for automatically disabling 18S transmitter-receiver No. 1 when transmitting on 18S No. 2 or vice-versa, output from the 18S equipment is fed to the pilot's, copilot's, and radio operator's radio selector boxes, and output from the BC-348 receivers is fed to the radio operator's and navigator's equipment selector boxes. In both CW and PHONE position, 28 volts potential is applied to the BC-348 antenna grounding relays, so that the BC-348 receivers are disabled when transmitting with any HF communication equipment.

4–168K. Controls and wiring are installed in the overhead control panel for a 150-channel HF transmitter-receiver. The free ends of wiring connected to the overhead radio control panel for the 150-channel HF equipment are taped and stowed in the radio junction box. In addition, provisions are installed for incorporation of distance measuring equipment.

4–168L. Illumination of the overhead control panel is provided by a floodlight on the center control stand. Intensity of panel back lighting is controlled through

WILL BE SUBMITTED WHEN AVAILABLE

Figure 4-27B — Radio Operator's Station (Domestic Configuration)† rheostats by three knobs placed near the base of the panel. The PANEL knob controls two lights, one adjacent to each ADF function switch. The ADF knob controls three lights, one adjacent to each ADF band change switch and one at the ADF tuning meter. The dial knob controls five lights, at the HF communication, VOR, and VHF communication channel selectors. All of the lights are replaceable from the outside of the control panel.

4–168M. RADIO SELECTOR BOXES. Individual radio selector boxes, together with microphones, and headphones, are provided for the pilot, copilot and radio operator. On airplanes equipped for international operation, the navigator is also provided with a radio selector box. The flight engineer is provided with a microphone-headphone jack box located just below the engine instrument panel. Each of the radio selector boxes has nine toggle switches for selection of aural reception from the ADF receivers, the marker beacon receivers, the VHF navigation receivers, the interphone system, H-F receivers, and the VHF communication receiver. The switches are on when in the up position. A control knob labeled INCREASE OUTPUT may be turned clockwise to adjust the volume of the selected receiver. The MICROPHONE switch is used to connect the microphone to the HF No. 1 transmitter, the HF No. 2 transmitter, the VHF COMMAND transmitter, the interphone system, or the cabin attendants' call system. The CALL position of the microphone selector switch is spring-loaded and is connected through the CALL positions on the other selector boxes to the headsets. When any one microphone selector switch is at the INTER (interphone) position, it is impossible to make transmissions to stations other than those connected to the interphone system. The filter switch has RANGE, VOICE, and NORMAL positions which make it possible to hear range signals only, voice only, or a combination of both from the radio receivers to which it is connected. A toggle switch with NORMAL and AUXILIARY positions is located on the underside of each radio selector box so that if the separate isolation amplifier fails, it can be by-passed by moving the switch to the AUXILIARY position. 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.

4–168N. INTERPHONE SYSTEM. The interphone system consists of modified and combined AN/AIC-3 and AN/AIC-2 systems. The AN/AIC-3 system includes the A-439 radio selector boxes and associated jack boxes, installed at the pilot's, copilot's, radio operator's and navigator's stations. The AN/AIC-2 or "mechanic's" system includes an AM-26AIC interphone amplifier, an RE-31/U relay, the cabin attendant's interphone jack, the flight engineer's jack box, and five mechanic's jack boxes. Power for the interphone system is supplied through three d.c. circuit breakers on the radio power panel.

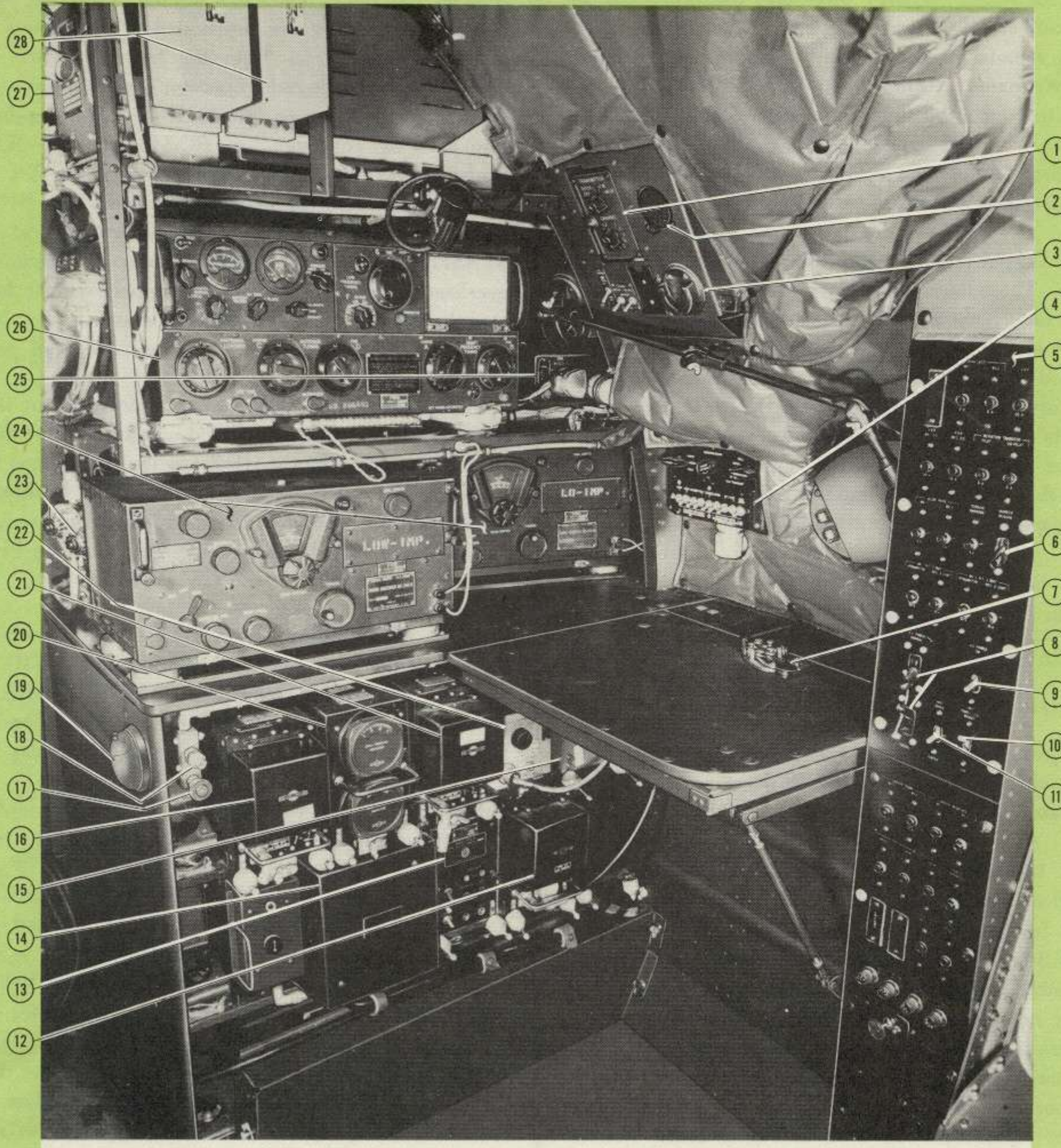
4–168P. The microphone switch alternately selects any one of the radio transmitters or connects the microphone to the interphone bus or to the call bus when the microphone button is depressed. The microphone button operates a relay within the radio selector box which grounds the amplifier input and furnishes sidetone to the headset. Should a radio selector box amplifier fail, the unit is so arranged that the attenuating resistors and the amplifier can be by-passed. A toggle switch at the base of the panel diverts the signal around the amplifier for auxiliary operation. In this case, the audio input is selected by placing the toggle switch for the desired receiver up and placing all those toggle switches to the left down. Only one position is usable at a time when the switch is in the AUXILIARY position, the furthermost left switch taking precedence.

4–168Q. Communication between any stations in the AN/AIC-2 system is possible at all times, provided that headsets and microphones are plugged in and the d.c. bus is energized. Operating the microphone button on AN/AIC-2 microphone energizes a relay that connects the AN/AIC-2 amplifier output to the AN/AIC-3 interphone bus, thus enabling communications with all interphone stations. With the relay de-energized, the AN/AIC-3 interphone and call buses are connected to the AN/AIC-2 amplifier input. In the AN–AIC-2 system, only the flight engineer's and cabin attendant's stations are equipped with CALL buttons. When a CALL button is depressed, the AN/AIC-3 interphone and call buses are connected together. Thus, only AN/AIC-3 stations, the cabin attendant and the flight engineer are able to CALL an AN/AIC-3 station, while direct connection to any AN/AIC-2 station can be made from any interphone box.

4–168R. PUBLIC ADDRESS SYSTEM. The public address system includes the public address amplifier, 15 loud speakers, a microphone and a switch at the cabin attendant's station, and two public address jacks and a handset in the flight station.

4–168S. The public address amplifier is energized from the radio power panel when the a.c. and d.c. radio

RADIO OPERATOR'S STATION† (INTERNATIONAL CONFIGURATION)



1. T-47/ART-13 transmitter remote controls
2. Clock
3. Microphone holder
4. Radio selector box
5. Radio control panel
6. Marker beacon circuit breaker switch
7. Telegraph key
8. D. C. radio power switches
9. A. C. radio power switch
10. Radio panel lights switch
11. Radio instruments power switch
12. 51V-1 glide slope receiver
13. Public address amplifier
14. RT-18/ARC-1 VHF transmitter-receiver
15. MN-53B marker beacon receiver
16. 51R-2 VHF navigation receiver
17. Supplemental oxygen outlet
18. Protective oxygen outlet
19. Ash receptacle
20. VOR accessory unit
21. VOR receiver
22. Interphone amplifier
23. Oxygen regulators
24. BC-348 receivers
25. DY-17/ART-13 dynamotor
26. T-47/ART-13 transmitter
27. Automatic pilot amplifier and signal generator
28. MN-89A amplifier

figure 4-27C

power switches are on. The front panel of the amplifier has two separate volume controls. One volume control adjusts the flight (HIGH) level and the other adjusts the ground (LOW) level. The choice between these two levels is remotely controlled by a switch on the cabin attendant's panel. Audio input to the amplifier is received either from the microphone at the cabin attendant's station or from the handset in the flight station. When the handset microphone is used, sidetone is returned to the handset headphone.

4–168T. Output from the amplifier is applied to 15 loudspeakers. These loudspeakers are connected in a parallel-series arrangement so that the output impedance of the amplifier is correctly matched. Ten of these loudspeakers are placed in line at intervals of about five feet, recessed in the overhead duct throughout the passenger compartments and the galley. One loudspeaker is in the overhead duct in the lounge, and four are recessed in the hat racks at the aft end of the main passenger compartments. The loudspeakers are behind plastic grills.

4–168U. OPERATION. To place the public address system in operation:

a. Turn on the d.c. and a.c. radio power switches.

b. Plug in the handset.

c. Adjust the volume to the flight or ground level by the public address HIGH-LOW level switch located on the cabin attendant's call box.

4–168V. 18S-4 H-F TRANSMITTER-RECEIVERS. Two independent Collins 18S-4 H-F transmitter-receivers are installed for radio-telephone operation in the frequency range of 2 to 18.5 megacycles on any one of ten separate crystal-controlled channels. By use of two frequencies, generally not more than 1% apart in each channel, the equipment is capable of operation on as many as twenty frequencies in the ten channels numbered from 1 to 10. A two-position, A-B, switch selects one or the other frequency where two are used in one channel. Where only a single frequency is used, it normally will be placed in the A position. The frequencies available are shown on the placard on the overhead panel. The frequency complement of the two 18S transmitter-receivers is identical.

4–168W. A PHONE-CW transfer switch is located in the center portion of the pilots' overhead panel. In PHONE position, the two 18S H-F transmitter-receivers are energized and the two ART-13 transmitters are inoperative. In the CW position, the ART-13 transmitters are energized and the transmitter sections of the two 18S H-F transmitter-receivers are inoperative. The BC-348 receivers operate at all times, regardless of transfer switch position (CW or PHONE), and may be heard at any time at the radio operator's station when the switches of his selector box are positioned at HF 2-way No. 1 or HF 2-way No. 2. With the transfer switch in the CW position and the radio operator's selector box switches on No. 1 HF 2-way or No. 2 HF 2-way, the pilots can also hear the corresponding BC-348 receiver. With the transfer switch in the PHONE position, the No. 1 18S transmitter-receiver is operated by means of a HF 2-way channel selector, A & B crystal selector, and a HF SENSITIVITY control on the lower left side of the overhead panel. The No. 2 transmitter-receiver is operated by the No. 2 controls (the same as for No. 1) on the lower right side of the pilots' overhead panel.

4–168X. Microphone and audio connections for the 18S transmitter-receivers are selected on the pilot's or copilot's radio selector box by the HF 2-way No. 1 positions for the primary unit, and the HF 2-way No. 2 positions for the back-up unit. The audio connections are transferred automatically to the BC-348 receivers when the PHONE-CW switch is moved to the CW position.

4–168Y. Audio output of the 18S transmitter-receivers is selected at the radio operator's station on the VHF range positions of the radio selector box. VHF RANGE No. 1 position provides audio from HF 2-way No. 1 and VHF RANGE No. 2 provides audio from the HF 2-way No. 2.

4–168Z. An emergency PHONE-CW switch is located in the radio junction box, to permit by-passing the overhead panel transfer switch in the event of PHONE-CW switch failure. Each switch has NORMAL and EMERGENCY positions, and both switches should be safetied in the NORMAL position. When the PHONE switch is moved to the EMERGENCY position, the No. 1 18S HF 2-way equipment is energized regardless of the transfer switch position, and the No. 2 ART-13 is interrupted. The CW switch, in the EMERGENCY position, interrupts the No. 2 18S and energizes the No. 1 ART-13, regardless of the transfer switch position. Use of the EMERGENCY position of either switch can result in damage to the No. 2 equipments. Therefore, it should be used only in a true emergency.

4–168AA. Relays are installed to prevent transmission from one transmitter-receiver when another is transmitting. The first transmitter operated, whether No. 1 or No. 2, locks out the other until the first microphone button is released.

4–168AB. OPERATION. To place the 18S transmitter-receivers in operation:

a. Turn on the d.c. radio power switch.

WILL BE SUBMITTED WHEN AVAILABLE

Figure 4-27D — Navigator's Station (International Configuration)†

b. Turn the transfer switch located on the pilots' overhead panel to PHONE.

c. Turn the HF COMM-1 or HF COMM-2 channel selector to the desired channel.

d. Turn the microphone selector switch to HF NO. 1 or HF NO. 2.

e. Turn on the HF 2-way NO. 1 or NO. 2 receiver selector switch.

4–168AC. RT-18/ARC-1 VHF TRANSMITTER-RECEIVER. A VHF transmitter-receiver, modified to utilize a maximum of 50 channels, is installed on the second shelf of the radio operator's rack. The unit is remotely controlled from the pilot's overhead panel. Reception or transmission on the set may be accomplished from any A-439 equipment selector box after the frequency and sensitivity are correctly adjusted on the pilots' overhead panel.

4–168AD. The RT-18/ARC-1 unit (TWA 58080) for domestic operation uses "domestic" crystals and includes a DMDFX-410 dynamotor. It is identified by "F-1" stenciled on the test panel. The RT-18/ARC-1 unit (TWA 58081) for international operation uses "international" crystals and includes a DY-9( )/ARC-1 dynamotor. It is identified by "F-2" stenciled on the test panel.

4–168AE. OPERATION. To place the RT-18/ARC-1 transmitter-receiver in operation:

a. Turn on the d.c. radio power switch.

b. Turn the VHF COMM turret control on the pilots' overhead panel to the desired frequency and adjust sensitivity as required.

c. Turn the microphone selector switch to VHF COMMAND.

d. Turn on the VHF COMM receiver selector switch.

4–168AF. RTA-1B HF TRANSMITTER-RECEIVER. The RTA-1B transmitter-receiver operates within the frequency range of 2500 to 13,000 kilocycles on any of ten fixed crystal-controlled channels. It is used only for domestic flights. The equipment is remotely controlled from the pilots' overhead radio HF No. 1 control when the CW-PHONE switch is in the "PHONE" position. Automatic channel switching is provided by an electrically-actuated turret assembly which is common to both the transmitter and receiver sections. Transmitter-receiver switching is accomplished by operating the PRESS-TO-TALK button on a microphone.

CAUTION

Never shift frequency without releasing the microphone button. Failure to observe this precaution will result in serious damage to the turret contacts and the transmitter tubes.

4–168AG. For domestic operation with the basic international configuration an RTA-1B transmitter-receiver can be substituted for the 18S-4 No. 1 transmitter-receiver. The 18S-4 mount may be used with the RTA-1B transmitter-receiver.

4–168AH. OPERATION. To place the RTA-1B transmitter in operation:

a. Turn on the d.c. radio power switch.

b. Turn the PHONE-CW switch to PHONE.

c. Turn the HF COMM-1 channel selector to the desired channel.

d. Turn the microphone selector switch to HF No. 1.

e. Turn on the HF 2-way No. 1 receiver selector switch.

4–168AJ. T-47/ART-13 COMMUNICATION TRANSMITTERS. The No. 1 T-47/ART-13 transmitter is on the main radio rack and the No. 2 T-47/ART-13 transmitter is on the auxiliary radio rack, when the airplane is used for international operation. These transmitters are used in conjunction with the BC-348 receivers for long range voice, MCW, and CW communication. The transmitter channels are selected by the radio operator. The No. 1 transmitter is controlled directly, and a C-87/ART-13 remote control unit is provided on the radio operator's control panel for the No. 2 transmitter. When the CW-PHONE switch on the pilots' overhead radio control panel is at "CW," either the radio operator or the navigator may transmit over the T-47/ART-13 transmitters. A key selector switch on the radio operator's control panel connects the radio operator's key to either the No. 1 or the No. 2 transmitter. All power leads to the T-47/ART-13 transmitters are routed through the corresponding DY-17/ART-13 dynamotor mounted near the transmitters.

4–168AK. The nominal frequency range of the T-47/ART-13 transmitters is from 200 to 1500 kc and from 2000 to 18,100 kc on 10 HF and 1 LF crystal-controlled channels. When the No. 1 transmitter is used for low frequency operation, the 180H-1 loading coil is connected between the transmitter and the antenna. The left and right antennas are connected in "V" to the No. 1 transmitter and the center antenna is connected directly to the No. 2 transmitter. Since the "V" antenna arrangement

WILL BE SUBMITTED WHEN AVAILABLE

Figure 4-27E — Auxiliary Radio Rack (International Configuration)†

†LAC Serials 4015–4024

offers the greater loading, the No. 1 transmitter is used for lower frequency channels than is the No. 2 transmitter.

4–168AL. In normal operation the T-47/ART-13 output may be heard through the HF audio system at any radio selector box. The transmitter side tone is connected directly to the HF audio interphone line by a NORMAL-MONITOR switch on the radio operator's control panel when the switch is in NORMAL position. However, when the switch is on MONITOR, the transmitter can be heard only through its corresponding liaison receiver. This enables accurate tuning (zero-heating) and adjustment of the transmitter to be made using the BC-348 receivers.

4–168AM. OPERATION. The transmitters are turned on and controlled by the radio operator. To place the T-47/ART-13 transmitters in operation:

a. Turn on the d.c. radio power switch.

b. Turn the PHONE-CW switch to CW.

c. Turn on the HF 2-way No. 1 or No. 2 receiver selector switch.

4–168AN. BC-348 RECEIVERS. Two BC-348 receivers are mounted on the fourth shelf of the main radio rack for international operations. The inboard receiver is the No. 1 and the outboard receiver is the "Liaison." These radio receivers are controlled by the radio operator and cover frequency ranges from 200–500 kilocycles and 1.5 to 18.0 megacycles.

4–168AP. Each receiver is capable of CW, MCW, and Voice reception. Either manual or automatic volume control may be selected by a switch on the front panel; likewise, normal or extreme selectivity is provided by means of an "i-f" crystal filter that may be switched in or out of the circuit as desired. The dial side is calibrated in six frequency ranges and any one range may be selected by means of the BAND SWITCH.

4–168AQ. When the liaison transmitter is turned on (either by pressing the telegraph key or the microphone button), a keying relay removes the liaison antenna from the liaison receiver and connects it to the liaison transmitter. Simultaneously, the liaison receiver input circuit is grounded by another contact of the keying relay. This fully protects the liaison receiver from the liaison transmitter. The same action occurs in the command transmitter which, when keyed, protects the command receiver.

4–168AR. OPERATION. To place the BC-348 receivers in operation:

a. Turn on the d.c. radio power switch.

b. Turn the AVC-OFF-MVC switch to AVC or MVC.

c. Turn the OFF-CW.OSC.-ON switch to ON.

d. Turn the crystal switch to IN.

e. Turn the BAND SWITCH to the desired frequency range and tune the station by using the tuning crank and the volume control.

4–168AS. MN-62A AUTOMATIC DIRECTION FINDER. The ADF system is used as a navigational aid and for aural reception of low-frequency CW and modulated radio signals. The system consists of a superheterodyne receiver with additional circuits necessary for automatic radio compass operation, a motor-driven rotatable loop antenna, a non-directional antenna, a bearing indicator system, and remote control facilities. A.C. and d.c. power for the system are supplied through circuit breakers on the radio power panel. Three types of operation are provided. These are designated ADF, ANT, and LOOP on the pilot's overhead radio control panel. With ADF operation, the loop antenna automatically seeks the direction of the selected station, and this bearing information is exhibited on the radio magnetic indicators. Simultaneously, aural reception over the selected frequency is available using the sense antenna. With ANT operation, aural reception using only the sense antenna is provided. With LOOP operation, the rotation of the loop is controlled from the overhead radio control panel, and the loop may be used for aural reception or null directional indications. The two radio compass receivers are in the main radio rack. Each receiver has a frequency range from 100 to 1750 kc.

4–168AT. Two separate and independent ADF systems are provided. These are designated RED (ADF No. 1) and GREEN (ADF No. 2). The antennas are on the bottom of the fuselage and the receivers are shock mounted on the lower shelf of the main radio rack. The two radio magnetic indicators are on the pilots' instrument panel. Both systems are remotely controlled from the pilots' overhead radio control panel. In addition, in the international configuration, the navigator can remotely control the green ADF system.

4–168AU. All remote controls to the ADF receiver are electrically actuated with the exception of the tuning cranks. The tuning cranks are coupled to the ganged tuning capacitors in the receiver by a flexible shaft. In the domestic configuration all remote controls are on the pilots' overhead radio control panel. In addition, in the international configuration, a remote control unit is installed at the navigator's station.

4–168AV. The band change switch selects frequency coverage 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

The volume control is concentric with the band change switch.

4–168AW. The function switch selects the type of operation (ADF, LOOP, or ANT), and in the green system operates the control transfer relay. The function switch is spring-loaded in the transfer (TFR) position. In the green system, after either the copilot or the navigator has obtained control of the system by momentarily placing the function switch at the TFR position, the green TFR light beside the function switch glows. Rotation of the loop antenna can be controlled by the operator when the function switch is turned to LOOP. The LOOP switch rotates the antenna clockwise or counter-clockwise at either of two speeds. Direction and speed of rotation are determined by the displacement of the LOOP switch from its neutral position. Rotation speed increases as the switch is moved away from neutral. The BFO switch, adjacent to the function switch, controls the type of reception. When BFO is ON, the system receives CW signals in addition to modulated signals. The tuning meter, adjacent to the green band change switch, may be alternately connected to either the green or red system.

4–168AX. The audio output from the ADF receivers may be heard at the A-439 radio selector boxes (AIC-3 interphone system). Four range filters are provided, one for each radio selector box. These filters can bring out either the range or voice components of the signals received as individually selected at each AIC-3 station.

4–168AY. Two radio magnetic indicators, one on the pilot's and one on the copilot's side of the instrument panel, are provided. The two pointers on each indicator repeat the bearings of the loop antennas with respect to the airplane heading. Rotating compass cards on the radio magnetic indicators repeat magnetic heading information alternately from either the pilot's or the copilot's master direction indicator, as controlled by the Flux Gate selector switch on the pilot's side of the instrument panel. The servo motors which drive the rotating cards on the radio magnetic indicators are coupled to the master direction indicators through Bendix type MN-89A servo-amplifiers. The two servo-amplifiers are on the sixth shelf in the radio rack. The rotating compass cards enable radio bearing information to be exhibited against a stabilized azimuth regardless of aircraft heading. The RMI pointer switches on the pilot instrument panel alternately connect the red RMI pointer to either the ADF No. 1 loop or the VOR No. 1 system, and the green RMI pointer to either the ADF No. 2 loop or the VOR No. 2 system.

4–168AZ. An autosyn transmitter, geared through the compensator unit to the rotatable loop, provides loop-position information, corrected for quadrantal error, to the remote indicator system. Operation of the loop is automatic when the radio compass function switch is at ADF. When the function switch is at LOOP, the loop drive-motor is controlled from the pilot's overhead radio control panel or from the navigator's remote control unit. Whenever the compass is in operation with the loop stationary, a damping current is automatically applied to the loop drive-motor to prevent loop rotation by vibration or other outside influences.

4–168BA. OPERATION. To place the MN-62A receivers in operation:

a. Turn on the d.c. and a.c. radio power switches.

b. Move the function switches located on the pilots' overhead panel from the OFF position to the desired type of operation (ADF, ANT, LOOP, or TFR).

c. Rotate the frequency band-selectors to the desired frequency bands.

d. Tune in the desired station with the tuning control. Tune each receiver for maximum strength as indicated by the tuning meter located between the two frequency band-selector switches. Move the tuning meter selector switch in the necessary direction before attempting to tune a receiver.

e. For aural reception, move the selector switches on the radio selector box to the desired receiver and type of reception.

f. Adjust volume with the volume controls.

4–168BB. 51R-2 VHF NAVIGATION SYSTEM. The visual omni-range system (VOR) as installed in the airplane for navigation requirements provides facilities for reception of all range, localizer, and voice signals in the VHF spectrum between 108.0 and 121.9 megacycles. In addition, some voice signals may be received with reduced efficiency up to 135.9 megacycles. Since the operating range of the VOR station is limited to line of sight, good coverage extends to approximately 140 miles from a station at an altitude of 10,000 feet, with correspondingly increased or decreased ranges as the altitude is raised or lowered.

4–168BC. The two receivers for the dual VOR systems are on the third shelf in the radio rack. D.C. power for the receivers is obtained through 10-ampere circuit breakers on the radio power panel, and a.c. power is obtained through 2-ampere fuses on the same panel. The receivers are remotely controlled from switches on the pilots' overhead control panel. As various frequencies are selected, the receiver is automatically adjusted to receive the type of signal transmitted on that channel.

4–168BD. The accessory unit for the VOR system is located between the VOR receivers. The omni-bearing indicators, which are on the face of the VOR accessory box in the radio rack, are not commonly used in radio navigation, and therefore are not located with other VOR instruments on the pilots' instrument panels. Rotating cards on the omni-bearing indicators are operated by the appropriate VOR system. The VOR No. 1 system controls the upper indicator and the VOR No. 2 system controls the lower indicator. Magnetic headings from the VOR stations are indicated by the degree markings on the omni-bearing indicators. These indicators primarily act as "master" indicators from which VOR information is repeated to the other VOR instruments.

4–168BE. Two omni-bearing indicators, two omni-bearing selectors, and two deviation indicators comprise the VOR instrumentation. In addition, the pointers of the radio magnetic indicators may be operated interchangeably from either the ADF or VOR systems, as described in paragraph 4–168BH.

4–168BF. The deviation indicators exhibit information from both the glide slope receivers and the VOR receivers. One deviation indicator is on the pilot's side and a second is on the copilot's side of the instrument panel. When used exclusively with the VOR system, the vertical pointer deflects if the airplane course differs from the radial set on the omni-bearing selector. When the airplane course agrees with the radial set of the omni bearing selector, the vertical pointer is aligned with the vertical mark at the center of the dial. When the deviation indicator is used with the instrument landing system, the horizontal pointer indicates deviations from the glide path, and the vertical (or localizer) pointer indicates lateral deviation. Flag markers on the deviation indicator warn when the strengths of the glide slope or localizer signals are below an intelligible level. The pointers on the deviation indicators may be operated independently by either of the VOR systems, as selected by the pilot or the copilot. A deviation indicator switch assembly is located directly beneath each deviation indicator.

4–168BG. The omni bearing selector for the VOR No. 1 system is on the pilot's left instrument panel and the omni-bearing selector for the VOR No. 2 system is on the copilot's right instrument panel. Any magnetic course may be set on the omni-bearing selector in whole degrees, measured to or from a VOR station. The flag marker on the selector indicates whether the airplane is heading TO or FROM the station. The vertical pointer on the deviation indicator accurately shows whether the airplane is on course. The flag marker on the omni-bearing selector can be used as a station marker. The flag indicates TO until the station is reached and switches to FROM as the station is passed. When the strength of either the reference or variable signal falls a safe level, the flag moves to a neutral position.

4–168BH. Remote control of the VOR systems is provided by facilities on the pilots' overhead control panel. Frequency selector and volume controls enable the pilot to select any one of 280 channels. However, since a communication antenna is not provided, only those channels between 108.0 and 121.9 mc may actually be received efficiently. The TONE-PHASE localizer switch should remain in the TONE position since phase modulated localizer transmission is not available. When a localizer channel is selected, the appropriate glide path receiver is automatically tuned to its corresponding channel. Switches on the pilots' instrument panel enable the red pointers of the radio magnetic indicators to be connected to the VOR No. 1 system, and the green pointers to be connected to the VOR No. 2 system. Additional switches on the pilots' instrument panel connect the deviation indicators alternately to either VOR No. 1 or VOR No. 2 system.

4–168BJ. OPERATION. To place the 51R-2 receivers in operation:

a. Turn on the d.c. radio power switch, instrument switch, and a.c. power switch.

b. Turn on either, or both, receivers by rotating the VOL switch on each frequency selector switch labeled VOR-1 and VOR-2 in a clockwise direction.

c. Select the desired frequency by rotating the concentric knobs until the correct frequency numbers appear in the vertical windows.

d. Turn the RMI No. 1 and RMI No. 2 selector switches to the VOR positions.

e. Set the desired heading on the omni-bearing selector.

4–168BK. 51V-1 GLIDE SLOPE RECEIVER. A glide slope receiver is on the second shelf in the radio operator's rack. Space provision and wiring are included for future installation of a second glide slope receiver. The glide slope receiver detects 90–150 cycles per second tone-modulated signals in the UHF range between 329 and 335 megacycles, and is used in conjunction with the VHF navigation system during instrument landings. The horizontal pointers on the deviation indicators are controlled by the glide slope receiver. The glide slope receiver is energized and automatically tuned when an ILS channel is selected with the No. 1 VHF navigation channel selector switch. D.C. power for the glide slope receiver is supplied through a 5-ampere circuit breaker on the radio power panel.

4–168BL. MN-53B MARKER BEACON RECEIVER. The marker beacon receiver is mounted on the third shelf in the main radio rack. It is a single-channel, crystal-controlled super-heterodyne receiver used to detect 75-megacycle marker signals modulated with either a 400, a 1300, or a 3000 cycle tone. The receiver output is available at any of the radio selector boxes. A portion of the audio output is filtered and supplied to indicator lights located on the pilot's and copilot's instrument panels. A different colored indicator light glows for each modulation frequency.

4–168BM. The marker receiver uses d.c. power supplied through a circuit breaker on the radio power panel. There is no ON-OFF control. The receiver is normally in operation when the d.c. bus is energized. The receiver operates on only one channel, to which it is preset, and no tuning controls are required. The only marker receiver controls are the HI-LO sensitivity switch on the pilots' overhead panel and the marker beacon selector switches on the radio selector boxes.

4–168BN. Two sets of indicator lights for the marker receiver are provided. These are on the left and right sides of the pilots' instrument panel. However, the indicator lights on the right (copilot's) side are not connected to the receiver. A different colored light goes on in response to each different tone. The lights also blink in accordance with the coding of the signal modulation. The relationships of the marker types, tones, and lights are given in the table below.

Visual Identification (Color of Indicator Lamp)	*Aural Indentification (Tone in Headset)*	*Type of Marker*
White	3000 cps steady tone	Airways (marker)
White (on-off in dashes)	3000 cps dashed tone	Airways (fan-marker)
Amber (on-off in dots)	1300 cps dotted tone	Inner marker (instrument landing system)
Blue (on-off in dashes)	400 cps dashed tone	Outer marker (instrument landing system)

4–168BP. OPERATION. To place the MN-53B marker beacon receiver in operation:

a. Turn on the d.c. radio power switch.

b. Check that the marker beacon switch-type circuit breaker is on.

c. Turn on the marker beacon receiver selector switch.

d. Turn the marker receiver selector switch to HI or LO.

4–168BQ. TRXED-13A TERRAIN WARNING. The terrain warning system provides the pilot with visual warning indications by means of orange, yellow, and red lights when the terrain clearance is less than 2000 feet, 1000 feet, or 500 feet, depending upon the selection. A warning gong also operates in conjunction with the colored warning lights.

4–168BR. The pilot's indicating system is located on the pilot's auxiliary instrument panel and consists of three different colored lights to indicate the three ranges, a toggle switch for range selection, and a push button test switch. The test switch permits the receiver to operate on any range from the transmitted pulse. Lights are also installed on the copilot's auxiliary instrument panel but they are inoperative.

4–168BS. When the system is operated in the 2000 feet range, the orange indicator lights glow when the aircraft is below 2000 feet absolute altitude. The yellow indicator light operates on the 1000 feet range and the red indicator light operates on the 500 feet range.

4–168BT. The warning gong is wired into the indicator light circuit and gives an aural indication each time a light glows. The terrain warning indicator cannot be operated concurrently with the AVQ-9 radio altimeter; a selector switch located on the pilot's side of the instrument panel permits operation of one or the other. A light on the pilot's auxiliary instrument panel indicates when the terrain warning unit is energized.

4–168BU. OPERATION. To place the terrain warning system in operation:

a. Turn on the a.c. and d.c. power switches.

b. Turn the terrain warning-radio altimeter selector switch to TERRAIN WARN.

c. Turn the range selector switch to the desired range.

4–168BV. AVQ-9 RADIO ALTIMETER. The AVQ-9 altimeter is a high altitude radio altimeter with a nominal range of 0–40,000 feet. The equipment functions to indicate the height of the aircraft above the terrain. The transmitting antenna sends the signals generated by the transmitter earthward. When the signals reach the earth, they are reflected and picked up by the receiving antenna. The travel time of the signals is proportional to altitude and the receiver converts the returned signals to a form suitable for operating the indicator. Two indications (lobes) always appear on the indicator cathode-ray tube; one indication appears at zero when a signal is transmitted and another when the signal is reflected from the earth's surface and picked up by the receiving antenna. The reflected lobe will be indicated at a point (on the indicator scale) which represents the distance above the earth. A terrain warning or radio altimeter selector switch is located on the pilot's side panel to prevent simultaneous operation and consequent interference of the two radar systems. The switch positions are labeled TERRAIN WARN. and AVQ ALT.

4–168BW. OPERATION. To place the radio altimeter in operation:

a. Turn on the a.c. radio power switch.

b. Turn the terrain warning-radio altimeter selector switch to AVQ ALT.

c. Turn the OFF-ON-REC. GAIN switch to ON and continue turning the knob clockwise to adjust the height of the lobes.

d. Adjust the size of the circle with the CIRCLE SIZE control knob.

e. Move the side toggle switch to the TIMES TEN or TIMES ONE position, depending upon whether the airplane altitude is above or below 5000 feet.

f. Adjust the reference indicator lobe to the zero position of the indicator dial by turning either the TIMES TEN ZERO ADJ. knob or the TIMES ONE ZERO ADJ. knob, whichever agrees with the position of the side toggle switch.

4–169. LIGHTING EQUIPMENT

4–170. EXTERIOR LIGHTS. The exterior position lights consist of the conventional wing tip, fuselage, and tail lights. Two toggle switches on the NAVIGATION LIGHTS section of the pilot's side panel control all of the position lights. The left switch is labeled with three-positions: FLASH, OFF, and STEADY. When the switch is placed on 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 on the STEADY position, the wing tip lights, and the white tail light burn steadily. To the right of the position lights switch is a toggle switch labeled FUS LT. When this switch is placed in the NORMAL position, both of the fuselage lights will operate in the manner selected by the position lights switch. With this switch in the OFF position, the fuselage lights are inoperative. When the FUS LT. switch is placed in the GROUND LOADING position the top lights will be out and the bottom fuselage light will burn steadily regardless of the position of the main switch. An amber warning light adjacent to the FUS LT. switch will glow when the FUS LT. switch is on the GROUND LOADING position. A white, leading edge, ice detector light is installed on each side of the fuselage sidewall. The lights, which are controlled by a switch on the pilot's side panel labeled LEADING EDGE LTS, are used to illuminate the leading edge of the outer wing panels for the purpose of detecting the formation of ice.

4–171. On LAC Serials 4001 through 4014, two retractable, 600-watt, landing lights are installed in the lower surface of each outer wing panel. Each light is controlled by a single, three-position, toggle switch, (11, 12, fig. 1-18) installed on the center control stand. The landing light switches are labeled with three-positions: ON, OFF, and RETRACT. When the switches are placed in the ON position, the lights will light and extend. The lights can be turned off while in the fully extended position by placing the control switches on the OFF position. The lights are retracted by placing the control switches on the RETRACT position. The lights may or may not remain lighted during retraction, but if they do they will be automatically turned off as they reach the fully retracted position.

4–171A. On LAC Serials 4015 through 4024, two 600-watt landing lights are installed in the lower surface of each outer wing panel. The lights are controlled by switches on the pilots' overhead panel. A switch (34, fig. 1-14) for each light, labeled LAMP ON and OFF, turns the light on or off and another switch (35, fig. 1-14) for each light, labeled, 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.

4–172. A white, 450-watt, taxi light is installed in a plexiglass housing in the nose of the fuselage. On LAC Serials 4001 through 4014, the light is controlled by a switch (13, fig. 1-18), on the center control stand labeled NOSE LIGHT. On LAC Serials 4015 through 4024, the taxi light is controlled by the PASSING LIGHTS switch (7, fig. 1-22A), when it is placed in the WHITE or OFF position.

4–173. 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. On LAC Serials 4001 through 4014, the light is controlled by a toggle switch on the pilot's side panel labeled PASSING LIGHT. On LAC Serials 4015 through 4024 the light is controlled by the PASSING LIGHTS switch (7, fig. 1-22A), when it is placed in the RED or OFF position.

4–174. White dome lights are installed at the top of each wheel well to illuminate all three wheel wells when the landing gear is extended and the navigation lights are on.

4–175. INTERIOR LIGHTING.

4–176. FLIGHT STATION. The flight instrument panels are provided with direct, indirect*, red and white lighting. Direct red lighting is supplied by small, red, incandescent lights installed along the lower edge of the glare shield. Rheostats, which turn on and control the intensity of these lights, are located on the DIRECT LIGHTS CONTROL panel mounted under the glare shield in front of the center instrument panel. The rheostats are labeled PILOT RED and COPILOT RED. Emergency, white instrument panel lighting is provided by two white incandescent lights (also installed under the glare shield) in front of the center instrument panel. These lights are controlled by a rheostat labeled EMER WHITE, installed on the DIRECT LIGHTS CONTROL panel. The emergency white lights can be turned on at any time, regardless of the position of the battery switch.

4–177. On LAC Serials 4001 through 4014 indirect panel lighting is supplied by white incandescent lights installed behind the instrument panels. The indirect lights are turned on by two toggle switches, on the pilot's switch panel, labeled INDIRECT INSTRUMENT LIGHTS. When the left toggle switch is placed on NORMAL, small white lights behind the instrument panels are turned on, the intensity of which can be controlled by two rheostats located below the pilot's switch panel and one rheostat located below the copilot's switch panel. When the right toggle switch is placed on the BRIGHT position, larger lights behind the instrument panels are turned on, providing white light at full intensity to the instruments. No rheostats are provided for the lights controlled by the right toggle switch.

4–177A.† A light controlled by a two position toggle switch on the copilot's side panel labeled, PEDESTAL REAR LT., (5, fig. 1-37A), illuminates the area between the pilots' seats aft of the center control stand.

4–178. The pilot's and copilot's side panels, and the overhead panels are provided with plastic edge lighting. Lights, surrounded with a red filter, are placed within a sheet of transparent plastic. The light issues from within the plastic panel, producing red illumination of the necessary markings to indicate the required control positions. Toggle switches controlling the lights within the switch panels are labeled PANEL LIGHTS and are installed at the forward end of each switch panel. The lights in the overhead switch panel are controlled by a rheostat (7, fig. 1-14) with an OFF position, installed on the panel and labeled PANEL LIGHTS.

4–179. The pilot's and copilot's radio selector boxes are illuminated by small red flood lights installed directly above each box. The lights contain integral switches that can be rotated continuously in either direction to turn ON or OFF. The ELECTRO-PNEUMATIC DE-ICER PANEL to the left of the pilot is also illuminated by direct red incandescent flood lights with integral switches.

4–180. Spot lights (8, fig. 1-14) with removable red lens covers are installed in snap-on bases on each side of the overhead panel. The left hand light is controlled by a toggle switch labeled CHART LIGHT on the pilot's switch console, and the right hand light is controlled by a toggle switch similarly labeled on the copilot's switch panel. The intensity of the lights can be controlled by rheostats labeled CHART LIGHT, located below each switch panel. The lights can be removed from their bases for hand use as flashlights.

4–180A. The pilots' overhead panel light, (14, fig. 1-18), is located on the center control stand and shielded to focus on the pilots' overhead panel. The light is controlled by a two position toggle switch, located adjacent to the light.

4–181. Illumination of the flight engineer's instrument panels is provided by either red flood lights installed on the radio rack and under the engineer's table, or by small red incandescent lights installed above or below the instrument panels. Two rheostats, labeled STA 260 INSTR PANEL FLOODLIGHT and F.E. INSTR PANEL FLOODLIGHTS, controlling the flood lights are located on the engineer's overhead panel. A third rheostat on the engineer's switch panel is labeled F.E. INSTR PANEL AUX LTS and controls the small incandescent lights installed in a glare shield below the instrument panels. The auxiliary lighting for the station 260 panel is controlled by a rheostat located under the aft edge of the flight engineer's lower instrument panel.

4–182. Illumination of the upper and lower MJB panels is provided by three small red incandescent lights, two of which are installed at the left edge of the flight engineer's table and one at the top of the main junction box. The lights are turned on by a rheostat on the upper MJB panel (17, fig. 1-26) labeled MJB PANEL LIGHTS.

4–183. Both red and white lighting is provided for the flight engineer's desk. Two red lights and one double white

*LAC Serials 4001–4014 †LAC Serials 4015–4024

light are flush-mounted in the under surface of the instrument panel. Selection of the red or white lights is made by a toggle switch (19, fig. 1-26) on the upper MJB panel labeled F.E. DESK LT. After the color selection is made the lights are turned on by a rheostat (18, fig. 1-26) to the right of the color selection toggle switch labeled F.E. DESK LIGHTS.

4–184. A dome light for general flight station lighting is installed in the fuselage ceiling directly above the flight engineer's station. The dome light is provided with a red and a white incandescent lamp the selection of which is made by a three-position toggle switch (16, fig. 1-26) on the upper MJB panel labeled DOME LIGHT.

4–185. The dome lights in the cargo sections and in the tail cone are turned on by a toggle switch on the flight engineer's overhead switch panel labeled INSPECTION LIGHTS, CARGO & TAIL SECT.

4–185A. The forward and aft cargo compartments are each illuminated by five overhead lights which are automatically switched on when the cargo compartment doors are opened, and switched off when the doors are closed. An override switch on the flight engineer's upper switch panel will energize these lights for inspection purposes when the cargo access doors are closed. The cargo door switches also actuate the red door warning light which is located on the flight engineer's lower instrument panel. Whenever one of the cargo compartment doors, or the main or forward passenger door is open, the red warning light will light.

4–186. Circuit breakers protecting the circuits of the external lights, flight station lights, landing lights, ordinance lights, and cargo compartment lights, are installed on the lower MJB panel.

4–187. PASSENGER COMPARTMENT. General passenger cabin lighting is provided by incandescent lights with diffusing lenses installed along the center of the overhead air conditioning duct. These lights are turned on to either bright or dim intensity by a three-position toggle switch (2, fig. 4-33) on the aft cabin attendant's switch panel, labeled CABIN LIGHTS.

4–188. Overhead night lights are installed in the overhead air conditioning duct at the aft cabin attendant's station and at the coat closets between the forward and aft passenger compartments. The night lights are turned on by a toggle switch (4, fig. 4-33) on the aft cabin attendant's switch panel labeled NIGHT LIGHT.

4–189. Individual reading lights are provided for each passenger seat. The lights are turned on by slide-type switches installed in the lower surface of the overhead baggage rack.

4–190. The general overhead lights for the lounge compartment are controlled by a single toggle switch (2, fig. 4-33) on the aft cabin attendant's switch panel labeled LOUNGE LIGHT. The lights in the lavatory compartments are also controlled by a single toggle switch (9, fig. 4-33) on the cabin attendant's switch panel labeled LAVATORY LIGHTS.

4–191. The overhead lights in the galley section are turned on to either dim or bright intensity by a switch installed on the partition separating the galley from the passenger compartment. The switch is labeled OVERHEAD GALLEY LIGHTS.

4–192. FASTEN SEAT BELT and NO SMOKING ordinance signs are located at the forward ends of the forward passenger compartment, main passenger compartment lounge and foremost passenger compartment.† PLEASE RETURN TO SEAT signs, which illuminate simultaneously with the FASTEN SEAT BELT signs are installed in the lavatories. The signs are controlled by toggle switches (23, 24, fig. 1-14) located on the pilot's overhead panel. The switch labeled NO SMOKING controls that portion of the sign, and the switch labeled FASTEN SEAT BELT controls that portion of the ordinance sign, the PLEASE RETURN TO SEAT signs in the lavatories, and the cabin chimes which will sound whenever the FASTEN SEAT BELT sign is illuminated. The ordinance signs can be dimmed by a toggle switch (7, fig. 4-33) labeled ORDINANCE LIGHT, located on the aft cabin attendants' switch panel. This is a momentary switch which dims that portion of the ordinance sign which is on at the time the switch is operated. Ordinance signs will always be bright when turned on, regardless of previous operation of the dimming switch.

4–193. Lights for the aft cabin attendant's work desk are controlled by a rheostat (1, fig. 4-33) located at the upper right hand corner of the cabin attendant's switch panel.

4–194. On LAC Serials 4001 through 4014 a dry battery-operated emergency cabin flood light is installed on the forward face of the partition at the aft cabin attendant's station. The light is designed to be automatically turned on by an impact switch designed to operate at an impact of 6 g's. The impact switch, which is installed under the cabin attendant's seat and is accessible through a panel on the inboard side of the seat, is provided with a manual override switch. The override switch is normally wired in the OFF position, but in the event that the impact switch fails to energize the light, the toggle switch can be used to bypass the impact switch to turn the light ON or OFF as desired.

†LAC Serials 4015–4024

4–194A. On LAC Serials 4015 through 4024 the ditching light is a two dry-cell battery powered light, permanently attached to the aft end of the left baggage rack, so positioned that its beam illuminates the passenger door latch when the door is closed and the area immediately outside the door when the door is open. It is controlled by an integral switch.

4–195. OXYGEN SYSTEM

(See Figure 4-28)
LAC Serials 4001 through 4014

4–196. GENERAL. The airplane is equipped with a high-pressure, continuous flow, oxygen system with outlets provided for the flight crew, cabin attendant, and passengers. An alternate, demand-type oxygen system is provided for the flight crew only. Controls for the oxygen systems, consisting of a pressure gage, an oxygen flow regulator, and a passenger oxygen supply shut-off valve are located on the flight engineer's 260 bulkhead. Plug-in outlets for the continuous flow system are provided for the pilot and copilot on panels adjacent to each radio selector box, while the outlet for the flight engineer is located on the oxygen control panel portion of the 260 bulkhead. Continuous flow outlets for passenger use are installed in each of the lavatory compartments.

4–197. Oxygen is supplied from a bottle located in the cabinet below the radio equipment rack in the galley section. The bottle has a capacity of 48.3 cu. ft. at a pressure of 1800 psi. Oxygen is routed from the bottle to a continuous flow regulator installed on the aft face of the 260 bulkhead. A line is routed from the bottle to an overboard discharge outlet, which includes a discharge indicator, in the fuselage skin near the forward fuselage door.

4–198. CONTINUOUS FLOW REGULATOR. (Figure 4-29) The continuous flow regulator is mounted on the aft face of 260 bulkhead. The purpose of the regulator is to reduce the high pressure of the oxygen bottle to a usable pressure, which varies with altitude, and to regulate the flow of oxygen to the outlets.

4–199. DEMAND-TYPE REGULATORS. Scott demand-type regulators are provided for the flight crew only. The regulators are installed in the following locations: On the forward face of the nose steering wheel support bracket for the pilot; on the forward face of the master junction box for the copilot; and on the 260 panel above the oxygen control panel for the flight engineer. The demand-type regulators are wired to deliver 100% oxygen and should be used in the event that the flight station becomes filled with smoke since no cabin air is admitted to the masks when the regulator is functioning in this manner.

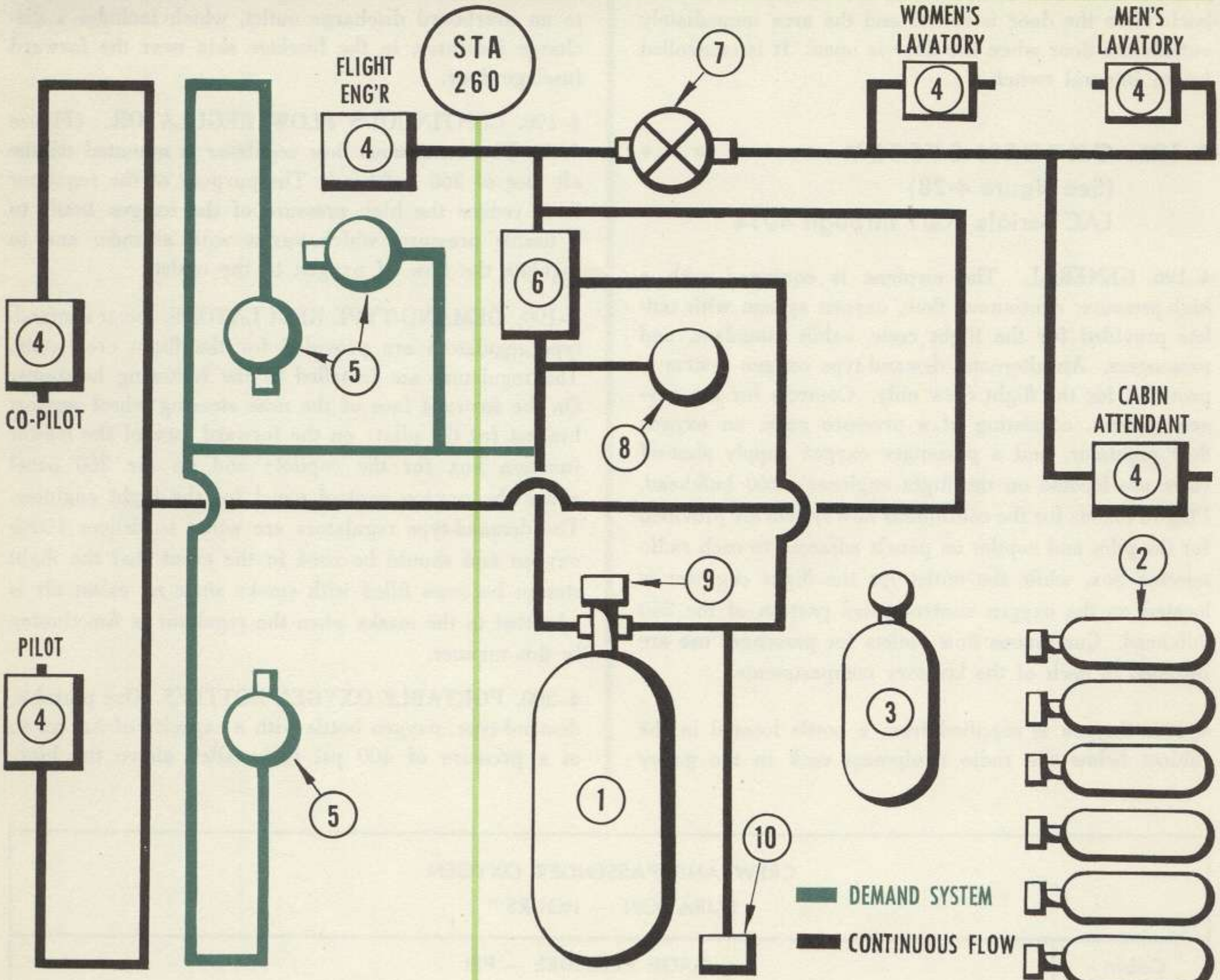
4–200. PORTABLE OXYGEN BOTTLES. One portable, demand-type, oxygen bottle with a capacity of 3.8 cu. ft. at a pressure of 400 psi is installed above the high-

CREW AND PASSENGER OXYGEN
DURATION — HOURS *

Cabin Altitude Feet	GAGE PRESSURE — PSI 1800	1600	1400	1200	1000	800	600	400	200	50
25,000	1.6	1.4	1.2	1.1	.9	.7	.51	.34	.14	EMERGENCY: Descend to altitude not requiring oxygen.
20,000	1.8	1.6	1.4	1.2	1.0	.8	.58	.37	.16	
15,000	2.1	1.8	1.6	1.3	1.1	.9	.65	.41	.18	
10,000	2.3	2.0	1.8	1.5	1.2	1.0	.72	.46	.20	
	Above indicates supplemental oxygen (crew and passengers)									
	PROTECTIVE OXYGEN (CREW ONLY). 1. Approximately 450 liters per crew member 1800 psi cylinder pressure. 2. Approximately 300 liters per crew member 1200 psi cylinder pressure.									

*LAC Serials 4001—4014

OXYGEN SYSTEM*

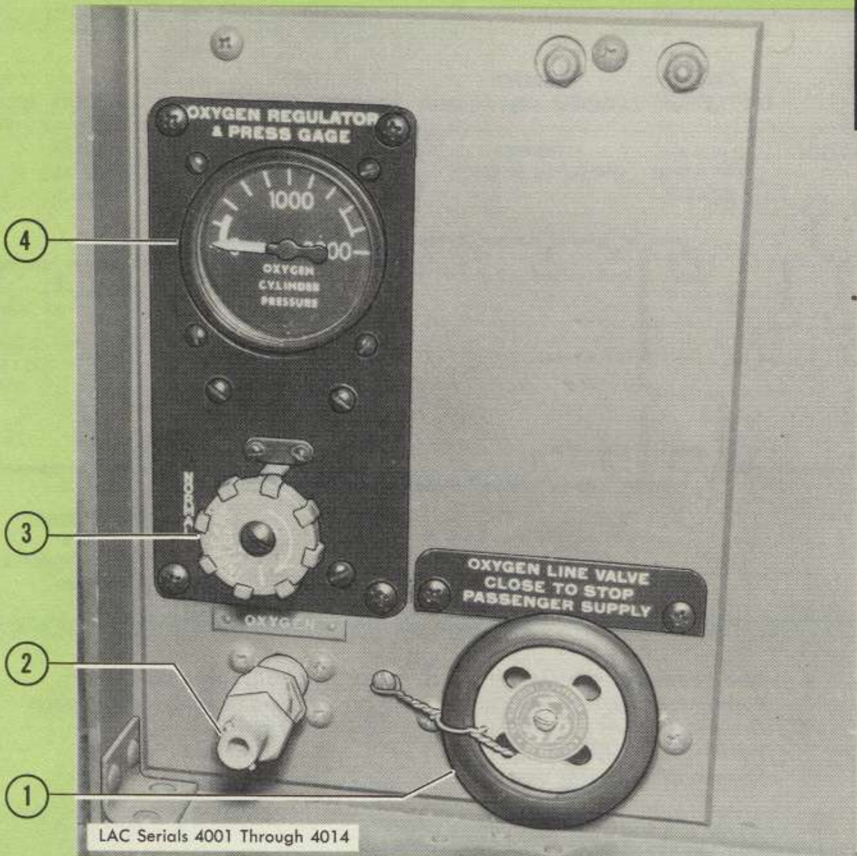


1. OXYGEN CYLINDER (HIGH PRESSURE)
2. PORTABLE CYLINDERS (HIGH PRESSURE)
3. PORTABLE CYLINDER (LOW PRESSURE)
4. CONTINUOUS FLOW OUTLET
5. DEMAND TYPE OUTLET
6. CONTINUOUS FLOW REGULATOR
7. PASSENGER SUPPLY SHUT-OFF VALVE
8. HIGH PRESSURE GAGE
9. SHUT-OFF VALVE
10. OVERBOARD DISCHARGE OUTLET

figure 4-28

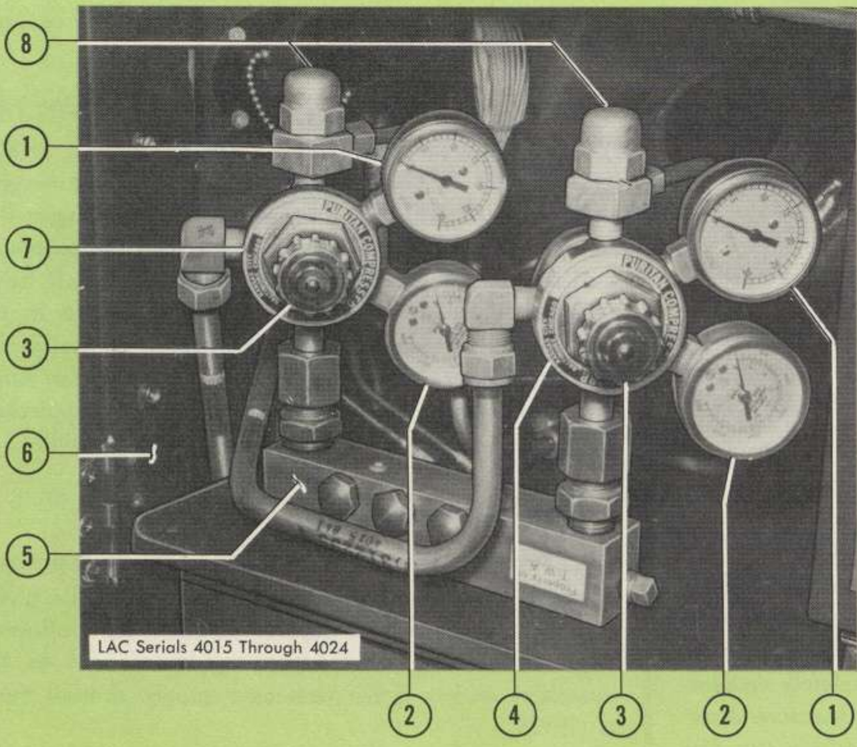
*LAC Serials 4001–4014

OXYGEN SYSTEM CONTROLS



1. Passenger supply shut-off valve
2. Oxygen outlet plug
3. Oxygen flow control knob
4. Oxygen cylinder pressure gage

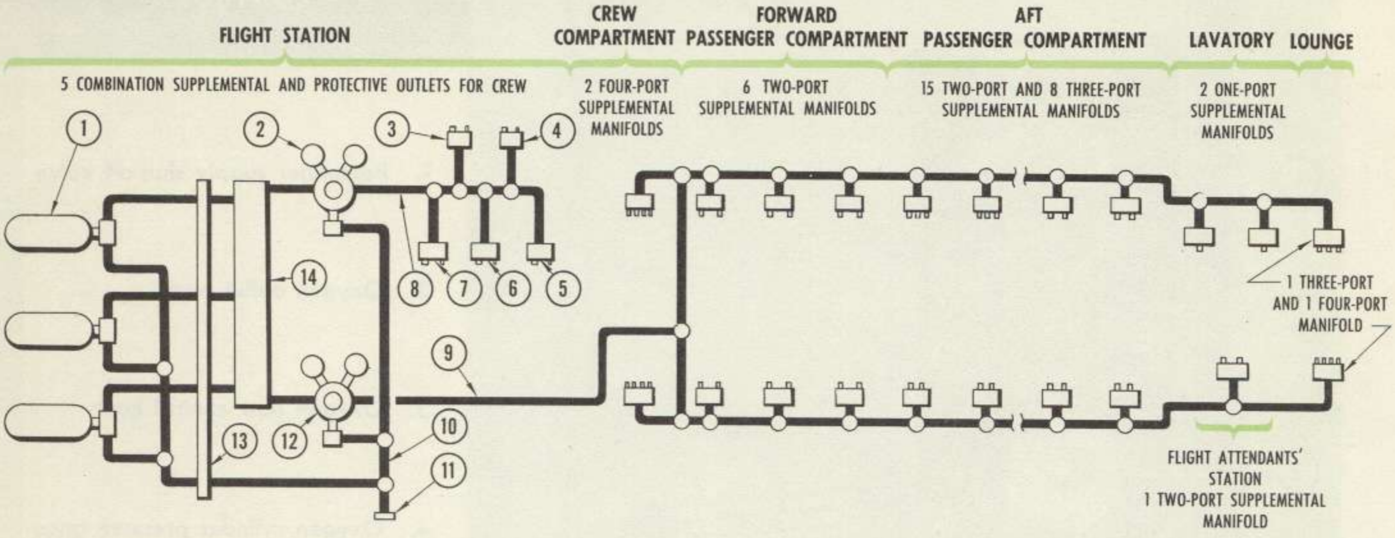
figure 4-29



1. Oxygen flow pressure gage
2. Oxygen cylinder pressure gage
3. Oxygen flow control valve
4. Crew oxygen regulator
5. Oxygen manifold
6. Station 260 bulkhead
7. Passenger oxygen regulator
8. Relief valves

figure 4-29A

OXYGEN SYSTEM†



1. Oxygen cylinder
2. Crew regulator with gage
3. Copilot's manifold
4. Flight engineer's manifold
5. Navigator's manifold
6. Radio operator's manifold
7. Pilot's manifold
8. Crew supply line
9. Passenger supply line
10. Overboard discharge line
11. Discharge indicator
12. Passenger regulator with gage
13. Manifold
14. Block manifold

figure 4-29B

pressure bottle in the cabinet below the radio rack in the galley section. Six portable, high-pressure, continuous-flow type, oxygen bottles for passenger use are stowed in a cabinet located on the aft face of the radio rack in the galley section.

4–201. OXYGEN SYSTEM INDICATORS.

4–202. PRESSURE GAGE. A pressure gage, indicating oxygen pressure in pounds-per-square-inch, is installed on the oxygen control panel portion of the flight engineer's 260 bulkhead. A reading of 1800 psi indicates a full supply of oxygen. Refer to the accompanying table for duration of the oxygen supply.

4–203. OXYGEN SYSTEM CONTROLS.

4–204. OXYGEN FLOW CONTROL KNOB. The red knob located below the pressure gage on the oxygen control panel is used to manually regulate the flow of oxygen through the continuous flow regulator. Normal flow results when the knob is turned completely counterclockwise. As the knob is turned in the clockwise direction it acts against the aneroid bellows within the flow regulator, allowing more oxygen to flow through the regulator. The knob is normally wired in the fully counterclockwise (normal) position.

4–205. PASSENGER OXYGEN SUPPLY SHUT-OFF VALVE. The passenger supply shut-off valve is located to the right of the flow control knob on the oxygen control panel. This valve is installed in the oxygen line between the continuous-flow regulator and the passenger outlets in the lavatory compartments and the aft cabin attendant's outlet. This valve should be wired in the off position to insure an adequate supply of oxygen for the flight crew except in the case of passenger emergency when the lavatory outlets are needed to supplement the oxygen supply provided by the portable bottles.

4–206. OXYGEN SYSTEM OPERATION.

a. Turn on the valve located on the high-pressure bottle in the cabinet under the radio rack in the galley section. Oxygen will be supplied to both the continuous flow outlets and demand-type regulators, and to the passenger outlets if the passenger supply shut-off valve is OPEN.

b. Check pressure gage for a reading of 1800 psi.

†LAC Serials 4015—4024

CREW AND PASSENGER OXYGEN DURATION — HOURS †

WILL BE SUBMITTED WHEN AVAILABLE

c. For normal operation, use the continuous-flow outlets.

d. During emergency operation, such as smoke in the flight station, use the demand-type regulators.

e. Adjust flow to masks, if necessary, by manipulation of the red flow control knob.

4–206A OXYGEN SYSTEM

(See Fig. 4-29B.)

LAC Serials 4015 through 4024

4–206B. GENERAL. The airplane is equipped with a high-pressure continuous-flow (supplemental) oxygen system and an oxygen outlet is provided for each crew member and each passenger. Additional oxygen outlets allow the use of protective type (full face) oxygen masks and 100% oxygen by the crew. The plug-in outlets for the oxygen masks are distributed as shown on Figure 4-29B and the oxygen duration is presented on page 184C.

4–206C. Oxygen is supplied by three high-pressure oxygen cylinders, each having a capacity of 107 cu. ft. at a pressure of 1800 psi. In airplanes with the domestic configuration, one of the cylinders is located on the aft left side of the station 260 bulkhead and the other two are located in the main radio rack. In airplanes with the international configuration, all three cylinders are mounted on the aft left side of the station 260 bulkhead. An overboard emergency discharge line is connected to relief valves on the flow regulators and to each oxygen cylinder. This line terminates in the fuselage skin near the forward passenger door and is covered with a discharge indicator. Two oxygen flow regulators control the flow of oxygen to the passengers or the flight crew.

4–206D. MULTI-STAGE OXYGEN REGULATORS. The two regulators are installed on the main radio rack. Each regulator is equipped with a 3000-pound cylinder pressure gage, a 30-pound flow pressure gage, an emergency relief valve, and a flow control valve. The regulators control the flow of oxygen and reduce the oxygen cylinder pressure to a pressure usable by the masks. The regulator (7, fig. 4-29A) that is nearer to the station 260 bulkhead controls the flow of oxygen to the passengers and the other regulator (4, fig. 4-29A) controls the flow of oxygen to the crew.

4–206E. OXYGEN MASKS. Pouches are provided for stowing three protective and three supplemental oxygen masks for the crew on the left side of the flight station above the radio operator's table. Two supplemental masks for the cabin attendants are stowed in the aft coat closet. When the airplane is converted for international usage, two protective and four crew supplemental masks are stowed on the left side of the crew compartment above the nagivator's table. Seventy-five supplemental masks, for passengers, are stowed in three boxes strapped to the floor of the aft coat closet.

4–206F. PORTABLE OXYGEN BOTTLES. Two portable, low-pressure protective-type oxygen cylinder units are mounted on the forward side of the main radio rack on airplanes with the domestic configuration. The oxygen cylinder units are located beneath the navigator's table when the airplane is converted to the international configuration. Each cylinder assembly incorporates a demand-type regulator with a pressure gage, a relief valve, a recharge adapter, carrying sling, full face mask, one pair of asbestos gloves, and a clamp for attaching to the clothing. The cylinders have a working pressure of 400 psi at 21°C (70°F) and 6.9 cubic feet of available oxygen.

4–206G. OXYGEN SYSTEM OPERATION.

a. Plug masks into proper oxygen outlets. For normal operation, use the supplemental oxygen masks and outlets and use the protective oxygen masks and outlets for emergency operation.

b. Turn flow control valves off (out).

c. Open oxygen cylinder valves.

d. Check the high pressure gages for readings of 1800 psi.

e. Adjust regulator low-pressure gages to the required pressures by the flow control valves.

f. Check that oxygen is reaching the masks and then adjust them to the wearer's face.

4–207. WATER SYSTEMS

(See Figure 4-30.)

4–208. GENERAL. Two separate, gravity-fed water systems are provided. One system is located forward and the other aft. The forward water system consists of drinking water provisions* and an overboard drain for galley and drinking water overflow. The aft water system consists of drinking water provisions; wash water provisions; filling and draining provisions for wash water system; and an overboard drain for waste wash-water and drinking water overflow.

4–209. FORWARD WATER SYSTEM. On LAC Serials 4001 through 4014 the forward drinking water provisions consist of one 6-quart, removable, thermos container (with faucet attached), mounted in a metal recess

*LAC Serials 4001—4014

WATER SYSTEM

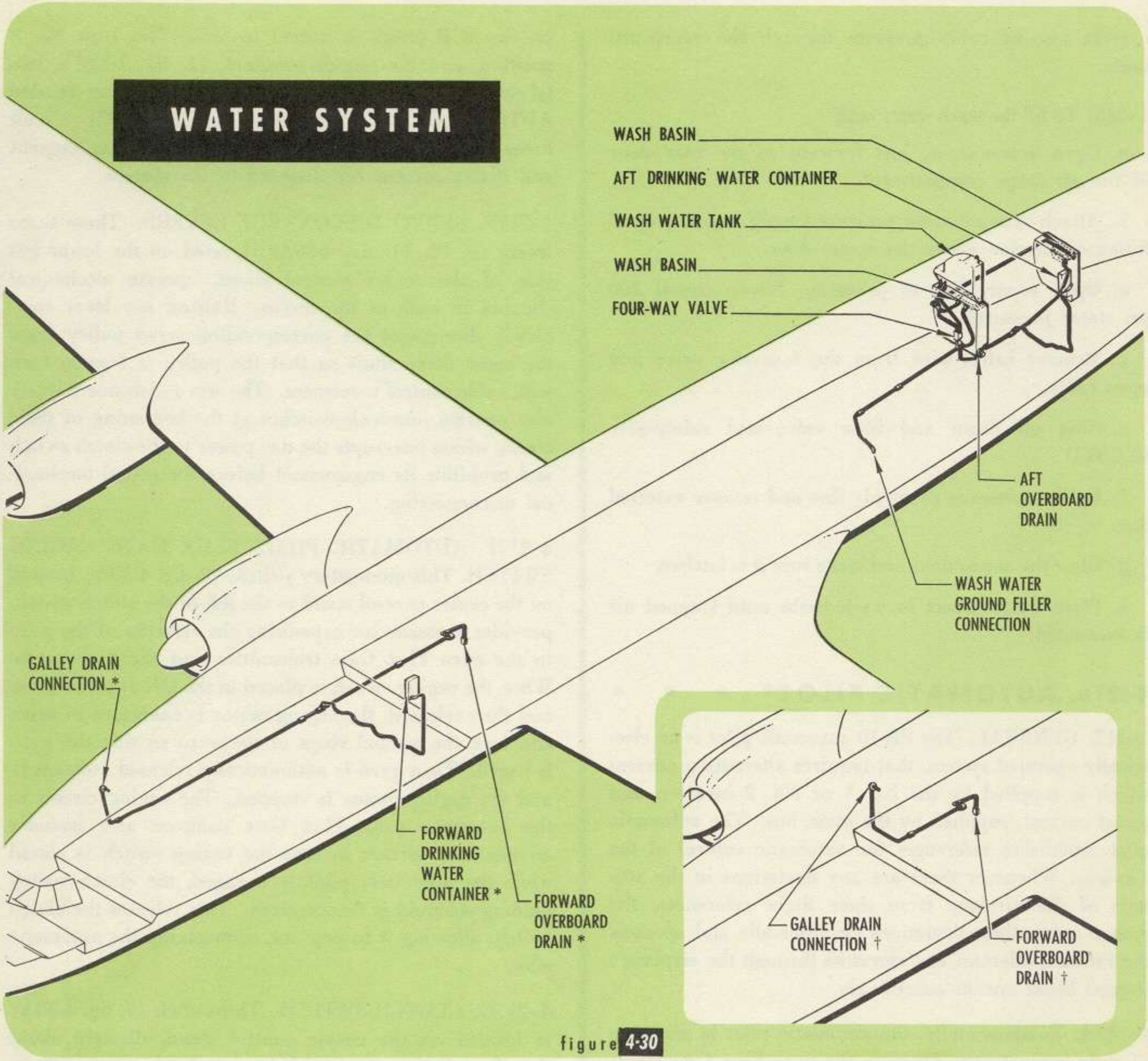


figure 4·30

at the forward left-hand coat compartment. A grille drain at the bottom of the recess is connected to the forward overboard drain line and catches drinking water overflow.

4–210. Waste water from the galley sink drains overboard when the drain is opened.

4–211. AFT WATER SYSTEM. The aft drinking water provisions consist of one 6-guart, removable thermos container (with faucet attached), located in a metal recess at the aft coat compartment. A grille drain at the bottom of the recess is connected to the aft overboard drain line and catches the overflow.

4–212. The wash water system, a part of the aft water system, services the wash basins located in the men's and women's lavatories.

4–213. The wash water supply tank is located in the forward partition of the men's lavatory behind the mirror. A direct reading float type water quantity gage is located in the inboard partition of the men's lavatory and is read from the aisle. Effective tank capacity is 25.5 U.S. gallons.

4–214. Draining and filling of the wash water tank is accomplished through the line leading to the ground filling connection which is located forward of the aft loading door for the rear cargo compartment. The four-way valve beneath the sink must be opened to permit filling or draining. After the tank has been serviced, the valve is safetied in the closed position. When the wash water supply tank is filled, a standpipe in the tank drains excess water overboard through the overboard drain. Spring-loaded valves in the overboard drain prevent loss of cabin pressure through the overboard drain.

4–215. To fill the wash water tank:

a. Open access door, just forward of the rear door of the aft cargo compartment.

b. Attach external water pressure supply line to ground filling connection above the access door.

c. Open supply line to pressure. Never exceed 200 psi water pressure.

d. Remove safety-wire from the four-way valve and open valve.

e. Shut off drain and filler valve and safety-wire CLOSED.

f. Release pressure in supply line and remove external line.

g. Close the access door and make sure it is latched.

h. Open water faucet in wash basin until trapped air is evacuated.

4–216. AUTOMATIC PILOT† • • •

4–217. GENERAL. The PB-10 automatic pilot is an electrically operated system, that requires alternating current which is supplied by the No. 1 or No. 2 inverter, and direct current, supplied by the main bus. The automatic pilot establishes references for automatic control of the airplane. Whenever there are any deviations in the attitude of the airplane from these flight references, the system senses these deviations electronically and operates the rudders, ailerons, and elevators through the airplane's normal boost system accordingly.

4–217A. Fundamentally, the automatic pilot is made up of eight components. Of these the gyro Flux Gate transmitter, the amplifier-signal generator and, the three main servos, 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.

4–217B. A safety circuit in the amplifier causes disengagement of the automatic pilot servo clutches in case of a.c. power failure likely to affect the operation of the gyros. The automatic pilot clutches are also automatically disengaged in case of d.c. power failure.

4–217C. AUTOMATIC PILOT CONTROLS.

4–217D. INVERTER SWITCH AND CIRCUIT BREAKERS. When the inverter switch (1, fig. 1-26) located on the MJB panel, is turned to either No. 1 or No. 2 position, and the circuit breakers, (1, fig. 1-33A), two labeled AUTO PILOT AΦ and BΦ, and one labeled AUTO PILOT D.C., located on the lower MJB circuit breaker panel, are pushed in, both alternating current and direct current are directed to the system.

4–217E. SERVO DISCONNECT LEVERS. These three levers (9, 10, 11, fig. 4-30A), located on the lower left side of the center control stand, operate mechanical clutches in each of the servos. Raising any lever completely disengages the corresponding servo pulley from the servo drive shaft so that the pulley is free to turn with cable control movement. The servo disconnect levers also operate interlock switches at the beginning of their travel, which interrupts the d.c. power to the clutch switch and prohibits its engagement before the actual mechanical disconnecting.

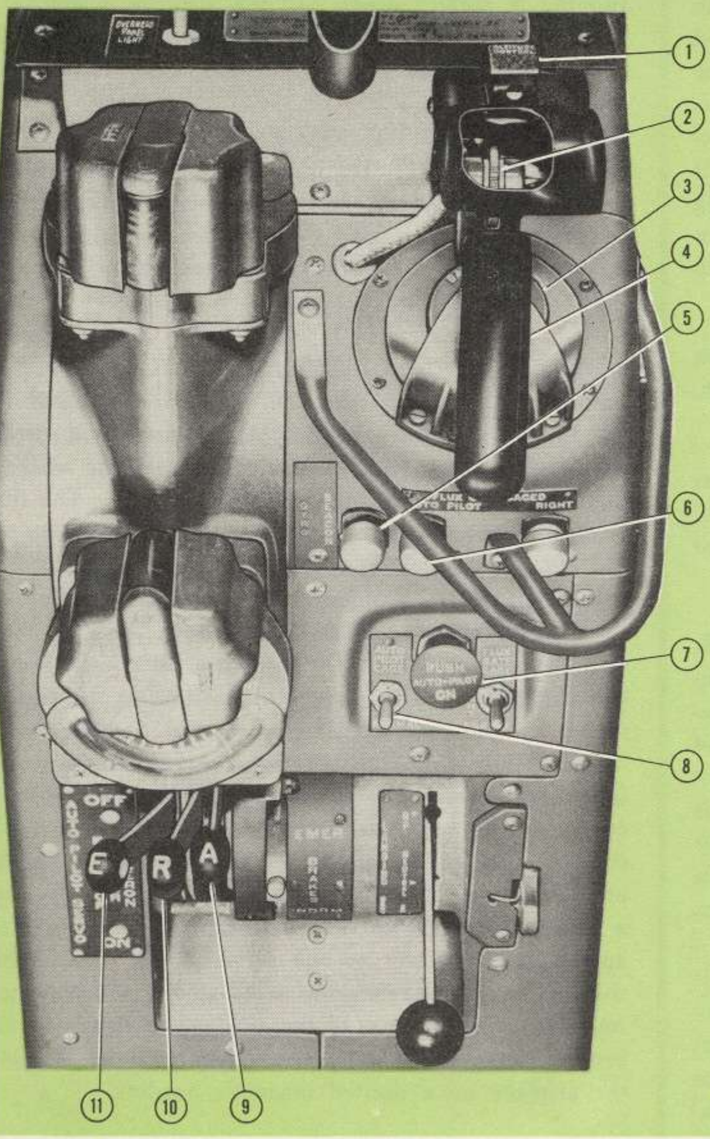
4–217F. AUTOMATIC PILOT FLUX GATE CAGING SWITCH. This momentary switch, (8, fig. 4-30A) located on the center control stand to the left of the clutch switch, provides a means for expediting the erection of the gyro in the gyro Flux Gate transmitter and the flight gyro. When the caging switch is placed in the ON (up) position and then released, the caging motor is energized to drive and lock the gimbal rings of the gyro so that the gyro is caged. Then gyro is automatically released (uncaged) and the caging motor is stopped. The caging circuit to the automatic pilot 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.

4–217G. CLUTCH SWITCH. This switch (7, fig. 4-30A) is located on the center control stand, directly above the Flux Gate caging switches, and when pressed in, operates a clutch in each of the servos and in 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 gyro is 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, the servos to turn to cancel the net channel signal before the automatic pilot takes control of the airplane. During this delay period, the clutch switch, when pressed, will not hold and will not operate the servo clutches.

4–217H. ALTITUDE CONTROL SWITCH. This switch (1, fig. 4-30A) which is mounted on top of the con-

†LAC Serials 4015—4024

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. Automatic pilot flux gate caged indicator light
7. Clutch switch
8. Automatic pilot flux gate caging switch
9. Aileron servo disconnect lever
10. Rudder servo disconnect lever
11. Elevator servo disconnect lever

figure 4-30A

troller, energizes a clutch which connects the altitude control signal generator (a section of the elevator channel) 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 airplane 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 airplane is displaced in altitude, the maximum pitch change that the unit can set in to return the airplane to its original altitude is $\pm$ 6°. 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.

4–217J. CONTROLLER. The controller, mounted on the center control stand, is installed to permit maneuvering the airplane 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 (4, fig. 4-30A) 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 airplane with the controller, the airplane will return to its original heading when the turn handle is returned to the detent.

b. The bank trim knob may be used to adjust bank attitude after squeezing the pistol grip trigger switch. (See paragraph 4–217Z, h.)

c. The pitch trim knob may be used to lower or raise the elevator for any desired angle of climb or descent. This control is not accessible with the altitude control switch ON.

4–217K. PILOTS' CLUTCH DISCONNECT SWITCHES. These switches, mounted on the right hand grip of each pilot's control wheel, provide a means for disengaging the automatic pilot. When pressed, either of these switches will electrically disconnect the auto pilot system and the clutch switch will pop out. When this happens, the clutches in the servos and in the master direction indicator are disengaged, preventing automatic control from being applied to the airplane control surfaces.

4–217L. 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 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 master direction indicator occurs when the setting is too low.

4–217M. AUTOMATIC PILOT INDICATORS.

4–217N. GYRO BEACON LIGHT. The gyro beacon light (5, fig. 4-30A), 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 at the top of the flight gyro, 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 airplane is not in a bank or steep climb, the neon bulb glows approximately 35 to 45 times per minute.

4–217P. AUTOMATIC PILOT FLUX GATE CAGED INDICATOR LIGHT. The indicator light (2, fig. 4-30A), located directly above the caging switch, glows during the last half of the caging cycle. When the caging cycle is complete and the gyros are automatically uncaged, the light will go out.

4–217Q. MASTER DIRECTION INDICATOR. The master direction indicator (30, fig. 1-9A), located on the lower left corner of the pilot's instrument panel, indicates the magnetic heading of the airplane 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 airplane. When the heading changes, the gyro Flux Gate transmitter, mounted in the wing, electrically senses this change due to its change of position in the earth's magnetic field, and transmits a signal to the master direction indicator. Here this signal serves two purposes; it is used to drive the dial of the master direction indicator, and to originate a course signal for automatic control. 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 servo motor. When this working signal energizes the servo motor, which is tied into the control system of the airplane, it drives in the proper direction to apply corrective force for holding the airplane on a desired magnetic heading.

4–217R. THREE AXIS TRIM INDICATOR. The three axis trim indicator (35, fig. 1-9A), mounted on the right of the pilots' center instrument panel 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 in which it is exerted. This out of trim condition requires manual correction by use of the trim tab controls.

4–217S. NORMAL OPERATING PROCEDURES.

a. Automatic pilot—engage.

1. Inverter switch—On No. 1.

2. Circuit breakers—in.

3. Servo disconnect levers—ON.

4. 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 gyros are erect and up to speed when it flashes at a rate of 35 to 45 times per minute.

5. Clutch switch—press.

4–217T. GROUND CHECK. The forces tabulated below refer to the elevator force applied on the center of the control wheel hub; the aileron force applied at the rim of the wheel; the rudder force applied on the rudder.

	Stall	*Overpower*
Elevator	30# +0 —10	50# ±10
Rudder	120# +0 —60	180# ±30
Aileron	30# +0 —10	50# ±10

4–217U. 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 with one hand.

f. Operate the pitch controller fore and aft and determine that the control column movement can be stopped with moderate effort with 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.)

4–217V. 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 fore 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 can be performed in flight as well as on the ground.

4–217W. The above check gives 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 putting out too little force.

Note

Wind blowing directly on the tail, may affect the required force on the controls.

4–217X. BEFORE TAKE-OFF.

a. Pilot's clutch disconnect switch—press.

b. Servo disconnect levers—OFF.

4–217Y. CLIMB.

a. After climb power is set, the airplane 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 airplane and disengage the automatic pilot before turning it OFF.

c. Servo disconnect levers—ON.

d. Clutch switch—push.

4–217Z. CRUISE. When the desired cruising altitude has been attained, proceed as follows:

a. Disengage the automatic pilot.

b. Trim the airplane 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.

Note

- If the altitude control fails to hold a steady altitude, it is possible that the airplane was slightly out of trim when the altitude control was turned

ON. To correct this, repeat the steps in this paragraph.

- 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 airplane trim tabs in the normal manner while on altitude control.

g. The automatic pilot now has control of all three axes of the airplane. With the altitude control OFF, the airplane 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 airplane trimmed for level flight. If changes in bank attitude become necessary, disengage the automatic pilot and re-trim the airplane 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 considerably 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 airplane 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 slightly in the desired direction, and then return it to the detent. The airplane will hold the new course.

4-217AA. 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 adjustments of the pitch trim knob.

4-217AB. 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.

4-217AC. EMERGENCY OPERATING PROCEDURES.

4-217AD. GENERAL. 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.

4-217AE. AUTOMATIC PILOT MALFUNCTIONS.

4-217AF. GENERAL. Automatic pilot failures will fall into one of the following categories:

a. 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.

b. Elevator hard nose-down. Should the automatic pilot malfunction to give an elevator hard nose-down signal, the airplane will pitch over quite rapidly to almost zero G., which is a 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.

c. Aileron hard-over. Another type of failure is an aileron hard-over signal which produces a smooth movement of the ailerons and the airplane 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 airplane 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.

d. Oscillating singals. 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.

4–217AG. 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 switches.

b. Pull out the clutch switch.

c. Move the servo disconnect levers to OFF, (up) position.

d. Move the automatic pilot Flux Gate caging switch to the ON (up) position and then release.

4–217AH. If a malfunction occurs, the pilot must restrain the controls while disconnecting the automatic pilot to prevent a sudden jerk when it disengages.

Note

The automatic pilot may be overpowered. However, the control forces required will be higher than when the automatic pilot is disengaged.

4–218. INTERIOR CONFIGURATION (See Figs. 4-31* and 4-31A†)

4–219. GENERAL. Airplanes designated LAC Serial 4001 through 4014 are Model 1049-53-67. The airplane model is the 1049; -53 indicates the power plant; and the -67 indicates the interior arrangement. The -67 interior provides for an active crew of six (consisting of a pilot, copilot, flight engineer and three cabin attendants), a flight observer and 88 passengers.

4–219A. Airplanes designated LAC Serial 4015 through 4024 are Model 1049-54-80. The airplane model is the 1049, -54 indicates the power plant, and the -80 indicates the interior arrangement. The -80 interior may be changed to provide for a crew of five and seats for 75 or 83 passengers; or for a crew of eleven and seats for 65 passengers.

4–220. INTERIOR DOORS. On LAC Serials 4001 through 4014 the fuselage is divided by two doors into the flight station, the galley compartment, and the passenger compartment. On LAC Serials 4015 through 4024 the fuselage is divided by four doors into the flight station, foremost passenger compartment (crew compartment when the airplane is converted for international usage), the forward passenger compartment and the main passenger compartment. The door between the flight station and the compartment aft has a window which can be obscured with a shutter from either side. It opens forward; may be latched in an open position, or locked to prevent entry to the flight station from compartments aft.

4–221. A folding pinch-proof door is installed at each of the two lavatories. The latch arrangement provides visual indication of compartment occupancy and a lock override is provided for emergency entrance from the outside.

4–222. ENTRANCE DOORS. The forward and aft passenger doors and the cargo compartment loading doors are equipped with micro-switches that are activated when the doors are unlatched. The micro switches turn on a warning light on the flight engineer's lower instrument panel. The switch at the aft passenger door also operates the entryway light.

4–223. The forward passenger compartment door is located in the left side of the fuselage aft of the flight station. It swings outward and is held fully open by a spring-loaded latch. The latch may be released by depressing the rod projecting from the edge of the door on the hinge side.

4–224. The main passenger door is located in the left, aft side of the passenger compartment. It is opened by moving it inward and sliding it aft on its tracks. A flush exterior handle and a centrally mounted interior handle operate the latch mechanism. A double-paned window is fitted in the door.

4–225. A crew entrance door is located on the right aft side of the flight station. A wide-angle lens in this door affords the flight engineer an unobstructed view of engines No. 3 and 4.

4–226. FLIGHT STATION. The interior configuration, is covered in Section 1.

4–226A. NAVIGATOR'S STATION.† In airplanes converted to the international configuration, the foremost passenger compartment becomes the crew compartment and the navigator's station is located on the left forward side. The navigator is provided with a stool, table, instrument panel, radio altimeter, driftmeter, and sextant. The table is equipped with two legs that may be folded toward each other and is hinged at the forward end so that it may be dropped to provide additional space for passage to the forward passenger door. The navigator's instrument panel is located above the table and contains an airspeed indicator, ADF indicator, clock, outside air temperature indicator, altimeter, and a Flux Gate compass repeater. A remote control panel for the ADF indicator is also located adjacent to the instrument panel.

4–226B. Provisions are made for installation of a periscopic sextant in the ceiling of the crew compartment and a gyro-stabilized driftmeter in the floor beneath the auxiliary radio rack. The driftmeter lens can be defogged by vacuum when the shut-off valve located in the step below the station 260 bulkhead door is opened. The

*LAC Serials 4001–4014 †LAC Serials 4015–4024

INTERIOR ARRANGEMENT*

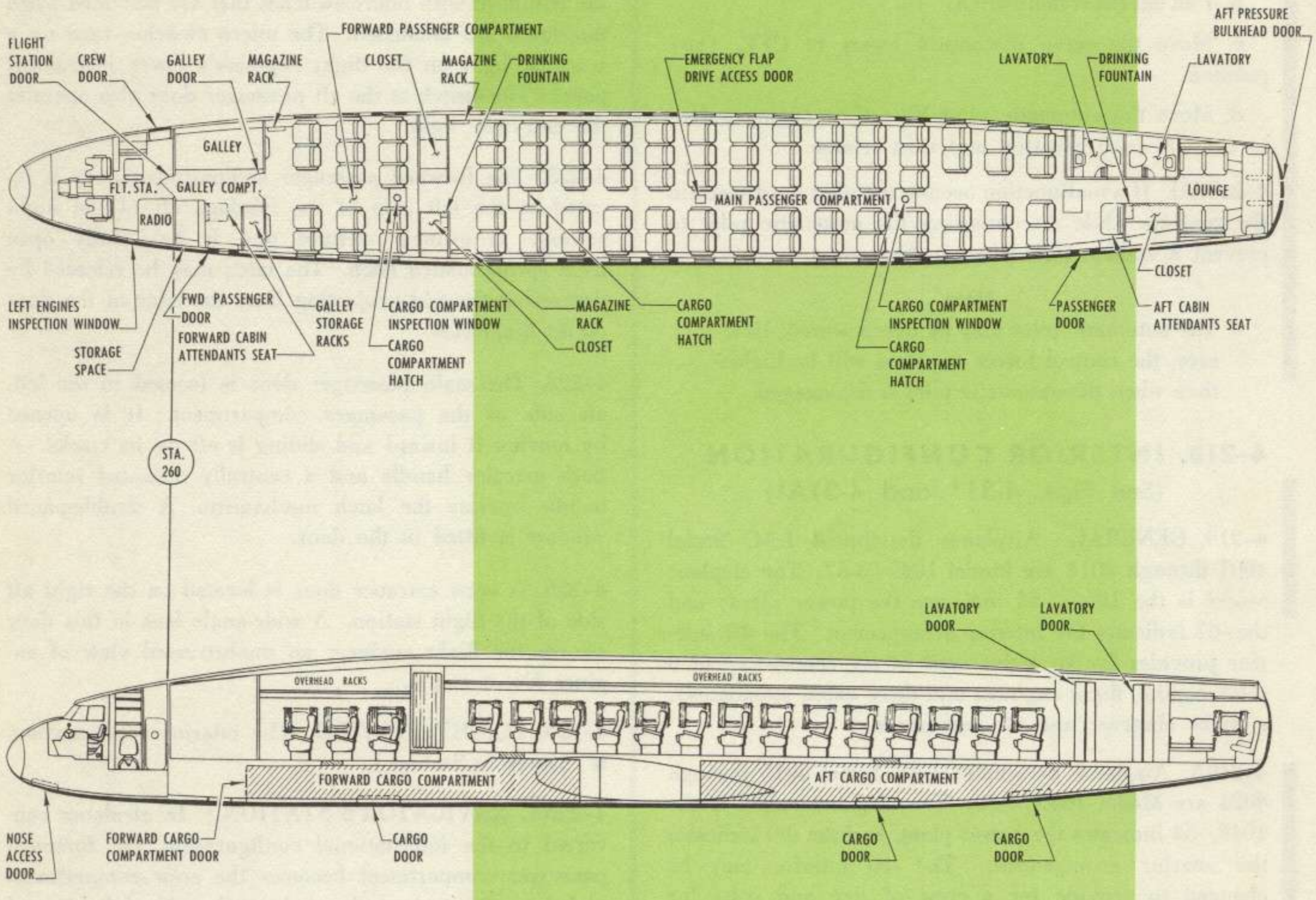


figure 4-31

driftmeter gyro is operated by 115 volt 400 cycle a.c. current. When the driftmeter and sextant are not installed, holes in the fuselage and floor are sealed by plugs.

4–227. MISCELLANEOUS EQUIPMENT. Two flashlights are provided; one clipped to the nose wheel steering column and one under the leading edge of the copilot's seat. Ash trays, folding (anti-hazard) hooks, and rag containers are conveniently located for each crew member. Two check-list holders are strapped to the back of the pilot's and copilot's chairs. Also strapped to the back of the pilot's chair is a refuse receptacle. Storage space for log books, operating manuals, spare fuses, and miscellaneous gear is provided in the flight engineer's desk. A bag is attached on the forward, right-hand face of the 260 bulkhead for storing the pitot head covers when not in use. Fuel quantity dipsticks are strapped to the 260 bulkhead near the crew door. Each gear safety pin is stored in a bag attached to the gear itself.

4–228. GALLEY COMPARTMENT.* The pulley compartment is located between the forward passenger compartment and the flight station. Included within this area are the forward cabin attendant's seat, the galley installation, the galley storage racks, closets, and the forward passenger entrance door. The galley is located on the right side of the galley compartment. Adjacent to the forward passenger entrance is a storage rack for casseroles and thermos jugs. The racks are held in place by retainer bars which pivot at one end, and fasten at the other end with a spring-loaded plunger.

INTERIOR ARRANGEMENT†

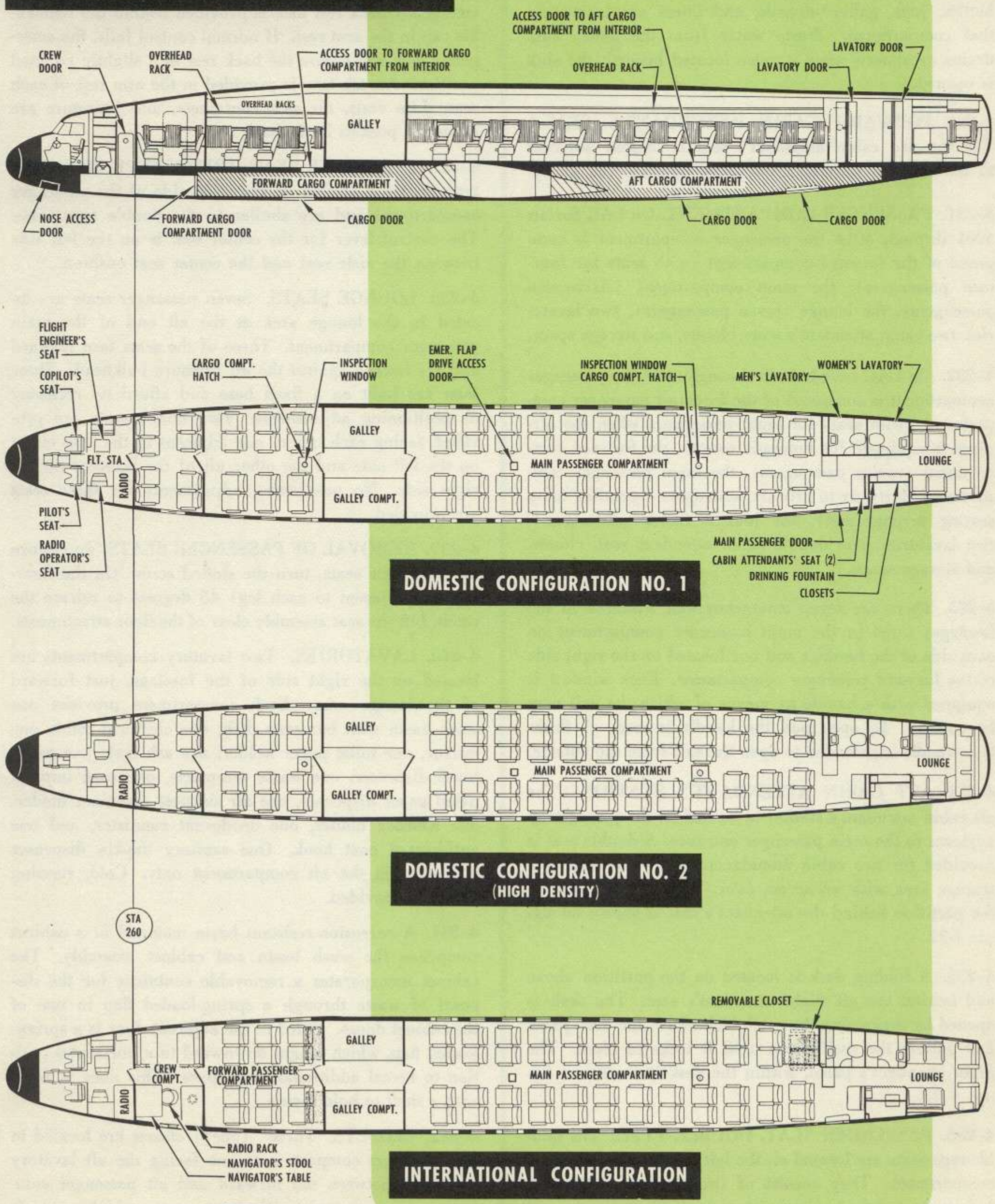


figure 4-31A

4–229. GALLEY COMPARTMENT.† The galley compartment is located between the forward and main passenger compartments. Cabinets, shelves, a sink, thermos bottles, jugs, galley utensils, and liners are located in that compartment. Waste water from the galley sink drains overboard when a valve located beneath the sink is opened.

4–230. FORWARD CABIN ATTENDANT'S SEAT.* The forward cabin attendant's seat is located adjacent to the forward passenger entrance, opposite the galley.

4–231. PASSENGER COMPARTMENT. On LAC Serials 4001 through 4014 the passenger compartment is composed of the forward compartment (with seats for fourteen passengers), the main compartment (sixty-seven passengers), the lounge (seven passengers), two lavatories, two cabin attendant's seats, closets, and storage space.

4–232. On LAC Serials 4015 through 4024 the passenger compartment is composed of the foremost passenger compartment (with seats for eight passengers when the airplane is equipped for domestic usage), the forward compartment (twelve passengers), the main passenger compartment (forty-six to fifty-six passengers depending upon seating arrangement), the lounge (seven passengers), two lavatories, one double cabin attendant seat, closets, and storage space.

4–233. There are seven emergency exit windows in the fuselage; three in the main passenger compartment on each side of the fuselage and one located on the right side of the forward passenger compartment. Each window is equipped with a handle by means of which the exit may be opened. To open pull the handle inward. A flush-type handle is provided to open the exit from the outside.

4–234. AFT CABIN ATTENDANT'S STATION. The aft cabin attendant's station is located in the passageway adjacent to the main passenger entrance. A double seat is provided for two cabin attendants. Below the seat is a storage area with an access door. The forward face of the partition behind the attendant's seat is shown on figure 4-32.

4–235. A folding desk is located on the partition above and behind the aft flight attendant's seat. The desk is opened by depressing the catch-lock above the desk panel and pulling the shelf down until it locks in place. The flight attendant's panel, within the desk is shown on figure 4–33.

4–236. PASSENGER SEAT, DOUBLE TYPE. The double-type seats are located on the left side of the passenger compartment. They consist of two separate seats with independent reclining backrests, removable armrests, and snap-on safety belts. The reclining control lever is located on the outboard arm rest and when operated, permits the passenger to adjust the back rest without rising. When the lever is released, the back rest locks in position. An emergency back rest lock is provided behind the removable cap in the arm rest. If normal control fails, the emergency lock will secure the back rest in a slightly reclined position. An ash tray is provided in the arm rest of each seat. Life vests, air sick containers, and literature are stowed in pockets in the back rest.

4–237. PASSENGER SEAT, TRIPLE TYPE. The triple-type seats are located on the right side of the passenger compartment and are similar to the double type seats. The control lever for the center seat is on the left side between the aisle seat and the center seat cushion.

4–238. LOUNGE SEATS. Seven passenger seats are located in the lounge area at the aft end of the main passenger compartment. Three of the seats face forward and are backed against the aft pressure bulkhead. These seats are built on a fixed base and afford no reclining or positioning adjustments. Two double-seats are provided, facing each other; one adjacent to the coat closet on the left side and the other aft of the lavatory on the right side. No positioning adjustments for these seats are provided.

4–239. REMOVAL OF PASSENGER SEATS. To remove the passenger seats, turn the slotted screw (in the flooring and adjacent to each leg) 45 degrees to release the catch. Lift the seat assembly clear of the floor attachments.

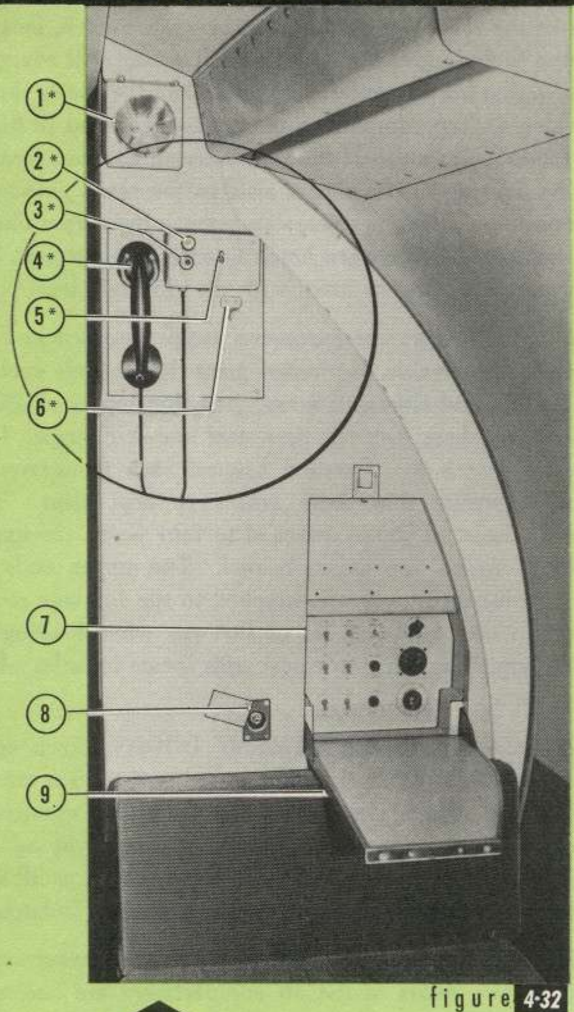
4–240. LAVATORIES. Two lavatory compartments are located on the right side of the fuselage, just forward of the lounge area. Each compartment provides one wash basin with bar soap dish, one chemical toilet, one mirror, one toilet paper holder, one ash tray, one paper towel dispenser, one waste receptacle, one soap impregnated paper dispenser, one air sickness container holder, one Kleenex holder, one deodorant cannister, and one anti-hazard coat hook. One sanitary napkin dispenser is located in the aft compartment only. Cold, running water is provided.

4–241. A corrosion-resistant basin mounted in a cabinet comprises the wash basin and cabinet assembly. The cabinet incorporates a removable container for the disposal of waste through a spring-loaded flap in one of the cabinet doors. Fitted in the adjacent door is a spring-loaded flap, which hinges downward to a horizontal position to reveal additional shelf space. This door is fitted with a shelf to hold towels.

4–242. CLOSETS. Three* (one†) closets are located in the passenger compartment; one facing the aft lavatory and two* between the forward and aft passenger compartments, separated by the passageway which connects the two passenger compartments. Stowed in the left for-

*LAC Serials 4001–4014 †LAC Serials 4015–4024

CABIN ATTENDANT'S STATION, AFT



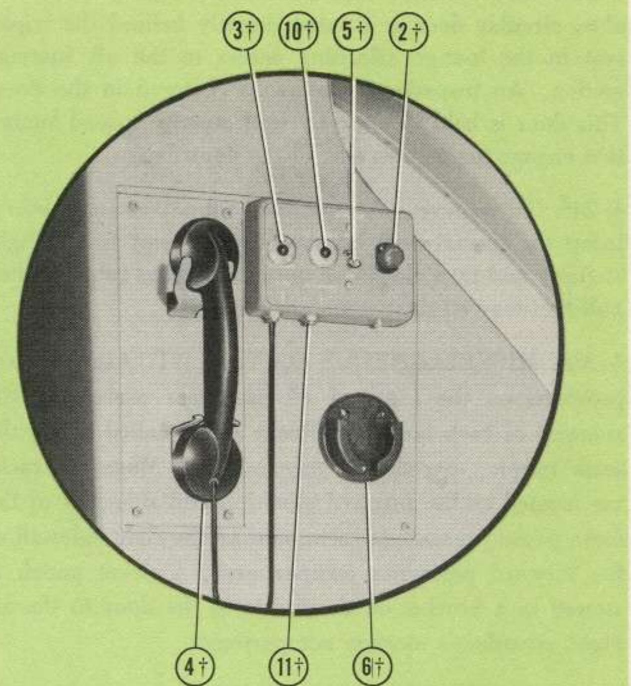


figure 4-32

1. Emergency cabin floodlight
2. Cabin attendant call light
3. Interphone call button
4. Interphone hand set
5. Public address system high-low level switch
6. Public address system microphone bracket
7. Cabin attendant's control panel
8. Oxygen outlet
9. Cabin attendant's desk
10. Flight station call button
11. Public address system microphone jack

CABIN ATTENDANTS' CONTROL PANEL

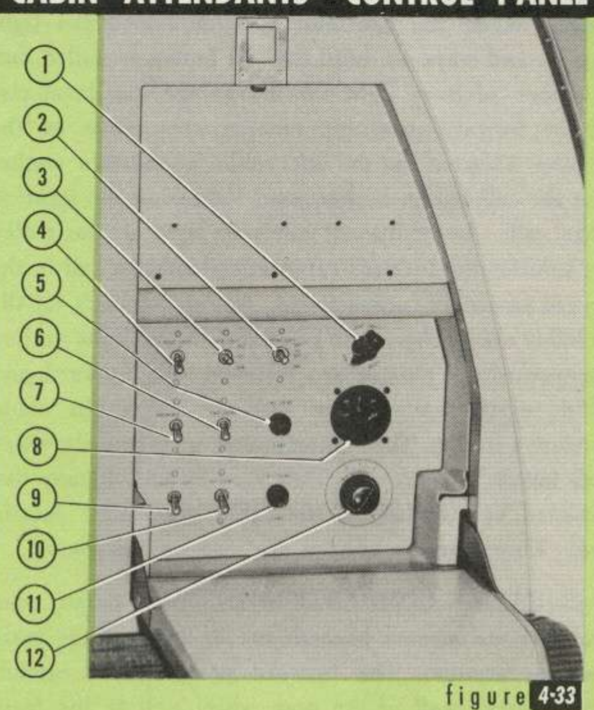


figure 4-33

1. Desk light rheostat
2. Lounge lights switch
3. Cabin lights switch
4. Night lights switch
5. Forward chime fuse
6. Forward chime switch
7. Ordnance lights dimming switch
8. Cabin temperature indicator
9. Lavatories lights switch
10. Aft chime switch
11. Aft chime fuse
12. Cabin temperature selector

ward closet* or in the galley compartment† is the emergency flap extension handle. In the aft coat closet is a portable card table for the lounge, an evacuation ladder, and the cabin door safety bar.

4–243. DRINKING FOUNTAINS. One drinking fountain incorporating a six quart rectangular thermos is located on the left side of the fuselage, at the forward* and aft coat closets. A cup holder is fitted centrally above the water tap and is replenishable without removal. A spring-loaded flap door is located in the lower part of each unit for cup disposal into a removable container. Spillage from the drinking fountain drains through the wash water drain outlet.

4–244. AFT-PRESSURE BULKHEAD DOOR. A removable, circular door is located directly behind the triple-seat in the lounge affording access to the aft fuselage section. An inspection window is centered in the door. This door is held in place by four equally spaced latches that engage the convex side of the door flange.

4–245. To remove, take out the lounge seat upholstery, insert the special door handle (usually kept in the flight station) and turn clockwise until the latches release; then pull the door straight out.

4–246. MISCELLANEOUS EQUIPMENT. Ash trays are provided on the arms of all passenger seats, and the sidewall of each lavatory. Racks are installed above the seats running parallel to the fuselage. Magazine racks are located on the forward partition and sidewalls of the main passenger compartment, and on the right sidewall of the forward passenger compartment. A ticket punch is stowed in a bracket on the inside of the door to the aft flight attendant's storage compartment.

4–247. PASSENGER CALL SYSTEM. A combination call button switch and light is installed adjacent to each double- and triple-seat; in each lavatory; and in the lounge. When the call button is depressed the light turns on and stays on, until the call button is pulled out. An amber advisory light for the lounge, the lavatories and the forward passenger compartment glows on the partition adjacent to the aft cabin attendant's station when the call button is depressed indicating the location of the call. An additional advisory light in the galley area informs the forward cabin attendant of a call in the forward passenger compartment. Circuit breakers for the call lights are on the upper 260 panel in the flight station. Two momentary chimes are installed, one forward and audible in the galley area, and one aft at the cabin attendant's station. The chimes sound, momentarily, when a call button is depressed. They may be individually disconnected by switches on the cabin attendant's control panel. Fuses for the chimes are also on this panel.

4–248. CARGO COMPARTMENTS. Two cargo compartments are located beneath the flooring of the main passenger section. The forward compartment extends from the rear wall of the nose wheel well to the front beam of the stub wing section and affords 266 cu. ft. of usable space. The aft compartment extends from the rear beam of the stub wing section to the bulkhead just aft of the main passenger entrance, and affords 390 cu. ft. of usable space.

4–249. Five overhead lights are provided in each compartment and are controlled by the opening and closing of any of the four access doors. An override switch, located on the flight engineer's upper switch panel, will energize these lights for inspection purposes when the access doors are closed. The compartments may be inspected in flight by removing any one of the four internal hatches, located in the flooring of the center aisle in the main passenger compartment. It is necessary to remove the carpet above the hatches. The forward hatch to each compartment has an inspection window fitted with a wide-angle lens.

4–250. Both cargo compartments are pressurized and insulated. Removable, laminated glass-cloth panels enclose the ceiling and side wall areas. The flooring is of aluminum alloy sheet with stainless steel non-skid strips. Collapsible fences are installed around each compartment door to insure that these areas are kept clear. The fences consist of straps attached to four posts, the upper ends of which are spring-loaded. The upper ends of the two inboard posts are attached to the fuselage structure and may be hung out of the way when loading or unloading. The other two post ends locate in holes when the assembly is in use.

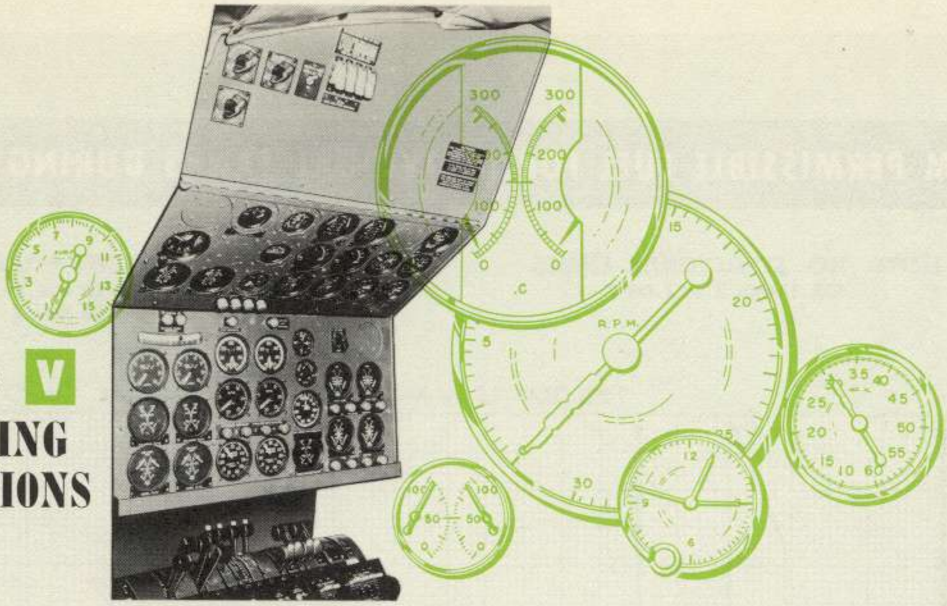
4–251. CARGO COMPARTMENT DOORS. Each compartment has two external doors equipped with a microswitch that is energized when the doors are unlatched. These switches energize the same warning light on the flight engineer's upper instrument panel that is illuminated when either passenger entrance door is unlatched.

4–252. The aft door of the forward cargo compartment and the two doors of the aft compartment are basically similar. Each hinges inward to the side of the fuselage and incorporates two tumble locks that engage a bar attached to the fuselage to lock the door when closed. The locking mechanism may be operated by either a flush-mounted handle, recessed on the outside of the door, or by a handle on the inside. To remove these doors, take out the retainer ring from each hinge pin, remove the hinge pins (while the door locks are unfastened) and lift the door clear of the frame.

4–253. The forward cargo compartment access door is located in the rear bulkhead of the nose wheel well. It slides up and aft on tracks into the upper section of the compartment permitting unobstructed entry for cargo handling. To open the door, turn the outside handle counter-clockwise and push up and aft. A door handle is located on the inside that works off a common shaft. To remove the door, take out the screw and nut securing the door hinge to the side of the door frame and slide the door aft and off its tracks.

V

OPERATING LIMITS



Section V OPERATING LIMITATIONS

PART I

Note

Part I of this section has been taken from Section I of Lockheed Report 7787 *(CAA Approved Flight Manual)*. If any discrepancies exist between the two, LR 7787 will govern.

5–1. WEIGHT LIMITS

5–2. GENERAL. Model 1049 airplanes shall be operated in accordance with the approved loading schedule.

5–3. TAKE-OFF WEIGHT LIMIT. The maximum take-off weight is 120,000 pounds up to an altitude of 100 feet unless restricted by runway length.

5–4. LANDING WEIGHT LIMITS. The maximum landing weight is 98,500 pounds up to an altitude of 5750 feet, unless restricted by runway length.

Note

For maximum take-off and landing weights at altitudes above those shown, and for minimum effective runway lengths, see Lockheed Report 7787.

Any weight in excess of the maximum landing weight must consist of disposable fuel.

5–5. FUEL LOADING AND USAGE LIMITATIONS.

5–6. Main tanks (1, 2A, 3A, and 4), tank-to-engine, and with auxiliary fuel boost pumps for these tanks on HIGH, shall be used for take-off and landing.

5–7. Maximum zero fuel weight—93,500 lbs.

5–8. Do not land with more than 1200 gallons (each) in tanks 1 and 4, or 515 gallons (each) in tanks 2A and 3A.

5–9. Figure 5-1 shows the variation of minimum permissible fuel in each tank with airplane gross weight necessary to comply with structural limitations. For example, if it is necessary to make a flight with tanks 2 and 3 empty with maximum payload and 2000 gallons of fuel, the procedure shown in paragraph 5–10 following, should be used.

5–10. The airplane could be loaded to 93,500 lbs. zero fuel weight. The gross weight for the flight then is $93{,}500 + (6 \times 2000) = 105{,}500$ lbs. For this weight, Figure 5-1 shows minimum allowable fuel in tanks 2A & 3A, and tanks 1 & 4, of 415 and 500 gallons respectively. The obvious division of fuel, therefore, should be 500 gallons in each of these tanks in order to obtain the desired total fuel load of 2000 gallons. During flight, as the gross weight decreases, it is necessary to maintain a quantity in each tank equal to or greater than the minimums shown on Figure 5-1.

5–11. Deleted.

MINIMUM PERMISSIBLE FUEL FOR INDIVIDUAL TANKS DURING FLIGHT

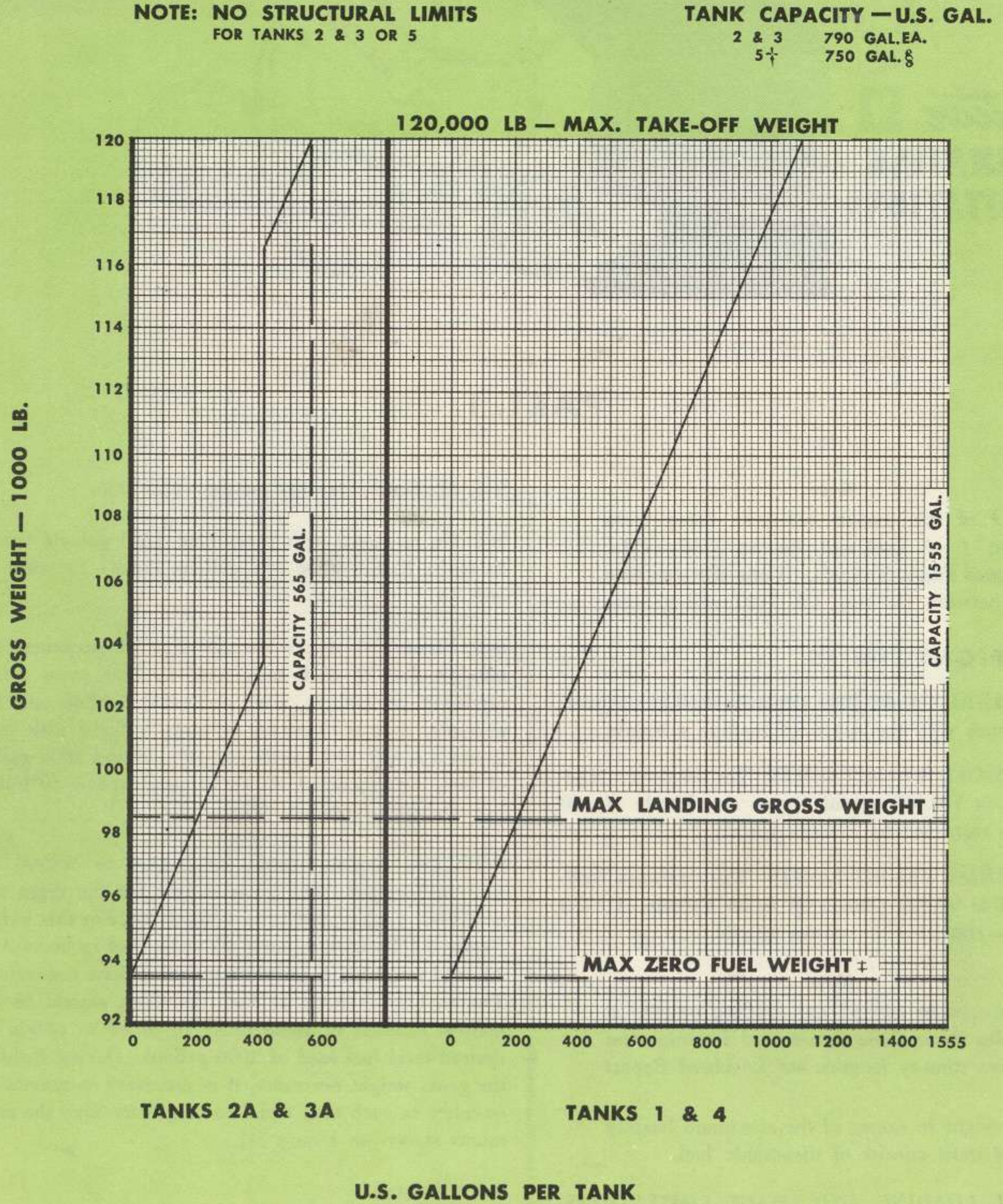


figure 5-1

†LAC Serials 4015–4024

§ Approximate value; exact value to be submitted when available.

‡If fuel is carried in tank No. 5, reduce by amount equal to the weight of that fuel.

5–12. During flight, there is no maximum limit on the quantity of fuel in any single tank (as long as lateral balance is maintained within limits set forth in this section), and as long as the quantity is greater than the minimum values shown for each tank on Figure 5-1.

5–13. LATERAL UNBALANCE OF FUEL LOAD.

5–14. The following table presents the maximum safe fuel differential between opposite tanks:

Tank	MAX. DIFFERENTIAL — GALS.* Flight or Landing	Take-Off
2A and 3A	565	200
or		
1 and 4	900	300
or		
2 and 3	790	790

* Symmetrical balance in loading of the other four tanks must be maintained if maximum unbalance differential is desired or necessary in any pair of opposite tanks.

5–15. In addition to restricting lateral unbalance to the values shown, it is necessary to observe the minimum permissible loadings for each tank as shown on Figure 5-1.

5–16. CENTER OF GRAVITY LIMITS

5–17. For the forward and aft center of gravity limits, refer to Figure 5-2.

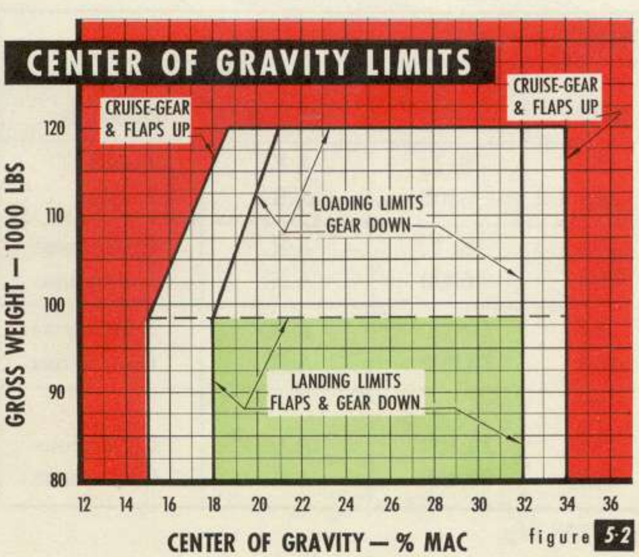


figure 5-2

5–18. POWER PLANT LIMITS

5–19. ENGINE.

a. Manufacturer	Wright Aeronautical Corp.
b. Model	956C18CA1* 975C18CB1†
c. Propeller drive ratio	.4375 to 1
d. Compression ratio	6.7 to 1
e. Impeller ratios	6.46 and 8.67 to 1
f. Fuel minimum octane	115/145, AMS Spec. 3036A
g. Oil Grade	120 second, WAC Spec. 5815

h. Temperatures (maximum).

	Eng. Spec.	Gage Marking
Cylinder head (take-off power)	260°C.	253°C.
Cylinder head (METO power)	246°C.	239°C.
Cylinder head (max. cruise power)	232°C.	225°C.
Oil inlet (take-off & METO power)	104°C.	94°C.

i. Pressures (in psi).

	MAXIMUM Eng. Spec.	MAXIMUM Gage Marking*	MINIMUM Eng. Spec.	MINIMUM Gage Marking*	IDLE Eng. Spec.	IDLE Gage Marking
Oil Pressure	75	75	65	65	15	—
Fuel Pressure	25	26	23	24**	—	—

* To avoid the possibility of operating with fuel and oil pressures outside the specified limits, as a result of instrument tolerances, the gages have been red-line marked and the pressures set in accordance with the new gage limits shown.

** 18 psi is emergency minimum.

5–20. POWER LIMITS. The table on the following page gives the engine manufacturer's power limits which do not include installation effects.

5–21. PROPELLER LIMITS.

a. Manufacturer	Hamilton Standard
b. Blades	6901A-0
c. Hub	43E60
d. Diameter	15′ 2″
e. Low pitch setting	12.0°
f. Feathered setting	81.5° (approximately)
g. Reverse pitch setting	—21.5°
h. Max. governing rpm	2900
i. Min. governing rpm	1350

*LAC Serials 4001–4014 †LAC Serials 4015–4024

j. Pre-take-off propeller check. The following checks should be made prior to take-off, to assure that the propellers are in forward pitch position:

1. Set all four engines at 1500 to 1700 rpm with the master propeller control in full INC. RPM position.

2. Run all four governors to full DEC. RPM as indicated by glowing of the limit lights. RPM should reduce quickly to minimum setting of the governors.

3. Engage the feathering button on each engine momentarily. If the rpm increases, the blades are in reverse pitch and take-off should not be attempted.

Note

On airplanes equipped with four reverse pitch indicator lights which are located so as to be easily visible to all three flight crew members, the procedure in paragraph 5–21, j, 3 may be omitted. Check reverse pitch indicator lights just prior to take-off run.

k. Unfeathering procedure:

1. Make sure the governor is set at full low rpm (indicator light on). Open the propeller reverse circuit breaker. (This must be done to prevent inadvertent reversing of the propeller in the event of failure of the throttle reversing switch.) Reduce airspeed to 139 knots (160 mph), then pull the feathering button out for one second and release. Pause several seconds and repeat until the propeller starts rotating. As soon as the propeller starts rotating, allow the governor to control the rpm without further use of the feathering button.

CAUTION

Do not hold the feathering button out longer than one second at a time, because the blades may unfeather very quickly to the low pitch stop and may cause overspeeding. Improper unfeathering may result in propellers slipping through the low pitch stops and going into reverse pitch.

2. Move the mixture control smoothly to AUTO-RICH.

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

l. Do not reverse propellers in flight.

5–22. POWER PLANT INSTRUMENT MARKINGS.

a. Maximum and minimum limits: red radial line

b. Take-off and precautionary ranges: yellow arc

c. Normal operating ranges: green arc

d. Prohibited operating ranges: red arc

5–23. SPEED LIMITATIONS

5–24. NEVER EXCEED SPEED—V_{NE}—. Maximum glide or dive speed from sea level to 11,000 feet is 293 knots (338 mph). Reduce airspeed 11 knots (12 mph) for each 2000 feet above 11,000 feet.

Note

The maximum placard glide or dive speed at the higher altitudes is dictated by a limiting Mach. number of .54. No compressibility effects have been encountered in flight up to a Mach. number of .6, the highest value tested. Wind tunnel data indicates that no compressibility effects will be encountered at Mach. numbers below .67. However, at some Mach. number above .67 buffeting, along with a pitching moment can be expected. Best recovery procedure is to reduce power and make a gradual pull-out.

POWER LIMITS

Operating Condition	Horse-Power	RPM	Manifold Pressure	BMEP	Alt.	Mixture	Max. Duration
Take off	2700	2900	54.0* 52.5†	220	S. L.	A.R.	5 Min.
low blower	2700	2900	52.5	220	5100	A.R.	5 Min.
METO	2300	2600	47.0	209	S. L.	A.R.	Continuous
low blower	2300	2600	45.5	209	6300	A.R.	Continuous
METO	2000	2600	48.0	182	10,600	A.R.	Continuous
high blower	2000	2600	46.5	182	15,800	A.R.	Continuous
Max. in auto lean							
low blower	1600	2400	‡	158§	12,100	A.L.	Continuous
high blower	1500	2400	‡	148§	20,400	A.L.	Continuous

‡ Maximum permissible MAP in auto lean mixture — 38" Hg.

§ For engine speeds below 2400 rpm, maximum BMEP; 150 low blower, 145 high blower.

*LAC Serials 4001–4014 †LAC Serials 4015–4024

5–25. NORMAL OPERATING LIMIT SPEED—V_{NO}—. Maximum level flight or climb speed from sea level to 11,000 feet is 260 knots (300 mph). Reduce airspeed 9 knots (10 mph) for each 2000 feet above 11,000 feet.

5–26. MANEUVERING SPEED—V_A—. Maximum deflection of the flight controls should be confined to speeds below 180 knots (208 mph).

5–27. FLAPS EXTENDED SPEED—V_{FE}—.

Flap Setting	Max. Speed (knots)	Max. Power
Take-off (60%)	184 (212 mph)	Take-off
Approach (66%)	161 (186 mph)	Take-off
80%	153 (177 mph)	Take-off
Landing (100%)*	148 (171 mph)	Take-off

* The high end of the white arc, on the airspeed indicator, is placed at the maximum airspeed at which the airplane can be operated with the flaps in the landing position.

5–28. LANDING GEAR OPERATING SPEED—V_{LO}—. The maximum speed at which the landing gear may be lowered or raised is 165 knots (190 mph).

5–29. LANDING GEAR EXTENDED SPEED—V_{LE}—. The maximum speed at which the airplane can be operated with the landing gear extended and locked is 165 knots (190 mph).

5–30. MINIMUM CONTROLLABILITY SPEED WITH ONE ENGINE OUT. Minimum controllability speed in the air with failure of one outboard engine (windmilling propeller), with take-off power on the remaining three engines, with wing flaps in the take-off position, and with the landing gear retracted or extended, is 87 knots (100 mph).

5–31. LANDING LIGHT OPERATION SPEED. Do not extend landing lights at speeds in excess of 156 knots (180 mph).

5–32. AIRSPEED INDICATOR MARKING.

Code	Significance	Symbol	Limits (Knots)	Limits (MPH)
Red radial line	Never exceed speed	V_{NE}	293	338
Yellow arc	Caution range	V_{NO} to V_{NE}	260 – 293	300 – 338
Green arc	Normal operating range	V_{s_1} to V_{NO}	115 – 260	132 – 300
White arc	Flaps extended range	V_{s_0} to V_{FE}	82 – 148	95 – 171

5–33. DEMONSTRATED CROSSWIND

5–34. The maximum crosswind component so far demonstrated on this airplane is 30 knots (35 mph). This is not a limiting value but represents the maximum value available at the time of the certification tests.

5–35. When determining the effective take-off and landing runway lengths in a crosswind, the full headwind component can be used, provided that the corresponding crosswind component does not exceed 30 knots (35 mph).

5–36. FLIGHT LOAD ACCELERATION LIMITS

5–37. Flaps up: 2.50 G's (at 120,000 lbs.)

5–38. Flaps down: 2.00 G's (at 98,500 lbs.)

5–39. TYPE OF AIRPLANE OPERATION

5–40. Transport category.

5–41. Instrument night flying (when the required equipment is installed).

5–42. MINIMUM CREW

5–43. The minimum crew with which this airplane can be flown consists of a pilot, copilot, and flight engineer.

5–44. FUEL DUMPING

5–45. Do not dump fuel with the gear or flaps down, or at speeds above 189 knots (218 mph). Do not release flares while dumping. Turn off all unnecessary electrical equipment and the cabin heaters.

5–46. DE-ICING

5–47. The de-icing capabilities of this airplane have not been demonstrated. However, the airplane is considered to have de-icing characteristics equivalent to the previous airplanes of the Constellation series.

5–48. MAXIMUM OPERATING ALTITUDE

5–49. The maximum normal operating altitude for this airplane is 25,000 feet.

5–50. CABIN PRESSURIZATION

5–51. Maximum cabin differential pressure—5.5 psi.

5–52. Maximum emergency relief pressure—5.66 psi.

5–53. Cabin pressurization is not permitted during take-off and landing.

5–54. PASSENGER LOADING LIMITATIONS

5–55. Do not load passengers through forward door on left side with adjacent engines operating.

5–56. AUXILIARY SURFACE CONTROL BOOSTER SYSTEM

5–57. The auxiliary booster system must be turned ON for take-off and landing.

5–58. GALLEY DOOR

5–59. The door between the galley and the passenger cabin must be secured in the open position during all take-offs and landings.

5–59A. PASSENGER SEATS†

5–59B. On airplanes equipped with TECO Reversible Seats, the occupied seats must be facing forward for all take-offs and landings.

PART II

5–60. GENERAL

5–61. The limitations and settings given in Part II below are in addition to the limitations imposed by the C.A.A. and given in Part I.

5–62. BRAKE SYSTEM

Normal Pressure 1675 (+25, —150) psi.

Maximum Pressure (setting of parking brake emergency pressure warning light) — Comes on at 1450 ±50 psi. Goes off at 1150 ±50 psi.

Debooster and Debooster Lockout Cylinders — Reduce pressure to 900 ±25 psi.

5–63. PNEUMATIC DE-ICING SYSTEM

Normal Suction	5-7 inch of Hg.
Minimum Suction	4 inch. of Hg.
Normal Pressure	18-22 psi.
Maximum Pressure	26 psi.
Vacuum pump warning light	On when suction is less than 4 (+.25, —.0) in. Hg.

5–64. 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—300 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 amp. Potential relay closes at 20-24 volts, opens at 18 volts or less.

Voltage applied to airplane from External Power Source

Normal	26–29 volts.
Minimum	20 volts at peak surges.

A.C. SYSTEM

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 —2140 engine rpm.

6-hour duty —2140–2570 engine rpm.

1-hour duty —2570–2900 engine rpm.

†LAC Serials 4015–4024

5–65. ENGINE OIL SYSTEM

Oil Low Pressure Warning Light	—Comes on at 55 ± 5 psi.
Oil Cooler — Surge Valve	—Opens at 60–70 psi.
	Closes at 45 psi.
By-pass Valve	—Opens at 40 psi.
	Closes at 37 ± 3 psi.

5–66. FUEL SYSTEM

Low Fuel Pressure Warning Light	—Comes on at 20 ± .5 psi.

Auxiliary Fuel Booster Pumps (Do not turn pumps ON in dry tank.)

With engine-driven fuel pumps operating	—HIGH setting, 25-27 psi.
	LOW setting, 24-26 psi.
Fuel cross-feed thermal 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.

5–67. HYDRAULIC SYSTEM

Primary Hydraulic System

Normal Pressure	—1700 (+0, —25) psi.

Secondary Hydraulic System

Normal Pressure	—1700 (+0, —25) psi.
Max. Pressure	—Relief valves open at 1800 (—0, +50) psi.
Min. Pressure	—Relief valves close at 1300 psi.
Low Pressure Warning Light	—On at 1325 ± 50 psi.
	Off at 1450 ± 50 psi.
Thermal Relief Valves	—Open at 3000 (+100, —0) psi.
	Close at 2400 psi.
Reservoir Relief Valve (Air)	—Opens at 30 (+0, —5) psi.
	Close at 23 psi.
Cross-over Check Valve	—Opens at 300–400 psi. differential pressure between primary and secondary hydraulic systems.

5–68. STRUCTURAL LIMITATIONS

5–69. Flight of any airplane 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.

5–70. In normal level flight the wing supports a load equal to the airplane's weight. When acceleration is applied to the airplane, 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 airplane's weight depending on the nature of the acceleration. The ratio of the load actually sustained by the wing to the weight of the airplane is called the load factor. The basic C.A.A. load factor requirement to which all transport airplanes are designed is 2.5.

5–71. 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 SPEED.

5–72. The reason for this precaution is explained by the fact that for an airplane entering a gust, the additional load imposed by the gust is directly proportional to the airplane's speed. Although for a given gust velocity,

STRUCTURAL LIMITATIONS

GUST STRENGTH ENVELOPE AT 120,000 LB. GROSS WEIGHT

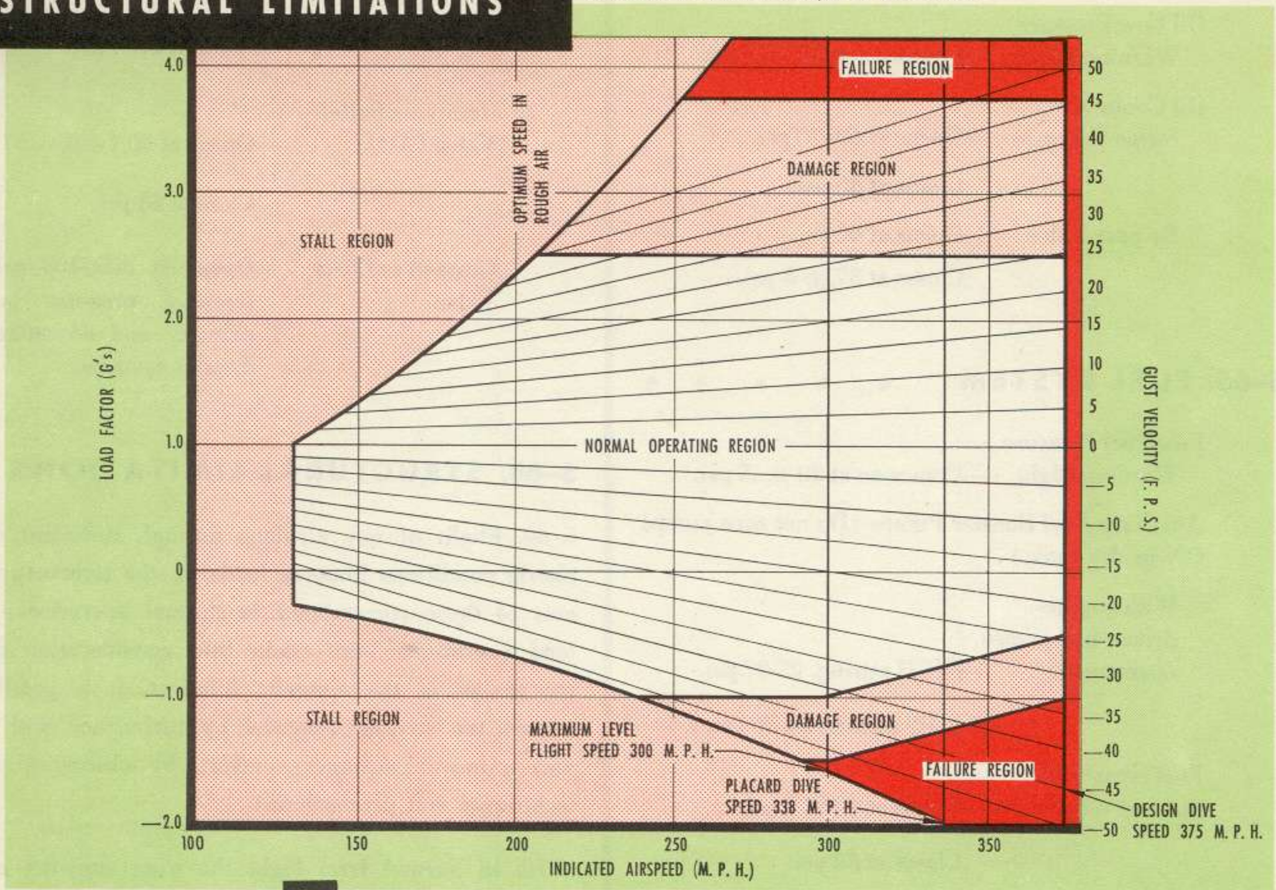


figure 5-3

the change in wing angle of attack to the relative wind decreases as the airplane speed increases, the load produced by the change in angle increases as the square of the speed.

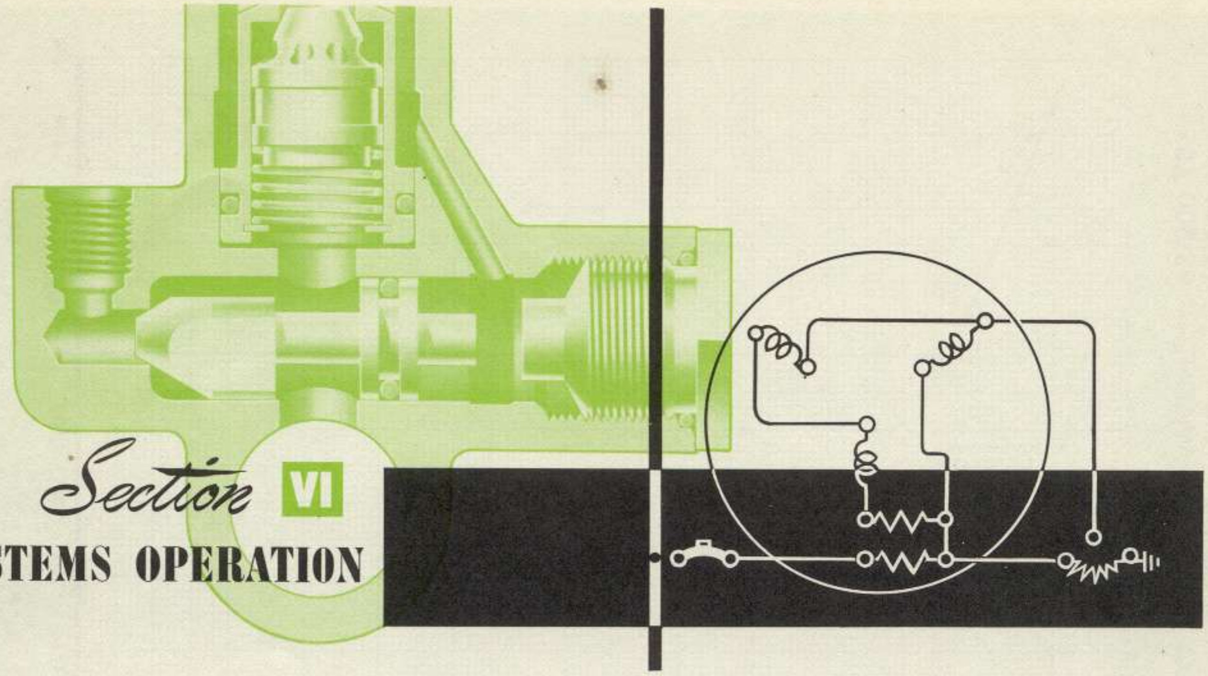
5–73. Because of these factors, it is apparent that it is advantageous from the standpoint of airplane strength to slow down in rough air. If this is carried too far, however, the danger of stalling of the wing by a gust is increased.

5–74. An up-gust has the same effect as a sudden increase in the wing angle of attack: hence, if the airplane 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.

5–75. Analysis of the structural and aerodynamic capabilities of the Constellation airplanes indicates that at about 175 knots (200 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 mph above the stall speed with gear and flaps up at 1g exists at this speed. The acceleration required to stall the airplane is approximately 2.5g.

VI

SYSTEMS OPERATION



Section VI
SYSTEMS OPERATION

6–1. PROPELLER

6–2. NORMAL OPERATION. Place the master engine selector switch to either No. 1 or No. 2, whichever is the more stable. Be sure the synchronizer circuit breaker switch is on. Move the master propeller control lever to the full forward position, until the propeller governor high and low position indicator lights come on. In this position, synchronization is eliminated and all the governors are under control of the calibrate system.

6–3. On the engine run-up at the end of the runway, exercise the propellers by running the rpm up to 1500 rpm with the throttles, then slowly pulling back on the master propeller control lever to the stop on the rear of the quadrant. The propeller governor high and low position indicator lights should light and remain on and the rpm should drop to 1350 rpm. Move the master propeller control lever to the forward end of the quadrant. The propeller indicator lights should go out, then come on again and stay lighted, and the rpm should increase to 1500 and stabilize. Repeat the test with the rpm toggle switches.

6–4. On take-off, the master propeller control lever should be full forward, the four-propeller governor indicator lights on, and the master engine selector switch on No. 1 or No. 2. After power reduction is made, reduce the rpm by slowly pulling back on the master propeller control lever until the tachometer of the master engine reaches the desired rpm. The others will automatically synchronize at this rpm. When cruise rpm is reached and synchronized, push the synchronizer reset button to re-center the limits of synchronization to ±3%. This button should only be used for this purpose and should not be used indiscriminately, especially in rough weather, when the engines may be hunting excessively. If one engine should overspeed, the individual propeller can be brought under control by use of the individual governor switch. Also, if any change of rpm on one engine is desired, use of the individual governor switch is recommended. It will be noted that operation of this switch may be followed by a small return toward the master engine rpm. Whenever a propeller is brought back to the synchronizing range with an rpm toggle switch, the re-synchronizer button should be pushed to center the synchronizing range.

6–5. FUEL SYSTEM

6–6. MANAGEMENT.* Take-offs and landings are to be made with tanks 1, 2A, 3A, and 4 supplying fuel to respective engines.

6–7. For recommended fuel loading, refer to figure 6-1. If it is desired to use loadings that are different from those recommended on figure 6-1, refer to paragraphs 5–9 through 5–12.

6–8. Refer to figure 6-2 for the proper fuel consumption sequence. If a different consumption sequence is desired, refer to paragraphs 5–9 through 5–12.

6–8A. MANAGEMENT.† Take-offs and landings are to be made with tanks 1, 2A, 3A, and 4 supplying fuel to respective engines.

6–8B. For recommended fuel loading, refer to figure 6-1A. If it is desired to use loadings that are different

*LAC Serials 4001–4014 †LAC Serials 4015–4024

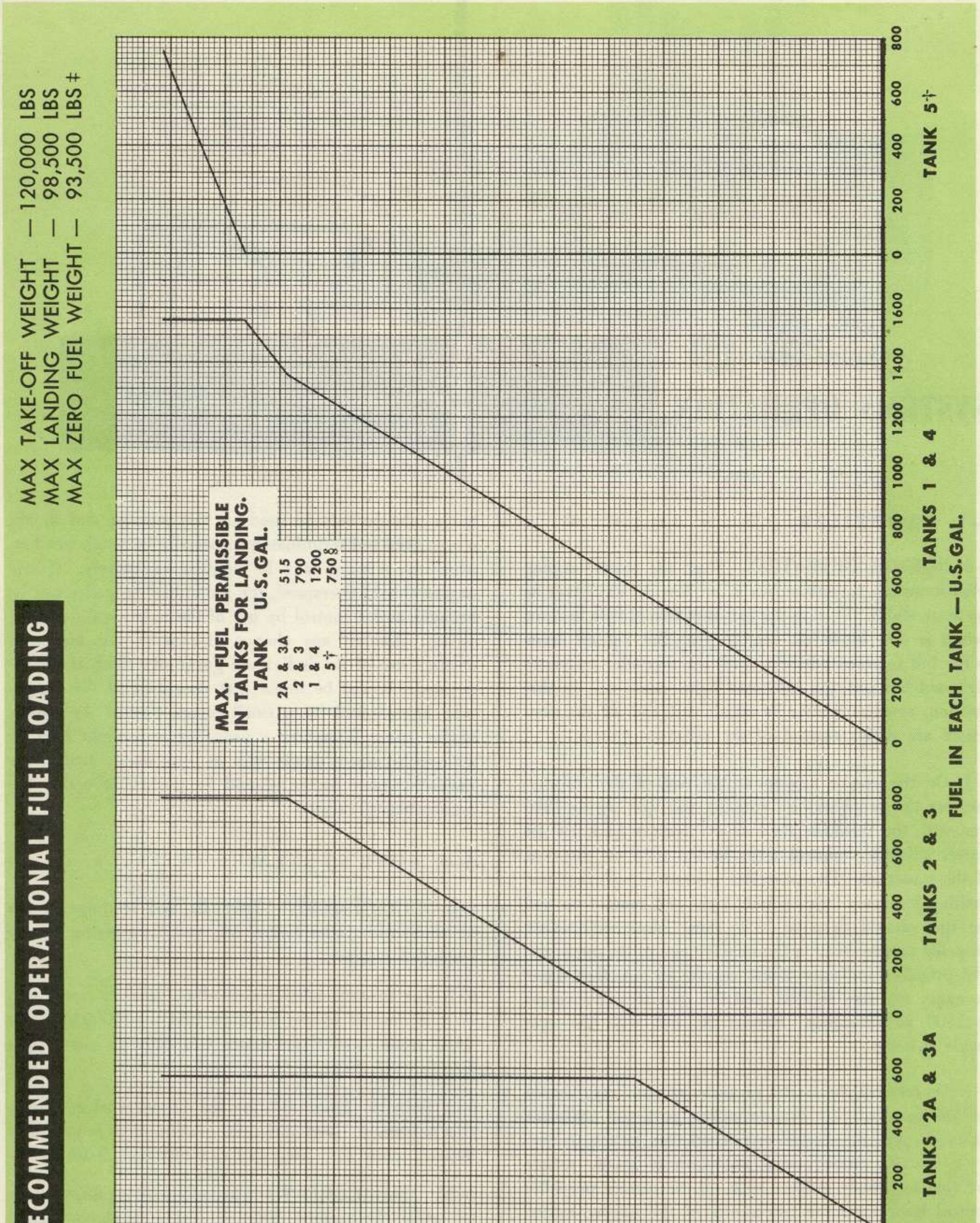

RECOMMENDED OPERATIONAL FUEL LOADING
MAX TAKE-OFF WEIGHT — 120,000 LBS
MAX LANDING WEIGHT — 98,500 LBS
MAX ZERO FUEL WEIGHT — 93,500 LBS ‡
MAX. FUEL PERMISSIBLE IN TANKS FOR LANDING.
TANK U.S.GAL.
2A & 3A 515
2 & 3 790
1 & 4 1200
5† 750§
TOTAL FUEL LOAD — U.S.GAL.
0
1000
2000
3000
4000
5000
6000
7000
TANKS 2A & 3A
0 200 400 600
TANKS 2 & 3
0 200 400 600 800
TANKS 1 & 4
0 200 400 600 800 1000 1200 1400 1600
TANK 5†
0 200 400 600 800
FUEL IN EACH TANK — U.S.GAL.
† LAC Serials 4015–4024
§ Approximate value; exact value to be submitted when available.
‡ If fuel is carried in tank No. 5, reduce by amount equal to the weight of that fuel.

figure 6-1

from those recommended on figure 6-1A, refer to paragraphs 5–9 through 5–12.

6–8C. Refer to paragraphs 6–8E through 6–8K for the proper fuel consumption sequence. If a different consumption sequence is desired, refer to paragraphs 5–9 through 5–12.

6–8E. OVER 6220 GALLONS. If recommended fuel loading is followed and total fuel on board is over 6220 gallons, use fuel in sequence as follows:

a. Take-off and climb on tank-to-engine operation from tanks 1, 2A, 3A, and 4. Continue this feed until 150 gallons have been used from each of these tanks.

b. Switch engines 2 and 3 to operate through crossfeed valves from tank 5 until that tank is empty.

Note

Always burn fuel from tank 5 through crossfeed valves to engines 2 and 3 simultaneously.

c. Switch engine 3 to tank 3 direct; switch engines 1 and 2 to operate through crossfeed valves from tank 2 until the sum total of fuel in tanks 2A and 2 is equal to that in tank 1.

d. Switch engines 1 and 2 to tank-to-engine operation from tanks 1 and 2; switch engines 3 and 4 to operate through crossfeed valves from tank 3 until the sum total of fuel in tanks 3A and 3 is equal to that in tank 4.

e. Switch all engines to tank-to-engine feed from tanks 1, 2, 3, and 4 until tanks 2 and 3 are empty.

f. Switch engines 2 and 3 to tanks 2A and 3A.

6–8F. FROM 6220 TO 5820 GALLONS. If recommended fuel loading is followed and the total fuel on board is between 6220 and 5820 gallons, use fuel in sequence as follows:

a. Take-off and climb on tank-to-engine operation from tanks 1, 2A, 3A and 4. Continue this feed until 150 gallons is used from each of these tanks.

b. Switch engines 2 and 3 to operate through crossfeed valves from tank 5 until this tank is empty.

Note

Always burn fuel from tank 5 through crossfeed valves to engines 2 and 3 simultaneously.

c. Switch engine 3 to tank 3 direct; switch engines 1 and 2 to operate through crossfeed valves from tank 1 until the excess of fuel in tank 1 over the total in tanks 2 and 2A is consumed.

d. Switch engines 1 and 2 to direct feed from tanks 1 and 2; switch engines 3 and 4 to operate through crossfeed valves from tank 4 until the excess of fuel in tank 4 over the total in 3 and 3A is consumed.

e. Switch all engines to tank-to-engine feed from tanks 1, 2, 3 and 4 until tanks 2 and 3 are emptied.

f. Switch engines 2 and 3 to tanks 2A and 3A.

6–8G. If fuel load is 6220 gallons, follow procedure given in paragraph 6–8F but omit steps c. and d.

6–8H. FROM 5820 TO 5420 GALLONS. If fuel load is between 5820 and 5420 gallons, follow procedure given in paragraph 6–8F but omit step b.

6–8J. FROM 5420 TO 2260 GALLONS. If fuel load is between 5420 and 2260 gallons, follow procedure given in paragraph 6–8F but omit steps b., c. and d.

6–8K. BELOW 2260 GALLONS. If fuel load is below 2260 gallons, feed tank-to-engine from tanks 1, 2A, 3A and 4 during entire flight.

6–9. REFUELING WITH PASSENGERS ABOARD. Passengers may remain in the cabin during refueling operation provided:

a. There is no smoking in the airplane.

b. There is no smoking on the ground in the vicinity of the airplane.

c. An employee of the operator is stationed in the entrance to the passenger cabin and remains there, alert for any emergency, until refueling is completed.

d. Passenger loading stairways are in position at the entrances and the doors are open.

e. At night only, the battery switch and cabin lights may be left on dim, navigation lights may be turned off or left on steady, as required by the airport, but all radio equipment, inverters, motors, and similar electrical equipment must be off, and no switches are to be operated after refueling is started.

f. The auxiliary power source must be shut down if it is not explosion proof.

6–10. COMBATING CARBURETOR ICING. With the fuel injection engine, the occurance of throat ice or refrigeration ice is very rare. Furthermore, precipitation particles of large density are removed by inertia separation at the induction scoop entrance. Icing in this installation, therefore, results from very fine particles of ice in the impact tube system of the carburetor. When visible moisture is present, with outside air temperatures below +10°C, the following steps should be taken when icing conditions are anticipated.

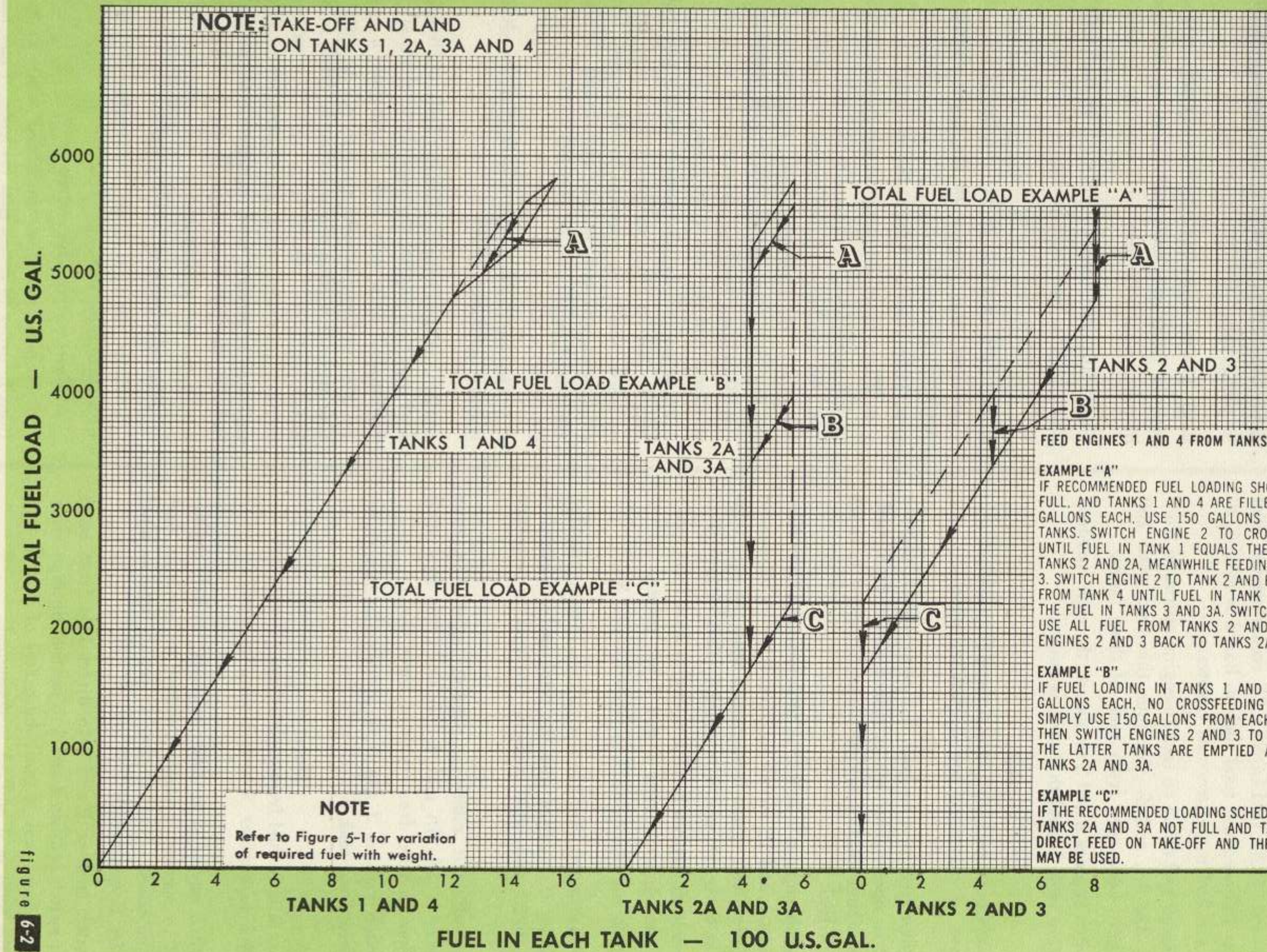
a. Mixture control—AUTO RICH.

b. Raise carburetor air temperature to 25°C—30°C with carburetor heat.

c. Reset mixture for cruising.

d. Monitor fuel flow and BMEP while in icing conditions in order to detect first evidence of any malfunction.

RECOMMENDED FUEL CONSUMPTION SEQUENCE *



FEED ENGINES 1 AND 4 FROM TANKS 1 AND 4 AT ALL TIMES

EXAMPLE "A"
IF RECOMMENDED FUEL LOADING SHOWS TANKS 2A AND 3A FULL, AND TANKS 1 AND 4 ARE FILLED TO MORE THAN 1355 GALLONS EACH, USE 150 GALLONS FROM EACH OF THESE TANKS. SWITCH ENGINE 2 TO CROSSFEED FROM TANK 1 UNTIL FUEL IN TANK 1 EQUALS THE SUM OF THE FUEL IN TANKS 2 AND 2A, MEANWHILE FEEDING ENGINE 3 FROM TANK 3. SWITCH ENGINE 2 TO TANK 2 AND ENGINE 3 TO CROSSFEED FROM TANK 4 UNTIL FUEL IN TANK 4 EQUALS THE SUM OF THE FUEL IN TANKS 3 AND 3A. SWITCH ENGINE 3 TO TANK 3. USE ALL FUEL FROM TANKS 2 AND 3 AND THEN SWITCH ENGINES 2 AND 3 BACK TO TANKS 2A AND 3A.

EXAMPLE "B"
IF FUEL LOADING IN TANKS 1 AND 4 IS LESS THAN 1355 GALLONS EACH, NO CROSSFEEDING WILL BE NECESSARY. SIMPLY USE 150 GALLONS FROM EACH OF TANKS 2A AND 3A, THEN SWITCH ENGINES 2 AND 3 TO TANKS 2 AND 3 UNTIL THE LATTER TANKS ARE EMPTIED AND THEN RETURN TO TANKS 2A AND 3A.

EXAMPLE "C"
IF THE RECOMMENDED LOADING SCHEDULE IS FOLLOWED, WITH TANKS 2A AND 3A NOT FULL AND TANKS 2 AND 3 EMPTY, DIRECT FEED ON TAKE-OFF AND THROUGHOUT THE FLIGHT MAY BE USED.

figure 6-2

*LAC Serials 4001–4014

Note

Impending loss of power is indicated by intermittent fluctuations of fuel flow and BMEP or gradual decrease or increase in fuel flow.

6–11. PROCEDURES TO COMBAT ICING. In case icing conditions are encountered without warning, and there is a BMEP drop, fuel flow loss or rpm surging, perform the following:

a. Follow steps a, b and c in the preceding paragraph (if not already done).

b. Leave (or set) mixture control in AUTO RICH. If fuel flow indicates that mixture is excessively rich, manually lean with mixture control.

c. Apply alcohol for 3 to 5 seconds, then release and observe whether stable power is regained. Continue intermittent application of alcohol until power is stabilized.

d. Reset mixture for cruising.

e. Leave heat on until approximately 5 minutes after leaving icing conditions. Then remove heat in progressive increments to assure that all ice is melted.

f. Observe for further power losses and re-apply above procedures if instability occurs.

g. 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.

6–12. The above procedures have been shown to be effective under all normal conditions where ice is likely to be encountered, i.e., at all altitudes below 20,000 feet and temperatures between +10°C and —25°C.

6–13. 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 enrichened and/or heating reduced. It may be necessary to use alcohol more frequently.

6–14. At ambient temperatures below —25°C, the amount of visible moisture in the air is extremely small and is not likely to cause icing trouble; however, the temperature in clouds may be considered different than outside the cloud. Therefore, it should be anticipated that icing conditions will be prevalent when entering a condition of visible moisture, and preventative measures should be taken.

6–15. EMERGENCY HYDRAULIC FILLER RESERVOIR*

6–16. Emergency hydraulic fluid may be used to replenish either the main reservoir or the emergency extension and hydraulic brake tank by the following method:

a. Emergency selector valve—set to reservoir to which fluid is to be transferred.

b. Operate emergency filler pump handle.

Note

If fluid fails to flow from the pump, the pump requires bleeding. Proceed as follows:

1. Pump bleed valve—OPEN.
2. Disperse air in pump by operating handle until fluid flows from bleed port.
3. Pump bleed valve—CLOSED.

6–17. BRAKES

6–18. GROUND OPERATION. When secondary hydraulic pressure is not available, the brake accumulators store the hydraulic pressure required to operate the brake system, and the following procedure should be used:

a. Brake selector—EMER.

b. Hand pump selector lever—BRAKE.

c. Emergency hand pump — Obtain brake pressure above 1300 psi by using the emergency hand pump before operating the brakes.

CAUTION

If the brakes are to be used to stop the airplane while it is being towed or while it is rolling, a crew member should be in the copilot's seat to operate the emergency hand pump to maintain the brake accumulator pressure at or above 1300 psi.

6–19. If the toe brakes are applied and released several times, and if the air pressure in the brake accumulators is allowed to drop below 1200 ± 50 psi without the brake pressure gage needle "dropping off," further use of the brakes will probably cause the emergency extension tank to overflow. The "dropping off" of the gage needle indicates the air charge in the accumulators, which at 1150 psi, or less, is inadequate for proper operation of the brakes. *Use the emergency hand pump, which will draw hydraulic fluid from the emergency extension tank and recharge the brake accumulators.*

6–20. When the engine-driven hydraulic pumps are operating, and the brake selector valve lever is in the EMER. position, the accumulators are charged and excess emergency brake return fluid is drawn from the top of the emergency extension reservoir by the aspirator. After the brakes are released for taxiing, move the brake selector valve lever to the NORM. position.

6–21. PARKING BRAKES OPERATION. With the brake selector valve in the EMER position, depress either the pilot's or the copilot's toe pedals and lift up the parking brake lever. The red warning light on the pilots' center instrument panel should go on. The warning light will not go on unless the selector valve is in the EMER. position and the parking brake lever lifted.

*LAC Serials 4001—4014

6–22. To release the parking brakes, depress either the pilot's or copilot's toe pedals. The red warning light should go out, indicating the brakes are off.

6–23. The parking brakes will remain set for approximately 24 hours until the action of the brake control valve has depleted the fluid in the accumulators.

6–24. HAND LEANING

6–25. The engine fuel metering is designed to give best economy in the AUTO LEAN mixture position. However, variables such as atmospheric conditions, induction configuration (alternate air source, pre-heat, etc.) 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 procedure outlined in the following:

CAUTION

Manual mixture control should not be used outside of the normal AUTO LEAN cruise power settings as outlined in the operating instructions issued by the engine manufacturer.

a. Set desired rpm.

b. Set desired BMEP in AUTO RICH.

c. Hand lean until BMEP gage shows best power.

d. Reset desired BMEP with throttle.

e. Hand lean for a 10% BMEP drop.

f. Open throttle to originally desired BMEP.

Note

It may be necessary to pull the mixture control back beyond the AUTO LEAN position toward OFF to get the desired setting.

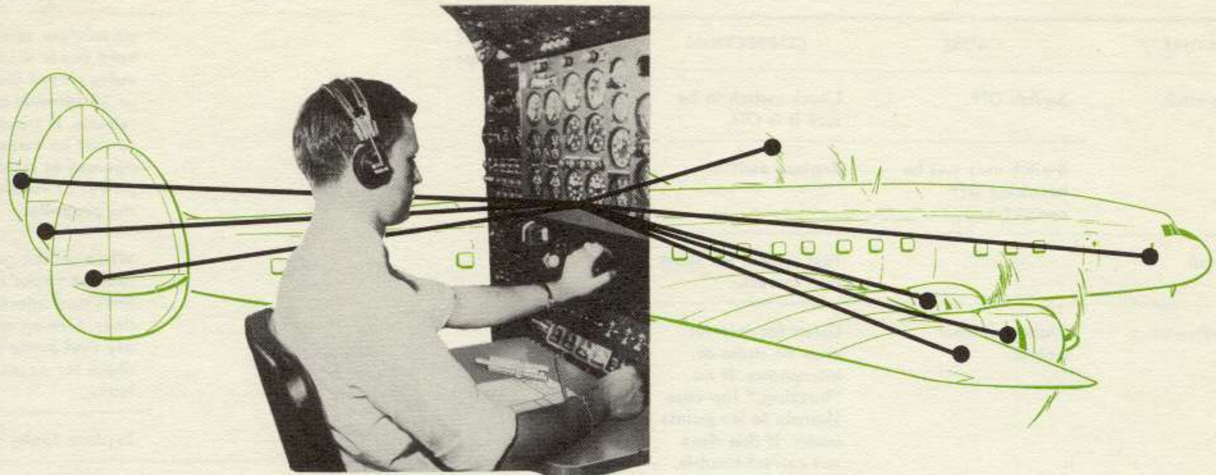
VII

TROUBLE SHOOTING

SECTION VII

INFORMATION CONTAINED IN THIS SECTION IS BEING REVISED AND NEW TEXT WILL BE INCLUDED IN THE NEXT REVISION.

(This page to be inserted between Section VII divider and page 205.)



Section VII TROUBLE SHOOTING

7–1. TROUBLE SHOOTING

7–2. GENERAL. This section presents some of the checking procedures which are most likely to expose the cause of possible troubles and their remedy. Other information will be added to this section from time to time as experience is gained.

7–3. ENGINE MALFUNCTION

7–4. STARTING FAILURE. One or more of the following checks may reveal the cause of a starting failure.

a. Fuel System Malfunction.

NATURE	CAUSE	CORRECTION
Lack of fuel.	Fuel valves closed.	Check fuel valves for ON and fire wall shut-off valves for OPEN.
	Mixture control stuck in OFF position.	Check mixture control rigging and linkage.
Insufficient fuel pressure.	Circuit breaker out.	Check circuit breaker.
	Dirty fuel strainer.	Check main fuel strainer and carburetor strainer.
	Low voltage.	Check voltage regulator.
	Malfunctioning fuel pump.	Check auxiliary fuel pump for delivery.
Insufficient priming.	Cold weather.	Extremely cold weather may necessitate use of primer. Use primer simultaneously with starter switch.
Insufficient fuel.	Mixture control in OFF position too long.	Do not wait too long to put mixture control in AUTO RICH on warm starts.
Excessive fuel.	Primer stuck open.	Indication: Fuel flowing out of blower case or primer line connection when the latter is loosened. Tap primer sharply. Test circuit to see if valve is being held open as a result of electrical malfunction. If no results, replace solenoid valve.
	Mixture control moved to AUTO RICH too soon.	Do not advance mixture control to AUTO RICH position too soon on warm starts.
		Open throttle farther and proceed with start. **CAUTION** Do not allow engine to accelerate too rapidly or to overspeed.
	Malfunctioning carburetor.	Check blower case drain for fuel flow. Replace carburetor if other possible trouble causes have been eliminated.

b. Ignition System Malfunction.

NATURE	CAUSE	CORRECTION
Ignition switch.	Switch OFF.	Check switch to be sure it is ON.
	Switch may not be breaking OFF contact.	Replace switch.
Short circuit.		Test system for short and correct.
Booster vibrator.	Frozen contact points.	Listen for interference on radio or interphone. If no "buzzing," tap case sharply to jar points apart. If this does not correct trouble, replace vibrator.
Spark plugs.	Fouled or wet.	Remove front plugs and clean with trichlorethylene or carbon tetrachloride, or replace with new plugs.
Connectors (Spark plugs to coils.)	Moisture-covered or dirty.	Wipe thoroughly with clean, dry rag, and replace. Do not touch insulator with fingers.
Distributors.	Carbon track.	Remove with gasoline-soaked cloth.
	Points corroded or out of adjustment.	Check gap and condition. Clean or replace.

7–5. ROUGH OPERATION. If the engine starts but does not run smoothly, apply the following tests.

a. Fuel System Malfunction.

NATURE	CAUSE	CORRECTION
Carburetor malfunction.	Excessively lean or excessively rich mixture.	Check fuel flow with Engine Calibration Charts. Change mixture control to correct setting.
	Excessive fuel leakage through vapor vents.	Hold vapor shut-off valve closed for 20 to 30 seconds and release.
		If all other causes have been eliminated, and indications point to this unit as the cause of the trouble, replace with a tested unit.
Malfunction of injector pumps.	Excessive fuel leakage through vapor vents.	If the carburetor has been eliminated as a possible cause of trouble, and the roughness occurs at all mixture settings, hold vapor shut-off valve closed for 20 or 30 seconds and release. If trouble cannot be corrected, operate at reduced power or feather the propeller.
		When on the ground, remove vapor return lines and injector lines, turn on auxiliary fuel pump and check for excessive leaks.
		Replace faulty unit.
Injector nozzle malfunction or open injector line.	Irregular or insufficient fuel delivery.	Reduce power to less than 1200 hp, and test ignition. If rpm remains the same on either magneto, and roughness continues, malfunctioning injector nozzle or open line could be the cause. Reduce power to point at which roughness is least, or feather the propeller.

Note

To achieve normal BMEP on an engine with a misfiring cylinder requires more throttle, and the MAP will be higher.

b. Ignition System Malfunction.

NATURE	CAUSE	CORRECTION
Intermittent grounding.	Loose connection or component in switch.	Move switch to LEFT, then to RIGHT, then back to BOTH at 1200 hp or less. If faulty switch is the cause, roughness will be reduced. Operate engine at reduced power or feather propeller.
	Carbon track in distributor.	Indications similar to fouled plugs or connectors. Remove track with gasoline-soaked rag.
	Dirty or pitted breaker points.	Clean and set to proper timing and clearance. Faulty points usually indicate a faulty condenser. Replace.
	Broken or shorted connectors.	Check leads for break or short circuit.

NATURE	CAUSE	CORRECTION
One or more cylinders misfiring.	Fouled or broken spark plugs.	Magneto check will show whether one or both plugs in one cylinder are faulty. One plug not firing in each of several cylinders can cause roughness, generally more evident at higher power settings. Reduce power to reduce roughness or feather the propeller.
Note Cylinder misfiring can be determined on the ground with a cylinder head temperature gage and a thermocouple mounted on a three or four foot rod. Touch each cylinder head with the thermocouple and note reading. Misfiring cylinder will be cold.	Damaged connector or grounding spark plug lead terminals.	Remove leads. Clean, or replace. Replace if punctured, or if moisture is the cause of the grounding out. Do not touch insulator with fingers.
Temperature increase and loss of power.	Ignition timing.	Ground check and adjust timing.

c. Miscellaneous Causes of Roughness.

NATURE	CAUSE	CORRECTION
	Carburetor icing.	Dislodge ice with carburetor anti-icer. Use carburetor heat. Never exceed 38°C.
	Vapor in fuel.	Turn on auxiliary fuel pumps. Auxiliary fuel pumps should be on for all normal operation. HIGH for take-off and landing; LOW at all other times.
	Malfunctioning valves.	Operate at reduced power or feather propeller. Ground check for: Tappet adjustment; Sticking, burned, or warped valves. Broken valve springs. Timing.

NATURE	CAUSE	CORRECTION
	Broken or burned piston rings.	Indicated by rise in oil-out temperature and loss of power. Feather propeller. Ground check compression.
	Loose, bent, badly nicked or unbalanced propeller blade.	Vibration at all speeds, increasing as rpm increases. Feather propeller and ground check.
	Engine loose on mount.	Feather propeller and ground check.
	Loose cylinder.	Feather propeller and ground check.

7–6. IDLING FAILURE. If the engine will not idle, check the following:

a. Fuel System Malfunction.

NATURE	CAUSE	CORRECTION
Insufficient fuel.	Idling mixture too lean.	Enrich until engine will continue to run. Set throttle stop to give 600 rpm. Toggle primer switch and note manifold pressure gage. A sudden rise indicates too much enrichment; a sudden drop indicates insufficient enrichment. Adjust mixture until MAP hangs momentarily before rising. Reset throttle stop to keep 600 rpm, the desired idling speed. Repeat momentary priming to check mixture adjustment. Cylinder head temperature should be kept near 150°C.
One row of cylinders too rich or too lean.	Synchronizing bar between injector pumps out of adjustment.	Check as follows: With head temperature at approximately 150°C, run engine at 2000 rpm and allow to stabilize. Move mixture control from AUTO RICH to AUTO LEAN and note rpm drop. Tap tachometer lightly. Change may be very slight. A drop of more than 50 rpm indicates poor adjustment of the synchronizer bar. Return mixture control to AUTO RICH. Decrease rpm to 1500 and allow engine to

NATURE	CAUSE	CORRECTION
One row of cylinders too rich or too lean (cont'd).		stabilize. Move mixture control to AUTO LEAN. A drop of more than 15 or 20 rpm indicates that the synchronizer bar is too long. A drop of less than 15 or 20 rpm indicates that the bar is too short. Repeat procedure at 1350 to 1400 rpm. RPM drop at this speed is slightly greater. 20 to 30 rpm is normal. A greater drop indicates rod is too short; less that the rod is too long. **Note** Idle mixture will affect rpm near 1400. Set it at the best mixture possible for this test. Due to the fact that fuel is injected directly into the cylinders, it is not necessary to have the mixture on the rich side. Adjust synchronizing bar according to the Stromberg direct fuel injection system service manual. This should be done by a Wright Aeronautical Corporation representative if possible.
Note Desired conditions to secure good idling: Cylinder head temperature, when making adjustments: 150°C At 2000 rpm; AUTO RICH TO AUTO LEAN; rpm drop of not more than 50. At 1500 rpm; AUTO RICH to AUTO LEAN; rpm drop of not more than 15 to 20. At 1400 rpm; AUTO RICH to AUTO LEAN; a rise of not more than 30 rpm.		
Excessive fuel.	Idle mixture set too rich.	Lean out until engine will run at 600 rpm, and repeat check for insufficient fuel.
Excessive fuel (cont'd).	Fuel leaking into pump balance line.	Indication: Fluctuating pressure and improved operation when mixture control is moved toward OFF. Ground check and correct.

b. Ignition System Malfunction.

NATURE	CAUSE	CORRECTION
Distributors.	Carbon track on distributor. Dirty or burned points. Faulty timing.	Remove with gasoline-soaked cloth. Check gap and condition. Clean and replace.
Magneto.	Improper timing with engine and/or distributor.	Ground check and reset according to Maintenance Instructions Manual.
High tension leads (Spark plugs to coils.) Spark plugs.	Moisture-covered or dirty.	Wipe leads thoroughly with clean, dry rag, or replace. Do not touch insulation with fingers. Test for cold cylinders. Replace faulty plugs.

7–7. ELECTRICAL SYSTEM MALFUNCTION

a. D.C. System Malfunction.

NATURE	CAUSE	CORRECTION
No amperage or voltage.	Field flash circuit breaker for generator switch out.	Reset it.
	Generator switch "OFF."	Turn switch "ON."
	Field circuit breaker out.	Reset it.
	Generator circuit protector out.	Reset it.
	Faulty generator.	Shut off generator switch and field circuit breaker.
Voltage reading. Low or no voltage reading.	Faulty voltmeter.	Select another generator and check voltmeter.
Amperage reading. Low or no amperage reading.	Faulty ammeter.	Read total amperage; then shut off questionable generator. If amperage on other generator rises, ammeter is faulty. If amperage does not rise, reverse current relay is faulty.

NATURE	CAUSE	CORRECTION
Amperage reading low (cont'd).	Generator circuit protector out.	Reset breaker switch. If this does not work, it is the circuit protector that is faulty. Shut off the generator.
	Note When breaker opens, reverse current relay is still on and bus voltage will feed back through it.	

b. A.C. Fixed Frequency Electrical System Malfunction.

NATURE	CAUSE	CORRECTION
Inverter switch on, but No. 1 inverter will not run.	Power breaker on MJB is off.	Turn it on.
	Transfer circuit dead.	Push in transfer circuit breaker on lower MJB panel. Test No. 2 inverter—if this runs, the transfer circuit is probably OK and inverter has failed.
Voltage is not 115V.	Voltage regulator inoperative.	Pull No. 1 power breaker switch off and let No. 2 take over.
Voltage is OK but both lights are on.	Test button on transfer unit is open.	You are on No. 2 inverter and can use it as it is until the next stop. If No. 2 fails, turn it off and reset button in forward baggage compartment and turn on No. 1 inverter.
If No. 1 inverter light is on.	Might have started on No. 2 inverter.	Turn switch OFF and then to ON and watch lights to see if it transfers.
Voltage on one phase reads low (below 105).	Faulty inverter.	Check No. 2 inverter and if it is OK, the inverter has failed.
	Excess load on circuit.	If voltage is still low, it is due to a load on that phase. By shutting off various units on that phase, you can isolate the trouble.

7–8. HYDRAULIC POWER SYSTEM MALFUNCTION

NATURE	CAUSE	CORRECTION
Hydraulic oil quantity dropping.	Leak in secondary line. Leak in gear system. Leak in flap system. Leak in brake or steering line.	Check hydraulic gage. Check landing gear handle for neutral position; if leak stops, leak is in gear system. Shut booster controls off, shut off 3 and 4 pumps.
	If gage still drops with boosters off, leak will be in primary pump lines or aspirator section of system.	Turn off No. 1 and No. 2 and try to isolate leakage by procedure below.
	If gage still drops with Nos. 1 and 2 off, leakage will be between pressure check valves and shut-off valves in aspirator section of system.	Examine lines in forward baggage compartment around aspirator. If leakage is found and no temporary fix can be made, turn OFF all pumps. Boosters OFF.
Isolated pump leakage.	Primary.	Turn OFF No. 1 and No. 2.
	If gage continues to drop, leakage is in the suction line of either No. 1 or No. 2 (between the reservoir and shut-off).	Turn OFF all pumps. Then turn ON No. 3 and No. 4.
	If gage does not drop, the leakage is in No. 2 pump line (between the shut-off and pressure line check valve).	Turn OFF all pumps. Then turn ON No. 1, No. 3 and No. 4.
	If gage continues to drop with No. 1 on.	Turn OFF No. 1. Turn ON No. 2.
	If gage does not drop, the leak is in No. 1 line (between the shut-off and pressure line check valve).	Turn OFF all pumps. Turn ON Nos. 2, 3, and 4.
	Secondary. Same procedure as for Primary. Be sure tank level is kept above full mark. When secondary pump leakage is isolated, it will not be necessary to turn off No. 1 and No. 2 electric motor driven shut-off valves. Turn OFF No. 3 and No. 4, then turn ON good pump. This procedure assures there will not be a pressure build-up between pumps and check valves.	
All warning lights on.	Low fluid.	Check quantity gage. Replenish supply. If lights go out, watch quantity gage for leakage.

NATURE	CAUSE	CORRECTION
Pump cavitation (Noticeable noise in hydraulic system).	Loss of oil.	Check quantity gage. If no lights show, test light. Turn OFF affected pumps. Replenish supply. Use isolation procedure.
	Loss of reservoir pressure due to: malfunction of aspirator.	Tap aspirator to dislodge any foreign particles which may be lodged in nozzle.
	Leakage in aspirator lines.	If temporary fix cannot be made, turn pumps OFF. Turn boosters OFF.
Secondary system malfunction.	Leakage isolated to pumps.	If leakage is slow, recommend turning pumps OFF until required to be used for gear extension. At this time, (1) fill tank; (2) gear selector in DOWN; (3) turn pumps ON. If not sufficient to lock gear DOWN, but hand pump selector in gear position and pump. When gear is down and locked, put selector back in BRAKE position.
Primary system malfunction.	Leakage isolated to booster system, either aileron, rudder or elevator.	Turn system OFF. If leakage is slow, turn ON for landing.
System pressure gages fluctuate or indicate no pressure when controls are in neutral	Faulty transmitter or gages.	Replace unit.
	Low fluid level in main reservoir.	Check system for leaks and refill reservoir.
	Stoppage, or air leak in pump suction line. Faulty pump pressure control.	Check plumbing lines. Operate one pump at a time and replace pump which is causing trouble.
	Faulty relief valve or setting too low.	Check seating of relief valve return line to determine which is open and replace or repair valve.
Engine pumps fail to deliver full pressure.	Open hydraulic line.	Check plumbing lines.
	No hydraulic fluid in main reservoir.	Check system for leaks and refill reservoir.
	Booster shut-off valve assembled improperly or linkage improperly installed, causing both cylinder by-pass and shut-off valve to be open at the same time.	Inspect units for proper assembly and installation.

NATURE	CAUSE	CORRECTION
Low fluid level in main reservoir.	Excessive external leakage in system.	Check all piping and valves for external leaks.
	Presence of air in system.	Bleed system and fill reservoir until fluid level is maintained.
Slow operation of hydraulic units.	Low hydraulic pressure.	Increase to desired pressure.
Failure to obtain pressure in main reservoir, evidenced by cavitation of hydraulic pumps.	Loose and leaking filler cap or gage stick.	Tighten caps or replace gaskets.
	Open or leaking overflow drain cock.	Close or replace drain cock.
Pressure build-up in sump tank when aspirator is functioning properly.	Air leak in aspirator suction line.	Check lines for leaks.
Return flow to primary side, when crossover in operation.	Crossover check valve bleed port blocked, return crossover does not shift.	Replace crossover check valve. Check by running No. 3 or No. 4 engine while watching tank. Return flow should be to secondary side.

7–9. PROPELLER MALFUNCTION

a. Propeller Leakage.

NATURE	CAUSE	CORRECTION
At dome cap.	Damaged seal.	Replace seal.
	Loose cap.	Tighten cap.
At dome retaining nut.	Damaged dome-barrel seal.	Replace seal.
	Loose nut.	Tighten nut.
At barrel blade bore.	Damaged blade packing.	Replace packing at overhaul shop.
	Improper blade packing.	Use latest type packing.
	Foreign material under blade packing.	Wipe packing and sealing surfaces clean.
In rear cone vicinity.	Damaged spider-shaft seal.	Replace seal.
	Damaged spider-shaft seal spacer.	Replace spacer.
	Engine thrust plate seal.	Consult engine manual.

b. Control Leakage.

NATURE	CAUSE	CORRECTION
Between head and body.	Damaged head-body gasket.	Replace head-body seal.
	Loose head-body attaching nuts.	Tighten attaching nuts.

NATURE	CAUSE	CORRECTION
At high pressure connector.	Damaged connector gasket.	Replace connector gaskets on all feathering models.
	Loose attaching nuts.	Tighten attaching nuts on all feathering models.
Between relief valve housing and body.	Damaged relief valve gasket.	Replace relief valve gasket.
	Loose relief valve housing.	Retighten valve housing.
Between relief valve housing and relief valve plug.	Damaged relief valve plug gasket.	Replace relief valve plug gasket.
	Loose relief valve plug.	Retighten plug.
Between body and base.	Damaged body-base seal.	Replace body-base seal.
	Loose body-base stud nuts.	Retighten body-base attaching stud nuts.
Between base and engine mounting pad.	Damaged mounting gasket.	Replace mounting gasket.
	Loose attaching nuts.	Retighten nuts.
	Warped base.	Lap base.
	Warped engine mounting pad.	Consult engine manual.
Between base and pressure cut-out switch.	Damaged pressure cut-out switch gasket.	Replace cut-out switch mounting gasket.
	Loose pressure cut-out switch attaching nuts.	Tighten switch attaching nuts.
	Blow holes or cracks in any part of the control housing.	Replace damaged part.

c. Propeller Roughness.

NATURE	CAUSE	CORRECTION
	Ignition or carburetion.	Check spark plugs and wiring, test induction system and carburetor. See engine manual.
	Engine part failure.	Feather propeller.
	Ice on propeller.	Turn on anti-icing system.
	Blade angles vary among blades.	Adjust all blades to the proper angle using protractor or index lines.
	Blade out of track.	If specification is exceeded, replace propeller.
	Propeller unbalance.	Remove propeller and rebalance.

d. Improper Synchronization.

NATURE	CAUSE	CORRECTION
	Ignition.	Check with ignition tester.
	Poor carburetion.	Check engine or carburetor manual.
	Excessive control internal leakage.	Check control on rig and make necessary replacements.
	Excessive engine nose section leakage.	Consult engine manual.
	Sticky control pilot valve or relief valves.	Remove and clean or replace.
	Pressure in control pilot valve positioning chamber.	Clean positioning chamber drain passages and leak test solenoid valve.
	Damaged control pilot valve.	Replace valve. If burrs are present, clean with crocus cloth.
	Sticky pilot valve ball bearing.	Remove head and pilot valve. Clean or replace bearing. (Check speeder spring for burning.)
	Sticky selector valve.	Take out valve and clean or replace.
	Galled or corroded speeder spring rack or bore.	Remove head, clean, and lubricate rack and bore.
	Erroneous reading tachometer.	Calibrate or replace instrument.
	Air in propeller system.	Operate controls two or three times between high and low rpm during engine run-up.
	Synchronizer malfunction.	Repair or replace synchronizer. See Hamilton Standard Overhaul Manual 177.

e. Inability to Attain Take-off RPM on the Blocks.

NATURE	CAUSE	CORRECTION
	Wrong high rpm setting on control.	Adjust high rpm limit setting. Reset on test rig if available.
	Low engine power.	Consult engine manual.
	Erroneous reading tachometers or manifold pressure gages.	Calibrate or replace instruments.

NATURE	CAUSE	CORRECTION
	Sticky pilot valve.	Remove head, clean pilot valve with crocus cloth. Check for straightness of pilot valve, and, if bent, replace.
	Faulty aircraft electrical system or electric head installation.	Check electric head circuits, check potential of battery, and check control wiring to electric head.
	Improper installation of low pitch stop lever assembly in propeller dome assembly.	Reset stop lever assembly in dome to establish low blade angle specified for the airplane.

f. Overspeeding on Take-off.

NATURE	CAUSE	CORRECTION
	Wrong setting of control head.	Reset control head. Use test rig if available.
	Too rapid opening of throttle.	Advance throttle evenly and slowly.
	Damaged or incorrect gasket between control base and engine mounting pad.	Install correct new gasket.
	Sticky control pilot valve or relief valve.	Disassemble, clean, and check for burrs. Replace pilot valve if bent.
	Erroneous reading tachometers or manifold pressure gages.	Calibrate or replace instruments.
	Insufficient exercise of propeller mechanism.	Move control several times through constant speed range with engine running.
	Damaged gasket between oil transfer housing and propeller shaft.	Install new gasket.
	High engine transfer ring or bearing leakage.	Replace rings or bearing according to engine manufacturer's specifications.

g. Inability to Feather.

NATURE	CAUSE	CORRECTION
	Faulty aircraft electrical system.	Check wiring and relays in auxiliary pump control and power circuit.
	Push-button not remaining engaged.	Check battery or pressure setting of cut-out switch. Check hold-down coil circuit.
	Sheared coupling in auxiliary pump.	Replace coupling.
	Restricted oil supply to auxiliary pump.	Check auxiliary pump inlet lines for foreign material.
	Malfunctioning auxiliary pump or motor.	Test pump and motor in accordance with instructions outlined in Preflight Inspection Instructions and replace if necessary.
	Damaged auxiliary oil line to control.	Replace auxiliary oil line.
	Auxiliary pressure check valve stuck in closed position.	Disassemble control, remove and clean auxiliary pressure check valve and then reassemble and test control.
	Low setting of high pressure relief valve.	Reset or replace valve.
	Stuck high or low pressure relief valve, selector valve, or pilot valve.	Clean or replace valves.
	Windmilling of propeller at high pitch angle.	Reset high pitch stop ring. Check blade friction torque.

h. Inability to Unfeather.

NATURE	CAUSE	CORRECTION
	Airplane batteries low.	Recharge or replace batteries and check generator system.
	Inoperative feathering (A) relay.	Check relay operation and replace.
	Open lead in aircraft electrical system, or malfunctioning of relay.	Check control and power circuits to auxiliary motor including circuit breakers, push-button controls, control relay, and power relays.
	Open control circuit in reversing system.	Check continuity through brushes, slip ring, connector assembly, and control switch.
	Restricted oil supply to auxiliary pump.	Check auxiliary pump inlet for foreign material.
	Malfunctioning auxiliary pump or motor.	Test pump in accordance with instructions outlined in Preflight Inspection and replace if necessary.
	Inoperative solenoid valve.	Replace solenoid valve or repair circuit to valve.

NATURE	CAUSE	CORRECTION
	Stuck selector valve, shuttle valve, high or low pressure relief valve, or pilot valve.	Clean or replace valve.
	Open circuit breaker.	Reset after determining reason.

i. Unfeather to Reverse Instead of to Forward Pitch.

NATURE	CAUSE	CORRECTION
Note This is principally a ground trouble since proper flight procedure requires release of the push-button when the propeller begins to windmill.	Stuck unfeathering relay.	Repair circuit or replace relay.
	Grounded unfeathering circuit.	Check and repair ground in lead from reversing control relay, propeller control relay, slip ring assembly, control switch, and connector assembly.
	Solenoid valve stuck open.	Test and clean or replace solenoid valve.

j. Inability to Reverse.

NATURE	CAUSE	CORRECTION
	Inoperative solenoid valve.	Test and clean or replace solenoid valve, or repair lead to solenoid.
	Malfunctioning of throttle microswitches or relay.	Inoperative single-pole switch will cut power lead to system. Inoperative double-pole switch will cut power lead to solenoid valve. Replace switches.
	Open reverse circuit breaker.	Reset after determining reason for condition.
	Stuck control selector valve, shuttle valve, pilot valve, or high and low pressure relief valves.	Clean and check for freedom of movement.
	Improper reverse setting.	Reset stop ring.
	Low system voltage.	Assure correct system voltage of 18 volts minimum.
	Low pitch stop levers do not retract due to improperly positioned wedge spiral lock ring.	Replace low pitch stop lever assembly.

k. Inability to Unreverse.

NATURE	CAUSE	CORRECTION
Note To stop auxiliary pump, pull reverse circuit breaker momentarily.	Improper operation of control selector valve.	Clean and check for freedom of movement.
	Inoperative throttle double-pole microswitch contact.	Replace or relocate switch to operate at proper time.
	Grounded reversing circuit.	Check control circuit, propeller slip ring assembly, propeller control brush, and connector assembly.
	Control relay inoperative.	Check relay contacts and hold-in system.
	Solenoid valve no longer reseats after reversing.	Repair or replace solenoid valve.
	Open circuit breaker.	Reset after determining reason for difficulty.
	Dump valve in propeller set improperly. Check by manually moving the blades to a flat pitch position and attempt to unreverse by depressing the feathering button. Successful unreversing would indicate dump valve open too much.	Adjust dump valve as required.
	Either or both lock-in relays not energized or faulty throttle switches.	Check for open circuit to relays. Check relays and throttle switches and repair or replace as necessary.
	Grounded No. 1 control switch or its circuit.	Repair or replace grounded circuit or grounded switch as required.
	Inoperative auxiliary pump. Check by depressing feathering button.	Replace motor and pump, pump relays, or repair motor circuit as required.

l. Unreverse to Feather.

NATURE	CAUSE	CORRECTION
	Open reversing circuit.	Check control circuit, propeller slip ring assembly, propeller control brush, and connector assembly.
	Open control relay circuit.	Repair wiring.
	Open circuit breaker.	Reset after determining reason for difficulty.
	Control relay inoperative.	Repair or replace relay.

m. Propeller Feathers During Unreverse.

NATURE	CAUSE	CORRECTION
Note Immediately pull feathering circuit breaker.	Open No. 1 control switch, broken lead, or poor control brush contact.	Clean, repair, or replace switch or control brushes and inspect circuit.

n. Propeller Slips Back Into Reverse After Unreverse Has Been Accomplished.

NATURE	CAUSE	CORRECTION
	The wedge in the low pitch stop lever assembly is stuck in the reverse position.	De-sludge stop lever assembly to provide free movement of the wedge.

o. Inoperative Reverse Indicator Light With Throttle In Reverse Position.

NATURE	CAUSE	CORRECTION
	Burned-out indicator light bulb.	Depress light shield to test bulb. Check light circuit breakers; replace bulb if inoperative.
	Insure reverse position by pulling the reverse circuit breaker and depressing feathering button momentarily. RPM increase indicates propeller is in reverse position. RPM decrease indicates propeller is not in reverse position.	If propeller is in reverse, check for open circuit through No. 2 control switch.

p. Propeller Feathers When Attempting to Reverse.

NATURE	CAUSE	CORRECTION
	With propeller feathered, isolate trouble by energizing the unfeathering circuit. (Make sure feathering circuit breaker is closed.) Pull feathering button and listen for solenoid click. If no click is audible, check the voltage reading between the solenoid lead and ground:	
	a. Voltage reading is above 18 volts.	Replace solenoid valve or control assembly as required.
	b. No voltage reading at the solenoid valve.	Check circuit to reversing relay.
	c. Voltage reading between 0 and 18.	Check aircraft power supply.
	If unfeathering attempt is successful, check the reversing relay and the throttle micro-switch system.	Repair or replace reversing relay and/or throttle micro-switch.

INDEX

ALPHABETICAL INDEX

A — Page

Accelerating Limits, Flight Load ... 197
Air Conditioning System ... 135
- Air Distribution, Cabin ... 149
- Air Distribution, Flight Station ... 151
- Anti-icing System, Water Separator ... 138
- Circuit Breakers ... 155
- Circuit, Indicator Lights and Temperature Indicator ... 159
- Components, Major ... 135
- Compressors, Secondary ... 137
- Controls ... 155
- Control Circuit, Cabin Heater§ ... 146
- Control Circuit, Refrigeration§ ... 148
- Control Circuit, Auxiliary Heater, Flight Station§ ... 147
- Control Circuit, Pressurization§ ... 143
- Control Circuit, Auxiliary Ventilation§ ... 144
- Control Knob, Aux. Vent., Emergency Operation§ ... 162B
- Control Knob, Aux. Vent., Normal Operation§ ... 162
- Control Panel, (Station 260)§ ... 157
- Control System, Pressurization§ ... 142
- Cooling and Refrigeration ... 155
- Cooling Air ... 155
- Cooling in Cabin and Flight Station During Pressurized Flight§ ... 151
- Cooling Fans (Ground), Secondary Heat Exchanger ... 137
- Depressurization, Emergency ... 123
- Distribution System, Air ... 147
- Drive System, Supercharger ... 135
- Ducting§ ... 138, 139, 140
- Ducting, Window§ ... 141
- Electrical Equipment Locations§ ... 136
- Fan, Flight Station ... 141
- Fans, Recirculating, Cabin Air ... 141
- Heater Assemblies, Cabin ... 141
- Heater, Auxiliary, Flight Station ... 141
- Heater System, Cabin§ ... 145
- Heat Exchangers, Secondary ... 137
- Heat Exchangers, Primary ... 136
- Heat in Cabin and Flight Station During Pressurized Flight§ ... 150
- Heating, Cabin ... 154
- Heating, Flight Station ... 155
- Indicators and Warning Lights ... 158
- Instruments ... 160
- Operating Procedures, Emergency ... 162A
  - Cabin Heater Malfunction ... 162A
  - Pressurization Control, Manual ... 162A
- Operating Procedures, Normal ... 161
  - Ground Truck, Heating or Cooling ... 161
  - Pilot's Auxiliary Heater ... 162A
  - Pressurized Flight ... 161
    - After Engine Start ... 161
    - After Landing ... 162A
    - Before Engine Start ... 161
    - Before Touchdown ... 162A
    - During Climb ... 161
    - Start of Descent ... 161
- Pressurization, Cabin ... 198
- Pressurization System ... 151
- Refrigeration, Cooling and ... 155
- Refrigeration Equipment§ ... 149
- Refrigeration, Ground, with Outboard Engines Operating at 1200 RPM§ ... 152
- Refrigerator Assemblies ... 137
- Selectors ... 158
- Separators, Water ... 138
- Supercharger, Cabin ... 135
- Supercharger Drive Shaft Disconnect ... 134B, 136
- Switches ... 155
- Turbines, Expansion ... 138
- Valves:
  - Check, Cabin Supercharger Duct ... 136
  - Control, Cabin Pressure Regulator (Sensing Head) ... 141
  - Dump, Cabin Supercharger ... 137

A — Page

Air Conditioning System (Continued)
- Valves (Continued)
  - Limiter, Pressure Ratio ... 141
  - Mixing, Cabin Air§ ... 137, 138
  - Mixing, Flight Station ... 141
  - Pressure Relief, Cabin Supercharger ... 136
  - Regulator, Cabin Pressure (Outflow) ... 145
  - Restrictor, Cold Air ... 145
  - Safety Relief and Dump, Cabin Pressure ... 145
- Ventilation System, Auxiliary ... 153
- Ventilation in Flight without Heating, Auxiliary§ ... 153
- Ventilation, Ground, Low Pressure Truck§ ... 154
- Warning Lights, Indicators and ... 158

Airplane, General ... 1
Airplane Operation, Type of ... 197
Airspeed Indicator Marking ... 197
Anti-icing and De-icing Systems ... 163
- Alcohol Anti-icing Systems ... 170
- Alcohol Anti-icing System§ ... 169
  - Carburetor ... 170
  - Propeller ... 170
  - Pumps ... 170
  - Tanks ... 170
  - Windshield ... 170
- Boots, De-icer (Pneumatic System) ... 163
- Boots, De-icer, Limitations and Settings ... 198
- Carburetor Icing, Combating ... 203
- Controls, Pneumatic System (Boots) ... 163
- Defogging, Cabin Windows ... 173
- De-icing Limitations ... 197
- Gage, Pressure, De-icer ... 87, 166
- Gage, Vacuum ... 87, 166
- Indicators, Surface Ice Elimination System ... 166
- Lights, Indicator, Electro-pneumatic De-icer System ... 166
- Lights, Warning, De-icer Pump ... 166
- Operating Procedures, Normal:
  - Alcohol Anti-icing Systems ... 170
    - Carburetors ... 171
    - Propellers ... 171
    - Windshield Alcohol ... 170
  - Boots, De-icer (Pneumatic System) ... 166
  - De-fogger, Windshield ... 171
  - De-fogger, Spot, Windshield ... 171
  - Nesa Windshield Anti-icing System ... 168
    - Ground Operation ... 168
    - In-flight Operation ... 168
  - Pitot Head De-icer ... 170
  - Radio Mast De-icer ... 168
  - Windshield Wipers ... 171
- Operating Procedure Emergency:
  - Boots, De-icer (Pneumatic System) ... 167
- Pitot Head De-icer ... 170
- Pneumatic De-icer System (Boots)§ ... 164
- Pressure System, De-icer ... 163
- Pumps, De-icer ... 163
- Radio Antenna Mast De-icer ... 168
- Regulator, Pressure ... 163
- Surface Ice Elimination (Boots) ... 163
- Timer, De-icer Boot§ ... 165
- Timer, Electronic De-icer (Boots) ... 166
- Values:
  - Distributor ... 165
  - Outflow, Cabin Pressure Regulator ... 166
  - Pressure Relief ... 165
  - Safety Relief and Dump (Cabin Pressure) ... 166
  - Selector, De-icer Air Pump ... 165
  - Selector De-icer Vacuum ... 165
  - Shut-off, Driftmeter† ... 165
  - Suction Relief ... 165
- Vacuum System, De-icer ... 163
- Vacuum Warning Unit ... 165
- Water Separators, Air Conditioning System ... 138

* LAC Serials 4001–4014   † LAC Serials 4015–4024   § Denotes illustration

A — Page

Anti-icing and De-icing Systems (Continued)
Windshield Anti-icing and De-icing Systems:
Alcohol Anti-icer System....170
Anti-icing and De-fog§....167
De-fogger....171
De-fogger, Spot....171
Nesa Windshield Anti-icing System....167
Circuit, Nesa....167
Controls, Nesa....167
Glass, Nesa....167
Indicators, Nesa System....168
Light, No. 2 Inverter on Nesa....55, 168
Light, Cycling, Nesa....168
Light, Power ON....168
Switch, Nesa System....167
Switch, Power Selector, Nesa....52, 167
Switch, Reset, Nesa....167
Wipers, Windshield....171
Arrangement Diagram, General§....Facing page 1
Arrangement, Interior *§....188
Arrangement, Interior †§....189
Automatic Pilot†....186
Controls....186
Controls§....186A
Controller....186A
Control, Flux Gate Sensitivity....186B
Disconnect Lever, Servo....186
Indicators:....186B
Master Direction Indicator....186B
Three-axis Trim....88, 186B
Light, Gyro Beacon....186B
Light, Indicator, Automatic Pilot Flux Gate Caged....186B
Operating Procedure, Normal....186B
Before Take-off....186C
Climb....186C
Cruise....186C
Descent....186D
Ground Check....186C
Pre-traffic Pattern....186D
Operating Procedures, Emergency....186D
Switch, Altitude Control....186
Switch, Caging, Automatic Pilot Flux Gate....186
Switch, Clutch....186
Switch, Clutch Disconnect....186B
Auxiliary Equipment, Description and Operation of....135

B

Boots, De-icer....163
Brake System....79
Brakes§....79
Controls§....80
Debooster....81
Debooster, Debooster Lockout§....82
Debooster Lockout....81
Ground Operation....204
Indicator, Pressure, Emergency Brake....87
Light, Indicator, Parking Brake....82
Limitations and Settings....198
Operating Procedures, Emergency....134A
Parking Brakes....82
Parking Brakes, Operation of....204A
Pedal Angle vs. Brake Pressure§....81
Valve, Control....80
Valve Lever, Brake Selector....79
Valves, Shuttle....82

C

Cabin Attendant's Station, Aft§....191
Call System, Passenger....192
Carburetor....10
Cargo Compartments....1, 192
Center Control Stand*§....32
Center Control Stand†§....32
Center of Gravity Limits§....195
Check List, Cockpit (Normal Operating Procedures) Facing page 97
Check List, Emergency Procedures, Abbreviated....Facing page 115
Closets....190

C — Page

Communication and Radio Navigation Equipment*....173
Communication and Radio Navigation Equipment†....180
ADF System †....180K
Altimeter, Radio, AVQ-9†....180N
Antenna Diagram *§....172
Antenna Diagram †§....180A
Antenna System*....173
Antenna System†....180B
Call System, Passenger....192
Control Panel, Pilot's Overhead†....180B
Direction Finder, MN-62A Automatic*....177
Direction Finder, MN-62A Automatic†....180K
Interphone System*....174
Interphone System†....180D
Navigation Receivers, 51R-2 VHF*....175
Navigator's Station (International Configuration)†§....180G
Navigation System, 51R-2 VHF†....180L
Public Address System*....179
Public Address System†....180D
Radio Equipment Rack & Junction Box (Flight Station)*§....176
Radio Magnetic Indicators†....180L
Radio Operator's Station (Domestic Configuration)†§....180C
Radio Operator's Station (International Configuration)†§....180E
Radio Rack, Auxiliary (International Configuration)†§....180J
Radio Rack (Galley Section)*§....178
Receiver, BC-348†....180K
Receiver, Glide Slope*....177
Receiver, Glide Slope†....180M
Receiver, Marker Beacon, MN-53B*....179
Receiver, Marker Beacon, MN-53B†....180N
Selector Boxes, Radio*....174
Selector Boxes, Radio†....180D
Terrain Warning, TRXED-13A†....180N
Terrain Warning Indicator Lights†....88, 180N
Transmitters, Communication, T-47/ART-13†....180H
Transmitter-Receiver, RTA-1B*....174
Transmitter-Receiver, RTA-1B HF†....180H
Transmitter-Receiver, RT-18/ARC-1†....180H
Transmitter-Receiver, 18S-4 HF†....180F
Transmitter-Receiver, 440A VHF*....175
Compass, Flux Gate....84
Control Panel — Also See Instrument Panels
Control Panel Cabin Attendant's§....191
Control Quadrant, Flight Engineer's§....78
Control Stand, Center*§....32
Control Stand, Center†§....32
Cowl Flaps....10
Cowl Flap Position Indicators....86
Crew, Minimum....197
Crosswind, Demonstrated....197

D

De-icer Boots....163
De-icing Systems, Anti-icing and....163
Depressurization, Emergency....123
Diagram, General Arrangement§....Facing page 1
Diagram, Replenishing§....96
Diagram, Stations§....4 & 5
Difference Table, Main....2
Dimensions, General....3
Dimensions and Differences....1
Ditching....124
Doors—Also see Hatches....6
Cargo Compartment....192
Crew....1
Entrance....187
Galley....198
Interior....187
Pressure Bulkhead Aft....192
Driftmeter Shut-off Valve†....165
Drinking Fountains....191

E

Electrical Power System....38B
Air Conditioning Electrical Equipment Locations§....136
Alternators....52
Ammeters, DC....52

* LAC Serials 4001–4014 † LAC Serials 4015–4024 § Denotes illustration

E — Page

Electrical Power System (Continued)
- Batteries ... 48
- Bus, Main DC ... 38B
- Circuits:
  - Air Conditioning System Indicator Lights & Temperature Indicator§ ... 159
  - Battery§ ... 43
  - Emergency Alternator*§ ... 44B
  - Emergency Alternator†§ ... 44B
  - Nesa ... 167
  - Reset ... 44B
- Circuit Breakers ... 48
  - Air Conditioning System ... 155
  - Generator Field ... 50
  - Control Quadrant*§ ... 47
  - Control Quadrant†§ ... 47
  - Lower Main Junction Box*§ ... 53
  - Lower Main Junction Box†§ ... 54
  - Under Desk Panel§ ... 51
  - Contactor, Auxiliary, Hartman A712 ... 38B, 49
- Controls, A.C. Power System ... 52
- Equipment Inoperative with Batteries and Generators Off ... 122
- Feeder Fault Protection ... 43
- Generators ... 38B, 48
- Generators, Paralleling of ... 47
- Generators, Pre-flight Check ... 109
- Indicators, A.C. Power System ... 52
- Indicators, D.C. Power System ... 52
- Indicators, Power Failure ... 55
- Inverters ... 52
- Junction Box Panel, Upper Main ... 42
- Light, Indicator, Ground Power ... 52
- Light, Indicator, No. 2 Inverter on Nesa ... 55
- Light, Warning, Generator Overheat ... 52
- Light, Warning, Inverter Out ... 52
- Limitations & Settings, Electrical Systems ... 198
- Overvoltage Protection ... 40
- Power Distribution, D.C.§ ... 39
- Power Sources, Effect of Emergency Operation ... 123
- Power System, A.C.*§ ... 44
- Power System, A.C.†§ ... 44A
- Power System, A.C. ... 52
- Power System Controls ... 50
- Power System, D.C. ... 38B
- Power System Locations§ ... 41
- Power System Schematic, D.C.§ ... 40
- Power System Units, D.C. ... 48
- Receptacle, Cart ... 48
- Receptacle, External Power Connection ... 38B
- Regulators, Voltage ... 38B, 48
- Relays:
  - Armature Shorting ... 50
  - Battery ... 48
  - Cart ... 48
  - Contactor, Hartman A726 Reverse Current and Fault Sensing Relay ... 38B
  - Differential and Reverse Current ... 48
  - Equalizer ... 49
  - Fault Protection ... 48
  - Fault Sensing ... 49
  - Field Latching ... 49
  - Forward Current ... 49
  - Forward Current, Hartman AVR735 ... 38B
  - Overvoltage ... 49
  - Overvoltage Control Panel ... 49
  - Potential ... 49
  - Reset Lockout ... 50
  - Selector ... 50
- Shunt, Ammeter ... 50
- Switches:
  - Battery ... 50
  - Generator ... 50
  - Inverter, Main ... 52
  - Power, A.C. Flight Instruments* ... 55
  - Selector, A.C. Voltmeter ... 55
  - Selector, D.C. Voltmeter ... 52
  - Selector, Gyro Horizon Power† ... 55
  - Selector, Nesa Power ... 52

E — Page

Electrical Power System (Continued)
- Table, Electrical Load*§ ... 45
- Table, Electrical Load†§ ... 46
- Tables, Electrical Load ... 55
- Undervoltage Protection ... 40
- Voltmeter, A.C. ... 55
- Voltmeter, D.C. ... 52

Elevators ... 9

Emergency Equipment ... 92

Emergency Exits ... 6

Emergency Operating Procedures — See Operating Procedures
- Emergency ... 115

Empennage ... 9

Engines ... 9
- Aft View§ ... 13
- Blowers ... 10, 110
- BMEP Gage (Torquemeter) ... 12, 85
- Carburetor ... 10
- Carburetor Air ... 10
- Controls, Mixture ... 9
- Controls, Mixture, Manual (Hand Leaning) ... 204B
- Control Plates, Mixture, Long Range ... 9
- Cylinder Number and Firing Order§ ... 10
- Failure, Engine ... 115
- Flaps, Cowl ... 10
- Flaps, Cowl, Position Indicators ... 86
- Fuel Injection System Schematic§ ... 7 & 8
- Fuel System — Also see **Fuel System** ... 33
- Horse Power Formula ... 12
- Ignition System ... 10
- Ignition System§ ... 12
- Ignition Booster ... 11
- Jet Stacks ... 10
- Magnetos ... 110
- Pre-flight Check ... 109
- Pumps, Fuel Injection ... 10
- Selector, Engine and Starter ... 10
- Starter Circuit§ ... 11
- Spark Advance, Automatic§ ... 11, 12
- Throttles ... 9

Engine Oil System ... 28
- Controls ... 30
- Gages, Pressure ... 33
- Indicators, System ... 33
  - Position, Oil Cooler Flap ... 33, 86
  - Pressure, Rear Pump ... 86
  - Quantity Indicators ... 33
  - Temperature, Oil Inlet ... 33
  - Temperature, Oil Outlet ... 33
- Levers, Shut-off, Firewall ... 33
- Limitations and Settings ... 199
- Switches, Oil Cooler Flap ... 30
- System§ ... 29
- Tank§ ... 30
- Tank* ... 28
- Tank† ... 28
- Valve, Control, Operation of ... 29
- Valve, Oil Flow Control§ ... 31
- Valve, Shut-off ... 28

Emergency Equipment ... 92

Equipment, Miscellaneous ... 188, 192

Exits, Emergency ... 6

F

Feathering—Also see Propellers ... 13

Feathering§ ... 18

Feathering, Automatic ... 23

Feathering, Automatic, Pre-flight Check ... 110

Ferrying, Three Engine Take-off ... 118

Fins ... 9

Fire:
- Cabin Heater Fire Control ... 122
- Cargo Compartment Fire Extinguishing Procedure ... 121
- Carbon Dioxide (CO_2) Cylinders ... 95
- CO_2 Ground Connection, Auxiliary ... 95
- Control, Fire ... 118
- Controls, Fire Extinguishing System ... 95

F — Page

Fire (Continued)
Controls, Fire Extinguishing System (Station 260 Upper Panel)§ 93, 94
Control Handles, Fire Extinguisher 95
Detection System, Fire 92
Detection System, Fire§ 90
Extinguishing System, Fire 95
Extinguishing System, Fire§ 91
Electrical Fire Control 122
Electrical Fire Extinguishing Procedure 122
Extinguishers, Portable* 95
Extinguishers, Portable† 95
Engine Fire Control 118
Engine Fire After Start 118
Engine Fire During Flight 119
Engine Fire During Start 118
Fuselage Fire Control 119
Fuselage Fire Extinguishing Procedure 120
Indicators, Discharge, CO_2 Cylinders 88, 95
Indicators, Fire Detection System 92
Selector Handle, Cabin Heater and Cargo Compartment Fire Extinguisher 95
Selector Handle, Engine Fire Extinguisher 95
Warning Lights, Individual Area 92
Warning Lights and Bell, Master 92
Flaps, Cowl 10
Flaps, Wing 9, 69
Flaps, Wing§ 70
Controls 70
Control Unit and Selector Valve 70
Crank, Hand (Manual Flap Extension) 69
Drive, Wing Flap Carriage 69
Emergency Operation 134
Extension, Manual 69
Hand Crank Socket and Emergency Extension By-pass Valve§ 71
Indicators, Position 70, 86
Valve, Emergency Extension By-pass§ 71
Valve, Flap Control 72
Valve, Selector, Wing Flap Control Unit 70
Flares, Landing 96B
Flare Chute Location§ 92
Flare Controls 96B
Flight Engineer's Control Quadrant§ 78
Flight Engineer's Station*§ 72B
Flight Engineer's Station†§ 73
Flight Station* 1
Flight Station† 1
Flux Gate System 84
Fuel System 33
Consumption Sequence, Recommended§ 204
Control Unit, Master 10
Diagram, Fuel System§ 34, 35
Dip Sticks, Filler Wells and 33
Dump Rates§ 132
Dump System 36
Dumping 131, 197
Drains, Water 33
Filler Wells and Dip Sticks 33
Filters 37
Gages 35
Indicators, Fuel Flow 86
Injection System, Schematic Diagram§ .... 7 & 8
Limitations and Settings 199
Load, Lateral Unbalance of 195
Load, Minimum Permissible for Individual Tanks During Flight§ 194
Loading, Operational, Recommended§ 202
Loading and Usage Limitations 193
Management* 201
Management† 201
Pressure Indicators 86
Pressure Warning Lights, Switch and Transmitter 36
Priming System 36
Pumps, Booster, Submerged 36
Refueling with Passengers Aboard 203
Standpipes 37
Surge Boxes 33
Tanks 33

F — Page

Fuel System (Continued)
Valves:
Automatic Relief 36
Cross-feed 36
Tank Selector 35
Shut-off, Motor Driven 36
Valve Levers, Fuel Cross-feed§ 36
Vapor Return 36
Vent Lines, Tank 36
Fuselage 1

G

Galley Compartment* 1, 188
Galley Compartment† 6, 190
Gear, Landing — Also see **Landing** 70
Controls 72
Electrical System 71
Extension, Emergency 134A
Hand Pump Selector Lever, Emergency 72
Hydraulic System (Landing Gear) 71
Hydraulic System, Nose Gear Steering§ 77
Lever, Control 72
Lever, Selector, Emergency Hand Pump 72A
Main Landing Gear 74
Main Landing Gear§ 74
Nose Gear 76
Nose Landing Gear§ 75
Steering, Nose Gear 77
Steering System, Nose Gear§ 76
Generators and Propellers, Pre-flight Check 109

H

Hatches, Access 6
Hydraulic Power Systems 55
Aspirator 58
By-pass System, Hydraulic Pump 57
Controls 62B
Cross-over System 57
Failure 133
Filter, Aspirator 58
Filter, Emergency Filler Line 60
Filters, Main System (Primary & Secondary) 60
Filters, Pulsation 61
Gage, Differential Pressure, Return Line Secondary Filter* 63, 88
Gage, Sight, Emergency Reservoir 63
Indicators 62B
Indicators, Pressure 63, 86
Indicator, Quantity 63
Lever, Emergency Hand Pump Selector 62B
Levers, Firewall Shut-off Valve 62B
Lights, Warning, Pump 63
Limitations and Settings 199
Primary Hydraulic System 56
Pump, Emergency Filler 59
Pumps, Engine Driven 61
Pump, Hand, Emergency 59
Reservoir, Emergency Extension§ 56
Reservoir, Emergency Filler*§ 57
Reservoir, Emergency Filler, Operation* 204A
Reservoir, Main 61
Secondary Hydraulic System 56
Switches, Hydraulic Suction Shut-off Valve 62B
Switches, Pressure Warning 60
System Schematic§ .... 54A & 54B
Tank, Emergency Extension 59
Test Connection, Ground Pressure 60
Test Connection, Ground Suction 60
Transfer System, Emergency Filler Reservoir*§ 57
Transmitter, Pressure 60
Units, System 58
Valves:
By-pass, Booster Return 58
Check, Aspirator—Emergency Extension Tank Line 58
Check, Cross-over 59
Check, Hand Pump—Landing Gear Emergency Extension Line 58

* LAC Serials 4001–4014 † LAC Serials 4015–4024 § Denotes illustration

H — Page

Hydraulic Power Systems (Continued)
- Valves: (Continued)
  - Check, Main Reservoir—Emergency Filler Selector Valve Line 58
  - Check, Primary Pressure—Primary Return Manifold 58
  - Check, Pump Case Drain Lines 58
  - Levers, Firewall Shut-off Valve 62B
  - Pump Relief 61
  - Shut-off, Manual 61
  - Shut-off, Motor Driven 61
  - Restriction Control 56, 61
  - Selector, Emergency Filler 59
  - Shut-off, Emergency Extension 60
  - Shut-off, Solenoid 61
- Valve Handle, Emergency Supply Filler Selector 63

I

Instruments 83
- Air Conditioning System Instruments 160
- Alternating Current Instruments 85
- Altimeters 88, 90
- Ammeter 83
- Clocks 87
- Compass, Standby (Magnetic) 88
- Compass, Flux Gate (Master Direction Indicators) 84
- Differential Pressure Instruments 87
- Direct Current Instruments 83
- Directional Gyro 87
- Direct Reading Instruments 86
- Flux Gate System 84
- Gages:
  - BMEP (Torquemeter) 12, 85
  - Differential Pressure, Cabin 87, 160
  - Differential Pressure, Hydraulic Return Line Secondary Filter* 63, 88
  - De-icer Pressure 87
  - Vacuum 86, 87
  - Wash Water Tank 88
- Inclinometer* 87
- Indicators:
  - ADF † 85
  - Airspeed 88, 89
  - Airspeed Indicator Marking 197
  - Altitude, Cabin 88, 160
  - Altitude, (above terrain) Terrain Warning 180N
  - Auto Pilot 186B
  - Discharge, CO_2 Cylinder 88, 95
  - Discharge, Oxygen Cylinders 88, 183, 184D
  - Flux Gate Master 85
  - Flux Gate Repeater† 85
  - Fuel Flow 86
  - Gyro Horizon Power Failure 55
  - ILS Deviation 85
  - Lights, Caging, Flux Gate System 84
  - Lights, Terrain Warning 88, 180N
  - Manifold Pressure 86
  - Position, Cowl Flap 86
  - Position, Wing Flap 70, 86
  - Position, Oil Cooler Flap 33 86
  - Power Failure† 85
  - Pressure, Emergency Brake 87
  - Pressure, Fuel 86
  - Pressure, Hydraulic Fluid 63, 86
  - Pressure, Rear Pump Oil 86
  - Pressure, Supercharger Air 87, 160
  - Pressure, Supercharger Oil 86, 158
  - Quantity, Anti-icer Fluid Tank 83
  - Quantity, Fuel 83
  - Quantity, Hydraulic Fluid Tank 84
  - Quantity, Oil 84
  - Radio Magnetic (RMI) 85
  - Rate of Climb 88, 90
  - Temperature, Cabin 87, 160
  - Temperature, Carburetor Air 83
  - Temperature, Cylinder Head 83
  - Temperature, Heater Discharge Duct 83
  - Temperature, Oil Inlet 83

I — Page

Instruments (Continued)
- Indicators: (Continued)
  - Temperature, Oil Outlet 83
  - Temperature, Outside Air 85
  - Temperature, Refrigerator Discharge Duct 83
  - Temperature, Supercharger Drive Shaft Bearing 83
  - Temperature, Supercharger Oil 83
  - Trim, Three-Axis 88, 186B
  - Turn and Bank† 87
  - Turn and Bank* 85
- Omni-bearing Selectors (OBS) 85
- Polyphase Instruments 84
- Switch, Caging, Flux Gate System 84
- Switch, Power, A.C. Flight Instruments* 55
- Switch, Selector, Gyro Horizon Power† 55
- Tachometers 84
- Vacuum Operated† 87
- Voltmeter, A.C. 85
- Voltmeter, D.C. 83

Instrument Panels, Control Panels, Control Quadrants, and Stations:
- Instrument Panels:
  - Copilot's Side Panel*§ 62
  - Copilot's Side Panel†§ 62A
  - Flight Engineer's Instrument Panel*§ 88A
  - Flight Engineer's Instrument Panel†§ 88B
  - Pilots' Instrument Panels*§ 14
  - Pilots' Instrument Panels†§ 14A
  - Pilots' Overhead Panel*§ 27
  - Pilots' Overhead Panel†§ 27
  - Pilot's Side Panel*§ 38
  - Pilot's Side Panel†§ 38A
- Control Panels:
  - Air Conditioning System Control Panel (Station 260)§ 157
  - Cabin Attendants' Control Panel§ 191
  - Main Junction Box Upper Panel§ 42
  - Station 260 Upper Panel*§ 93
  - Station 260 Upper Panel†§ 94
- Circuit Breaker Panels:
  - Control Quadrant*§ 47
  - Control Quadrant†§ 47
  - Main Junction Box, Lower*§ 53
  - Main Junction Box, Lower†§ 54
  - Under Desk§ 51
- Control Quadrants:
  - Flight Engineer's§ 78
  - Flight Engineer's Auxiliary§ 36
  - Pilots' Center Control Stand*§ 32
  - Pilots' Center Control Stand†§ 32
- Radio Equipment Rack & Junction Box (Flight Station)†§ 176
- Radio Rack Auxiliary (International Configuration)†§ 180J
- Radio Rack (Galley Section)*§ 178
- Stations:
  - Aft Cabin Attendants' 191
  - Flight Engineer's Station*§ 72B
  - Flight Engineer's Station†§ 73
  - Navigator's Station† 187
  - Navigator's Station†§ 180G
  - Radio Operator's Station (Domestic Configuration)†§ ... 180C
  - Radio Operator's Station (International Configuration)†§ 180E

Intercommunication System — See Communication and Radio Navigation Equipment

Interior Arrangement*§ 188

Interior Arrangement†§ 189

Interior Configuration 187

J

Junction Box, Main, Upper Panel§ 42

Junction Box, Main, Lower Panel*§ 53

Junction Box, Main, Lower Panel†§ 54

K

L

Landing 114A

Landing, Boost-off 133

Landing Gear — Also see Gear, Landing 70

* LAC Serials 4001–4014 † LAC Serials 4015–4024 § Denotes illustration

L — Page

Landing Pattern§ 106, 107
Landing with Gear Retracted 124
Lavatories 190
Life Rafts 129
Lights:
- Ditching Light† 183
- Emergency Light* 182
- Exterior Lights 180P
- Flight Station Lights 181
- Interior Lighting 181
- Ordinance Lights 182
- Passenger Compartment Lights 182

Lighting Equipment 180P
Limitations, Operating 193
- Acceleration Limits, Flight Load 197
- Center of Gravity Limits§ 195
- Fuel Loading & Usage Limitations 193
- Galley Door 198
- Passenger Loading 198
- Power Plant 195
- Propeller 195
- Seats, Passenger 198
- Speed Limitations 196
- Surface Control Booster System Auxiliary 198
- Weight 193

M

Magnetos, Pre-flight Check 110
Malfunctions, Auto Pilot 186D
Manhole, After Pressure Bulkhead 6
Manifold Pressure Indicators 86

N

Navigation Equipment — See Communication and Radio Navigation Equipment
Navigator's Station †§ 180G, 187
Normal Operating Procedures — See Operating Procedures, Normal 97
Nose Gear 76
Nose Wheel Steering 76

O

Oil System, Engine — See Engine Oil System 28
Operating Limitations 193
Operating Procedures, Emergency 115
- Air Conditioning System 162A
- Automatic Pilot 186D
- Boosters, Loss of in Flight 133
- Boosters, Turning Off in Flight 134
- Boosters, Turning On in Flight 134
- Boost-off Landing 133
- Boots, Pneumatic De-icer 167
- Brakes 134A
- Check List, Abbreviated Emergency Procedures ... Facing Page 115
- Depressurization 123
- Descent, Rapid 123
- Ditching 124
  - Abandonment 129
  - Alighting 128
  - Exits 129
  - Crew Responsibilities 127, 130
  - Life Rafts 129
  - Life Rafts, to Inflate and Load 130
  - Night Ditching Procedure 129
  - Preparation 124
- Electrical Power Sources, Effect of Emergency Operation 123
- Engine Failure 115
  - Failure During Take-off 115
  - Failure in Flight 115
  - Failure of One Engine 115
  - Failure of Two Engines 116
    - No. 1 & No. 4 Out 116
    - No. 2 & No. 3 Out 116
    - No. 3 & No. 4 Out 116
    - No. 1 & No. 2 Out 117
    - No. 1 & No. 3 or No. 2 & No. 4 Out 117

O — Page

Operating Procedures, Emergency (Continued)
- Engine Failure (Continued)
  - Landing with One or More Engines Inoperative 117
  - Minimum Controllability Speed with One Engine Out 197
- Equipment Inoperative with Batteries and Generators Off 122
- Equipment Locations, Emergency*§ 116
- Equipment Locations, Emergency†§ 117
- Escape Routes—Land§ 125
- Escape Routes—Water§ 126
- Fire — See **Fire** under **F** 118
  - Cabin Heater Fire Control 122
  - Cargo Compartment Fire Control 121
  - Electrical Fire Control 122
  - Engine Fire Control 118
  - Fuselage Fire Control 119
- Flaps 134
- Flight Control Systems 133
- Fuel Dumping 131
- Fuel Dump Rates§ 132
- Go-around Procedure 114B, 118
  - Two Engines Operating, Boost on 118
  - Three Engines Operating, Boost on 118
  - Four Engines Operating, Boost on 118
- Hydraulic Power System Failure 133
  - Primary and Secondary Systems 133
  - Primary Pumps 133
  - Secondary Pumps 133
- Landing Gear, Emergency Extension 134A
- Landing with Gear Retracted 124
- Propeller Malfunction 118
  - Overspeeding in Flight 118
  - Reversing in Flight 118
- Smoke Removal 119
- Supercharger Drive Shaft Disconnect 134B, 136
- Systems, Airplane 131
- Three Engine Take-off, Ferrying 118
- Unfeathering Procedure 117

Operating Procedures, Normal 97
- Airplane 97
  - Before Entering the Airplane 97
  - On Entering the Airplane 98
  - Pre-flight Airplane Check 111
  - Before Starting Engines 102
  - Starting Engines 103
  - Engine Ground Operation 104
  - Taxiing 105
  - Before Take-off 109
  - Take-off 111
  - Take-off Pattern§ 106, 107
  - After Take-off 112
  - Climb 112
  - Descent 113
  - Pre-Traffic Pattern Check List 113
  - Traffic Pattern Check List 114
  - Go-around 114B, 118
  - Landing 114A
  - Landing Pattern§ 106, 107
  - After Landing 114B
  - Post Flight Engine Check 114B
  - Stopping Engines 114B
- Air Conditioning System 161
- Alcohol Anti-icing Systems 170
- Altitude, Maximum Operating 198
- Automatic Pilot 186B
- Boots, Pneumatic De-icer 166
- Brakes 204A
- Cockpit Check List .... Facing page 97
- Fuel Dumping 131
- Fuel Dump Rates§ 132
- Fuel System 201
- Hydraulic Power Systems, Emergency Filler Reservoir* 204A
- Inspection:
  - Cabin 98
  - Exterior 97
  - Flight Station 99
- Mixture Control, Manual (Hand Leaning) 204B
- Oxygen System* 184B
- Oxygen System† 184D

* LAC Serials 4001–4014 † LAC Serials 4015–4024 § Denotes illustration

O Page

Operating Procedures, Normal (Continued)
Pitot Head De-icer 170
Propeller 201
Radio Mast De-icer 168
Systems Operation 201
Type of Airplane Operation 197
Unreversing 114B
Windshield Anti-icing System, Nesa 168
Windshield De-fogger 171
Windshield Spot De-fogger 171
Windshield Wipers 171
Oxygen System* 183
Oxygen System† 184D
Oxygen System*§ 184
Oxygen System†§ 184B
Controls* 184B
Control Knob, Flow* 184B
Cylinders, Oxygen, Portable* 183
Cylinders, Oxygen, Portable† 184D
Duration Table* 183
Duration Table† 184C
Gage, Pressure* 184B
Indicators* 184B
Indicator, Discharge, Oxygen Cylinder* 88, 183
Indicator, Discharge, Oxygen Cylinder† 88, 184D
Masks† 184D
Operating Procedure* 184B
Operating Procedure† 184D
Regulator, Continuous Flow* 183
Regulator, Demand Type* 183
Regulators, Multi-stage† 184D
Regulator, Pressure*§ 184A
Regulator, Pressure†§ 184A
Valve, Shut-off Passenger Supply* 184B

P

Panels, Instrument — See **Instrument Panels**
Passenger Compartment 190
Passenger Compartments* 6
Passenger Compartments† 6
Passenger Loading Limitations 198
Pilot, Automatic† 186
Pilots' Center Control Stand*§ 32
Pilots' Center Control Stand†§ 32
Pitot-Static System 89
Pitot-Static System§ 89
Pitot-Static System Indicators 89
Pneumatic De-icer System 163
Power Plant Limits 195
Pre-flight Engine Check 109
Pre-traffic Pattern Check List 114
Pressurization, Cabin 198
Propellers 12
Blade Switch 13
Constant Speed 20
Controls 26
Feathering 13
Feathering, Automatic 23
Feathering, Automatic, Pre-flight Check 110
Feathering and Reversing Circuit§ 25
Feathering Buttons 26
Generators and Propellers, Pre-flight Check 109
Governor 13
Governor Head 21
Governor Pitch Position Lights 28
Hub§ 22
Indicators 28
Lights:
Arming, Automatic Feathering 28
Feathering, Automatic 26
Feathering Button 28
Governor Pitch Position 28
Reverse Pitch 28
Warning 26
Limits 195
Lever, Master Control 26
Lever, Reverse Lock Override 26

P Page

Propellers (Continued)
Levers, Reverse Throttle 26
Malfunction 118
On-speed 21
Operating System, Constant Speed§ 15
Operating System, Feathering§ 18
Operating System, Reversing§ 16
Operating System, Unfeathering§ 19
Operating System, Unreversing§ 17
Operation, Principles of 13
Operation, System 201
Overspeed 21
Parts, Description of 21
Pre-flight Check 109
Pump, Gear 21
Resynchronize Button 26
Reverse Lock Override Lever 26
Reverse Throttle Levers 26
Reversing 14B
Reversing & Feathering Circuit§ 25
Selector, Master Engine 26
Switches:
Blade 13
Feathering, Automatic, Master 26
Feathering, Automatic, Test 26
Governor Control 26
Test, Pre-flight 26
Torque Pressure 26
Synchronizer Circuit§ 24
Synchronizer Operation 23
Synchroscope 28, 84
Underspeed 20
Unfeathering 14B
Unfeathering Procedure 117
Unreversing 13
Unreversing Procedure 114B
Valves:
Auxiliary Check 21
Pilot 21
Pump Output Check 21
Relief, High Pressure 21
Relief, Low Pressure 21
Selector 23
Shuttle 21
Solenoid 21
Public Address System 179

Q

Quadrants — Also see **Instrument Panels**
Flight Engineer's Control Quadrant§ 78
Flight Engineer's Auxiliary Control Quadrant§ 36
Pilots' Control Quadrant — See **Center Control Stand**

R

Rafts, Life 129
Rafts, Life to Inflate and Load 130
Radio — See **Communication and Radio Navigation Equipment** 173, 180
Radio Equipment Rack & Junction Box (Flight Station)*§ 176
Radio Magnetic Indicators† 180L
Radio Operator's Station (Domestic Configuration)†§ 180C
Radio Operator's Station (International Configuration)†§ 180E
Radio Rack, Auxiliary (International Configuration)†§ 180J
Radio Rack (Galley Section)*§ 178
Restrictions, Flight (See Section V) 193
Replenishing Diagram 96, 96A
Rudders 9

S

Seats:
Cabin Attendants' 92
Cabin Attendants', Aft 190
Cabin Attendants', Forward* 190
Crew 90
Flight Engineer's 91
Lounge 190

* LAC Serials 4001–4014 † LAC Serials 4015–4024 § Denotes illustration

S — Page

Seats: (Continued)
- Navigator's† 92
- Observer's* 91
- Passenger 198
- Passenger, Double Type 190
- Passenger, Triple Type 190
- Passenger, Removal of 190
- Pilots' 91
- Radio Operator's† 91

Smoke Removal, Emergency 119
Speed Limitations 196
Speed, Minimum Controllability with One Engine Out 197
Stabilizer 9
Static System 89
Stations Diagram .... 4 & 5
Stations—Also See Instrument Panels
- Aft Cabin Attendants'§ 191
- Flight Engineer's*§ 72B
- Flight Engineer's†§ 73
- Navigator's† 187
- Navigator's (International Configuration)†§ 180G
- Radio Operator's (Domestic Configuration)†§ 180C
- Radio Operator's (International Configuration)†§ 180E

Steering, Nose Wheel 108
Stopping, Methods of 108
Stops, Power Off 109
Stops, Power On 108
Structural Limitations 199
Structural Limitations§ 200
Superchargers, Cabin 135
Surface Controls 63
- Ailerons 9
- Aileron Booster Control Lever 64
- Aleron Booster Ratio 64
- Aileron Cable Control System§ 66
- Aileron Control System§ 65
- Aileron Tabs 64
- Auxiliary Boosters 64
- Boosters 63
- Booster Controls, Auxiliary 198
- Booster Control Valve 64
- Booster System, Auxiliary§ 64
- Booster System Filters 64
- Boosters, Loss of in Flight 133
- Boosters, Turning Off in Flight 134
- Boosters, Turning On in Flight 134
- Boost-off Landing 133
- Debooster 68
- Elevator Balance 68
- Elevator Booster Controls, Auxiliary 69
- Elevator Booster Control Lever 66
- Elevator Booster Ratio 68
- Elevator Booster Ratio§ 69
- Elevator Control System§ 68
- Elevator Tab, Electric 69

S — Page

Surface Controls (Continued)
- Elevator Tabs 69
- Indicator Light, Auxiliary Elevator Booster 69
- Indicator Light, Auxiliary Rudder Booster 66
- Lock, Control 64
- Rudder Booster Controls, Auxiliary 66
- Rudder Booster Control Lever 66
- Rudder Booster Ratio 66
- Rudder Control System§ 67
- Rudder Tabs 66
- Trail Center Control Valve 66

Systems Operation ....

T

Tabs—See Surface Controls
Tachometers 8
Take-Off—See Operating Procedures
Taxiing—See Operating Procedures
Temperature, Indicators—See Instruments
Trim Indicator, Three-Axis .... [illegible]
Turn and Bank Indictors .... 85, [illegible]

U

V

Vacuum System—Also see Anti-icing & De-icing Systems 90

W

Water Systems 184D
Water System§ 185
Water System, Aft 185
Water System, Forward* 184D
Weight Limits 193
Windows 6
Windows, Lense 1
Windshield—Also see Anti-icing, Windshield 1
Windshield Wipers 171
Wing 6
- Center Section 6
- Flaps 69
- Inner Panels 6
- Outer Panels 9
- Outer Tips 9
- Tips 9

X

Y

Z

* LAC Serials 4001–4014   † LAC Serials 4015–4024   § Denotes illustration