Pilot's Handbook

for

NAVY MODEL

PV-2 • PV-2C • PV-2D
Airplanes

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REVISED 1 JULY 1945

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1 December 1945
Revised 15 April 1946

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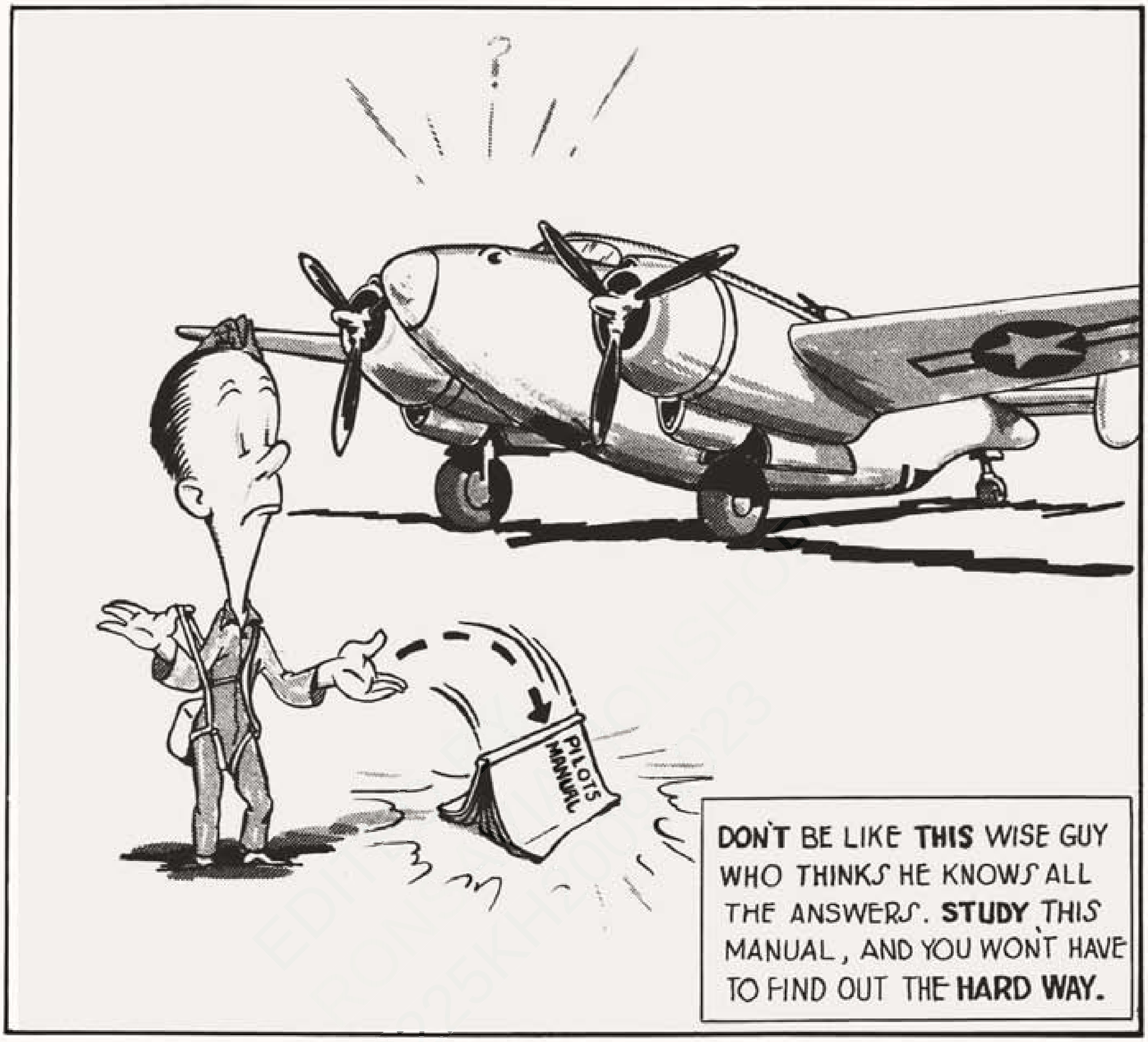
PV-2 AIRPLANE

FIGURE 1



SECTION I

DESCRIPTION

1. GENERAL.

a. AIRPLANE.

(1) The PV-2 medium patrol airplane is manufactured by Lockheed Aircraft Corporation, Burbank, California, under contract number NOa(s) 285.

(2) The over-all dimensions are:

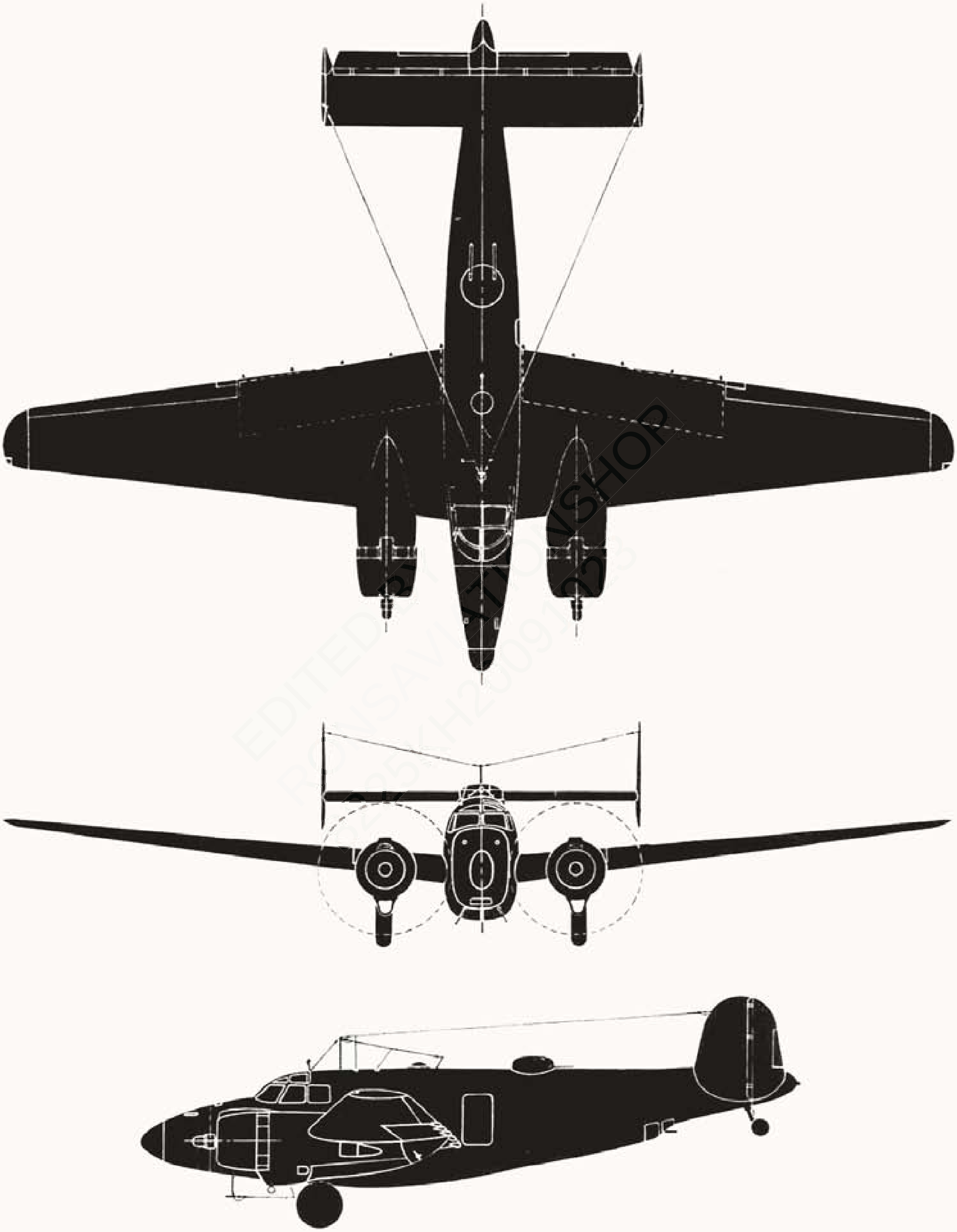
Span	75 ft
Length	51 ft 9½ in.
Height	11 ft 11 in.

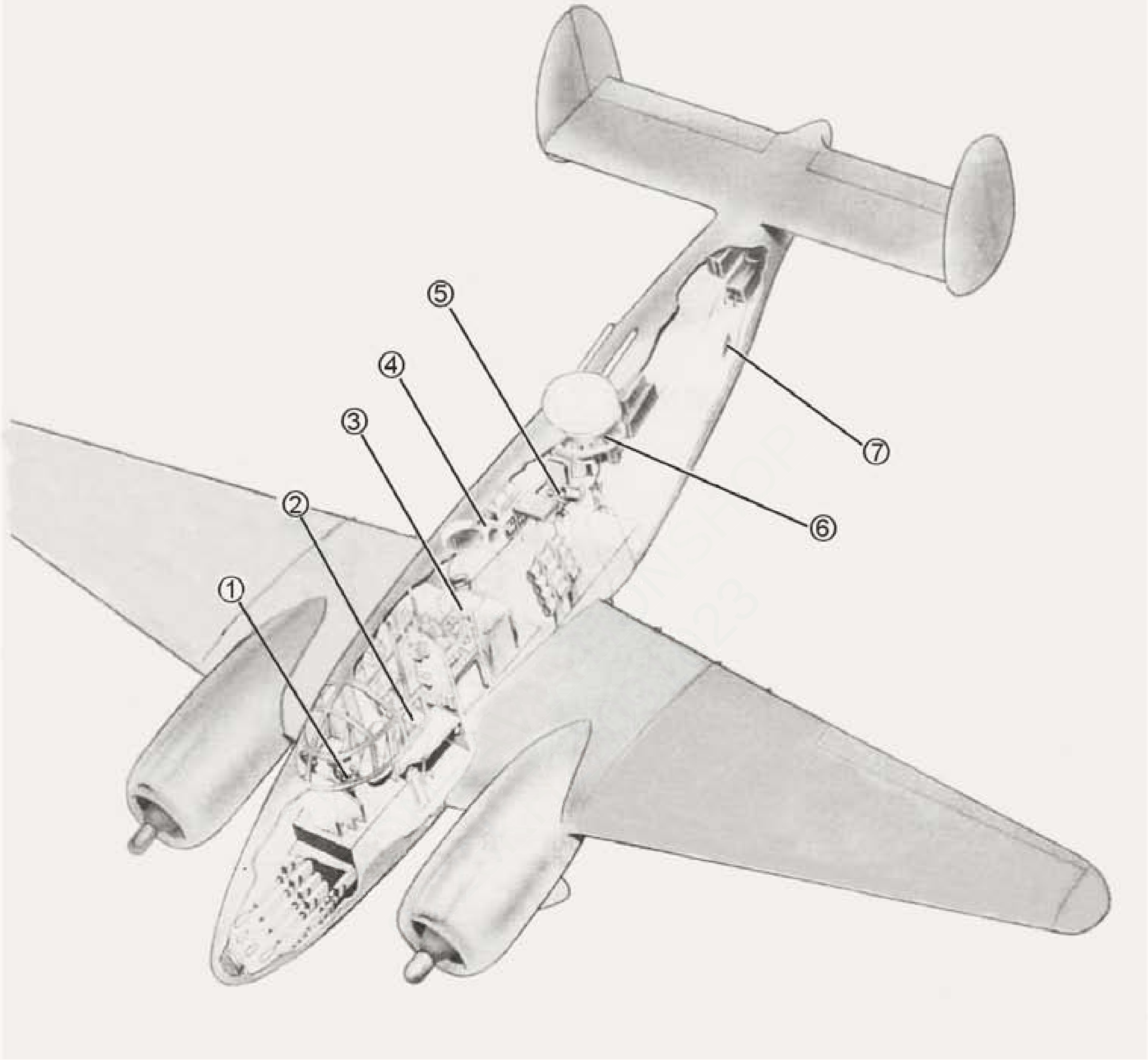
(3) The weight is as follows:

Basic weight (tactical)	21,000 lb (approx)
Gross weight	33,000 lb

(4) The entrance door is on the left side of the airplane. All compartments are readily accessible from the main cabin except the bow compartment, which is inaccessible when the airplane is in flight.

b. CREW.—The normal combat crew consists of the pilot, copilot-navigator, radio operator, turret gunner, and radar operator-tunnel gunner. The location of the crew compartments and stations is shown on figure 2.





1 FLIGHT COMPARTMENT

2 RADIO OPERATOR'S COMPARTMENT

3 NAVIGATOR'S STATION

4 RADAR OPERATOR'S STATION

5 FLARE CHUTE

6 TURRET GUNNER'S STATION

7 TUNNEL GUNNER'S STATION[1]

1. Tunnel guns are installed on airplanes bearing BuAer serial numbers 37035 through 37193 and 37289 through 37513.

Figure 2 — Fuselage Interior Arrangement

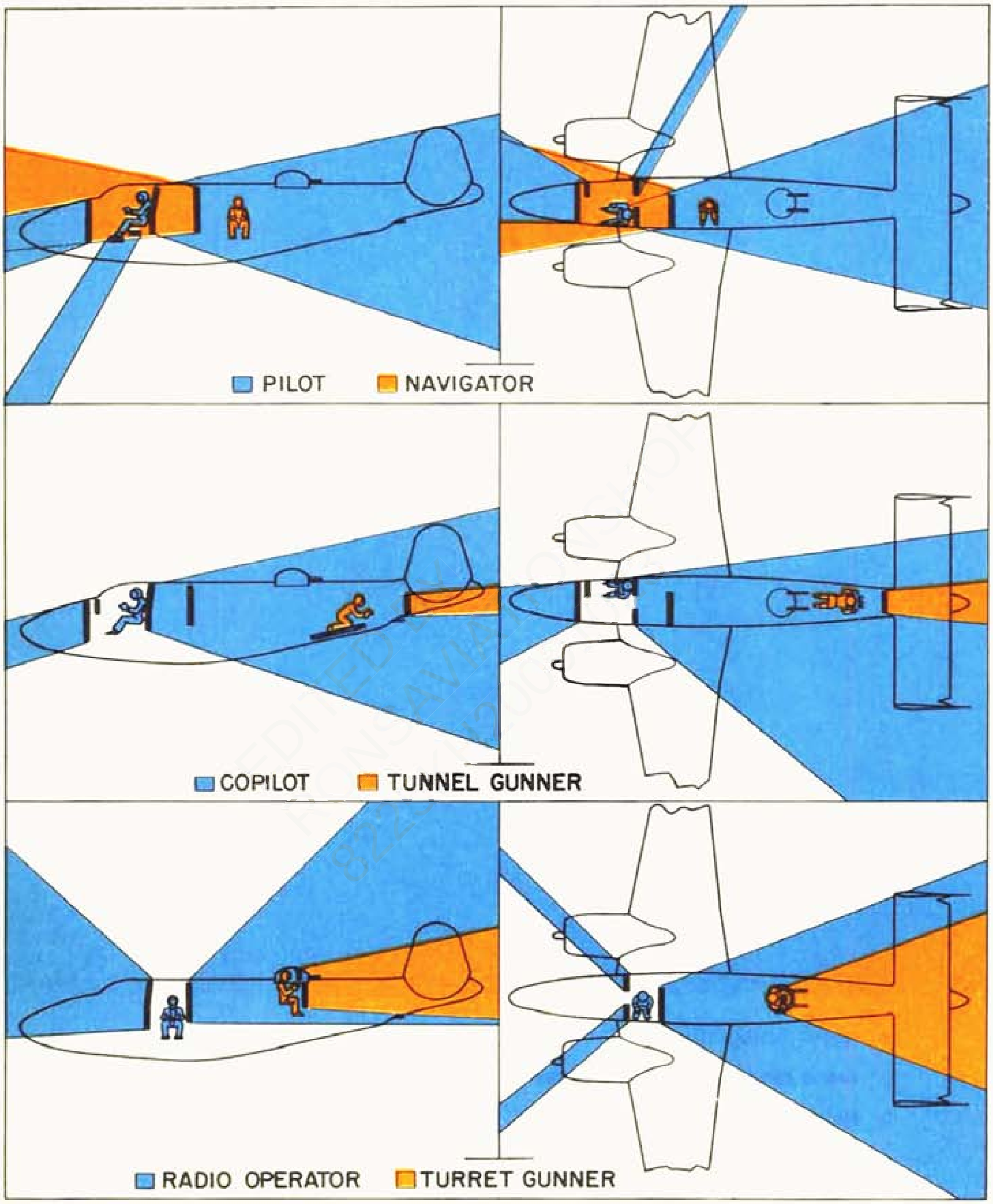


Figure 3 — Angles of Armor Protection

(Tunnel gunner's armor plate is installed on airplanes bearing BuAer serial numbers 37035 through 37193 and 37289 through 37513.)

c. ARMOR PROTECTION. — Gunfire originating within the areas represented by the colored portions of figure 3 cannot reach the crew.

2. POWER PLANT.

The airplane is powered with two R2800-31 radial double-row, 18-cylinder, air-cooled engines, which are equipped with single stage, two-speed superchargers. The fuel and oil used in these engines shall conform to the following requirements:

(1) FUEL.—Specification AN-F-28.
Grade 100 130.

(2) OIL.—Specification AN-VV-O-446a.
Grade 1100 for temperate zones, 1120 for torrid zones.

3. PROPELLER.

The airplane is equipped with three-blade, automatic full feathering, Hamilton Standard propellers.

4. ELECTRICAL SYSTEM.

A 28-volt, direct current, single wire, electrical system is provided. There are two engine-driven generators and two storage batteries. Circuit breakers for all equipment are incorporated in the system to protect it from sustained overloads. (See figures 10 and 14.)

5. FUEL SYSTEM.

a. A separate fuel system, which is suitable for fuels containing 40 percent of aromatics, is provided for each engine. (See figure 6.) All fuel tanks except the rear bomb bay tank are made of self-sealing material. Provisions are made for the installation of external (droppable) fuel tanks.

b. The fuel transfer, flow control, and cross-feed valve controls; the low level and selector indicator lights; and the transfer pump and external tank electrical release switches are located on the central control panel (figure 10). The booster pump switches and the external tank manual release controls are on the control stand (figure 16); and the fuel pressure and quantity gages, flowmeter indicators, and primer switches are on the right side of the instrument panel (figure 13).

6. OIL SYSTEM.

a. A separate oil system is provided for each engine. (See figure 7.) The main tanks on all airplanes and the auxiliary tanks on late airplanes are made of self-sealing material. The main tanks contain hoppers which accelerate oil warming.

b. The transfer pump switches and low level indicator lights are located on the central control panel (figure 10). The oil dilution switches and the pressure and quantity gages are on the right side of the instrument panel (figure 13).

7. HYDRAULIC SYSTEM.

a. The main hydraulic system operates the landing gear, brakes, flaps, bomb bay doors, gyro pilot, and bow gun chargers. (See figure 8.) Power is normally supplied to the system by two engine-driven pumps. An auxiliary hand pump is provided as a source of power in case of engine pump failure or when the engines are inoperative. There is also an emergency system which extends the main landing gear and operates the brakes when the main system has failed. On airplanes bearing BuAer serial number 84057 and subsequent, hydraulic fuses are installed in the bomb bay door, landing gear, and flap lines to prevent the loss of pressure in case of damage to a system.

b. The landing gear, bomb bay door, wing flap, and gyro pilot controls are located on the control stand (figure 16); the pressure gages are on the right side of the instrument panel (figure 13); the system bypass valve control and auxiliary hand pump are on the central control panel (figure 10); the emergency hydraulic unit is in the radio compartment (see figure 21); and the bow gun charger control is in the "V" of the windshield above the instrument panel or below the left instrument panel on late airplanes. (See figures 32 and 13.)

8. CONTROLS.

a. ENGINE CONTROLS.—The engine controls are located on the central control panel, instrument panel, and the control stand. (See figures 10, 13, and 16.)

b. PROPELLER CONTROLS.—The propeller pitch and feathering controls are located on the control stand (figure 16).

c. FLIGHT CONTROLS.—Dual controls and a type A-3A gyro pilot are provided. (See figure 4.)

d. LANDING GEAR CONTROL. — The landing gear control is on the control stand (figure 16).

e. BRAKES.—Hydraulic toe pedal and parking brakes are provided for the pilot only. The parking brake locking control is on the control stand (figure 16).

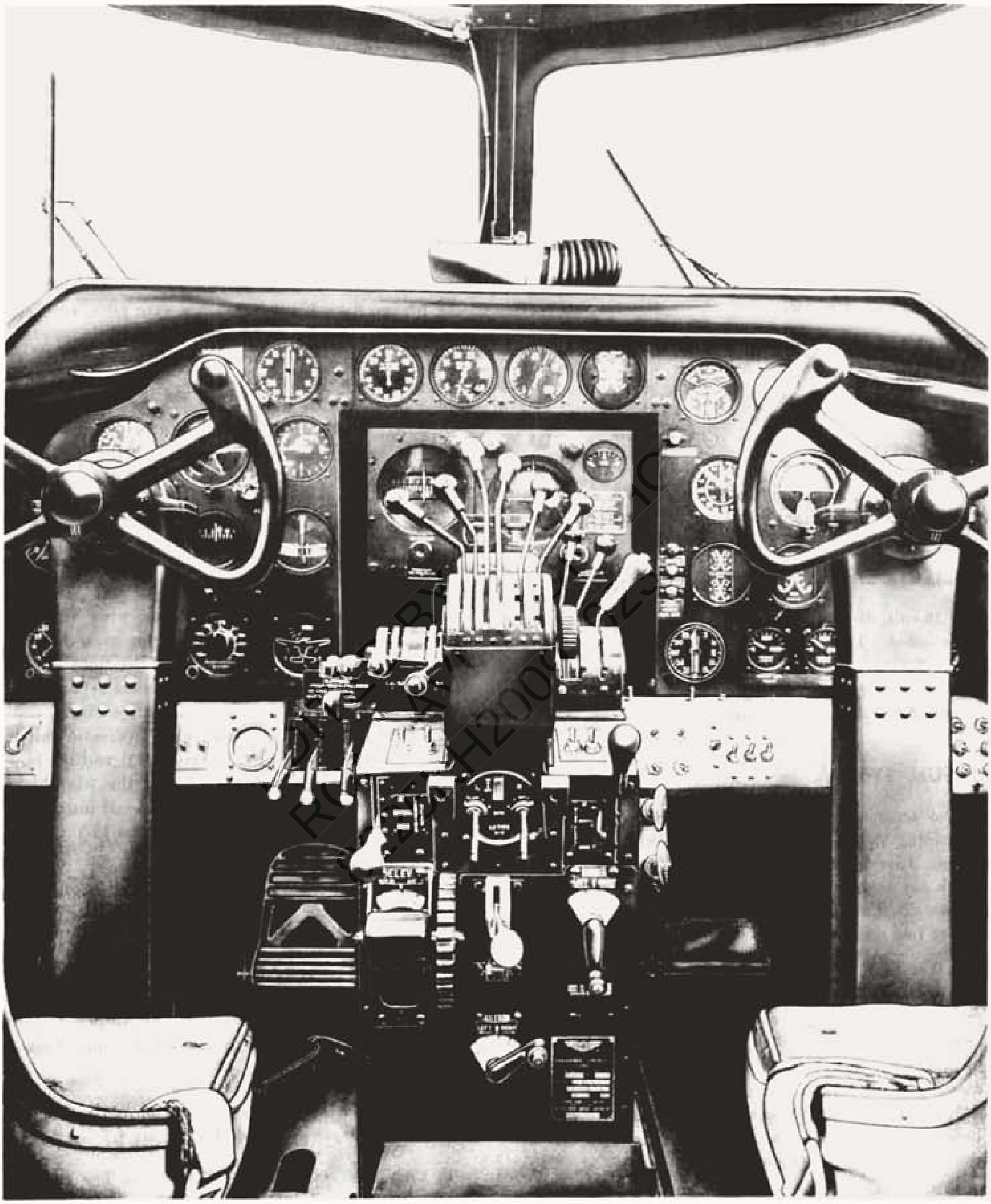


Figure 4 — Flight Compartment — Forward View

9. OPERATIONAL EQUIPMENT.

a. ARMAMENT. — The following armament and equipment are provided:

(1) Five fixed .50 caliber nose guns on airplanes up to BuAer serial number 37535. Eight fixed .50 caliber nose guns on subsequent airplanes.

(2) Two flexible .50 caliber, power-operated tunnel guns on airplanes bearing BuAer serial numbers 37035 through 37193 and 37289 through 37513.

(3) One Martin turret, model 250CE-13, -13A, or -13B, equipped with two .50 caliber guns.

(4) Internal racks for six 325-pound or 500-pound bombs, or four 650-pound or 1000-pound bombs, or one 2000-pound torpedo.

(5) External carriers for two 325-pound, 500-pound, 650-pound, 1000-pound, or twin .50 caliber gun packages.

(6) Eight rocket launchers.

b. RADIO EQUIPMENT. *(See figure 9.)*—The radio equipment consists of the following:

(1) AN/AIA-2 Interphone System.

(2) AN/ARC-5 Command Set.

(3) AN/ART-13 and ARB-3 Liaison Set.

(4) MN-31 Radio Compass.

(5) AN/ARN-8 Marker Beacon Receiving Equipment.

(6) AN/APN-4 Navigation Equipment.

(7) AN/APN-1 Radio Altimeter.

(8) AN/APX-2 or AN/APX-8 Special Service Equipment.

(9) AN/APS-3 Radar Equipment.

(10) SCR-578B Life Raft Transmitter (customer installed).

(11) LM Series Frequency Meter.

c. OXYGEN EQUIPMENT. *(See figure 44.)* — The oxygen system provided is complete with the exception of the cylinders, regulators, and masks which are to be installed by the customer. (Refer to Appendix I for operating instructions.)

d. CARBURETOR AIR FILTER. — Provisions are made for the installation of carburetor air filters and a control switch. The control switch will be located on the right side of the instrument panel (figure 13).

e. WINDSHIELD WIPERS.—Dual two-speed electrical windshield wipers are installed. The control switch is located on the central control panel (figure 10).

CAUTION

Permit wipers to stop when changing speeds.

f. EXTERIOR LIGHTS.—Landing, formation, section, wing tip, tail running, and recognition lights are provided. The control switches for the recognition lights are on the right side of the instrument panel (figure 13) and the switches for all other lights are on the auxiliary electrical control panel (figure 14).

g. ANTI-ICING SYSTEMS.

(1) WING AND STABILIZER ANTI-ICING. *(See figure 5.)*—(This anti-icer installation is effective on a few airplanes only. See figure 5 for serials.) The formation of ice on the wing and stabilizers is prevented by heating the leading edges with hot air which is supplied by two exhaust heat exchangers. Waste gates are incorporated in the system so that the hot air may be bypassed overboard when it is not needed. The waste gate controls are on the right side of the radio compartment. A damper is installed in the duct at the tunnel gunner's station to regulate the flow of air to the stabilizers. Three temperature gages, which indicate the temperature of the air at the heat exchangers and stabilizers, are located just above the waste gate control levers.

(2) PROPELLER AND WINDSHIELD ANTI-ICING.—An alcohol anti-icing system is provided for the propellers and windshield. The alcohol is supplied by two electrically driven pumps, which are controlled by switches on the central control panel (figure 10.) A 16 U. S. gallon (13.3 Imp. gal) alcohol tank is installed under the removable floor panel between the main beam and the rear shear beam. An alcohol drain cock is located under a cover plate just forward of the rear shear beam.

(3) WINDSHIELD DEFROSTING. *(See figure 5.)*—A hot air outlet, which is connected to the cabin heating and ventilating system, is provided for the windshield. Dampers are installed in the duct just below the bottom of the windshield and at floor level in the radio compartment.

(4) CARBURETOR ANTI-ICING.—A valve incorporated in the carburetor air duct permits the selection of air which has been heated by the engine cylinders. The carburetor heat control levers are on the control stand (figure 16).

(5) PITOT-STATIC HEAD ANTI-ICING. — An electrical heating element is built into the pitot-static head. The control switch is on the central control panel (figure 10).

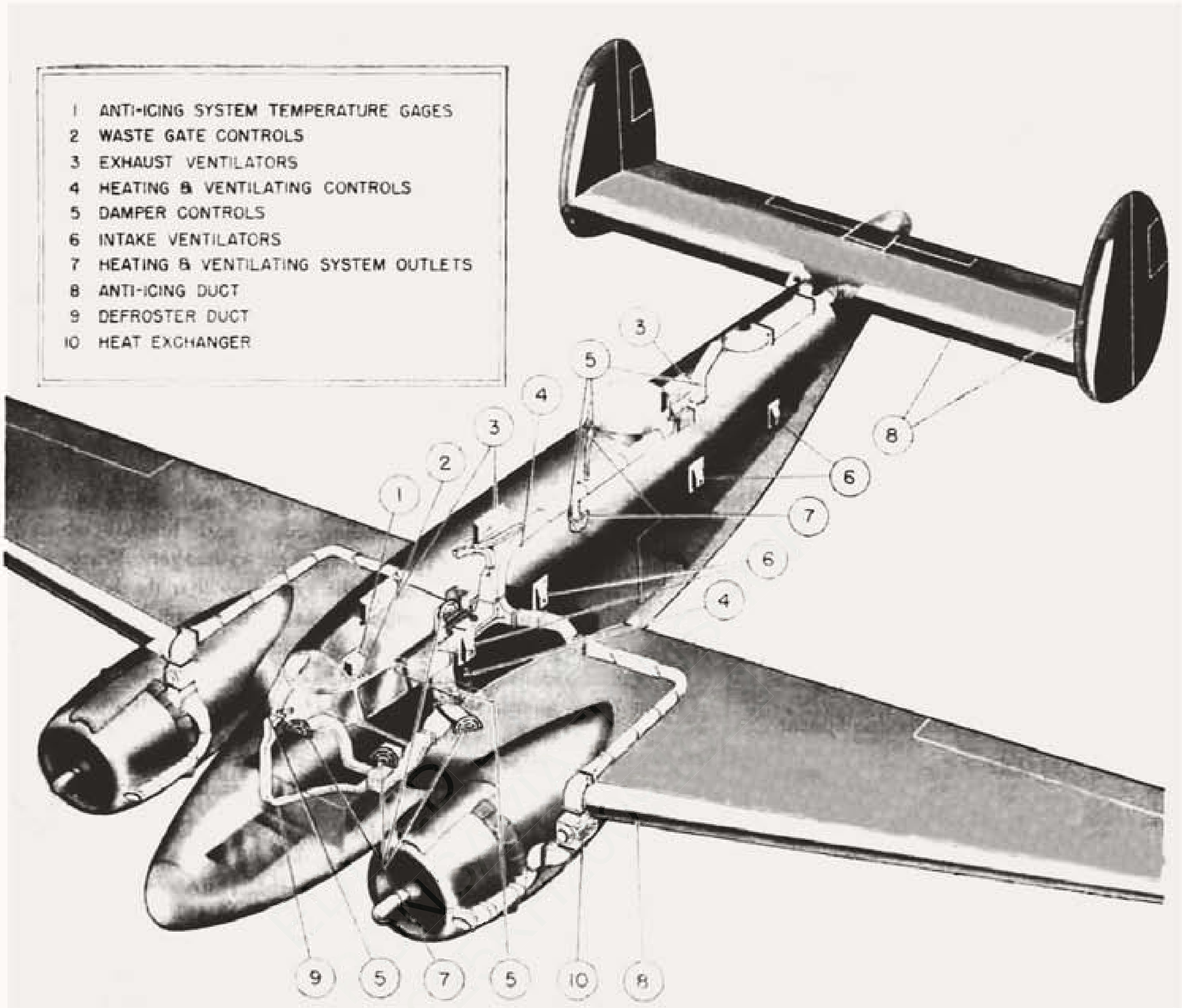


Figure 5 — Anti-icing, Heating, and Ventilating Systems

(Wing and stabilizer anti-icing system and the left-hand exhaust heat exchanger are installed on airplanes bearing BuAer serial numbers 37345, 37424 through 37434, 37436, 37437, 37440, and 37482 through 37488. Turret gunner's outlet is installed on serials 37035 through 37574.)

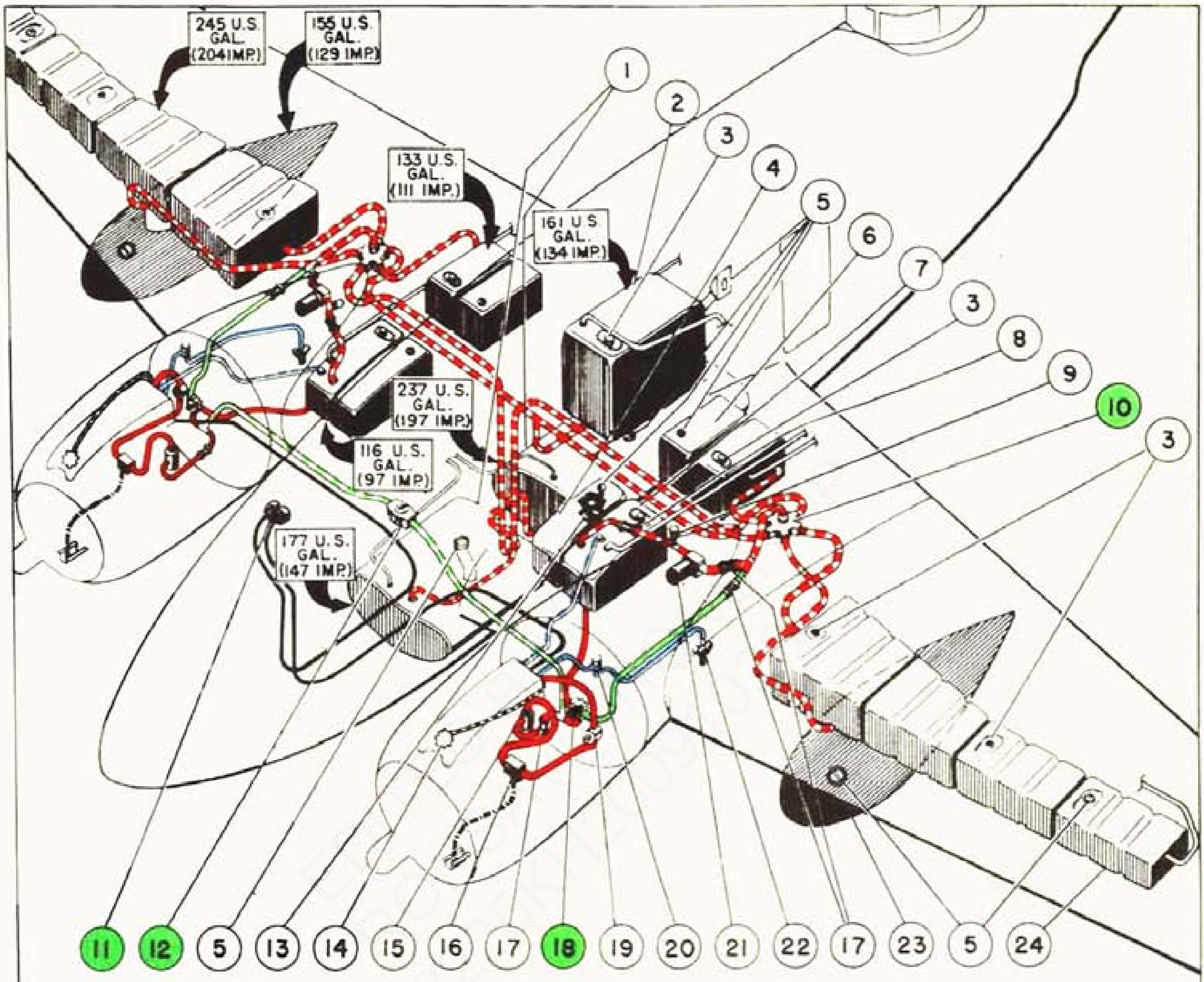
b. HEATING AND VENTILATING. (*See figure 5.*)

(1) The heating and ventilating system is supplied hot air by the exhaust heat exchanger and fresh air by a scoop on the right side of the fuselage. The air flow to the outlets at the pilot's, copilot's, and radio operator's stations may be regulated by the damper which is located at floor level in the radio compartment. The air flow to the other outlets may be regulated by the dampers at the individual outlets. The temperature of the air is regulated by the heating-ventilating controls at the navigator's and radio operator's stations. The quantity of air admitted may be increased by closing the stabilizer damper (if installed) provided the heat is not needed for anti-icing.

(2) In addition to the main heating and ventilating system four adjustable intake ventilators and three non-adjustable exhaust ventilators are installed in the positions shown on figure 5.

(3) A carbon monoxide indicator is installed to warn the crew of the presence of excess carbon monoxide. The indicator light and reset switch (7, figure 13) are located on the instrument panel.

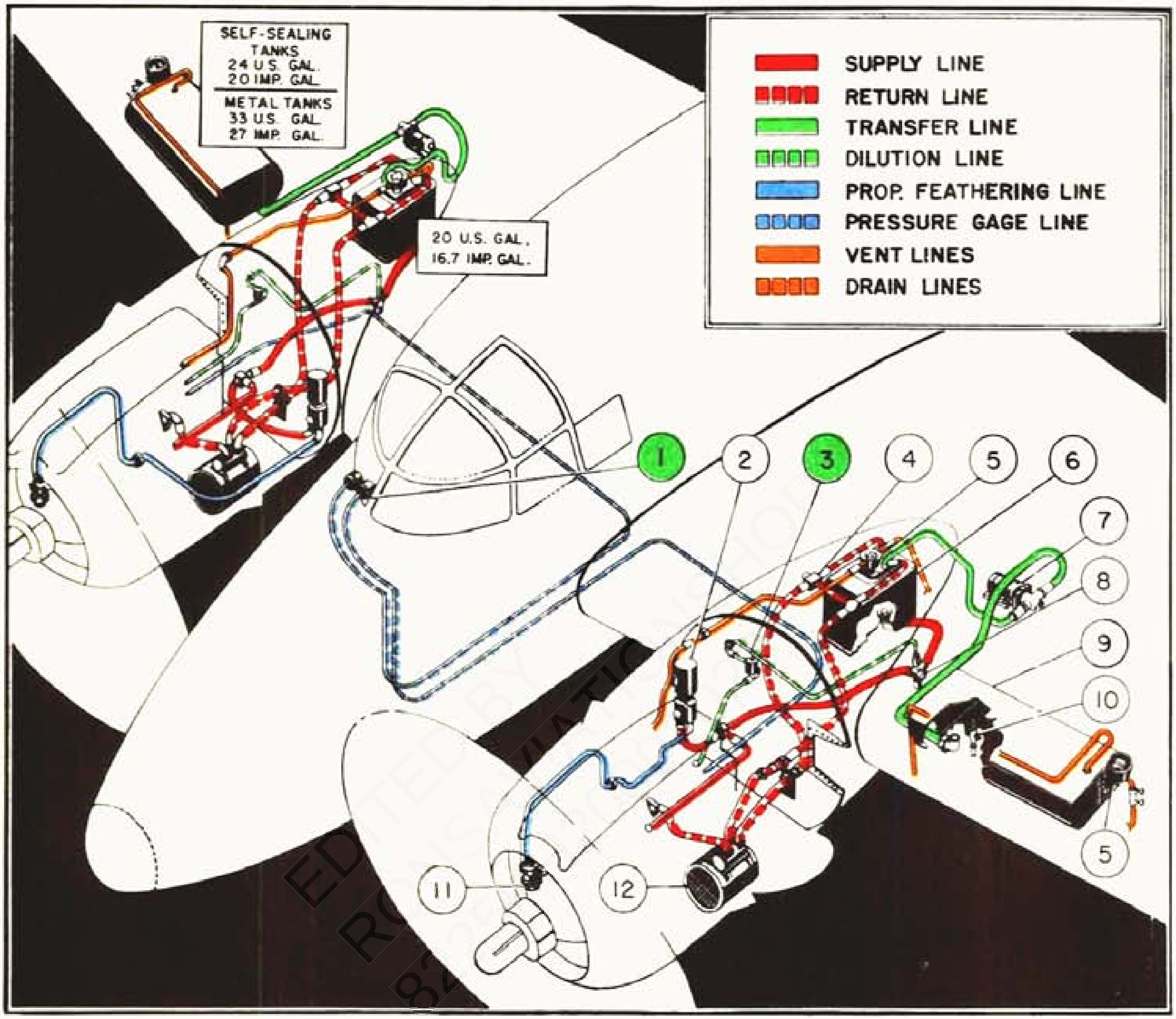
(4) Outlets for electrically heated suits and other portable electrical equipment are provided in the bow compartment and at all crew stations.



1	FRONT & REAR BOMB BAY TANKS *	9	PRESSURE SWITCH	17	CHECK VALVE
2	CABIN TANK	10	TRANSFER SELECTOR VALVE	18	FLOW CONTROL VALVE
3	GAGE UNIT	11	PRESSURE GAGES	19	FLOWMETER
4	FRONT CENTER SECTION TANK	12	CROSSFEED VALVE	20	OIL DILUTION VALVE
5	FILLER CAPS	13	BOOSTER PUMP	21	TRANSFER PUMP
6	REAR CENTER SECTION TANK	14	PRIMER DISTRIBUTOR	22	"Y" DRAIN
7	GAGE UNIT & LOW LEVEL SWITCH	15	STRAINER	23	EXTERNAL TANK * *
8	RESTRICTOR	16	ENGINE DRIVEN PUMP	24	WING TANK

* REAR BOMB BAY TANK IS FOR FERRYING ONLY. * * EXTERNAL TANKS ARE NOT STANDARD EQUIPMENT.

Figure 6 — Fuel System Diagram



1 PRESSURE GAGE

2 PROPELLER FEATHERING PUMP

3 DILUTION VALVE

4 DIVERTER VALVE

5 FILLER CAP

6 MAIN TANK

7 TRANSFER PUMP

8 "Y" DRAIN VALVE

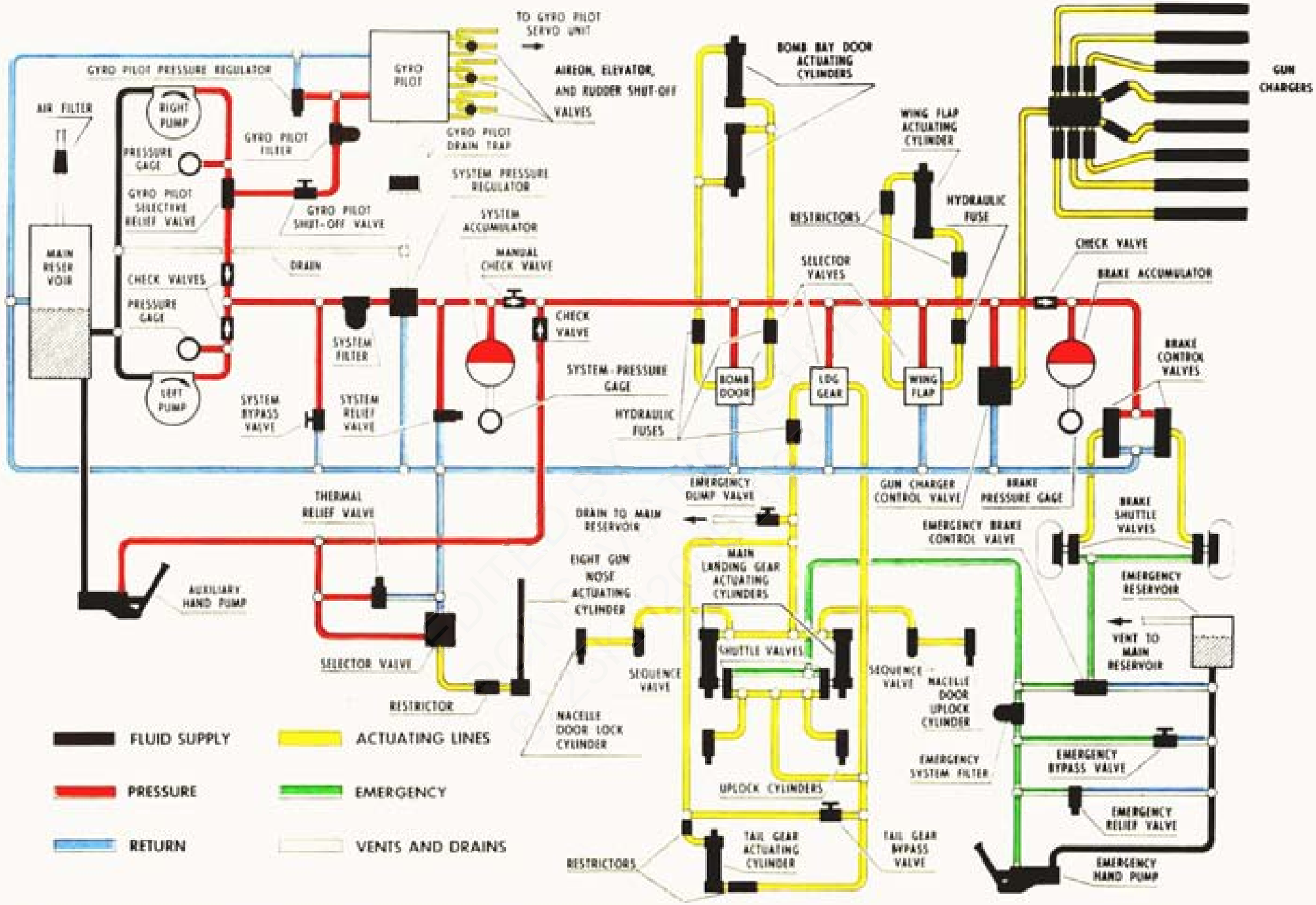
9 AUXILIARY TANK

10 AUXILIARY TANK DRAIN VALVE

11 PROPELLER GOVERNOR

12 OIL COOLER

*Figure 7 — **Oil System Diagram***



(Nose gun package actuating unit, three additional gun charger cylinders, and an auxiliary hydraulic hand pump check valve are installed on airplanes bearing BuAer serial numbers 37525 and subsequent. Hydraulic fuses are installed on serials 84057 and subsequent. Individual gyro pilot shut-off valves are installed on serials 84116 and subsequent.)

Figure 8 — Hydraulic System Flow Diagram

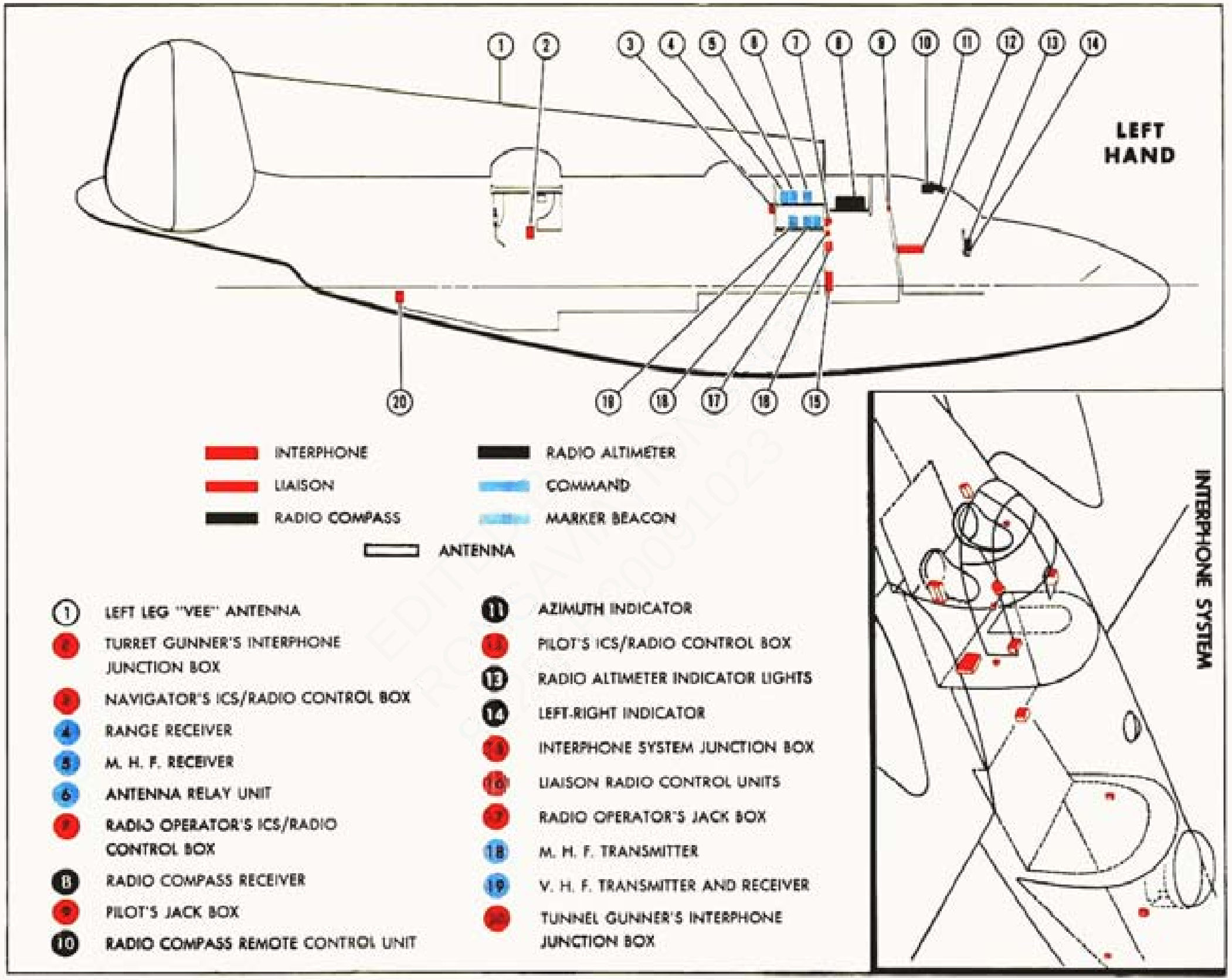


Figure 9 — Radio Equipment Diagram (Sheet 1 of 2 Sheets)

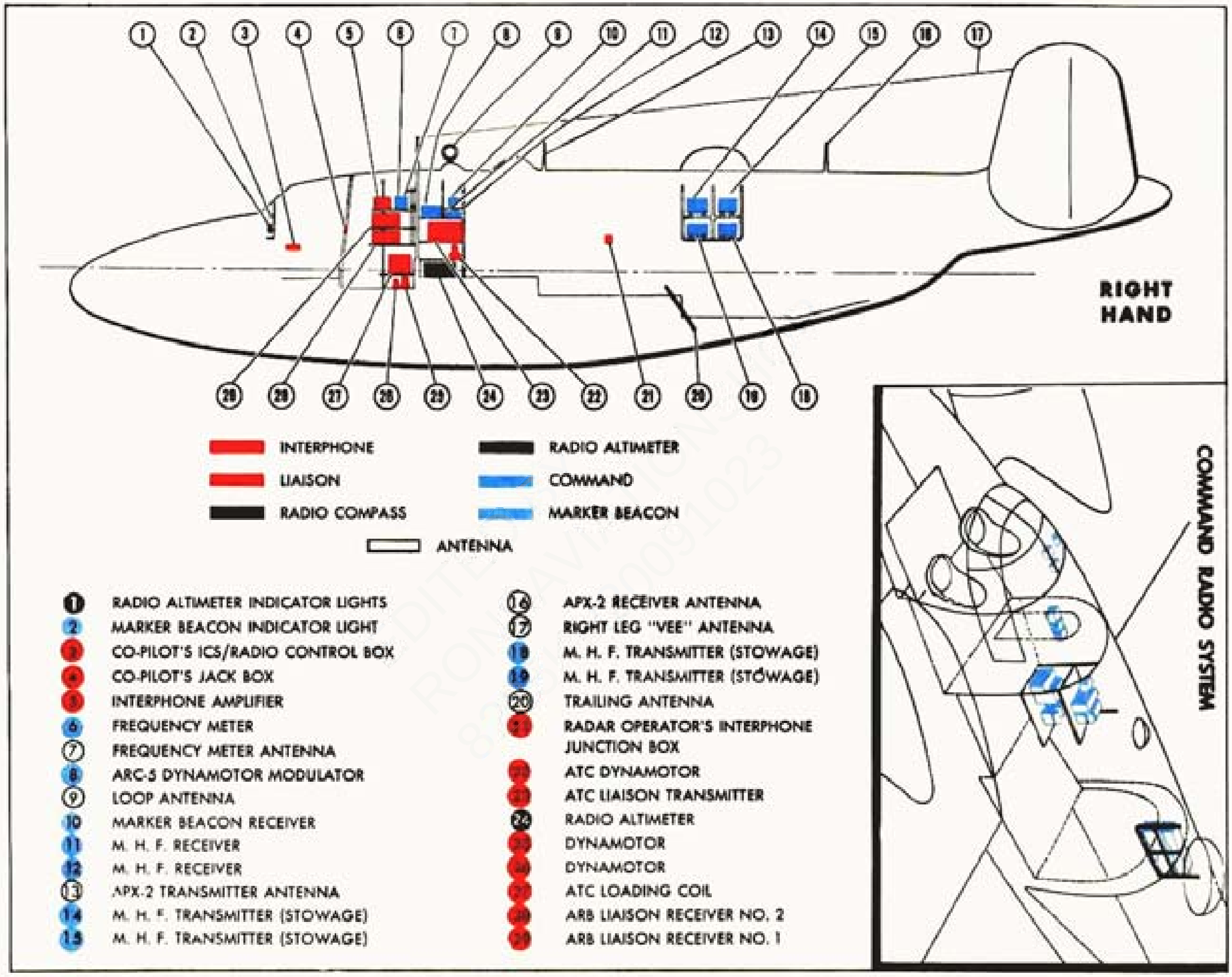
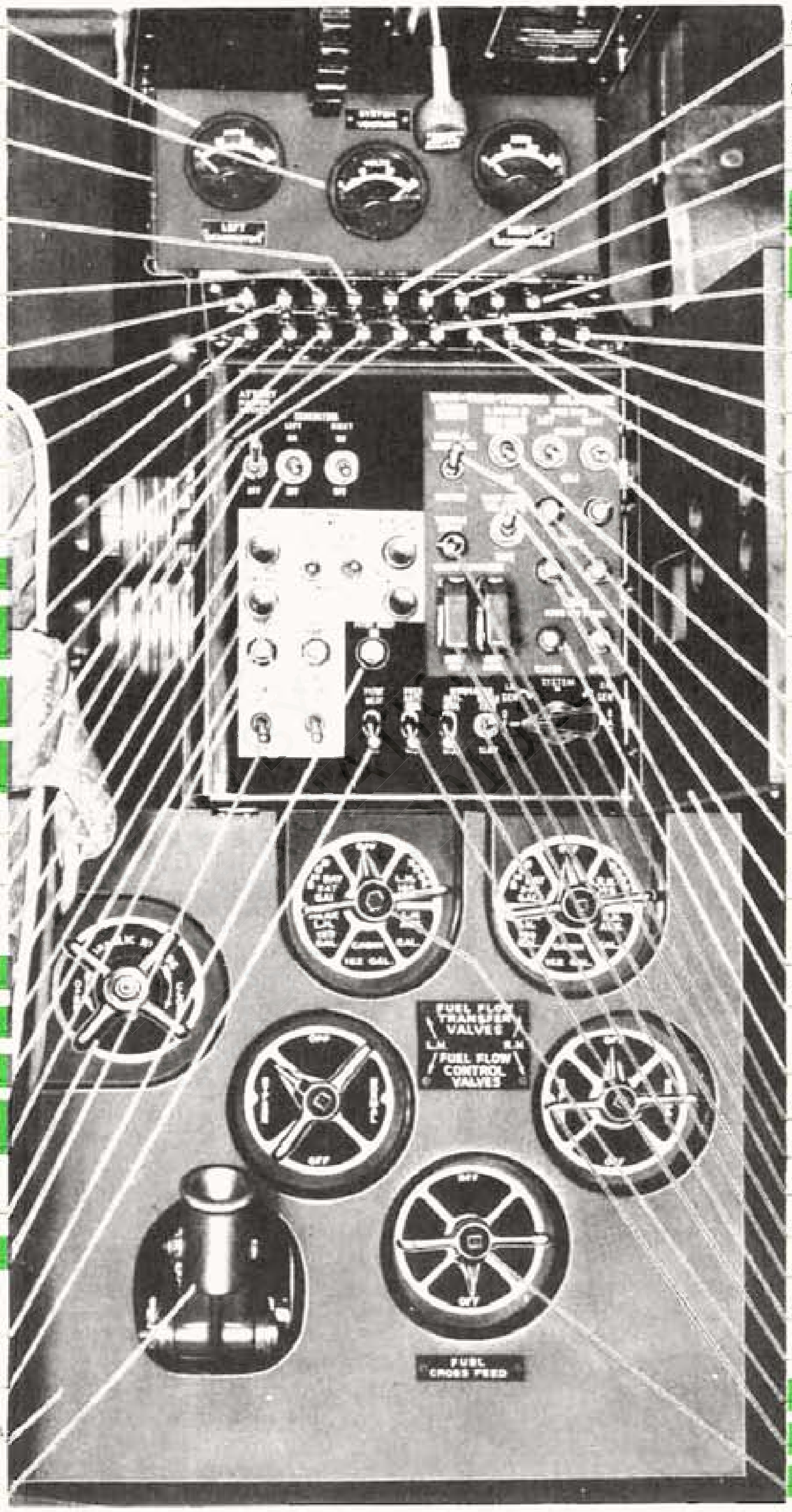


Figure 9 — Radio Equipment Diagram (Sheet 2 of 2 Sheets)



1 AMMETERS

2 VOLTMETER

3 MAIN ELECTRICAL CONTROL PANEL

4 TORPEDO CAMERA HEATER CIRCUIT BREAKER

5 GUN CAMERA HEATER CIRCUIT BREAKER

6 GUN FIRING CIRCUIT BREAKER

7 BOMB TORPEDO RELEASE CIRCUIT BREAKER

8 RADAR CIRCUIT BREAKER

9 PROPELLER FEATHERING CIRCUIT BREAKER

10 GUN HEAT CIRCUIT BREAKER

11 OIL COOLER SHUTTER CIRCUIT BREAKER

12 FUEL TRANSFER PUMP CIRCUIT BREAKER

13 FUEL BOOSTER PUMP CIRCUIT BREAKER

14 GUN POWER CIRCUIT BREAKER

15 BATTERY SWITCH

16 GENERATOR SWITCHES

17 FUEL SELECTOR INDICATOR LIGHTS

18 FUEL LOW LEVEL INDICATOR LIGHTS

19 FUEL TRANSFER PUMP SWITCHES

20 OIL LOW LEVEL INDICATOR LIGHTS

21 HYDRAULIC SYSTEM BYPASS VALVE CONTROL

22 OIL TRANSFER PUMP SWITCHES

23 PITOT STATIC HEAD HEAT INDICATOR LIGHT

24 PITOT STATIC HEAD HEAT SWITCH

25 HYDRAULIC AND FUEL CONTROL PANEL

26 AUXILIARY HYDRAULIC HAND PUMP

27 LANDING GEAR CONTROL LOCK CIRCUIT BREAKER

28 LANDING LIGHT MOTOR CIRCUIT BREAKER

29 FORMATION AND SECTION LIGHT CIRCUIT BREAKER

30 OIL TRANSFER PUMP CIRCUIT BREAKER

31 STARTER OIL DILUTION AND PRIMER CIRCUIT BREAKER

32 ENTRANCE AND FLUORESCENT LIGHT CIRCUIT BREAKER

33 RECOGNITION LIGHT CIRCUIT BREAKER

34 LANDING GEAR WARNING HORN CIRCUIT BREAKER

35 WINDSHIELD WIPER CIRCUIT BREAKER

36 WING RACK SELECTOR SWITCHES

37 BOMB BAY AND EXTERNAL BOMB NOSE ARMING SWITCH

38 WING RACK BOMB RELEASE INDICATOR LIGHT

39 BOMB-TANK TORPEDO SELECTOR MASTER SWITCH

40 EXTERNAL BOMB TAIL ARMING SWITCH

41 MAIN ELECTRICAL CONTROL PANEL COVER

42 WING RACK LOAD INDICATOR LIGHT

43 BOMB BAY DOOR POSITION INDICATOR LIGHT

44 VOLMETER SELECTOR SWITCH

45 TORPEDO RELEASE INDICATOR LIGHT

46 WING RACK SALVO SWITCH

47 BOMB BAY BOMB SALVO SWITCH

48 WINDSHIELD WIPER SWITCH

49 WINDSHIELD ANTI ICER SWITCH

50 PROPELLER ANTI ICER SWITCH

51 FUEL TRANSFER VALVE CONTROLS

52 FUEL FLOW VALVE CONTROLS

53 FUEL CROSS-FEED VALVE CONTROL

Figure 10 — Central Control Panel

SECTION II

PILOT'S OPERATING INSTRUCTIONS

1. BEFORE ENTERING THE FLIGHT COMPARTMENT.

FLIGHT LIMITATIONS

Maximum recommended gross weight for take-off — 33,000 pounds.

Maximum recommended gross weight for landing — 30,000 pounds.

Center of gravity recommendations for take-off and landing — 22 to 33 percent M.A.C.

Maximum permissible accelerations:

Gross Weight	*Position Acceleration*	
	Empty Wing Fuel Tank	*Full Wing Fuel Tanks*
27,000 lb	3.00 g	3.26 g
30,000 lb	2.70 g	2.94 g
33,000 lb	2.45 g	2.67 g

The accelerations listed are those which are permissible in operations which do not involve the use of ailerons.

Do not use the ailerons under conditions of high accelerations.

Maximum permissible indicated air speeds:

Operation	*Speed (knots)*
Lowering flaps or flying with them down	120
Lowering landing gear or flying with it down	150
Opening bomb bay doors or flying with them open	309
Diving	309

In rough air, the permissible maximum air speed (309 knots) is considerably reduced. In extremely rough air, operation in the range of from 135 to 150 knots is recommended from the standpoint of strength and controllability. At lower speeds the danger of losing control due to violent gusts is increased.

Avoid abrupt use of the ailerons at high speeds.

a. Be sure that the miscellaneous equipment and cargo are properly stowed.

b. Check gross weight and C.G. location for take-off and for anticipated loading for landing. Data are furnished in the Handbook of Weight and Balance Data, AN 01-1B-40, and supplemented by a load adjuster.

c. Check the quantity of fuel in the cabin tank. (The gage is on the top of the tank.)

d. At night move the cabin dome light switch (8, figure 25) to "ON."

2. ON ENTERING THE FLIGHT COMPARTMENT.

a. BEFORE ALL FLIGHTS.

(1) Check to see that the escape hatch is securely fastened in place.

(2) Remove the elevator and aileron locking bar (3, figure 11) as follows:

(a) Unfasten the control wheel straps (1, figure 11).

(b) Lift the latch (4, figure 11) and disengage the pins in the control stand head.

(3) Stow the bar in the stowage compartment (13, figure 38).

(4) Release the rudder locking bar (2, figure 11) and strap it to the floor.

(5) Adjust the seats, if necessary, releasing and locking them with the levers on the right side.

(6) Adjust the rudder pedals, if necessary, by lifting the pawls and moving the pedals to the desired position. (See figure 12.)

(7) If an external electrical power source is available, instruct the ground crew to connect it to the receptacle which is accessible from the outside and located just aft of the cabin door.

(8) If an external power source is not used, move the battery switch (15, figure 10) to "ON."

(9) Move the instrument switch (10, figure 14) to "ON."

(10) Note the quantities of fuel and oil which are indicated by the gages on the right side of the instrument panel (24 and 47, figure 13).

(11) Test the fuel selector and low level indicator lights (17 and 18, figure 10) by pressing the lights down.

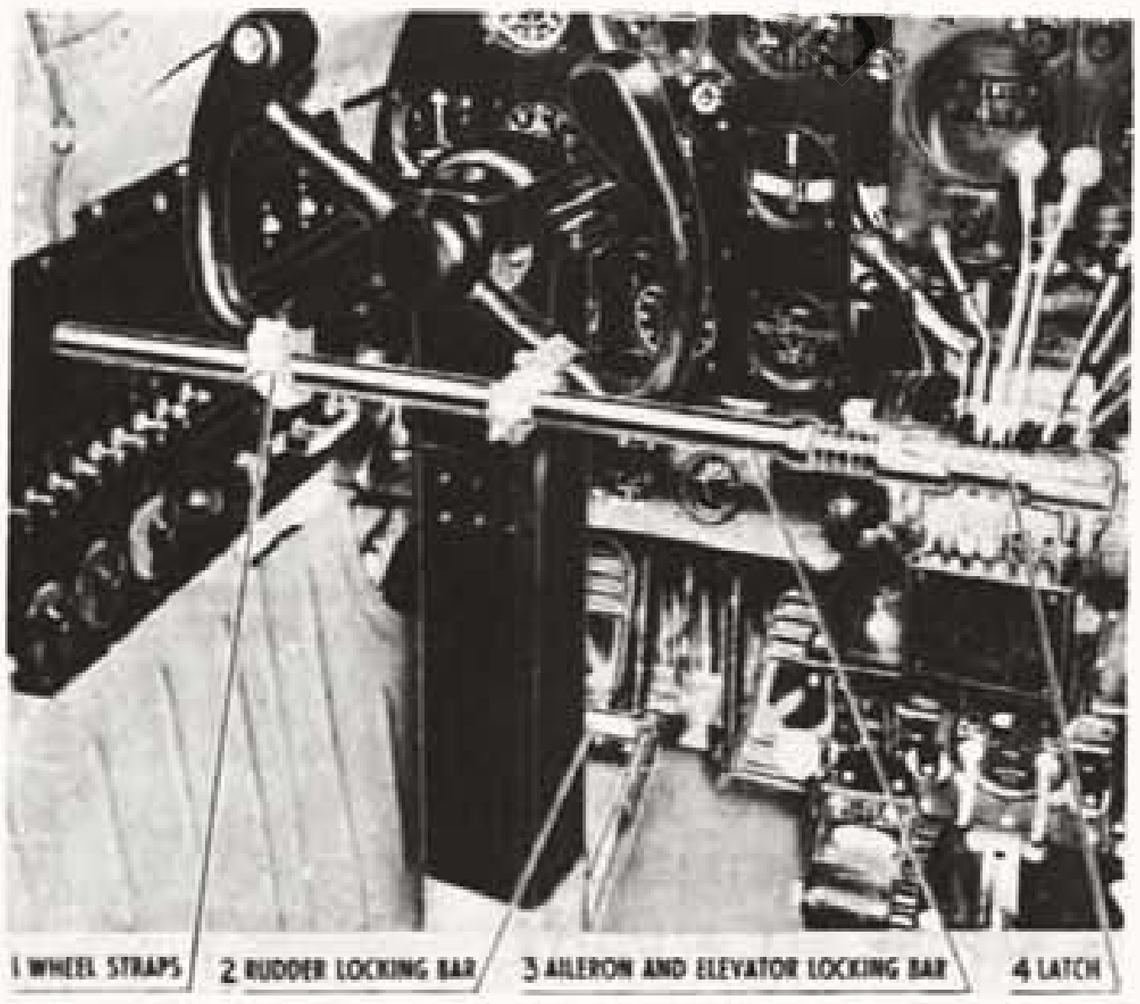


Figure 11 — Flight Control Locks

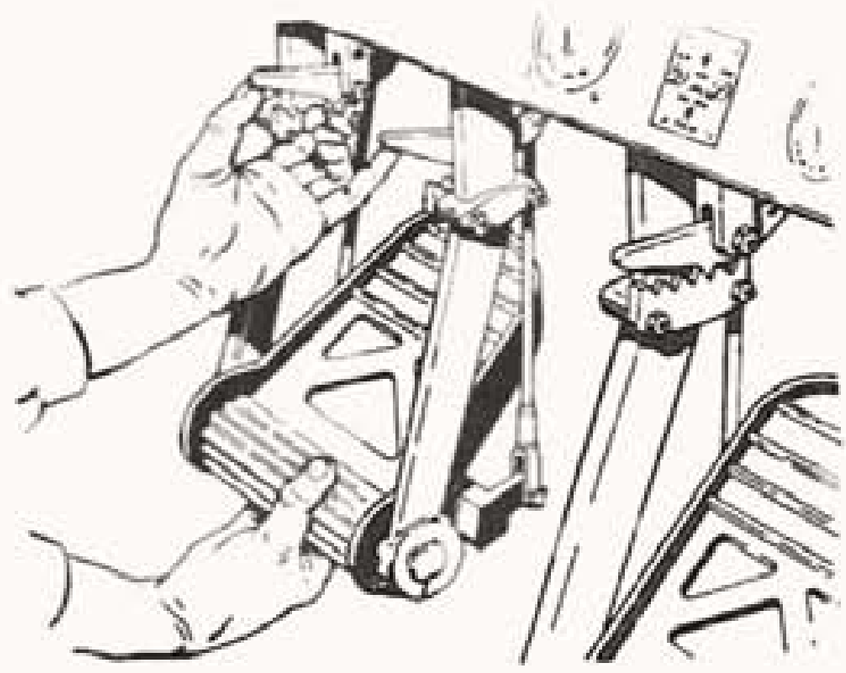


Figure 12 — Rudder Pedal Adjustment Diagram

(12) Open the dimmer masks on all indicator lights by aligning the white marks on the caps and bases. (See figures 10, 13, and 14.)

(13) See that the hydraulic system bypass valve control (21, figure 10) is in the closed position (turned as far as possible in a clockwise direction). Then check the auxiliary hydraulic hand pump and the brake accumulator by operating the hand pump (26, figure 10) and noting the effect on the reading of the brake pressure gage (49, figure 13).

(14) Check to see that the controls are set as follows:

(a) Gyro pilot control (16, figure 16)—"OFF."

(b) Bomb bay door control (15, figure 16)—"CLOSED."

(c) Flap control (20, figure 16)—"UP."

(15) Close the bomb bay doors if they remain open, and raise the flaps if they remain down, by operating the auxiliary hydraulic hand pump.

(16) If the airplane is equipped with an eight gun nose, check to see that it is retracted. (The indicator light (22, figure 13) will glow if it is not.) If the nose is not retracted, retract it following the procedure in Section V, paragraph 1,*d*,(5),*(b)*.

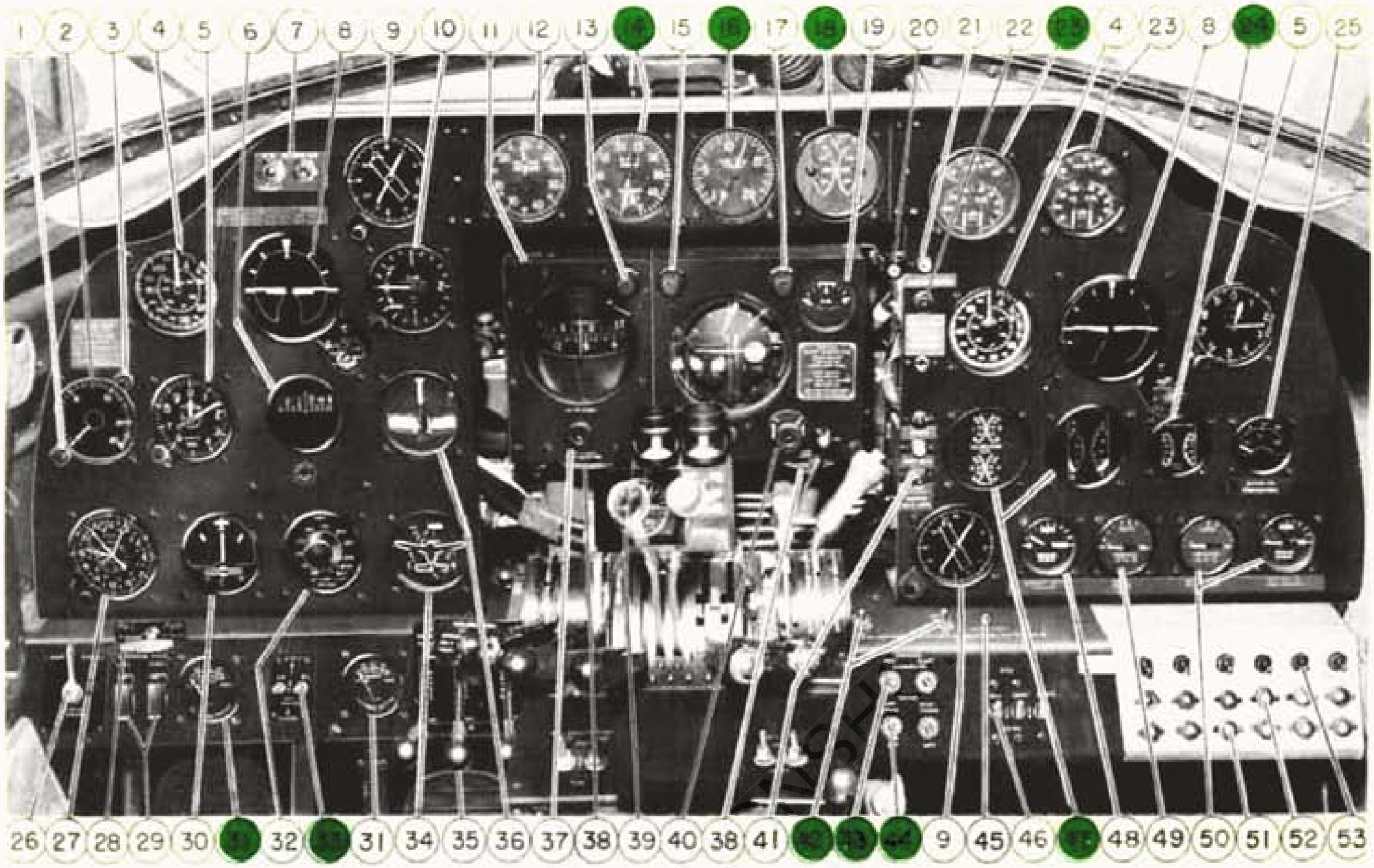
(17) Check the operation of the windshield and propeller anti-icer motors by moving each switch (49 and 50, figure 10) to "ON" momentarily and listening for the sound of the motor.

(18) Set the altimeters and clock.

(19) Check to see that the armament control switches are set as follows:

(a) Gun safety switches, (2, 3, 23 and 24, figure 14)—"SAFE."

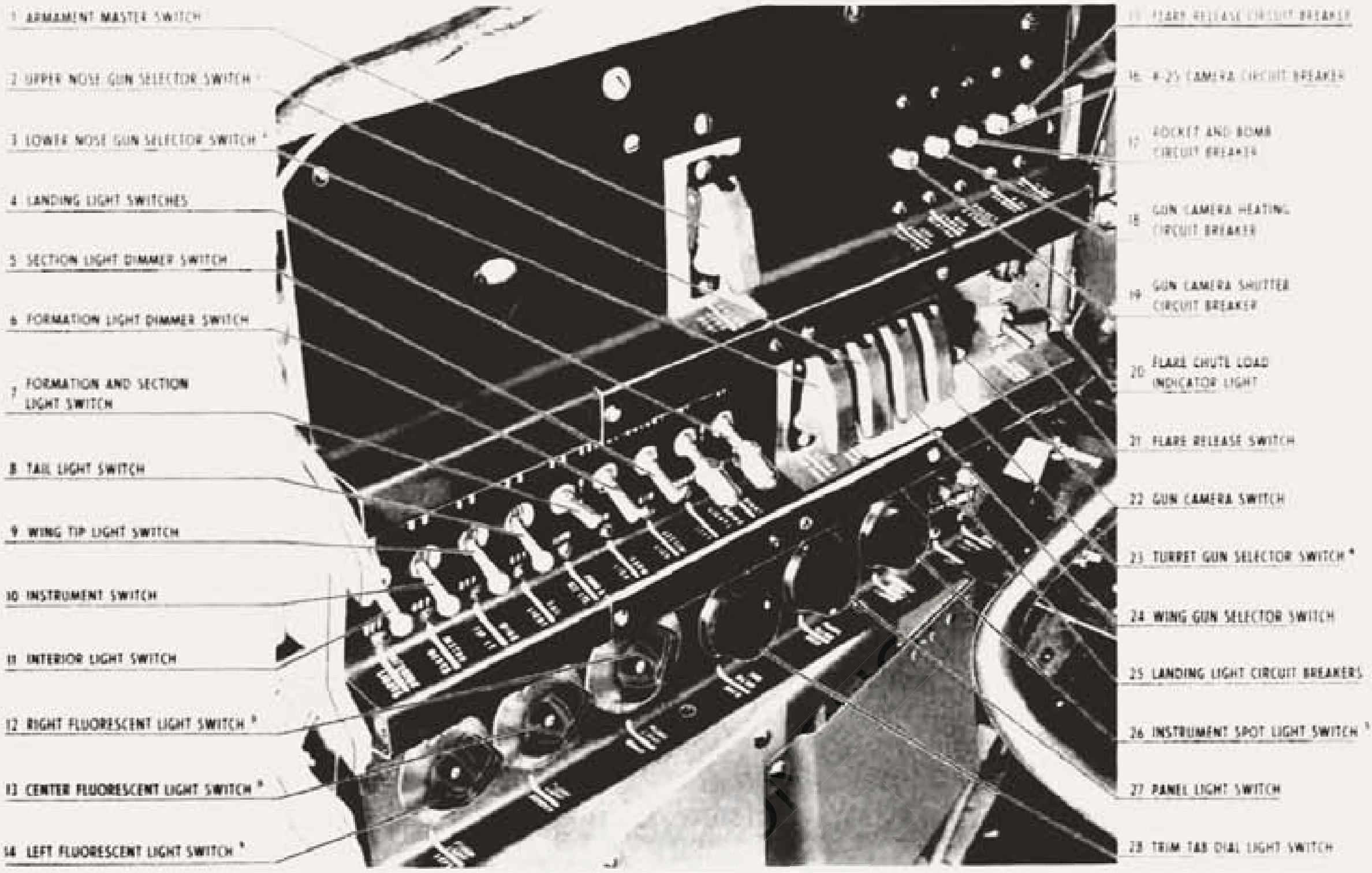
(b) Bomb-tank-torpedo selector master switch (39, figure 10)—"OFF."



1 POWER SWITCH
2 RADIO ALTITUDE INDICATOR
3 RANGE CONTROL
4 AIR-SPEED INDICATORS
5 ALTIMETERS
6 TURN GYRO
7 CARBON MONOXIDE INDICATOR AND RESET SWITCH
8 BANK AND CLIMB GYROS
9 GYRO FLUX GATE COMPASS INDICATORS
10 VERTICAL SPEED INDICATOR
11 GYRO PILOT CONTROL UNIT
12 MANIFOLD PRESSURE GAGE
13 RUDDER CONTROL
14 TACHOMETER
15 AILERON CONTROL
16 FUEL FLOWMETER
17 ELEVATOR CONTROL
18 CYLINDER HEAD TEMPERATURE INDICATOR
19 VACUUM GAGE
20 WINDSHIELD DEFROSTER CONTROL
21 MARKER BEACON INDICATOR LIGHT
22 NOSE GUN PACKAGE WARNING LIGHT[1]
23 FUEL AND OIL PRESSURE AND OIL TEMPERATURE GAGE UNITS
24 MAIN OIL TANK QUANTITY GAGE UNIT
25 FREE AIR TEMPERATURE INDICATOR
26 ALTIMETER VALVE CONTROL
27 CLOCK
28 NOSE GUN CHARGER CONTROL[2]
29 GENERATOR FIELD SWITCHES[3]
30 RADIO COMPASS INDICATOR
31 OIL COOLER SHUTTER POSITION INDICATORS
32 RADIO ALTITUDE LIMIT SWITCH
33 OIL COOLER SHUTTER SWITCHES
34 FLAP AND LANDING GEAR POSITION INDICATOR
35 GYRO PILOT AILERON, ELEVATOR, AND RUDDER CONTROLS[4]
36 TURN AND BANK INDICATOR
37 TURN GYRO CAGING CONTROL
38 SENSITIVITY CONTROLS
39 GYRO PILOT PRESSURE GAGE
40 BANK AND CLIMB GYRO CAGING CONTROL
41 RADIO ALTITUDE INDICATOR LIGHTS
42 OIL DILUTION SWITCHES
43 STARTER SWITCHES
44 PRIMER SWITCHES
45 RECOGNITION LIGHT KEYING SWITCH
46 RECOGNITION LIGHT SWITCHES
47 FUEL QUANTITY GAGE UNITS
48 HYDRAULIC SYSTEM PRESSURE GAGE
49 HYDRAULIC BRAKE PRESSURE GAGE
50 HYDRAULIC PUMP PRESSURE GAGES
51 BOMB BAY BOMB LOAD INDICATOR LIGHTS
52 BOMB BAY BOMB RELEASE INDICATOR LIGHTS
53 BOMB BAY BOMB SELECTOR SWITCHES

1. Nose gun package warning light is installed on airplanes bearing BuAer serial numbers 37535 and subsequent.
2. Nose gun charger moved to this location on serials 37515 and subsequent.
3. Generator field switches are installed on serials 37135 and subsequent.
4. Individual gyro pilot controls are installed on serials 84116 and subsequent.

Figure 13 — Instrument Panel



1. Armament master switch is installed on airplanes bearing BuAer serial numbers 37535 and subsequent.
2. Upper and lower nose gun selector switches are installed on serials 37535 and subsequent. Prior to this serial one switch controls all nose guns and the turret guns.
3. Fluorescent light switches are replaced by the instrument spot light switch on serials 37575 and subsequent.
4. Turret gun selector switch is installed on serials 37535 and subsequent. Prior to this serial turret guns are controlled by the nose gun switch.

Figure 14 — Auxiliary Electrical Control Panel

(c) Rocket switch (4, figure 28)—"OFF."

(d) Armament master switch (1, figure 14), if installed—"OFF."

(20) Turn the gun sight light switch (10, figure 32) to "ON" momentarily, and check to see that the light comes on.

(21) Check the operation of the radio equipment. (See Section V, paragraph 1, *c*.)

b. BEFORE NIGHT FLIGHTS.—Move the following light switches to the "ON" position momentarily and check to see that the corresponding lights come on:

(1) Interior light switch (11, figure 14) and then the panel light switch (27, figure 14) and trim tab dial light switch (28, figure 14).

(2) Instrument spot light switches (12, 13, 14, and 26; figure 14).

(3) Indirect instrument light switch, if installed. (Switch is located on top of the control stand just forward of the carburetor heat controls.)

(4) Formation and section light switch (7, figure 14).

(5) Gun sight light switch (10, figure 32).

(6) Tail light switch (8, figure 14).

(7) Wing tip light switch (9, figure 14).

(8) Landing light switches (4, figure 14).

(9) Recognition light switches (46, figure 13).

CAUTION

Do not leave landing or recognition lights on for more than a few seconds at a time when the airplane is at rest.

3. FUEL SYSTEM MANAGEMENT.

a. GENERAL. *(See figure 15.)*—Normally, fuel is transferred by the automatic transfer pumps from the external, wing, cabin, rear center section, and bomb bay tanks to the front center section tanks. It is then pumped to the engines by the engine-driven pumps and,

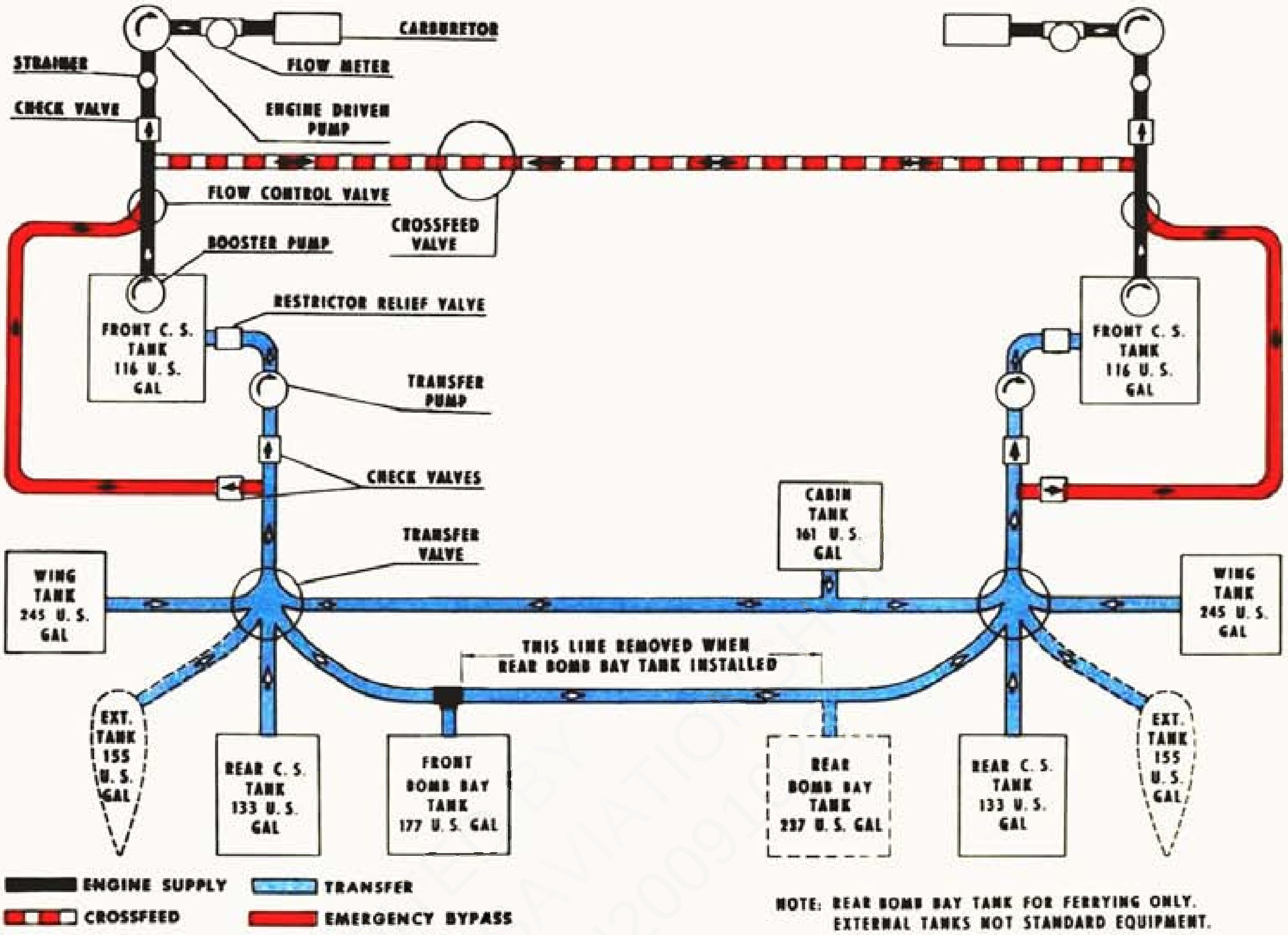


Figure 15 — Fuel System Flow Diagram

if necessary, the booster pumps. In an emergency, fuel may be bypassed directly from any tank to the engine; or it may be cross-fed from any tank on one side of the airplane to the engine on the other side.

A selector indicator light (17, figure 10) comes on whenever the transfer pump circuit is energized and there is no fuel pressure in the lines between the transfer pump and the front center section tank. A low level indicator light (18, figure 10) comes on when there are about 40 gallons of fuel remaining in the front center section tank.

b. ORDER OF TANK USAGE.

(1) Bomb Bay (if installed).

(2) External (if installed).

(3) Cabin.

(4) Wing.

(5) Rear Center Section.

c. NORMAL OPERATION.

(1) Set the controls as listed in table 1. (See figures 10 and 16.)

(2) When a selector indicator light comes on and remains on for a few seconds, turn the transfer valve control to the next full tank.

d. EMERGENCY OPERATIONS.

(1) GENERAL.

(a) If a selector indicator light remains on after selecting the next full tank and the fuel level in the front center section tank continues to drop, the fuel line to the tank selected, the transfer pump motor, or the transfer valve may have been damaged. One or more of the following steps should be taken to determine if fuel can be transferred or supplied to the engine before the fuel in the front center section tank is exhausted:

1. Turn the transfer valve control to another full tank.

2. Use the bypass system.

3. Use the cross-feed system.

(b) If a selector indicator light does not come on and the low level indicator light does, either the automatic transfer system is not functioning properly or the front center section tank has been damaged. One or more of the following steps should be taken to determine if fuel can be transferred or supplied to the engine:

1. Hold the transfer pump switch in the "MANUAL" position until the front center section tank is full. If necessary, turn the transfer valve control to the next full tank.

2. Use the bypass system.

3. Use the cross-feed system.

(c) If a fuel line fails between the carburetor and the check valve on the fire wall, the fuel on the damaged side may be cross-fed to the operating engine. The only means of determining if the line is damaged between the carburetor and check valve is by a successful attempt to cross-feed to the operating engine.

CAUTION

Do not use the booster pump on the damaged side under the above conditions.

NORMAL OPERATION

Transfer from Tanks	*Valve Control Positions*			*Pump Switch Positions*	
	Left and Right Flow Control	*Left and Right Transfer*	*Cross-feed*	*Left and Right Transfer*	*Left and Right Booster*
Bomb Bay	"NORMAL"	"BOMB BAY"	"OFF"	"AUTO"	"OFF" normally. "SLOW" for engine priming and whenever engine surging occurs. "FAST" when operating at take-off power.
Left and Right External	"NORMAL"	"DROP"	"OFF"	"AUTO"	
Cabin	"NORMAL"	"CABIN"	"OFF"	"AUTO"	
Left and Right Wing	"NORMAL"	"WING"	"OFF"	"AUTO"	
Left and Right Rear Center Section	"NORMAL"	"REAR"	"OFF"	"AUTO"	

Table 1

EMERGENCY BYPASS OPERATION

Engine Supply from Tanks	*Valve Control Positions*			*Pump Switch Positions*	
	Left and Right Flow Control	*Left and Right Transfer*	*Cross-feed*	*Left and Right Transfer*	*Left and Right Booster*
Bomb Bay	"BYPASS"	"BOMB BAY"	"OFF"	"OFF"	"OFF"
Left and Right External	"BYPASS"	"DROP"	"OFF"	"OFF"	"OFF"
Cabin	"BYPASS"	"CABIN"	"OFF"	"OFF"	"OFF"
Left and Right Wing	"BYPASS"	"WING"	"OFF"	"OFF"	"OFF"
Left and Right Rear Center Section	"BYPASS"	"REAR"	"OFF"	"OFF"	"OFF"

Table 2

CROSS-FEED TO LEFT ENGINE

Engine Supply From Tank	*Valve Control Positions*					*Pump Switch Positions*			
	Left Flow Control	*Right Flow Control*	*Left Transfer*	*Right Transfer*	*Cross-feed*	*Left Transfer*	*Right Transfer*	*Left Booster*	*Right Booster*
Right Front Center Section	"OFF"	"NORMAL"	"OFF"	(As Desired)	"ON"	"OFF"	"AUTO"	"OFF"	"OFF" normally. "SLOW" if engine surges.
Bomb Bay	"OFF"	"BYPASS"	"OFF"	"BOMB BAY"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Right External	"OFF"	"BYPASS"	"OFF"	"DROP"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Cabin	"OFF"	"BYPASS"	"OFF"	"CABIN"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Right Wing	"OFF"	"BYPASS"	"OFF"	"WING"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Right Rear Center Section	"OFF"	"BYPASS"	"OFF"	"REAR"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"

Table 3

CROSS-FEED TO RIGHT ENGINE

Engine Supply From Tank	*Valve Control Positions*					*Pump Switch Positions*			
	Left Flow Control	*Right Flow Control*	*Left Transfer*	*Right Transfer*	*Cross-feed*	*Left Transfer*	*Right Transfer*	*Left Booster*	*Right Booster*
Left Front Center Section	"NORMAL"	"OFF"	(As Desired)	"OFF"	"ON"	"AUTO"	"OFF"	"OFF" normally. "SLOW" if engine surges.	"OFF"
Bomb Bay	"BYPASS"	"OFF"	"BOMB BAY"	"OFF"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Left External	"BYPASS"	"OFF"	"DROP"	"OFF"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Cabin	"BYPASS"	"OFF"	"CABIN"	"OFF"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Left Wing	"BYPASS"	"OFF"	"WING"	"OFF"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"
Left Rear Center Section	"BYPASS"	"OFF"	"REAR"	"OFF"	"ON"	"OFF"	"OFF"	"OFF"	"OFF"

Table 4

(2) BYPASS OPERATION.

(a) If the bypass system is used for both engines, set the controls as listed in table 2. If the bypass system is used for only one engine, set the controls for the engine affected as listed in table 2. (See figures 10 and 16.)

(b) When the fuel pressure begins to fluctuate, turn the transfer valve control to the next full tank immediately.

(3) CROSS-FEED OPERATION.—Set the controls as listed in tables 3 or 4 when cross-feeding with one engine dead and also when cross-feeding to one engine and supplying the other engine direct. (See figures 10 and 16.)

(a) If cross-feeding from the front center section tank, turn the transfer valve control to the next full tank when the selector indicator light comes on, and remains on for a few seconds.

(b) If cross-feeding directly from any tank other than the front center section, turn the transfer valve control to the next full tank immediately when the fuel pressure begins to fluctuate.

4. OIL SYSTEM MANAGEMENT.

a. GENERAL. — A minimum of 8 gallons of oil should be kept in the main tanks by transferring oil to them from the auxiliary tank. Low level indicator lights (20, figure 10) come on when the 8-gallon level is reached.

b. OPERATION.—When a low level indicator light comes on, hold the transfer pump switch (22, figure 10) in the on position until the quantity gage indicates that the main tank is full.

CAUTION

Do not operate a transfer pump longer than is necessary to fill the main tank or the tank may burst.

5. STARTING THE ENGINES.

a. PREPARATION.

Note

Engine fire extinguishers are NOT installed on this airplane. Strict adherence to the following instructions as to the mixture control positions will reduce the possibility of fire.

(1) Apply the parking brakes by holding the lock control (6, figure 16) in the aft position and depressing the toe pedals. A definite click will be heard when the brakes lock. If the hydraulic brake pressure is low, build it up to 800 psi by operating the auxiliary hydraulic hand pump (26, figure 10).

(2) See that the cabin door is closed.

(3) Be sure the ignition is off and then instruct the ground crew to turn the propellers through 3 or 4 revolutions by hand to clear the cylinders of any accumulated fuel or oil.

(4) Set the controls as follows:

(a) Supercharger controls (3, figure 16) — "LOW."

(b) Propeller pitch controls (2, figure 16) — "LOW."

(c) Carburetor heat controls (4, figure 16) — "DIRECT."

(d) Mixture controls (13, figure 16) — "CUT OFF."

(e) Fuel flow valve controls (52, figure 10)— "NORMAL."

(f) Fuel cross-feed valve control (53, figure 10) —"OFF."

(g) Fuel transfer valve controls (51, figure 10) —Set on correct tank. (See paragraph 3, *b*.)

(h) Fuel transfer pump switches (19, figure 10) —"AUTO."

(i) Cowl flap switches (18, figure 16)—"OPEN."

(j) Oil cooler shutter switches (33, figure 13)—"CLOSED," if the oil is cold.

(k) Master ignition switch (7, figure 16) — "ON."

(l) Generator switches (16, figure 10)—"ON."

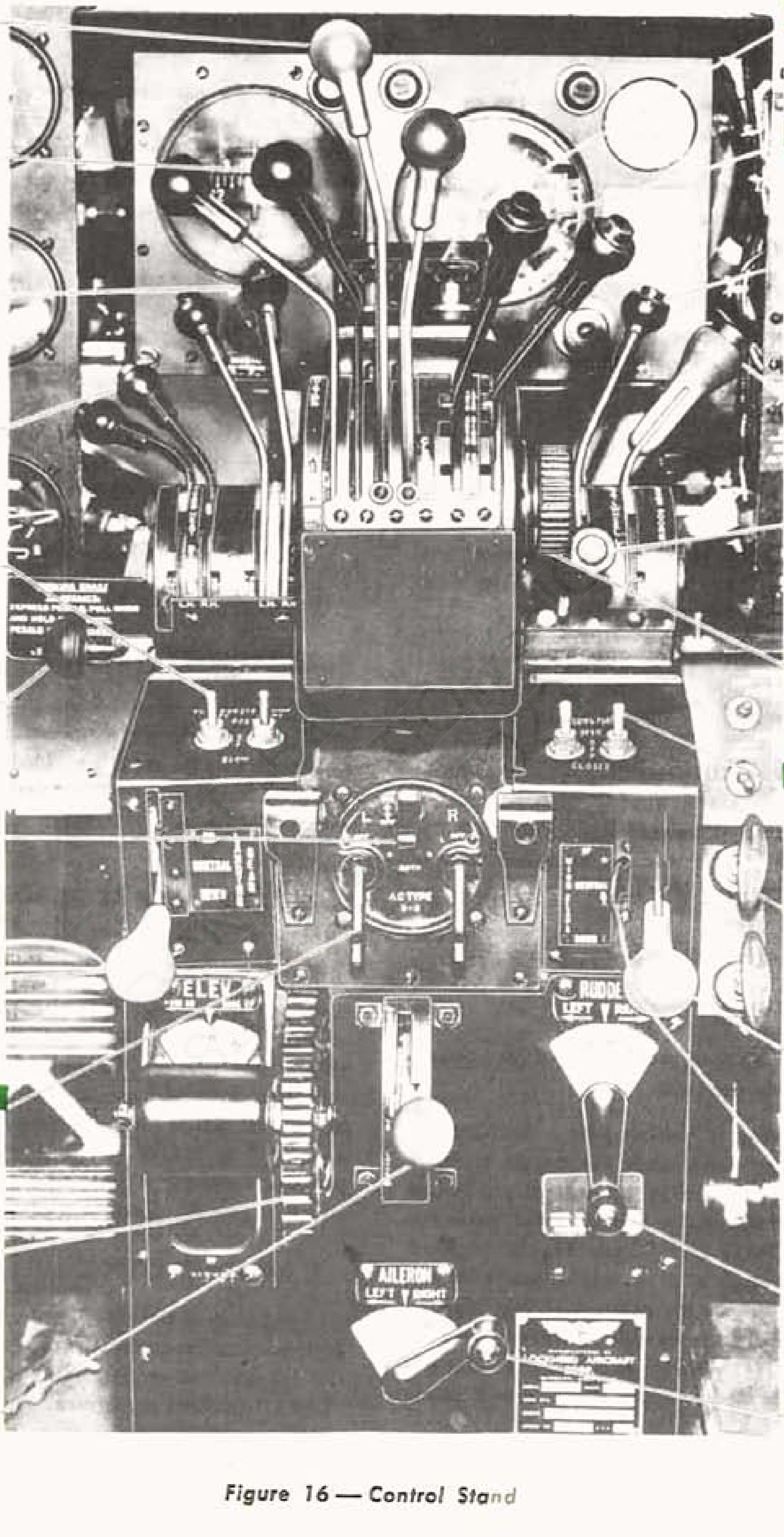
(m) Generator field switches (52, figure 13), if installed—"ON."

b. STARTING.—The starting procedures for a warm and a cold engine differ slightly. In the following instructions a warm engine will be referred to as one which has not cooled from previous running or is exposed to an outside temperature of 15 deg C or above, and a cold engine will be referred to as one which is not warm from previous running and is exposed to an outside temperature below 15 deg C.

(1) Move the fuel booster pump switch (5, figure 16) to "SLOW." When this is done the fuel pressure gage (23, figure 13) should indicate a pressure of 9 psi.

(2) Move the throttle control (1, figure 16) to approximately 1/5 "OPEN" for a warm engine, or 1/4 "OPEN" for a cold engine.

(3) If the engine is warm, priming will usually not be necessary. If the engine is cold, prime it by holding the primer switch (44, figure 13) in the on position. When the engine and outside air temperatures are be-



14 TAIL WHEEL LOCK CONTROL

15 BRAKE KEY LOCK CONTROL

16 SYNC PILOT CONTROL

17 CONTROL TENSION ADJUSTMENT KNOB

19 EXTERNAL TANK ACME MANUAL RELEASE CONTROL

21 WING FLAP CONTROL LEVER

22 RUDDER TRIM TAB CONTROL

23 AILERON TRIM TAB CONTROL

Figure 16 — Control Stand

tween 4 deg C and 15 deg C a 5-to-10-second prime is usually sufficient. If the temperatures are below 4 deg C, the priming time should be increased.

(4) Hold the starter switch (43, figure 13) in the "ACCELERATE" position for about 20 seconds.

(5) When the starter gains maximum rotational speed, move the starter switch to the "ENGAGE" position and hold it there until the engine starts.

CAUTION

Do not crank the engine for more than 30 seconds without allowing the starter to cool for that length of time.

(6) When the engine has turned through about one revolution, turn the ignition switch (9, figure 16) to "BOTH."

(7) When the engine starts, move the mixture control to "AUTO RICH" and adjust the throttle to limit the speed to from 600 to 800 rpm.

(8) Watch the oil pressure gage (23, figure 13) and if there is no pressure indication in about 30 seconds, stop the engine and investigate.

CAUTION

Due to the fire hazard, electric fuel pumps must not be operated unless the mixture control is in the CUT OFF position or unless the engine is running.

(9) If a cold engine does not start in a short time, it should be primed for a few seconds while it is being turned by the starter.

(10) If a start is not effected in about 30 seconds, investigate to ascertain the cause.

(a) Overloading is indicated by a discharge of fuel from the blower drain when the engine is warm and by a strong odor of fuel in the exhaust pipe when the engine is cold. If the engine is overloaded, move the mixture control to "CUT OFF," open the throttle, and turn the engine through 6 or 8 revolutions with the starter. This will clear out the engine and may start it, so be prepared to retard the throttle and move the mixture control to "AUTO RICH." If the engine does not start, repeat the starting procedure above, except prime for a shorter period.

(b) Insufficient priming is indicated by backfiring through the intake system when the engine is either warm or cold, by no discharge of fuel from the blower drain when the engine is warm, and by the lack of fuel vapor or odor in the exhaust stack when the engine is cold. If the engine is not sufficiently primed, repeat the starting procedure above, except prime for a slightly longer period.

(11) If a nacelle fire develops, turn the fuel valve control and booster pump switch to "OFF" and open the throttle. The engine will burn the fuel in the lines and carburetor and may blow out the fire. If the fire is not out when the engine stops, use a ground fire extinguisher.

6. ENGINE WARM-UP.

a. After operating at from 600 to 800 rpm for a half minute, adjust the throttles to give an engine speed of 1000 rpm.

b. Move booster pump switches to "OFF."

CAUTION

Keep the cowl flaps open at all times during ground operation or burned spark plug leads will result.

7. EMERGENCY TAKE-OFF.

If the oil was diluted when the engines were stopped or if the outside air temperature is above 4 deg C, a take-off may be made provided there has been a rise in the oil temperature, the oil pressure is steady, and the engines are running smoothly.

8. ENGINE AND ACCESSORY GROUND CHECK.

a. GENERAL.—When the oil temperature has risen above 40 deg C and the cylinder head temperature is at least 120 deg C, the engine speed may be increased above 1000 rpm for the ground test. All ground tests should be made with the mixture controls (13, figure 16) in "AUTO RICH" and the propeller pitch controls (2, figure 16) in "LOW." The engine control friction adjustment knob (17, figure 16) should be tightened sufficiently to prevent the throttles from creeping.

b. IGNITION CHECK.

(1) Adjust the throttle to give an engine speed of 2000 rpm, and note the loss of revolutions when turning the ignition switch (9, figure 16) from "BOTH" to "LEFT." Return the ignition switch to "BOTH" and allow the engine speed to stabilize. Then switch to "RIGHT" and note the loss of revolutions. When switching from "BOTH" to "LEFT" or "RIGHT," the normal drop is 50 to 75 rpm and should not exceed 100 rpm. Do not operate on one switch point longer than is necessary or serious detonation may occur.

(2) At low engine speeds when the ignition switch is on "BOTH," "LEFT," or "RIGHT," the lack of engine vibration is an excellent indication of proper functioning of the engine, particularly the ignition system.

Note

When the oil temperature reaches 60 deg C, open the oil cooler shutters sufficiently to keep the temperature from rising higher.

c. IDLE MIXTURE CHECK.—Adjust the throttle to give an engine speed of 600 rpm, with propeller control in "HIGH" rpm position. Then move the mixture control momentarily, but smoothly and steadily into the "CUT-OFF" position and observe the tachometer for any change in rpm. Return the mixture control to the "AUTO RICH" position before the engine cuts out. A rise of more than 10 rpm indicates too rich an idle mixture, and no change or a drop in rpm indicates that the mixture is too lean. A rise of five to ten rpm is recommended in order to permit idling at low speeds without danger of fouling plugs and at the same time to afford good acceleration characteristics.

d. OIL PRESSURE CHECK.—Adjust the throttle to give an engine speed of 2000 rpm, and note the reading of the oil pressure gage (23, figure 13). It should be 75 to 80 psi when the oil temperature is 60 deg C. Oil pressure will vary with rpm and temperature and need cause no alarm by falling as low as 25 psi when the engine is idling, or by rising to 100 psi when the engine is running at 2700 rpm.

e. FUEL PRESSURE CHECK.

(1) While the engine is running at 2000 rpm and the booster pump is off, note the reading of the fuel pressure gage (23, figure 13). It should be 17 ± 1 psi. At very low idling speeds the fuel pressure may be as low as 9 or 10 psi, but this is satisfactory if it rises to the desired amount at 800 to 1000 rpm.

(2) Idle the engine, place the fuel booster pump switch (5, figure 16) in the "FAST" position for a moment, and note the fuel pressure. It should be 17.5 psi.

f. HYDRAULIC PRESSURE CHECK.—When the accumulators are fully charged, the hydraulic system and brake pressure gages (48 and 49, figure 13) should indicate a pressure of from 800 to 1000 psi and the pump pressure gages (50, figure 12) should show practically no pressure. If the accumulators are not fully charged, the system and brake pressures should be rising toward 1000 psi and the pump pressures should be slightly higher than the system and brake pressures.

g. SUPERCHARGER CHECK.

(1) Adjust the throttle to give an engine speed of about 1400 rpm (between 1200-1600 rpm allowable).

(2) Move the supercharger control (3, figure 16) rapidly from "LOW" to "HIGH." A momentary drop in oil pressure should accompany this shift.

(3) After 30 to 60 seconds operation in "HIGH," adjust the throttle to obtain a manifold pressure of 30 in. Hg or an engine speed of not more than 2000 rpm.

(4) Move the supercharger control rapidly from "HIGH" to "LOW." A drop in manifold pressure when this shift is made is a positive indication that the supercharger control is functioning properly.

(5) If the shift did not appear to be satisfactory, reduce the engine speed to 1000 rpm or less for 2 minutes and then repeat the shifting procedure. Prolonged fluctuation or loss of manifold pressure after shifting from low to high ratio indicates improper high clutch engagement.

(6) Check and recheck that the control is returned to "LOW" when the test is completed.

b. PROPELLER CHECK.

(1) Adjust the throttle to give an engine speed of 1600 rpm.

(2) Move the propeller pitch control (2, figure 16) from "LOW" to "HIGH." The engine speed should drop to about 1200 rpm when this is done.

(3) Return the control to the "LOW" position. The original rpm should be resumed.

CAUTION

Do not allow the cylinder head temperature to exceed 232 deg C during ground operation. This may occur if the engines are run above 1400 or 1500 rpm for prolonged periods.

i. GYRO PILOT CHECK. *(See figure 13.)*

(1) See that the bank and climb gyro (40, figure 13) is uncaged.

(2) See that the turn gyro (37, figure 13) is uncaged.

(3) Turn the aileron, elevator, and rudder sensitivity controls (38, figure 13) to "3" or "AV. AIR."

(4) Align the follow-up indices by turning the rudder, aileron, and elevator control knobs (13, 15, and 17, figure 13).

(5) Increase the speed of the right engine to 1000 rpm for the remainder of the check.

(6) Move the master gyro pilot control (16, figure 16) to "ON."

(7) If the airplane is equipped with separate aileron, elevator, and rudder gyro pilot controls (35, figure 13), move them to "ON."

(8) Check the readings of the vacuum and pressure gages (19 and 39, figure 13). They should be 4 in. Hg and 100 ± 5 psi respectively.

(9) Turn the aileron, elevator, and rudder control knobs and note the response of the control surfaces.

(10) Check the overpower valves by operating each control manually against the gyro pilot.

(11) By means of the aileron, elevator, and rudder control knobs, move each control surface to each extreme position several times to force any air, which may be present, from the system.

CAUTION

Do not nose over the airplane by applying full down elevator while operating the engine at high rpm.

(12) Move the master gyro pilot control to "OFF," but leave the gyros uncaged.

j. ELECTRICAL SYSTEM CHECK.

(1) If the battery switch (15, figure 10) is "OFF," move it to "ON."

(2) If an external electrical source was used, instruct the ground crew to disconnect it.

(3) Move both generator switches (16, figure 10) to "OFF," and turn the voltmeter selector switch (44, figure 10) to "BAT." The voltmeter (2, figure 10) should indicate about 24 volts if the batteries are properly connected and are supplying the electrical load.

(4) Instruct a crew member to introduce a heavy electrical load by operating some of the radio equipment.

(5) Move the left generator switch (16, figure 10) to "ON," move the right generator switch to "OFF," and turn the voltmeter selector switch to "LH GEN." Slowly increase the speed of the left engine. The closing of the reverse current relay should occur at 26.5 volts and before reaching 1600 rpm. This will be indicated by a dip in the voltmeter needle and a charge reading on the left ammeter (1, figure 10). When the engine speed is increased to 1800 rpm the voltmeter reading should increase to 28.5 volts and remain steady at this point regardless of any further increase in engine speed.

(6) Check to see that the reverse current relay opens on reverse current by slowly reducing the engine speed and watching the ammeter. The ammeter needle should fall to zero, continue in the direction of discharge, and then jump back to zero when the relay opens.

(7) Let the left engine idle, and repeat the entire check for the right engine. When both checks have been completed, turn both generator switches to "ON."

(8) Increase the speed of both engines to 1800 rpm, and check the electrical load distribution over both ammeters by first turning on a light electrical load and then a heavy electrical load. The ammeter readings should not differ by more than 60 amperes under any load condition.

(9) The following conditions are indications of generator system trouble and should be corrected before taking off.

(a) Generators fail to cut-in at less than 1600 rpm.

(b) Failure of a reverse current relay to close at 26 to 27 volts, or open when there is a reverse flow of current.

(c) Generators do not maintain steady electrical output between 27.5 and 28.5 volts.

(d) Ammeter readings differ by more than 60 amperes under all loading conditions.

k. POWER CHECK.—Just prior to take-off, check to see that the mixture controls are in "AUTO RICH" and the supercharger and propeller pitch controls are in "LOW"; then open the throttle of each engine (one

at a time) to the take-off position for not more than 30 seconds and check oil pressure, fuel pressure, manifold pressure, and engine speed. The readings should be as follows:

(1) Oil pressure—75 to 100 psi.

(2) Fuel pressure—16 to 18 psi.

(3) Manifold pressure — 52 in. Hg at sea level under standard atmospheric conditions.

(4) Engine speed—2700 rpm.

9. TAXIING.

a. See that the cabin and bomb bay doors are closed, the wing flaps are up, and the external power source disconnected.

b. See that the turn gyro and the bank and climb gyro (6 and 8, figure 13) are uncaged.

c. Move the tail wheel lock control (14, figure 16) to "UNLOCKED."

d. Release the parking brakes by depressing the toe pedals.

e. Advance the throttles and taxi, but avoid running the engines above 1500 rpm except in an emergency. Steer the airplane with the engines, rather than by excessive use of the brakes. Use a steady flow of power in preference to "gunning" the engines.

10. TAKE-OFF.

a. See that the controls are set as follows:

(1) Mixture controls—"AUTO RICH."

(2) Propeller pitch controls—"LOW."

(3) Supercharger controls—"LOW."

(4) Carburetor heat controls—"DIRECT," normally; "ALTERNATE" if icing conditions exist.

(5) Master gyro pilot control—"OFF."

(6) Booster pump switches—"FAST."

(7) Ignition switches—"BOTH."

(8) Wing flap control—"UP," unless it is necessary to take off in a minimum distance. If this is the case, extend the flaps a maximum of 20 percent and return the lever to "NEUTRAL."

(9) Trim tab controls—Set as required.

(10) Battery switch—"ON."

(11) Generator switches—"ON."

(12) Fuel transfer pump switches—"AUTO."

(13) Fuel flow valve controls—"NORMAL."

(14) Fuel cross-feed valve controls—"OFF."

(15) Instrument switch—"ON."

(16) Cowl flaps—½ open.

(17) Oil cooler shutters—½ to full open, depending on outside air temperature.

(18) Parking brakes—off.

b. See that the control surfaces are free.

c. Line up the airplane with the runway.

d. Move the tail wheel lock control to "LOCKED."

e. If external fuel tanks or bombs are carried it is recommended that the selector switches be set so that they may be released instantly in case of an engine failure. (Refer to Section IV, paragraph 7, for instructions.)

CAUTION

A take-off should not be attempted until the cylinder head temperature has reached a minimum of 120 deg C and the oil temperature is at least 40 deg C, preferably 60 deg C.

f. Lock and tighten shoulder harness and safety belts.

g. Advance the throttles slowly so that the full open position will be reached by the time the airplane attains an indicated air speed of about 45 knots. This is necessary because of the high torque produced by the engines. Do not attempt to decrease the take-off run by running up the engines with the brakes on and then releasing the brakes. Keep the tail wheel on the ground during the early portion of the take-off run to maintain directional control. Do not use the brakes. When the indicated air speed reaches 45 knots, the rudders will have become effective and the tail should be raised. Lift the airplane off the ground when it attains an indicated air speed of 90 knots.

WARNING

The airplane has a tendency to swing left during the first part of the take-off run when throttles are opened rapidly. This tendency can be checked by opening left throttle slightly ahead of the right and by applying right rudder.

11. ENGINE FAILURE DURING TAKE-OFF.

Precise procedures, to be followed in case of single engine failure, take into consideration such variables as the pilot's strength, rudder reach, and reaction time, as well as the size and density altitude of the airport and the configuration and gross weight of the airplane. The following procedures will apply for average conditions:

a. If an engine fails during the early portion of the take-off run, close both throttles and apply the brakes.

b. If an engine fails after the airplane leaves the ground and before attaining an indicated air speed of 105 knots, drop the external fuel tanks or bombs if either are carried and make the best possible landing. (Refer to Section IV, paragraph 7, for instructions on the emergency release of fuel tanks and bombs.)

c. If an engine fails after attaining an indicated air speed of more than 105 knots, the flight may be continued. If external fuel tanks or bombs are carried, drop them. Every effort must be made to prevent the airplane from yawing excessively. Do not use the ailerons. Maintain all the power possible while holding a straight course. If the flight is continued, retract the landing gear, adjust the rudder trim tab to the minimum required for straight and level flight, and then feather the inoperative propeller.

WARNING

Level flight cannot be maintained on one engine with landing gear down and flaps down 20 percent or more. If sufficient altitude remains, retract the flaps at once. If there is not sufficient altitude to retract the flaps, a landing must be made.

d. Set the inoperative engine controls as follows:

(1) Cowl flap switch—"CLOSED."
(2) Oil cooler shutter switch—"CLOSED."
(3) Mixture control—"CUT OFF."
(4) Fuel booster pump switch—"OFF."
(5) Fuel flow valve control—"OFF."
(6) Fuel transfer valve control—"OFF."
(7) Ignition switch—"OFF."

e. Adjust the elevator trim tabs and readjust the rudder trim tabs to the minimum amount required for straight and level flight. Excessive rudder tab will cause vibration and buffeting.

f. The best climbing speed when operating on one engine is 110 to 115 knots indicated.

12. CLIMB.

a. When definitely air-borne apply the brakes to stop the wheels from turning and then retract the landing gear by moving the control (8, figure 16) to the "UP" position. If the control lock should fail to release, it can be released manually by inserting the index finger in the hole on the side of the control stand opposite the lever and pressing the pawl down. (See figure 17.)

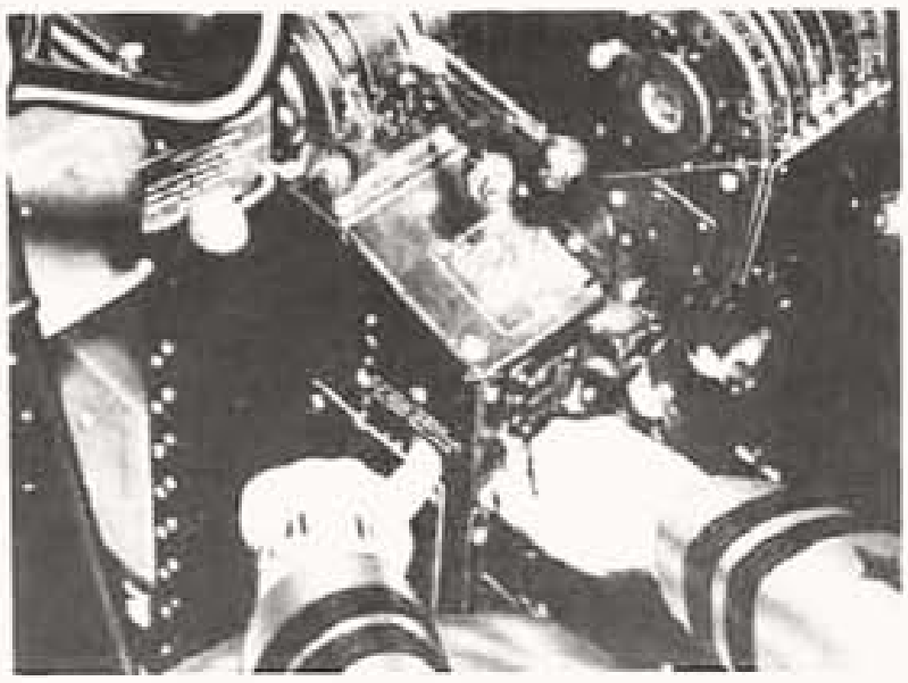


Figure 17 — Release of Landing Gear Control Lock

b. If the flaps were used during the take-off, raise them by moving the control (20, figure 16) to the "UP" position. Be prepared for a change in trim.

c. If the controls were set before take-off to make possible immediate release of the external fuel tanks or bombs in case of engine failure, move the bomb-tank-torpedo selector master switch (39, figure 10) to the off position and move the wing rack selector switches (36, figure 10) to "HOLD."

Note

In airplanes preceding BuAer serial number 84057, landing gear and flap controls should be in the "UP" position when in flight, except when going into combat; then gear and flap control should be placed in the "NEUTRAL" position to prevent the loss of fluid in case of damage to a hydraulic line. Airplanes beginning with BuAer serial number 84057 are equipped with hydraulic fuses, and the landing gear and flap controls should be left in the "UP" position at all times.

d. Maintain take-off power until the indicated air speed is at least 120 knots but never longer than five minutes, and then reduce to rated power or less according to the procedure outlined in paragraph 13, *c.*

e. After the power has been reduced, turn off the fuel booster pumps and adjust the cowl flaps and oil cooler shutters to maintain temperatures below the maximum allowables specified by the "Specific Engine Flight Chart" (figure 19).

f. Refer to the "Take-off, Climb, and Landing Chart" (figure 46) for the best climbing speeds and engine operation data.

g. When climbing at or near the maximum rate and using the anti-icing, heating, and ventilating system, there is a possibility of exceeding the maximum permissible exhaust heat exchanger temperature. Instruct

the radio operator to check the readings of the temperature indicators (2, figure 21) often, and if they exceed 220 deg C to move the waste gate controls (4, figure 21) to "WASTE."

13. FLIGHT OPERATIONS.

a. FLIGHT DATA.—Refer to Appendix II for flight operation data and sample problems.

b. INCREASING ENGINE POWER.

(1) Set the mixture as specified by the proper "Flight Operation Instruction Chart" (figure 47, 48, or 49) for the desired power condition.

(2) Adjust the propeller pitch to obtain the desired rpm.

(3) Adjust the throttle to obtain the desired manifold pressure.

(4) Adjust cowl flaps and oil cooler shutters, if necessary, to maintain the proper temperatures as specified by the "Specific Engine Flight Chart."

c. DECREASING ENGINE POWER.

(1) Adjust the throttle to obtain the approximate manifold pressure desired.

(2) Adjust the propeller pitch to obtain the desired rpm.

(3) Readjust the throttle, if necessary, to obtain the desired manifold pressure.

(4) Adjust cowl flaps and oil cooler shutters, if necessary, to maintain the proper temperatures.

(5) After the cylinder head temperature has dropped below the maximum allowable for the power condition, set the mixture as required for the power condition.

CAUTION

Always reduce manifold pressure before reducing rpm to avoid exceeding BMEP limits.

d. SUPERCHARGER OPERATION.

(1) GENERAL.

(a) The "Flight Operation Instruction Charts" specify the proper supercharger blower ratio for the various power conditions and altitudes.

(b) Do not shift blowers more often than at 5 minute intervals while in flight in order to allow adequate time for dissipation of heat generated in the

clutches during shifting. During prolonged flight in either low or high blower ratio, shift to the other ratio for a period of five minutes every two or three hours to desludge the blower clutches. If desired, it is equally satisfactory to make TWO shifts of the same duration at the end of each 5 hour interval. When operations do not permit blower shifts according to this schedule, at least one shift should be made immediately before landing. Prolonged operation in either blower ratio is conducive to sludging of the clutches. Since sludge accumulation is a major cause of clutch failures, it is of the utmost importance that desludging be made a regular and frequent practice. Except in emergencies, shifts shall not be made at engine speeds higher than 2400 rpm. Clutch life and reliability will be extended by shifting at lower engine speeds. Manifold pressure must not exceed the limit corresponding to rpm and altitude. If "AUTO LEAN" mixture is being used before the blower shift, it is optional whether the mixture controls are changed to "AUTO RICH" while the blower shift is being performed. If the engines show a tendency to cut out during the blower shift, the tendency will be reduced by changing to "AUTO RICH" before operating the supercharger controls.

(2) SHIFT FROM LOW TO HIGH BLOWER.

(a) Shift supercharger controls rapidly from "LOW" to "HIGH." Do not hesitate between these positions.

(b) Immediately retard throttles to reduce manifold pressure about 3 or 4 in. before high ratio engages. (High ratio does not engage until several seconds after controls have been shifted.)

(c) After high ratio has engaged and engines have settled down, readjust propeller controls and throttles as necessary for desired power.

(3) SHIFT FROM HIGH TO LOW BLOWER.

(a) Shift supercharger controls rapidly and without hesitation from "HIGH" to "LOW."

(b) After engines have settled down, readjust throttles and propeller controls as necessary for desired power.

e. GYRO PILOT OPERATION. *(See figures 13 and 16.)*

(1) GENERAL.—The operating limit for the bank and climb gyro is 50 degrees from the vertical, and the limit for the directional gyro is 55 degrees. During maneuvers which would exceed the operating limits, both gyros should be caged. At all other times, the gyros should be uncaged. Remember that the gyro pilot can be overpowered at any time. Airplanes bearing BuAer serial numbers 84116 and subsequent are equipped with separate aileron, elevator, and rudder gyro pilot shut-off controls. One, two, or all control surfaces may be operated by the gyro pilot on these airplanes.

(2) RESTRICTIONS.—Do not use the gyro pilot when the engines are not delivering normal power or when the indicated air speed is less than 115 knots.

(3) ENGAGING THE GYRO PILOT.

(a) Trim the airplane "hands off."

(b) Turn the aileron, elevator, and rudder sensitivity controls to "3" or "AV. AIR" if the best setting is not known.

(c) Set the turn gyro card to agree with the magnetic compass by pushing in the caging control and turning it. When the card has been set, pull the caging control out.

(d) Set the rudder follow-up card to match the turn gyro card by turning the rudder control knob.

(e) Set the aileron follow-up index to match the bank index by turning the aileron control knob.

(f) Set the elevator follow-up index to match the elevator alignment index by turning the elevator control knob. Do not align the elevator follow-up index with the horizon bar as relative movement between them is in the opposite directions.

(g) Be sure that the directional gyro and the bank and climb gyro are uncaged and that the airplane is in straight and level flight.

(h) If the airplane has separate aileron, elevator, and rudder controls (35, figure 13), move them to "ON."

(i) Slowly move the master gyro pilot control to "ON."

(4) CHANGING COURSE. — To change course, turn the rudder control knob slowly and smoothly. If a sharp turn is to be made, set in bank with the aileron control knob.

(5) CHANGING ATTITUDE. — Set the desired fore-and-aft attitude with the elevator control knob.

CAUTION

Do not allow the airplane to get too far out of trim.

(6) Check the directional gyro periodically, and when it has drifted 2 or 3 degrees off course, correct the heading.

f. COLD WEATHER OPERATION.

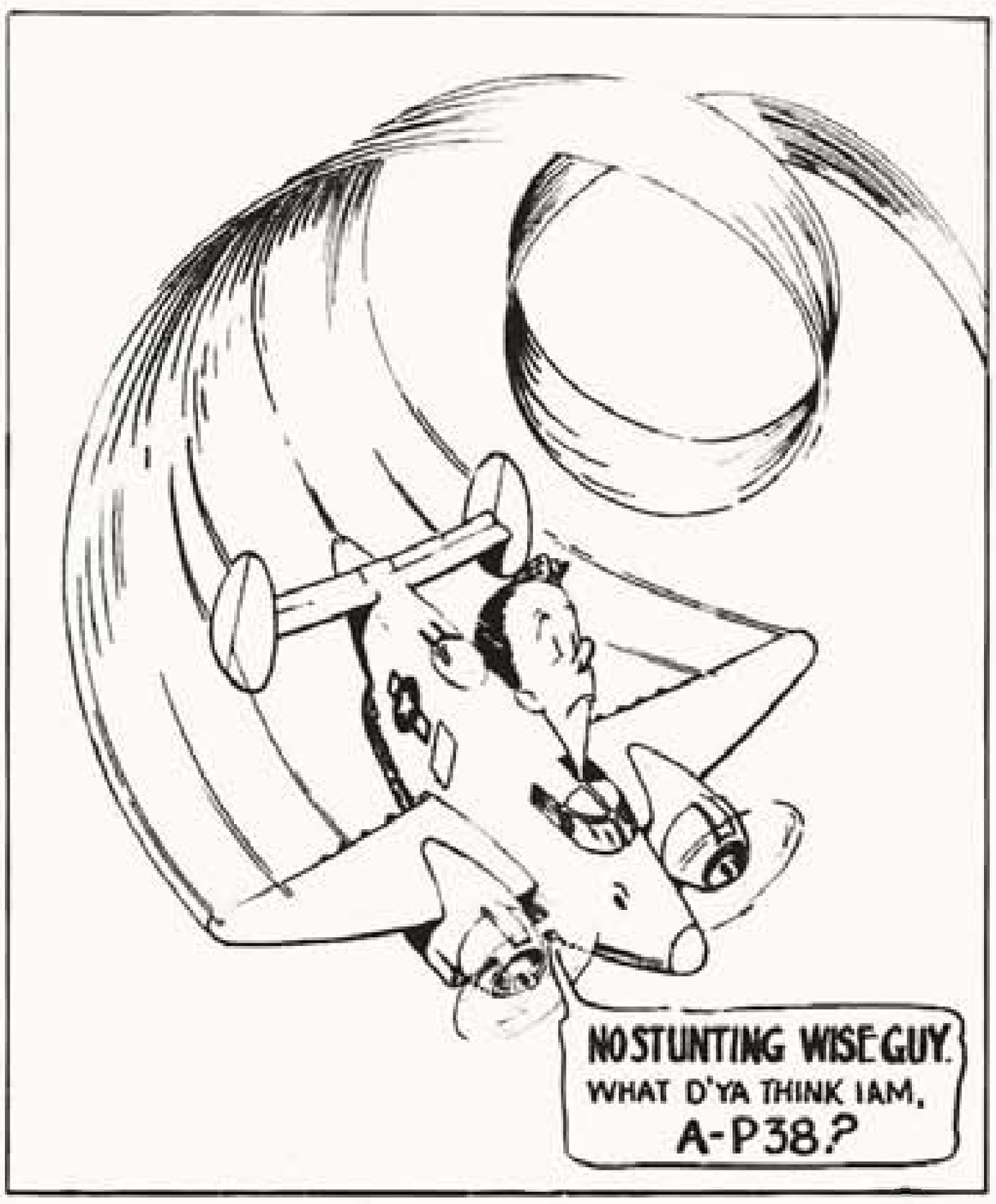
(1) ICING CONDITIONS.—When icing conditions are encountered, the following action should be taken.

(a) Move the carburetor heat controls (4, figure 16) to "ALTERNATE."

(b) Instruct the radio operator to move the exhaust heat exchanger waste gate controls (4, figure 21) to "DEICE-HEAT," push the heating-ventilating control (6, figure 33) to the heating position and turn the heating-ventilating damper control (1, figure 20) to "ON." Instruct the radar operator-tunnel gunner to turn the heating-ventilating control (4, figure 5) and the stabilizer damper control (5, figure 5) to "ON." Instruct the co-pilot-navigator to move the defroster damper control (20, figure 13) to the on position.

(c) Move the windshield and propeller anti-icer switches (48 and 49, figure 10) to "ON." Use the windshield anti-icer as sparingly as possible. Remember that the anti-icer tank holds enough fluid for only 2 hours of continuous operation of the propeller and windshield anti-icers.

(2) OIL TEMPERATURE CONTROL. — In extremely cold weather, the oil temperature should be checked frequently so that the oil can be prevented from congealing in the coolers. The proper temperature, which is about 70 to 75 deg C, can usually be maintained when the oil cooler shutters are practically closed. Congealing is indicated by a steady rise in temperature and will result in serious damage to the engine unless corrected. If congealing occurs, completely close the oil



cooler shutters until the temperature drops to normal and starts to rise. The shutters should then be opened slightly to maintain the proper temperature.

14. GENERAL FLYING CHARACTERISTICS.

a. STABILITY.—The airplane is stable at any permissible gross weight when it is loaded properly. Refer to the Handbook of Weight and Balance Data, AN 01-1B-40, for loading data. Refer to paragraph 1 of this section for flight restrictions.

b. TRIM CHANGES.

(1) Wing flaps extended—Nose heavy.

(2) Landing gear extended—Nose heavy.

(3) Bomb bay doors open—No noticeable change in longitudinal stability.

(4) Cowl flaps open—Slightly nose heavy.

(5) Engine failure—Nose heavy.

15. STALLS.

a. The airplane has very good stalling characteristics. As the stalling condition is approached, noticeable tail buffeting occurs. When the airplane is fully stalled with power on, it will roll appreciably; however, with power of , it may roll slightly. In either case, the recovery is easy and rapid and without an excessive loss of altitude.

b. The stalling speeds for various flight conditions are given in figure 18.

16. SPINS.

Intentional spinning is prohibited; however, if a spin develops, throttle back, push the control column forward, and then apply the opposite rudder.

17. ACROBATICS.

All acrobatics are prohibited.

18. DIVING.

a. Before going into a dive, close the cowl flaps and set propeller controls for 2000 to 2200 rpm.

b. If operating in "High" blower, shift to "Low" blower before starting the dive, regardless of altitude.

c. If dive is to be prolonged and steep, place the mixture controls in the "Auto-Rich" position. This is to prevent backfire due to the lag of the automatic mixture control during rapid loss of altitude.

d. The throttles should not be fully closed; but they may be closed enough to maintain not less than 15 in. of manifold pressure. Higher manifold pressure may be used if desired, providing care is taken during the

dive not to exceed the manifold pressure limit corresponding to rpm and altitude, the maximum permissible indicated air-speed (309 knots), or the engine overspeed rating of 2980 rpm for 30 seconds.

WARNING

In prolonged dives manifold pressure will build up rapidly at a constant throttle setting; also, the engines may be cooled enough to cut out if the throttles are advanced too rapidly at the completion of the dive.

e. If the engine speed exceeds the overspeed limit (2980 rpm), the following procedure should be followed:

(1) Close the throttles immediately.

(2) Move the propeller controls to "HIGH."

(3) Reduce the air speed immediately to the minimum safe gliding speed.

WARNING

Do not reduce air speed by a dangerously abrupt pullout.

19. APPROACH AND LANDING.

a. APPROACH.

(1) Fasten and tighten the safety belt and lock the shoulder harness.

(2) Check the loading of the airplane to determine if the center of gravity is within the permissible limits for landing.

(3) Check with the radar operator-tunnel gunner to see that the trailing antenna has been reeled in and that the tunnel guns are in an elevated position.

(4) Set the altimeters.

(5) Set the controls as follows:

(a) Master gyro pilot control—"OFF."

(b) Cowl flap switches—"CLOSED."

(c) Supercharger controls—"LOW."

(d) Propeller pitch controls—Set for 2400 rpm.

(e) Carburetor heat controls—"DIRECT" unless icing conditions exist.

(f) Mixture controls—"AUTO RICH."

(g) Fuel booster pump switches—"FAST."

(h) Tail wheel lock control—"LOCKED."

(6) Extend the landing gear when the indicated air speed has dropped to 150 knots.

Note

A warning horn will sound when one throttle is less than one-fifth open, if the landing gear is not fully extended. Warning horn may be silenced only by opening throttle.

(7) Instruct a crew member to stand by the emergency hydraulic system, as a precaution against failure of the regular brake system after landing. If the regular brake system fails to operate after airplane is on the ground, proceed immediately as outlined in Section IV, paragraph 9, *d*.

(8) Extend the flaps 20 percent when the indicated air speed has dropped to 120 knots and the airplane is lined up with the runway. Avoid making turns when the flaps are extended.

(9) Adjust the elevator trim tabs to counteract the nose heaviness caused by the extension of the flaps.

(10) Check the brakes by depressing the toe pedals and noting the feel of the pedals as well as the effect on the brake pressure gage reading. There will be no noticeable drop in the pressure if the brake system is functioning properly.

(11) Make the initial approach at an indicated air speed of 110 knots and the final approach over the end of the runway at an indicated air speed of 95 knots.

(12) If operating on one engine, return the rudder trim tabs to the neutral position when it is certain that the landing can be made without further use of power.

b. LANDING.

(1) NORMAL LANDING.

(a) Transport landings are recommended where length of runway permits; however, the airplane lands excellently in the 3-point attitude. In either case the airplane has good directional stability and no ground looping tendency. Use the brakes sparingly to reduce wear unless it is necessary to stop short.

(b) At the conclusion of the landing run:

1. Open the cowl flaps.
2. Move the propeller controls to "LOW."
3. Unlock the tail wheel.
4. Raise the wing flaps.
5. Turn off the fuel booster pumps.

(2) INCOMPLETE LANDING.—If the landing is not completed:

(a) Open the throttles.

(b) Set the propeller controls as required.

(c) Open the cowl flaps 50 percent.

(d) Retract the landing gear as soon as the airplane leaves the ground, and then raise the flaps cautiously. Be prepared for a trim change as this is done.

WARNING

The airplane will not maintain altitude on one engine when the flaps and landing gear are extended. If an engine is dead, only one landing attempt can be made.

(3) CROSS-WIND LANDING.—Extend the wing flaps only 50 percent and make a transport landing.

20. STOPPING THE ENGINES.

a. WARM WEATHER.—If the outside air temperature is expected to be above 4 deg C the next time the engines are started, the following procedure should be used in stopping the engines.

(1) Increase the engine speed to 1400 rpm, shift to "HIGH" blower for one minute, then shift back to "LOW." If time is available, it is well to repeat this operation several times. It is especially desirable to desludge clutches before stopping the engines after a long flight, and it is good practice to desludge clutches after every flight when operations will permit.

Note

Engines should not be operated below 1200 rpm while "HIGH" blower ratio is engaged. At lower rpm, slippage and burning of the "HIGH" ratio clutch elements may occur because of insufficient oil pressure.

(2) Idle the engines at about 800 rpm, if necessary, until the cylinder head temperature drops below 175 deg C.

(3) Increase the speed of each engine to about 1000 rpm and move the mixture controls to "CUT OFF."

(4) Tura the ignition switches to "OFF" when the engines stop.

b. COLD WEATHER.—If the outside air temperature is expected to be below 4 deg C the next time the engines are started, dilute the oil and stop the engines according to the following procedure:

(1) Desludge supercharger clutches as above.

(2) Idle the engines about 800 rpm, if necessary, until the cylinder head temperature is below 175 deg C. If at this time, the oil temperature is above 50 deg C stop the engines until it drops to 40 deg C. Service the oil tanks, if necessary, but remember that space must be allowed for the gasoline that is used to dilute the oil. Approximately 2 gallons of gasoline are added in each oil system during each 3-minute dilution period. Do not allow the oil temperature to exceed 50 deg C while diluting the oil. If necessary, stop the engines and allow the oil to cool. A drop in fuel pressure when the oil dilution switches (42, figure 13) are in the on position indicates that the oil dilution system is functioning properly.

(3) Idle the engines at 800 rpm and hold the oil dilution switches in the on position for the period of time determined by the anticipated starting temperature. During the last minute of the dilution period press the propeller feathering switches (12, figure 16) and after about 3 seconds pull them out. Repeat this procedure 3 times allowing the engines to regain their speed each time after the propeller feathering switches are pulled out. This supplies diluted oil to the propeller domes and feathering lines.

(a) For an anticipated starting temperature between 4 deg C and —12 deg C, dilute the oil for 3 minutes.

(b) For a starting temperature between —12 deg C and —29 deg C, dilute for 6 minutes.

(c) For a starting temperature between —29 deg C and —46 deg C, dilute for 9 minutes.

(4) At the end of the oil dilution period, increase the speed of the engines to 1000 rpm, move the mixture controls to "CUT OFF," and continue to dilute the oil until the engines stop.

(5) Turn the ignition switches to "OFF" when the engines stop.

c. DILUTION OF AUXILIARY TANK OIL. — When temperatures below 4 deg C are anticipated, on the ground or in flight, the oil in the auxiliary tanks must be diluted with one part of fuel to six parts of oil to prevent overloading the transfer pumps. This can be done by adding fuel to the oil drained from the auxiliary tanks direct; or the oil can be drained from the main tanks, diluted, and then returned to the auxiliary tanks after transferring the oil in the auxiliary to the main tanks. Whichever method is used, the auxiliary tanks must be completely drained before diluted oil is added. After the oil in the auxiliary tanks has been diluted the transfer pumps must be operated for a few seconds to fill the pumps and lines with diluted oil.

21. BEFORE LEAVING THE FLIGHT COMPARTMENT.

a. Be sure that the cowl flaps are open.

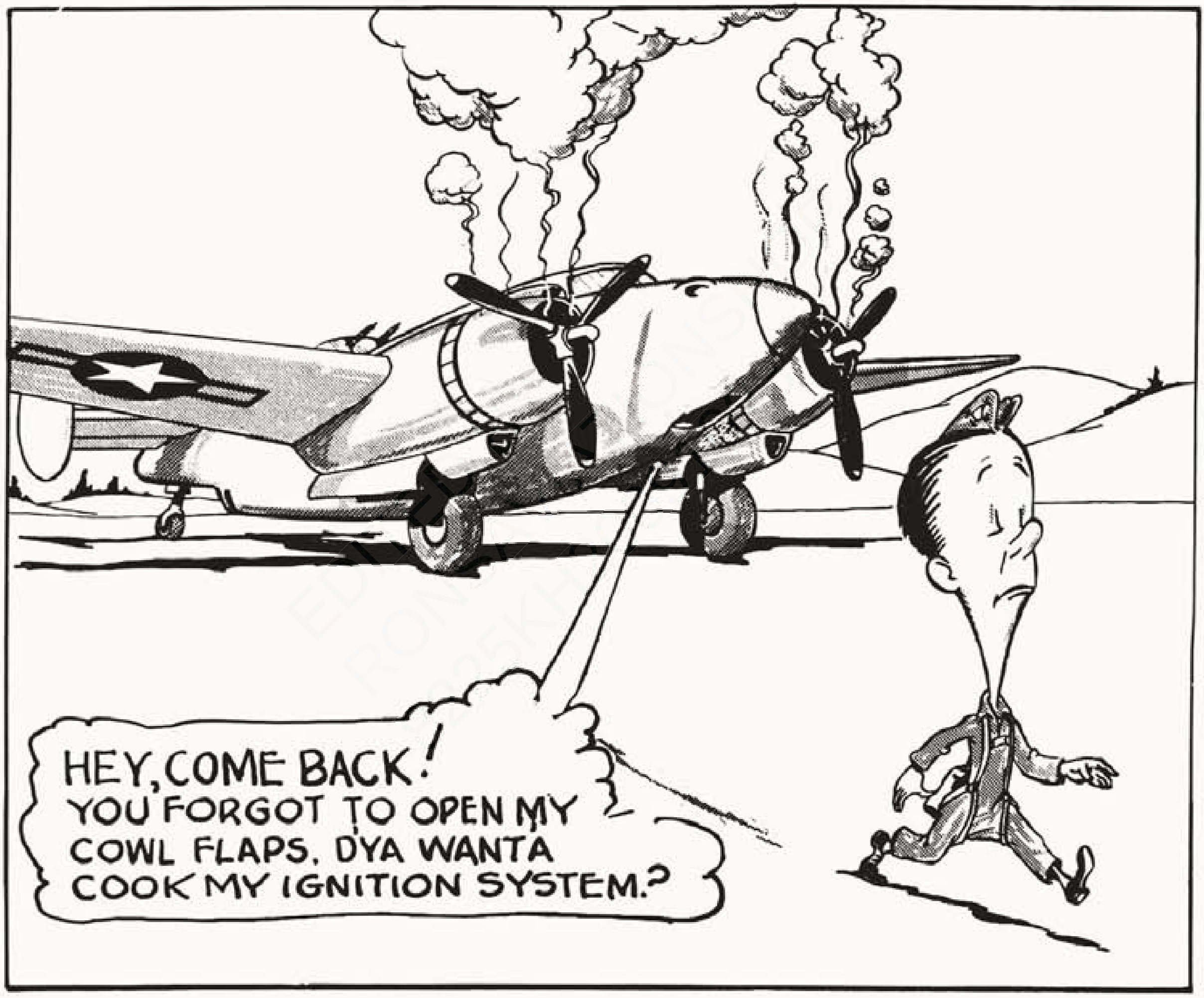
b. Turn off all electrical switches.

c. Turn off battery master switch.

d. Turn off all fuel valves.

e. Lock the flight controls with the locking bars provided and not with the gyro pilot.

f. Apply parking brakes unless the brakes are hot from excessive use. If this is the case, allow them to cool first. Do not use parking brakes in freezing weather.



SECTION III

FLIGHT OPERATION DATA

1. AIR-SPEED LIMITATIONS.

a. Do not exceed an indicated air speed of 309 knots under any condition at any time.

b. Do not exceed an indicated air speed of 150 knots when the landing gear is extended.

c. Do not exceed an indicated air speed of 120 knots when the wing flaps are extended.

2. AIR-SPEED DEFINITIONS.

a. INDICATED AIR SPEED.—All speeds referred to in this manual as "indicated air speeds" are those read directly from the air speed indicator.

b. TRUE INDICATED AIR SPEEDS.—Speeds referred to as "true indicated air speeds" are indicator readings which have been corrected for the location of the pitot-static tube, instrument error, and the airplane's attitude in flight. (Refer to paragraph 3 for the conversions from indicated to true indicated air speeds.)

c. TRUE AIR SPEEDS.—Speeds referred to as "true air speeds" are true indicated air speeds which have been corrected for altitude. True air speed is equal to ground speed under no-wind condition.

3. SPECIFIC ENGINE FLIGHT CHART.

The "Specific Engine Flight Chart" (figure 19) is provided to show engine limitations, fuel and oil pressures, cylinder head and oil temperatures, etc. It should not be used as a source of flight operation data. (Refer to the "Flight Operation Instruction Charts," figures 47 through 52.)

4. AIR-SPEED CORRECTIONS.

a. FLAPS AND LANDING GEAR UP.

Indicated Air Speed	*True Indicated Air Speed*
80 knots (92 mph)	95 knots (109 mph)
90 knots (104 mph)	102 knots (118 mph)
100 knots (115 mph)	110 knots (127 mph)
110 knots (127 mph)	119 knots (137 mph)
120 knots (138 mph)	127 knots (146 mph)
130 knots (150 mph)	136 knots (157 mph)
140 knots (161 mph)	146 knots (168 mph)
150 knots (173 mph)	155 knots (179 mph)
160 knots (184 mph)	165 knots (190 mph)
170 knots (196 mph)	175 knots (202 mph)
180 knots (207 mph)	184 knots (212 mph)
190 knots (219 mph)	194 knots (224 mph)
200 knots (230 mph)	204 knots (235 mph)

b. FLAPS AND LANDING GEAR DOWN.

Indicated Air Speed	*True Indicated Air Speed*
60 knots (69 mph)	75 knots (86 mph)
70 knots (81 mph)	82 knots (95 mph)
80 knots (92 mph)	90 knots (104 mph)
90 knots (104 mph)	97 knots (112 mph)
100 knots (115 mph)	104 knots (120 mph)
110 knots (127 mph)	113 knots (130 mph)
120 knots (138 mph)	123 knots (141 mph)

Note

Instrument error is not included in the air-speed correction tables above.

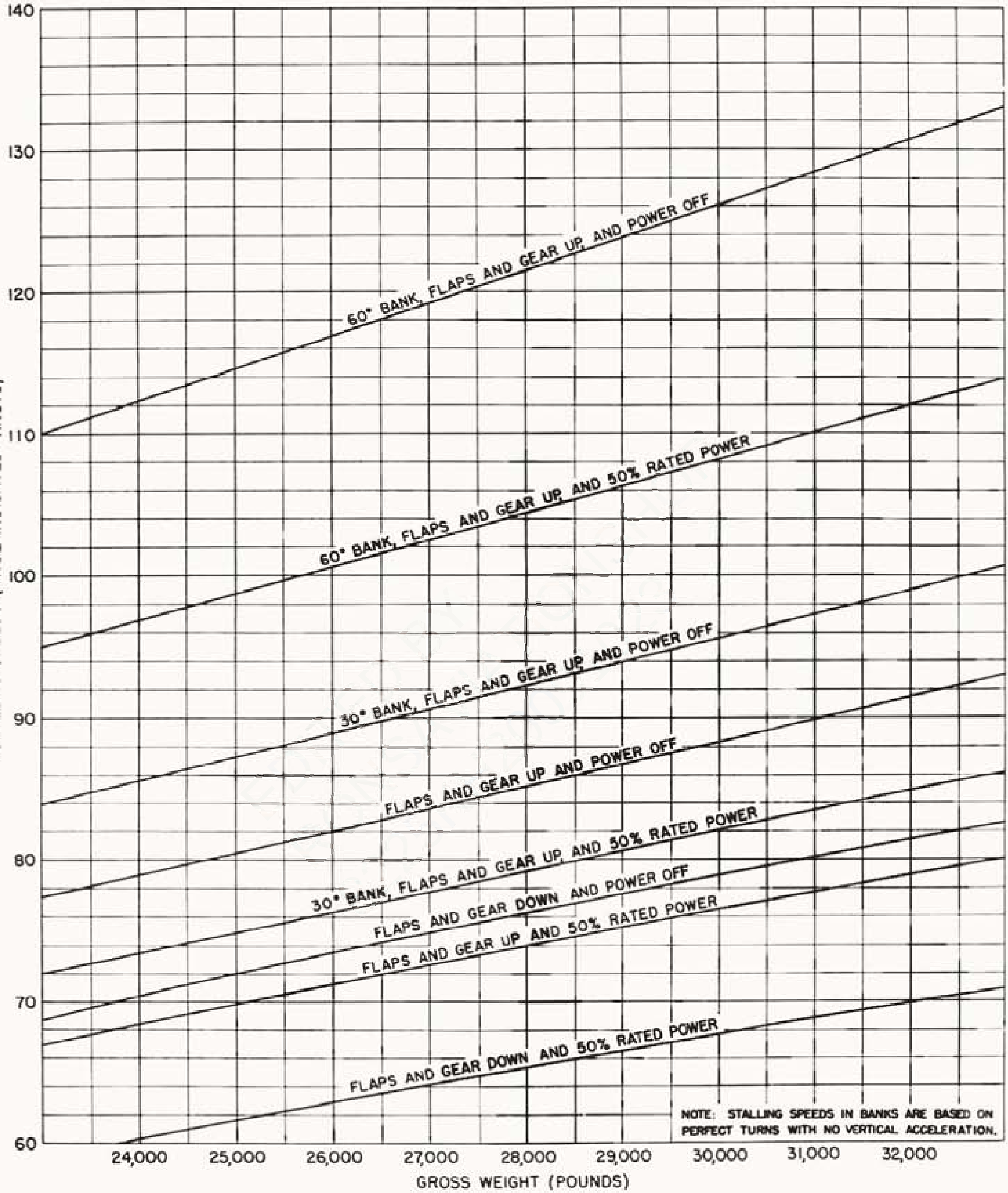


Figure 18 — Stalling Speed Curves

SPEC. AN-H-3
DEC. 18, 1942

AIRPLANE MODELS

PV-2

SPECIFIC ENGINE FLIGHT CHART

ENGINE MODELS

R-2800-31

CONDITION	FUEL ⑥ PRESSURE (LB/SQ. IN.)	OIL PRESSURE (LB/SQ. IN.)	OIL TEMP. °C	OIL TEMP. °F	COOLANT TEMP. °C	COOLANT TEMP. °F
DESIRED	17	75	60-75	140-167	—	—
MAXIMUM	18	100	95	203	—	—
MINIMUM	16	50	54 ⑨	129	—	—
IDLING	9	25	—	—	—	—

MAX. PERMISSIBLE DIVING RPM: 2980

CONDITION	ALLOWABLE OIL CONSUMPTION
MAX. CONT.	20 U.S.QT/HR. 30 IMP.PT/HR
MAX. CRUISE	15 U.S.QT/HR. 25 IMP.PT/HR
MIN. SPECIFIC	6 U.S.QT/HR. 10 IMP.PT/HR

OIL GRADE: (S) 1100 (W) 1100

SUPERCHARGER TYPE: TWO SPEED GEARED BLOWER

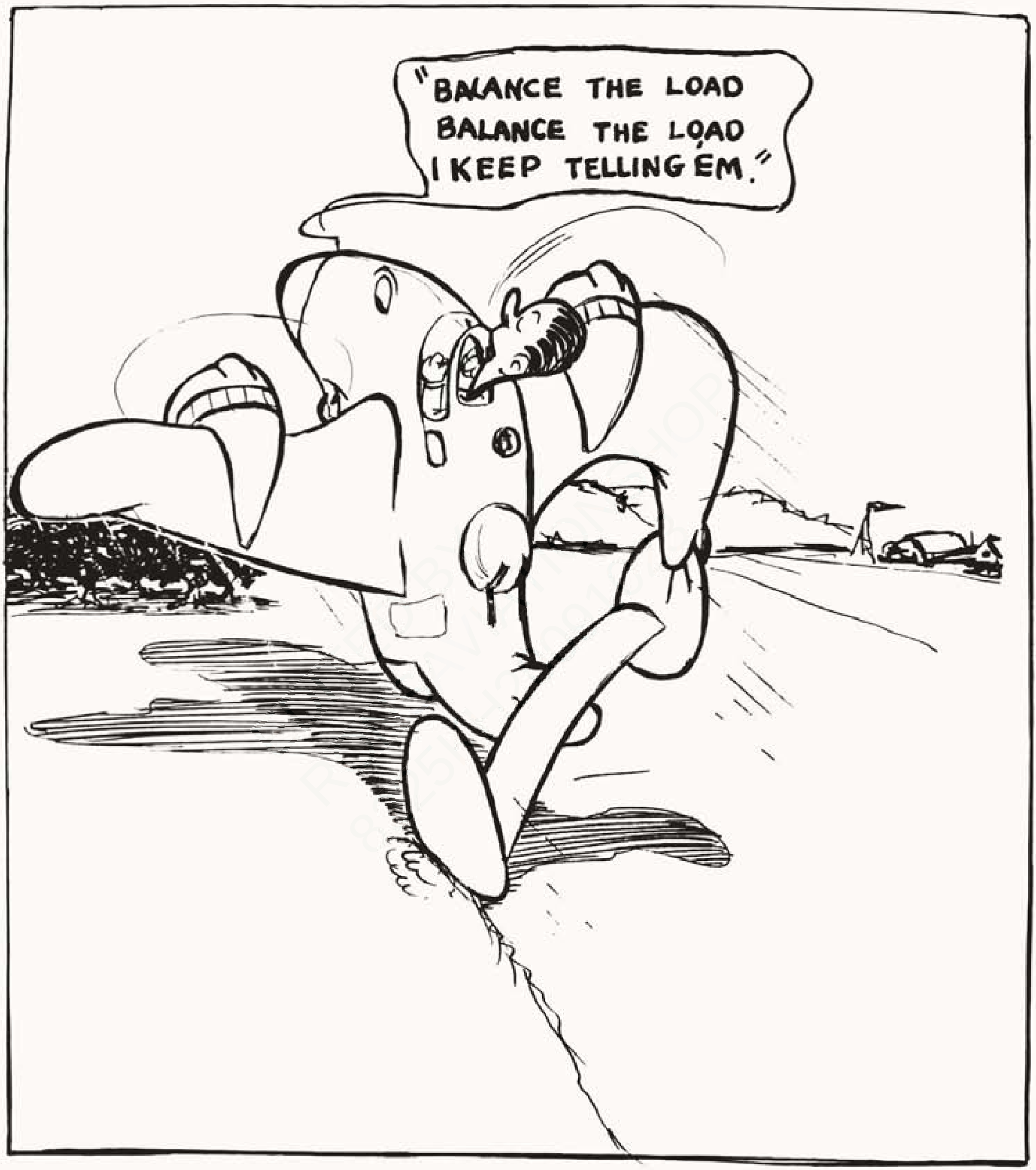
FUEL SPEC.: AN-F-28 GRADE: 100-130

OPERATING CONDITION	RPM	MANIFOLD PRESSURE (BOOST) ②	HORSE-POWER	CRITICAL ALTITUDE WITH RAM	CRITICAL ALTITUDE NO RAM	BLOWER	USE LOW BLOWER BELOW:	MIXTURE CONTROL POSITION	FUEL FLOW (GAL/HR/ENG.) U.S.	FUEL FLOW (GAL/HR/ENG.) IMP.	MAXIMUM CYL. TEMP. °C	MAXIMUM CYL. TEMP. °F	MAXIMUM DURATION (MINUTES)
TAKE-OFF ①	2700	52.0	2000	———	S.L.	LOW	———	AUTO RICH	300	250	260	500	5
WAR EMERGENCY	NOT APPLICABLE TO THIS ENGINE												
MILITARY	2700 2700	51.0 47.0	2000 1600	3500 13,500	1500 12,000	LOW HIGH	11,000 FT.	AUTO RICH	300 260	250 215	260	500	5
MAXIMUM CONTINUOUS	2400 2400	41.5 42.5	1600 1450	7000 14,500	5300 13,200	LOW HIGH	10,500 FT.	AUTO RICH ③	230 210	190 175	232 260	450 500	NO LIMIT 60
MAXIMUM CRUISE	2100 2100	32.5 30.0	1100 975	11,500 21,000	10,000 20,000	LOW HIGH	15,000 FT.	AUTO LEAN	85 85	71 71	232	450	NO LIMIT
MINIMUM SPECIFIC CONSUMPTION ④	1800 1800	34.0 33.0	940 875	7000 14,500	5700 13,300	LOW HIGH		AUTO LEAN	70 66	59 55	232	450	NO LIMIT

REMARKS:
1. DECREASE MANIFOLD PRESSURE ONE INCH BETWEEN S.L. AND 1500 FT. — ABOVE 1500 FT. USE FULL THROTTLE.
2. MANIFOLD PRESSURES ARE FOR CRITICAL ALTITUDES EXCEPT FOR TAKE-OFF.
3. AVOID CRUISING BELOW 1400 RPM BECAUSE OF REDUCED PROPELLER EFFICIENCY.
4. TAKE-OFF IS PERMISSIBLE WHEN OIL TEMPERATURE REACHES 40°C (104°F).
5. AUTO LEAN MAY BE USED AT THIS AND ANY LOWER POWER PROVIDED CYLINDER HEAD TEMPERATURE OF 232°C (450°F) IS NOT EXCEEDED.
6. BOOSTER PUMP OFF.

RED FIGURES HAVE NOT BEEN FLIGHT CHECKED

Figure 19 — Specific Engine Flight Chart


"BALANCE THE LOAD
BALANCE THE LOAD
I KEEP TELLING EM."

SECTION IV

EMERGENCY OPERATING INSTRUCTIONS

1. ENGINE FAILURE DURING FLIGHT.

a. Single engine flight characteristics are good. When operating at a gross weight up to 33,000 pounds the airplane has a positive rate of climb at sea level on rated power, provided the flaps and landing gear are retracted.

b. When an engine failure occurs, the following procedure is recommended:

(1) Set the controls for the dead engine, as listed below:

(a) Mixture control—"CUT OFF."

(b) Propeller feathering switch—Depressed.

(c) Cowl flap switch—"CLOSED."

(d) Oil cooler shutter switch—"CLOSED."

(2) Adjust the rudder and elevator trim tabs.

Note

It is important that single engine operation be conducted with the minimum amount of rudder tab required for straight level flight. Excessive rudder tab will cause vibration.

(3) Turn the ignition, fuel booster, and transfer pump switches and the fuel flow and transfer valve controls for the dead engine to "OFF."

CAUTION

Do not make turns into the dead engine at an indicated air speed of less than 120 knots, or an angle of bank greater than 20 degrees.

(4) If difficulty is experienced in maintaining altitude when loaded heavily, the external fuel tanks, gun packages, or bombs and bomb bay load may be disposed of. (Refer to paragraphs 5, 6, and 7 for instructions.)

(5) If the wing and stabilizer anti-icing and cabin heating system is being used, instruct the radio operator to move the heat exchanger waste gate control for the dead engine to "OFF." This will prevent cold air from entering the system.

c. Refer to the "Flight Operation Instruction Charts" (figures 50, 51, and 52) for single engine operation data.

2. NACELLE FIRE IN FLIGHT.

If a nacelle fire develops in flight, the following procedure is recommended:

a. Set the controls for the affected engines as listed below:

(1) Propeller feathering switch—Depressed.

(2) Mixture control—"CUT OFF."

(3) Fuel flow valve control—"OFF."

(4) Fuel booster pump switch—"OFF."

(5) Cowl flap switch—"OPEN."

(6) Oil cooler shutter switch—"OPEN."

(7) Ignition switch—"OFF."

(8) Generator switch—"OFF."

b. Adjust the rudder trim tabs.

c. When the fire goes out set the controls as follows:

(1) Cowl flap switch—"CLOSED."

(2) Oil cooler shutter switch—"CLOSED."

d. Adjust the elevator trim tabs and readjust the rudder trim tabs.

CAUTION

Do not attempt to restart the engine.

3. ELECTRICAL FIRE.

If practical, locate the circuit which is defective and turn that switch to "OFF." Otherwise, turn off the generator and battery switches and the generator field switch (if installed). If the fire is extinguished, turn the circuits back on one at a time, starting with the generator field, generator, and battery switches. Watch for the circuit which caused the fire. It may flare up again when its switch is thrown.

4. GENERATOR SYSTEM FAILURE.

High voltage (over 30.0 volts) indicates a defective generator system. The following steps should be taken to prevent burning out the batteries and other equipment.

a. Turn both generator switches to "OFF."

b. Turn each generator switch "ON" individually and determine, by means of voltmeter, which generator is putting out the excessive voltage.

c. Leave the switch for the defective generator "OFF," and turn "ON" the other generator switch.

d. If possible, do not draw more than 200 amperes from the one generator which is operating. Keeping the load below this point will prevent the generator from overheating and eventually failing.

5. EMERGENCY RELEASE OF BOMBS.

a. GENERAL.—Bomb bay bombs that are released electrically are automatically tail armed. All bombs that are released mechanically and external bombs that are released electrically are normally not armed. When released electrically or mechanically all bombs may be nose armed and the external bombs may be tail armed by moving the bomb-tank-torpedo selector master switch (39, figure 10) to "BOMBS & WING RACKS" and moving the arming switches (37 and 40, figure 10) to the armed position.

b. BOMB BAY BOMB SALVO.

(1) ELECTRICAL RELEASE.

(a) Move the bomb bay door control (15, figure 16) to "OPEN."

(b) Move the torpedo-bomb manual release control (11, figure 16) to "SELECTIVE."

(c) Move the bomb-tank-torpedo selector master switch to "BOMBS & WING RACKS."

(d) When the bomb bay doors are fully open as shown by the blue position indicator light (43, figure 10), move the bomb bay bomb salvo switch (47, figure 10) to "ON."

(2) MECHANICAL RELEASE.

(a) Move the bomb bay door control to "OPEN."

(b) When the doors are fully open, move the torpedo-bomb manual release control to "SALVO."

WARNING

On airplanes bearing BuAer serial numbers up to 37235 it is possible to salvo the bombs or torpedo manually after placing the bomb bay door control in the "OPEN" position even though the doors are not open. If there is any doubt about the doors being open, move the bomb-tank-torpedo selector master switch to "BOMBS & WING RACKS" or "TORPEDO" and observe the bomb bay door position indicator light.

c. EXTERNAL BOMB, GUN PACKAGE, OR FUEL TANK SALVO.

(1) ELECTRICAL RELEASE.

(a) Move the bomb-tank-torpedo selector master switch to "BOMBS & WING RACKS."

(b) Move the wing rack salvo switch (46, figure 10) to "ON."

(2) MECHANICAL RELEASE.—Pull the external tank-bomb manual release controls (19, figure 16).

6. EMERGENCY RELEASE OF TORPEDO.

a. Move the bomb bay door control (15, figure 16) to "OPEN."

b. When the bomb bay doors are fully open, move the torpedo-bomb manual release control (11, figure 16) to "SALVO."

7. RELEASE OF EXTERNAL FUEL TANKS, BOMBS, OR GUN PACKAGES.

a. In addition to the two methods mentioned in paragraph 5, *c*, the tanks or bombs may be released as follows:

(1) If the armament master switch (1, figure 14) is installed, move it to "ON."

(2) Move the bomb-tank-torpedo selector master switch (39, figure 10) to "BOMBS & WING RACKS."

(3) Move the wing rack selector switches (36, figure 10) to "RELEASE."

(4) Press the bomb-tank-torpedo release switch (9, figure 32).

b. The foregoing procedure is recommended in case of engine failure immediately after take-off, since the tanks and bombs can be dropped instantly by pressing the release switch on the control wheel provided the three selector switches have been set before take-off.

8. ENGINE FUEL PUMP FAILURE.

If an engine-driven fuel pump fails, move the fuel booster pump switch (5, figure 16) for the affected engine to "FAST."

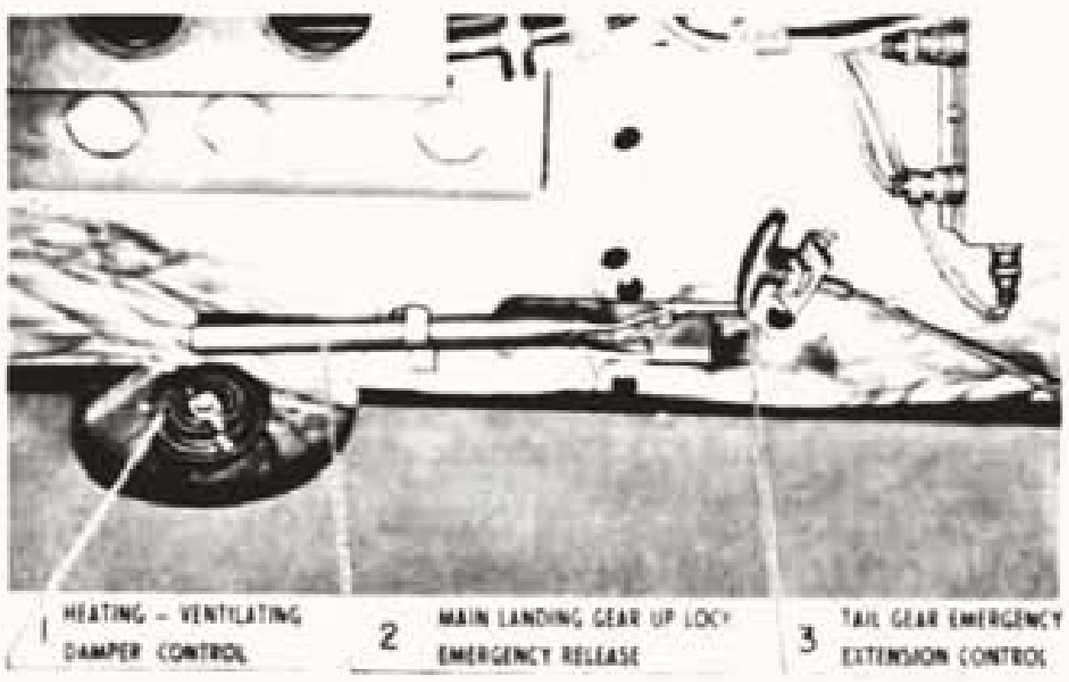
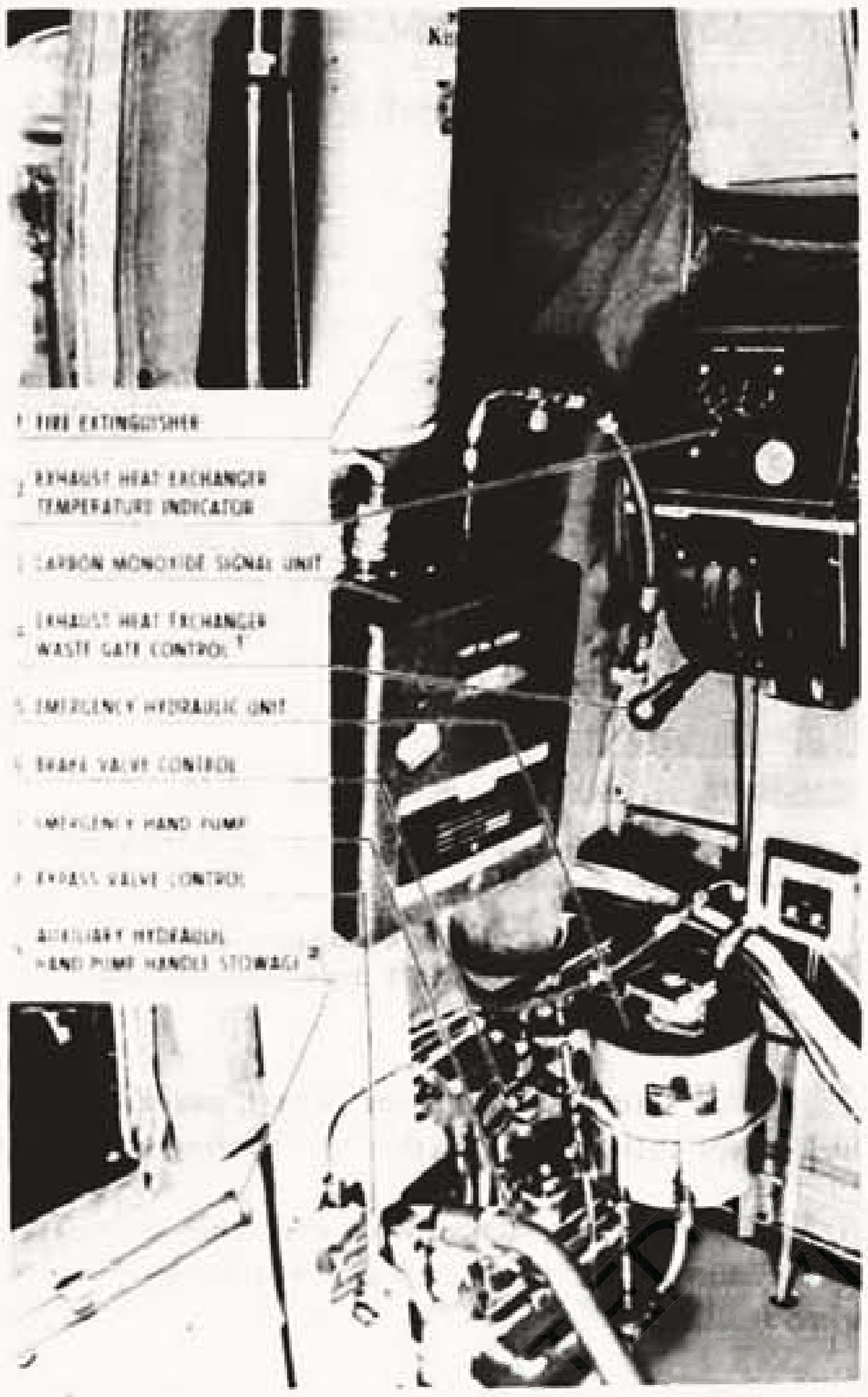


Figure 20 — Radio Compartment — Lower Aft Side



1. There are two heat exchanger controls and a wing and empennage temperature indicator on a few airplanes.
2. The hydraulic hand-pump handle is stowed in this position on serials 37274 and subsequent. Prior to this serial it is stowed on the bulkhead behind the pilot's seat.

Figure 21 — Radio Compartment — Right Forward Side

9. HYDRAULIC SYSTEM FAILURE.

a. GENERAL.

(1) If the hydraulic system pressure gage (48, figure 13) indicates a pressure of only 450 psi and the landing gear cannot be extended with the auxiliary hand pump (26, figure 10), the main landing gear must be extended with the emergency hydraulic system and the tail gear must be extended manually. If the brake pressure gage (49, figure 13) indicates a pressure of 800 to 1000 psi and the pressure does not decrease to 450 psi when the pedals are held in the depressed position, the brakes may be operated in the conventional manner even though the system pressure gage reading is only 450 psi.

(2) If the brake pressure gage indicates a pressure of only 450 psi and the pressure cannot be increased with the auxiliary hand pump, the main landing gear and brakes must be actuated by the emergency hydraulic system.

b. EMERGENCY EXTENSION OF MAIN LANDING GEAR.

(1) Move the landing gear control (8, figure 16) to "DOWN."

(2) Instruct the radio operator to proceed as follows:

(a) Pull the landing gear up lock emergency release (2, figure 20). The flap and landing gear position indicator (34, figure 13) will show when the gear has dropped from the locks.

(b) Turn the emergency brake valve control (6, figure 21) to "OFF."

(c) Turn the emergency hydraulic system bypass valve control (8, figure 21), to "CLOSED."

(d) Extend the gear by operating the emergency hydraulic system hand pump (8, figure 21) until the position indicator shows that the gear is down.

(e) If difficulty is encountered in releasing the up lock or extending the gear, turn the emergency hydraulic dump valve (figure 22) to "DUMP" and repeat step *(d)* and if necessary step *(a)*.

c. EMERGENCY EXTENSION OF TAIL LANDING GEAR.—Instruct the radio operator to pull the tail gear emergency extension control (3, figure 20) until the position indicator shows that the gear is down.

d. EMERGENCY OPERATION OF BRAKES.—Instruct the radio operator to perform the following operations:

(1) If the emergency hydraulic system was used to extend the landing gear, before landing, see that the

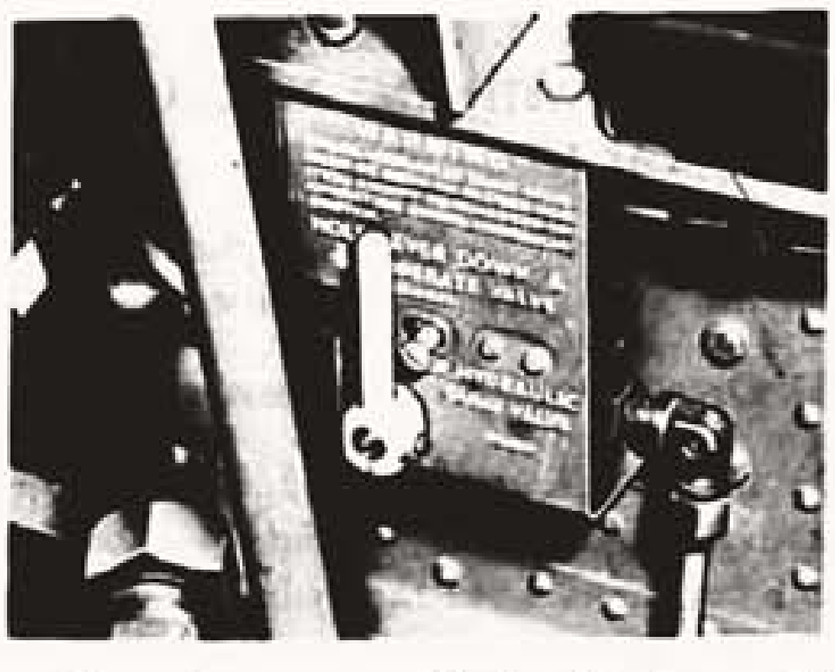


Figure 22 — Emergency Hydraulic Dump Valve

emergency brake valve control (6, figure 21) is in the "OFF" position and then push in the control and turn it to "ON." This is important since the brakes can be locked when the landing gear has been extended with the emergency system.

(2) If the emergency system was not used to extend the landing gear the following steps are necessary:

(a) Turn the emergency bypass valve control to "CLOSED."

(b) See that the emergency brake valve control is in the "ON" position.

(3) Apply the brakes when instructed by operating the emergency hydraulic hand pump.

(4) Release the brakes when instructed by turning the valve control to "OFF."

Note

To make possible immediate application of the emergency brakes in case of unexpected failure of the regular brake system, the brake valve control should be left in the "ON" position, except when the landing gear is being extended with the emergency hydraulic system.

10. EMERGENCY EXITS IN FLIGHT.

(See figure 24.)

a. Normally, everyone should leave through the cabin door, which may be jettisoned by pulling the emergency release located in the flight compartment, radio compartment, at the navigator's station, or at the forward side of the cabin door.

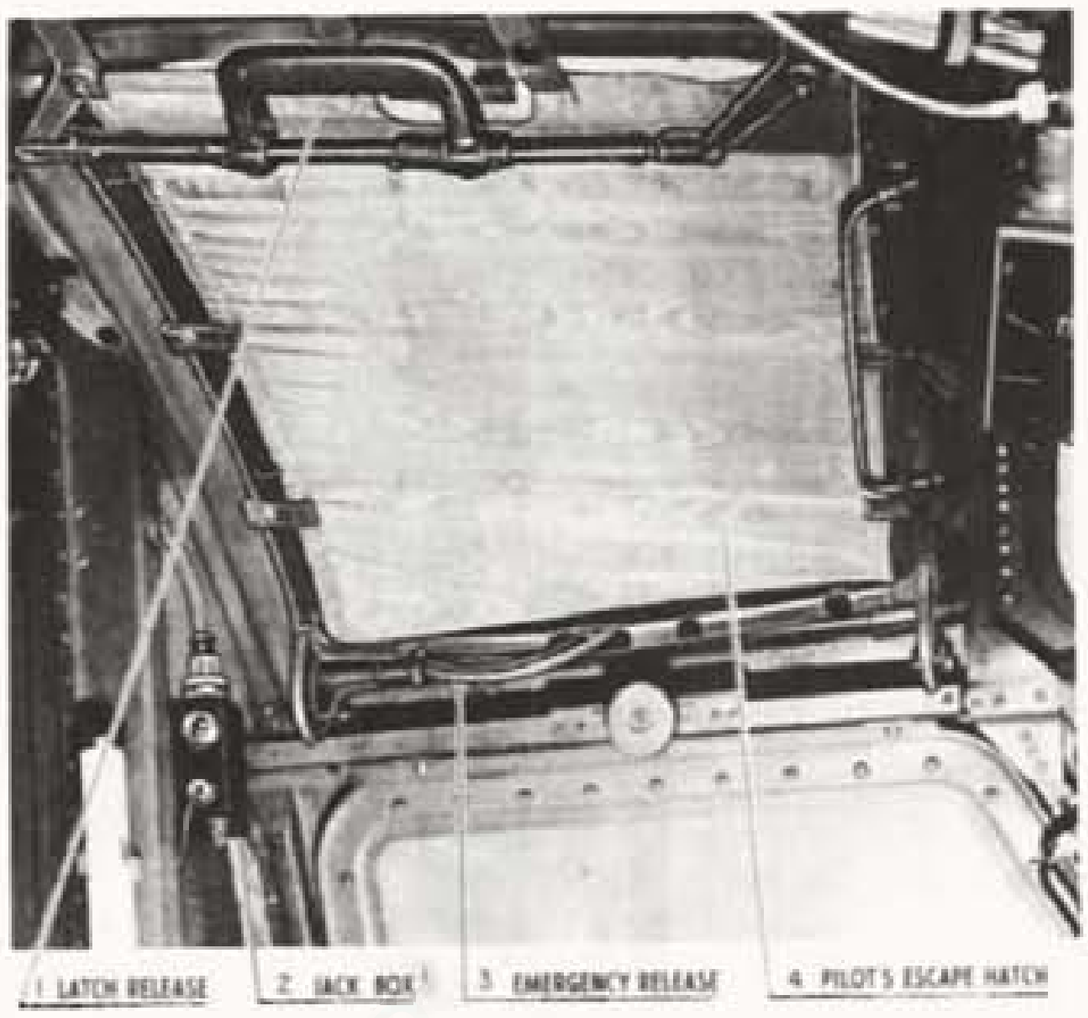
b. If it is impossible to use the cabin door, the pilot may leave through the escape hatch in the flight compartment. The hatch is jettisoned by pulling the emergency release (3, figure 23).

11. LANDING WITH THE WHEELS RETRACTED.

a. If it is necessary to land with the wheels retracted the pilot will warn the crew and proceed as follows:

(1) Drop the external fuel tanks or bombs.

(2) Drop the bomb bay load, if time permits. Approximately 10 seconds are required to open and close the bomb bay doors when the hydraulic system pressure is 800 to 1000 lb sq in. and both engines are operating. Be sure the doors are closed before landing.



1. Jack box is located behind the pilot's seat on airplanes bearing BuAer serial numbers 37575 and subsequent.

Figure 23 — Flight Compartment — Upper Left Side

(3) If time and conditions permit, use all of the fuel except that needed for the final landing approach.

(4) Release the escape hatch and cabin door. This will eliminate the possibility of their being jammed when landing.

(5) Several minutes before the landing, instruct the crew to proceed to their respective crash stations and prepare for the landing. When the order is given:

(a) The copilot-navigator will sit in the copilot's seat and fasten his safety belt and shoulder harness.

(b) The radio operator will sit in his chair, fasten his safety belt, face forward, hold a parachute or life jacket against the bulkhead, and brace his head and shoulders on it.

(c) The radar operator-tunnel gunner will lie on his back between his chair and the cabin door and brace his feet against the rear beam.

(d) The turret gunner will sit on the floor at the navigator's station with his back against the radio compartment door, fasten his safety belt, and place a parachute or life jacket between his head and the door.

(e) If there are any additional personnel on board they should lie on their backs at the radar station with their heads aft, feet braced on the rear shear beam, and knees slightly bent.

WARNING

Do not take a crash station aft of the step below the turret during a crash landing or ditching since this portion of the fuselage may be smashed in.

(6) Extend the flaps and make a normal landing approach. Plan on landing in the dirt rather than on a surfaced runway if possible.

(7) Warn the crew a few seconds before the crash, and move the master ignition switch to "OFF." Do not feather the propellers.

(8) Instruct the copilot-navigator to turn the fuel flow valve controls and battery switch to "OFF."

(9) Make a full stall landing.

b. When the airplane comes to rest abandon it as quickly as possible, and disperse a safe distance away from it if there is imminent danger of a fire.

12. LANDING IN WATER.

a. The following should be taken into consideration when it is necessary to ditch the airplane:

(1) If imminent fuel exhaustion is the reason for the forced landing, the pilot should not wait until the engines sputter, but should land while power is available.

(2) If ditching without power, sufficient altitude and speed must be allowed to break the glide smoothly and attain a nose high attitude before striking the water.

(3) In the daytime when a choice is possible, the landing should be made into the wind unless there is a light wind (under 20 knots) and a heavy swell. When landing into the wind, contact with the water should be made on the up-slope and near the top of an on-coming swell. If there is a light wind and a heavy swell, land parallel to and along the top of a swell.

(4) At night, as much of the procedure in the foregoing paragraph should be used as is possible. Advantage should be taken of flares, float lights, and landing lights. If waves are breaking, landing lights will help a great deal in the actual landing; but if the sea is calm and smooth, landing lights may confuse the pilot and prove dangerous.

b. Immediately after realizing that a forced landing is necessary the pilot will order the crew to prepare for ditching and tell them whether it will be immediate or deferred. When the order is given if time permits:

(1) The copilot-navigator will determine the position, notify the pilot and radio operator, and go to the copilot's station.

(2) The radio operator will transmit a distress signal giving the position, and clamp the telegraph key down. He will then turn the IFF switch to "EMERGENCY."

(3) The radar operator-tunnel gunner will dispose of all load possible and check to be sure that the camera hatches are securely fastened in place.

(4) The turret gunner will put the first aid kit inside his shirt, remove the astro-hatch, assist the radar operator-tunnel gunner, and if the forced landing is being made at night, release flares and float lights as instructed by the pilot.

c. In the meantime, the pilot will proceed as follows:

(1) If the forced landing is being made at night:

(a) Instruct the tunnel gunner to release flares and float lights.

(b) Turn on the landing lights if the waves are breaking.

(2) Feather the inoperative propeller if there is one.

(3) Drop the external fuel tanks, gun packages, or bombs.

(4) Drop the bomb bay load, if time permits, and make sure that the bomb bay doors are closed.

(5) Release the flight compartment escape hatch.

(6) Transmit a distress message if time permits.

(7) Several minutes before landing, instruct the crew to go to their respective crash stations and put on their life jackets. (When this order is given each crew member will prepare for the landing as outlined in paragraph 11, *a*, (5).)

(8) Check to be sure that the landing gear is retracted.

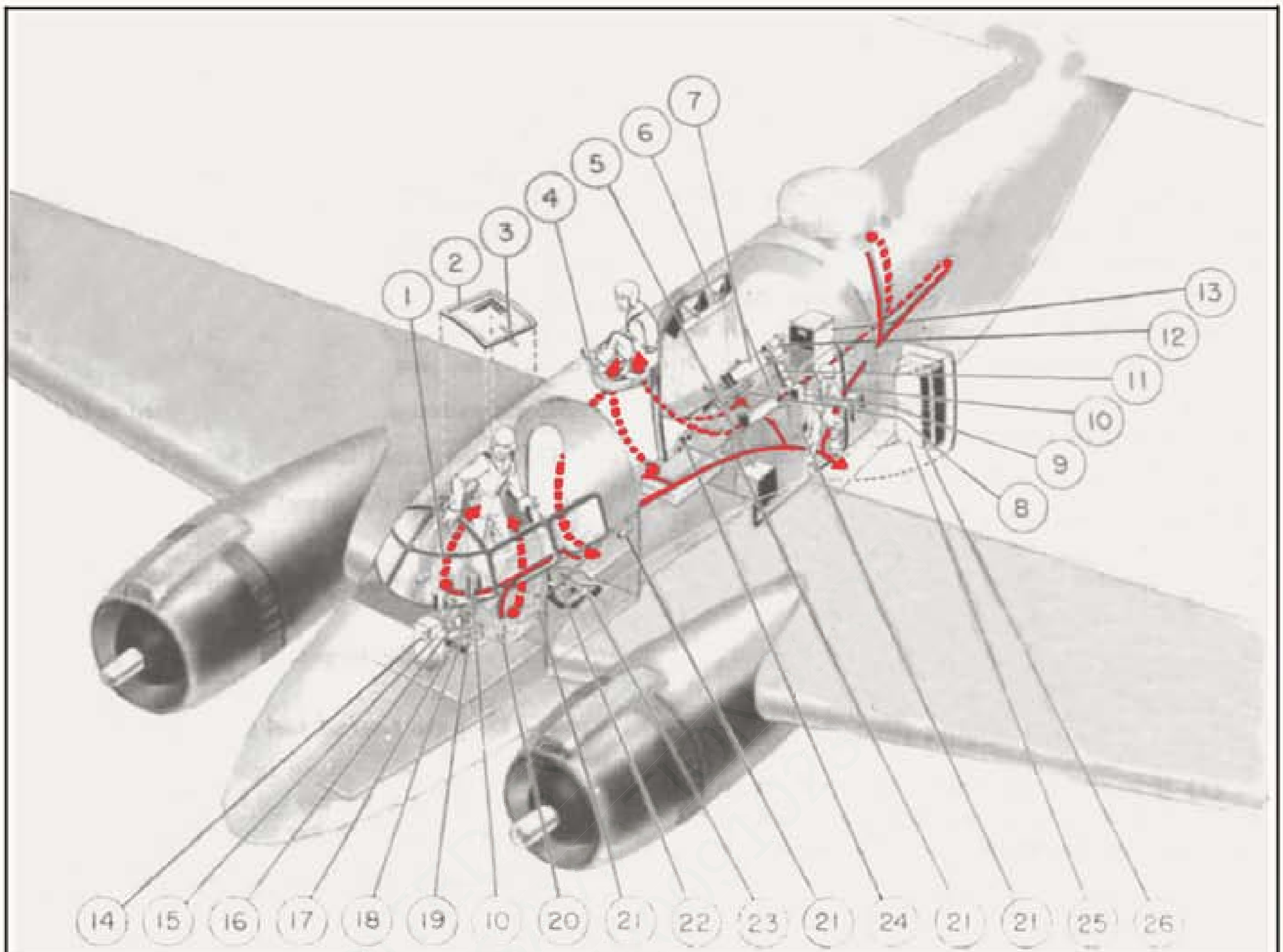
(9) Extend the flaps 100 percent.

(10) Warn the crew a few seconds before the landing.

(11) Make a full stall landing or the airplane will probably bounce off the water and may plunge in nose first on second contact. If power is available, use it to reduce the stalling speed as much as possible. There will be a slight primary impact as the rear of the airplane strikes the water, followed by a more severe impact and a sudden deceleration as the nose buries. The tail and nose sections may collapse.

CAUTION

Do not inflate life jackets until after exit from the airplane.



NORMAL EXIT ROUTES

EMERGENCY EXIT ROUTES

1 EMERGENCY HYDRAULIC BRAKE VALVE
2 PILOT'S ESCAPE HATCH
3 ESCAPE HATCH RELEASE
4 ASTRO HATCH
5 LIFE RAFT RADIO TRANSMITTER
6 PARACHUTE BINS
7 SIGNAL PISTOL CARTRIDGE CASES
8 FLOAT LIGHTS
9 FIRST AID KIT
10 FIRE EXTINGUISHERS
11 FLARE CHUTE
12 FLARES
13 FLARE STOWAGE BOX
14 EXTERNAL TANK-BOMB MANUAL RELEASE CONTROLS
15 BOMB-TORPEDO MANUAL RELEASE CONTROL
16 EMERGENCY HYDRAULIC SYSTEM HAND PUMP
17 EMERGENCY HYDRAULIC SYSTEM BYPASS VALVE
18 AUXILIARY HYDRAULIC HAND PUMP
19 HYDRAULIC SYSTEM BYPASS VALVE CONTROL
20 EMERGENCY HYDRAULIC DUMP VALVE CONTROL
21 CABIN DOOR AND LIFE RAFT RELEASE
22 MAIN LANDING GEAR UPLOCK EMERGENCY RELEASE
23 TAIL GEAR EMERGENCY EXTENSION CONTROL
24 SIGNAL PISTOL AND FIRING TUBE
25 EMERGENCY EQUIPMENT CONTAINER (IN CABIN DOOR)
26 LIFE RAFT (IN CABIN DOOR)

Figure 24 — Emergency Equipment and Exits Diagram

d. Immediately after the final impact, everyone must leave the airplane as quickly as possible since it may not float for more than 30 seconds depending on whether or not the nose section collapsed. Normally, everyone should leave through the cabin door, but if time or conditions do not permit, the pilot and copilot may leave through the flight compartment escape hatch and the radio operator may leave through the astro-hatch. The duties of the crew are as follows:

(1) The pilot will pull the cabin door and life raft release (7, figure 26) immediately after the final impact.

(2) The copilot-navigator will take some flashlights and the signal pistol and cartridges.

(3) The radio operator will take a parachute.

(4) The radar operator-tunnel gunner and the turret gunner will release the cabin door and life raft if it has not been done, throw the life raft transmitter overboard, right the raft if necessary, and stand by.

13. EMERGENCY EQUIPMENT.

(See figure 24.)

a. PARACHUTE BINS.—A bin (6, figure 24) for two parachutes is installed on the right side of the cabin.

b. SIGNAL PISTOL AND CARTRIDGE STOWAGE.—The signal pistol is stowed in the firing tube (3, figure 36) above the navigator's table. Two waterproof cases (7, figure 24), which hold 10 cartridges each, are installed on the left side of the cabin just forward of the cabin door.

c. FLARE CHUTE AND STOWAGE.—A flare chute (10, figure 38) is installed just forward of the turret. A box and two racks (7 and 8, figure 38) are provided near the flare chute for the stowage of eight reconnaissance flares.

d. FLOAT LIGHT STOWAGE.—A stowage rack (8, figure 24) for 12 float lights is installed on the right side of the cabin opposite the cabin door.

e. FIRST AID KIT.—A 10-unit first aid kit (9, figure 24) is located on the left side of the cabin just forward of the door.

f. FIRE EXTINGUISHERS.—Two CO_2 fire extinguishers (1, figure 21 and 4, figure 25) are provided. One is installed on the right forward side of the radio compartment and the other is on the left side of the cabin just aft of the door.

g. LIFE RAFT AND EQUIPMENT.—A Mark 7, type D, life raft and emergency equipment container are installed in the cabin door. The raft may be released by pulling the controls (7, figure 26; 5, figure 33; and 5, figure 25) at the flight station, radio operator's station, navigator's station, and cabin door. The control at the door may be reached from outside the airplane by opening the access door (6, figure 25). An automatic submersion release mechanism is also provided.

b. LIFE RAFT TRANSMITTER. — Provisions are made for stowing a SCR-578B radio transmitter just forward of the cabin door.

14. EMERGENCY OPERATION OF RADIO AND COMMUNICATION EQUIPMENT.

a. AIRPLANES PRECEDING BUAER SERIAL NUMBER 37320.—In the event of failure of the jack box or associated cabling, it may be possible to continue use of the ICS/Radio Control Box by shifting the microphone and headset plugs from the jack box to the emergency jacks in the left end of the ICS/Radio Control Box. This emergency connection permits radio oper-

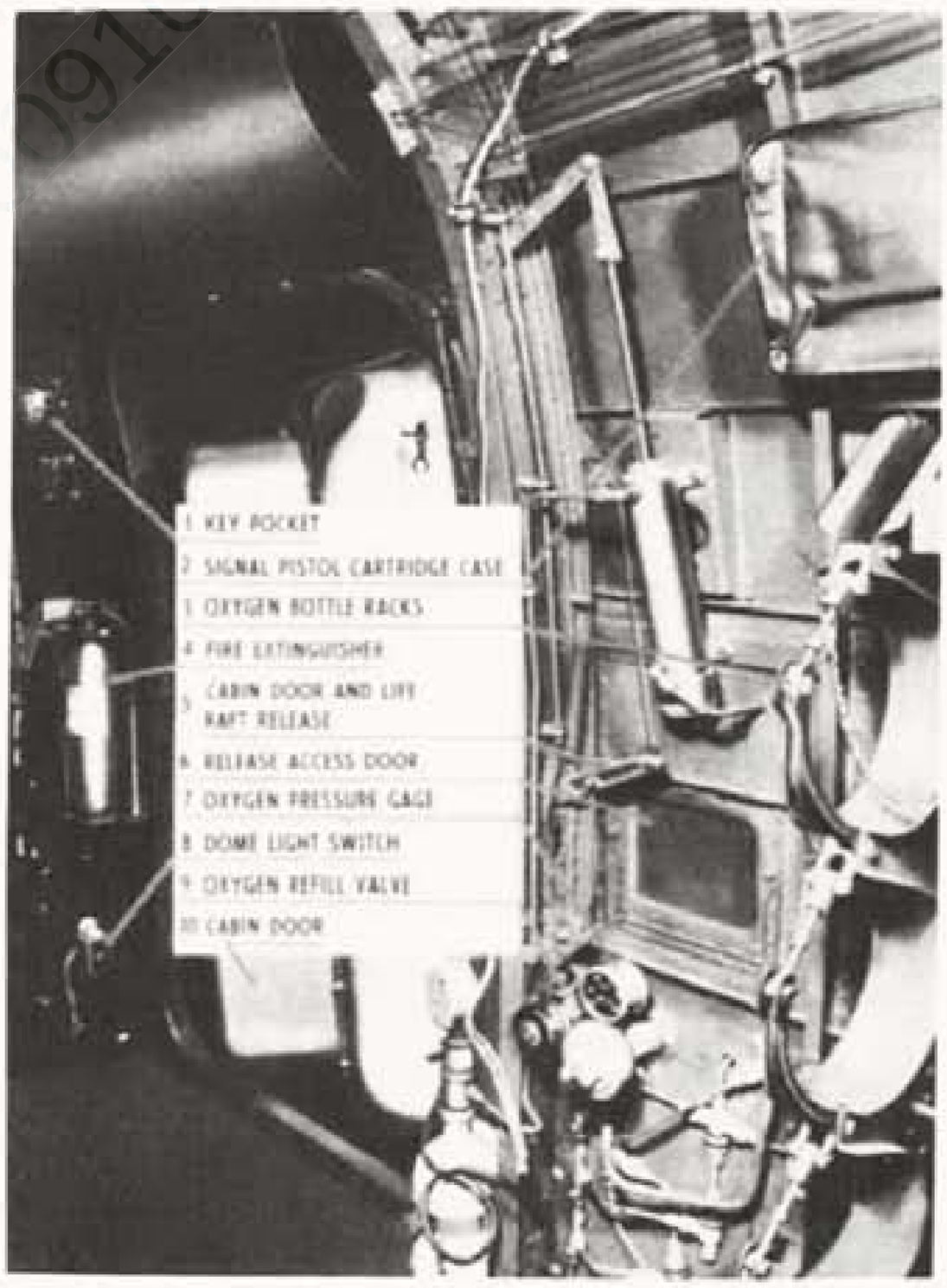


Figure 25 — Cabin — Left Side

ation, but interphone operation is not possible. In the event of failure of either pilot's ICS/Radio Control Box, partial emergency operation can be utilized depending on the nature of the failure. If the failure is such as to cause loss of radio reception through the defective ICS/Radio Control Box yet reception is normal on the other ICS/Radio Control Box, the headset plug can be shifted from the jack box associated with the defective control box to the headset jack on the other control box. Interphone reception is not available through this emergency jack. If the failure prevents transmission via the defective ICS/Radio Control Box, shift the microphone plug from the jack box associated with the defective control box to the microphone jack on the other control box.

b. AIRPLANES STARTING WITH BUAER SERIAL NUMBER 37320 AND SUBSEQUENT. — These airplanes are equipped with ICS/Radio Control Boxes which have emergency provisions slightly different from those in the control boxes in earlier planes. The headphone and microphone jacks located on the jack boxes and ICS/Radio Control Boxes are wired in parallel so that either box may be used interchangeably at the pilot's, copilot's, or radioman's station. Moreover, the "EMGCY" jack on the pilot's ICS/Radio Control Box is connected in parallel with the headphone jack on the copilot's control box; while the "EMGCY" jack on the copilot's control box is connected in parallel with the headphone jack on the pilot's control box. In the event of failure of either of these ICS/Radio Control Boxes, both the pilot and copilot may listen to the control box which is still operative by utilizing the "EMGCY" jack. On the radio operator's ICS/Radio Control Box, the "EMGCY" jack parallels the headphone jack. These emergency provisions provide both radio and ICS operation.

SECTION V

OPERATIONAL EQUIPMENT

1. FLIGHT COMPARTMENT.

a. LOCATION.—The flight compartment is located just forward of the front shear beam. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

(1) LIGHTING.

(a) GENERAL.—All compartment lights are supplied power through the battery switch (15, figure 10) and the interior light switch (11, figure 14), except the fluorescent instrument lights or red instrument lights. (The fluorescent lights are replaced by red lights on airplanes bearing BuAer serial 37575 and subsequent.) On airplanes preceding BuAer serial 84116 the fluorescent or red lights are supplied power directly from the battery. On subsequent airplanes power is supplied to these lights through the battery switch.

(b) CENTRAL AND AUXILIARY ELECTRICAL CONTROL PANEL LIGHTS.—The central control panel light is installed in the control stand head and the auxiliary electrical control panel lights are located inside the panel just above the switches. The lights are controlled by the panel illumination switch (27, figure 14.)

(c) TRIM TAB LIGHTS.—A light is mounted behind each translucent trim tab dial. The control switch (28, figure 14) is on the auxiliary electrical control panel.

(d) SPOT LIGHTS.—Adjustable fluorescent or red spot lights (3, figure 26; 6, figure 28; and 8, figure 30) are installed in the ceiling. (The red lights replace the fluorescent lights on airplanes bearing BuAer serial numbers 37575 and subsequent.) The control switches (12, 13 and 14 or 26, figure 14) are installed on the auxiliary electrical control panel.

(e) INDIRECT INSTRUMENT LIGHTING.—On airplanes bearing BuAer serial numbers 37575 and subsequent, red indirect instrument panel lighting is provided. The control switch is located on top of the control stand just forward of the carburetor heat controls.

(2) HEATING AND VENTILATING.

(See figure 5.)

(a) A heating and ventilating outlet is installed under each seat and there is an adjustable defroster tube for the windshield. The flow of air to the outlets and defroster tube is regulated by the damper control (1, figure 20) and an additional damper control is provided in the defroster duct near the bottom of the windshield The temperaturd of the air admitted from the outlets may be regulated by the heat-ventilating control (6, figure 33), provided the waste gate controls (4, figure 21) are in the "DEICE-HEAT" position. If the waste gate controls are in "WASTE" position, only outside air is admitted.

(b) The carbon monoxide indicator, which warns of the presence of excessive CO, is on at all times. The indicator light (7, figure 13) may come on when the airplane engines are being warmed up, but this is no cause for alarm. The light is turned off by pressing the reset switch (7, figure 13). If the warning light comes on during flight and after being turned off comes on again within a few seconds, move the exhaust heat exchanger controls to "WASTE" and pull the heating ventilating control. If the light comes on again open the windows.

(c) Suit heater outlets for the pilot and co-pilot are located on the main electrical control panel.

(3) OXYGEN OUTLETS.—An oxygen outlet (., figure 26 and 10, figure 28) is located on each side the compartment. (Refer to Appendix I for information on the use of oxygen.)

(4) RELIEF TUBE.—A relief tube is clipped to the pilot's seat on the left bottom side.

(5) WINDSHIELD WIPERS.—Each of the two windshield panels is provided with a windshield wiper. Both wipers are driven by a two-speed reversible motor and are controlled by a single three-position switch (48, figure 10) located on the main electrical control panel. The switch is marked "FAST," "SLOW,' and "OFF." Do not operate wipers on dry glass.

CAUTION

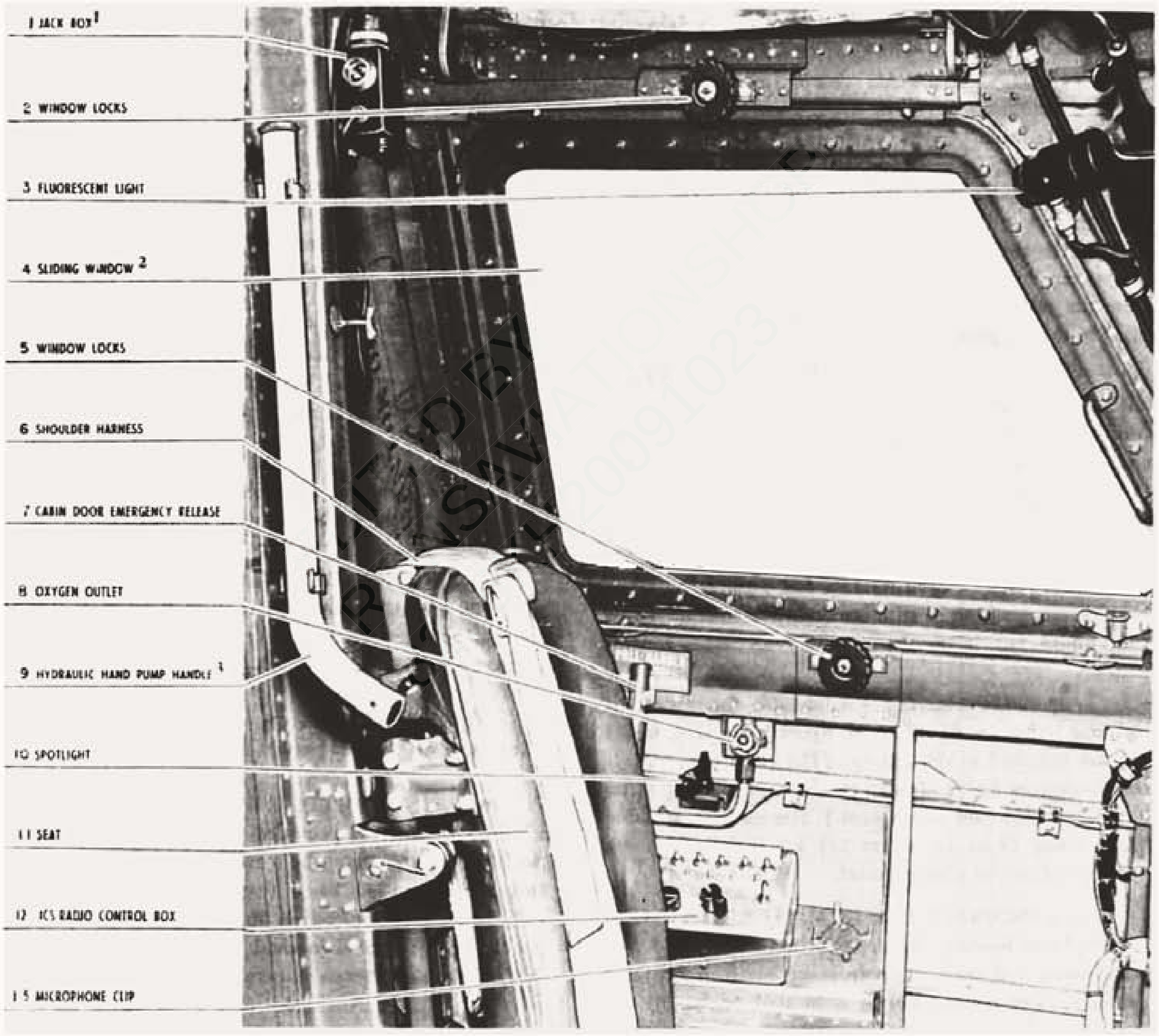
Changing speed from fast to slow reverses the direction of rotation of the motor. Stop the wiper for a few seconds when changing from fast to slow and vice versa.

c. RADIO COMMUNICATION AND NAVIGATION SYSTEM.

(1) GENERAL.

(a) This system incorporates the following equipment: AN/ARC-5 transmitter and receiving equipment including VHF components, AN/ART-13 transmitter, ARB receiver, MN-31 or SCR-269-F radio compass, AN/ARN-8 marker beacon receiver, and AN/AIA-2 interphone equipment. Generalized control (microphone switching and receiver seection) is provided for the pilot, copilot, and radio operator through the medium of the individual ICS/Radio control boxes. Tuning of the individual equipment is provided by means of associated control boxes which are divided between the pilot, copilot and radio operator. In the following instructions, no distinction will be made between the pilot and copilot. Where the text refers to the pilot, it should be understood that for some operations it will be necessary for the copilot to perform the operation indicated.

(b) Upon entering the cockpit, plug the headset into the phone extension cord leading to the jack box. Make certain that the microphone and headset plugs are fully engaged in the jack box.



1. Jack box is located behind the pilot's seat on airplanes bearing BuAer serial numbers 37575 and subsequent.
2. Window is changed to type shown in figure 77 on serials 37094 and subsequent.
3. Hydraulic hand-pump handle is stowed on the back side of the front shear beam on serials 37274 and subsequent.

Figure 26 — Flight Compartment — Left Side

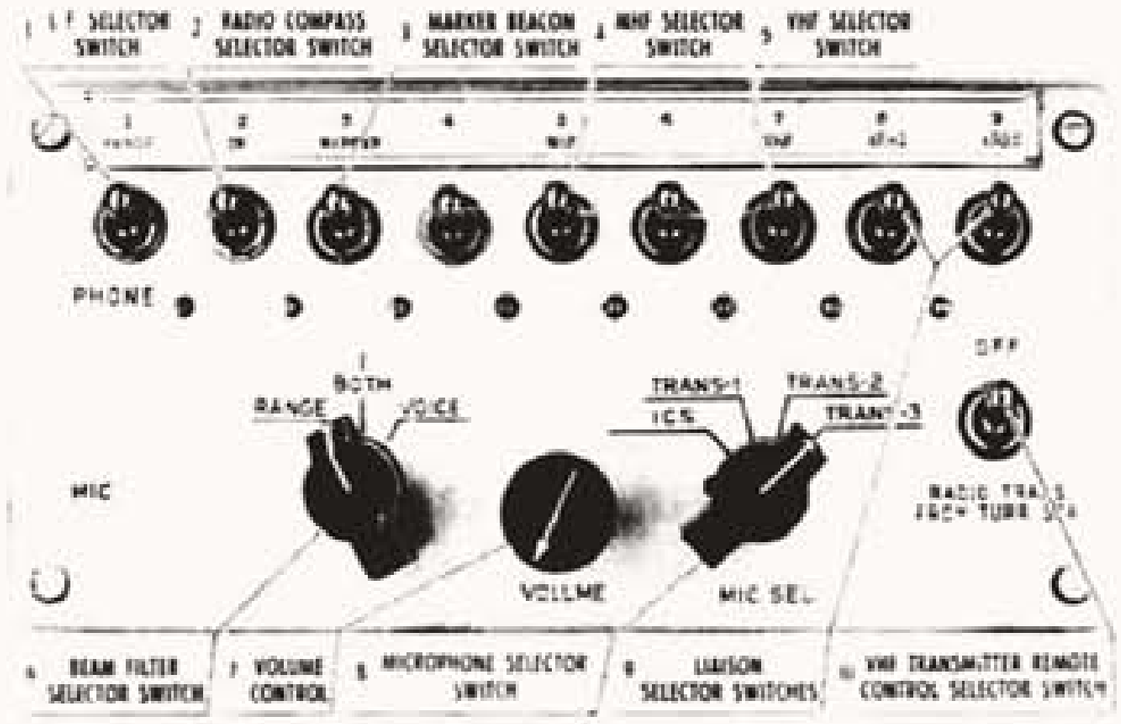
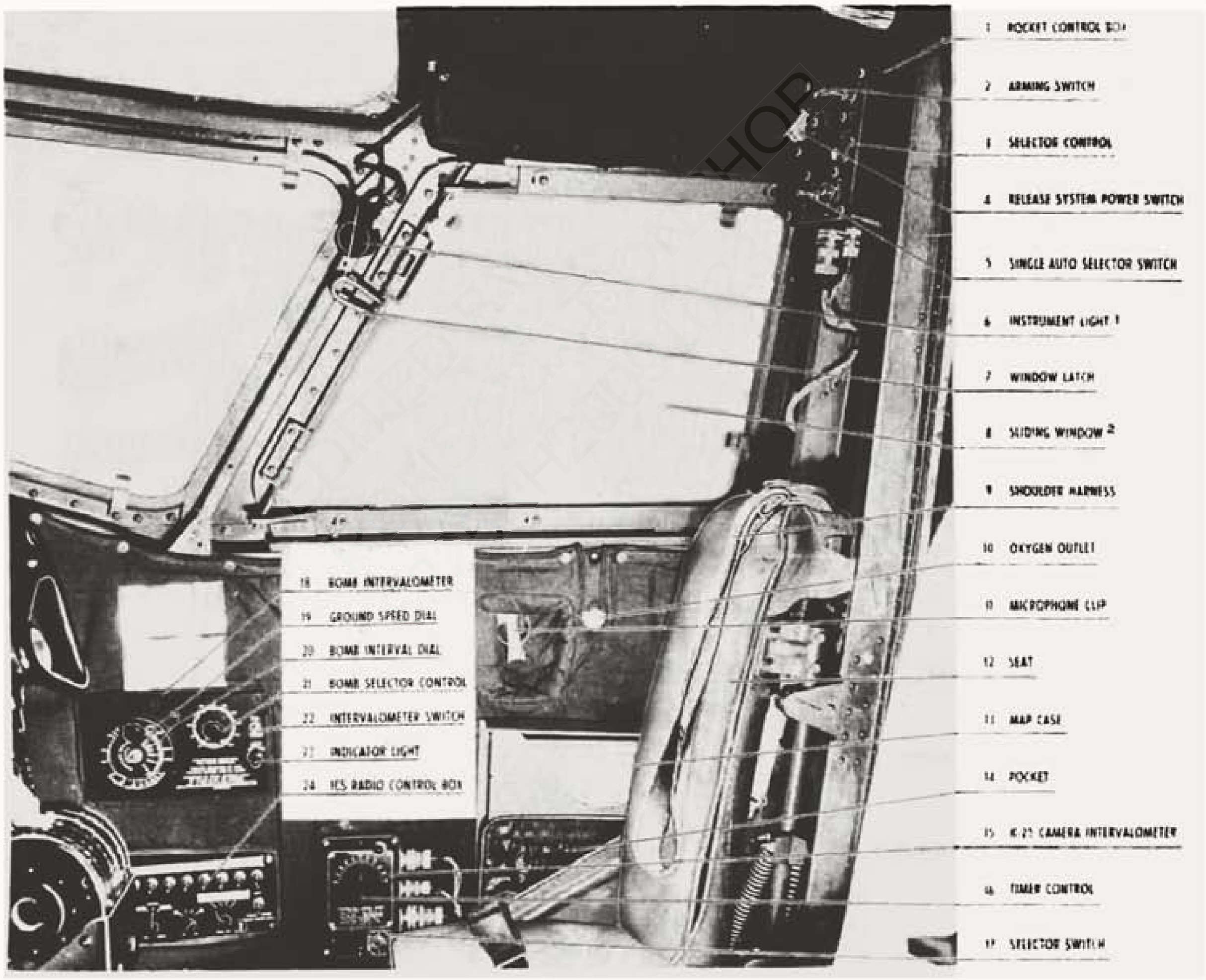


Figure 27 — ICS Radio Control Box

(c) With the battery switch "ON" and the generator charging, have the radio operator turn "ON" the radio master and interphone switches which are located on the junction box above the radio operator's table.

(2) RECEPTION.

(a) GENERAL. — On the ICS/Radio Control Box, provision is made by the nine toggle switches along the top front of the box for up to nine receiver out-puts of which the pilot, copilot, or radio operator may select any single receiver or combination of receivers, without affecting the reception of the other listeners. Only seven



1. **Red light** replaces the fluorescent light on airplanes bearing BuAer serial numbers 37575 and subsequent
2. **Window** changed from the type shown on figure 26 on serials 37094 and subsequent

Figure 28 — Flight Compartment — Right Side

switches are actually used in this installation (see figure 27). Range-filter switches are so connected that any of the above flight crew members may select "RANGE," "VOICE," or "BOTH" from either of two range frequency receivers without affecting other crew members. To select any receiver, the pilot, copilot, or radio operator has only to turn on the switch associated with that receiver. If either the LF ARC-5 receiver or the radio compass receiver is selected, he may then use the range-filter switch to select "RANGE," "VOICE," or "BOTH." The following table gives the outputs controlled by each of the nine switches: (See figure 27.)

Switch No.	*Equipment Output*
1.	LF AN/ARC-5 with range filter—pilot tuned.
2.	MN-31 or SCR-269-F Radio Compass with range filter—pilot tuned.
3.	AN/ARN-8 Marker Beacon Receiver—no tuning required.
4.	Not connected.
5.	MF/HF AN/ARC-5—pilot tuned.
6.	Not connected.
7.	VHF AN/ARC-5 plus transmitter sidetone—pilot tuned.
8.	ARB Receiver No. 2 plus AN/ART-13 (ATC) sidetone No. 2—radio operator tuned.
9.	ARB Receiver No. 1 plus AN/ART-13 (ATC) sidetone No. 1—radio operator tuned.

When switching from one or more of the above channels, the VHF AN/ARC-5 equipment (switch No. 7) should be the first set up. This equipment does

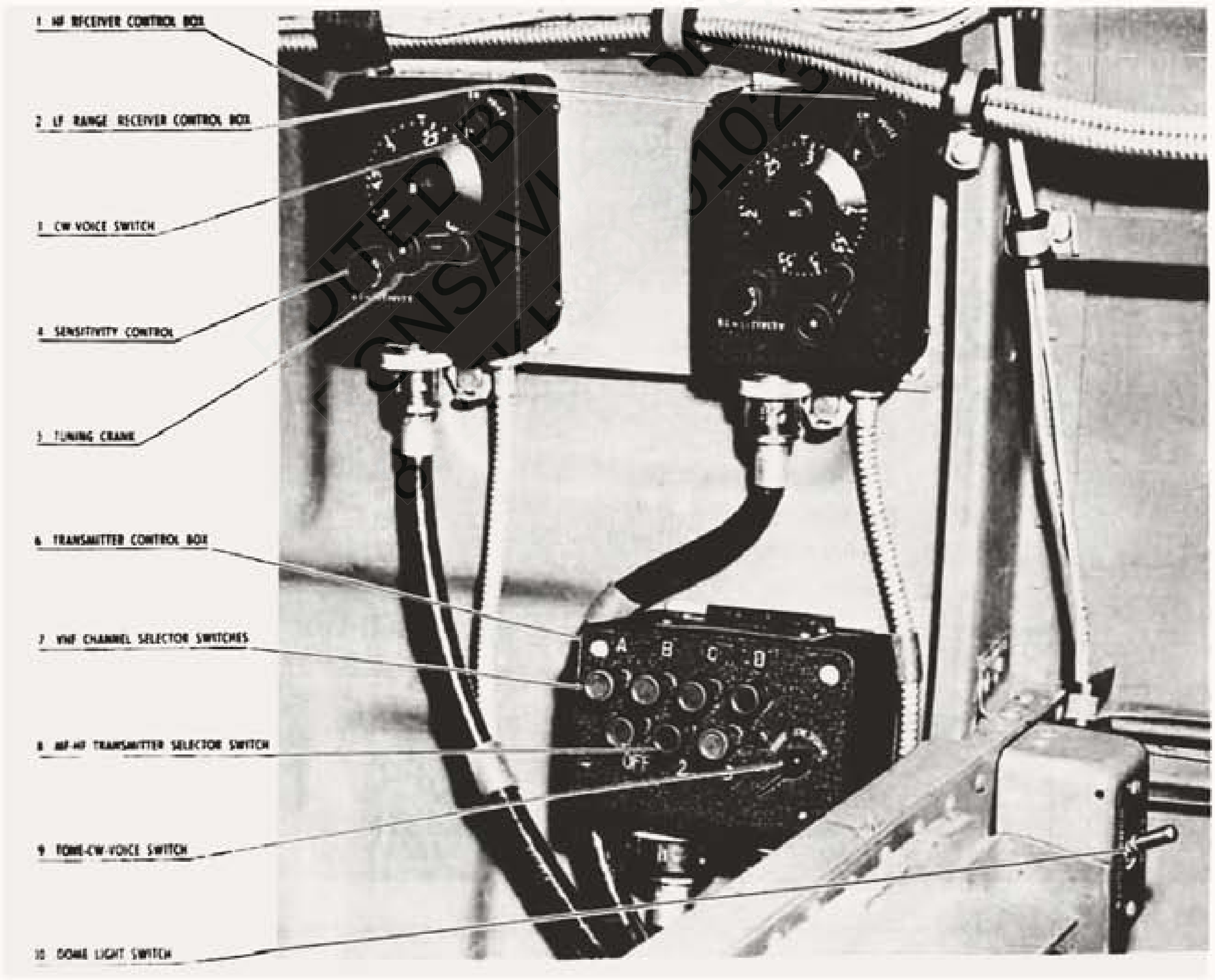
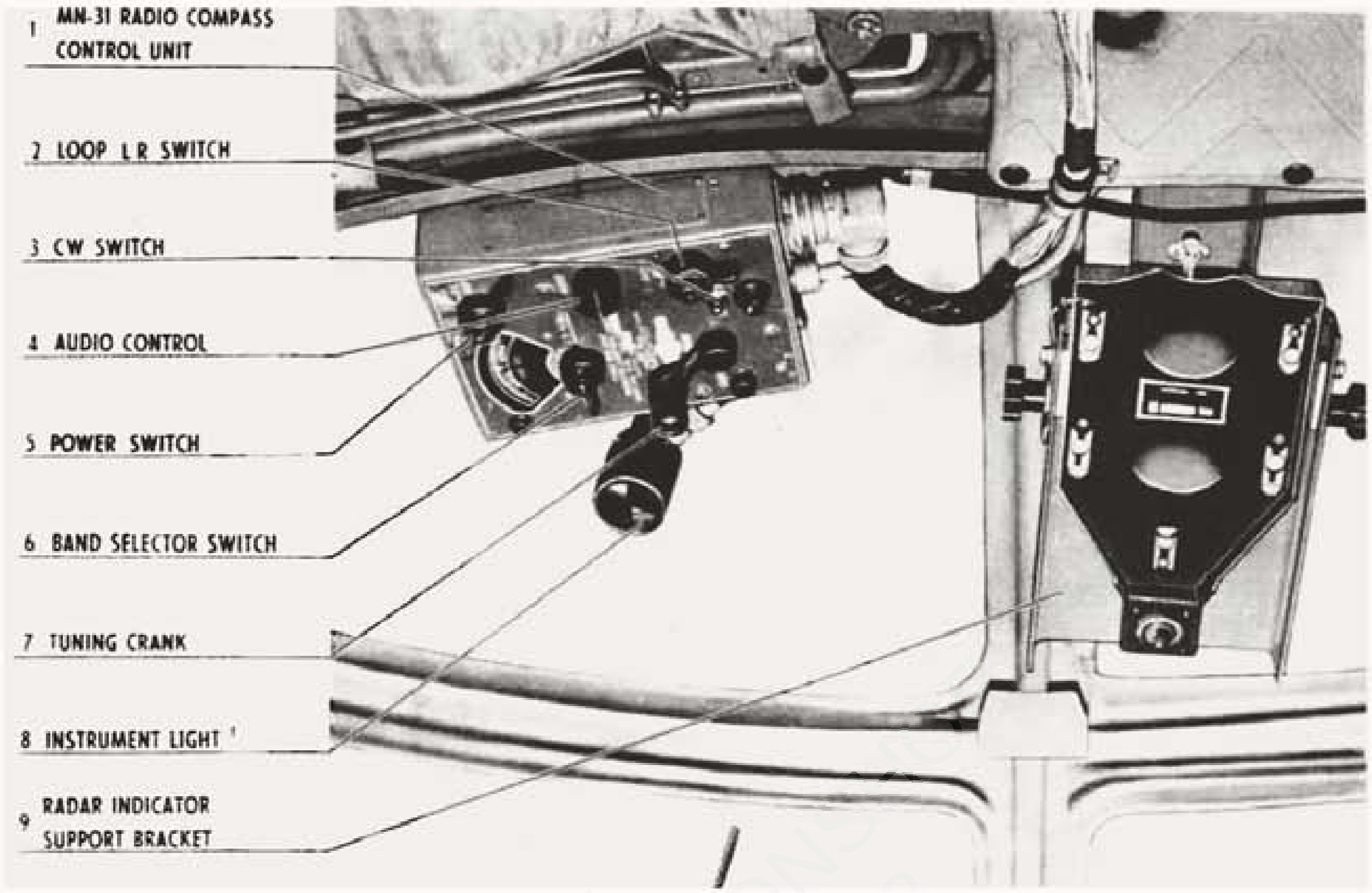


Figure 29 — Flight Compartment Ceiling — Aft Right Side



1. Light removed from airplanes bearing BuAer serial numbers 37535 and subsequent.

Figure 30 — Flight Compartment Ceiling — MN-31 Compass Installation (Effective on serials 37035 through 37634)

not have an individual volume control. Its output can be adjusted only by means of the "VOLUME" control on the ICS/Radio Control Box. The setting of this control is, therefore, governed entirely by the audio level desired from the VHF Receiver. The audio outputs from the other equipment must be adjusted by their individual volume controls. The order in which the other equipment is switched on at the ICS/Radio Control Box is not important. Tuning of the equipment associated with each receiver is described below.

(b) INTERPHONE TEST.—On the ICS/Radio Control Box, place the "ICS, TRANS-1—TRANS-2—TRANS-3" switch on "ICS"; press the press - to - talk switch on the microphone and call other stations. Release the press-to-talk switch while awaiting replies.

(c) VHF RECEIVER (VHF unit of AN/ARC-5).—For a conclusive operating test of the equipment, it is necessary that signals be present on the channels on which operation is contemplated. In the absence of signals, the squelch circuit reduces the receiver output to zero, or almost zero, so that most of the noise picked up by the receiver is not passed on to the headphones; thus, it is difficult to gauge receiver performance properly from its noise output. The tuning procedure is as follows:

On the transmitter control box (6, figure 29), push button "A," "B," "C," "D," according to the VHF channel desired. On the ICS/Radio Control Box (figure 27), turn on switch No. 7. Advance the "VOLUME" control (7, figure 27) for normal reception if a signal is present. It is good practice to set high for good operation of the rest of the equipment. If a signal is not present, push one of the other "A," "B," "C," or "D" buttons to obtain a channel on which a signal is present in order to check receiver operation and to adjust the "VOLUME" control. Allow six seconds for the channel-shifting mechanism to operate after pushing the button before attempting to check reception. If no signals can be heard on any of the VHF channels, set the "VOLUME" control at maximum (full clockwise). Turn off switch No. 7 on the ICS/Radio Control Box and set up the remaining receivers on which reception is contemplated, as follows:

(d) RANGE RECEIVER (LF unit of AN/ARC-5).—On the ICS/Radio Control Box, turn on switch No. 1. Throw the "RANGE—BOTH—VOICE" switch (6, figure 27) to "BOTH." On the LF receiver control box (2, figure 29), throw the "CW-VOICE" switch to "VOICE." Advance the "SENSITIVITY" control (4,

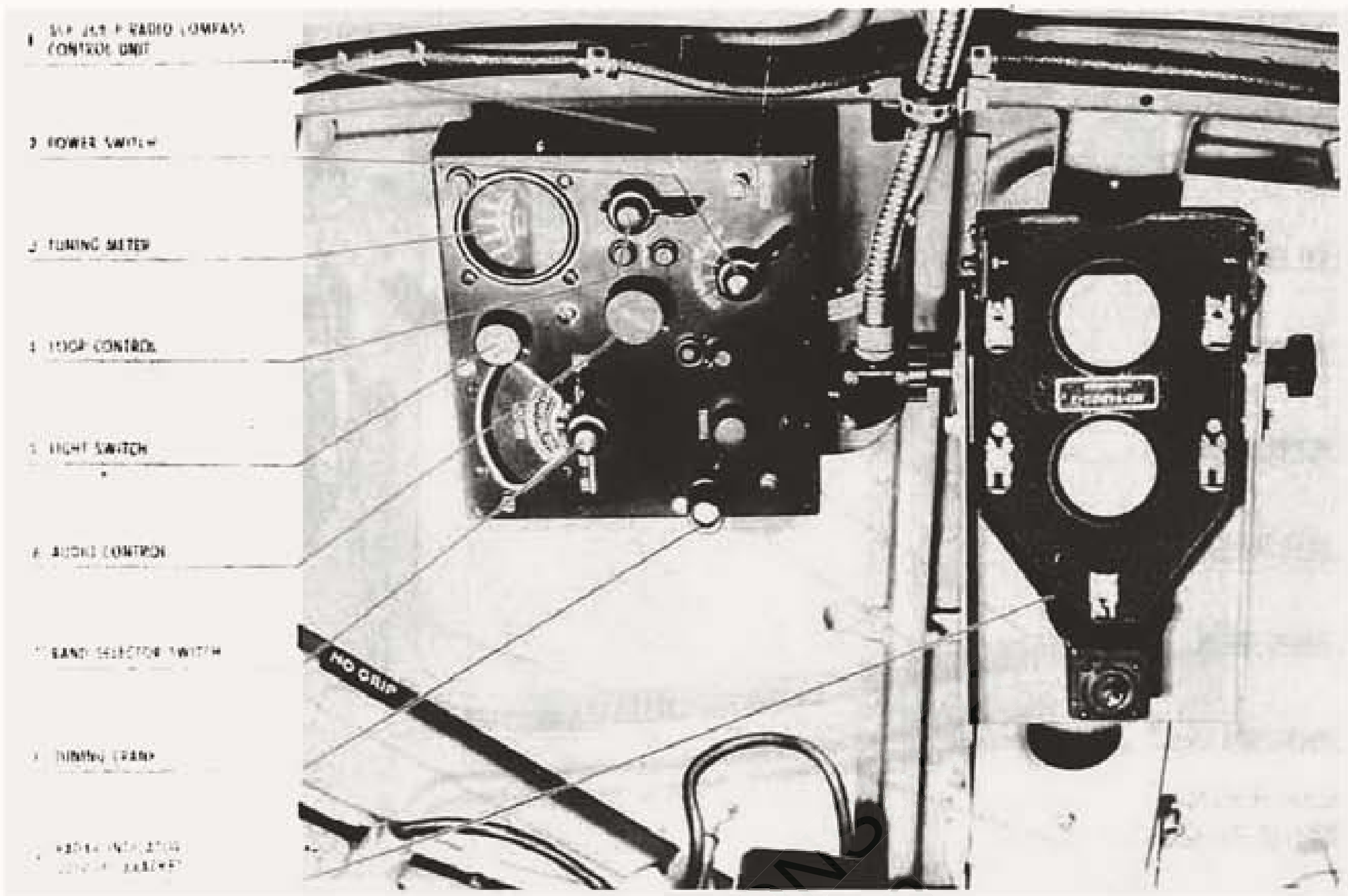


Figure 31 — Flight Compartment Ceiling — SCR-279F Compass Installation (Effective on serials 84057 and subsequent)

figure 29) until normal background noise is heard. Tune in the desired station and readjust the "SENSITIVITY" control for normal operation. Normally, CW reception will not be used on this receiver, but weak signals can be found more readily if the "CW-VOICE" switch (3, figure 29) is thrown to "CW" during the search. The switch should be thrown to "VOICE" for actual reception. For radio-range flying, the "SENSITIVITY" control should be set to the minimum values required for reception in order to avoid incorrect course indication. When voice reception only is desired from the range station, the "RANGE—BOTH—VOICE" switch (6, figure 27) on the interphone control box may be set on "VOICE." For all other signals this switch may be left on "BOTH." The "RANGE" position of the switch is available for complete elimination of voice signals, if desired. When satisfied with operation, turn off switch No. 1 on the ICS/Radio Control Box.

(e) AUTOMATIC RADIO COMPASS (MN-31 or SCR-269-F).—The MN-31 compass is installed on airplanes bearing BuAer serial numbers 37035 through 37634 and the SCR-269-F compass is installed on subsequent airplanes. The operation of either compass is identical and entirely automatic. It is only necessary to tune to the frequency of the desired radio station and the bearing of that station, with respect to the airplane's heading, will be directly indicated on the bearing indicator.

1. PRELIMINARY TUNING.—On the ICS/Radio Control Box, turn on switch No. 2. Turn the "RANGE—BOTH—VOICE" switch to "BOTH." On the radio compass remote control unit, turn the "OFF-COMP.—REC. ANT.—REC. LOOP" switch (5, figure 30 or 2, figure 31) to "REC. ANT."

Note

When first tuning for a station, always use the "REC. ANT." position because when the equipment is on the "COMP" position, the automatic volume control is in the circuit and it is difficult to tune accurately for maximum signal. Preliminary tuning on "REC. LOOP" is also undesirable because the loop may be in the null position with reference to the desired station and the station may not be heard at all.

Turn the band selector control (6, figure 30 or 7, figure 31) to the desired frequency band. Advance the "AUDIO" control (4, figure 30 or 6, figure 31) until background noise is heard. Tune in the desired station

by means of the "TUNING" crank (7, figure 30 or 8, figure 31) and rock the control slightly back and forth for maximum signal strength to make sure that the desired station is properly tuned in. Readjust the "AUDIO" control for satisfactory volume. Listen for station identification to be sure the correct station is being received. For identification of CW signals, the "CW—ON—OFF" switch (3, figure 30) should be thrown to "ON." Upon completion of preliminary tuning, the following types of operation may be utilized.

2. DIRECTION FINDING — VISUAL METHOD.—Upon completion of preliminary tuning, turn the "OFF—COMP.—REC. ANT.—REC. LOOP" switch (5, figure 30 or 2, figure 31) to "COMP." Adjust the "AUDIO" control (4, figure 30 or 6, figure 31) to the desired headset level. Select three or more stations at least 30 degrees apart, if possible, for use in the fix determination, tune them in, and record the frequency dial readings. This will avoid delay when obtaining the fix. Record the reading of the gyro flux gate compass indicator (9, figure 13) and hold the airplane on this course while making the fix. Tune in the stations selected in rapid succession, and record the readings shown by the tail end of the indicator pointer (30, figure 13). (These will be the station-to-aircraft bearings.) Add the flux gate compass reading (true heading) to each station bearing. Plot these sums (station-to-aircraft bearings from north) on the map. The point of intersection was the location of the airplane at the time of obtaining the fix.

3. VISUAL HOMING.—The procedure for this type of operation is very similar to that described in the previous paragraph for obtaining relative bearings, except that instead of merely taking the bearing, rudder is applied in the direction shown by the indicator needle. When the needle is at the zero index, the airplane is headed toward the radio station.

4. DIRECTION FINDING—AURAL NULL METHOD.—Upon completion of preliminary tuning, turn the "OFF—COMP—REC. ANT.—REC. LOOP" switch (5, figure 30 or 2, figure 31) to "REC. LOOP." By means of the loop (L-R) switch (2, figure 30; 4, figure 31) on the control box, rotate the loop to obtain a null (minimum signal). The loop may be rotated quickly or slowly depending on whether the "LOOP L-R" switch is depressed or not as it is turned to "L" or "R." It must be realized that a strong signal heard in the headset provides a sharp null, while a weak signal results in a broad null. If the null is broad, advance the "AUDIO" control (4, figure 30 or 6, figure 31) (clockwise). When the null has been narrowed as much as possible by the use of the "AUDIO" control, the bearing can be closely determined by splitting the null width on the indicator dial. The reading will be the bearing of the radio station relative to the longitudinal axis of the airplane, but it will be subject to 180 degree ambiguity.

5. AURAL HOMING. — The procedure for this type of operation is very similar to that described in the previous paragraph for obtaining relative bearings except that instead of merely taking the bearing, the airplane is turned until a null is heard in the headset. The radio station will then be *either* directly ahead or directly behind.

6. RANGE AND GENERAL RECEPTION.—Tune in the signal as described in the preceding paragraph on preliminary tuning. In flying radio ranges, certain precautions must be taken. For the most reliable aural reception of radio range signals, retain the "OFF—COMP—REC. ANT.—REC. LOOP" switch on "REC. ANT." If precipitation static causes poor reception, turn the switch to "REC. LOOP" and rotate the loop to maximum signal position by use of the loop (L-R) knob on the azimuth control box. However, do not rely on the signals received on "REC. LOOP" when near the station because the "A" and "N" are often reversed and the cone of silence may be difficult to detect. Do not use the "COMP" position because the automatic volume control is then in the circuit and will cause a broad "on-course" indication. Fades and builds of signal strength will be very difficult to detect on this position. A range filter is available for use on this receiver and is controlled by the "RANGE—BOTH—VOICE" switch on the ICS/Radio Control Box. When satisfied that the equipment is functioning properly, turn off switch No. 2 on the ICS/Radio Control Box.

(f) MARKER BEACON RECEIVER (AN/-ARN-8)—No adjustments of this receiver are necessary by plane personnel. It operates the marker beacon indicator light (21, figure 13) on the pilot's instrument panel regardless of the position of switch No. 3 on the ICS/Radio Control Box. The audio output signal from the receiver may be heard in the headphones by turning switch No. 3 on.

(g) HF RECEIVER (HF unit of AN/ARC-5).—On the ICS/Radio Control Box turn on switch No. 5. On the HF receiver control box (1, figure 29), throw the "CW-VOICE" switch (3, figure 29) to "VOICE." Advance the "SENSITIVITY" control (4, figure 29) until normal background noise is heard. Tune in the desired station and readjust the sensitivity control for normal operation. Normally, "CW" reception will not be used on this receiver, but weak voice signals can be found more easily if the "CW-VOICE" switch is thrown to "CW" during the search. The switch must be thrown

to "VOICE" for actual reception. When satisfied that the equipment is operating properly, turn off switch No. 5 on the ICS/Radio Control Box.

(b) In addition to the above facilities, two receiver channels for equipment tuned by the radio operator can be switched to the headphones at the ICS/Radio Control Box. Switches No. 8 and 9 provide reception on ARB receivers No. 2 and No. 1 respectively.

(3) TRANSMISSION.

(a) GENERAL. — The four-position switch (8, figure 27) on the ICS/Radio Control Box serves to switch the microphone to ICS, the AN/ARC-5, or the AN/ART-13 (ATC) equipment. In position "TRANS-1," the microphone controls the AN/ARC-5 equipment HF or VHF, depending on the channel selected by means of the transmitter control box. On "TRANS-2" position, no transmitter is provided in this installation. "TRANS-3" position provides for control of the AN/ART-13 (ATC) transmitter. Sidetone is provided through the channels of the receiver associated with the transmitter selected, provided that the receiver output is switched on at the ICS/Radio Control Box. The pilot, copilot, or radio operator may also switch control of the VHF transmitter to members of the gun crews. To do this, he throws his "OFF—RADIO TRANS. FROM TURR. STA." switch (10, figure 27) to "RADIO TRANS. FROM TURR. STA." When the switch is thrown to this position, any member of either the flight or gun crew may use the VHF transmitter. With the switch thrown to "OFF," the gun crew is restricted to use of the interphone only.

Note

The instructions on all transmissions are subject to local limitations regarding radio silence.

(b) AN/ARC-5 TRANSMISSION. — On the ICS/Radio Control Box, place the four-position switch on "TRANS-1." On the transmitter control unit, make certain that the rotary switch (3, figure 29) is set on "VOICE." For VHF transmission, push buttons "A," "B," "C," or "D" to obtain the desired channel. Wait six seconds after operating the pushbutton, then press the press-to-talk switch on the hand-held microphone and commence transmission. For HF transmission, push button "2" (6, figure 29), and use the microphone as described above.

CAUTION

On the transmitter control box, no button in the second row should be pushed within six seconds after pushing buttons "A," "B," "C," or "D." If this caution is not observed, the band selector motor will continue to run and dangerously overheat. A symptom of a continuously running motor is a "dead" VHF receiver. The motor may be stopped by pressing buttons "A," "B," "C," or "D." Button 3 should never be pushed because no radio transmission will take place in spite of the fact that sidetone will be heard. No transmitter is provided for this button in this installation.

(c) AN/ART-13 (ATC) TRANSMISSION.—Operation of this transmitter requires cooperation of the radio operator, who makes all necessary transmitter adjustments. The pilot then obtains control of the transmitter by placing the four-position switch on the ICS/Radio Control Box on "TRANS-3." Press the press-to-talk button and commence transmission.

(4) CHECK-OFF LIST.

(a) BEFORE TAKE-OFF.

1. Plug in headset and mask or lip microphone, if used.

2. Turn on the radio master switch.

3. Test ICS. (Have radio operator line up his equipment.)

4. Set up VHF receiver first.

5. Set up remaining receiver equipment.

6. Each pilot should then select the channel he intends to use by means of the switches on his individual ICS/Radio Control Box.

7. Set up transmitting equipment on channels most likely to be used. *Observe local radio silence regulations.*

(b) AFTER LANDING.—Turn off the radio master switch.

(5) AN/APN-1 RADIO ALTIMETER.

(See figure 9.)

(a) GENERAL.—The double range radio altimeter indicates the altitude of the airplane above the underlying terrain over a low range of 0 to 400 feet and a high range of 0 to 4000 feet. When operating in the high range the altitude limit switch settings are 10 times those shown on the dial. There are 3 indicator lights which indicate the following:

White light—desired altitude.

Red light—more than 5 feet below the desired altitude during low range operation or more than 50 feet during high range operation.

Green light—more than 5 feet above the desired altitude during low range operation or more than 50 feet during high range operation.

(b) OPERATION.

1. Turn the power switch (1, figure 13) to "ON."

Turn the range control (3, figure 13) to the desired range. For most accurate operation use the 0 to 400 feet range below 400 feet.

2. Check to see that the altitude indicator (2, figure 13) has moved from its sub-zero position. Do not attempt to adjust the indicator to the "0" position when the airplane is on the ground. True altitude indications are given only after take-off.

3. Set the desired altitude on the altitude limit switch (32, figure 13.)

(6) SPECIAL SERVICE EQUIPMENT. — The AN/APX-2 equipment is installed and provisions are made for the installation of the AN/APX-8 equipment. The transmitter-receiver is installed on the right side of the fuselage just aft of the turret and a control box is provided for the pilot and radar operator. The pilot's control box is located in the ceiling just aft of the flight compartment.

(7) AN/APS-3 RADAR EQUIPMENT. — The transmitter converter and antenna are installed in the nose of the airplane and the receiver, modulator, and control box are installed at the radar operator's station. Indicators are provided for the pilot and radar operator.

d. ARMAMENT.

(1) BOMB EQUIPMENT.

(a) GENERAL.—The bomb equipment consists of internal racks for six 325-pound or 500-pound bombs, or four 650-pound or 1000-pound bombs; external carriers for two 325-pound, 500-pound, 650-pound, or 1000-pound bombs; and an intervalometer and the necessary release controls which are located in the flight compartment.

(b) OPERATION.

1. If the intervalometer is to be used, instruct the copilot to set the intervalometer controls as follows at least one minute before the bombs are released:

a. Move the intervalometer switch (22, figure 28) to "TRAIN."

b. Turn the bomb selector control (21, figure 28) to the number of bombs that are to be dropped. The external bombs are not included in the number of bombs selected, but they will be released simultaneously with the first bomb bay bomb if the wing rack selector switches (36, figure 10) are in the "RELEASE" position.

c. Turn the ground speed dial (19, figure 28) until the estimated ground speed is opposite the desired distance on the bomb interval dial (20, figure 28).

2. If the intervalometer is not to be used, instruct the copilot to move the intervalometer switch to "SEL."

3. Move the torpedo-bomb manual release control (11, figure 16) to "SELECTIVE."

4. If the armament master switch (1, figure 14) is installed, move it to "ON."

5. Move the bomb-tank-torpedo selector master switch (39, figure 10) to "BOMBS & WING RACKS." A bomb load indicator light (42, figure 10 and 51, figure 13) for each loaded station and a bomb bay door position indicator light (43, figure 10) will come on when this is done.

6. Instruct the copilot to move the bomb bay bomb selector switches (53, figure 13) to "RELEASE." A release indicator light (52, figure 13) for each loaded station will come on when the corresponding selector switch is set.

7. If external bombs are to be dropped, move the wing rack selector switches (36, figure 10) to "RELEASE." The release indicator lights (38, figure 10) will come on when this is done.

8. Move the bomb nose arming switch (37, figure 10) to the armed position if nose arming of all bombs is desired. Move the bomb tail arming switch (40, figure 10) to the armed position, if the external bombs are to be tail armed. The internal bombs are automatically tail armed when released electrically.

9. Move the bomb bay door control (15, figure 16) to "OPEN." The red bomb bay door position indicator light (43, figure 10) will be off and the blue indicator light will come on when the doors are fully open.

10. If only external bombs are to be dropped, omit steps *1.*, *2.*, *3.*, *6.*, and *9.*, and press the bomb-tank-torpedo release switch (9, figure 32) to release the bombs. Both bombs will be released simultaneously, and the release and load indicator lights will go out as they are released.

11. If bomb bay bombs, or bomb bay and external bombs, are to be released, press the bomb-tank-torpedo release switch to release each bomb bay bomb or start the operation of the intervalometer. The external bombs will be released simultaneously with the first internal bomb if they were selected. As each bomb is released, the corresponding release and load indicator light will go out.

(2) TORPEDO EQUIPMENT.

(a) GENERAL. — The torpedo equipment consists of a rack for a Mark 13-1 or 13-2 2000-pound torpedo, a Mark 32 torpedo director (the torpedo director is not installed in airplanes bearing BuAer serial numbers 37185 and subsequent), and the necessary release controls. The director and release controls are located in the flight compartment.

(b) PREFLIGHT CHECK.—See that the front sight post of the director is set for the model torpedo to be carried.

(c) OPERATION.

1. Instruct the navigator to remove the access cover plate in the cabin and set the torpedo depth control.

2. Loosen the position locking thumb screw (1, figure 32), move the director (4, figure 32) to the sighting position, and then tighten the thumb screw.

3. Move the director engaging control (5, figure 32) to "DIRECTOR ENGAGED."

4. Pull out the altitude-torpedo run dial knob, turn the altitude dial (14, figure 32) to the torpedo release altitude, and re-engage the knob.

5. Turn the torpedo run dial (16, figure 32) until the torpedo run distance is opposite the ground speed.

6. Turn the target speed dial (6, figure 32) to the estimated target speed.

7. Set the model ship (7, figure 32) parallel to the target course by turning the adjustment control (3, figure 32) on the director mounting adapter. Be sure that the ship model is headed in the same direction as the target.

8. Approach the target using evasive "jinking" maneuvers and keeping the target approximately in the line of sight.

9. Move the torpedo-bomb manual release lever (11, figure 16) to "SELECTIVE."

10. If the armament master switch (1, figure 14) is installed, move it to "ON."

11. Move the bomb-tank-torpedo selector master switch (39, figure 10) to "TORPEDO." The torpedo release indicator light (45, figure 10) and red bomb bay door position indicator light (43, figure 10) will come on when this is done.

12. Make any necessary corrections to the director settings.

13. Move the bomb bay door control (15, figure 16) to "OPEN." When the doors are fully open the red bomb bay door indicator light will be off and the blue light will come on.

14. As the release range is approached, settle down to the altitude set on the director dial and adjust the indicated air speed to give the preset ground speed.

15. Align the sights on the target.

16. When the estimated preset range is reached, release the torpedo by pressing the bomb-tank-torpedo release switch (9, figure 32) on the control wheel. When the torpedo is released the indicator light (45, figure 10) will go out.

(For further information on the torpedo director see Naval Bureau of Ordnance publication 1045.)

(3) ROCKET PROJECTILE EQUIPMENT.

(a) GENERAL.—The rocket equipment consists of Mark 5-2, 5-3, or 5-4 launchers for eight 5-inch rockets and the necessary release controls which are located in the flight compartment.

(b) OPERATION.

1. If the armament master switch (1, figure 14) is installed, move it to "ON."

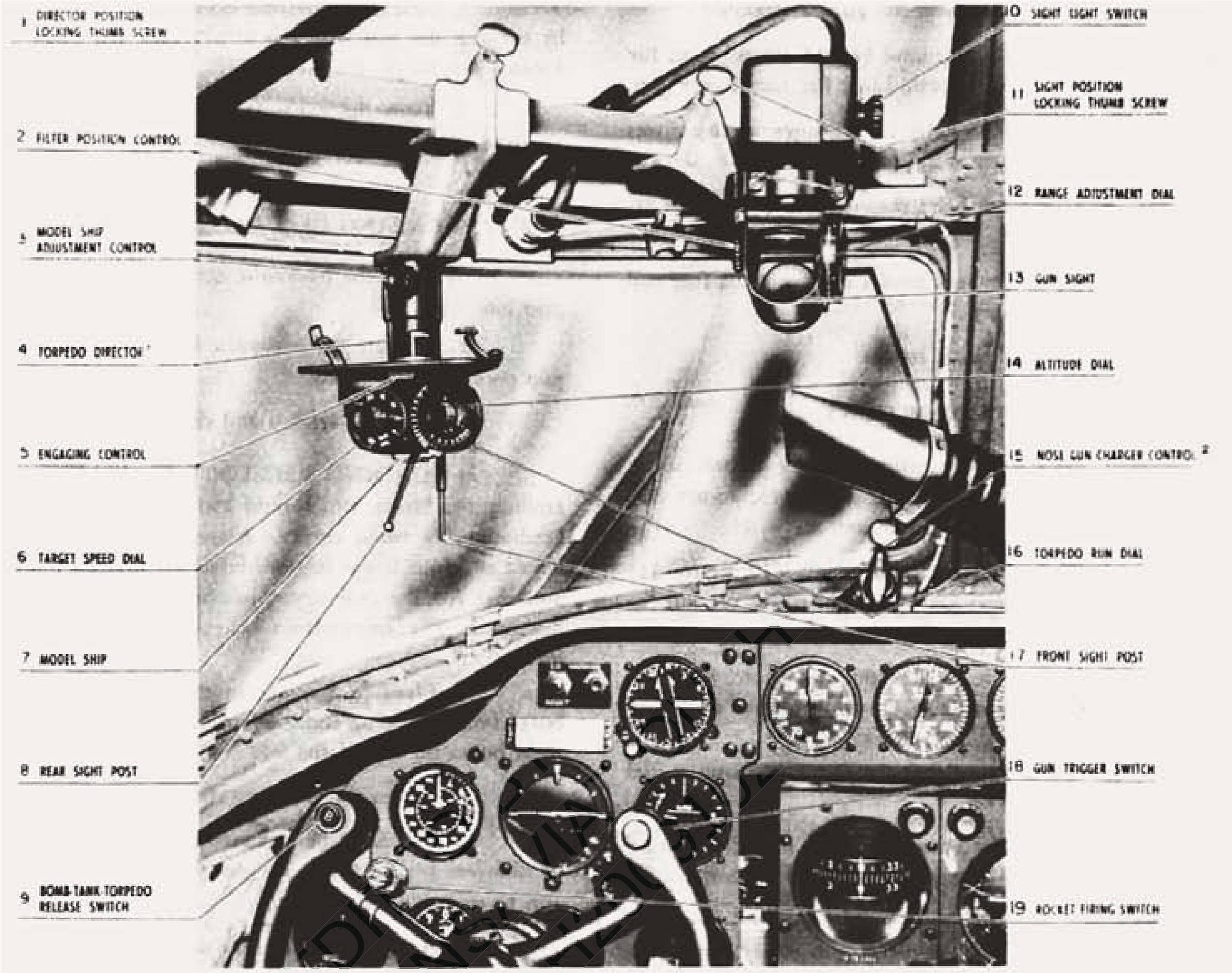
2. Select the number of rockets to be fired by turning and releasing the selector control (3, figure 28).

3. Move the arming switch (2, figure 28) to "ARM."

4. Move the single-auto selector switch (5, figure 28) to the desired position.

5. Move the release system power switch (4, figure 28) to "ON."

6. Fire the rockets by pressing the switch (19, figure 32) on the control wheel.



1. Torpedo director removed from airplanes bearing BuAer serial numbers 37185 and subsequent.
2. Gun charger control moved to location shown on figure 13 on serials 37515 and subsequent.

Figure 32 — Flight Compartment — Left Forward View

(4) FIVE GUN NOSE. — Five fixed .50 caliber Browning M-2 machine guns are mounted in the nose of airplanes bearing BuAer serial numbers 37065 through 37534.

(c) LOADING AMMUNITION.—Two upper nose gun ammunition boxes, which hold 250 rounds each, are interchangeable when empty, but must be loaded for a particular gun. The three lower nose gun ammunition boxes which hold 225 rounds each, are also interchangeable when empty, but two of them must be loaded for a particular gun. The ammunition for each gun must point forward and the double loop end of the ammunition link must be toward the gun. The boxes are mounted from the inside. The upper boxes may be loaded from the outside through the access panels just above them and the lower boxes may be loaded through the side door. The upper boxes are mounted as follows:

1. Unfasten the hinged plates which are on the bulkhead opposite the front support lugs.

2. Engage the tubes on the back of the boxes in the first notch of the rear support lugs.

3. Swing the boxes into position and slide them forward.

4. Fasten the hinges on the bulkhead.

The lower ammunition boxes are mounted as follows:

1. Set the boxes in the rack.

2. After the boxes have been filled, close the covers and fasten the retaining straps.

Thread the ammunition into the guns as follows:

1. Prepare a 15-round belt of ammunition for each upper gun and a 50-round belt for each lower gun.

2. Attach the belts to the ones in the boxes with additional rounds of ammunition.

3. Lower the belts through the chutes and attach the chutes to the boxes.

4. Open the back covers and enter the free end of the belts in the guns.

5. Close the back covers.

(b) OPERATION OF GUNS.

1. Loosen the position locking thumb screw (11, figure 32), move the gun sight (13, figure 32) into position, and tighten the thumb screw.

2. Turn the sight light switch (10, figure 32) in a clockwise direction until the light comes on and the desired intensity is obtained.

3. If there is an objectionable glare, snap the filter into place by turning the position control (2, figure 32).

4. Check to see that the range adjustment dial (12, figure 32) is set on "0."

5. Charge the guns by pulling back the charger control (15, figure 32 or 48, figure 13) for three to five seconds.

6. Move the nose-turret gun safety switch (2, figure 14) to "FIRE."

7. Fire the guns by pressing the trigger switch (18, figure 32).

(5) EIGHT GUN NOSE.—Eight fixed .50 caliber Browning M-2 machine guns are installed in the lower section of the nose on airplanes bearing serial numbers 37535 and subsequent. This gun package may be lowered to permit quick loading and servicing of the guns. An indicator light (22, figure 13) is installed on the instrument panel to warn the crew when the nose gun package is not retracted.

(a) LOWERING GUN PACKAGE.

1. Open the access panels on each side of nose section.

2. Turn the hydraulic valve, which is located just forward of the left access hole, to the up position.

3. Operate the hydraulic hand pump (26, figure 10) until the brake pressure gage (49, figure 13) indicates a pressure of 1200 psi.

4. Release the latches on each side of the nose by turning the nut which is attached to the plate and located just inside the access hole.

5. Turn the control valve lever to the down position, and the gun package will drop to the lower position.

(b) RAISING GUN PACKAGE.

1. Turn the hydraulic control valve to the up position.

2. Operate the hydraulic hand pump until the gun package is retracted.

3. Lock the latches and close the access doors.

(c) LOADING AMMUNITION. — The eight ammunition boxes, which hold 250 rounds each, are interchangeable when empty. Ammunition for the outboard and four lower inboard boxes must point inboard and that for the two upper inboard boxes must point outboard. The ammunition boxes are installed as follows:

1. Place four boxes in the racks. (The outboard boxes stand on end.) Place the remaining left and right boxes on top of the left and right inboard boxes.

2. Fasten the retaining straps.

3. Prepare a belt of ammunition for each gun of sufficient length (15 to 40 rounds) to reach from the gun to its ammunition box.

4. Attach the belt to the ones in the boxes with additional rounds of ammunition.

5. Lower the belts through the chutes and attach the chutes to the boxes.

6. Open the back covers and enter the belts in the guns.

7. Close the back covers.

(d) OPERATION OF GUNS.

1. Charge the guns by pulling out the charger control (48, figure 13 or 15, figure 31) for three to five seconds.

2. Move the armament master switch (1, figure 14) to "ON."

3. Move the upper or lower or both of the gun selector switches (2 and 3, figure 14) to "FIRE."

4. Fire the guns by pressing the trigger switch (18, figure 31).

(6) WING GUNS. — A package containing two fixed .50 caliber Browning M-2 machine guns may be

attached to each external fuel tank rack. These guns may be operated separately or simultaneously with the other fixed guns.

(a) LOADING AMMUNITION. — The four ammunition boxes, which hold 300 rounds each, may be interchanged from one package to the other provided they are used on the same side of the package. The ammunition for the inboard guns of both packages must point inboard and that for the outboard guns must point outboard. The ammunition boxes are installed as follows:

1. Set the ammunition boxes in place and fasten the latches at the forward end of the boxes.

2. Attach the electrical connectors to the ammunition boosters.

3. Prepare a 40-round belt of ammunition for each gun.

4. Attach the belts to the ones in boxes with additional rounds of ammunition.

5. Feed the belts through the chutes and attach the chutes to the boxes.

6. Open the back covers and enter the belts in the guns.

7. Close the back covers.

8. Charge the guns, if ready for the take-off.

9. Close the gun package doors and secure them.

(b) OPERATION OF GUNS.

1. If the armament master switch (1, figure 14) is installed, move it to "ON."

2. Move the wing gun selector switch (24, figure 14) to "FIRE."

Note

The guns must be charged manually before take-off.

3. Fire the guns by pressing the trigger switch (18, figure 31).

(7) TURRET.

(a) GENERAL.—The turret guns may be locked in a forward firing position and operated by the pilot separately or simultaneously with the fixed guns.

(b) OPERATION.

1. Instruct the turret gunner to check the following:

a. See that the turret guns are locked.

b. See that the profile interrupter cable is disconnected and the firing control is connected in its place.

c. See that the guns are charged.

2. If the armament master switch (1, figure 14) is installed, move it to "ON."

3. If the turret gun selector switch (23, figure 14) is installed, move it to "FIRE." If not, move the nose-turret gun selector switch (2, figure 14) to "FIRE."

4. Fire the guns by pressing the trigger switch (18, figure 32).

(8) TORPEDO TRAINING CAMERA. — Provisions are made for the installation of the F-46 torpedo training camera on airplanes bearing BuAer serial numbers 37035 through 37234. A camera switch is installed on the auxiliary electrical control panel. The procedure for operating the camera is the same as that for releasing a torpedo except that the camera switch must be in the "ON" position.

(9) NOSE GUN CAMERA.—Provisions are made for the installation of the AN-N-4 automatic camera on airplanes bearing BuAer serial numbers 37035 through 37336 and 37535 and subsequent. A camera switch (22, figure 14) is installed on the auxiliary electrical control panel. The camera is operated by moving the camera switch to the "ON" position and pressing the gun trigger switch (18, figure 32).

(10) K-25 CAMERA CONTROLS. — An intervalometer (15, figure 28) for the K-25 camera is mounted on the right side of the compartment.

(11) RELEASE OF FLARES.

(a) GENERAL.—The flare chute is equipped with an electrically operated release that is remotely controlled from the pilot's station.

(b) OPERATION.

1. Instruct the turret gunner to load the flare chute and attach the reel clip to the tear cord ring.

2. Drop the flare by moving the release switch (21, figure 14) to "ON." The load indicator light (20, figure 14) will go out when the flare is released.

Note

The flare chute door must be closed manually after the flare is dropped.

2. RADIO COMPARTMENT.

a. LOCATION.—The radio compartment is located between the front shear beam and the main beam. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

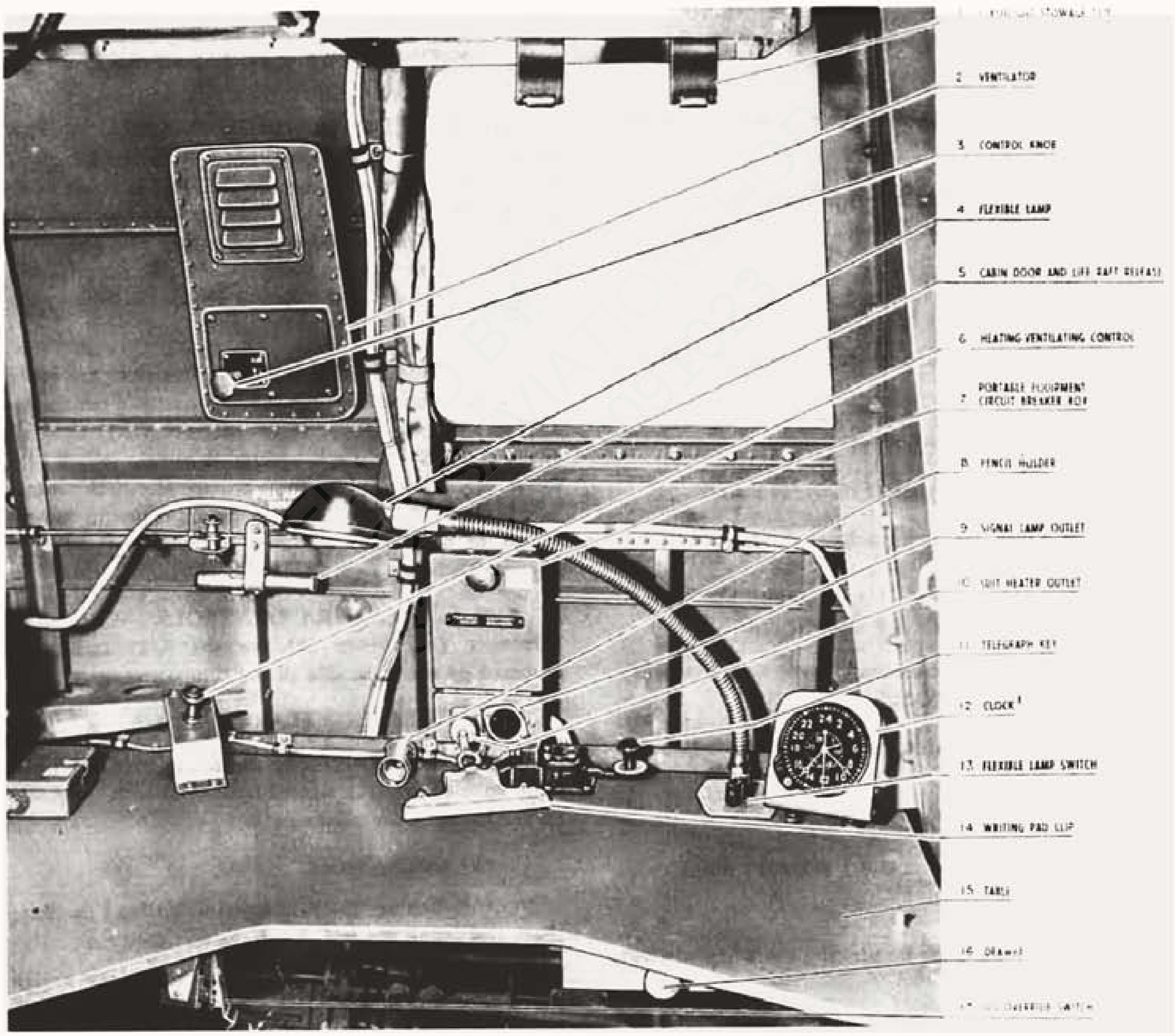
(1) LIGHTING.

(a) A flexible lamp (4, figure 33) is installed on the forward end of the table and a switch (13, figure 33) is provided at the base of the lamp. Power is supplied to the lamp through the battery switch (15, figure 10) and the interior light switch (11, figure 14).

(b) A dome light is installed on the ceiling of the compartment and control switches (8, figure 25 and 10, figure 29) are provided at the cabin door and on the forward side of the compartment. Power is supplied to the light directly from the battery.

(2) HEATING AND VENTILATING.

(a) A heating and ventilating outlet and a dampener control (1, figure 20) are installed at the floor level in the compartment. The temperature of the air admitted



1. Clock removed from airplanes bearing BuAer serial numbers 37243 through 37288 and 37548 and subsequent.

Figure 33 — Radio Compartment — Left Side

may be regulated by the heating-ventilating control (6, figure 33), if the exhaust heat exchanger waste gate controls (4, figure 21) are in the "DEICE-HEAT" position.

(b) A suit heater outlet (10, figure 33) is installed below the window.

(c) An auxiliary adjustable ventilator (2, figure 33) is installed just aft of the window.

(3) OXYGEN OUTLET. — An outlet (7, figure 34) is located on the rear bulkhead just above the table. (Refer to Appendix I for information on the use of oxygen.)

c. RADIO OPERATION.

(1) POWER FOR RADIO.

(a) Plug the headset into the phone extension cord leading to the jack box (2, figure 34). Make certain that the microphone and headset plugs are fully engaged in the jack box.

(b) After the battery switch has been turned on by either pilot, power to the radio equipment will be supplied by turning on the radio master switch located in the junction box on the ceiling. While waiting about one minute for the equipment to warm up, turn off the audio outputs by throwing all nine toggle switches on the ICS/Radio Control Box (figures 27 and 34) to "OFF."

(2) INTERPHONE TEST.—See Section V, paragraph 1, *c*, (2), *(b)*.

(3) RECEPTION IN GENERAL.—See Section V, paragraph 1, *c*, (2), *(a)*. It will be noted that switches No. 8 and No. 9 on the ICS/Radio Control Box control the outputs of radio operator tuned ARB receivers. The ICS override switch (17, figure 33) may be used to cut out interstation communications.

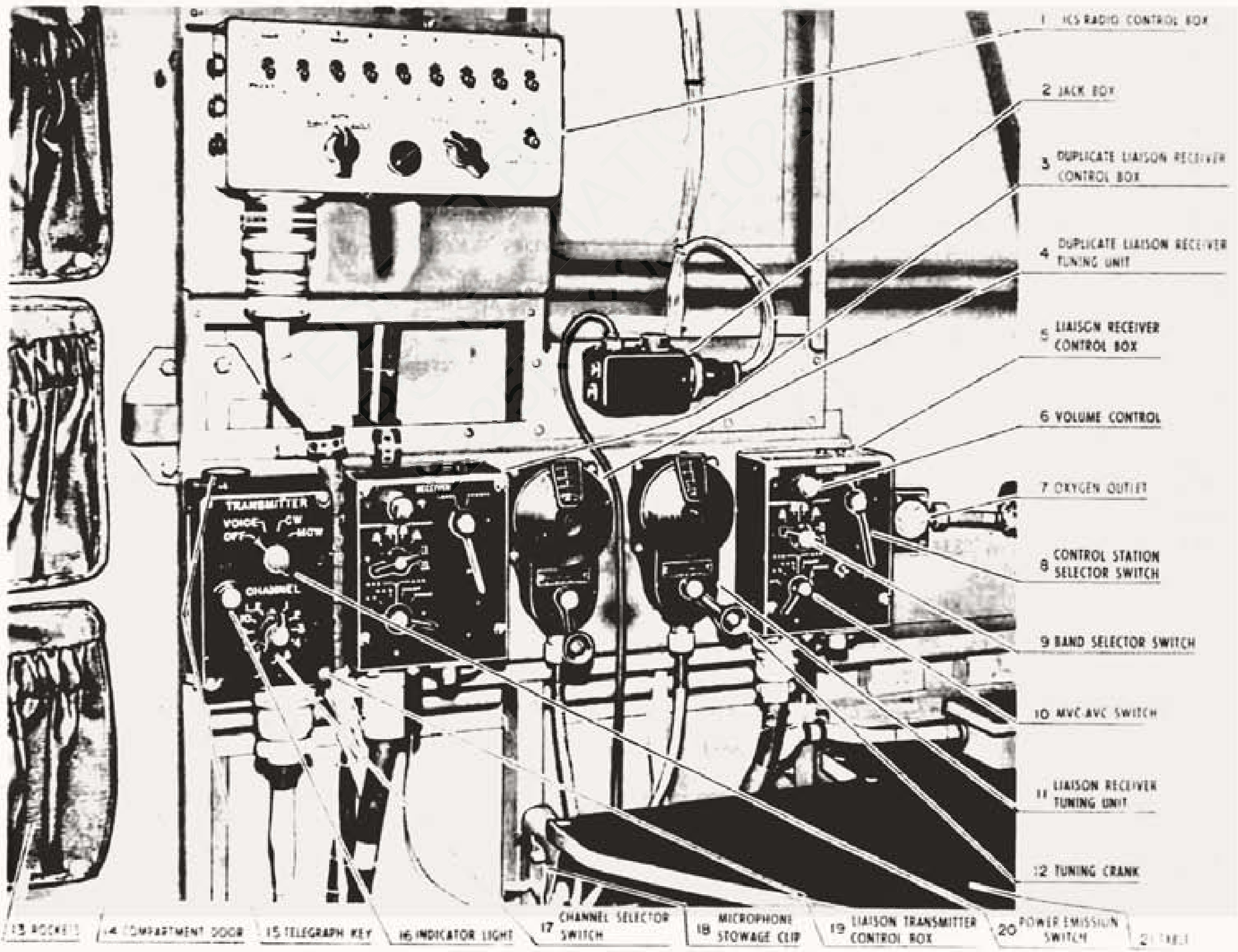


Figure 34 — Radio Compartment — Aft Left Side

(4) ARB RECEIVERS.

(a) GENERAL. — On the ICS/Radio Control Box, turn on switch No. 8 or 9 corresponding to the ARB receiver No. 2 or No. 1 depending on which receiver is desired first. The "VOLUME" control (7, figure 27) on the ICS/Radio Control Box should be set near maximum. Before proceeding with the operation of the ARB controls, it should be noted that certain combinations of the settings of the "HOMING-COMMUN." and "MVC-AVC" switches on the ARB control box (5, figure 34) cannot be obtained. This is a normal condition and no attempt should be made to force these switches into any position to which they cannot be moved by normal pressure. It should be noted further that the two positions under "HOMING" on the "HOMING-COMMUN." switch are not used in this installation and that no antenna is provided for these positions. Make certain that the "LOCAL-REMOTE" switches on both boxes are in the "LOCAL" position; the "REMOTE" position is not used in this installation. In the detailed instructions which follow, all tuning operations are accomplished by means of the control box and tuning head associated with the receiver being tuned.

(b) MCW AND VOICE RECEPTION.—Set the "HOMING-COMMUN." switch on one of the four bands under "COMMUN." on which reception is desired. If the band selected is either 195-650 kc, or 560-1600 kc, set the "MVC-AVC" switch on "MVC." Advance the "INCREASE OUTPUT" control until background noise is heard. Tune in the signal by means of the tuning head. Perform adjustments of the dial carefully with the "INCREASE OUTPUT" control reduced to a low but comfortable level. If the band selected is either 1.6-4.5 mc or 4.9-9.05 mc, set the "MVC-AVC" switch in the "BROAD" position while searching for the signal. When the signal has been located, shift the "MVC-AVC" switch to "MVC" and perform the final tuning as described above. For voice reception, shift the "MVC-AVC" switch to "SHARP."

Note

Shifting from "MVC" to "AVC" operation, or vice versa, may require readjustment of the "INCREASE OUTPUT" control to maintain satisfactory volume level in the headphones.

(c) CW RECEPTION.

1. Set the "HOMING-COMMUN." switch to the desired band under "COMMUN." Set the "MVC-AVC" switch on "CW." Advance the "INCREASE OUTPUT" control until normal background noise is heard. Tune in the desired signal and readjust the "INCREASE OUTPUT" control for comfortable volume level.

2. When satisfied that the receiver is performing satisfactorily, turn off its toggle switch on the ICS/Radio Control Box and set up the other ARB receiver in the same manner. Upon conclusion of the tuning operations, both receivers may be switched on by means of the toggle switches on the ICS/Radio Control Box. The signals will be available at the pilot's ICS/Radio Control Box regardless of the position of these toggle switches.

(5) TRANSMISSION.

(a) GENERAL. — See Section V, paragraph 1, *c*, (3), *(a)*. Note that the radio operator is responsible for frequency selection on the AN/ART-13 (ATC) transmitter. Voice operation, on the channel so selected, may be carried on from any of the ICS/Radio Control Boxes.

(b) AN/ART-13 (ATC) TRANSMITTER. — The following instructions assume that the "LOCAL-REMOTE" switch (8, figure 34) located on the transmitter front panel has been placed in the "REMOTE" position. On the AN/ART-13 transmitter control box (19, figure 34), set the power emission switch (20, figure 34) on "VOICE," "CW," or "MCW" depending on the type of emission desired. Select the desired channel by means of the "CHANNEL" switch (17, figure 34). It takes about 25 seconds for the bank shifting mechanism to complete the operation, completion of which is indicated by the lighting of the indicator lamp (16, figure 34). For operation on LF, it will be necessary to let out the trailing wire to the proper length previously determined for that frequency and transmitter adjustment. Make certain that the trailing wire antenna switch provided for switching the antenna from the Loran receiver to the AN/ART-13 transmitter is thrown to the transmitter position. For voice operation from the radio operator's position, place the four-position switch on the ICS/Radio Control Box on "TRANS-3." Press the microphone press-to-talk switch and proceed with transmission. Telegraph transmission is accomplished by means of the telegraph key (11, figure 33) on the operator's table.

3. NAVIGATOR'S STATION.

a. LOCATION.—The navigator's station is located just aft of the main beam. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

(1) LIGHTING.—Two flexible lamps and a switch (4, 12, and 13, figure 36) and an instrument light and switch (10 and 14, figure 36) are installed above the

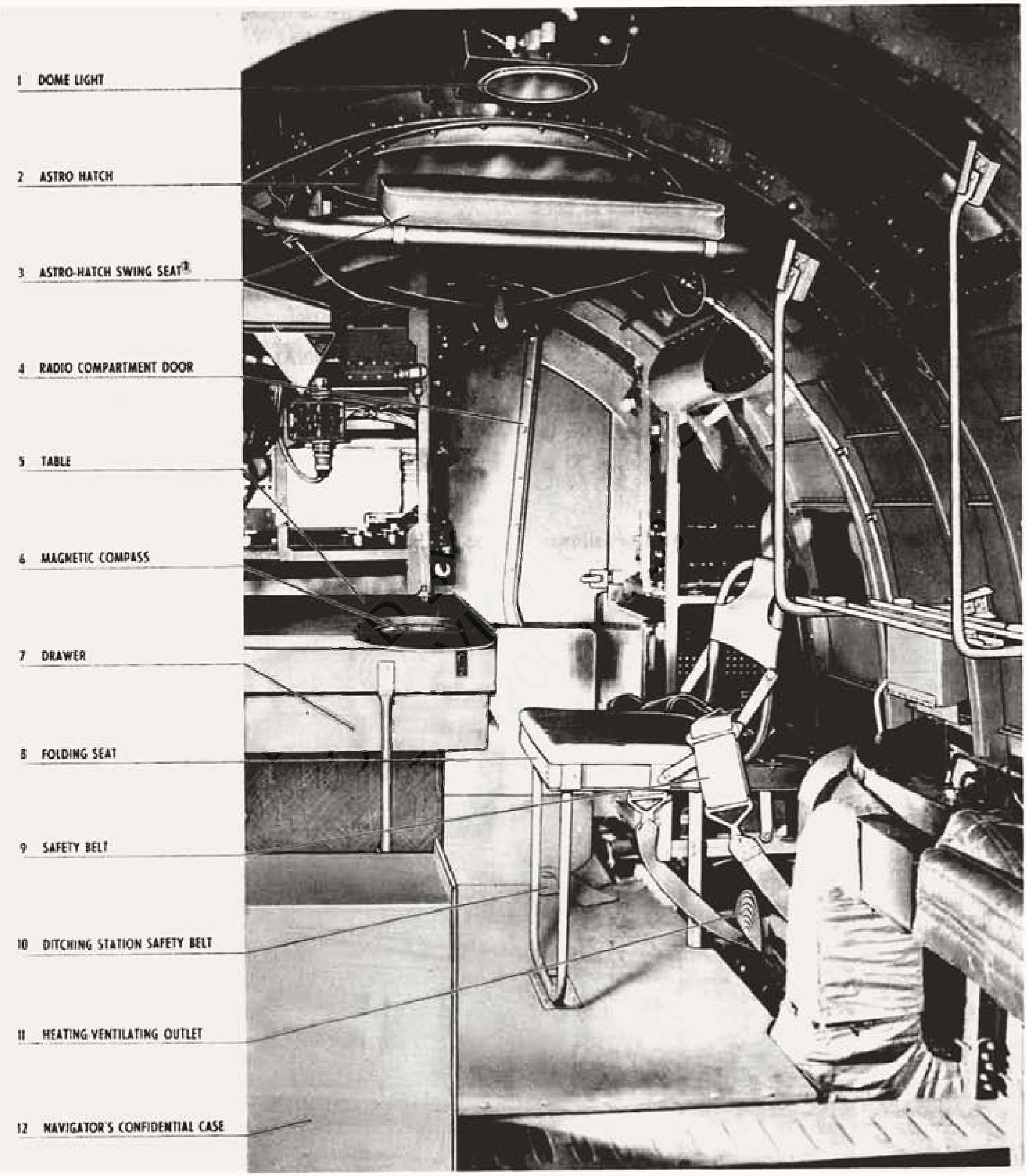


Figure 35 — Navigator's Station — Looking Forward

table. A dome light (1, figure 35) is located on the ceiling and control switches (8, figure 25 and 10, figure 29) are installed at the cabin door and in the radio compartment. The flexible lamps are supplied power through the battery switch (15, figure 10) and the interior light switch (11, figure 14). The instrument and dome lights are supplied power directly from the batteries.

(2) HEATING AND VENTILATING.

(a) A heating and ventilating duct outlet (11, figure 35) and a damper control are installed at floor level opposite the table.

(b) A suit heater outlet (5, figure 36) is located above the table.

(c) An auxiliary adjustable ventilator and control (22, figure 36) are installed above the table.

(3) OXYGEN OUTLET. — An oxygen outlet is located above the table. (Refer to Appendix I for information of the use of oxygen.)

c. INTERPHONE EQUIPMENT.

The interphone equipment is operated as follows:

(1) Plug the microphone and headphone cables into their respective jacks on the station box (15, figure 36).

(2) Turn the interphone-radio selector switch (18, figure 36) to "ICS CREW," "ICS ALL," or "RADIO" as desired. The "ICS CREW" position provides communication with all stations except the pilot's, copilot's, and radio operator's; the "ICS ALL" position provides communication with all stations; and the "RADIO" position makes possible the use of the VHF radio equipment if the controls have been set by the pilot or copilot.

(3) To transmit, press the microphone switch and talk.

(4) To receive, release the microphone switch. Adjust the volume control.

d. NAVIGATIONAL EQUIPMENT.

(1) An astro-hatch (2, figure 35) is installed in the ceiling, and an adjustable swing seat (3, figure 35) is installed directly beneath it on early airplanes. A mount is provided for an astro compass.

(2) A direct reading magnetic compass (6, figure 35) is mounted in the table.

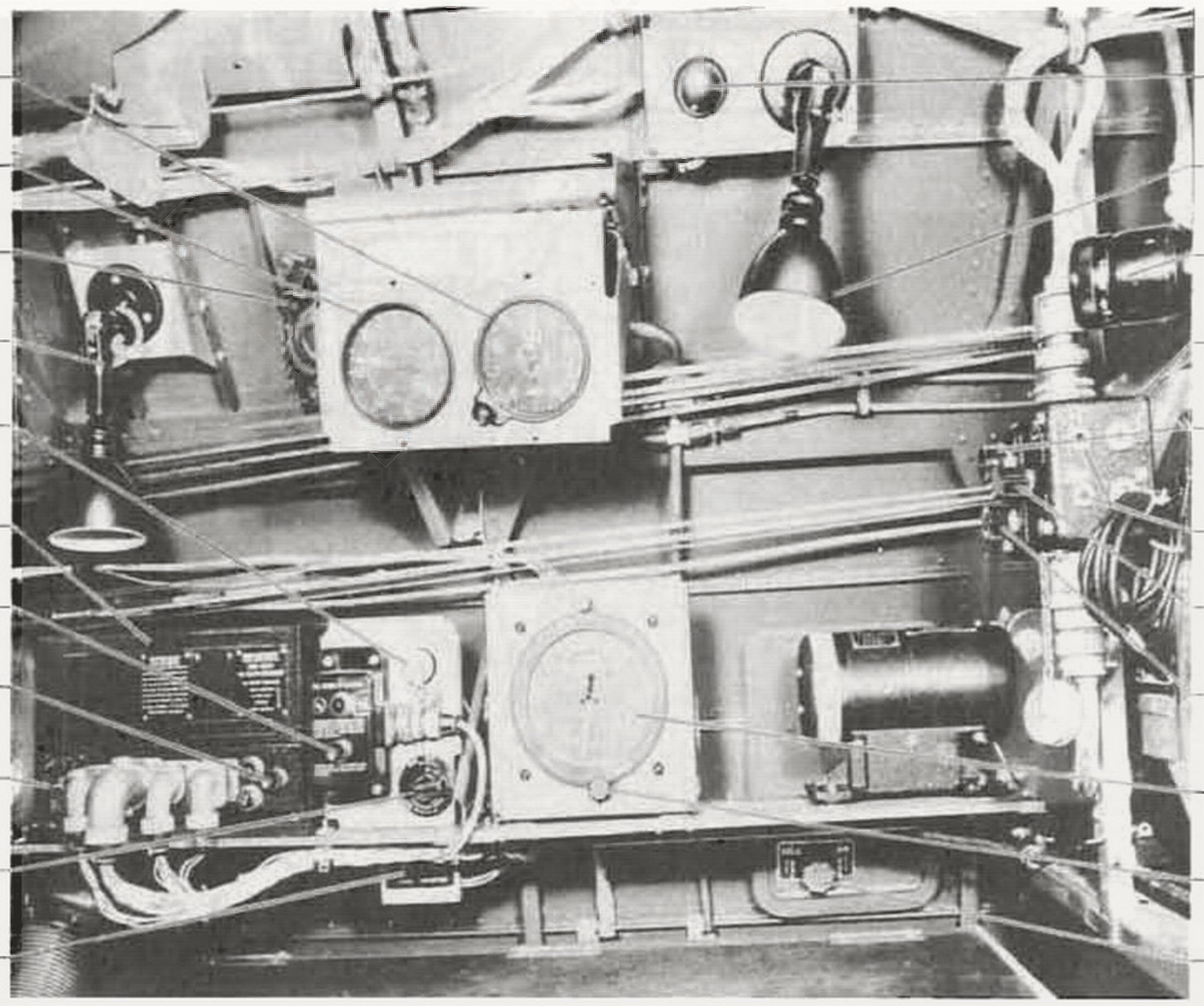


Figure 36 — Navigator's Equipment

(3) An air-speed indicator (2, figure 36) and an altimeter (1, figure 36) are located above the table.

(4) Space and mounting provisions are made for the AN/APN-4 radio navigational equipment.

(5) GYRO FLUX GATE COMPASS.

(a) GENERAL. *(See figure 36.)*

1. The caging switch, amplifier, inverter, and master indicator for the flux gate compass are installed above the table and two secondary indicators are installed on the pilot's and copilot's instrument panel. A fuse, pilot light, and gain control adjustment knob are incorporated in the front of the amplifier.

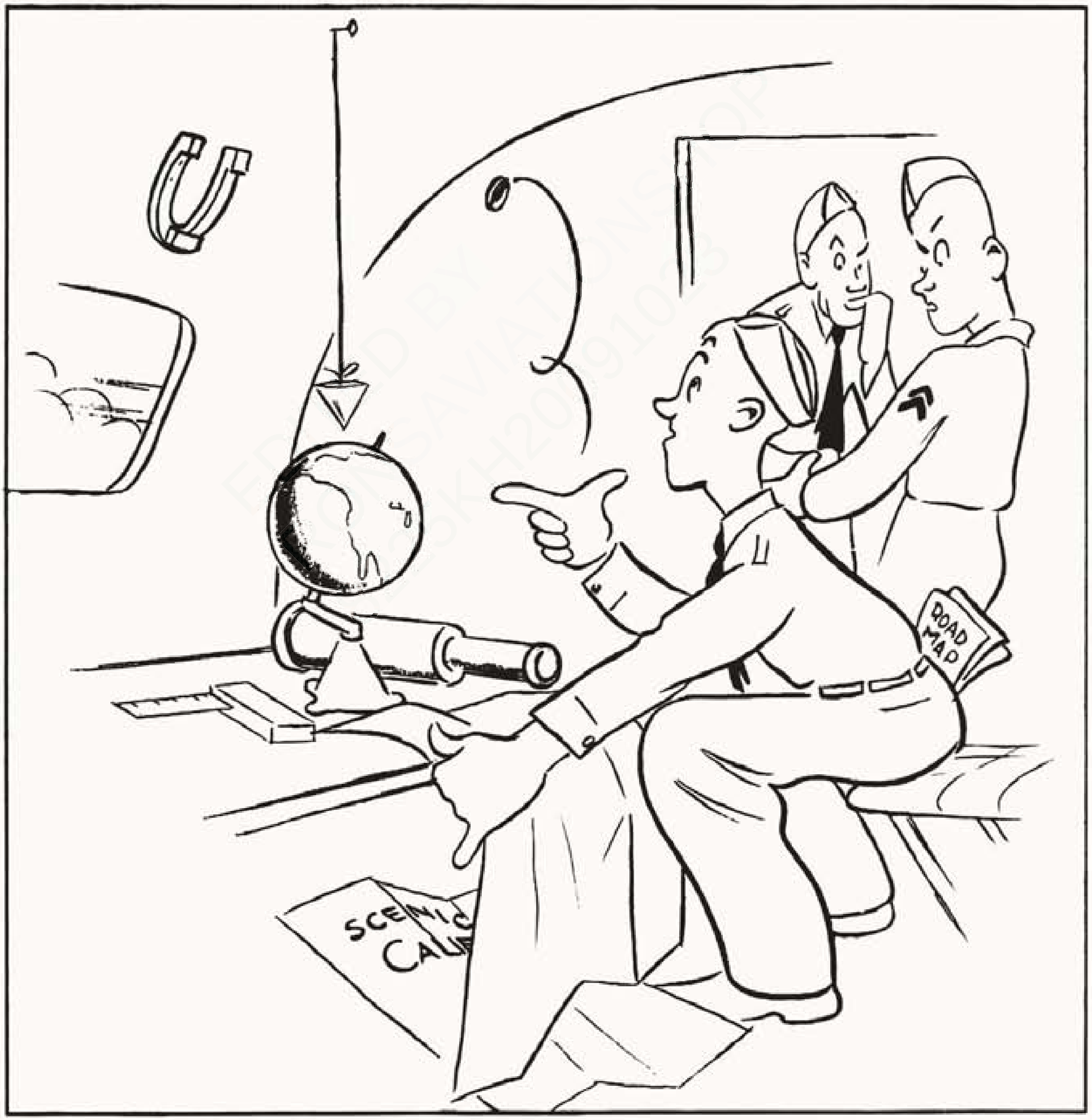
2. The compass is turned on by the airplane battery switch.

(b) OPERATION.

1. Set the gain control (9, figure 36) just below the point which produces a slight oscillation of the master indicator needle.

2. Correct for magnetic variation by turning the knurled knob (21, figure 36) on the face of the indicator (20, figure 36).

3. Erect the gyro after take-off and after violent maneuvers by depressing the erector switch (7, figure 36) until the indicator light comes on. The light will go out when the erection cycle is completed.



4. RADAR OPERATOR'S STATION.

a. LOCATION.—The radar operator's station is located opposite the cabin door. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

(1) LIGHTING.—A dome light is installed on the ceiling and the control switch (12, figure 37) is on the junction box below the window. A spotlight and switch (8, figure 37) are mounted on the table, and there is a dimmer rheostat (6, figure 37) for the light on the junction box. Both lights are supplied power through the battery switch (15, figure 10) and the interior light switch (11, figure 14).

(2) HEATING AND VENTILATING.

(a) A heating and ventilating outlet (16, figure 37) and a damper control (15, figure 37) are located on the right side of the station.

(b) A suit heater outlet (13, figure 37) is installed in the junction box on the wall just below the window.

(3) OXYGEN EQUIPMENT.—An oxygen outlet is installed on the bulkhead just aft of the seat. (Refer to Appendix I for information on the use of oxygen.)

c. RADIO EQUIPMENT.

(1) INTERPHONE EQUIPMENT.—Refer to Section V, paragraph 3, for operating instructions.

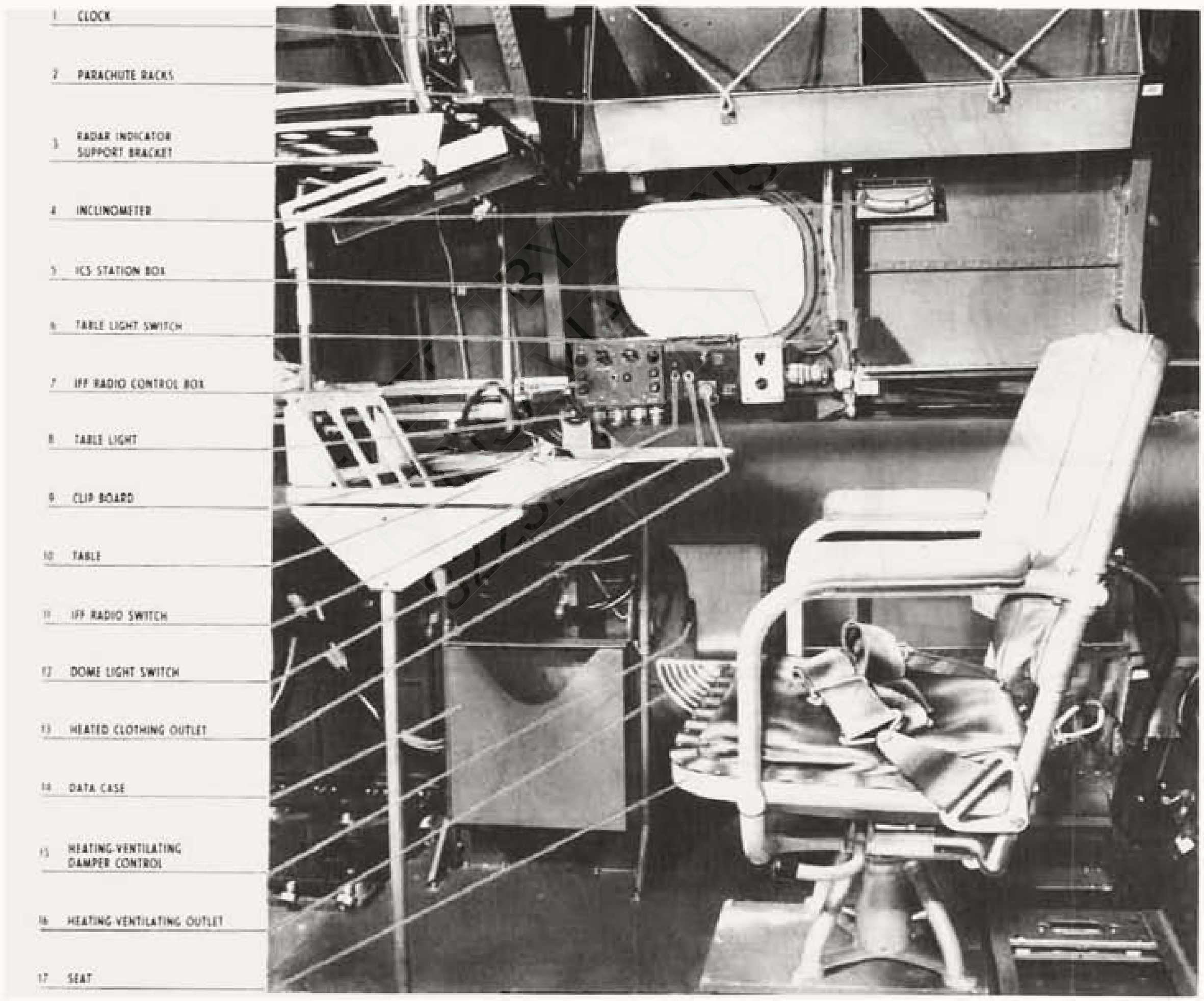


Figure 37 — Radar Operator's Station

(2) SPECIAL SERVICE EQUIPMENT. — A control box (7, figure 37) for the AN/APX-2 equipment is installed on the right side of the radar operator's station.

(3) RADAR EQUIPMENT.—An AN/APS-3 control box and indicator are located on the radar operator's table. Some airplanes are also equipped with the AN/APA-16 bomb sight.

5. TURRET GUNNER'S STATION.

a. LOCATION.—The turret gunner's station is located just aft of the cabin door. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

(1) LIGHTING.—A trouble light (15, figure 38) and switch (16, figure 38) are installed in the turret on the right side of the seat.

(2) HEATING AND VENTILATING.

(a) A heating and ventilating outlet (5, figure 38) and a damper control (4, figure 38) are installed on airplanes bearing BuAer serial numbers 37035 through 37574.

(b) A suit heater outlet (4, figure 39) is installed on the left side of the turret.

(c) An auxiliary adjustable ventilator (17, figure 38) is located opposite the turret on the left side of the cabin.

(3) OXYGEN OUTLET.—An oxygen outlet is installed beside the turret seat. (Refer to Appendix I for information on the use of oxygen.)

c. INTERPHONE EQUIPMENT.—The station box is installed outside the turret and there is a jack box inside the turret on airplanes bearing BuAer serial numbers through 37336. The station box is inside the turret on subsequent serials, and the equipment is operated as outlined in Section V, paragraph 3, *c*. On early airplanes the equipment is operated as follows:

(1) Before entering the turret move the interphone selector switch (19, figure 38) to the desired position and turn the interphone volume control (20, figure 38) to the maximum gain position.

(2) After entering the turret, plug the microphone and headphone cables into their respective jacks in the interphone junction box (14, figure 38).

(3) To transmit, press the switch on the microphone and talk. If a mask or lip microphone is used, press the switch on the junction box (14, figure 38) and talk.

(4) To receive, release switch and adjust the junction box volume control.

d. TURRET.

(1) GENERAL.—A Martin electrically driven turret (3, figure 38), equipped with two .50 caliber Browning M-2 aircraft machine guns, is installed on top of the fuselage just aft of the cabin door. The model 250CE-13 turret is installed on airplanes bearing BuAer serial numbers 37035 through 37245, the 250CE-13A is installed on serials 37246 through 37514, and the 250CE-13B is installed on subsequent airplanes. The –13 turret is equipped with a Mark 9 gun sight and the –13A and –13B are equipped with Mark 18 sights.

(2) LOADING AMMUNITION.

(a) GENERAL.—The four ammunition boxes (3, figure 39), which hold 200 rounds each, are interchangeable when empty, but they must be loaded for a particular gun. The ammunition must point in the same general direction as the guns and the double loop end of the ammunition link must be toward the gun.

(b) MOUNTING AMMUNITION BOXES.

1. Engage the rollers and the guide of the ammunition box in the tracks on the armor plate.

2. Move the box toward the inboard position until it locks in place.

3. Mount the other boxes in the same manner.

4. Connect the ammunition belts in the inboard boxes to those in the outboard boxes with two extra rounds of ammunition.

(c) THREADING AMMUNITION INTO GUNS.

1. Prepare a 35-round belt of ammunition for each gun.

2. Open the ammunition booster cover.

3. Lower the belt through the booster with the double end of the ammunition link toward the gun.

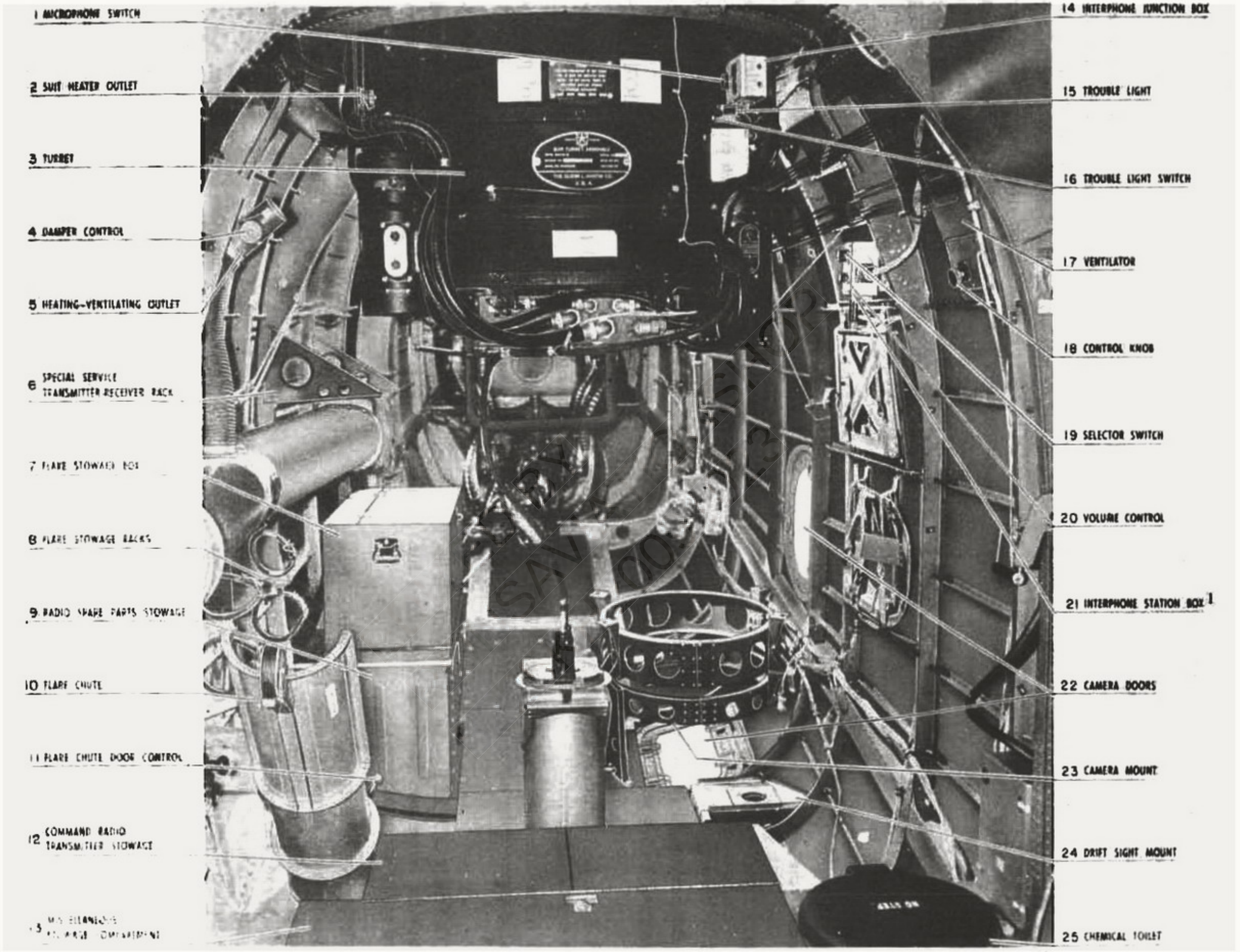
4. Close the booster cover.

5. Connect the lower end of the belt to the belt in the inboard box with an extra round of ammunition.

6. Enter the free end of the belt in the gun.

(d) REMOVING AMMUNITION BOXES.

1. Turn the inboard latch one-quarter turn to the rear and hold it.



1. Interphone station box replaces the jack box in the turret on airplanes bearing BuAer serial numbers 37337 and subsequent.

Figure 38 — Turret Gunner's Station — Looking Aft

2. Move the inboard box toward the center, disengage the rollers from the track, and remove the box.

3. Move the outboard box to the inboard position, and when empty, remove it as outlined for the inboard box.

(3) NORMAL OPERATION.

(a) Before entering the turret, check to see that the turret power supply switch by the door is in the "ON" position.

(b) Check to see that the electrical drive motor clutches are engaged and the hand cranks (6 and 15, figure 40) are disengaged.

(c) Check to see that the elevation and azimuth locking pins are disengaged.

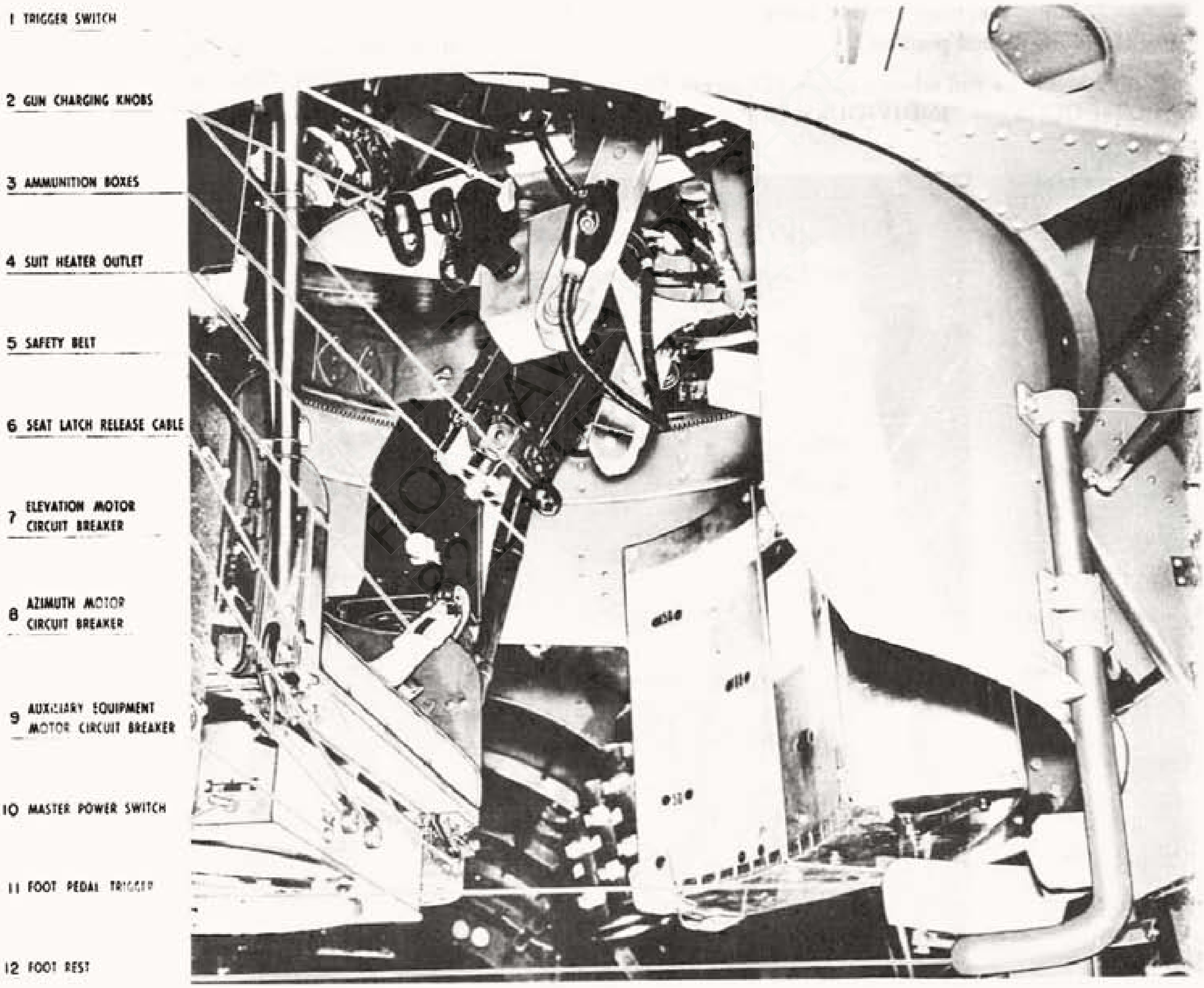
(d) Move the master power switch (10, figure 39) to "ON."

(e) If the armament master switch (1, figure 14) is installed, ask the pilot to move it to "ON."

(f) If the turret is equipped with a Mark 9 sight[1]

1. Turn the sight light switch (9, figure 40) in a clockwise direction until the light comes on and the desired intensity is obtained.

2. If there is an objectionable glare, snap the sight filter into place by turning the position control (8, figure 40).



1. Mark 9 sight is installed on airplanes bearing BuAer serial numbers 37035 through 37245.

Figure 39 — Turret — Right Side Looking Up

(g) If the turret is equipped with a Mark 18 sight:

1. Move the sight switch (1, figure 41) to "ON."

2. Turn the air-speed control (3, figure 41) to the true indicated air speed obtained from the pilot.

3. Turn the altitude control (5, figure 41) to the altitude of the airplane.

4. Turn the selector-dimmer control (4, figure 41) to the desired position.

5. Turn the target span control (4, figure 42) to the proper position.

6. Move the filter control (5, figure 42) to the desired position.

7. Move the fixed reticule mask control (2, figure 42) to the desired position.

(h) Move the gun selector switch (12, figure 40) to "BOTH GUNS" or "INDIVIDUAL GUNS" as desired. When the selector switch is on "BOTH GUNS," the trigger switch (1, figure 39) on either grip will fire both guns. When the selector switch is on "INDIVIDUAL GUNS," the guns are fired by their respective triggers.

(i) Charge the guns by pulling the charging knobs (2, figure 39) as far aft as possible and releasing them.

(j) Raise the guard and move the gun power switch (11, figure 40) to "ON."

(k) Place both hands on the control grips (7, figure 40), closing the deadman switch (5, figure 40) on each grip.

(l) Elevate or depress the guns by turning the grips (7, figure 40) about a horizontal axis in the desired direction.

(m) Rotate the turret by turning the grips about a vertical axis in the desired direction.

(n) If it is necessary to rotate the turret or move

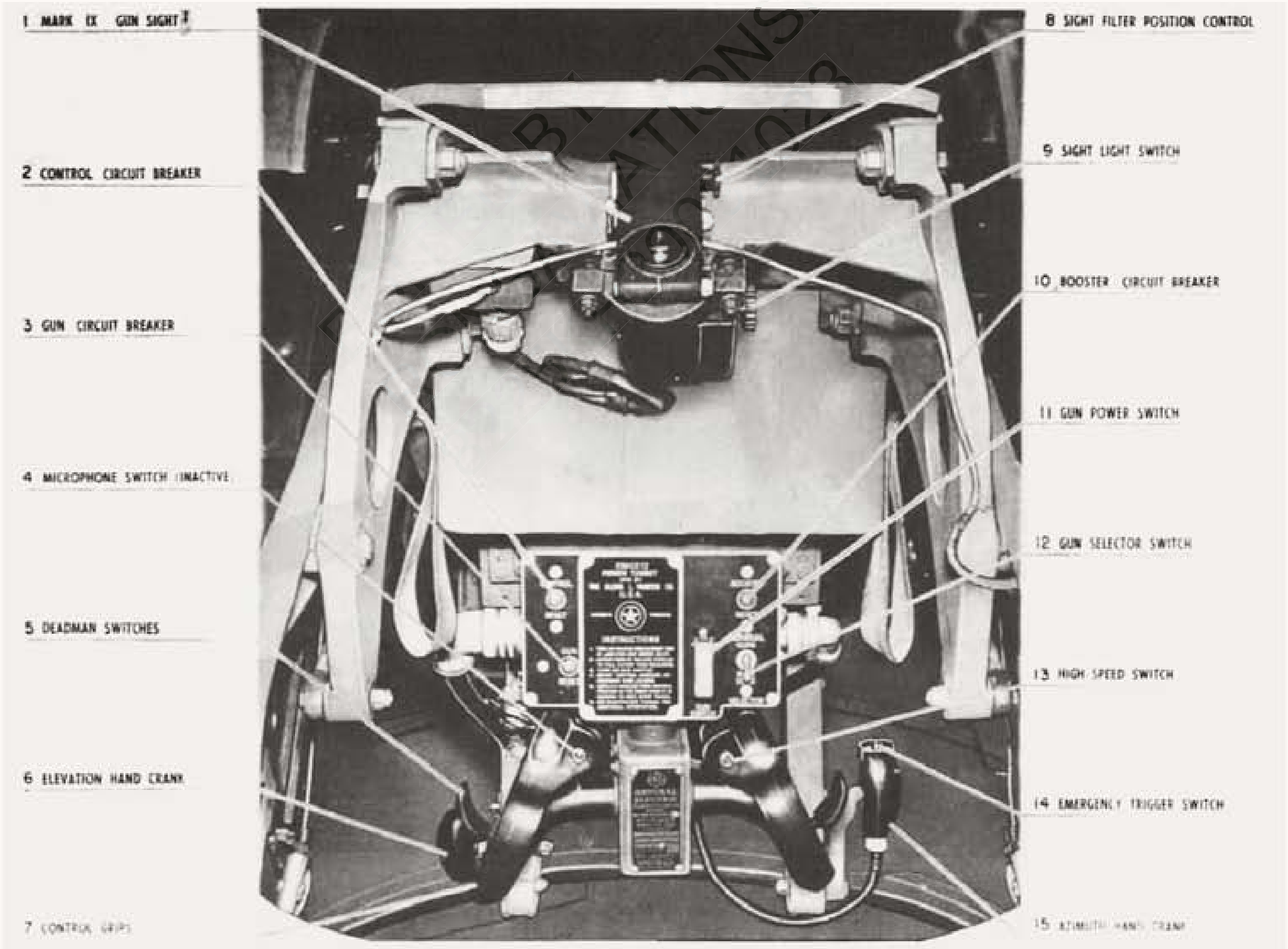


Figure 40 — Turret Controls

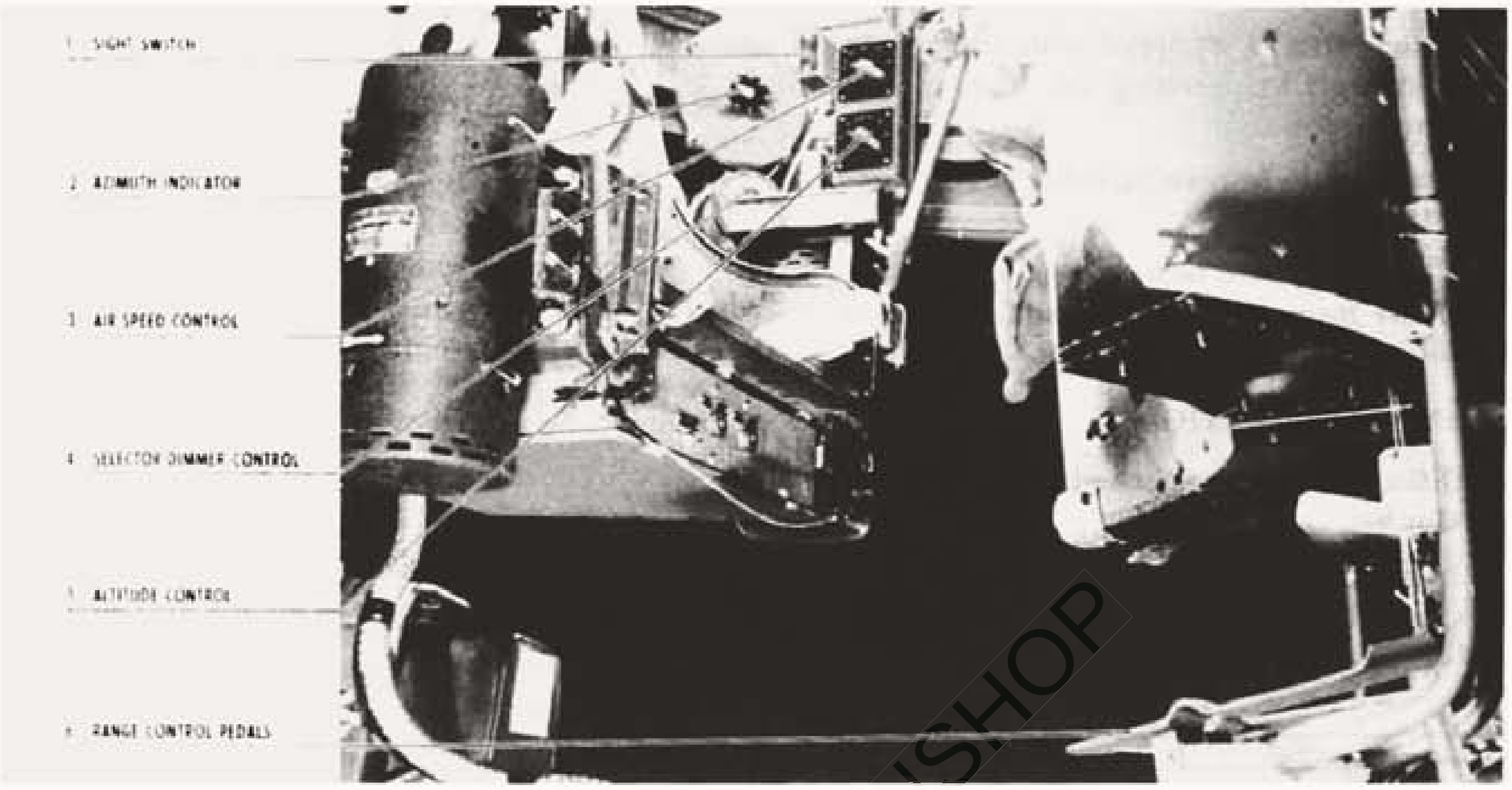


Figure 41 — Turret — Mark 18 Sight Controls (Effective on serials 37246 and subsequent)

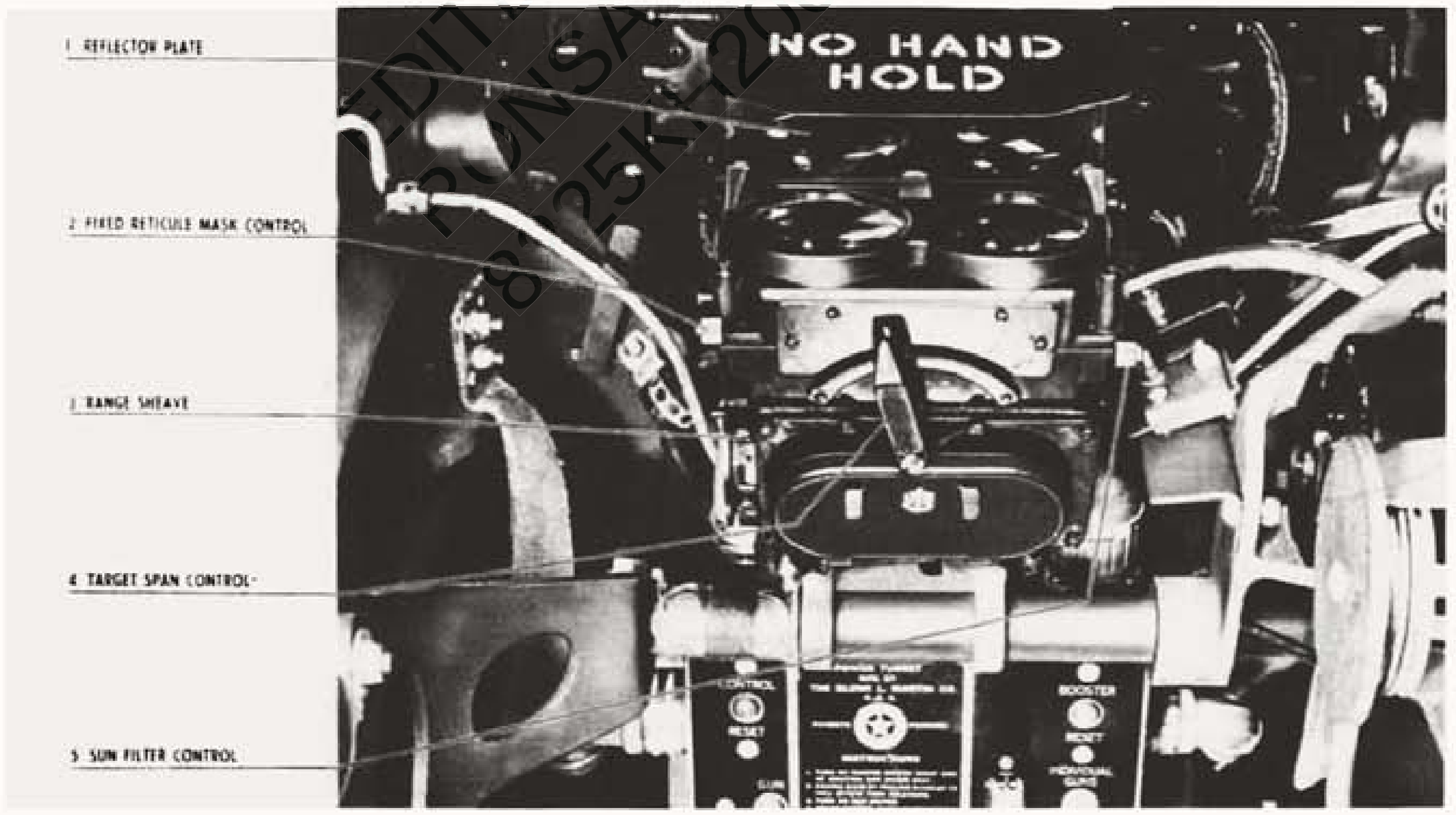


Figure 42 — Mark 18 Turret Gun Sight (Effective on serials 37246 and subsequent)

the guns at very high speeds, depress the high-speed switch (13, figure 40).

(o) Return the grips to their normal position or release both of the deadman switches to stop all motion.

(p) If the turret is equipped with a Mark 18 sight, frame the target by operating the range control pedals (6, figure 41).

(q) Fire the guns by pressing either or both trigger switches (1, figure 39).

(r) When the inboard boxes of ammunition have been used remove them and move the outboard boxes to the inboard position.

(4) MANUAL OPERATION.

(a) Disengage the elevation and azimuth electric drive motor clutches.

(b) Engage the manual drive by turning the hand cranks in either direction.

(c) Charge the guns in the usual manner.

(d) Move the gun selector switch to "BOTH GUNS."

(e) Lift the guard and move the gun power switch to "ON."

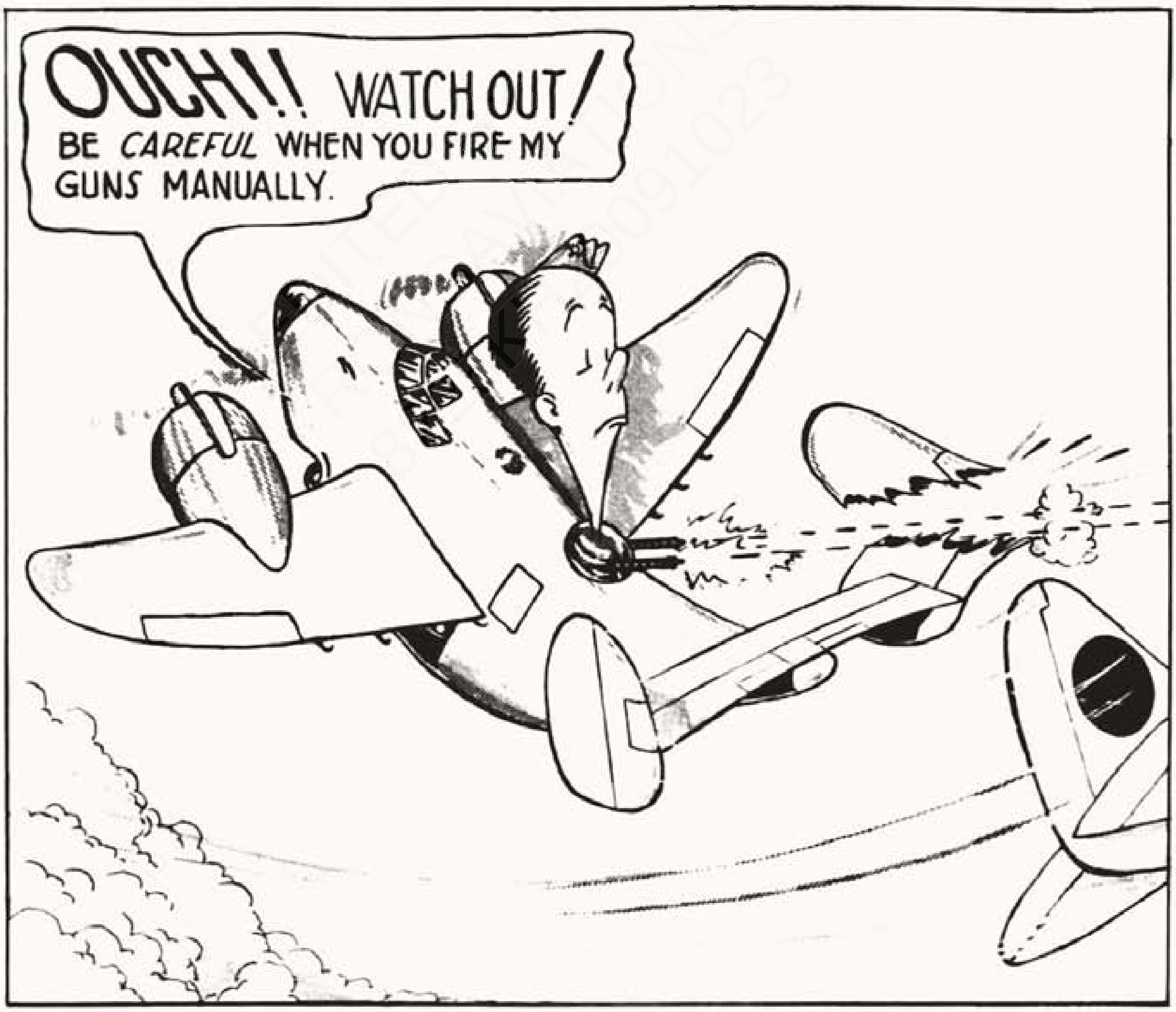
(f) Rotate the turret by turning the azimuth hand crank.

(g) Elevate or depress the guns by turning the elevation hand crank.

(h) Fire the guns by pressing the emergency trigger switch (14, figure 40), or in the case of complete power failure, by depressing the foot pedal trigger (11, figure 39).

WARNING

When the guns are fired with the foot pedal trigger, it is possible to shoot the airplane structure since the electrical gunfire interrupter is inoperative.



6. TUNNEL GUNNER'S STATION.

a. LOCATION.—The tunnel gunner's station is located in the aft end of the cabin. (See figure 2.)

b. SUPPLEMENTARY OPERATIONAL EQUIPMENT.

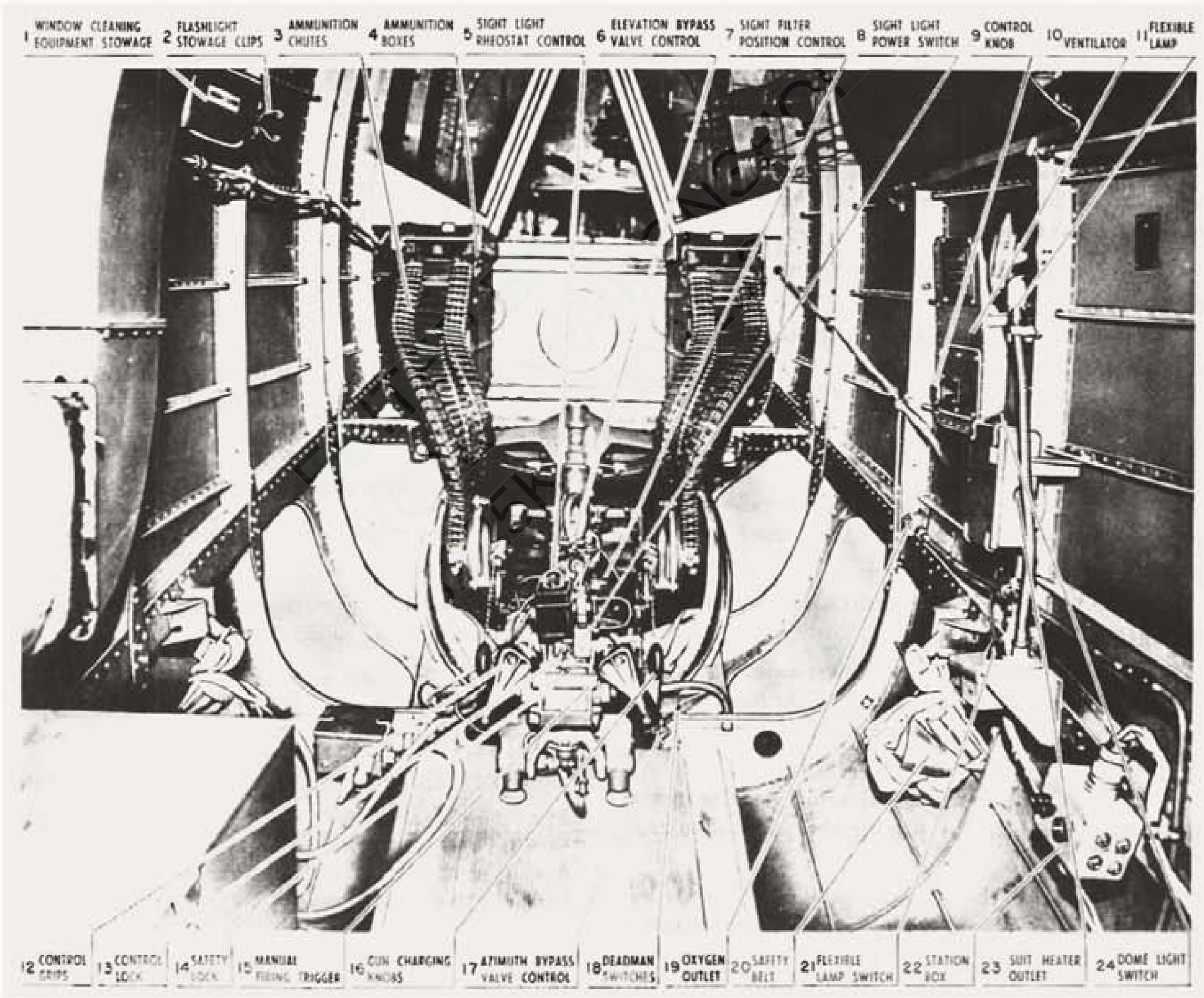
(1) LIGHTING.—A dome light is located on the ceiling above the station, and the control switch (24, figure 43) is installed on the left side of the station in the junction box. A flexible lamp (11, figure 43) is located on the left side of the station and a control switch (21, figure 43) is provided at the base of the lamp. Power is supplied to both lights through the battery switch (15, figure 10) and the interior light switch (11, figure 14).

(2) VENTILATING.—A ventilator (10, figure 43) is located on the left side of the station. The volume of air inducted is regulated by the control knob (9, figure 43) on the ventilator.

(3) HEATING.—A suit heater outlet (23, figure 43) is provided on the left side of the station.

(4) OXYGEN OUTLET.—An oxygen outlet (19, figure 43) is provided on the left side of the station. (Refer to Appendix I for information on the use of oxygen.)

c. INTERPHONE EQUIPMENT.—Refer to Section V, paragraph 3, *c*, for operating instructions.



(Tunnel guns and associated equipment installed on airplanes bearing BuAer serial numbers 37035 through 37193 and 37289 through 37513.)

Figure 43 — Tunnel Gunner's Station

d. TUNNEL GUNS.

(1) GENERAL.—On airplanes bearing BuAer serial numbers 37035 through 37193 and 37289 through 37513, two .50 caliber Browning M-2 machine guns are mounted in the tunnel on a hydraulically operated Bell adapter.

(2) LOADING AMMUNITION.

(a) GENERAL.—The two ammunition boxes (4, figure 43), which hold 250 rounds each, are interchangeable when empty but must be loaded for a particular gun. The ammunition for each gun must point inboard.

(b) MOUNTING AMMUNITION BOXES.—Lift each box into place and shove it aft in the rack until it is locked by the spring clip. (See figure 43.)

(c) THREADING AMMUNITION INTO GUNS.

1. Prepare a 40-round belt for each gun.

2. Lower the belt through the flexible chute and attach it to the belt in the box with an additional round of ammunition.

3. Attach the ammunition chutes (3, figure 43) to the boxes.

4. Open the back cover, and enter the free end of the belt into the gun.

5. Close the back cover.

(3) OPERATION.

(a) See that the hydraulic bypass valve controls (6 and 17, figure 43) are closed. (Turned as far as possible in a clockwise direction.)

(b) See that the control lock (13, figure 43) is disengaged.

(c) Move the sight light power switch (8, figure 43) to the on position, then turn the sight light rheostat control (5, figure 43) clockwise until the light comes on and the desired intensity is obtained.

(d) If there is an objectionable glare, snap the sight filter into place by turning the position control (7, figure 43).

(e) Charge the guns by pulling the charging knobs (16, figure 43) as far aft as possible and releasing them.

(f) Place both hands on the control grips (12, figure 43), closing the deadman switch (18, figure 43) on each grip.

(g) Elevate or depress the guns by turning the grips (12, figure 43) about a horizontal axis.

(h) Rotate the guns in azimuth by turning the grips about a vertical axis.

(i) Fire the guns by pressing either trigger switch on the back of the control grips.

(j) If the hydraulic mount becomes inoperative, the guns may be operated manually after the hydraulic bypass valves have been opened and the control lock has been engaged.

(k) If the trigger switches become inoperative, the guns may be fired by releasing the safety lock (14, figure 43) and pressing the mechanical tripper (15, figure 43).

Note

When the guns are not in use, they should be left in an elevated position.

e. DRIFT METER.

(1) GENERAL.

(a) A B-3 drift meter is installed on the left side of the airplane just aft of the turret, and provisions are made for an alternate installation of a Mark 6 drift sight.

(b) The operating limit for the B-3 drift meter gyro is 20 degrees from the vertical in any direction. During maneuvers which would exceed the operating limits, during take-off and landing, and when the gyro motor is running slowly or stopped, the gyro should be caged. At all other times the gyro should be uncaged.

(2) OPERATION OF B-3 DRIFT METER.

(a) Move the converter power switch to the "ON" position.

(b) With the gyro caged, move the power switch on the gyro housing to the "ON" position.

(c) Adjust the reticule light to the desired intensity by turning the rheostat control on the top of the gyro housing.

(d) After the gyro has run for at least 3 minutes, pull out the caging knob, and move it as far as possible in the direction marked "UNCAGE." Allow the gyro to run for at least 10 minutes after uncaging before attempting to take any readings.

(e) Focus the eyepiece by turning the adapter at its base.

(f) Move the shade glass to the "IN" position if desired.

(g) Rotate the instrument to the approximate position desired as follows:

1. Pull the tangent screw knob out and move it away from the tube as far as possible.

2. Rotate the instrument to the desired position.

3. Pull the tangent screw knob out and move it toward the tube as far as possible.

(b) Determine the drift as follows:

1. Turn the tangent screw until the apparent path of the object being sighted or the "speed lines" are parallel to the grid lines.

2. Read the angle of drift on the azimuth scale.

(i) Determine bearing as follows:

1. If the object is far away, turn the line of sight knob until it appears on the edge of the grid.

2. Turn the tangent screw until the object is on the fore-and-aft center line of the grid.

3. Read the bearing on the azimuth scale.

(j) Determine ground speed as follows:

1. Turn the tangent screw until the grid lines are parallel to the apparent direction of motion of the ground.

2. Select an object on the ground and hold this object at the intersection of the cross hairs by turning the line of sight knob.

3. When the 50 degree detent is felt, start a stop watch.

4. When the 70.9 degree detent is felt, stop the watch and note the elapsed time.

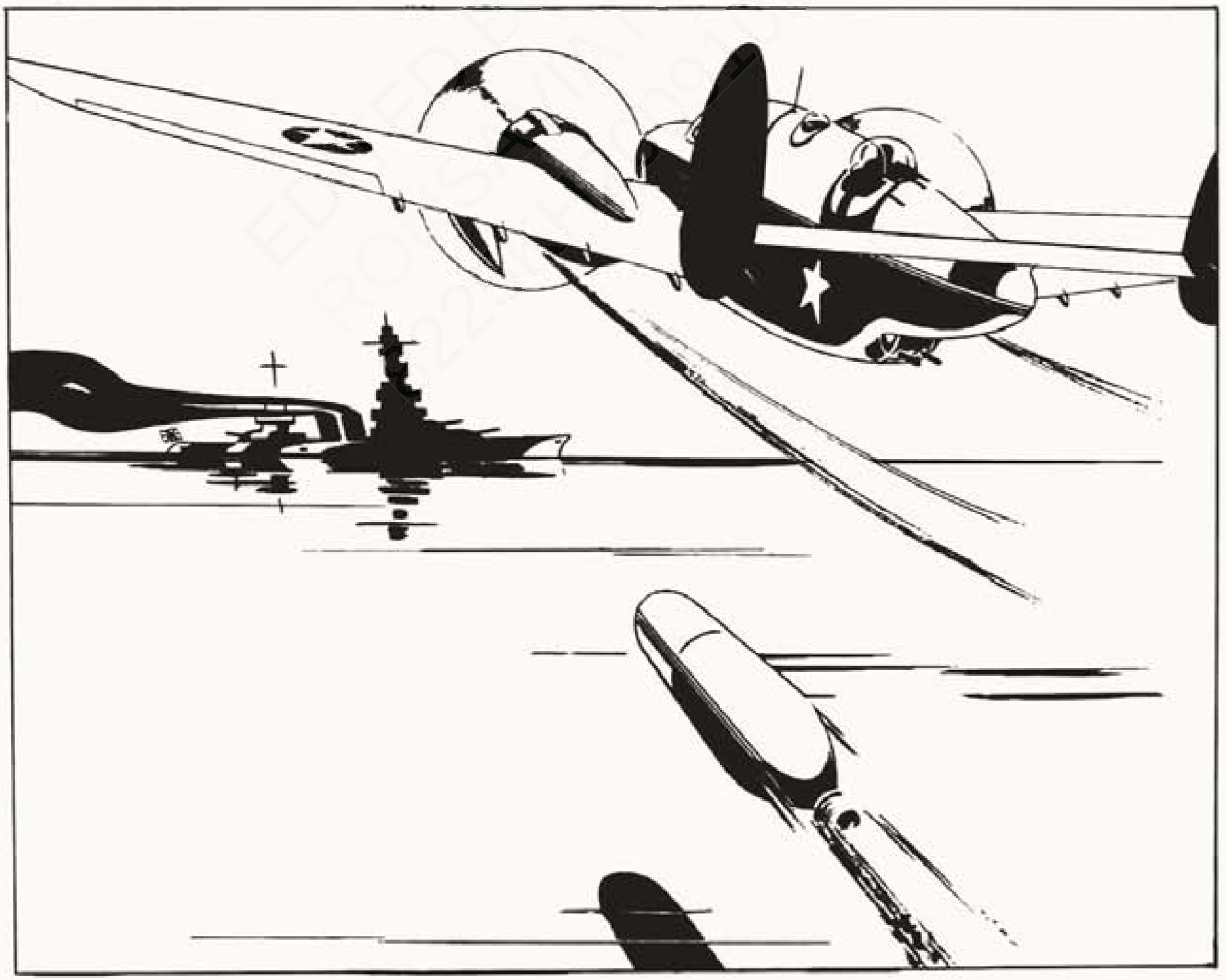
5. Calculate the ground speed using the following formula:

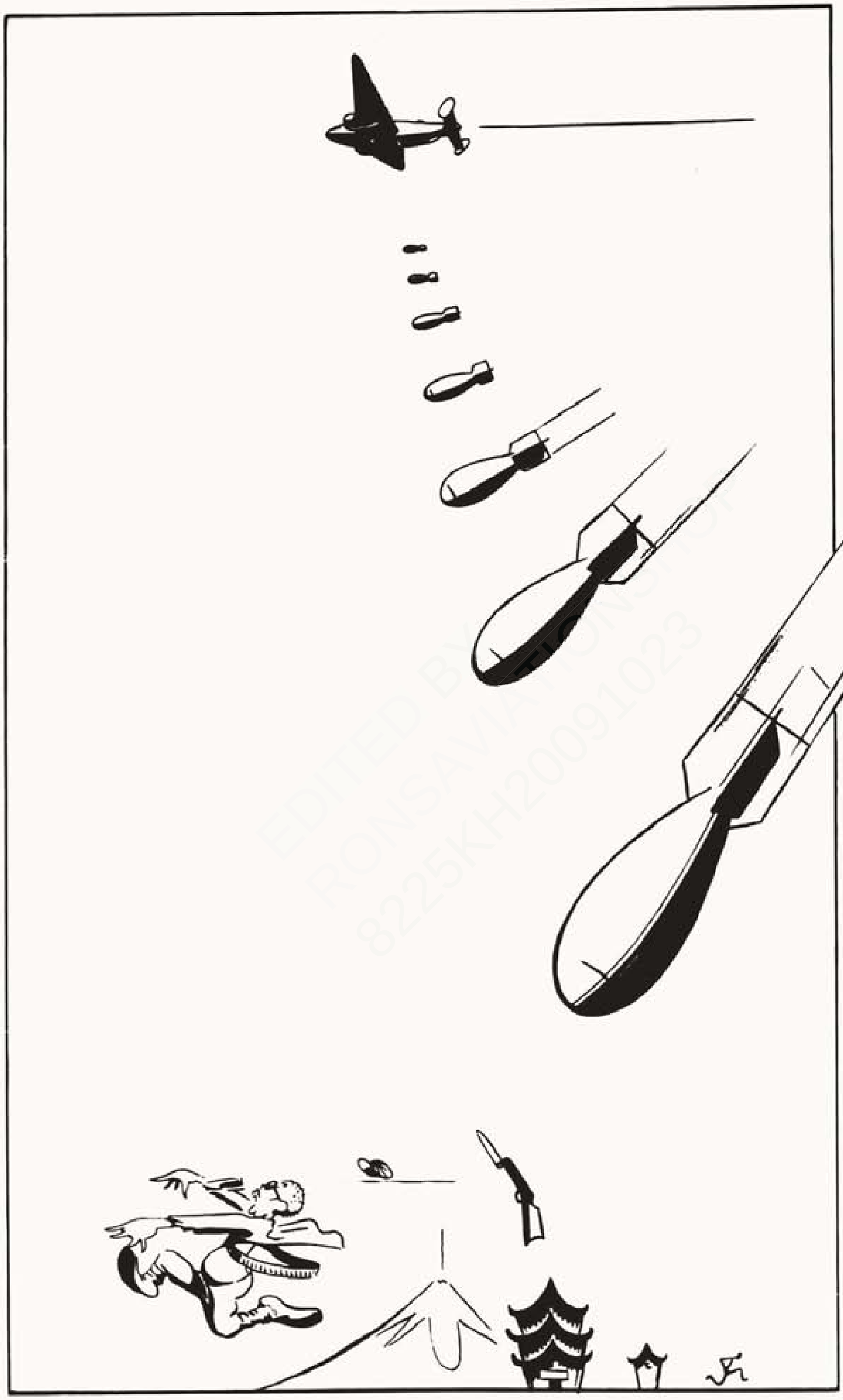
$$V = \frac{H}{t}$$

when V = ground speed in knots
H = altitude in feet
t = time in seconds

f. CAMERA EQUIPMENT. — Provisions are made for the installation of a K-25 camera. Camera doors (22, figure 38) for vertical and oblique photography are provided on the left side of the cabin just aft of the turret. An intervalometer is installed in the flight compartment.

g. TOW TARGET REEL.—Provisions are made for the installation of the Mark 7 tow target reel in lieu of the tunnel guns.





APPENDIX I

OXYGEN EQUIPMENT

1. GENERAL.

The oxygen system is complete with the exception of the cylinders, diluter-demand regulators, and masks which are to be installed by the customer when needed. Racks are provided for four 514 cu in. high-pressure oxygen cylinders. A pressure regulator is installed to reduce the cylinder pressure to 60 psi for distribution to the outlets which are provided at each flight station. A cylinder pressure gage and refill valve are installed on the panel between the cabin door and the oxygen cylinders.

2. PREFLIGHT CHECK.

a. Open the oxygen cylinder valves (3, figure 44) and allow at least ten seconds for the pressure in the lines to equalize. Check the reading of the cylinder pressure gage (5, figure 44). It should be 1800 ± 50 psi if the cylinders are fully charged.

b. Close the cylinder valves for a few minutes and then open them and simultaneously observe the pressure gage. If the gage pointer jumps, leakage is indicated. If leakage is indicated, note the pressure gage reading and

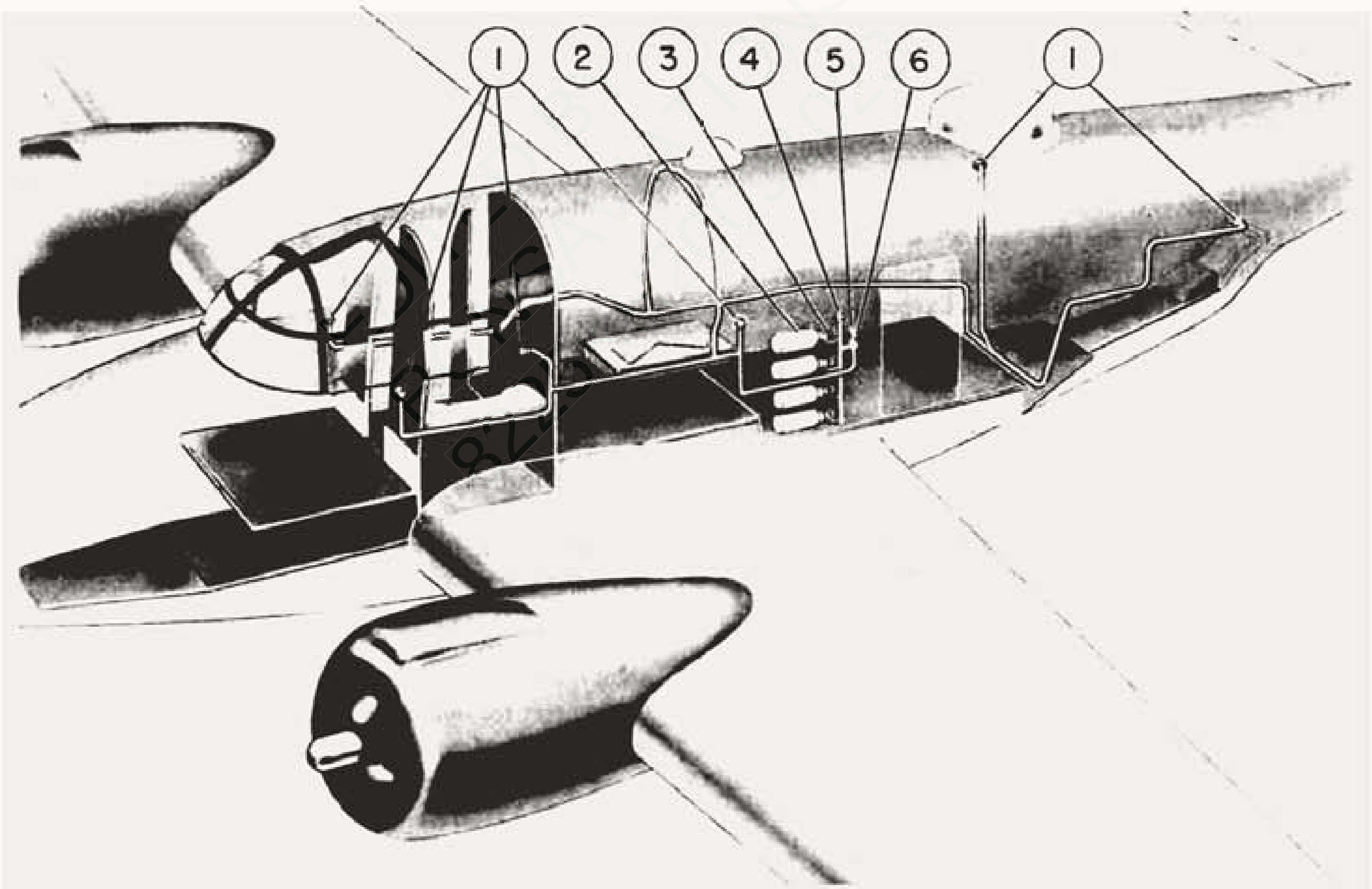


Figure 44 — Oxygen System Diagram

close the cylinder valves. If the pressure drops more than 100 psi in 5 minutes, there is excessive leakage and the system must be repaired prior to use.

c. When the leakage check is completed, open the cylinder valves.

d. Turn the regulator emergency bypass valve control (6, figure 45) as far as possible in the "OFF" direction.

e. Put on the mask and check the fit by squeezing off the corrugated breathing tube and inhaling lightly. The mask will adhere tightly to the face if there are no leaks. If the mask leaks, tighten the mask suspension straps. Then repeat the test for leakage.

CAUTION

Do not use an oxygen mask that leaks.

Do not check mask fit by squeezing the tube when regulator is connected and the emergency bypass valve is open.

f. Plug the bayonet fitting of the regulator supply tube into an oxygen outlet.

g. Turn the air diluter control (5, figure 45) to the "ON" position and depress the diaphragm knob (4, figure 45) for a few seconds to see that oxygen flows into the mask.

h. Breathe several times and observe the flow indicator (2, figure 45) for the "blink" which indicates a positive flow of oxygen. The flow indicator may not operate, since the amount of added oxygen is very small at sea level. If this is the case, turn the air diluter control to "OFF," recheck, and then turn the control to "ON." If the flow indicator operates satisfactorily, adequate oxygen flow and "blinker" operation will be assured at altitude when the air diluter control is in the "ON" position.

Figure 45 — Diluter-demand Oxygen Regulator

i. Check the operation of the emergency bypass valve by turning the control slowly toward the "ON" position until oxygen flows into the mask.

j. Close the regulator bypass valve and the cylinder valves.

3. ALTITUDE FLIGHTS.

a. When oxygen equipment is installed, it shall be used as follows:

(1) On all flights when above 10,000 feet.

(2) A minimum of 15 minutes out of every hour on flights of more than four hours' duration at altitudes between 8,000 and 10,000 feet.

(3) On *night* flights when above 5,000 feet.

WARNING

Symptoms suggestive of the onset of anoxia (oxygen deficiency) are drowsiness, dizziness, dimming of vision, slow or awkward performance of routine tasks, or nausea. As soon as the pilot or a crew member becomes aware of any symptoms suggestive of the onset of anoxia, immediate corrective action is imperative. The corrective action is to descend to 10,000 feet altitude, using emergency oxygen supply, and at such safe altitude inspect and test the individual regulator or complete oxygen system in accordance with recommended pre-flight test procedure. Be sure oxygen apparatus is operating properly before regaining former altitude.

b. When oxygen equipment is not installed, flights shall not exceed 15,000 feet in altitude, or continue above 10,000 feet for longer than two hours except in an emergency.

4. OPERATION.

a. Open the oxygen cylinder valves.

b. Close the regulator emergency bypass valve.

c. Put on the mask and check the fit by squeezing off the corrugated breathing tube and inhaling lightly. The mask will adhere tightly to the face if there are no leaks. If the mask leaks, tighten the suspension straps and repeat the test for leakage.

d. Plug the bayonet fitting of the mask supply tube into the oxygen outlet.

e. Turn the air diluter control to "ON" unless the presence of excessive carbon-monoxide is suspected. If this is the case, turn the control to "OFF" (100% oxygen).

f. Breathe normally and observe the flow indicator for the "blink" which indicates a positive flow of oxygen.

g. Check the cylinder pressure frequency for available oxygen and flow indicator for the flow of oxygen.

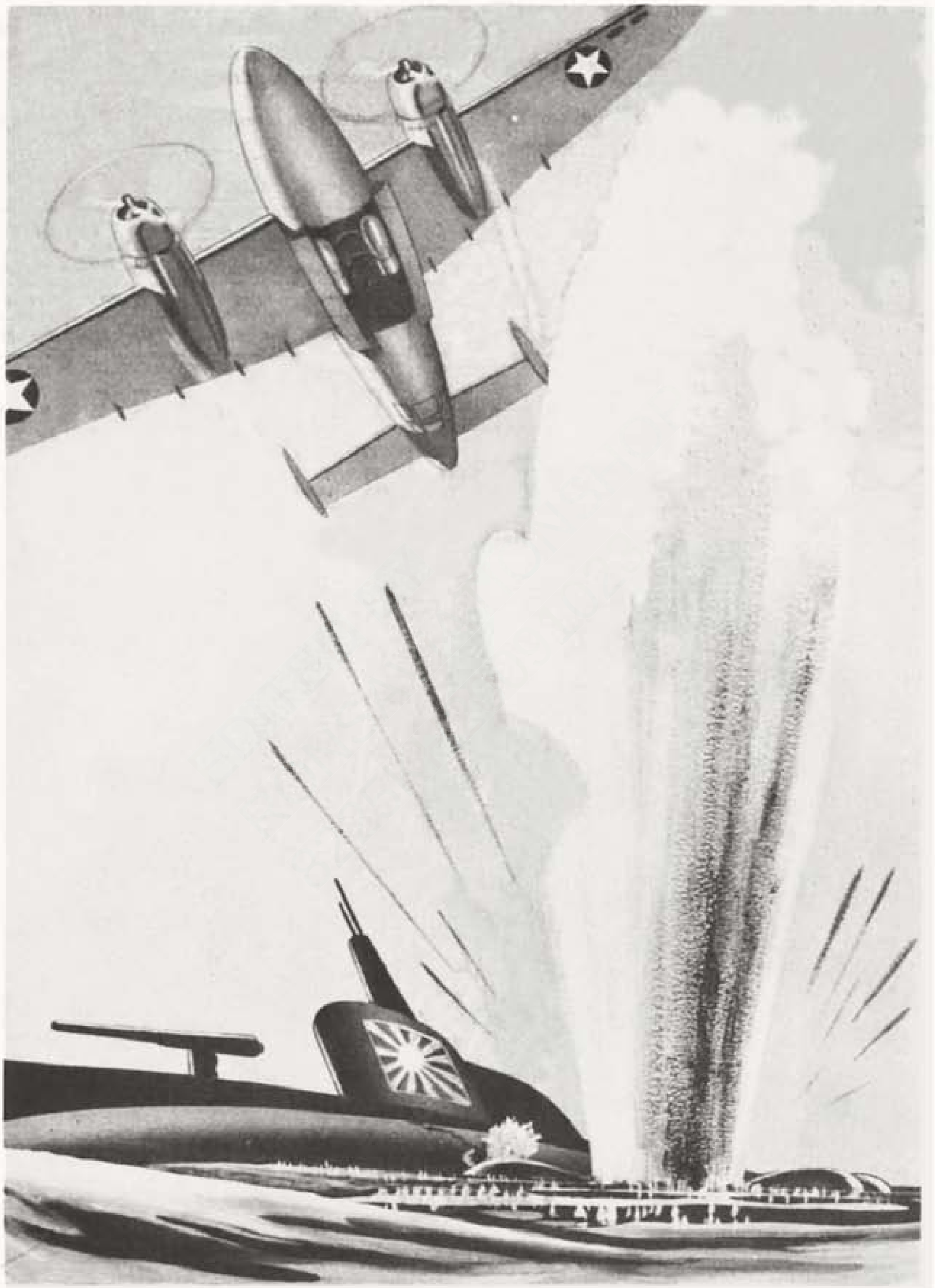
h. If the diluter-demand valve becomes inoperative, close it and slowly open the emergency bypass valve until the minimum flow required is obtained.

i. When oxygen is no longer required, close the cylinder valves.

Cylinder Pressure	*675 psi*				*1050 psi*				*1425 psi*				*1800 psi*			
	Air Diluter Control				*Air Diluter Control*				*Air Diluter Control*				*Air Diluter Control*			
	"ON"		*"OFF"*		*"ON"*		*"OFF"*		*"ON"*		*"OFF"*		*"ON"*		*"OFF"*	
Altitude Feet	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*	*Hrs*	*Min*
S.L.	—	—	*1*	*30*	—	—	*3*	*0*	—	—	*4*	*30*	—	—	*6*	*0*
5,000	—	—	*1*	*47*	—	—	*3*	*34*	—	—	*5*	*21*	—	—	*7*	*8*
10,000	8	30	*2*	*9*	17	0	*4*	*18*	25	30	*6*	*27*	34	0	*8*	*36*
15,000	10	0	*2*	*38*	20	0	*5*	*16*	30	0	*7*	*54*	40	0	*10*	*32*
20,000	9	0	*3*	*16*	18	0	*6*	*32*	27	0	*9*	*48*	36	0	*13*	*4*
25,000	6	20	*4*	*7*	12	40	*8*	*14*	19	0	*12*	*21*	25	20	*16*	*28*
30,000	5	10	*5*	*10*	10	20	*10*	*20*	15	30	*15*	*30*	20	40	*20*	*40*

Table 1 — Man Hours of Available Oxygen

Appendix I and II of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of the enemy.



APPENDIX II

FLIGHT OPERATION CHARTS AND CURVES

1. TAKE-OFF, CLIMB, AND LANDING CHART.

a. GENERAL.—The "Take-off, Climb, and Landing Chart" (figure 46) gives the take-off and landing distances and the best climbing speeds for various altitudes and gross weights. The chart also includes the necessary engine operation data.

b. EXAMPLES.

(1) TAKE-OFF DISTANCE.

(a) GIVEN:

Gross weight — 33,000 lb

Airport elevation — 3000 ft

Runway — Sod-turf surface

Headwind — 15 knots

Temperature — 40 deg C (104 deg F)

(b) REQUIRED: Determine take-off distance necessary to clear 50-foot obstacle.

(c) SOLUTION:

1. On the take-off distance portion of figure 46 for the given conditions read 3690 feet.

2. Refer to the curve on the lower right portion of figure 53 and note that the standard altitude temperature at 3000 feet is 10 deg C (50 deg F). The temperature given in the example is 30 degrees higher than the standard altitude temperature, so the take-off distance must be corrected. The note at the bottom of the take-off distance portion of figure 46 specifies a 6 percent increase in distance for each 10 deg C (18 deg F) above standard altitude temperature.

$$\text{Corrected Distance} = 3690 + \frac{3690 \times .06 \times 30}{10} = 4355 \text{ ft}$$

(2) CLIMBING TIME.

(a) GIVEN:

Gross weight — 33,000 lb

Airport elevation — Sea level

Type of climb — Combat

Temperature at 15,000 ft—0 deg C (32 deg F)

(b) REQUIRED: Determine time required to climb 15,000 feet.

(c) SOLUTION:

1. On the climb data portion of figure 46 for the given condition read 11.5 minutes.

2. Refer to the curve on the lower right portion of figure 53 and note that the standard altitude temperature at 15,000 feet is — 15 deg C (+ 5 deg F). The temperature given in the example is 15 degrees higher than the standard altitude temperature so correct the climbing time by increasing it 7 percent for each 10 deg C (18 deg F) above standard altitude temperature as specified by the chart.

$$\text{Correct Climbing Time} = 11.5 + \frac{11.5 \times .07 \times 15}{10} = 12.7 \text{ min}$$

(3) LANDING DISTANCE.

(a) GIVEN:

Gross weight — 26,000 lb

Runway — Hard dry surface

Airport elevation — Sea level

Temperature — 30 deg C (86 deg F)

(b) REQUIRED: Determine length of runway necessary for landing.

(c) SOLUTION: On the landing distance portion of figure 46 for the given condition read 1790 feet. This figure requires no correction since the temperature in the example is below that specified on chart.

2. FLIGHT OPERATION INSTRUCTION CHARTS.

a. GENERAL.

(1) The "Flight Operation Instruction Charts" (figures 47 through 52) are used in flight planning to determine range, air speed, and engine operation data for various gross weights and altitudes.

(2) The charts cover the gross weight range of 23,000 through 33,000 pounds for both normal and single engine operation. Each chart is divided into five major columns which for a given quantity of fuel show progressive increases in range from that obtained when operating at maximum continuous power to that obtained when operating at the maximum range condition. The engine operation data in each column for any altitude is based on constant miles per gallon of fuel.

(3) The data contained in the charts is based on standard atmospheric conditions. The air speeds will vary from the values shown on the charts when operating under conditions other than standard. If the range values shown on the charts are to be obtained, the charted air speed must be maintained by making power corrections for non-standard atmospheric conditions for all flight operation. This is especially important when operating at very low powers. When it is necessary to readjust the power to maintain the air speed shown on the chart, increase or decrease the manifold pressure by not more than 3 in. Hg. If this is not sufficient, adjust the rpm as necessary to maintain the air speed.

CAUTION

Do not exceed 232°C cylinder head temperature while operating with mixture control in "AUTO LEAN."

Do not reduce engine speed to less than 1600 rpm.

(4) If external fuel tanks or bombs are carried, the range for a given amount of fuel will decrease 10 percent. To obtain the range shown on the chart increase the quantity of fuel 10 percent.

b. EXAMPLE.

(1) GIVEN: An enemy target 350 nautical miles away is to be bombed. Four 1000-lb bombs will be carried in the bomb bay, and all ammunition boxes will be loaded. The flight plan is as follows: fly at 3000 feet at the speed for maximum range until the objective is reached; drop the bombs; fly from the objective at maximum continuous speed at an altitude of about 200 feet until safely away from enemy fighter attack (approximately 100 nautical miles), then fly the remainder of the distance to the base at maximum range speed at 3000 feet. There is a 10 knot headwind on the out-going trip.

(2) REQUIRED: Determine the amount of fuel required for the flight allowing enough reserve for one hour of flying at maximum range speed at 3000 feet after return to the base.

(3) SOLUTION:

(a) TOTAL AIR MILES TO BE COVERED.

1. The headwind allowance, S_w, is determined from the true air speed found in column V (maximum range) of figure 49 since the gross weight will be about 33,000 pounds. The following equation may be used:

$$S_w = \frac{\text{Distance to Objective x Headwind}}{\text{True Air Speed}}$$

$$S_w = \frac{350 \times 10}{152} = 23 \text{ nautical miles}$$

2. The distance, S_r, that can be covered on one hour of reserve fuel after return to the base is determined from the true air speed found in column V of figure 47, since the gross weight will be about 25,000 pounds. The following equation may be used:

$$S_r = \frac{\text{True Air Speed}}{\text{Time}}$$

$$S_r = \frac{152}{1} = 152 \text{ nautical miles}$$

3. Total Air Distance.

$$S = 700 + 23 + 152 = 875 \text{ nautical miles}$$

(b) FUEL REQUIREMENT ESTIMATE.—Since a part of the flight will be made at maximum continuous speed instead of maximum range speed, estimate the amount of fuel required, F, from the data in column III of figure 49. The following equation may be used:

$$F = \frac{\text{True Air Distance x Fuel Consumption}}{\text{True Air Speed}}$$

$$F = \frac{875 \times 135}{178} = 663 \text{ gal}$$

(c) GROSS WEIGHT ESTIMATE.

Airplane weight empty (tactical)	21,900 lb
Five man crew	1,000
Ammunition (2800 rounds at .312 lb/round)	875
Bombs and carriers	4,043
Oil (88 gal at 7.5 lb/gal)	660
Fuel (663 gal plus 70 gal allowance for warm-up, take-off, and climb at 6 lb/gal)	4,398
Gross Weight	32,876 lb

(d) ACTUAL FUEL REQUIREMENT.

1. Fuel required on out-going trip is determined from data in column V of figure 49 using the equation given in paragraph *(b)* above.

$$F = \frac{(350 + 23) \times 105}{152} = 258 \text{ gal}$$

2. Fuel required for 100 miles of flight at maximum continuous power is determined from data in column I of figure 48, since the gross weight is now 32,876 pounds less the weight of the bombs and fuel consumed, or about 27,328 pounds.

$$F = \frac{100 \times 462}{227} = 203 \text{ gal}$$

3. Fuel required to cover the 250 miles to the base is determined from column V of figure 48 since the gross weight is now about 26,110 pounds.

$$F = \frac{250 \times 102}{152} = 168 \text{ gal}$$

4. Read the reserve fuel required for one hour of flight after return to the base from column V of figure 47.

$$F = 102 \text{ gal}$$

5. Total Fuel.

$$F = 70 + 258 + 203 + 168 + 102 = 801 \text{ gal}$$

6. The actual fuel required is in close agreement with the estimate. If it were not, it would be necessary to go through the calculations again using a more accurate estimate due to the variation of fuel consumption with gross weight.

7. Recheck the gross weight.

$$\text{Gross Wt} = 32{,}876 + (801 \times 6 - 4{,}398) = 33{,}284 \text{ lb}$$

3. ENGINE CALIBRATION CURVES.

a. GENERAL.

(1) The "Engine Flight Calibration Curves" (figures 53 and 54) are used primarily to determine horsepower and show engine limitations. They do not accurately prescribe the methods of operation, since propeller efficiency and airplane characteristics are not taken into consideration. Refer to the "Flight Operation Instruction Charts" (figures 47 through 52) for accurate flight operation data.

(2) "Engine Flight Calibration Curves" are provided for high and low blower ratios. Each of these curves is divided into two parts, one for calibration at sea level or a base altitude of 10,000 feet and the other for altitude calibration. The sea level or 10,000-foot altitude calibration curves are for various throttle settings and show brake horsepower as a function of rpm and manifold pressure. Altitude calibration curves are provided for constant rpm—full throttle, constant rpm—manifold pressure, and constant horsepower—rpm for maximum permissible cruising BMEP. The constant rpm—full throttle curves show a decrease in horsepower and manifold pressure with an increase in altitude and extend from the critical altitudes to an altitude of 25,000 feet for low blower and 35,000 feet for high blower. The constant rpm—manifold pressure curves show an increase in horsepower with an increase in altitude and extend to the critical altitudes. The constant horsepower—rpm curves for maximum permissible BMEP extend from sea level, or the base altitude, to the critical altitudes. Both parts of the curves give mixture and BMEP limits. All of the curves are based on a no-ram condition so critical altitudes will be slightly higher than those shown when in flight at relatively high speeds.

b. EXAMPLE.

(1) GIVEN:

Engine speed—1800 rpm

Manifold pressure—34 in. Hg

Throttle setting—"OPEN"

Blower ratio—"LOW"

Altitude—5,400 ft

Temperature at 5,400 ft—15 deg C (59 deg F)

Temperature at 3,000 ft—10 deg C (50 deg F)

(2) REQUIRED: Determine the full-throttle horsepower at 5,400 feet and the part-throttle horsepower at 3,000 feet.

(3) SOLUTION: (Refer to figure 53.)

(a) HORSEPOWER AT 5,400 FEET.

1. Locate point "A" on the altitude part of the curves for the given conditions.

2. Project horizontally to the left and read 940 horsepower.

3. Project down vertically from point "A" and note that the standard altitude temperature is 5 deg C (41 deg F). Since the given temperature is 10 degrees higher than standard, the horsepower reading is slightly high and should be corrected in accordance with the instruction in the upper left corner of the curves.

$$\text{Actual Horsepower} = 940 - \left(940 \times \frac{10}{6} \times .01\right) = 924$$

(b) HORSEPOWER AT 3,000 FEET.

1. Locate point "B" on the sea level part of the curves for the given rpm and manifold pressure.

2. Project horizontally to point "C." This gives the horsepower developed at sea level for the given conditions at standard temperature.

3. On a straight line between points "A" and "C" locate point "D" at the 3,000 foot altitude line.

4. Project horizontally to the left and read 920 horsepower. This is the correct reading since the temperature given in the example is standard altitude temperature.

SPEC. ANC-18 Jan. 18, 1943 FORM ANC-18A

AIRPLANE MODELS
PV-2

TAKE-OFF, CLIMB & LANDING CHART

ENGINE MODELS
R-2800-31

TAKE-OFF DISTANCE (IN FEET)

GROSS WEIGHT (IN LBS.)	HEAD WIND		HARD SURFACE RUNWAY						SOD-TURF RUNWAY						SOFT SURFACE RUNWAY					
			AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.		AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.		AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.	
	MPH	KNOTS	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.	GROUND RUN	TO CLEAR 50' OBJ.
26,000	0	0	1310	2180	1490	2480	1770	2950	1390	2290	1580	2610	1880	3100	1640	2620	1870	2984	2220	3540
	17	15	940	1670	1070	1910	1280	2260	1000	1760	1140	2000	1350	2370	1180	2003	1350	2280	1600	2700
	34	30	660	1250	750	1420	890	1680	700	1310	790	1490	940	1770	820	1490	940	1690	1110	2010
	51	45	390	840	450	960	530	1140	420	880	470	1010	560	1190	490	1000	560	1140	660	1350
30,000	0	0	1800	3040	2050	3460	2430	4110	1930	3230	2200	3680	2610	4370	2350	3860	2680	4390	3180	5220
	17	15	1330	2380	1520	2710	1800	3220	1430	2540	1630	2890	1930	3440	1740	3020	1980	3440	2350	4080
	34	30	940	1810	1070	2060	1270	2440	1000	1910	1140	2170	1350	2590	1220	2280	1390	2600	1650	3080
	51	45	610	1297	700	1480	830	1750	660	1370	750	1560	890	1860	800	1630	910	1860	1080	2210
33,000	0	0	2200	3790	2510	4310	2980	5130	2380	4070	2710	4640	3220	5500	2990	5000	3410	5690	4050	6760
	17	15	1650	3010	1880	3430	2230	4070	1790	3240	2030	3690	2420	4380	2240	3960	2560	4510	3030	5350
	34	30	1190	2330	1360	2650	1610	3150	1290	2500	1460	2850	1740	3380	1610	3050	1840	3470	2180	4120
	51	45	800	1700	900	1940	1070	2300	860	1820	980	2070	1160	2460	1080	2230	1230	2540	1460	3020

NOTE: INCREASE DISTANCE 6% FOR EACH 10° C OR 18° F ABOVE STANDARD ALTITUDE TEMPERATURE — ENGINE LIMITS FOR TAKE-OFF: 2700 RPM & 52.0 IN. HG

COMBAT MISSIONS USE	2700 RPM &	52.0 IN. HG	③ ④	LOW BLOWER	
COMBAT MISSIONS USE	2700 RPM &	47.0 IN. HG	⑤	HIGH BLOWER	

④ CLIMB DATA

③	LOW BLOWER	FERRY MISSIONS USE	2100 RPM &	35.5 IN. HG
⑤	HIGH BLOWER	FERRY MISSIONS USE	2100 RPM &	31.5 IN. HG

GROSS WEIGHT IN LBS.	TYPE OF CLIMB	S. L. TO 3000 FT. ALT.				6000 FT. ALT.					9000 FT. ALT.					12,000 FT. ALT.					15,000 FT. ALT.					BLOWER CHANGE
		BEST T.I.A.S.		FT/MIN	TIME FROM S.L.	BEST T.I.A.S.		FT/MIN	TIME FROM S.L.	FUEL FROM S.L.	BEST T.I.A.S.		FT/MIN	TIME FROM S.L.	FUEL FROM S.L.	BEST T.I.A.S.		FT/MIN	TIME FROM S.L.	FUEL FROM S.L.	BEST T.I.A.S.		FT/MIN	TIME FROM S.L.	FUEL FROM S.L.	
		MPH	KNOTS			MPH	KNOTS			U.S. / IMP.	MPH	KNOTS			U.S. / IMP.	MPH	KNOTS			U.S. / IMP.	MPH	KNOTS			U.S. / IMP.	
26,000	COMBAT	155	135	2660	1.6	155	135	2380	2.8	58 / 48	150	130	2110	4.1	69 / 58	150	130	1650	5.6	82 / 68	150	130	1460	7.6	96 / 80	10,000
	FERRY	145	125	1210	2.9	145	125	1150	5.5	50 / 42	145	125	1080	8.1	59 / 49	145	125	930	11.1	67 / 56	140	125	790	14.6	77 / 64	14,000
30,000	COMBAT	165	140	2190	1.8	160	140	1940	3.3	63 / 52	155	135	1690	5.0	77 / 64	155	135	1290	7.1	93 / 77	155	135	1120	9.6	111 / 92	10,000
	FERRY	150	130	920	3.7	150	130	870	7.0	54 / 45	145	130	810	10.6	64 / 54	150	130	670	14.6	65 / 54	145	125	540	19.6	89 / 74	14,000
33,000	COMBAT	165	145	1910	2.0	160	140	1670	3.7	67 / 56	160	140	1450	5.8	81 / 67	155	135	1060	8.6	100 / 83	155	135	900	11.5	122 / 101	10,000
	FERRY	155	135	750	4.2	150	130	690	8.5	59 / 49	150	130	640	13.1	74 / 62	150	130	510	18.2	88 / 73	150	130	390	25.1	107 / 89	14,000

NOTE: INCREASED ELAPSED CLIMBING TIME 7% FOR EACH 10° C OR 18° F ABOVE STANDARD ALTITUDE TEMPERATURE — FUEL INCLUDES WARM-UP AND TAKE-OFF ALLOWANCE

LANDING DISTANCE (IN FEET)

GROSS WEIGHT IN LBS.	BEST T.I.A.S. APPROACH		HARD DRY SURFACE						FIRM DRY SOD						WET OR SLIPPERY					
			AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.		AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.		AT SEA LEVEL		AT 3,000 FT.		AT 6,000 FT.	
	MPH	KNOTS	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL	TO CLEAR 50' OBJ.	GROUND ROLL
26,000	100	85	2670	1790	2890	1960	3140	2150	2820	1940	3050	2120	3310	2320	4230	3350	4590	3660	4990	4000
30,000	105	90	3035	2070	3290	2260	3570	2480	3200	2240	3470	2440	3760	2670	4830	3860	5250	4220	5700	4610

NOTE: FOR GROUND TEMPERATURES ABOVE 35° C (95° F) INCREASE APPROACH T.I.A.S. 10% AND ALLOW 20% INCREASE IN GROUND ROLL.

REMARKS
① USE AUTO RICH MIXTURE FOR COMBAT CLIMBS AND AUTO LEAN FOR FERRY CLIMBS.
②③ REDUCE MANIFOLD PRESSURE ONE INCH BETWEEN SEA LEVEL AND 2000 FT. – ABOVE 2000 FT. USE FULL THROTTLE.
②③ REDUCE MANIFOLD PRESSURE ONE INCH FOR EACH 3000 FT. BETWEEN SEA LEVEL AND 12,000 FT. – ABOVE 12,000 FT. USE FULL THROTTLE.
④ AFTER 5 MINUTES COMBAT CLIMB: IF IN LOW BLOWER, REDUCE RPM TO 2400 AND USE FULL THROTTLE. IF IN HIGH BLOWER, REDUCE RPM TO 2400 AND USE 43.0 INCHES MANIFOLD PRESSURE.
⑤ REDUCE MANIFOLD PRESSURE ONE INCH FOR EACH 3000 FT. BETWEEN 14,000 FT. AND 30,000 FT. – ABOVE 30,000 FT. USE FULL THROTTLE.

T.I.A.S.: True Indicated Air Speed
M.P.H.: Miles Per Hour
S.L.: Sea Level
U.S.: U. S. Gallons
IMP.: Imperial Gallons
NOTE: All Distances are Average
RED FIGURES HAVE NOT BEEN FLIGHT CHECKED

Figure 46 — Take-off, Climb, and Landing Chart

MODEL (S) PV-2

FLIGHT OPERATION INSTRUCTION CHART

SHEET 1 OF 6 SHEETS

GR. WT. 26,000 TO 23,000 POUNDS

EXTERNAL LOAD ITEMS

NONE (See Note 4)

CONDITION	R.P.M.	M.P. (IN. HG.)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MIN.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF	2700	52 (2)	LOW	AUTO RICH	5	600	500
MILITARY POWER	2700	51	LOW	AUTO RICH	5	600	500
ENGINE ID:	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

ALTERNATE CRUISING CONDITIONS

(NO WIND) (3) — (NO RESERVE FUEL ALLOWANCE) (3)

I (MAX. CONT. POWER) RANGE IN AIR MILES (3) STATUTE AT S.L.	I STATUTE AT 15,000	I NAUTICAL AT S.L.	I NAUTICAL AT 15,000	FUEL U.S. GALS. (3)	II RANGE IN AIR MILES (3) STATUTE	II NAUTICAL	III RANGE IN AIR MILES (3) STATUTE	III NAUTICAL	IV RANGE IN AIR MILES (3) STATUTE	IV NAUTICAL	FUEL IMP. GALS. (3)	V (MAX. RANGE) RANGE IN AIR MILES (3) STATUTE	V NAUTICAL
360	305	**325**	265	500	**600**	390	**745**	630	**805**	700	416	**835**	725
330	275	**300**	240	450	**615**	530	**670**	585	**735**	630	375	**750**	650
305	245	**180**	210	400	**545**	475	**600**	520	**645**	560	333	**670**	580
180	215	**155**	185	350	**480**	415	**525**	455	**565**	490	292	**585**	505
155	185	**135**	160	300	**410**	355	**450**	390	**485**	420	250	**509**	435
130	155	**110**	135	250	**340**	295	**375**	325	**400**	350	208	**430**	360
105	120	**90**	105	200	**270**	235	**300**	260	**330**	280	167	**335**	290
80	90	**65**	80	150	**200**	180	**225**	195	**240**	210	125	**250**	215
50	60	**45**	55	100	**135**	120	**150**	130	**160**	140	83	**165**	145
25	30	**20**	25	50	**70**	60	**75**	65	**80**	70	42	**85**	70

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET
						30000
						25000
						20000
2400	**199**	**251**	F.T.	**437**	**364**	15000
2400	**207**	**269**	43.0	**821**	**281**	12000
2400	**214**	**248**	F.T.	**408**	**338**	9000
2400	**222**	**243**	41.5	**443**	**388**	6000
2400	**226**	**234**	42.0	**465**	**388**	3000
2400	**229**	**229**	43.0	**462**	**388**	S. L.

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET
						30000
						25000
						20000
2100	**172**	219	F.T.	348	121	15000
2100	**184**	221	F.T.	384	137	12000
2100	**188**	215	52.5	367	119	9000
2050	**190**	208	48.0	360	133	6000
2050	**195**	202	48.5	351	129	3000
2000	**192**	192	48.0	348	122	S. L.

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET
						30000
						25000
						20000
2100	**169**	214	F.T.	347	120	15000
2000	**172**	208	50.5	342	116	12000
1950	**171**	197	49.5	335	113	9000
1950	**173**	190	49.5	331	109	6000
1900	**173**	182	50.5	326	103	3000
1850	**173**	173	51.0	320	101	S. L.

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET
						30000
						25000
						20000
2000	**158**	200	36.5	329	107	15000
1900	**157**	189	37.0	325	104	12000
1800	**157**	180	38.0	317	98	9000
1730	**157**	171	39.0	310	92	6000
1700	**156**	168	38.2	304	87	3000
1700	**154**	154	36.5	99	83	S. L.

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET
						30000
						25000
						20000
2000	**145**	183	33.5	313	93	15000
1900	**145**	171	34.0	309	90	12000
1800	**145**	158	35.0	303	86	9000
1700	**145**	149	36.5	98	81	6000
1700	**145**	133	36.5	94	78	3000
1700	**145**	143	37.0	92	77	S. L.

1. INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE
2. ALLOW 60 U.S. GALS., 50 IMP. GALS. FOR WARM-UP, TAKE-OFF, AND CLIMB TO 5000 FEET ALTITUDE.
3. REDUCE TAKE-OFF M.P. ONE INCH BETWEEN S.L. AND 1500 FEET.
4. IF GUN PACKAGES OR EXTERNAL FUEL TANKS ARE CARRIED, ASSUME RANGE VALUES 3% BELOW THOSE LISTED FOR A GIVEN AMOUNT OF FUEL.
5. RANGE VALUES ARE REDUCED 10% BELOW OPTIMUM TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCE SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.
6. RETURN FUEL FLOWS TO FRONT (INTER SECTION TANK.
7. REFER TO SECTION II, PARAGRAPH 3 FOR ORDER OF FUEL TANK USAGE.
8. REFER TO "SPECIFIC ENGINE FLIGHT CHART" FOR ADDITIONAL ENGINE OPERATION DATA.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
with TWO SPEED BLOWER: Use high blower above heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)

RED FIGURES ARE PRELIMINARY, SUBJECT TO REVISION AFTER FLIGHT CHECK

Figure 47 — Flight Operation Instruction Chart

Appendix I and II of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of the enemy.

MODEL (S) P-V-2

FLIGHT OPERATION INSTRUCTION CHART

SHEET 2 OF 6 SHEETS

GR. WT. 30,000 TO 26,000 POUNDS

EXTERNAL LOAD ITEMS
NONE (See Note 4)

CONDITION	R.P.M.	M.P. (IN. HG.) (2)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MIN.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF	2700	52	LOW	AUTO RICH	5	600	500
MILITARY POWER	2700	51	LOW	AUTO RICH	5	600	500
ENGINE (3)	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

(NO WIND) (5) — ALTERNATE CRUISING CONDITIONS — (NO RESERVE FUEL ALLOWANCE) (6)

I (MAX. CONT. POWER) RANGE IN AIR MILES (5)				FUEL U.S. GALS. (7)	II RANGE IN AIR MILES (5)		III RANGE IN AIR MILES (5)		IV RANGE IN AIR MILES (5)		FUEL IMP. GALS. (7)	V (MAX. RANGE) RANGE IN AIR MILES (5)	
STATUTE		NAUTICAL			STATUTE	NAUTICAL	STATUTE	NAUTICAL	STATUTE	NAUTICAL		STATUTE	NAUTICAL
AT S.L.	AT 15,000	AT S.L.	AT 15,000										
618	729	536	632	1200	1611	1393	1748	1520	1658	1613	1000	1908	1673
563	668	489	580	1100	1472	1277	1598	1390	1497	1473	916	1764	1528
512	607	444	526	1000	1329	1159	1449	1260	1356	1332	833	1596	1383
460	543	400	474	900	1203	1041	1300	1130	1278	1192	750	1456	1238
408	484	355	421	800	1067	923	1151	1000	1214	1052	666	1362	1093
357	423	310	368	700	931	803	1003	870	1063	912	583	1098	948
306	363	266	313	600	798	690	858	744	900	780	500	956	810
255	302	222	262	500	665	575	715	620	750	650	416	780	675
204	242	177	210	400	532	460	572	496	600	520	333	624	540

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. (IN. Hg)	U.S. G.P.H.	IMP. G.P.H.	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	(1) DENSITY ALT. IN FEET	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.
						30000													30000						
						25000													25000						
						20000													20000						
2400	197	348	F.T.	437	364	15000	2100	166	310	F.T.	148	123	2100	163	308	F.T.	148	123	2050	136	197	F.T.	113	112	15000	2000	145	180	31.5	121	101
2400	205	346	43.0	421	351	12000	2100	179	311	F.T.	164	136	2000	171	301	F.T.	146	122	1900	136	188	28.0	110	108	12000	1900	145	173	26.0	116	97
2409	213	342	F.T.	408	338	9000	2100	184	310	32.0	166	138	2000	172	296	30.0	141	117	1900	137	181	28.0	123	104	9000	1800	145	166	27.5	111	93
2400	220	341	41.5	462	388	6000	2050	185	304	33.0	158	132	1950	172	289	30.5	135	113	1850	138	175	28.5	121	100	6000	1700	145	158	25.5	106	89
2400	224	334	42.0	462	388	3000	2050	187	296	33.0	153	127	1900	172	280	31.0	130	108	1800	137	163	29.0	113	96	3000	1700	145	152	28.5	102	85
2400	227	327	43.0	462	388	S.L.	2000	186	288	33.5	145	121	1900	172	272	33.0	123	104	1700	136	156	30.5	108	90	S.L.	1700	145	143	29.0	99	82

LEGEND

1. INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE.
2. ALLOW 45 U.S. GALS., 34 IMP. GALS. FOR WARM-UP, TAKE-OFF, AND CLIMB TO 5000 FEET ALTITUDE.
3. REDUCE TAKE-OFF M.P. ONE INCH BETWEEN S.L. AND 1500 FEET.
4. IF GUN PACKAGES OR EXTERNAL FUEL TANKS ARE CARRIED, ASSUME RANGE VALUES 5% BELOW THOSE LISTED FOR A GIVEN AMOUNT OF FUEL.
5. RANGE VALUES ARE REDUCED 12% BELOW OPTIMUM TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCE SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.
6. RETURN FUEL FLOWS TO FRONT CENTER SECTION TANK.
7. REFER TO SECTION II, PARAGRAPH 3 FOR ORDER OF FUEL TANK USAGE.
8. REFER TO "SPECIFIC ENGINE FLIGHT CHARTS" FOR ADDITIONAL ENGINE OPERATION DATA.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
WITH TWO SPEED BLOWERS: Use high blower where heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)

ESTIMATED FIGURES ARE PRELIMINARY; SUBJECT TO REVISION AFTER FLIGHT CHECK

Figure 48 — Flight Operation Instruction Chart

MODEL (S) PV-2

FLIGHT OPERATION INSTRUCTION CHART

SHEET 3 OF 6 SHEETS

GR. WT. 33,000 TO 30,000 POUNDS

EXTERNAL LOAD ITEMS

NONE (See Note 4)

CONDITION	R.P.M.	M.P. (IN. HG.)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MINS.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF	2700	52 (2)	LOW	AUTO RICH	5	600	500
MILITARY POWER	2700	51	LOW	AUTO RICH	5	600	500
ENGINE NO.	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

ALTERNATE CRUISING CONDITIONS

(NO WIND) (1) — (NO RESERVE FUEL ALLOWANCE) (2)

I (MAX. CONT. POWER) RANGE IN AIR MILES (3) STATUTE AT S.L.	I STATUTE AT 15,000	I NAUTICAL AT S.L.	I NAUTICAL AT 15,000	FUEL U.S. GALS. (5)	II RANGE IN AIR MILES (4) STATUTE	II NAUTICAL	III RANGE IN AIR MILES (4) STATUTE	III NAUTICAL	IV RANGE IN AIR MILES (4) STATUTE	IV NAUTICAL	FUEL IMP. GALS. (5)	V (MAX. RANGE) RANGE IN AIR MILES (4) STATUTE	V NAUTICAL
				1620							1350		
790	917	686	808	1850	2037	1781	2198	1915	2306	2002	1292	2390	2075
712	845	619	729	1400	1853	1606	1975	1720	2065	1792	1166	2140	1853
660	784	574	676	1300	1717	1488	1826	1590	1904	1652	1082	1972	1708
609	723	529	623	1200	1581	1370	1677	1460	1743	1513	1000	1805	1563
558	664	485	570	1100	1448	1255	1533	1334	1590	1380	916	1646	1425
507	602	441	517	1000	1315	1140	1390	1210	1440	1250	833	1490	1290
456	547	396	465	900	1182	1025	1247	1085	1290	1120	749	1334	1155
405	481	352	412	800	1049	910	1104	962	1140	990	666	1178	1020

OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. HG.	U.S. G.P.H.	IMP. G.P.H.	(6) HEIGHT ALT. IN FEET	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. HG.	U.S. G.P.H.	IMP. G.P.H.	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. HG.	U.S. G.P.H.	IMP. G.P.H.	(6) HEIGHT ALT. IN FEET	OPERATING DATA R.P.M.	T.I.A.S. KNOTS	T.A.S.	M.P. IN. HG.	U.S. G.P.H.	IMP. G.P.H.
						30000													30000						
						25000													25000						
						20000													20000						
2400	195	245	P.T.	437	364	15000	2100	161	201	P.T.	147	123	2100	139	201	P.T.	147	123	2100	133	196	P.T.	147	123	15000	2100	145	181	28.0	133	111
2400	203	244	43.0	421	351	12000	2100	174	208	P.T.	161	134	2050	167	201	99.5	135	121	2000	157	188	29.0	139	116	12000	1900	145	171	28.0	125	104
2400	215	241	P.T.	405	338	9000	2100	180	207	32.5	160	141	2000	167	191	96.5	144	120	1950	155	178	29.0	132	110	9000	1800	145	166	29.5	121	101
2400	218	239	41.5	462	385	6000	2050	181	199	33.0	136	112	2000	168	185	93.0	139	116	1900	157	172	30.0	128	107	6000	1700	145	159	30.5	110	90
2400	222	232	42.0	462	385	3000	2050	183	192	33.0	134	128	1950	169	178	32.5	135	112	1850	158	166	30.5	125	103	3000	1700	145	152	30.5	103	87
2400	225	225	43.0	462	385	S.L.	2000	182	182	33.5	145	121	1900	169	169	32.0	129	107	1800	157	157	31.0	118	98	S.L.	1700	145	145	30.5	103	87

1. INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE
2. ALLOW 90 U.S. GALS., 88 IMP. GALS. FOR WARM-UP, TAKE-OFF, AND CLIMB TO 6000 FEET ALTITUDE
3. REDUCE TAKE-OFF M.P. ONE INCH BETWEEN S.L. AND 1000 FEET.
4. IF GUN PACKAGES OR EXTERNAL FUEL TANKS ARE CARRIED, ASSUME RANGE VALUES 3% BELOW THOSE LISTED FOR A GIVEN AMOUNT OF FUEL.
5. RANGE VALUES ARE REDUCED 10% BELOW OPTIMUM TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCE SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.
6. REFER TO SECTION II, PARAGRAPH 3 FOR ORDER OF FUEL TANK USAGE.
7. REFER TO "SPECIFIC ENGINE FLIGHT CHART" FOR ADDITIONAL ENGINE OPERATION DATA.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
WITH TWO SPEED BLOWER: Use high blower above heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)

RED FIGURES ARE PRELIMINARY: SUBJECT TO REVISION AFTER FLIGHT CHECK

Figure 49 — Flight Operation Instruction Chart

Appendix I and II of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of the enemy.

MODEL (S) PV-2 SINGLE ENGINE CRUISE

FLIGHT OPERATION INSTRUCTION CHART

SHEET 4 OF 6 SHEETS

GR. WT. 26,000 TO 23,000 POUNDS

EXTERNAL LOAD ITEMS DEAD PROPELLER FEATHERED

CONDITION	R.P.M.	M.P. (IN. HG)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MIN.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF							
MILITARY POWER	2700	51	LOW	AUTO RICH	5	300	250
ENGINE (S)	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

ALTERNATE CRUISING CONDITIONS

③ (NO WIND) (NO RESERVE FUEL ALLOWANCE) ⑤

I (MAX. CONT. POWER) RANGE IN AIR MILES ③ STATUTE AT S.L.	I STATUTE AT 6,000	I NAUTICAL AT S.L.	I NAUTICAL AT 6,000	FUEL U.S. GALS. ①	II RANGE IN AIR MILES ③ STATUTE	II NAUTICAL	III RANGE IN AIR MILES ③ STATUTE	III NAUTICAL	IV RANGE IN AIR MILES ③ STATUTE	IV NAUTICAL	FUEL IMP. GALS. ①	V (MAX. RANGE) RANGE IN AIR MILES ③ STATUTE	V NAUTICAL
385	405	335	350	500	495	430	560	485	610	530	416	720	625
345	365	300	315	450	445	385	505	440	550	475	375	650	565
310	320	265	280	400	395	345	450	390	490	425	333	575	500
270	280	235	245	350	345	300	390	340	425	370	291	505	440
230	240	200	210	300	295	260	335	290	365	320	250	430	375
190	200	165	175	250	245	215	280	245	305	265	208	360	315
155	160	135	140	200	200	170	225	195	245	210	167	290	250
115	120	100	105	150	150	130	170	145	185	160	125	215	190
75	80	65	70	100	100	85	110	95	120	105	83	145	125
35	40	30	35	50	50	45	55	50	60	55	42	70	60

OPERATING DATA — I

① DENSITY ALT. IN FEET	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. HG	U.S. G.P.H.	IMP. G.P.H.
30000						
25000						
20000						
15000						
12000						
9000						
6000	2400	164	180	41.5	231	193
3000	2400	168	176	42.0	231	193
S. L.	2400	172	172	43.0	231	193

OPERATING DATA — II

① DENSITY ALT. IN FEET	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. HG	U.S. G.P.H.	IMP. G.P.H.
30000						
25000						
20000						
15000						
12000						
9000						
6000	2300	154	148	37.0	176	147
3000	2300	158	145	38.0	173	144
S. L.	2300	161	141	39.0	167	139

OPERATING DATA — III

① DENSITY ALT. IN FEET	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. HG	U.S. G.P.H.	IMP. G.P.H.
30000						
25000						
20000						
15000						
12000						
9000						
6000	2250	147	160	35.0	148	123
3000	2200	150	157	36.0	145	120
S. L.	2200	153	153	37.0	141	117

OPERATING DATA — IV

① DENSITY ALT. IN FEET	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. HG	U.S. G.P.H.	IMP. G.P.H.
30000						
25000						
20000						
15000						
12000						
9000						
6000	2150	138	151	33.5	128	106
3000	2150	143	149	34.5	126	105
S. L.	2150	146	146	35.5	124	103

OPERATING DATA — V

① DENSITY ALT. IN FEET	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. HG	U.S. G.P.H.	IMP. G.P.H.
30000						
25000						
20000						
15000	ADJUST R.P.M. TO MAINTAIN PROPER T.I.A.S. DO NOT EXCEED 2400 R.P.M.					
12000						
9000						
6000	2100	130	142	32.5	113	94
3000	2050	130	136	33.0	106	88
S. L.	2050	130	130	33.0	99	83

NOTES

① INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE.

② ALLOW 0 U. S. GALS., 0 IMP. GALS. FOR WARM UP, TAKE-OFF AND CLIMB TO 0 FEET ALTITUDE.

③ RANGE VALUES HAVE BEEN REDUCED 10% BELOW OPTIMUM TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCES SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.

④ RETURN FUEL FLOWS TO FRONT CENTER SECTION TANKS.

⑤ REFER TO SECTION II, PARAGRAPH 3 FOR ORDER OF FUEL TANK USAGE.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
WITH TWO SPEED BLOWER: Use high blower above heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)
M.P.: Manifold Pressure (In. Hg)
U.S.G.P.H.: U. S. Gallons Per Hour
IMP.G.P.H.: Imperial Gallons Per Hour
F.T.: Full Throttle
S.L.: Sea Level

RED FIGURES ARE PRELIMINARY AND SUBJECT TO REVISION AFTER FLIGHT CHECK

Figure 50 — Flight Operation Instruction Chart

MODEL (S) PV-2 — SINGLE ENGINE CRUISE

FLIGHT OPERATION INSTRUCTION CHART

SHEET 5 OF 6 SHEETS

GR. WT. 30,000 TO 26,000 POUNDS

EXTERNAL LOAD ITEMS
DEAD PROPELLER FEATHERED

CONDITION	R.P.M.	M.P. (IN. HG.)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MIN.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF							
MILITARY POWER	2700	51	LOW	AUTO RICH	5	300	250
ENGINE (S)	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

ALTERNATE CRUISING CONDITIONS

(2) (NO WIND) (NO RESERVE FUEL ALLOWANCE) (2)

I (MAX. CONT. POWER) RANGE IN AIR MILES (3)				FUEL U.S. GALS. (1)	II RANGE IN AIR MILES		III RANGE IN AIR MILES		IV RANGE IN AIR MILES		FUEL IMP. GALS. (1)	V (MAX. RANGE) RANGE IN AIR MILES	
STATUTE		NAUTICAL			STATUTE	NAUTICAL	STATUTE	NAUTICAL	STATUTE	NAUTICAL (5)		STATUTE	NAUTICAL (5)
AT S.L.	AT 6,000	AT S.L.	AT 6,000										
833	870	725	755	1100					1140	990	916	1315	1160
735	790	655	685	1000					1020	885	833	1190	1035
680	710	590	615	900					893	780	750	1130	995
600	625	525	545	800					773	675	666	995	785
525	545	455	475	700					653	565	583	760	660
450	470	390	405	600					550	480	500	640	560
375	390	325	340	500					460	400	416	535	465
300	310	260	270	400					370	320	333	430	370

NOTE: TO OBTAIN ABOVE RANGE VALUES, OPERATING DATA FROM PRECEDING CHART MUST BE USED AS GROSS WEIGHT CHANGES. WHEN WEIGHT REACHES 26,000 LB, USE OPERATING DATA FROM CHART FOR 26,000-22,000 LB.

OPERATING DATA						(1) DENSITY ALT. IN FEET	OPERATING DATA						OPERATING DATA						(1) DENSITY ALT. IN FEET	OPERATING DATA					
R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.		R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.	R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.		R.P.M.	T.I.A.S. KNOTS	T.A.S. KNOTS	M.P. IN. Hg	U.S. G.P.H.	IMP. G.P.H.
						30000													30000						
						25000													25000						
						20000													20000						
						15000													15000	ADJUST R.P.M. TO MAINTAIN					
						12000													12000	PROPER T.I.A.S. DO NOT					
						9000													9000	EXCEED 2400 R.P.M.					
2400	189	174	41.3	231	193	6000													6000	2250	130	145	38.5	132	127
2400	183	171	42.0	231	193	3000													3000	2200	130	146	38.5	127	116
2400	168	168	43.0	231	193	S.L.													S.L.	2150	130	130	36.0	127	106

NOTES
(1) INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE.
(2) ALLOW 0 U. S. GALS., 0 IMP. GALS. FOR WARM UP, TAKE-OFF AND CLIMB TO 0 FEET ALTITUDE.
(3) RANGE VALUES HAVE BEEN REDUCED 10% BELOW OPTIMUM TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCES SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.
(4) RETURN FUEL FLOWS TO FRONT CENTER SECTION TANKS.
(5) REFER TO SECTION II, PARAGRAPH 3 FOR ORDER OF FUEL TANK USAGE.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
WITH TWO SPEED BLOWER: Use High blower above heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)
M.P.: Manifold Pressure (In. Hg)
U.S.G.P.H.: U. S. Gallons Per Hour
IMP.G.P.H.: Imperial Gallons Per Hour
F.F.: Full Throttle
S.L.: Sea Level

RED FIGURES ARE PRELIMINARY AND SUBJECT TO REVISION AFTER FLIGHT CHECK.

Figure 51 — Flight Operation Instruction Chart

MODEL (S) P.V.-2

SINGLE ENGINE CRUISE

FLIGHT OPERATION INSTRUCTION CHART

SHEET 6 OF 6 SHEETS

GR. WT. 33,000 TO 30,000 POUNDS

EXTERNAL LOAD ITEMS
DEAD PROPELLER FEATHERED

CONDITION	R.P.M.	M.P. (IN. HG.)	BLOWER POSITION	MIXTURE POSITION	DURATION IN MIN.	U.S. G.P.H.	IMP. G.P.H.
TAKE-OFF							
MILITARY POWER	2700	51	LOW	AUTO RICH	5	300	250
ENGINE NO.	R-2800-31						

INSTRUCTIONS FOR USING CHART: Select figure in fuel column equal to or less than total amount of fuel in airplane. Move horizontally to the right or left and select a figure equal to or greater than the air miles to be flown. Vertically below and opposite desired cruising altitude read optimum cruising conditions. NOTES: (A) Avoid continuous cruising in Column I except in emergency. (B) Columns (II, III, IV & V) toward the right progressively give increase in range at sacrifice in speed. (C) Manifold Pressure (M.P.), Gallons Per Hour (G.P.H.), are approximate maximum values for reference. (D) For quick reference, take-off and military power data are listed in the upper left corner of chart.

ALTERNATE CRUISING CONDITIONS

① (NO WIND) I (MAX. CONT. POWER) RANGE IN AIR MILES ③ STATUTE AT S.L.	STATUTE AT 15,000	NAUTICAL AT S.L.	NAUTICAL AT 15,000	FUEL U.S. GALS. ①	II RANGE IN AIR MILES STATUTE	NAUTICAL	III RANGE IN AIR MILES STATUTE	NAUTICAL	IV RANGE IN AIR MILES ③ STATUTE	NAUTICAL	FUEL IMP. GALS. ①	V (MAX. RANGE) RANGE IN AIR MILES ④ STATUTE	NAUTICAL	⑤ (NO RESERVE FUEL ALLOWANCE)
1113		970		1500					1425	1235	1230	1570	1450	
1040		905		1400					1300	1130	1166	1530	1335	
960		835		1300					1180	1025	1082	1385	1300	
885		770		1200					1060	920	1000	1240	1075	
810		705		1100					955	830	916	1120	975	
735		640		1000					865	750	833	1015	880	
660		575		900					775	670	750	910	790	
585		510		800					680	590	666	800	695	

NOTE: TO OBTAIN ABOVE RANGE VALUES, OPERATING DATA FROM PRECEDING CHART MUST BE USED AS GROSS WEIGHT CHANGES. WHEN WEIGHT REACHES 30,000 LB. USE OPERATING DATA FROM CHART FOR 30,000-26,000 LB. WHEN WEIGHT REACHES 26,000 LB. USE OPERATING DATA FROM CHART FOR 26,000-23,000 LB.

OPERATING DATA R.P.M.	T.I.A.S. (KNOTS)	T.A.S. (KNOTS)	M.P. (IN. HG)	U.S. G.P.H.	IMP. G.P.H.	⑥ DENSITY ALT. IN FEET
						30000
						25000
						20000
						15000
						12000
						9000
						6000
						3000
2400	163	163	43.0	331	193	S.L.

OPERATING DATA R.P.M.	T.I.A.S. (KNOTS)	T.A.S. (KNOTS)	M.P. (IN. Hg)	U.S. G.P.H.	IMP. G.P.H.

OPERATING DATA R.P.M.	T.I.A.S. (KNOTS)	T.A.S. (KNOTS)	M.P. (IN. Hg)	U.S. G.P.H.	IMP. G.P.H.

OPERATING DATA R.P.M.	T.I.A.S. (KNOTS)	T.A.S. (KNOTS)	M.P. (IN. Hg)	U.S. G.P.H.	IMP. G.P.H.	⑥ DENSITY ALT. IN FEET
						30000
						25000
						20000
						15000
						12000
						9000
						6000
						3000
2350	150	180	40.8	191	159	S.L.

OPERATING DATA R.P.M.	T.I.A.S. (KNOTS)	T.A.S. (KNOTS)	M.P. (IN. Hg)	U.S. G.P.H.	IMP. G.P.H.	⑥ DENSITY ALT. IN FEET
						30000
						25000
						20000
						15000
						12000
						9000
						6000
						3000
2250	130	150	38.0	164	136	S.L.

ADJUST R.P.M. TO MAINTAIN PROPER T.I.A.S. DO NOT EXCEED 2400 R.P.M.

NOTES:
① INDICATED ALTITUDE CORRECTED FOR FREE AIR TEMPERATURE.
② ALLOW 0 U. S. GALS., 0 IMP. GALS. FOR WARM UP, TAKE-OFF AND CLIMB TO 0 FEET ALTITUDE.
③ RANGE VALUES HAVE BEEN REDUCED 10% BELOW OPTIMUM, TO COVER VARIATIONS IN ENGINES AND CARBURETORS. ADDITIONAL ALLOWANCES SHOULD BE MADE FOR OPERATIONAL CONTINGENCIES AND RESERVE FUEL.
④ RETURN FUEL FLOWS TO FRONT CENTER SECTION TANKS.
⑤ REFER TO SECTION II, PARAGRAPH 8 FOR ORDER OF FUEL TANK USAGE.

BOLD NUMBERS: Use Auto-Rich
LIGHT NUMBERS: Use Auto-Lean
WITH TWO SPEED BLOWER: Use high blower above heavy line only

T.A.S.: True Air Speed (Knots)
T.I.A.S.: True Indicated Air Speed (Knots)
M.P.: Manifold Pressure (In. Hg)
U.S.G.P.H.: U. S. Gallons Per Hour
IMP.G.P.H.: Imperial Gallons Per Hour
S.L.: Sea Level

RED FIGURES ARE PRELIMINARY AND SUBJECT TO REVISION AFTER FLIGHT CHECK

Figure 52 — Flight Operation Instruction Chart

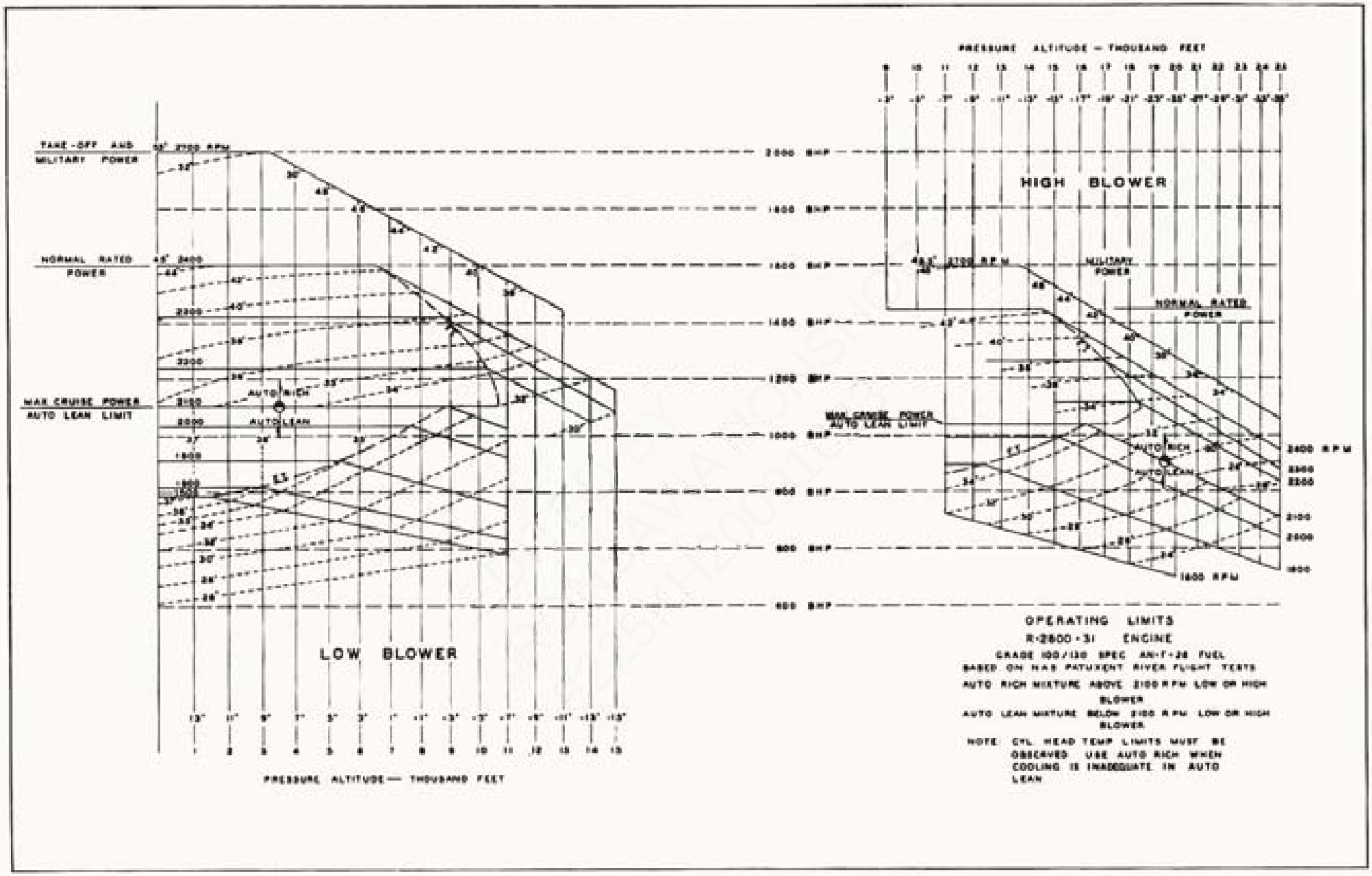


Figure 53 — Engine Calibration Curve

Appendix I and II of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of the enemy.

SUPPLEMENTARY OPERATING INSTRUCTIONS
MODEL PV-2C AIRPLANES

1. ORIGIN AND SCOPE OF DATA.

The data presented in this preliminary issue of PV-2C Airplane Supplementary Operating Instructions are based on the results of flight tests conducted on a Model PV-2C airplane, BuNo. 37041, at the Naval Air Test Center, Patuxent River, Maryland. Fuel consumption tables are given for AUTO LEAN (or AUTO RICH, as applicable) at 150 kts. Calibrated Airspeed (CAS), at Maximum Cruise Power, at Maximum Range Airspeed, and at Maximum Range Airspeed, One Engine Operative; each of which taken at gross weights of 31,000 down to 26,000 lbs. in increments of 1000 lbs. The density altitude of the tests ranged from -2000 feet to 20,000 feet. (Except the single-engine performance runs which were limited to 10,000 feet.) Charts, shown in Plates I to VI inclusive, give the above data extended to present power settings and fuel consumption figures for all combinations of loading, calibrated airspeed, and density altitudes.

For these tests the airplane was flown with the armament in the least drag position, the cowl flaps closed, and the oil cooler flaps 50% open to give adequate cooling in level flight. Flights were also made with the cowl flaps half open and full open; and with the oil cooler flaps closed and full open to determine the effect of flap opening on speed.

All fuel flow values are direct readings of the Pioneer flowmeters mounted in the fuel discharge line between the carburetor and the discharge nozzle. Engine power was determined by torquemeters on both engines. Airflow was measured by metering suction differential gages.

2. CONDITIONS OF THE FLIGHT TEST.

The test airplane was equipped with two Pratt and Whitney Model R-2800-31 engines and three-blade, 10'7" diameter, Hamilton Standard propellers, Hub Design No. 23E50-473, and Blade Design No. 6477A-12. The low pitch propeller stop was set at 26 degrees, and the high pitch stop was set at 88 degrees. Stromberg Model PT13G-9 carburetors, setting (Parts List Number) 395516-11 were used.

Throughout the tests the airplane was flown in the following drag condition: (except for variation in cowl and oil cooler flaps mentioned above)

(a) 2 fixed, forward-firing .50 cal. guns, muzzles sealed, protruding from upper surface of nose.
(b) 3 fixed, forward-firing .50 cal. guns with 18" blast tubes, muzzles sealed, mounted in package beneath nose.
(c) Top turret and tunnel mounting, guns trained aft.
(d) Yawmeter mounted on nose forward of cockpit.
(e) Pitot airspeed head beneath fuselage at approximately 75" aft of the horizontal reference line.
(f) Oil cooler beneath each engine cowl, oil cooler exit flaps 50% open. Cowl flaps closed.
(g) Drop tank pylons and Fowler flap rails on wings.
(h) Radio altimeter antenna beneath port wing.
(i) DF loop, IFF antenna, radio antenna mast; atop fuselage aft of cockpit. Antenna from mast to each vertical fin, trailing antenna from mast to each vertical fin. Trailing antenna (retracted) and sheath beneath fuselage.
(j) Trim tabs on all control surfaces.
(k) The exterior finish of the airplane as received was considered typical of a standard production job. At the conclusion of the test however, due to deterioration and various external repairs (such as capping strips on wing skin) the finish was considered rough.

3. USE OF TABLES AND CHARTS.

The tables presenting the data are arranged in the following order:

Maximum Cruise - (gross weights 31,000 - 29,000 lbs. (Table 1)).
Maximum Cruise - (gross weights 28,000 - 26,000 lbs. (Table 2)).
Maximum Cruise - (gross weights 25,000 - 23,000 lbs. (Table 3)).
150 Knots CAS - (gross weights 31,000 - 29,000 lbs. (Table 4)).
150 Knots CAS - (gross weights 28,000 - 26,000 lbs. (Table 5)).
150 Knots CAS - (gross weights 25,000 - 23,000 lbs. (Table 6)).
Maximum Range - (gross weights 31,000 - 29,000 lbs. (Table 7)).
Maximum Range - (gross weights 28,000 - 26,000 lbs. (Table 8)).
Maximum Range - (gross weights 25,000 - 23,000 lbs. (Table 9)).
Maximum Range, Single Engine (gross weights 31,000-29,000 lbs.(Table 10)).
Maximum Range, Single Engine (gross weights 28,000-26,000 lbs. (Table 11)).
Maximum Range, Single Engine (gross weights 25,000-23,000 lbs. (Table 12)).
Operating Chart (Plate I).
Operating Limits, Engine Calibration Curve (Plate II).
Drag Correction Charts (Plate III).
Range Chart, Two Engines Operative (Plate IV).
Range Chart, One Engine Operative (Plate V).
Climb Data (Plate VI).
Single Engine Ceiling (Plate VII).

All the values in the tables and charts should correlate closely in flights with other PV-2C airplanes only under standard conditions. Standard conditions occur when the outside air temperature at the pressure altitude being flown corresponds to the standard temperature for that altitude. In standard conditions, the "pressure altitude" and the "density altitude" will coincide. The effect of moisture content is not considered in these instructions.

Under standard conditions the tabulated CAS and GPH will be obtained with the corresponding tabulated MP and RPM. Under non-standard conditions close correlation between airspeeds and power settings should not be expected. However, by entering the standard altitude column of these tables with density altitude, and using calibrated airspeed as a guide in setting up power, the resulting rate of fuel consumption at that CAS can be read directly from the tables.

Maximum economy in the cruise range, evidenced by maximum miles per gallon, was obtained at the limiting BMEP of 150 in LOW BLOWER and at the limiting BMEP of 140 in HIGH BLOWER. However, at engine speeds below 1500 RPM, loss in propeller efficiency overbalances the gain in fuel economy, resulting in a lower net value of miles per gallon. The minimum RPM recommended for cruising is 1500 RPM.

4. USE OF THE DATA.

To obtain the most economical engine operation consistent with long engine life, the engines should be operated in accordance with the Operating Chart, and the Engine Operating Limits. These charts and Tables 1-8 (incl.) are obtained from the same test data.

RPM is found on Plate I for the normal configuration by finding the intersection of the gross weight line and the desired CAS line at the bottom of the chart, and from that point extending a line vertically upward to intersect the density altitude line, measured on the ordinate. This intersection determines the RPM and fuel consumption. In the part throttle cruise range, the intersection of the vertical line with the pressure altitude, also measured on the ordinate, determines the approximate manifold pressure and may be corrected by this rule:

Increase manifold pressure one inch for
each twenty degress centigrade that actual out-

side air temperature is above standard. Decrease manifold pressure one inch for each twenty degrees that outside air temperature is below standard.

This approximate manifold pressure may also be obtained from Plate II from the intersection of RPM and pressure altitude.

In the part throttle range, powers are first set up by using the RPM and manifold pressure (corrected for variation from standard temperature conditions) thus found. If any change in power is then necessary to obtain the desired CAS, this change should be accomplished by varying the manifold pressure only.

In the full-throttle range, full throttle and approximately the RPM shown by Plate I should be used. The RPM should then be adjusted until the desired airspeed is obtained.

5. MAXIMUM RANGE AIRSPEED.

The airspeeds for maximum range at all gross weights with two engines operative are shown on Plate I, Plate IV, and Tables 7 to 9. The airspeeds for maximum range at all gross weights with one engine operative are shown on Plate V and Tables 10 to 12.

Range available with any starting gross weight and full load, both engines operative, is shown on Plate IV. Although Plate IV is drawn for 1500 feet density altitude, it is approximately correct for all altitudes below 11,000 feet in LOW BLOWER. However, since no allowance has been made for the fuel consumed and for the miles flown during climb, Plate VI must be used in conjunction with Plate IV in order to determine the fuel available after the altitude is reached and the miles (covered during the climb) to be added to the resulting range. (See Section 16. Use of Charts and Tables in setting up a flight plan.)

It will be noted from the Distance vs Time graph at the upper right of Plate IV, that very nearly the same range may be attained at 150 knots CAS as at maximum range speed, and the flight time considerably reduced. For most operation, 150 knots CAS is considered more satisfactory than maximum range speed. The engine settings and fuel consumption at 150 knots CAS are indicated on Table 2.

Range available with one engine operative is plotted on Plate V. Plate V should be entered with the present gross weight and fuel available at the time single-engine flight is begun.

Correct engine settings and resultant fuel consumption for maximum range flight with one engine operative are listed on tables 10 to 12 (inclusive).

When flying in the cruise range, particularly, it is desirable to approach the desired flight altitude from approximately 200 feet higher altitude to obtain the benefit of initial speed and altitude to offset mushing.

6. MAXIMUM ENDURANCE SPEED.

Maximum endurance will be obtained at the lowest flyable power at the lowest practicable altitudes. Minimum recommended speed is approximately 10 knots slower than the maximum range speed at each weight.

7. CLIMBS.

Rated power climbs should be made in accordance with the recommended instructions on Plate VI. Some cowl flap opening may be required when climbing under warm weather conditions. Increase the airspeed as much as five knots by reducing angle of climb slightly in preference to using greater than one-half cowl flap opening.

8. SINGLE ENGINE OPERATION.

The maximum altitude at which level flight may be maintained at normal rated power on one engine (if failure occurs above this altitude) is plotted against gross weight on Plate VII. Keep cowl and oil flaps closed on the feathered engine, and use minimum flap opening required to maintain cylinder head and oil temperatures on operating engine.

If it is required to cruise on a single engine for any considerable length of time, the maximum range airspeed for single engine operation should be used, according to Table IV. The range available with one engine operative is shown on Plate V.

Data presented are for the starboard engine operative, port engine feathered. If the operative engine is the port engine, some slight improvement over this performance may be expected.

9. CYLINDER HEAD TEMPERATURE LIMITS.

Take-off	AUTO RICH, 5 Min.	260°C
Military Power	AUTO RICH, 5 Min.	260°C
Rated Power and below	AUTO RICH, 1 Hour	260°C
Rated Power and below	AUTO RICH, Continuous	232°C
Maximum Cruise and below	AUTO LEAN, Continuous	232°C

AUTO RICH must be used for all powers above maximum cruise, and for takeoff, landing, landing approach, and for all ground operation, and whenever cylinder head temperatures cannot be maintained within limits in AUTO LEAN.

AUTO LEAN may be used for all flight operation up to maximum cruise power (2100 RPM and recommended manifold pressure from Plate II) in both LOW and HIGH BLOWER, except as listed under AUTO RICH above.

10. MANUAL LEANING.

Manual leaning is not recommended.

11. BLOWER RATIO.

For most economical operation in the cruise range, 2100 RPM or less, use LOW BLOWER below 11,000 feet altitude and HIGH BLOWER above this altitude. For high powers, operating between 2100 and 2400 RPM, AUTO RICH, use LOW BLOWER below 15,000 feet altitude and HIGH BLOWER above this altitude. However, if more power is desired than is available at full throttle and rated RPM (2400 RPM) in LOW BLOWER, shift to HIGH BLOWER.

Level flight shift altitudes for normal rated and military power are indicated.

Normal rated power (2400 RPM) - shift from LOW BLOWER to HIGH BLOWER at 9250 feet altitude.

Military power (2700 RPM) - shift from LOW BLOWER to HIGH BLOWER at 10,000 feet altitude.

Blower shift altitudes in climbs are somewhat lower than the above. In climbs when 41 inches Hg. manifold pressure at military RPM, or 39 inches Hg. at normal rated RPM is reached at full throttle in LOW BLOWER, shift to HIGH BLOWER.

Correct altitudes for shifting blowers are plotted on Plates I, II, and VI.

12. CARBURETOR AIR.

Plates I to VI and Tables 1 to 12 are for airplane operation using direct carburetor air. The use of alternate air will increase fuel consumption and decrease power at the specified RPM - Manifold Pressure settings. Operation in alternate air causes a large rise in carburetor air temperature, thus lowering the detonation limited power at any RPM.

13. COWL FLAPS.

Opening the cowl flaps creates considerable drag, as indicated on Plate III. Therefore, as far as possible, their use should be restricted to ground operation. The use of cowl flaps on the test airplane was not required in level flight, with either one or both engines operative. It is recommended that the cowl flaps be opened gradually as the cylinder head temperatures approach the limit rather than opening them wide when the limit is reached.

14. OIL COOLER FLAPS.

In order to maintain satisfactory oil temperatures on the test airplane in level flight, 50% oil cooler exit flap opening was required. Plate I has been drawn to include the drag caused by this amount of flap opening. The increase in speed due to closing these flaps, or decrease in speed due to opening them more than 50% is plotted on Plate III. Single engine operation required 75% oil cooler exit flap opening on the operating engine. The oil cooler flaps were closed on the dead engine.

15. FACTORS AFFECTING PERFORMANCE.

Any PV-2C airplane corresponding to the test airplane in external configuation should perform comparably and within 5% of the charted fuel consumption. The following factors must be considered in checking actual versus plotted results:

(a) AIRSPEED.

Airspeed meter lines must be free from water and dirt. The test airplane had a large calibration error at low airspeeds. The difference between calibrated and indicated airspeed is plotted on Plate III.

(b) WEIGHT.

Plate I is applicable for all weights by use of the weight chart which is an integral part of the chart. Range data is plotted on Plates IV and V as a function of gross weight. The climbs of Plate VI are plotted for two gross weights and may be interpolated for intermediate weights. Single engine ceiling is plotted on Plate VII as a function of gross weight.

Tables 1 to 12 indicate engine settings, airspeeds, and fuel consumption for normal cruise operation, and for cruise operation on a single engine for increments of gross weight throughout the range of operating weights.

Accurate airplane weight records should be kept in order to estimate performance correctly, and to make proper use of the performance, range, and climb charts and tables.

(c) DRAG.

Plates I, IV, and V, and Tables 1-9 are constructed to indicate the performance of the airplane in the configuration of the airplane listed on page one of these Supplementary Operating Instructions. The drag introduced

by further opening of the oil cooler flaps, opening the cowl flaps, or feathering the propeller on one engine is plotted on Plate III. The appropriate chart of Plate III is entered with the actual CAS, and the correct CAS to enter Plate I is read from the scale. This value is used to enter Plate at the existing gross weight.

(d) CONDITION OF ENGINES AND CARBURETOR.

Failure to realize the performance indicated on the various plates and tables, using the indicated engine settings (corrected for temperature as recommended), may be caused by faulty carburetion, incorrect magneto timing, or incorrect valve clearance and timing. If the fuel consumption is substantially the same as indicated, the carburetor may be eliminated as a cause for the discrepancy. Magneto and valve timing should then be carefully checked to determine the cause for the loss in performance.

(e) PRESSURE ALTITUDE.

Pressure altitude is indicated on the altimeter when the adjustment scale ("window number") is set at 29.92 inches Hg. All engine output and manifold pressure requirements are based on pressure altitude. On the conversion chart of Plate I pressure altitude lines are inclined upward to the right; density altitude lines are horizontal; outside air temperature lines are vertical.

(f) DENSITY ALTITUDE is determined by finding the intersection of pressure altitude and outside air temperature on the conversion chart of Plate I, and reading the density altitude on the horizontal line. All computations of airplane performance concerning airspeed must be based on density altitude.

(g) OUTSIDE AIR TEMPERATURE.

As indicated above, outside air temperature is used to determine the density altitude. Manifold pressure requirements must also be corrected for deviation of actual outside air temperature from standard. Climb performance shown on Plate VI varies widely with temperature, decreasing the time to climb in cold weather and increasing the time to climb in hot weather. Since the exact corrections are too complex for field use, the data shown on Plate VI should be considered merely as average values, subject to ± 15% variation.

16. USE OF CHARTS AND TABLES IN SETTING UP FLIGHT PLAN - SAMPLE PROBLEM.

Altitude to be flown is 5000 feet. Patrol CAS will be 150 knots.

Expected air temperatures - 14 degrees Centrigrade; 9 degrees warmer than standard.

Airplane weight including all gear, ammunition, 2 - 1000 pound bombs, oil, crew of five, and 836 gallons of fuel (full front and rear center section tanks, cabin tank, and front bomb bay tank) = 31,000 pounds.

A two-hour reserve at maximum range speed must be allowed, plus an additional reserve for five minutes of military power operation, and fifteen minutes of normal rated power operation.

The total distance which may be flown is to be determined. This distance may then be divided to determine the limits of a sector patrol or an out and back mission.

(a) Determine the amount of fuel reserve, and usable fuel: (Fuel weight computed at 6 lbs/gal)

Initial gross weight	31,000 lbs.
836 gals. x 6 lbs/gal	5,016 lbs.
Return weight (no fuel)	25,984 lbs.

Reserve will be computed at 27,000 lbs. From Plate I or Table II, fuel required at maximum range CAS at 1000 feet = 95 gals/hr.

2 hrs. x 95 gals/hr. = 190 gals.

Miliary power operation at S.L. - 1000 feet requires 510 gals/hr from Plate I.

$$510 \text{ gals/hr} \times \frac{5 \text{ Min.}}{60 \text{ Min.}} = 42.5 \text{ gals.}$$

Normal rated power operation from S. L. to 5000 feet requires 355 gals/hr.

$$355 \text{ gals/hr} \times \frac{15 \text{ Min.}}{60 \text{ Min.}} = 88.5 \text{ gals.}$$

190 gals.	836 gals. Total Fuel
42.5 gals.	321 gals. Reserve
88.5 gals.	515 gals. Usable Fuel
321 gals. Total Reserve	

(b) Construction of a Flight Plan - Howgozit.

Plate I is used for determining engine settings, and fuel consumption, or Table II may be used. The true airspeeds are obtained from a computer (i.e., Mark 8a).

The fuel burned and distance covered in the climb are determined from Plate VI. The chart is extrapolated to a weight of 31,000 pounds, and indicates that the climb to 5000 feet (including warm-up and take-off) will require 48 gals. of fuel and cover 10 miles.

Plate I altitude conversion chart is entered with 5000 feet pressure altitude and 14 degrees Centrigrade. The density altitude is found to be 6000 feet. All RPM settings and fuel consumption will be found on the horizontal line of 6000 feet density altitude. Normally the manifold pressures would be found on the 5000 feet pressure altitude line, and increased 0.5 inches according to the rule of thumb stated above on page 2. Since the engine is already at full throttle, the RPM must be increased above the approximate value indicated on Plate I in order to obtain 150 knots.

The HOWGOZIT TABLE may now be filled out. Increments of 1.5 hours are adequate for a change of power settings. As the new weight is found each 1.5 hours, the lower chart of Plate I is entered with that weight. Where the 150-knot CAS line intersects this weight line, a vertical line is followed to intersect the 5000 foot altitude line. This approximately determines the manifold pressure. The vertical line is continued to intersect 6000 feet altitude. This determines the RPM and fuel consumption.

If Table II is used, enter the column at the nearest 1000 lb. weight. The same technique is used on Plate I, i.e.; select manifold pressure at the pressure altitude, and both RPM and fuel consumption at the density altitude.

When completely worked out, the HOWGOZIT FORM shows that the distance which may be flown under the conditions of the problem is 682 nautical miles. The time required will be 4.18 hours.

(c) CHECK ON IMPROVEMENT IN RANGE USING MAXIMUM RANGE CAS INSTEAD OF 150 KNOTS CAS.

From the HOWGOZIT TABLE, the fuel available and weight after climbing to 5000 feet are:

467 gals. and 30,712 lbs.

Enter Plate IV at this weight and follow down the slant line to 467 gals. The distance is read from the lower scale as 675 nautical miles. The distance covered during the climb, 10 miles, is added to this distance to get the total range.

675 + 10 = 685 miles at Maximum Range CAS.

There is no appreciable improvement by using Maximum Range CAS instead of 150 knots CAS.

HOWGOZIT FORM											
Weight at Start of Period	Max Range CAS	RPM	MP	Flow-Meter	IAS	Total Miles	Time Hours	GPH (Both Engines)	Gals This Period	Total Gals.	Weight End of Period
31,000 LBS						10	.08		48	48	-288 lbs 30,712
30,712 LBS	150	1600	PT	340	164	256	1.5	116	174	222	-1,044 lbs 29,668
29,668 LBS	150	1580	PT	335	164	502	1.5	114	171	393	-1,026 lbs 28,642
28,642 LBS	150	1560	PT	330	164	682	1.1	111	122	515	-732 lbs 27,910

Total distance = 682 Miles (nautical)

Total fuel burned = 515 Gallons

Total time required = 4 hrs. 11 min.

MAXIMUM CRUISE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 31,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 30,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 29,000 LBS. RPM	MP	GPH	CAS
20000	- 25	HIGH BLOWER	2100	FT	149	142	2100	FT	149	145	2100	FT	149	147
18000	- 21		2100	FT	161	154	2100	FT	161	156	2100	FT	161	158
16000	- 17		2100	34.5	172	164	2100	34.5	172	165	2100	34.5	172	167
14000	- 13		2100	35.0	171	167	2100	35.0	171	168	2100	34.0	171	170
12000	- 9		2100	35.0	170	170	2100	35.0	170	171	2100	35.0	170	172
10000	- 5	LOW BLOWER	2100	FT	171	174	2100	FT	171	175	2100	FT	171	176
9000	- 3		2100	FT	173	178	2100	FT	173	179	2100	FT	173	180
8000	- 1		2100	34.5	173	180	2100	34.5	173	180	2100	34.5	173	181
7000	1		2100	34.0	174	181	2100	35.0	174	182	2100	34.0	174	183
6000	3		2100	35.0	175	182	2100	35.0	175	183	2100	35.0	175	184
5000	5		2100	35.5	176	183	2100	35.5	176	184	2100	35.5	176	185
4000	7		2100	35.5	177	185	2100	35.5	177	186	2100	35.5	177	186
3000	9		2100	36.0	178	186	2100	36.0	178	187	2100	36.0	178	187
2000	11		2100	36.5	179	187	2100	36.5	179	188	2100	36.5	179	189
1000	13		2100	37.0	180	188	2100	37.0	180	189	2100	37.0	180	190
S.L.	15		2100	37.5	181	189	2100	37.5	181	190	2100	37.5	181	191
-1000	17		2100	37.5	182	190	2100	37.5	182	191	2100	37.5	182	192
-2000	19		2100	37.5	184	192	2100	37.5	184	193	2100	37.5	184	193

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 1

MAXIMUM CRUISE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 28,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 27,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 26,000 LBS. RPM	MP	GPH	CAS
20000	- 25	HIGH BLOWER	2100	FT	149	149	2100	FT	149	151	2100	FT	149	153
18000	- 21		2100	FT	161	159	2100	FT	161	161	2100	FT	161	162
16000	- 17		2100	34.5	172	168	2100	34.5	172	169	2100	34.5	172	171
14000	- 13		2100	35.0	171	171	2100	35.0	171	172	2100	35.0	171	173
12000	- 9		2100	35.0	170	173	2100	35.0	170	174	2100	35.0	170	175
10000	- 5	LOW BLOWER	2100	FT	171	177	2100	FT	171	178	2100	FT	171	179
9000	- 3		2100	FT	173	181	2100	FT	173	182	2100	FT	173	183
8000	- 1		2100	34.5	173	182	2100	34.5	173	183	2100	34.5	173	184
7000	1		2100	35.0	174	184	2100	35.0	174	185	2100	35.0	174	186
6000	3		2100	35.0	175	185	2100	35.0	175	186	2100	35.0	175	187
5000	5		2100	35.5	176	186	2100	35.5	176	187	2100	35.5	176	188
4000	7		2100	35.5	177	187	2100	35.5	177	188	2100	35.5	177	189
3000	9		2100	36.0	178	188	2100	36.0	178	189	2100	36.0	178	190
2000	11		2100	36.5	179	190	2100	36.5	179	190	2100	36.5	179	191
1000	13		2100	37.0	180	190	2100	37.0	180	191	2100	37.0	180	192
S.L.	15		2100	37.5	181	192	2100	37.5	181	193	2100	37.5	181	193
-1000	17		2100	37.5	182	193	2100	37.5	182	194	2100	37.5	182	195
-2000	19		2100	37.5	184	194	2100	37.5	184	195	2100	37.5	184	196

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 2

MAXIMUM CRUISE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 25,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 24,000 LBS. RPM	MP	GPH	CAS	GROSS WEIGHT 23,000 LBS. RPM	MP	GPH	CAS
20000	- 25	HIGH BLOWER	2100	FT	149	155	2100	FT	149	156	2100	FT	149	158
18000	- 21		2100	FT	161	164	2100	FT	161	165	2100	FT	161	166
16000	- 17		2100	34.5	172	172	2100	34.5	172	173	2100	34.5	172	174
14000	- 13		2100	25.0	171	174	2100	35.0	171	175	2100	35.0	171	176
12000	- 9		2100	35.0	170	176	2100	35.0	170	177	2100	35.0	170	178
10000	- 5	LOW BLOWER	2100	FT	171	180	2100	FT	175	181	2100	FT	171	183
9000	- 3		2100	FT	173	184	2100	FT	173	185	2100	FT	173	185
8000	- 1		2100	34.5	173	185	2100	34.5	173	186	2100	34.5	173	187
7000	1		2100	35.0	174	187	2100	35.0	174	187	2100	35.0	174	188
6000	3		2100	35.0	175	188	2100	35.0	175	188	2100	35.0	175	189
5000	5		2100	35.5	176	189	2100	35.5	176	189	2100	35.5	176	190
4000	7		2100	35.5	177	190	2100	35.5	177	191	2100	35.5	177	192
3000	9		2100	36.0	178	191	2100	36.0	178	192	2100	36.0	178	193
2000	11		2100	36.5	179	192	2100	36.5	179	193	2100	36.5	178	194
1000	13		2100	37.0	180	193	2100	37.0	180	194	2100	37.0	180	195
S.L.	15		2100	37.5	181	194	2100	37.5	181	195	2100	37.5	181	196
-1000	17		2100	37.5	182	195	2100	37.5	182	196	2100	37.5	182	197
-2000	19		2100	37.5	184	197	2100	37.5	184	198	2100	37.5	184	198

ABBREVIATIONS:

MP- - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 3

150 KNOTS CAS

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 31,000 LBS. RPM	MAP	GPH	GROSS WEIGHT 30,000 LBS. RPM	MAP	GPH	GROSS WEIGHT 29,000 LBS. RPM	MAP	GPH
20000	- 25	HIGH BLOWER									
18000	- 21		2060	FT	154	2030	FT	149	2000	FT	145
16000	- 17		1940	FT	147	1910	FT	141	1880	FT	138
14000	- 13		1830	FT	140	1800	FT	135	1780	FT	131
12000	- 9		1730	FT	133	1710	FT	129	1690	FT	126
10000	- 5	LOW BLOWER	1820	FT	127	1800	FT	123	1780	FT	120
9000	- 3		1780	FT	124	1760	FT	120	1730	FT	118
8000	- 1		1720	FT	121	1690	FT	118	1670	FT	115
7000	1		1660	FT	119	1620	FT	116	1610	FT	113
6000	3		1610	FT	117	1590	FT	114	1570	FT	111
5000	5		1570	FT	115	1540	FT	112	1510	FT	110
4000	7		1510	FT	113	1500	33.5	110	1500	33.0	109
3000	9		1500	34.0	112	1500	33.5	109	1500	33.0	108
2000	11		1500	34.5	111	1500	34.0	108	1500	33.5	107
1000	13		1500	35.0	111	1500	34.5	108	1500	34.0	107
S.L.	15		1500	35.5	112	1500	34.5	109	1500	34.0	107
-1000	17		1500	35.5	113	1500	35.0	110	1500	34.0	108
-2000	19		1500	36.0	114	1500	35.0	111	1500	34.5	109

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 4

150 KNOTS CAS

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 28,000 LBS. RPM	MAP	GPH	GROSS WEIGHT 27,000 LBS. RPM	MAP	GPH	GROSS WEIGHT 26,000 LBS. RPM	MAP	GPH
20000	- 25	HIGH BLOWER	2100	FT	149	2080	FT	145	2050	FT	141
18000	- 21		1980	FT	141	1960	FT	138	1920	FT	134
16000	- 17		1860	FT	134	1830	FT	130	1820	FT	128
14000	- 13		1770	FT	128	1740	FT	126	1720	FT	123
12000	- 9		1670	FT	123	1650	FT	121	1630	FT	119
10000	- 5	LOW BLOWER	1750	FT	118	1730	FT	116	1700	FT	113
9000	- 3		1700	FT	116	1670	FT	113	1640	FT	111
8000	- 1		1640	FT	113	1610	FT	111	1590	FT	110
7000	1		1590	FT	111	1560	FT	109	1540	FT	108
6000	3		1540	FT	110	1510	FT	108	1500	FT	106
5000	5		1500	32.0	108	1500	31.5	106	1500	31.0	105
4000	7		1500	32.5	107	1500	32.0	105	1500	31.5	103
3000	9		1500	32.5	106	1500	32.0	104	1500	31.5	102
2000	11		1500	33.0	105	1500	32.5	103	1500	32.0	101
1000	13		1500	33.0	105	1500	33.0	103	1500	32.5	101
S.L.	15		1500	33.5	105	1500	33.0	103	1500	32.5	101
-1000	17		1500	34.0	105	1500	33.5	103	1500	33.0	101
-2000	19		1500	34.0	106	1500	34.0	104	1500	33.5	101

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 5

150 KNOTS CAS

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 25,000 LBS.			GROSS WEIGHT 24,000 LBS.			GROSS WEIGHT 23,000 LBS.		
			RPM	MAP	GPH	RPM	MAP	GPH	RPM	MAP	GPH
20000	- 25	HIGH BLOWER	2020	FT	138	2000	FT	135	1980	FT	131
18000	- 21		1900	FT	131	1880	FT	129	1860	FT	126
16000	- 17		1800	FT	126	1780	FT	123	1760	FT	121
14000	- 13		1710	FT	121	1700	FT	119	1680	FT	117
12000	- 9		1610	FT	117	1600	FT	115	1580	FT	112
10000	- 5	LOW BLOWER	1670	FT	111	1640	FT	109	1620	FT	108
9000	- 3		1620	FT	109	1600	FT	107	1580	FT	106
8000	- 1		1570	FT	108	1550	FT	105	1530	FT	104
7000	1		1520	FT	106	1500	FT	103	1500	29.5	102
6000	3		1500	30.5	104	1500	30.0	102	1500	29.5	100
5000	5		1500	31.0	102	1500	30.5	101	1500	30.0	99
4000	7		1500	31.0	101	1500	30.5	100	1500	30.0	98
3000	9		1500	31.0	100	1500	31.0	99	1500	30.5	97
2000	11		1500	31.5	100	1500	31.0	98	1500	30.5	97
1000	13		1500	31.5	99	1500	31.0	97	1500	31.0	96
S.L.	15		1500	32.0	99	1500	31.5	97	1500	31.0	96
-1000	17		1500	32.5	99	1500	32.0	97	1500	31.5	96
-2000	19		1500	32.5	99	1500	32.0	97	1500	31.5	96

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 6

MAXIMUM RANGE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 31,000 LBS (146 CAS) RPM	MAP	GPH	GROSS WEIGHT 30,000 LBS (145 CAS) RPM	MAP	GPH	GROSS WEIGHT 29,000 LBS (144 CAS) RPM	MAP	GPH
20000	- 25	HIGH BLOWER	Use Max. Cruise			Use Max. Cruise			2050	FT	141
18000	- 21		2010	FT	147	1970	FT	140	2050	FT	141
16000	- 17		1900	FT	140	1850	FT	133	1810	FT	129
14000	- 13		1790	FT	133	1760	FT	128	1720	FT	124
12000	- 9		1700	FT	128	1670	FT	123	1640	FT	120
10000	- 5	LOW BLOWER	1790	FT	121	1750	FT	117	1700	FT	114
9000	- 3		1730	FT	119	1700	FT	115	1640	FT	112
8000	- 1		1680	FT	117	1640	FT	113	1590	FT	110
7000	1		1620	FT	115	1580	FT	111	1550	FT	108
6000	3		1570	FT	113	1540	FT	109	1500	FT	107
5000	5		1530	FT	111	1500	32.0	108	1500	31.5	105
4000	7		1500	33.0	109	1500	32.5	106	1500	31.5	103
3000	9		1500	33.5	108	1500	32.5	105	1500	32.0	102
2000	11		1500	34.0	108	1500	33.0	104	1500	32.0	102
1000	13		1500	34.0	108	1500	33.0	104	1500	32.5	101
S.L.	15		1500	34.5	108	1500	33.5	104	1500	32.5	101
-1000	17		1500	34.5	109	1500	34.0	105	1500	33.0	101
-2000	19		1500	35.0	110	1500	34.0	105	1500	33.0	101

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 7

MAXIMUM RANGE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 28,000 LBS (142 CAS) RPM	MAP	GPH	GROSS WEIGHT 27,000 LBS(140 CAS) RPM	MAP	GPH	GROSS WEIGHT 26,000 LBS (138 CAS) RPM	MAP	GPH
20000	- 25	HIGH BLOWER	2000	FT	136	1960	FT	129	1910	FT	123
18000	- 21		1900	FT	129	1850	FT	124	1800	FT	118
16000	- 17		1790	FT	124	1750	FT	120	1700	FT	113
14000	- 13		1700	FT	120	1660	FT	115	1620	FT	110
12000	- 9		1610	FT	116	1580	FT	110	1540	FT	106
10000	- 5	LOW BLOWER	1650	FT	110	1600	FT	106	1560	FT	102
9000	- 3		1600	FT	108	1560	FT	104	1510	FT	100
8000	- 1		1550	FT	106	1510	FT	102	1500	28.0	98
7000	1		1510	FT	104	1500	29.5	100	1500	28.5	97
6000	3		1500	30.5	102	1500	29.5	99	1500	28.5	95
5000	5		1500	30.5	101	1500	30.0	98	1500	29.0	94
4000	7		1500	31.0	100	1500	30.0	97	1500	29.0	93
3000	9		1500	31.0	99	1500	30.5	96	1500	29.5	92
2000	11		1500	31.5	98	1500	30.5	95	1500	29.5	92
1000	13		1500	31.5	98	1500	31.0	95	1500	30.0	91
S.L.	15		1500	32.0	98	1500	31.0	95	1500	30.0	91
-1000	17		1500	32.0	98	1500	31.0	95	1500	30.5	90
-2000	19		1500	32.0	98	1500	31.5	95	1500	30.5	90

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 8

MAXIMUM RANGE

DIRECT AIR
CLEAN CONFIGURATION

AUTO LEAN
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 25,000 LBS (135 CAS) RPM	MAP	GPH	GROSS WEIGHT 24,000 LBS (132 CAS) RPM	MAP	GPH	GROSS WEIGHT 23,000 LBS (128 CAS) RPM	MAP	GPH
20000	- 25	HIGH BLOWER	1850	FT	116	1800	FT	109	1730	FT	102
18000	- 21		1750	FT	111	1700	FT	106	1630	FT	100
16000	- 17		1660	FT	108	1620	FT	103	1570	FT	98
14000	- 13		1590	FT	105	1540	FT	100	1500	FT	95
12000	- 9		1510	FT	101	1500	28.0	97	1500	27.0	93
10000	- 5	LOW BLOWER	1500	FT	97	1500	26.0	93	1500	25.0	88
9000	- 3		1500	27.0	96	1500	26.0	92	1500	25.0	86
8000	- 1		1500	27.0	95	1500	26.0	90	1500	25.0	85
7000	1		1500	27.5	93	1500	26.5	88	1500	25.5	83
6000	3		1500	27.5	91	1500	26.5	87	1500	25.5	81
5000	5		1500	28.0	90	1500	27.0	86	1500	25.5	80
4000	7		1500	28.0	89	1500	27.0	85	1500	26.0	79
3000	9		1500	28.5	88	1500	27.5	84	1500	26.0	79
2000	11		1500	28.5	88	1500	27.5	83	1500	26.5	78
1000	13		1500	29.0	88	1500	27.5	83	1500	26.5	78
S.L.	15		1500	29.0	87	1500	28.0	82	1500	27.0	77
-1000	17		1500	29.0	87	1500	28.0	82	1500	27.0	77
-2000	19		1500	29.5	87	1500	28.5	82	1500	27.0	77

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C

TABLE 9

MAXIMUM RANGE - SINGLE ENGINE

DIRECT AIR
CLEAN CONFIGURATION

AUTO RICH (EXCEPT AS NOTED)
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 31,000 LBS (143 CAS) RPM	MAP	GPH	GROSS WEIGHT 30,000 LBS (140 CAS) RPM	MAP	GPH	GROSS WEIGHT 29,000 LBS (137 CAS) RPM	MAP	GPH
10000		LOW BLOWER									
9000											
8000	- 1								2400	FT	170
7000	1					2400	FT	175	2350	40.0	160
6000	3					2370	41.0	168	2330	39.5	155
5000	5					2360	41.0	164	2320	39.5	151
4000	7		2400	43.0	177	2350	40.5	160	2310	39.0	146
3000	9		2390	43.0	171	2340	40.5	155	2300	39.0	142
2000	11		2375	42.5	167	2320	40.0	151	2290	39.0	138
1000	13		2360	42.0	164	2310	40.0	147	2275	39.0	134
S.L.	15		2350	42.0	160	2300	40.0	143	2260	39.0	131
-1000	17		2335	42.0	156	2290	40.0	139	2250	39.0	129
-2000	19		2320	42.0	152	2280	40.0	136	2240	39.0	127

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots

GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 10

MAXIMUM RANGE - SINGLE ENGINE

DIRECT AIR
CLEAN CONFIGURATION

AUTO RICH (EXCEPT AS NOTED)
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

STD. ALT.	STD. TEMP. °C.		GROSS WEIGHT 28,000 LBS (135 CAS) RPM	MAP	GPH	GROSS WEIGHT 27,000 LBS (134 CAS) RPM	MAP	GPH	GROSS WEIGHT 26,000 LBS (133 CAS) RPM	MAP	GPH
10000	- 5					2400	FT	153	2300	FT	132
9000	- 3		2400	FT	160	2290	FT	140	2250	36.5	124
8000	- 1		2310	38.5	150	2275	37.0	135	2240	36.0	120
7000	1		2300	38.5	143	2260	37.0	130	2225	36.0	117
6000	3	LOW BLOWER	2290	38.0	139	2250	37.0	126	2210	35.5	114
5000	5		2280	38.0	134	2240	37.0	123	2200	35.5	112
4000	7		2270	38.0	130	2230	37.0	120	2190	35.5	110
3000	9		2260	38.0	128	2220	37.0	118	2175	36.0	108
2000	11		2250	38.0	125	2210	37.0	116	2160	36.0	106
1000	13		2235	38.0	122	2200	37.0	113	2150	36.0	104
S.L.	15		2220	38.0	120	2190	37.0	111	2140	36.5	102
-1000	17		2210	38.0	117	2175	37.0	109	2125	36.5	100
-2000	19		2200	38.0	115	2160	37.0	107	2110	36.5	98

ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 11

MAXIMUM RANGE - SINGLE ENGINE

DIRECT AIR
CLEAN CONFIGURATION

AUTO RICH (EXCEPT AS NOTED)
COWL FLAPS CLOSED
OIL COOLER FLAPS 50% OPEN

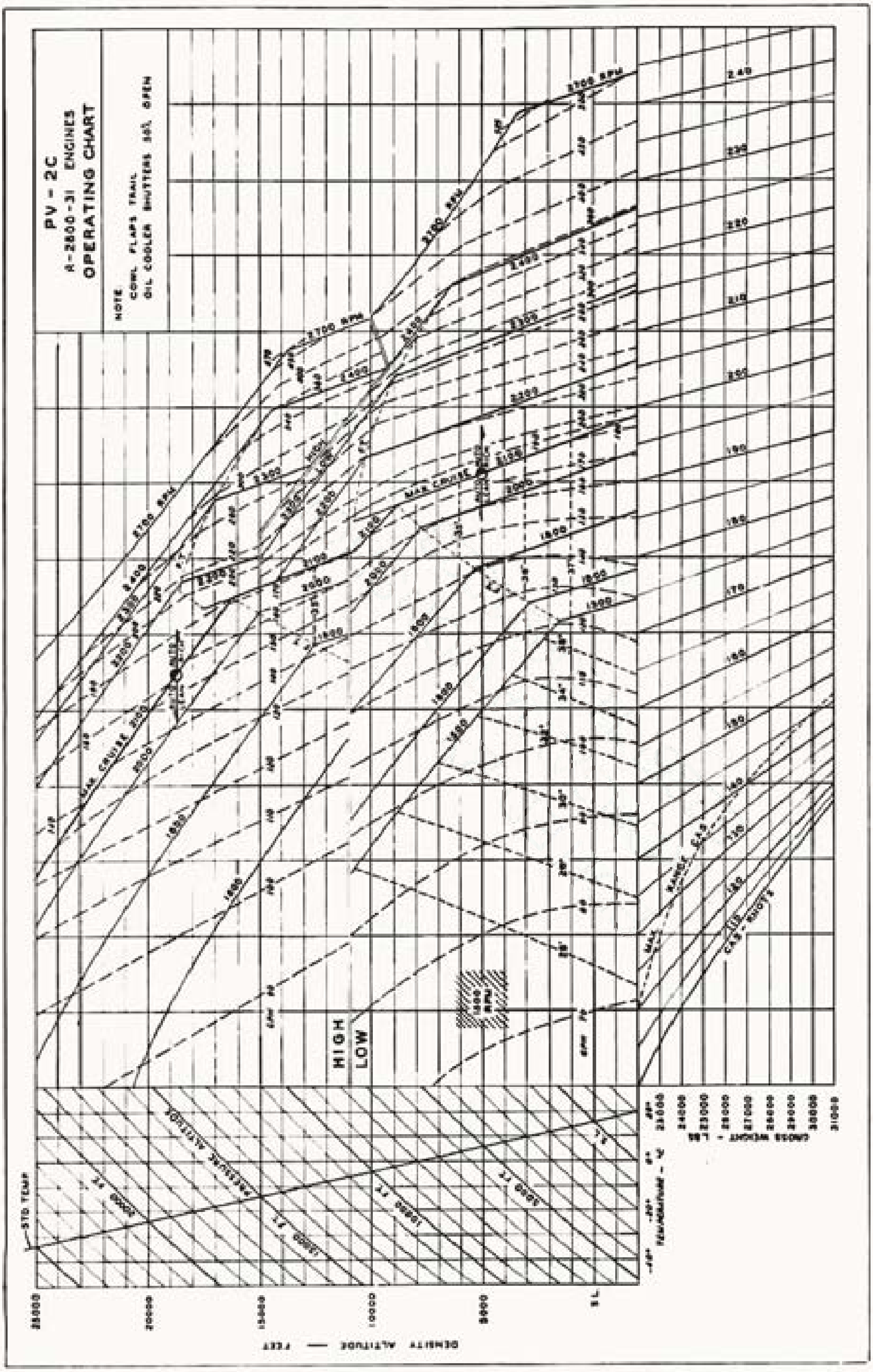
STD. ALT.	STD. TEMP. °C		GROSS WEIGHT 25,000 LBS (132 CAS) RPM	MAP	GPH	GROSS WEIGHT 24,000 LBS (131 CAS) RPM	MAP	GPH	GROSS WEIGHT 23,000 LBS (130 CAS) RPM	MAP	GPH
10000	- 5		2220	FT	116	2190	34.0	108	2130	33.0	98
9000	- 3		2210	35.0	114	2175	34.0	105	2120	33.0	95
8000	- 1		2200	35.0	111	2160	34.0	101	2110	33.0	93
7000	1	LOW BLOWER	2190	35.0	108	2145	34.0	99	2090	35.0	87*
6000	3		2175	35.0	105	2130	34.0	97	2060	35.0	85*
5000	5		2160	35.0	103	2115	34.0	94	2040	35.5	83*
4000	7		2150	35.0	101	2100	35.5	88*	2010	35.5	81*
3000	9		2135	35.0	99	2080	36.0	88*	1990	36.0	80*
2000	11		2120	35.5	97	2060	36.5	87*	1960	36.5	79*
1000	13		2110	35.5	95	2040	37.0	86*	1930	37.0	79*
S.L.	15		2090	37.5	90*	2020	37.5	85*	1910	37.5	78*
-1000	17		2075	37.5	89*	2000	37.5	84*	1880	37.5	78*
-2000	19		2040	37.5	88*	1980	37.5	83*	1860	37.5	78*

* GPH in Auto Lean Mixture Below 2100 RPM.

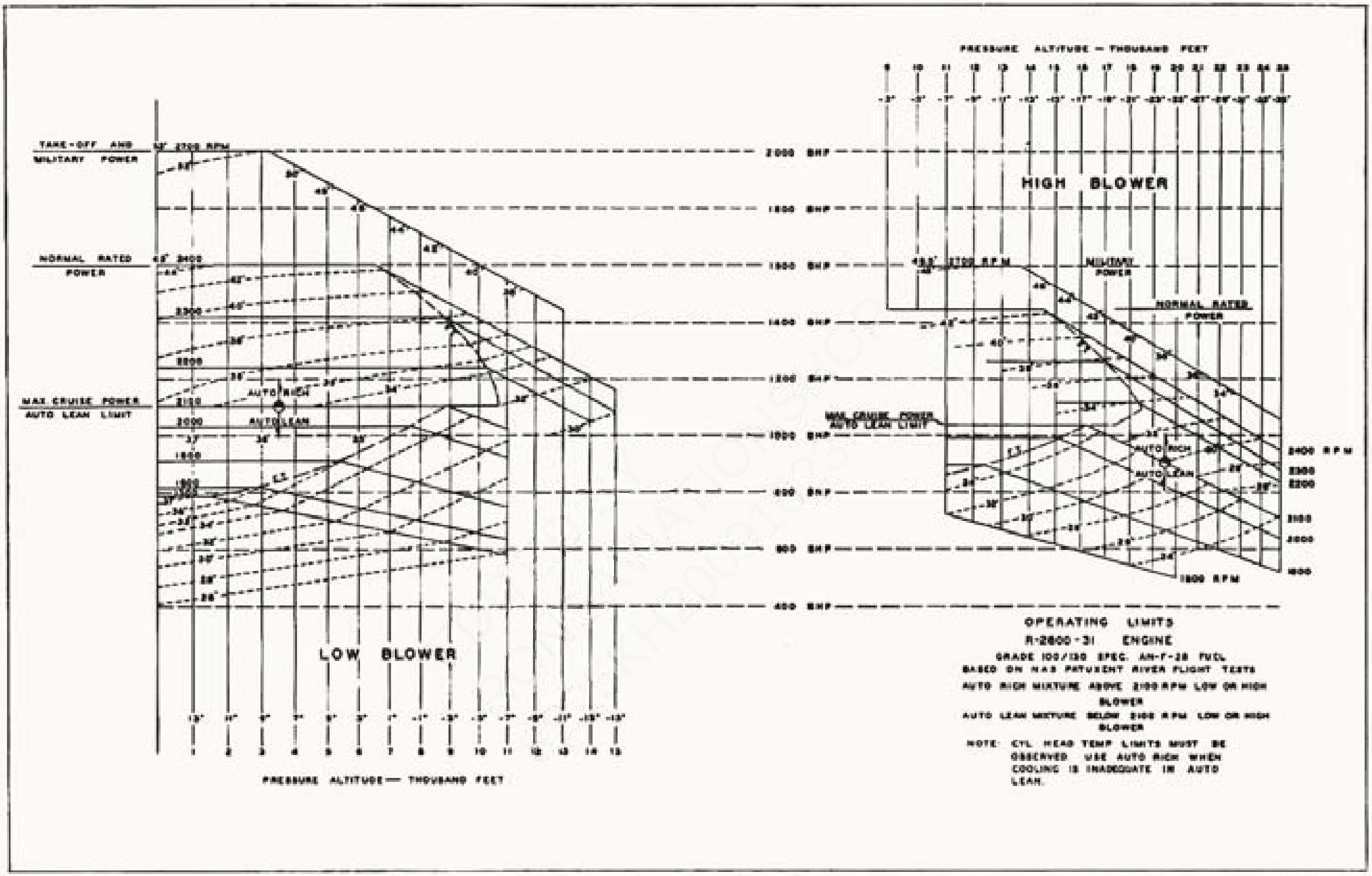
ABBREVIATIONS:

MP - Manifold Pressure
FT - Full Throttle
CAS - Calibrated Airspeed, Knots
GPH - Gallons Per Hour, Both Engines
OAT - Outside Air Temperature, °C.

TABLE 12


PV - 2C
R-2800-31 ENGINES
OPERATING CHART
NOTE
COWL FLAPS TRAIL
OIL COOLER SHUTTERS 50% OPEN
HIGH
LOW
1500 RPM
MAX CRUISE
DENSITY ALTITUDE — FEET
STD TEMP
PRESSURE ALTITUDE
GROSS WEIGHT - LBS
CAS - KNOTS

PLATE



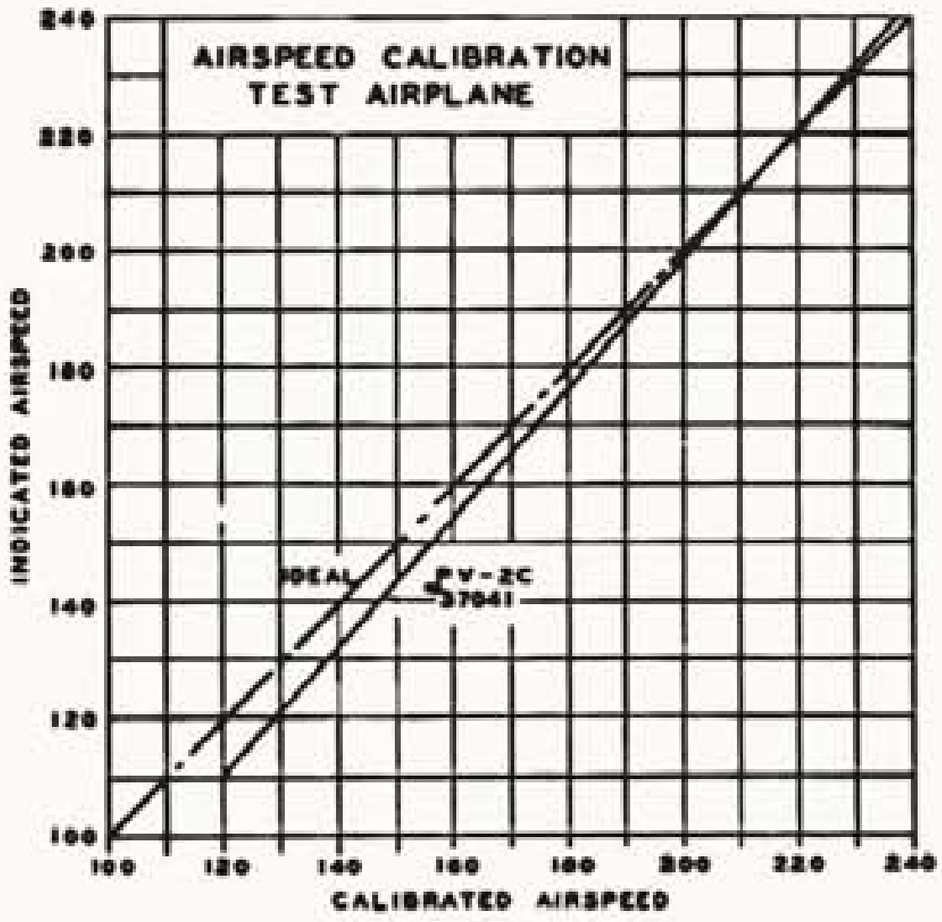
ENGINE CALIBRATION CURVE

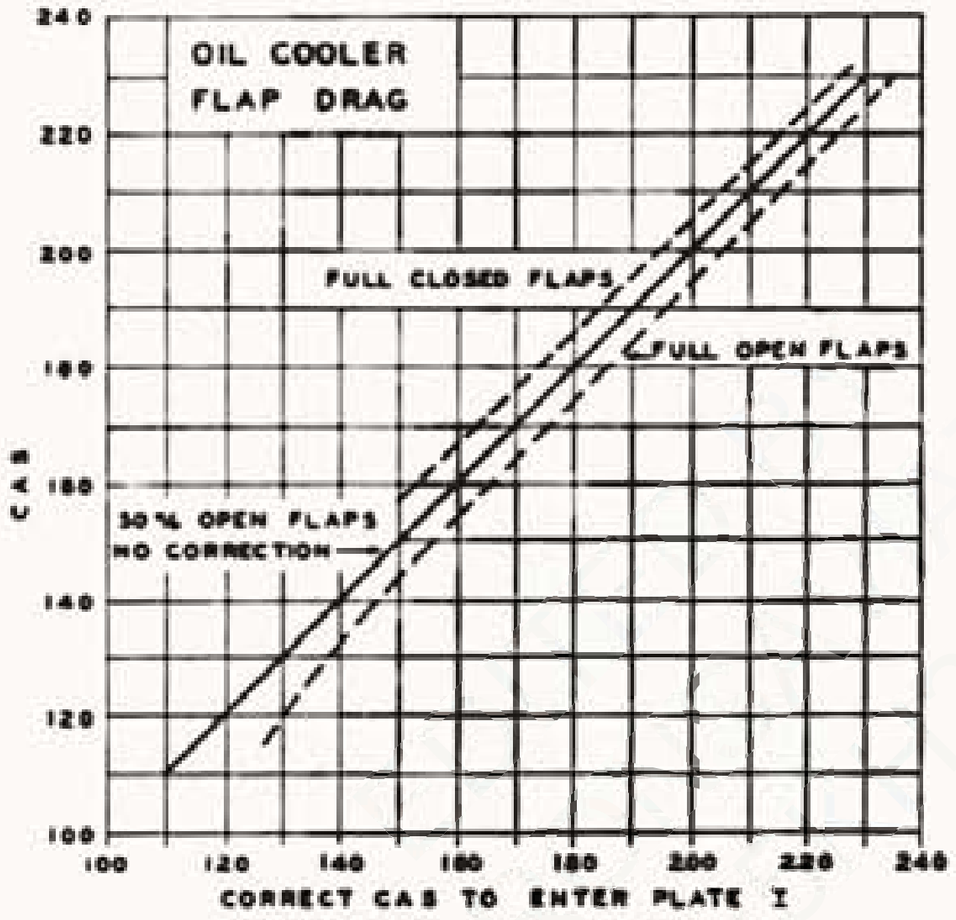
PV-2C

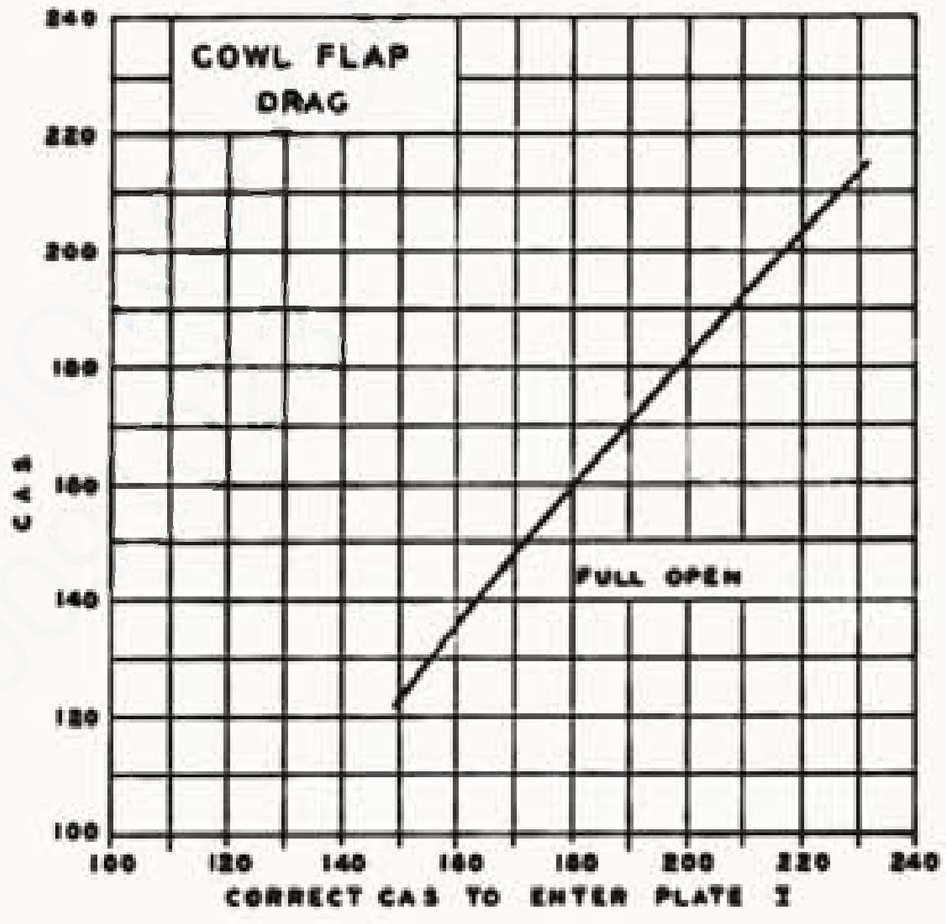
PLATE D

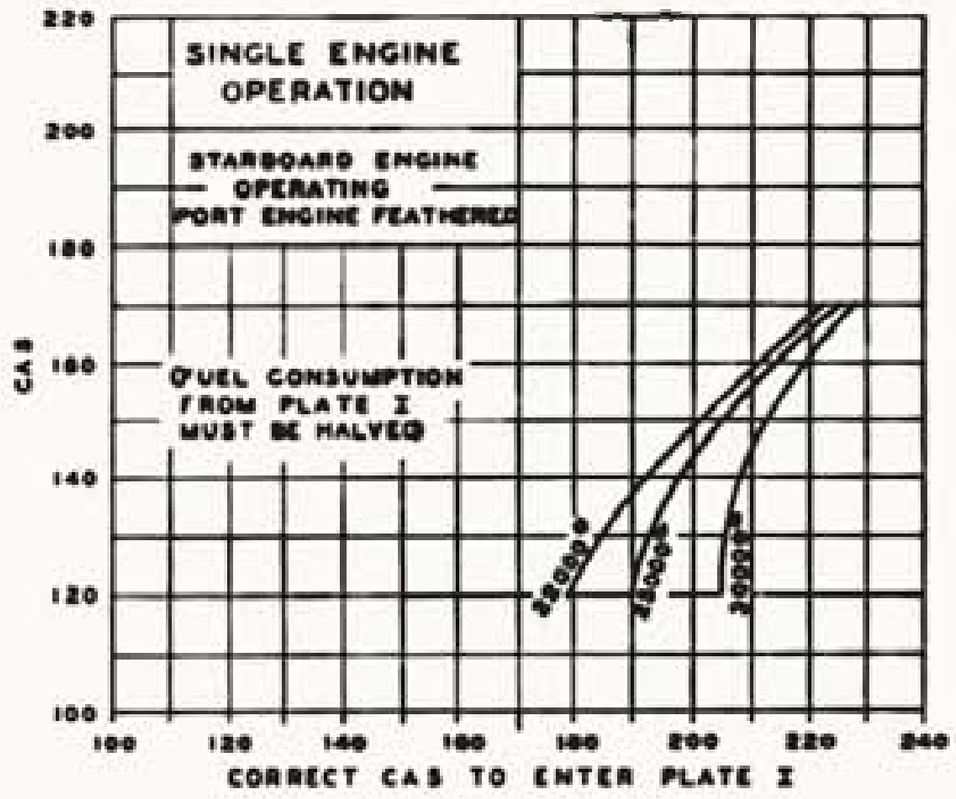
INSTRUCTIONS

ENTER THE CHART APPLICABLE TO THE EXISTING DRAG CONDITION WITH THE C A S DESIRED AND READ FROM THE HORIZONTAL SCALE THE CORRECT C A S TO ENTER PLATE I









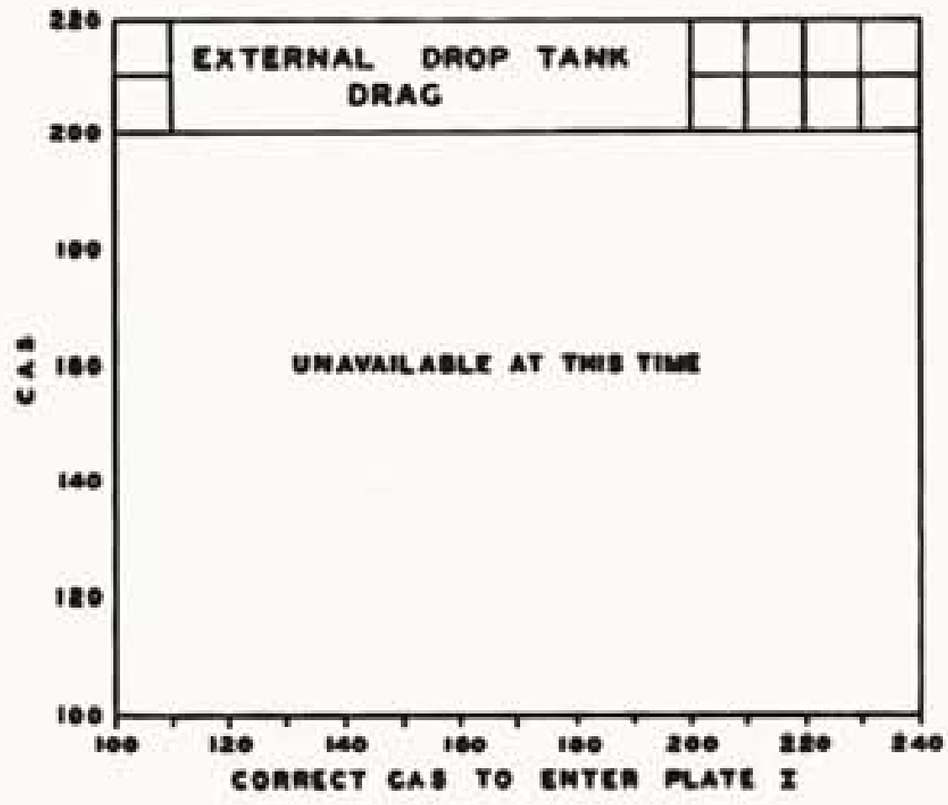
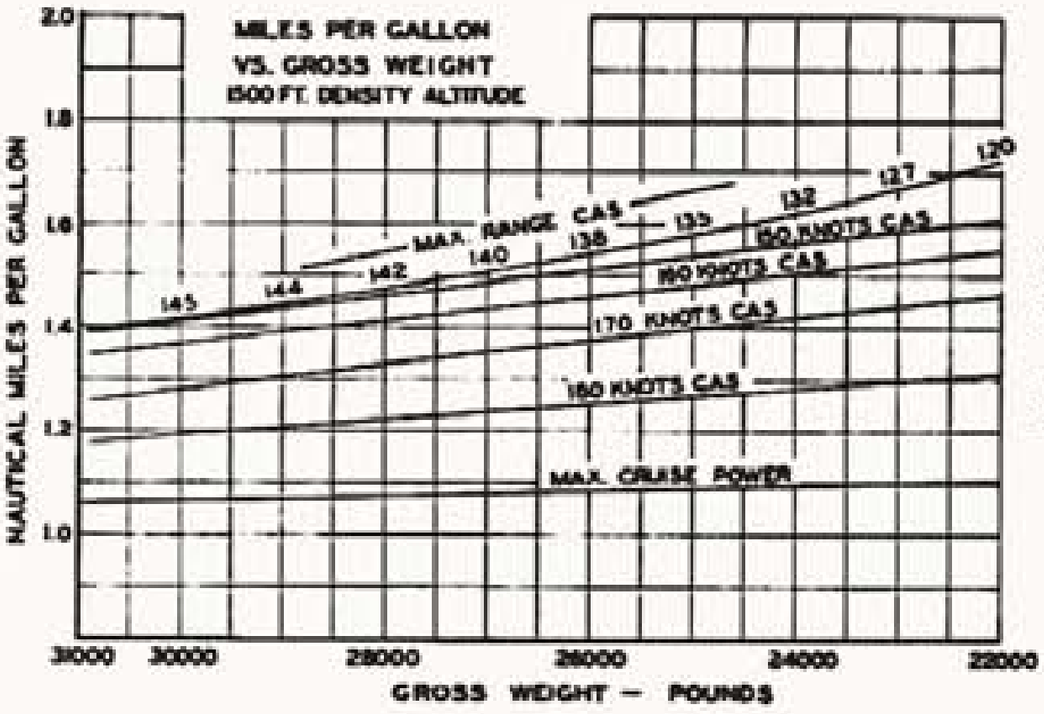


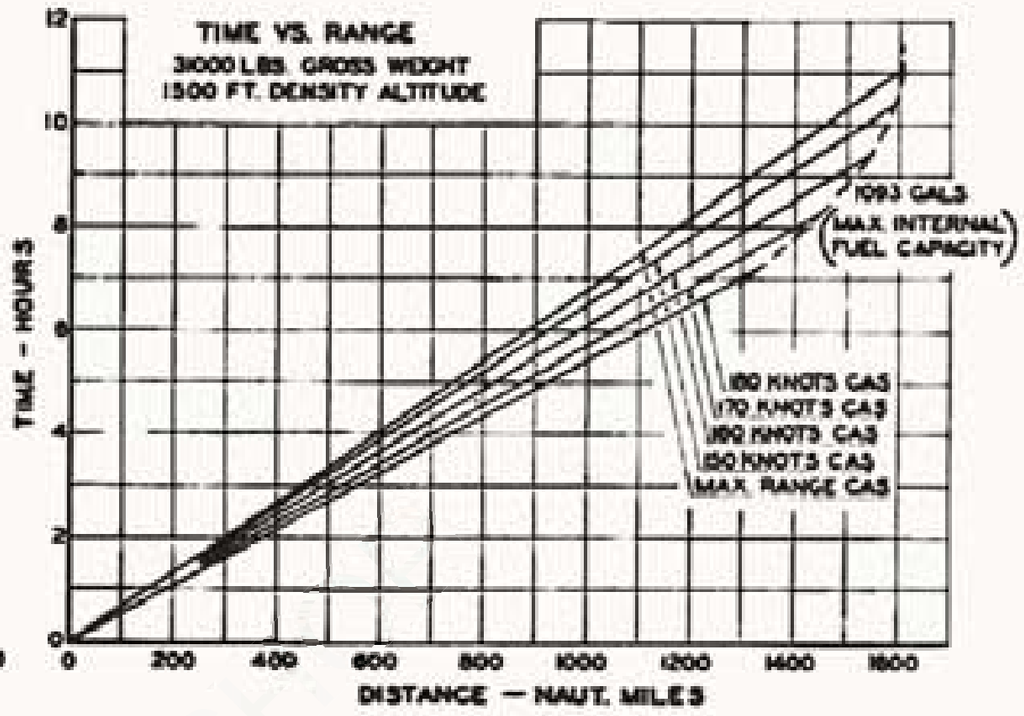
PLATE-III

PV-2C

F.T. VPB-24 7-2-45

RANGE CHART
PV-2C
TWO ENGINES OPERATIVE





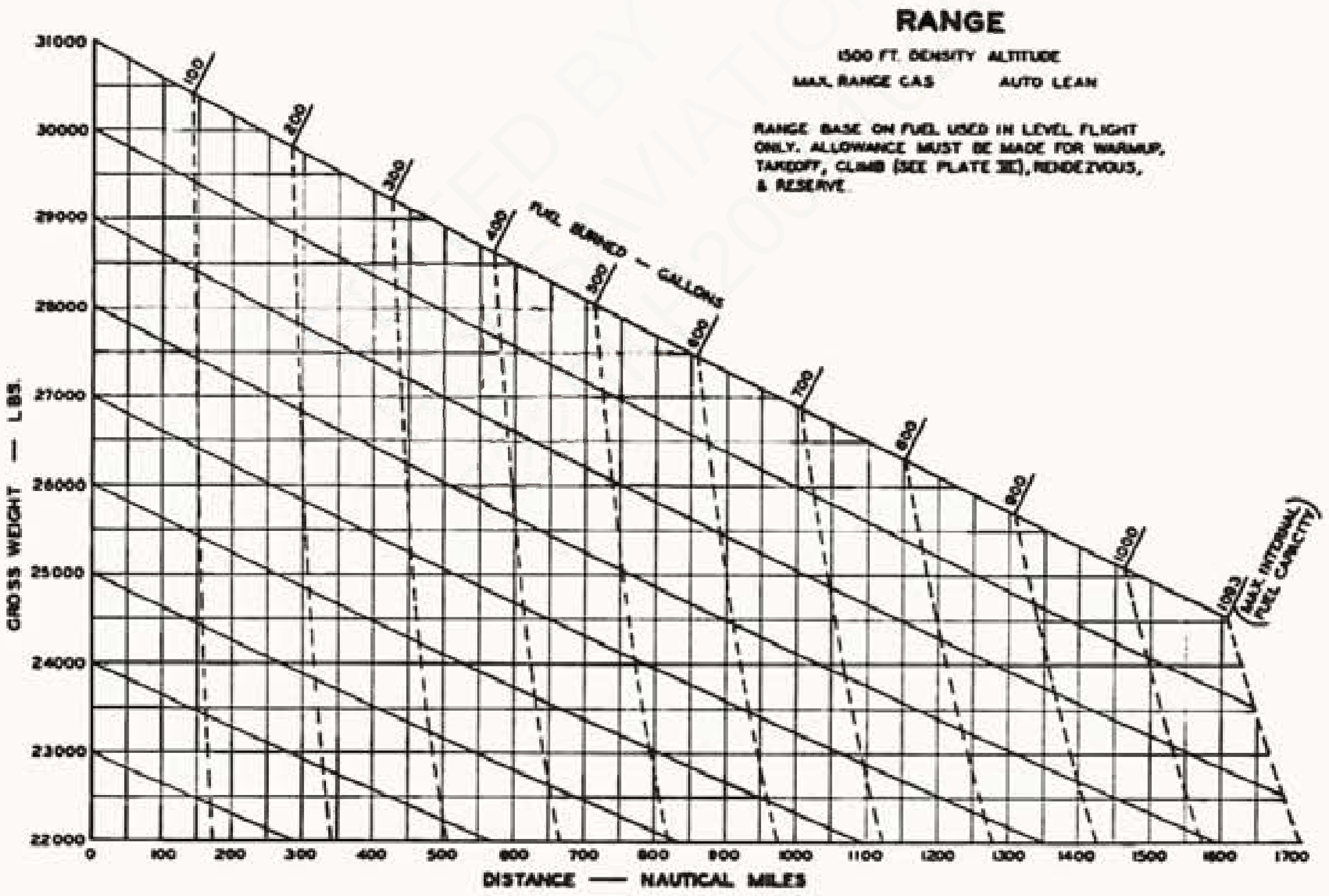
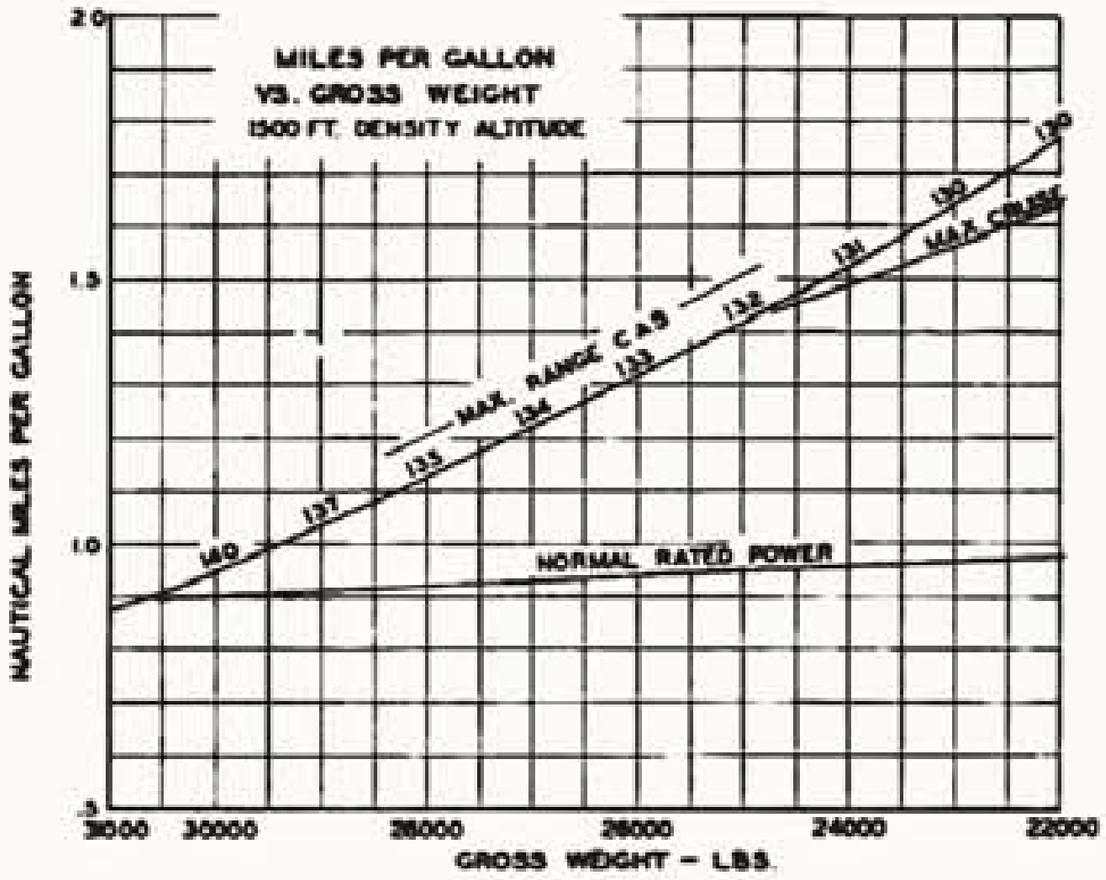
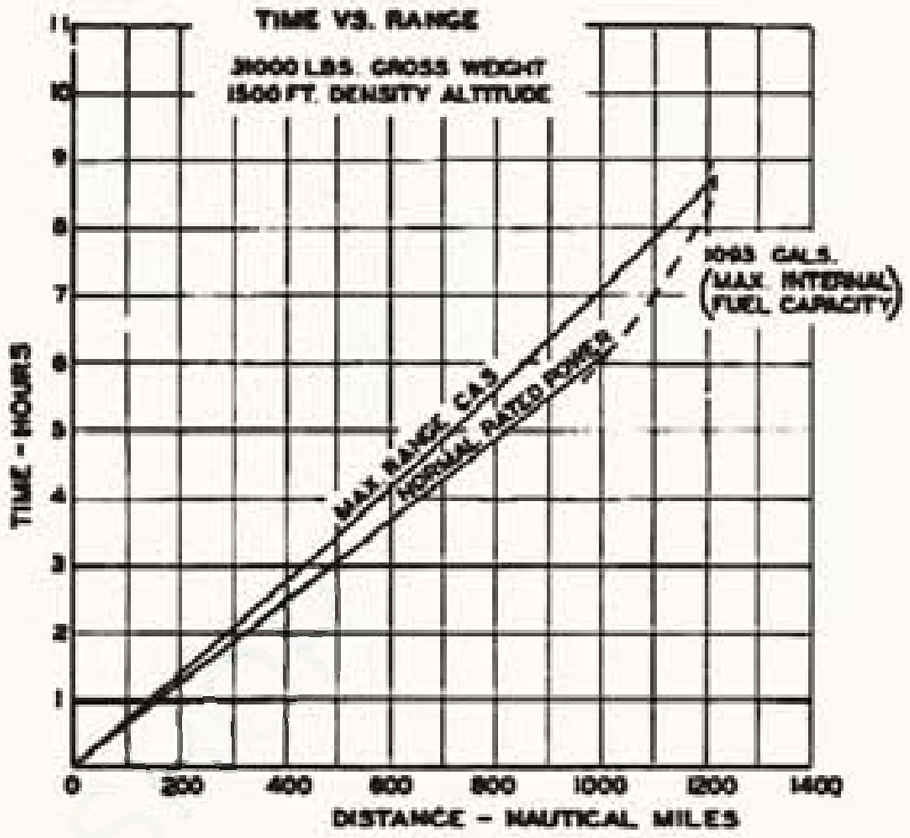


PLATE IVC

7-9-45 FT VPB-25

RANGE CHART
PV-2C
—ONE ENGINE OPERATIVE —





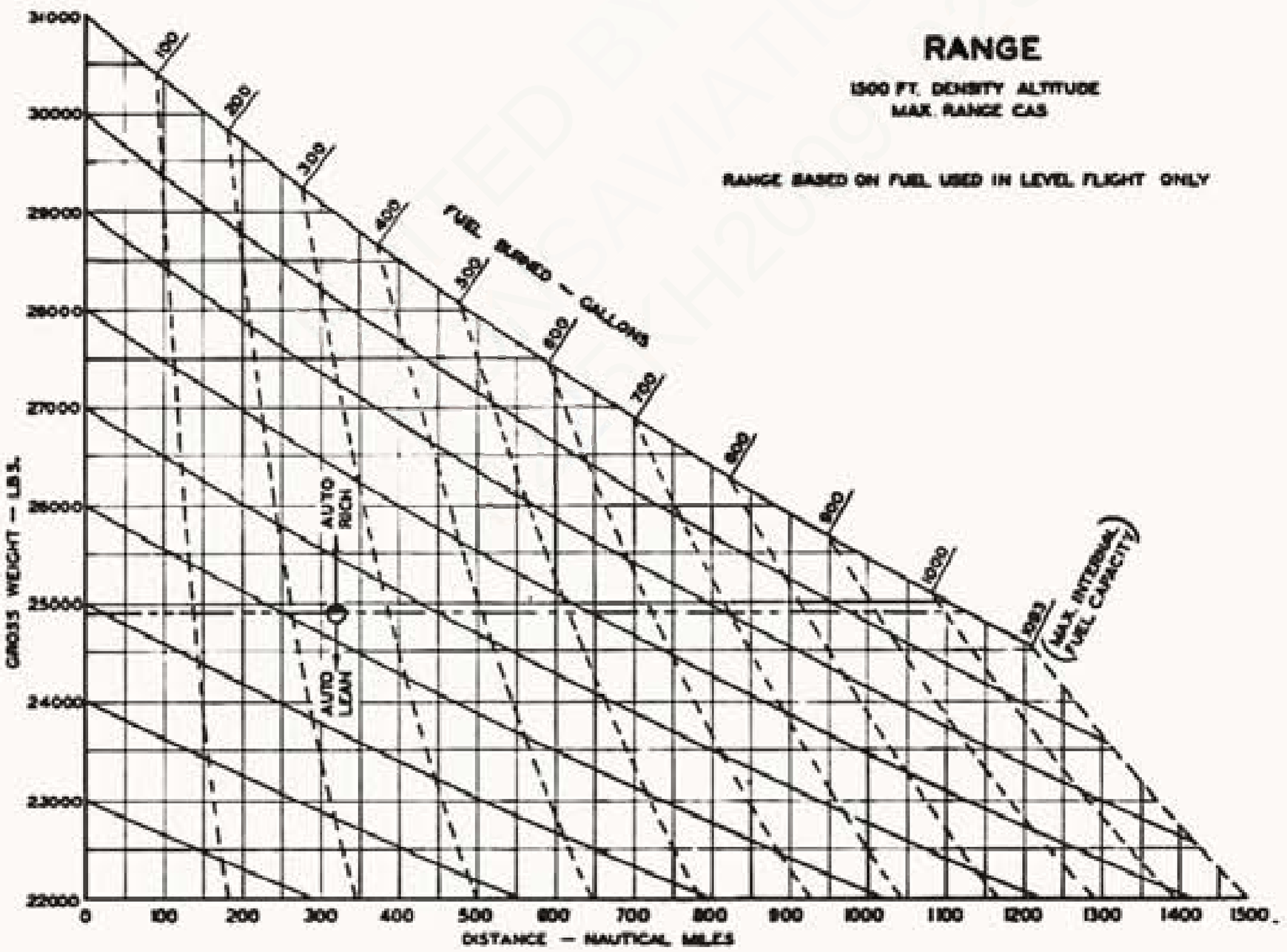
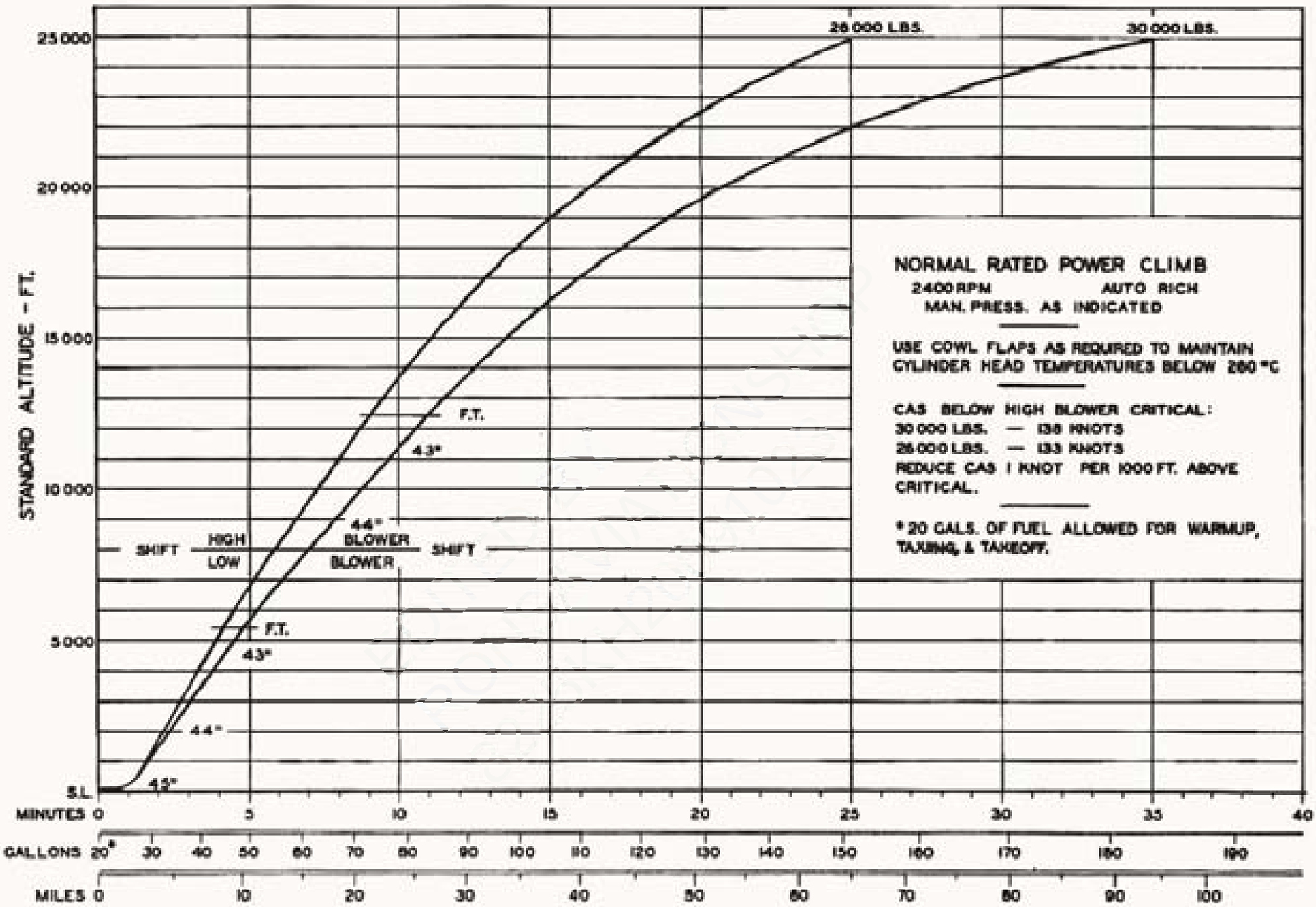


PLATE IX

6-22-45 FT VPB-19



PV-2C CLIMB DATA

PLATE VI

6-29-45 F.T. VPB-21

PV-2C

SINGLE ENGINE CEILING

NORMAL RATED POWER
PORT ENGINE FEATHERED - STARBOARD ENGINE OPERATING
2400 R.P.M. MANIFOLD PRESSURE FROM PLATE II 129 KNOTS CAS

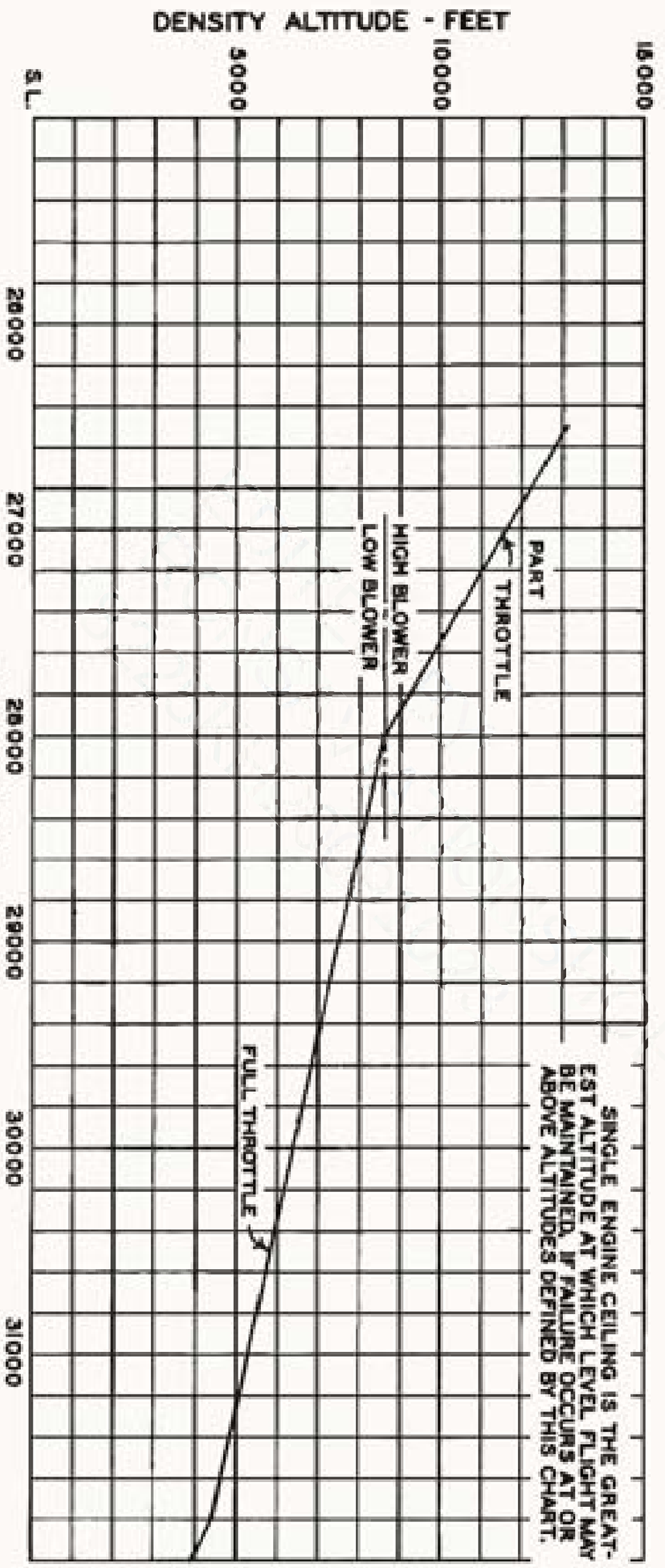


PLATE VII

FT VPB-30 7-23-45

Note

Supplementary operating instructions for Model PV-2D Airplane will be added when the information becomes available.