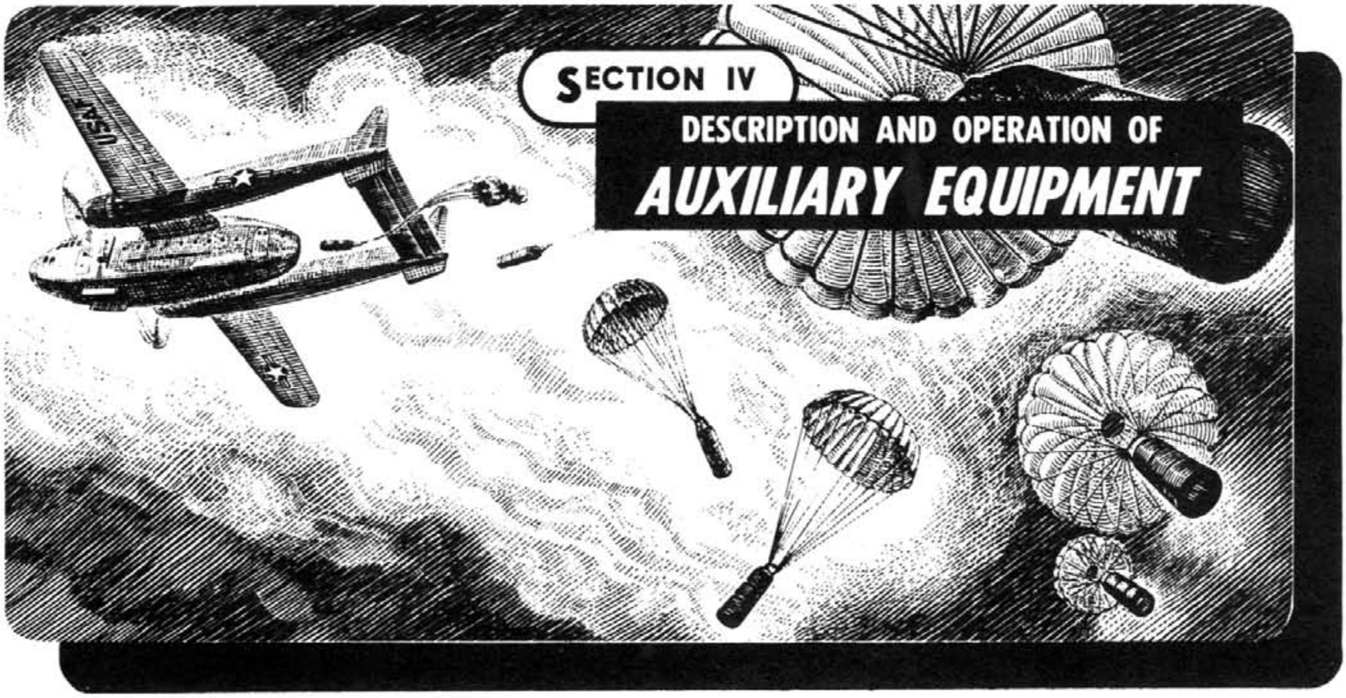


TABLE OF CONTENTS

HEATING, VENTILATING AND ANTI-ICING.

The heating and anti-icing system is a hot air system designed in such a manner that hot air for heating the crew and cargo compartments and for anti-icing the flight surfaces can be supplied throughout the airplane both on the ground and in flight. Provisions are also included for supplying heat to the engine accessories and the engine itself prior to starting. The anti-icing system, installed to heat the leading edge of all wing and tail surfaces, will defrost on the ground as well as prevent the formation of ice during flight. Utilizing the same ducts as the heating system, with the exception of the heater units, the ventilating system provides the crew and cargo compartments with outside air. Fresh air is also supplied to the pilot and co-pilot through fresh air ducts forward of the control pedestal. Eight internal combustion-type heaters, employing what is termed the "whirling

HEATING, VENTILATING AND ANTI-ICING SCHEMATIC

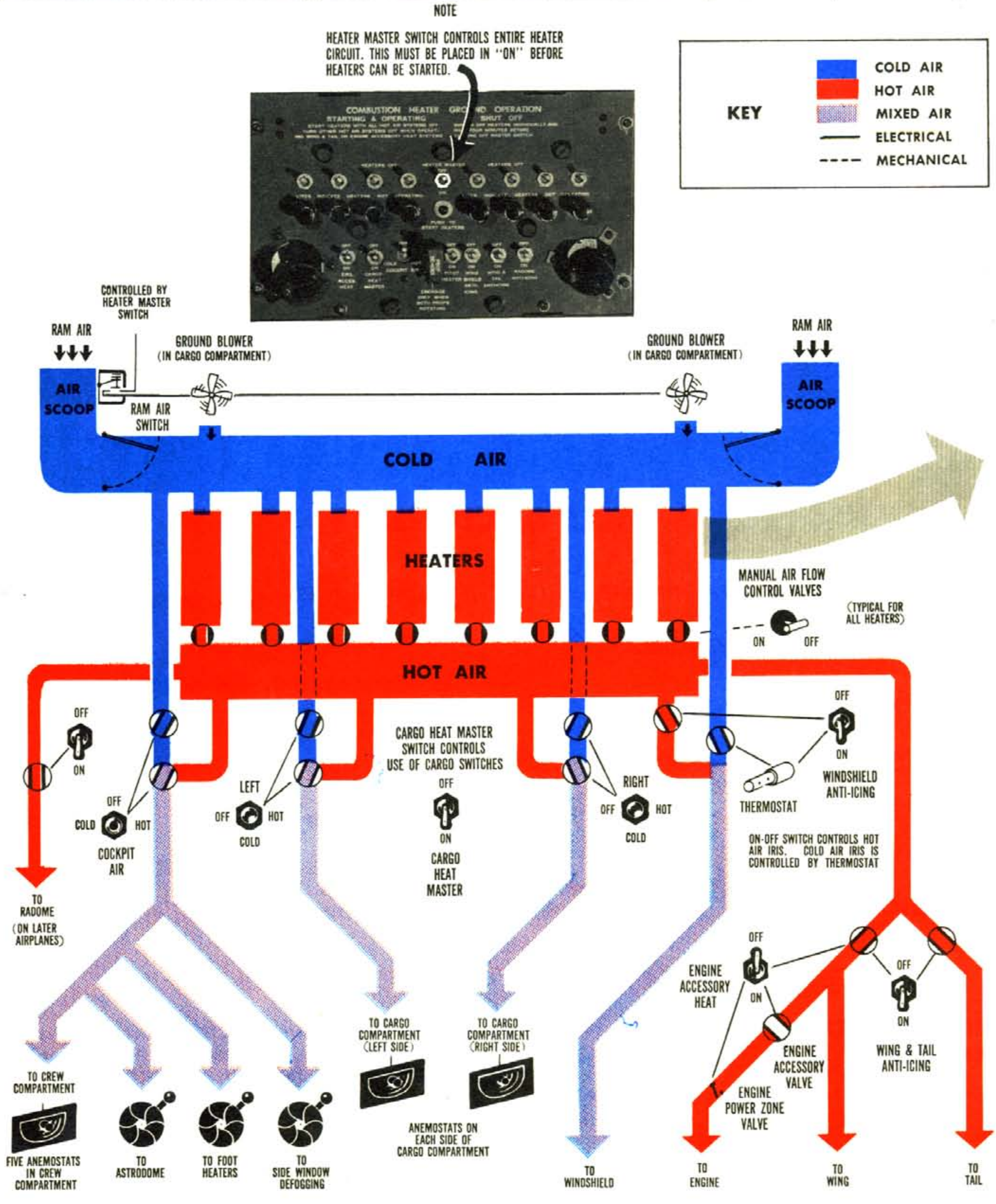
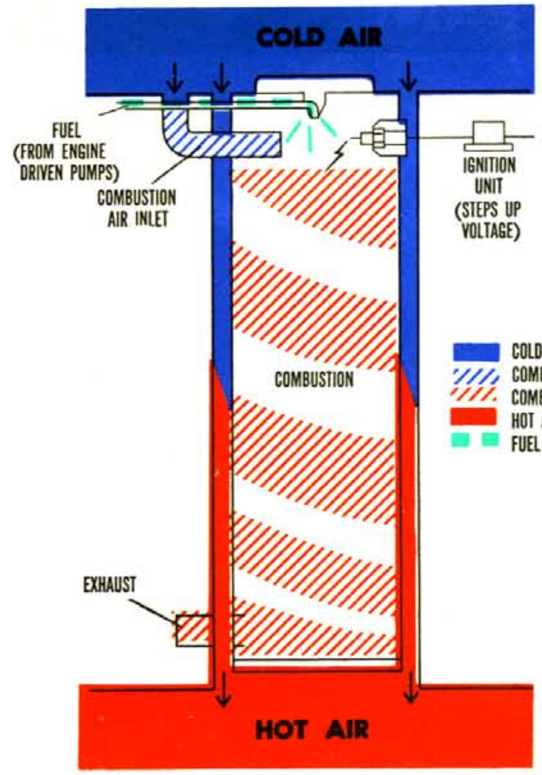


Figure 4-1



HEATER SCHEMATIC

flame" design, are located in the heater compartment, and furnish hot air for the system. Mixing chambers, just forward of the heater compartment, with cold and hot air ducts attached, are used for mixing the cold and hot air in desired proportions. Through an assemblage of ducts controlled by valves and switches, heated air is directed from the mixing chambers to the cockpit, cargo compartment, front windshield panels, side windows, astrodome, engine and engine accessories, and the flight surfaces.

The fuel supply lines for the heaters are routed from the engine-driven fuel pumps, and either the engine pumps or the booster pumps in the fuel tanks must be operating before operation of the heaters is possible. The heater fuel supply is controlled by left and right solenoid valves which are operated by the master heater switch. Should any individual heater become inoperative, the flow of cold air may be shut off so that it will not dilute the system when maximum heat is required. In flight, air for the operation of the system is obtained through two ram air scoops, one in each side of the wing center section immediately outboard of the fuselage. Ground heater operation is accomplished with air provided by two ground blowers and associated duct assemblies, and an automatic pressure switch located in the left ram air duct. Sensing a lack of sufficient ram air pressure, the switch activates the ground blowers—provided electrical power is available—and static air from the cargo compartment is forced through the system. Conversely, when the speed of the airplane produces sufficient ram air to operate the system, the pressure switch cuts off the ground blowers.

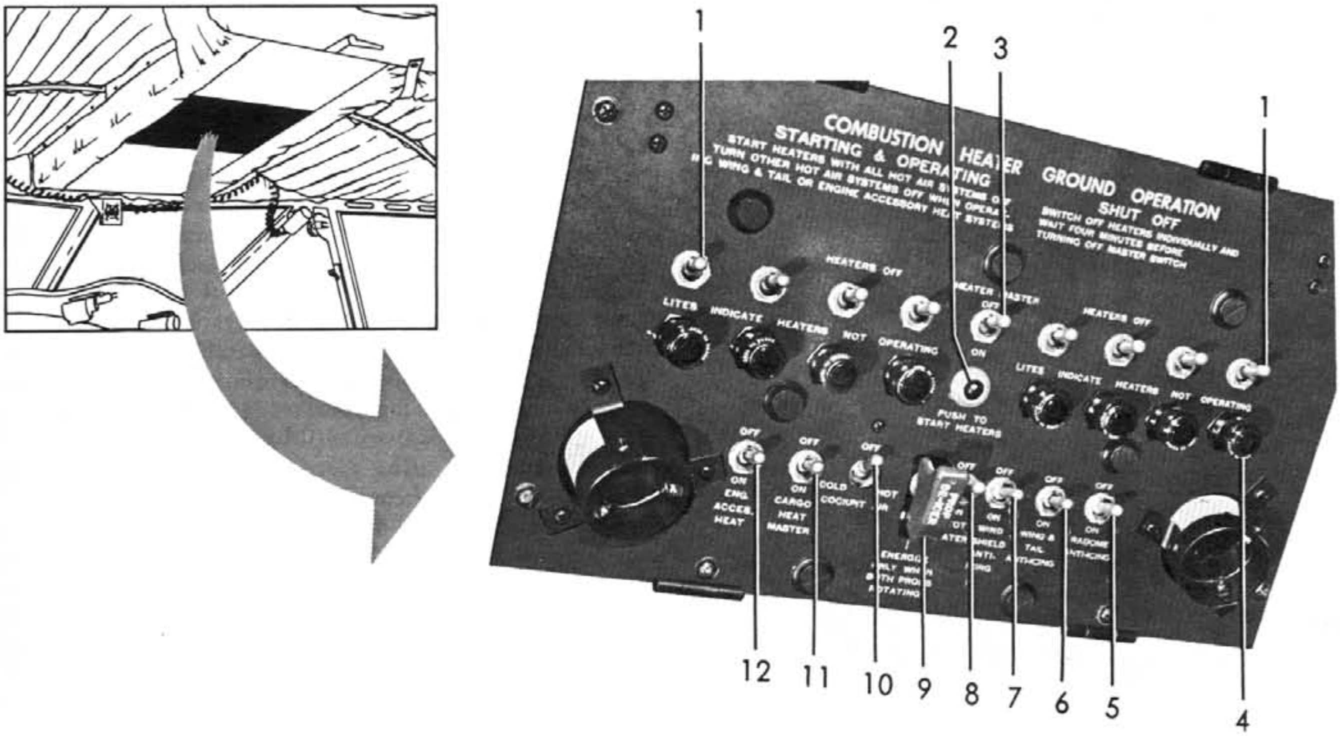
Fuel flow and emergency shut-off of each of the eight individual heaters are controlled by a set of five switches. Two cycling and two overheat switches are mounted in the hot air plenum adjacent to the outlet end of each heater, and one low temperature switch is mounted in each heater exhaust stack. The cycling switches control the cycling solenoid valve in the fuel line of each heater; when the temperature of the heated air exceeds 410°F, the cycling switches open and the cycling solenoid valve closes shutting off the fuel supply. The high temperature (overheat) switches shut off the overheat solenoid valve and the ignition in the event the cycling solenoid fails to close and the temperature of the heated air exceeds 490°F. The low temperature switch senses the heater exhaust temperature, closes the fuel solenoid valves, and shuts off the heater ignition when the temperature within the exhaust stack drops below 300°F. Either the high or low heat condition described above will cause the indicator light on the overhead panel to glow, indicating that the heater has ceased to function.

Fire detector devices, installed throughout the heater compartment, indicate any excessive rise in temperature which a fire may produce. A fire extinguisher system for the heater compartment, consisting of two carbon dioxide cylinders located in the fuselage, is electrically controlled by a switch on the overhead panel. Disc discharge indicators located below the windows on the left side of the fuselage indicate either a normal or an overheat discharge of the cylinders.

HEATER MASTER SWITCH.

The heater master switch (3, figure 4–2) is the master control for actuating the heating system. When this switch is placed in the ON position, 28-volt dc current is permitted to energize the heater bus bar and only at that time do the individual heater switches become operative. Similarly, the two heater primary fuel valve solenoids are energized and the flow of fuel is permitted to the fuel valve of each individual heater unit. During ground operation of the heat and ventilating system, the master heater switch also controls the cold air supply. When the master heater switch is placed in the ON position, current is directed from the 28-volt dc bus through the ram air pressure switch to the ground blowers in the cargo compartment. The contacts of the ram air pressure switch, located in the left heater supply duct, are normally closed permitting

HEATER CONTROL PANEL



1. HEATER SWITCHES
2. HEATER STARTER BUTTON
3. HEATER MASTER SWITCH
4. HEATER INDICATOR LIGHTS
5. RADOME ANTI-ICING
6. WING AND TAIL ANTI-ICING
7. WINDSHIELD ANTI-ICING
8. PITOT HEATER SWITCH
9. PROPELLER DE-ICING
10. COCKPIT AIR SWITCH
11. CARGO HEAT MASTER SWITCH
12. ENGINE ACCESSORY HEAT

Figure 4–2.

the ground blowers to be energized and to supply air for operation of the system. However, when the forward motion of the airplane causes sufficient air for operation of the heat and ventilating system to be forced into the air supply ducts through the air scoops in each inboard section of the airplane's center section, the pressure of the ram air actuates the ram air pressure switch which interrupts the circuit and shuts off the ground blowers. At anytime during operation, the entire heating system may be shut down by merely turning the master switch OFF.

HEATER SWITCHES AND INDICATOR LIGHTS.

The eight individual heater switches (1, figure 4–2) which control the eight heater units are two position OFF-ON switches located on the overhead panel. They become operative only after the master heater switch has been turned on. During fresh air ventilation, these switches are left in the OFF position. Each of the eight individual heater lights (4, figure 4–2) will glow when its associated switch is ON but the heater is not operating. When starting the heaters, the individual heater indicator lights will continue to glow until the heater warms up to operating temperature.

HEATER STARTER SWITCH.

The heater starter switch (2, figure 4–2) is a push button switch used to start those heaters that are selected for use by the individual heater switches. Located on the overhead panel, this switch functions only after the master heater and one or more of the individual heater switches are placed in the ON position. When the starter switch is depressed, the circuit is complete to the ignition units of the heaters and also to the individual fuel solenoid valves.

COCKPIT AIR SWITCH.

The flow of heater air to the crew compartment is controlled by the cockpit air switch (10, figure 4–2) on the overhead panel. The switch positions are OFF, NEUTRAL, HOT, and COLD. The switch being toggled to the HOT or COLD positions, iris and star mixing valves are electrically controlled to vary the ratio of hot and cold air supplied, thereby determining the temperature of the mixed air. Since the switch is spring-loaded to return to the NEUTRAL position, it will then hold the last selected temperature setting. The OFF position is not spring-loaded and upon placing the switch in this position, the mixing valves are closed and all air flow is shut off. Operation of the cockpit air switch will also defog the side windows and the astrodome and will provide heat for the lavatory compartment.

FOOT HEATERS CONTROL VALVE.

On later airplanes, increased heat is provided at the pilot's and copilot's foot level and is manually controlled by a push-pull control knob located between the rudder pedals at the pilot's and copilot's stations. When pulled out, movement of the control operates an iris valve and increases heat flow.

SIDE WINDOWS DEFOGGING VALVES.

Control of the heated air for defogging the side windows of the crew compartment is accomplished by utilizing two side window defogging valves, one of which is located above the center anemostat installed on either side of the crew compartment. The positions of these manually-operated iris valves are OPEN and CLOSE.

ASTRODOME DEFOGGING VALVE.

Defogging of the astrodome is accomplished by use of the manually-operated iris valve located immediately aft of the radio operator's oxygen regulator on the top of the radio rack. The valve positions, which are OPEN and CLOSE, permit control of astrodome defogging.

CARGO HEAT MASTER SWITCH.

Heated air supplied to the cargo compartment is controlled by a cargo heat master switch (42, figure 1-6) located on the overhead panel. This switch enables the pilot to completely control the use of heat in the cargo compartment. Subordinate, individual cargo heat switches located on the cargo compartment forward bulkhead are inoperative until the cargo heat master switch is turned ON.

INDIVIDUAL CARGO HEAT SWITCHES.

Two individual cargo heat switches (3, figure 4-23), one for actuating the hot air flow in each side of the fuselage, are mounted on the forward bulkhead of the cargo compartment. Similar to the cockpit air switch, the positions of the individual cargo heat switches are OFF, NEUTRAL, COLD and HOT. The HOT and COLD positions are used for obtaining the desired cargo compartment temperature. The OFF position closes the mixing valves, and in doing so, shuts off all air flow. NEUTRAL will hold the valves at the last position selected.

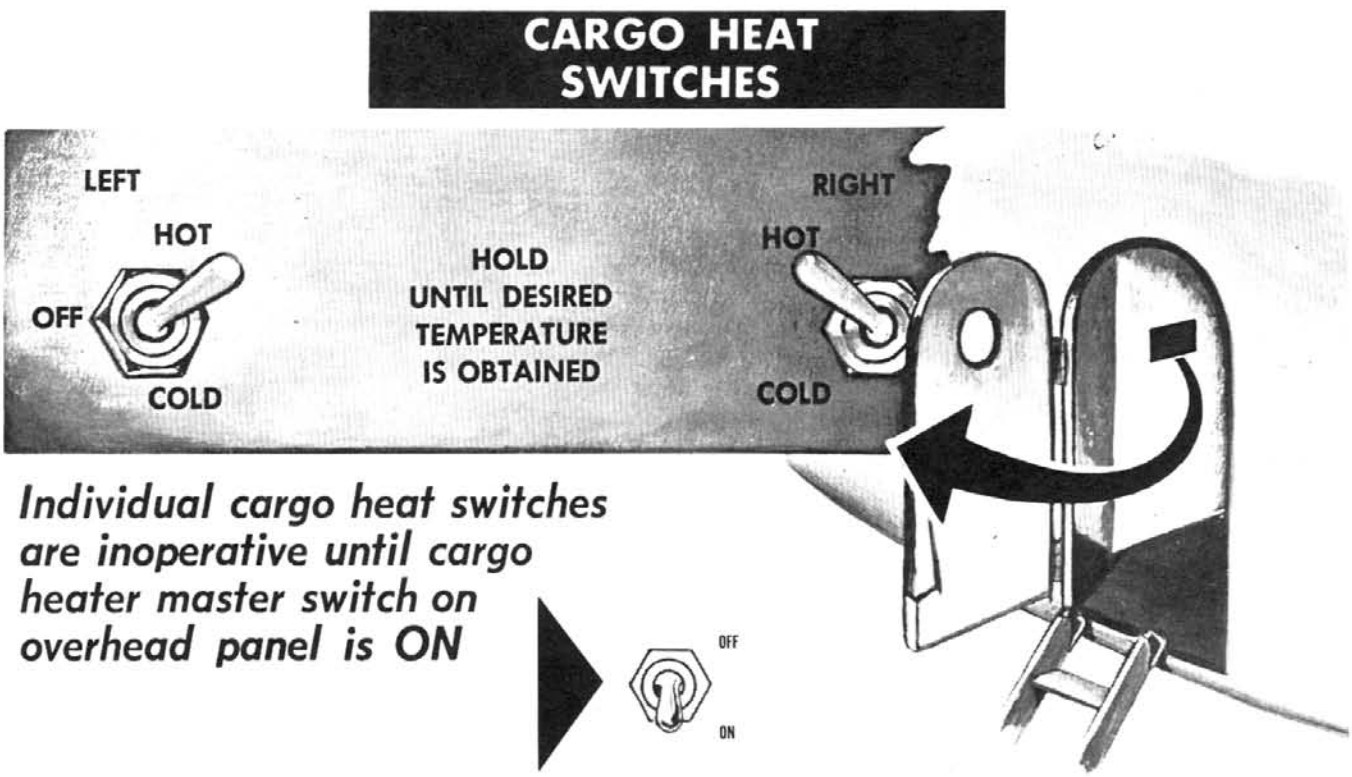


Figure 4-3

WINDSHIELD ANTI-ICING SWITCH.

The windshield anti-icing switch (7, figure 4–2), located on the overhead panel, is a two-position ON-OFF switch and controls the heated air which is passed through the double panes of the two windshield panels. When the windshield anti-icing switch is turned ON, it opens fully the hot air iris valve and at the same time completes a circuit to a temperature sensing element installed on the top panel of the windshield mounting. The temperature sensing element automatically controls the cold air iris valve and consequently the temperature of the mixture, keeping it at 200°F. The windshield anti-icing system will raise foot-level temperatures in the cockpit since heated air for windshield anti-icing is exhausted at the base of the windshield behind the instrument panel.

RADOME ANTI-ICING SWITCH.

When Radar Navigation and Search Equipment (AN/APS-42) is installed, provisions for heating the radome are incorporated into the airplane. The radome anti-icing switch (5, figure 4–2) located on the overhead panel energizes a 28-volt dc actuator which positions the radome anti-icing iris valve. When the switch is placed in the ON position, the valve is electrically positioned so that heated air is transferred from the hot air plenum to the radome assembly. In the OFF position of the switch, the iris valve is closed and the heated air is excluded from the radome.

WING AND TAIL ANTI-ICING SWITCH AND INDICATORS.

Hot air is ducted from the heaters to the leading edge of the wing center section, wing outer panels, horizontal stabilizer and vertical fins. It is controlled by a two-position ON-OFF wing and tail anti-icing switch (6, figure 4–2) located on the overhead panel. Movement of this switch to the ON position completes a circuit opening an actuator-driven, butterfly-type valve on either side of the hot air plenum which permits heated air to enter the wing anti-icing duct. At the same time, a second 28-volt actuator is energized opening a butterfly-type valve located in the ducts on either lower side of the hot air plenum. Heated air is then ducted from these valves across the nacelles and back through the booms to the horizontal stabilizer and vertical fins. This system permits defrosting of the surfaces on the ground as well as accomplishing its primary purpose, the prevention of ice formation on the flight surfaces. The wing and tail anti-icing indicators (22, 23, figure 1–22) are located on the instrument panel and register OVERHEAT, NORMAL, and OFF conditions as transmitted by temperature bulbs located in the wing tips and at opposite ends of the horizontal stabilizer.

Note

OVERHEAT indicates that heat is being wasted. It does not indicate probable structural failure due to excessive heat conditions.

ENGINE ACCESSORY PREHEAT SWITCH.

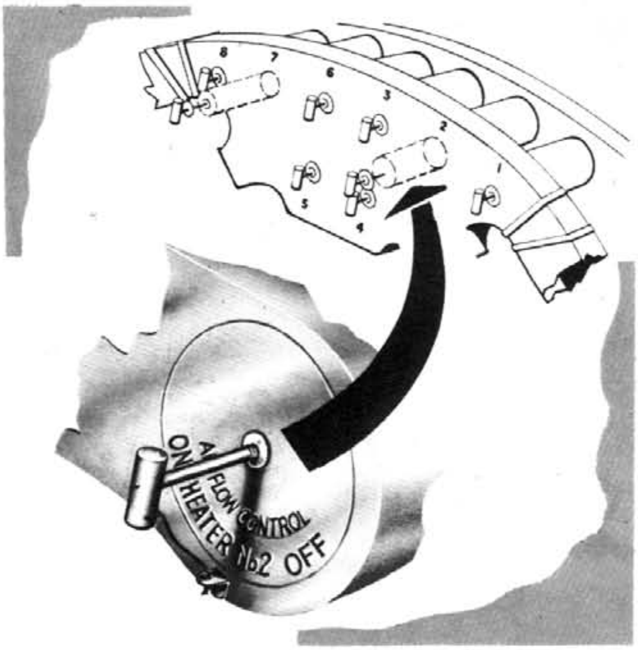
The two-position accessory preheat switch (12, figure 4–2) located on the overhead panel electrically operates three valves on each side controlling the flow of heated air to the engine and its accessories. When the switch is placed in the ON position, an actuator-driven butterfly-type valve is energized permitting passage of heated air from the hot air plenum of the heaters into the wing anti-icing duct. Simultaneously, a 28-volt dc actuator is energized which opens a flapper-type valve in the wing anti-icing duct and permits hot air to enter the engine accessory section. Similarly, when the switch is turned to ON, an iris valve on the lower portion of the engine baffle opens to permit heated air to reach the engine power section. The engine accessory preheat switch must be turned OFF before starting. Failure to do so could conceivably result in over-heating and damage to the engine accessories. Safety switches installed on both main landing gear break the engine accessory preheat circuit when the landing gear shock struts are extended, thus assuring a cut-off of engine accessory preheat at take-off.

MANUAL AIR FLOW CONTROL HANDLES.

When any individual heater is inoperative, cold air may be prevented from passing through the inoperative heater and diluting the system by manually turning the air flow control valve handle of the affected heater to OFF. These eight valve control handles located on the heater compartment bulkhead in the auxiliary equipment compartment, are marked by heater number and position of valve. Air flow control handle positions are ON and OFF.

Note

For maximum anti-icing, the airflow manual control valve for any inoperative heater should be turned OFF to prevent dilution of heated air. No attempt should be made to restart a heater with an airflow manual control valve closed.



PILOTS' IRIS VALVES CONTROL HANDLES.

Control of additional outside air for ventilating the crew compartment is provided at the pilot's and copilot's stations. This system being entirely independent of the main heat and ventilating system, outside air is ducted from a scoop just below the fuselage nose cap to the front of the pedestal. An iris valve on either side of the pedestal is manually operated by its respective control handle to obtain the degree of ventilation desired. The positions of the iris valve are OFF and ON.

HEATER FIRE DETECTOR LIGHT.

The heater fire detector light (27, figure 1–6), located on the overhead panel, will glow when an excessively high temperature condition exists in the heater compartment. This light also will glow when the fire detector test switch is engaged, thus permitting a check of system operation. For a fuller description of the heater fire detector system see Fire Detector System, Section I.

HEATER FIRE EXTINGUISHER SWITCH.

The heater fire extinguisher switch (25, figure 1–6), a two-position switch located on the overhead panel, serves to direct 28-volt dc power to a solenoid on top of each CO_2 cylinder which releases the charge from the two cylinders to extinguish fires in the heater compartment. A cover is provided to prevent accidental actuation of the switch. Refer to Section I for a fuller description of the heater fire extinguisher system.

PROPELLER DE-ICING SWITCH AND AMMETERS.

The propeller de-icing system is composed of electrical heating elements imbedded in the leading edge of the propeller blades. An intermittent power supply, fed to the blades through slip rings, is obtained from the airplane's 28-volt dc electrical system by means of the propeller de-icing switch (9, figure 4–2) on the overhead panel and an electrically operated timer. The de-icing cycle, as established by the electric timer, is based on an overall time element of 120 seconds during which the system is alternately energized for a period of 15 seconds and off for a 15-second interval. When the propeller de-icing switch is turned ON, the timer directs current to the heating elements in two opposite blades of one propeller. If, for example, the timer begins the cycle with two opposite blades of the left propeller, these two blades are energized for 15 seconds. At the end of this period, the timer breaks the circuit and 15 seconds later completes a circuit to two opposite blades of the right propeller. A 15-second period of shut-down follows, after which this procedure is similarly repeated until the remaining set of opposite blades on each propeller has been de-iced. Each of the four sets of opposite blades, then, is energized for 15 seconds and off for 105 seconds during one complete de-icing cycle. On airplanes 53-7880 through 53-7884 the propeller de-icing timer circuit breaker is on the monitor bus. Since the timer controls the de-icing system, propeller de-icing is inoperative in event of failure of a generator. If required, de-icing operation may be restored by reenergizing the monitor bus through the monitor bus switch.

The two de-icing ammeters (20, 21, figure 1–22) on the instrument panel are percentage load meters and, as such, indicate the percentage of current flow (250 amperes maximum) which the heating elements in either propeller are drawing at any given moment. The normal operating range (70-90%) is marked by a green band on each of the ammeters.

CAUTION

Do not attempt to operate the propeller de-icing system when the propellers are not rotating as damage to the blades will result. During ground checking procedures with propellers rotating, operate the de-icing system no longer than 2 complete cycles if the outside air temperature is greater than 16 degrees C. If outside air temperature is less than 16 degrees C, operate no more than 4 or 5 cycles.

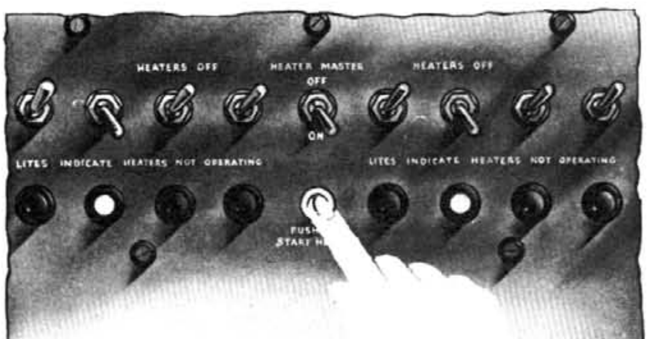
PITOT HEATER SWITCH.

The pitot heater switch (8, figure 4–2), located on the overhead panel, is a two-position switch used to control the electrical heating elements installed in the pitot tubes to prevent ice formation at the tube openings.

NORMAL OPERATION PROCEDURE.

TO START HEATERS.

1. Start auxiliary power plant if external power is not connected. (For ground operation only.)
2. Heater air flow manual control valves ON.
3. Fuel, oil and hydraulic shut-off switch NORM.
4. Fuel booster pump switch NORMAL ON if engines are not operating.
5. Turn either fuel selector switch to INBOARD or OUTBOARD as desired.
6. Heater master switch ON.
7. Individual heater switches ON for heaters selected. Check that heater indicator lights come on.
8. Push heater starter button and hold until heater indicator lights go out. Heaters should ignite within a 1-minute period; however, this time may vary with outside air temperature and altitude.
9. If it is desired to start additional heaters after the system is in operation, turn individual heater switch ON and push starter button, holding again until the additional heater lights go out.



PUSH TO START HEATERS!

Note

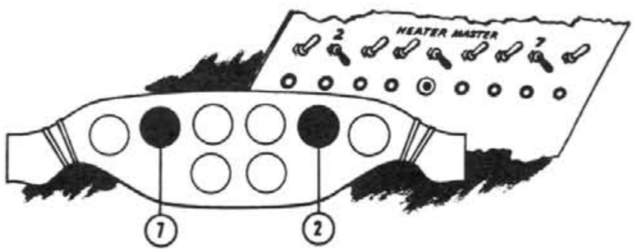
If indicator light comes on after heater has been started, repeat starting procedure several times. If condition persists, determine malfunction, or if this is not possible, turn the heater switch OFF. If maximum heat is required, turn the manual air flow control valve handle OFF on inoperative heater.

TO OBTAIN AND REGULATE CREW COMPARTMENT HEAT.

1. Start heaters.

Note

For most efficient operation when a limited amount of crew compartment heat is required, heaters numbers 2 and 7 should be used as heated air from these two heaters is directed immediately to the cockpit mixing chamber. For increased heat requirements, select additional heaters.



2. Hold cockpit air switch in the HOT position until a blast of hot air is felt at the outlets.
3. To regulate the degree of heated air, momentarily position the cockpit air switch to either COLD or HOT as desired.
4. To shut off air flow in the crew compartment, turn cockpit air switch OFF.

Note

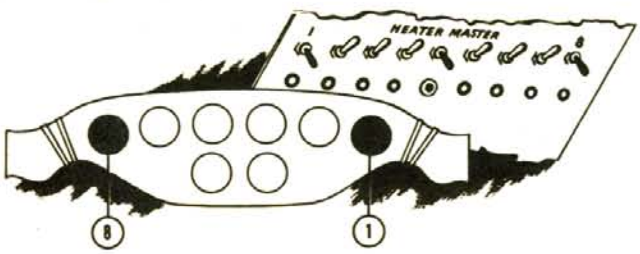
In order to raise the foot level temperature in the crew compartment, turn the windshield anti-icing switch ON. This will allow some heated air to be dumped in the vicinity of the pilot's and copilot's feet. On later airplanes, movement of the push-pull control between the rudder pedals will provide increased heat as desired.

TO OBTAIN AND REGULATE CARGO COMPARTMENT HEAT.

1. Start heaters.

Note

For most efficient operation when a limited amount of cargo heat is desired, heaters 1 and 8 should be used as heated air from these two heaters is directed immediately into the distributive ducts on both sides of the cargo compartment. For additional requirements, select additional heaters.



2. Set cargo heat master switch to ON.

3. Hold cargo heat switches in the HOT position until a blast of hot air is felt at the outlets.

4. To regulate the degree of heated air, momentarily position the cargo heat switches to either HOT or COLD.

5. To shut off air flow to the cargo compartment, turn cargo heat switch OFF.

TO OBTAIN ENGINE ACCESSORY COMPARTMENT PREHEAT.

1. Start heaters.
2. Set engine accessory switch ON.
3. After compartments are heated, turn switch OFF.

WARNING

Accessory heat must be turned OFF before starting engines. Failure to do so may cause overheating of the accessories, damage and possible failure of the engine.

TO ANTI-ICE WING AND TAIL SURFACES.

Refer to figure 4-4.

HEATER SHUT DOWN.

Note

To remove any moisture that may have collected in the heater differential pressure line, the following procedure should be accomplished immediately after using the heaters. Open the drain cocks, located on the right side under the heater compartment for at least one minute. Make certain that the drain cocks are closed after the draining is completed.

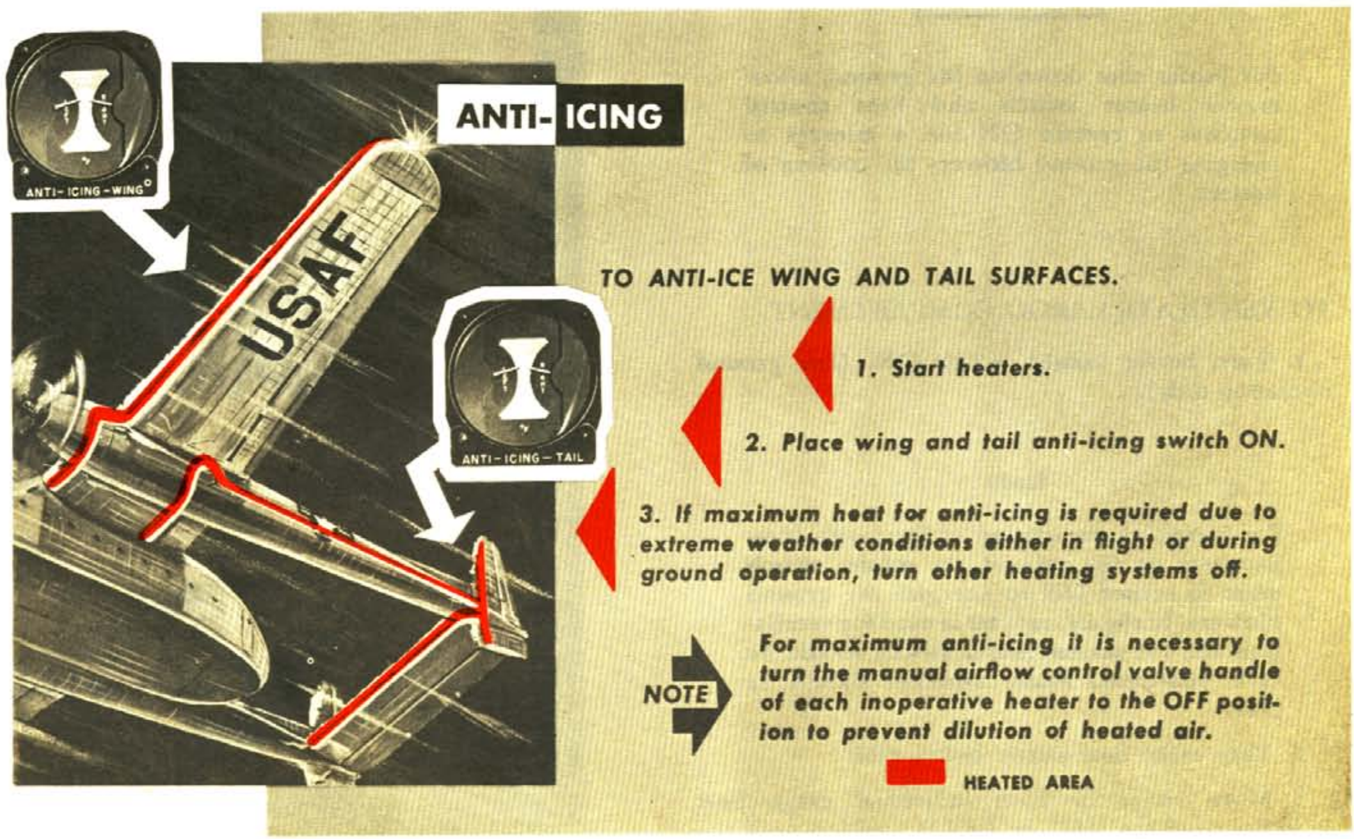
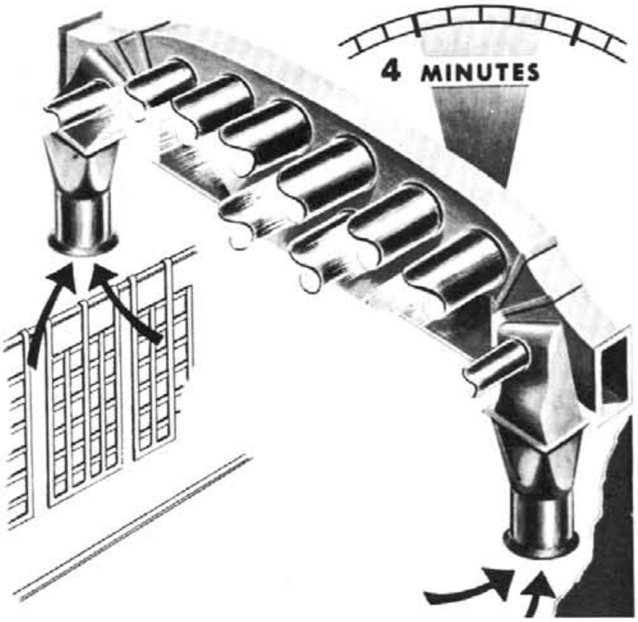


Figure 4-4

1. Individual heater switches OFF.
2. Heater master switch OFF.
3. Various heat control switches as desired.



CAUTION

For heater shut down on the ground, allow master heater switch and heat control switches to remain ON for 4 minutes to energize the ground blowers for cooling of heaters.

TO VENTILATE CARGO COMPARTMENT.

1. Turn heater master switch ON. (For ground operation only).

Note

For forced air ventilation of the cargo compartment on the ground, the master switch must be turned ON to energize the ground blowers. In the air, ram air is used for ventilation and the master heater switch should be OFF. Individual heater switches should be OFF.

2. Turn cargo heat master switch ON.

3. Move either or both individual cargo heat switches to either HOT or COLD position until the desired ventilation is obtained.

CREW VENTILATION

TO VENTILATE CREW COMPARTMENT.

1. *Manually open the iris valves of the outside air scoop.*

2. *For additional crew compartment ventilation, turn master heater switch ON.*

NOTE

Individual heater switches are OFF, as the heaters are not in operation during the period the system is used for fresh air ventilation.

3. *Move cockpit air switch to COLD until desired ventilation is obtained.*

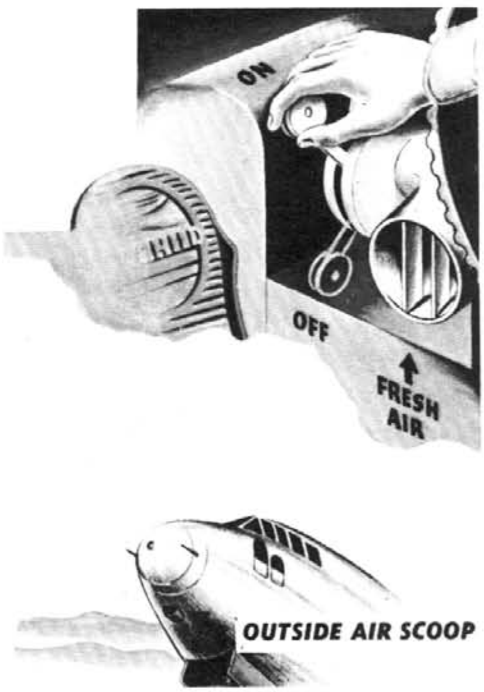


Figure 4-5

RADIO CONTROL PANEL

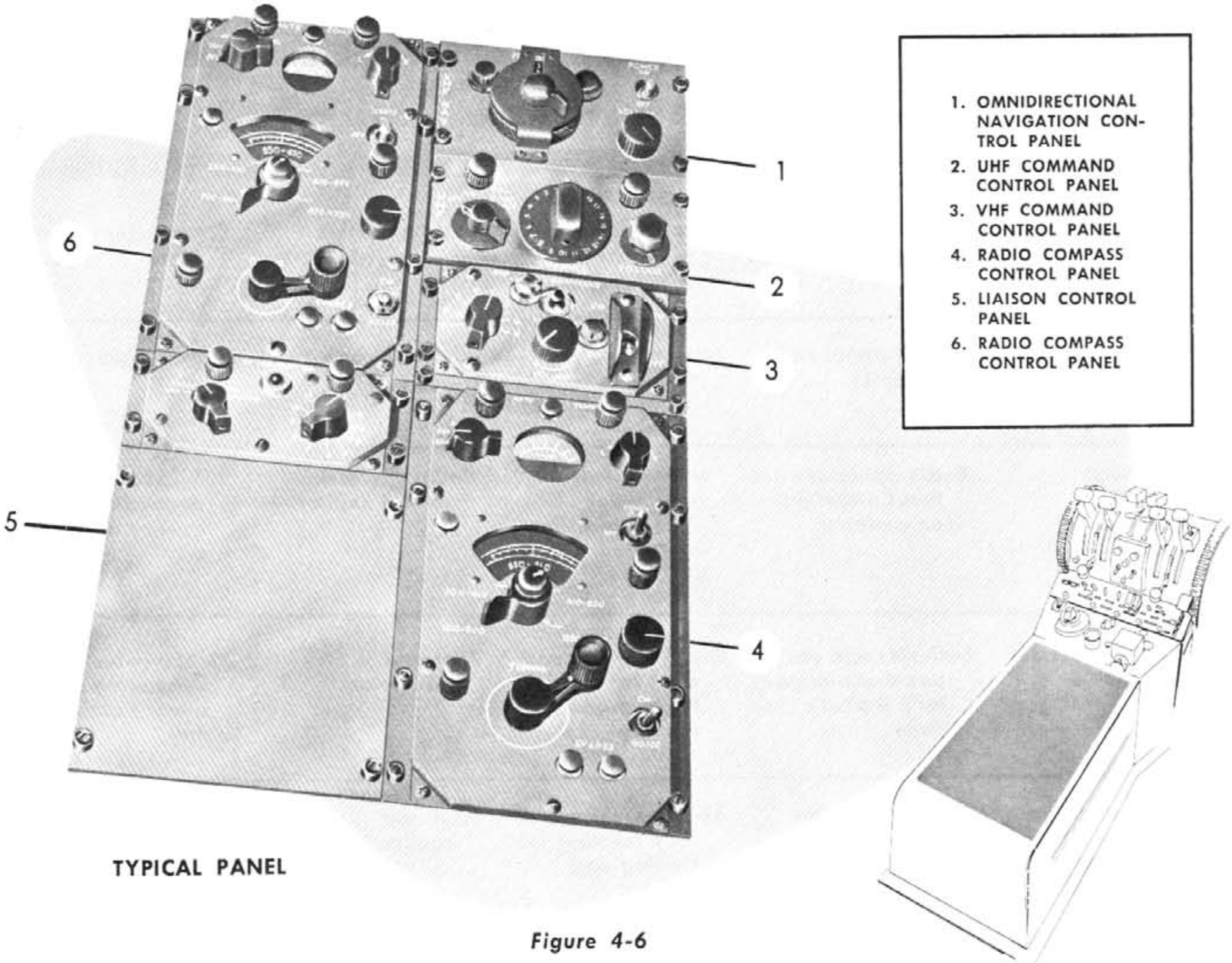


Figure 4-6

COMMUNICATION AND ELECTRONIC EQUIPMENT.

The airplane is equipped with various electronic sets which provide intercommunication facilities, communication from airplane to ground, sea and air stations, navigational aids, and identification of aircraft as friend or foe.

INTERPHONE EQUIPMENT AN/AIC-8.

Note

In compliance with Air Force directives which envision the elimination of VHF Command Set when more UHF ground stations have been completed, the following interphone control panel settings differ from their normal placarded function.

RECEIVER SWITCHES

VHF COMM switch permits UHF Command reception.

HF COMM switch permits VHF Command reception.

MICROPHONE SELECTOR SWITCH

VHF COMM setting permits UHF transmission.

LIAISON setting permits liaison transmission (pilot's liaison control panel placarded HF TRANSMITTER).

HF COMM setting permits VHF transmission.

COMMUNICATIONS AND

EQUIPMENT	LOCATION	FUNCTION	OPERATOR	RANGE
Interphone Equipment AN/AIC–8 or AN/AIC–10	Control panel at crew member stations	Inter-communication of the crew	Crew members	Crew stations in the plane
VHF Command Set AN/ARC–3	Control panel on pedestal	Two-way voice and code communication	Pilot and copilot	Line-of-sight
Liaison Sets: AN/ARC–8 AN/ARC–21 Collins 618S1 Collins 18S4	Radio operator's station Control panel on pedestal	Two-way voice and code communication	Radio operator, pilot & copilot	200-2500 miles depending on frequency and time of day
Radio Compass Set AN/ARN–6	Indicator and control panel at navigator's & pilot's stations	Receives voice and code for direction homing and bearing	Pilot and navigator	20-200 miles depending on frequency and time of day
Radio Compasses #1 and #2, AN/ARN–6	Indicators on instrument panel; control panels for pilot and copilot	Receives voice and code for direction homing and bearing	Pilot and copilot	20-200 miles depending on frequency and time of day
IFF Set AN/APX–6 AN/APX -25	Control panel at navigator's station	Identifies aircraft as friend or foe	Navigator	Line-of-sight
Marker Beacon Set AN/ARN–12	Indicator light on instrument panel	Receives signal on navigational beam	Pilot and copilot	
Radar Altimeter AN/APN–22	Indicators on instrument panel	Indicates distance from airplane to point below	Pilot	Airplane to point beneath

Figure 4-7

ELECTRONIC EQUIPMENT

EQUIPMENT	LOCATION	FUNCTION	OPERATOR	RANGE
Omnidirectional Navigation System AN/ARN-14	Control panel on pedestal, indicators on instrument panel and navigator's panel	Radio navigational and landing aid	Pilot	Line-of-sight
Loran Set AN/APN-9 (on early airplanes) Loran Set AN/APN-70 (on late airplanes)	Navigator's station	Indicates navigational fixes	Navigator	Day—700 miles Night—450-1400 miles
Radar Beacon Set AN/APN-12	Navigator's station	Radar beacon and interrogator-responser	Navigator	150 miles
Emergency (Dinghy) AN/CRT-3	Stowed in life raft compartment	Emergency transmitter	Crew	100 miles (low) 1000 miles (high)
UHF Command Set AN/ARC-27	Control panel on pedestal	Two-way voice and code communication	Pilot and Copilot	Line-of-sight
Glide Path Receiver AN/ARN-18	Indicator on instrument panel; control panel on pedestal	Indicates glide angle for landing	Pilot	15 miles
Emergency Keyer Equipment AN/ARA-26	Control panel on radio rack	Automatically transmits distress signal	Radio operator	200-2500 miles depending on time of day.
Radar Search and Navigation AN/APS-42	Pilot's station and navigator's station	Radar discrimination of objects	Navigator, pilot, co-pilot	200 miles
UHF Direction Finding Equipment AN/ARA-25	Indication on ID 250 compass Indicators		Pilot and Copilot	Line-of-sight

Figure 4-7

On earlier airplanes, installation of the AIC-8 interphone system provides intercommunication among the various crew members. Interphone control panels for the pilot and copilot are located below the side windows on either side of the crew compartment on some airplanes. On those airplanes equipped with only one radio compass, the interphone controls are located on the pedestal. Control panels for the radio operator and navigator are provided at their respective stations. Additional jack boxes are located at the jumpmaster's station and the right side of the cargo compartment. Interphone equipment has the following functions:

1. Voice communications between any interphone stations.

2. Selection at each major station of the audio output of seven receivers by individual toggle switches: VHF Command (HF COMM), Liaison (LIAISON), UHF Command (VHF COMM) automatic radio compass No. 1 (ADF-1), automatic radio compass No. 2 (ADF-2), marker beacon (MARKER), and omnirange plus localizer (VHF NAV). On some airplanes, only one radio compass is installed and is connected to the ADF-1 switch.

RADIO OPERATOR'S STATION

1. MONITOR SWITCH FOR AN/ARC-8
2. OXYGEN CONTROL PANEL
3. ANTENNA LOADING UNIT
4. LIAISON TRANSMITTER
5. LIAISON RECEIVER
6. KEY
7. INTERPHONE CONTROL PANEL
8. INTERPHONE FILTER
9. EMERGENCY KEYER CONTROL PANEL
10. UHF COMMAND CONTROL PANEL

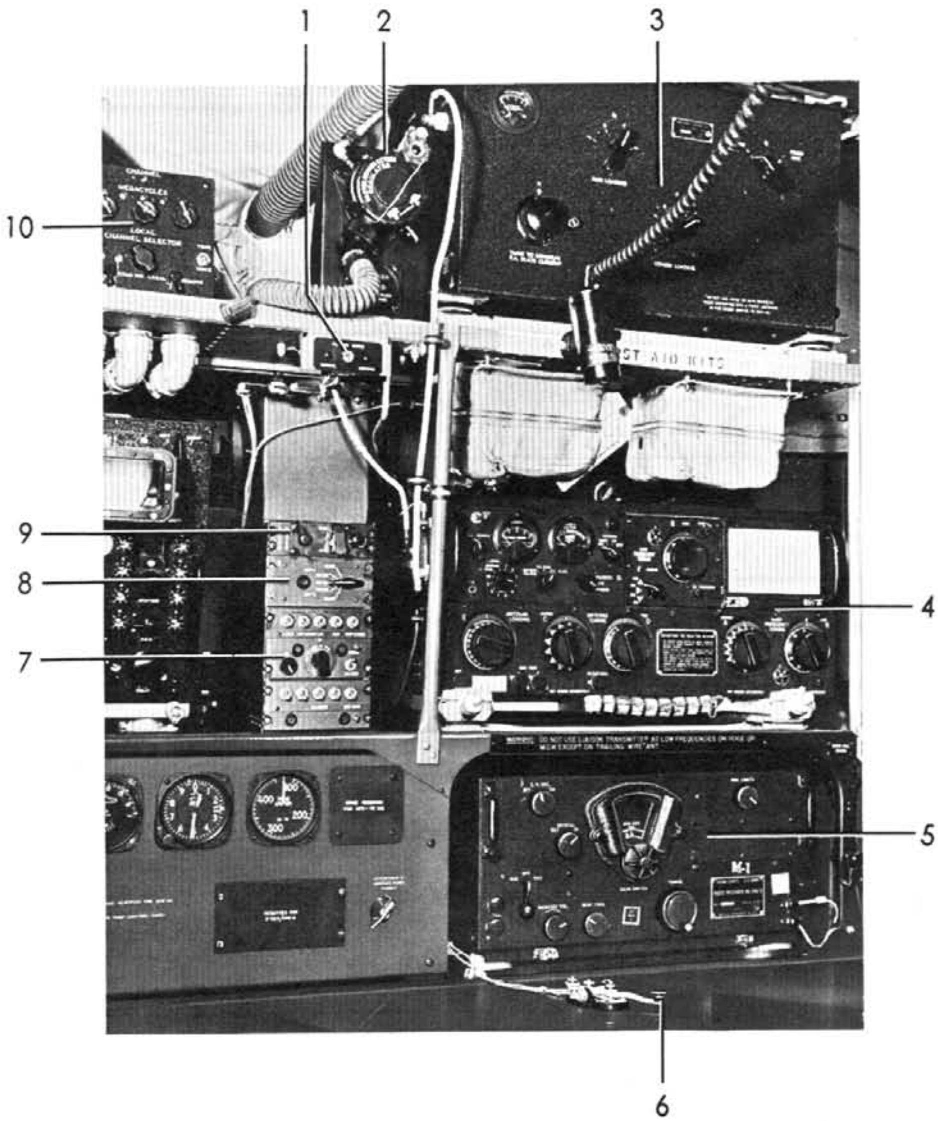


Figure 4–8

3. A means of switching the microphone to VHF transmitter, UHF transmitter, liaison transmitter, or the interphone system.

4. A spring-loaded CALL position on the transmitter selector switch that overrides all other facilities so the pilot can communicate with all interphone stations regardless of the setting of the switches and without the use of the foot switches or control wheel push buttons which normally permit use of the microphone.

5. A filter facility whereby the output signal of the automatic radio compass receivers may be fed through a radio range filter at each of the four major interphone stations.

6. A normal-single receiver switch which is used in the NORMAL position during all normal operations. However, if the mixer amplifier at any of the major interphone stations fails, the receiving equipment is still available by placing the switch in the SINGLE REC position, and the microphone selector switch in any of the transmitter positions. If the microphone switch is left in the INTER or CALL positions, only interphone signals will be heard. Since only one receiver may be heard at a time when the switch is in the SINGLE REC position, the desired receiver may be selected by turning on (up) the desired receiver switch and turning all other off (down).

MICROPHONE AND HEADSETS.

The pilot and copilot are provided with plug-in jacks just forward of the side windows, while the navigator and radio operator are provided with plug-in jacks located on the radio rack. The pilot's and copilot's microphones are controlled by a push-button on their respective control wheels. The navigator's and radio operator's microphones are controlled by a foot switch located under their respective work tables. A hand-held microphone with a headset and built-in push button is provided for the jumpmaster.

INTERCOMMUNICATIONS EQUIPMENT AN/AIC-10.

On later airplanes, a high-intelligibility interphone system, which is designed to function efficiently under all operating conditions, is installed to provide intercommunication among the various crew members throughout the airplane. On some airplanes, the pilot's and copilot's interphone control panels are mounted below the side windows on either side of the crew compartment. On those airplanes equipped with only one radio compass, the pilot's interphone panel is located below the left side window and the copilot's is mounted on the pedestal. Control panels for the radio operator and navigator are mounted on the radio rack at their respective stations. A smaller control panel with provisions for voice communication between any interphone station is installed on the rear and forward jumpmaster's panels, at the right voltage regulator station, at a maintenance station in each nacelle, and on the right side at the rear of the cargo compartment. Headsets with boom-type microphones and hand-held microphones are provided at each of the major crew stations. A loudspeaker is installed at the pilot's, copilot's and radio operator's stations to provide independence from headphones during routine operation, yet make certain that crew members who have removed their headsets will be reached. This intercommunications equipment is capable of performing the following functions:

1. Voice communication between any interphone stations. During interphone communication the output volume from any selected radio receivers is automatically reduced with respect to the interphone volume.

2. Selection at each major control panel of any one or combination of seven receiver outputs: UHF Command (UHF), Liaison (LIAISON), automatic radio compass No. 1 (ADF-1), VHF Command (VHF), marker beacon (MARKER), automatic radio compass No. 2 (ADF-2), and omni-range plus localizer (VHF NAV). Two unmarked spare switches are also provided for use when additional receivers are installed.

3. Selection of the microphone and control circuits of any one of three transmitters (UHF COMM, LIA, VHF COMM).

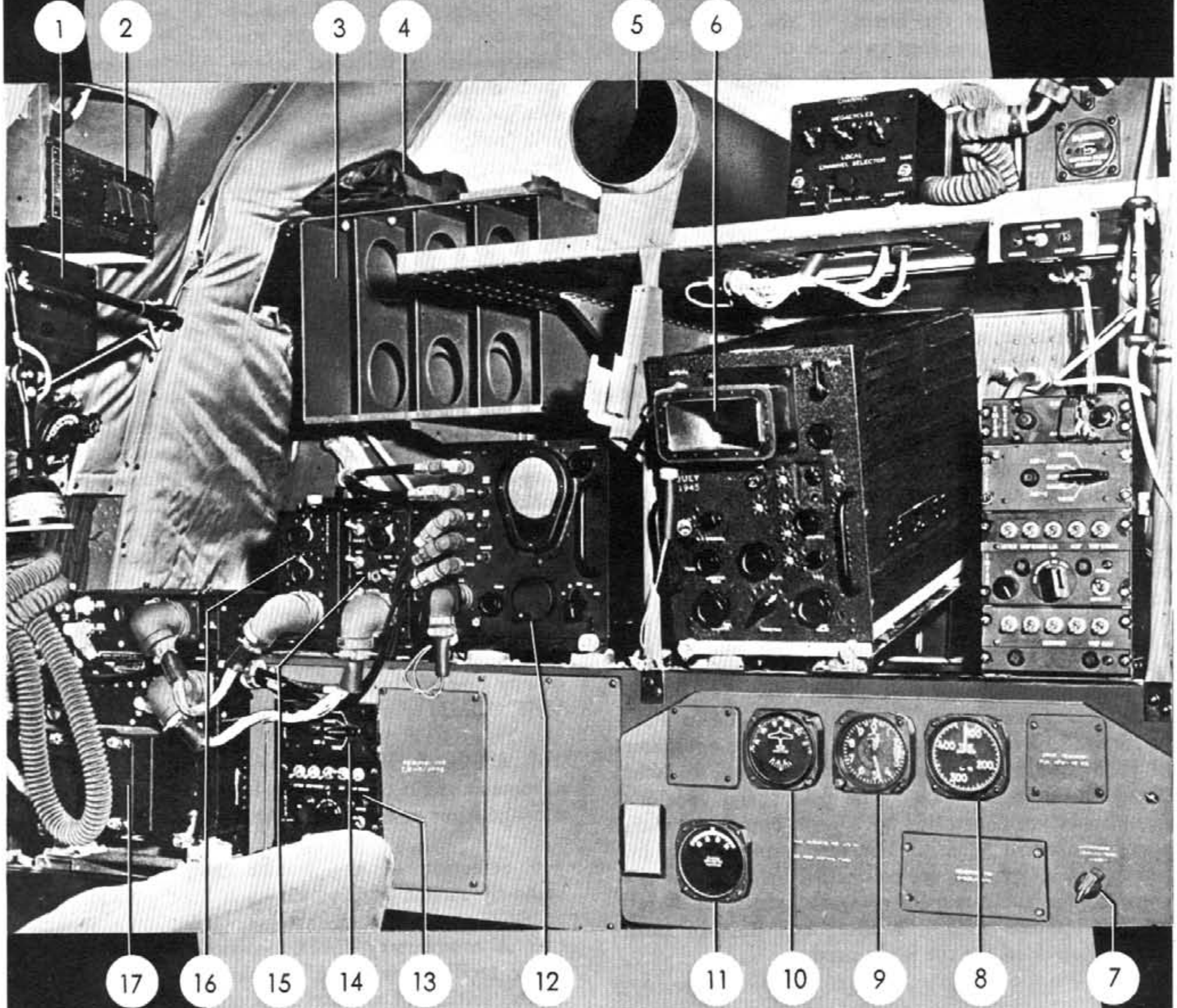
4. A filter facility whereby the output signal of the automatic radio compass receivers may be fed through a range filter at each of the major interphone stations.

5. Selection of the loudspeakers by use of the stand-by switch located on each loudspeaker.

6. A momentary CALL position that overrides all other facilities with voice communication regardless of the setting of the switches and without the use of the foot switches or control wheel push buttons that normally permit the use of the microphones. Voice communication in the CALL position is automatically delivered by the loudspeakers as well as the headsets regardless of the loudspeaker standby switch setting.

7. A single receiver switch which is used in the NORMAL position during all normal interphone operation. However, if the mixer amplifier at any of the major interphone stations fails, the receiving equipment is still available by placing the switch in the AUX. LISTEN position. Since only one receiver can be heard at a time when the switch is in the AUX. LISTEN position, the desired receiver may be selected by turning on (up) the desired receiver switch and turning all others off (down).

NAVIGATOR'S STATION



1. IGNITION ANALYZER LEAD STORAGE LOCKER
2. IGNITION ANALYZER SWITCH PANEL
3. STOWAGE COMPARTMENT
4. FLARE STOWAGE BAG
5. CHART TUBE
6. LORAN RECEIVER AN/APN–9
7. INTERPHONE AND COMPASS LIGHT RHEOSTAT
8. AIRSPEED INDICATOR
9. ALTIMETER
10. MASTER DIRECTION INDICATOR
11. BEARING CONVERTER AN/ARN-14
12. RADAR BEACON AN/APN-12
13. INTERPHONE CONTROL BOX
14. INTERPHONE FILTER CONTROL PANEL
15. POWER CONTROL BOX AN/APN-12
16. FREQUENCY CONTROL BOX AN/APN-12
17. TRANSCEIVER AN/APN-12

Figure 4–9

MICROPHONES AND HEADSETS.

The pilot and copilot are provided with plug-in jacks just forward of the side windows, while the navigator and radio operator are provided with plug-in jacks located on the radio rack. The pilot's and copilot's microphones are controlled by a push button on their respective control wheels. The navigator's and radio operator's microphones are controlled by a foot switch located under their respective work tables. A hand-held microphone with a headset and built-in push button is provided for the jumpmaster.

VHF COMMAND SET AN/ARC-3.

Note

To obtain VHF command reception at each of the four major interphone stations when the AIC-8 interphone system is installed, use the receiver switch designated HF COMM. The receiver switch placarded VHF COMM will give UHF reception. To permit VHF command transmission, use HF COMM position of the microphone selector switch. The VHF COMM position of the selector switch permits UHF transmission.

This set is a transmitting and receiving set designed to provide plane-to-plane or plane-to ground communication. The controls are located on the radio control panel.

1. To operate, turn master switch to ON, turn the frequency selector switch to the channel desired, and allow set to warm up

Note

The receiver will continuously monitor that frequency indicated by the frequency selector switch except during periods of transmission at which time the receiver is shut off.

2. To stop the unit, turn master switch to OFF.

LIAISON SET AN/ARC-8. (ON SOME AIRPLANES).

Note

The pilot's liaison control panel is placarded HF TRANSMITTER. However, to utilize liaison transmitter at any of the four major interphone stations when the AIC-8 interphone system is installed, use the liaison position of the microphone selector switch. Likewise, use LIAISON receiver switch for liaison reception.

This set is a long-range, two-way, voice and code communications set which consists of a 10-channel transmitter and a 6-band receiving set. The controls are available to the pilot, copilot and radio operator. A trailing antenna is used for low frequency transmission while a fixed antenna is used for high frequency transmission.

Note

On airplanes with the monitor bus installation this equipment will be automatically de-energized whenever an engine generator fails. Refer to ELECTRICAL SYSTEM, Section I.

1. To transmit, adjust frequency selector switch to desired frequency.

2. Turn liaison switch to ON.

3. Turn emission switch to VOICE.

4. Adjust volume control as desired.

5. To stop set, turn transmitter emission switch OFF and receiver switch to OFF position.

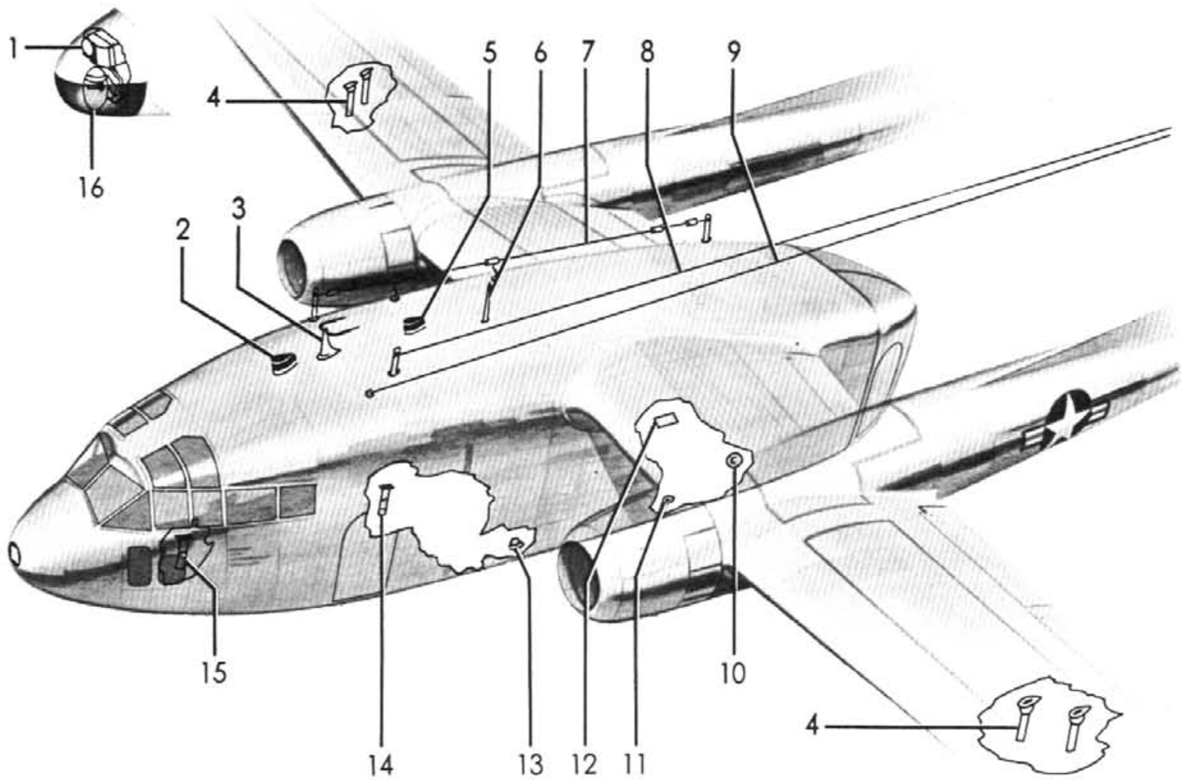
Note

A switch is provided for monitoring transmissions, and is located at the radio operator's station.

LIAISON SET AN/ARC-21. (ON SOME AIRPLANES.)

The radio set AN/ARC-21 consists of a 100-watt transmitter and receiver covering the frequency range of 2 to 24 megacycles. The transceiver may be operated on any one of 44,000 frequencies available in 500-cycle steps over the entire frequency range. The equipment is completely remote controlled. Selection of any desired frequency is accomplished by means of simple switches. To facilitate rapid frequency changes the master remote control panel on the pedestal includes facilities for presetting any desired twenty of

RADIO ANTENNAS



1. GLIDE PATH APPROACH
2. NO. 1 RADIO COMPASS LOOP
3. OMNI RANGE
4. RADAR BEACON
5. NO. 2 RADIO COMPASS LOOP
6. VHF COMMAND
7. RADIO COMPASS SENSE
8. LIAISON (ARC-21, 18S-4, 618S-1)
9. LIAISON (ARC-8)
10. HOMING ADAPTER
11. IFF RADAR
12. RADAR ALTIMETER
13. MARKER BEACON
14. UHF COMMAND
15. RADAR BEACON
16. NAVIGATIONAL RADAR

Figure 4-10

the 44,000 available frequencies. Once the master control panel has been preset to the desired frequencies, the tuning of both the receiver and transmitter is fully automatic. This radio set incorporates facilities for operation on voice communication, CW, and, modulated CW (MCW). The master control panel is located on the pedestal at the pilot's station and a smaller auxiliary control panel is provided at the radio operator's station. The auxiliary control panel provides all of the operational functions necessary for voice communication except for the ability to preset frequencies. The radio operator may take control of and operate the equipment on any one of the twenty preset channels without disturbing the settings on the pilot's master control panel. Operation of the equipment after the channels have been preset is as follows:

1. To put the equipment in operation, place the control knob in the ON position. This assures that the operator has control of the equipment. After a few seconds for completion of automatic tuning and warm-up, the equipment is ready for transmitting or receiving.

2. To stop the equipment, turn the take control knob to the OFF position.

LIAISON SET, COLLINS 18S-4 (ON SOME AIRPLANES).

The 18S-4 radio set consists of a 100-watt high frequency transmitter-receiver unit which covers a frequency range of 2 to 18.5 megacycles. A total of twenty frequencies are available for selection, and tuning of the transmitter-receiver is fully automatic. Both voice (PH) and radio telegraph (CW) transmission and reception are provided. The control panel, located on the pedestal at the pilot's station provides frequency selection, function selection, sensitivity and volume controls as well as the ON-OFF control switch. Operation of the equipment is as follows:

1. To start the equipment, first place the function switch in the PH or STDBY position. (This prevents starting the dynamotor as the set is turned on.) Then place the ON-OFF switch in the ON position.

2. After allowing a few seconds for the tubes to reach operating temperatures, select either the PH or CW position of the function selector, depending on the type of operation desired. Set the channel selector switch to the desired operating channel, allowing time for the selector mechanism to operate. Transmission may then be accomplished by microphone for voice transmission, according to the selection of the function selection switch. Reception of appropriate signals is similarly provided when either the microphone button or key is released. Regulate signal pitch with BFO control.

3. To stop the equipment, turn the ON-OFF switch to the OFF position.

Note

On airplanes with monitor bus installation, this equipment will be automatically de-energized whenever an engine generator fails. Refer to ELECTRICAL SYSTEM, Section I.

LIAISON SET, COLLINS 618S-1 (ON SOME AIRPLANES).

The Collins 618S-1 radio set provides transmitting and receiving facilities for high frequency communication in the 2 to 25 megacycle range. Either voice or CW operation is possible on any one of 144 channels. Complete tuning is automatically accomplished whenever the desired channel is selected. The control panel, located on the pedestal at the pilot's station, provides frequency selection, sensitivity and volume control, and ON-OFF control of the set. Operation is as follows:

1. To start the equipment first place the OFF-PH-CW switch in the OFF position. (This prevents starting the transmitter dynamotor as the set is turned on). Turn the ON-OFF control switch ON.

2. After allowing a few seconds for tubes to come up to operating temperature, select either the PH or CW position of the function selector, depending on the type of operation desired. Rotate the channel selector control to the desired operating channel, allowing time for the selector mechanism to operate. Transmission may then be accomplished by use of the microphone for voice transmission or operation of the key for CW transmission, according to the previous selection of the function switch. Reception of the appropriate signals is possible when either the microphone button or key is released. Regulate the signal pitch with the BFO control.

3. To stop the equipment, turn the ON-OFF switch to the OFF position.

Note

On airplanes with the monitor bus installation, this equipment will be automatically de-energized whenever an engine generator failure occurs. Refer to ELECTRICAL SYSTEM, Section I.

RADIO COMPASS AN/ARN-6.

This set is an automatic navigational instrument providing an automatic visual indication of direction from which radio frequency energy is being received.

It acts as a navigational aid in homing operations and in position finding operations. On some airplanes, two radio compasses are installed with an independent control panel for each on the pedestal in the crew compartment; the pilot's panel being for the No. 1 compass and the copilot's, for the No. 2 compass. Three ID/250 course indicators are mounted on the instrument panel. The #1 needle of each indicator is energized by the No. 1 radio compass (or the UHF Direction Finding Equipment, if operating). The #2 needles of the pilot's and copilot's indicators give omni-range indication only, and the #2 needles of the center indicator is used for the No. 2 radio compass.

1. Start the equipment by turning the function switch to ANT. Place the lights switch in the HI or LO position.

2. Turn the frequency selector knob to the desired frequency.

3. Turn the function switch to LOOP or COMP.

4. To stop the equipment, turn the function switch OFF. On some airplanes, only one radio compass is installed, with a control panel on the pedestal for the pilot and another panel at the navigator's station. Bearing information is displayed on the #1 needles of the ID/250 course indicators mounted on the instrument panel and at the navigator's station. Since the tuning controls on each control unit are interconnected, it is necessary to first place the function switch in the CONT position before operating the equipment. Remote control of the receiver is then indicated when the dial lights come on.

IFF SET AN/APX-6.

The AN/APX-6 IFF equipment enables the airplane to identify itself automatically whenever it is properly challenged by suitably equipped friendly surface and airborne radars. Supplementary functions of the equipment are to provide two separate channels for the identification of specific friendly airplanes among many friendlies, and to provide a means of transmitting a special coded reply for emergency. The control panel is located on the navigator's panel just below the navigator's altimeter. A means for destroying this equipment is provided by the use of the destruct switch.

1. To start the equipment, turn master switch to the LOW or NORM position and turn the mode switches to position desired.

2. The STDBY position of the master switch will keep the equipment ready for immediate operation.

3. The EMERGENCY position of the master switch will send out an emergency signal on all modes.

4. A push button guard is provided so that the switch is not accidentally turned to the EMERGENCY position.

5. To stop the equipment turn the master switch to the OFF position.

IFF SET AN/APX-25.

On some airplanes, provisions are included for installing IFF set AN/APX-25. Cover plates at the navigator's station indicate the space reserved for the control panel. For operating procedure of this set consult applicable Technical Orders.

MARKER BEACON AN/ARN-12.

The marker beacon set is a navigational and landing aid giving the pilot an aural or visual indication when the airplane passes a ground marker beacon station. An indicator light on the pilot's course indicator of the AN-ARN-14 set and a light on the copilot's side of the instrument panel are used to indicate the presence of a marker beacon. A switch on each interphone control panel provides a means for aural reception of marker beacon signal.

RADAR ALTIMETER AN/APN-22 (ON SOME AIRPLANES).

Radar altimeter AN/APN-22 is provided on some airplanes to measure the terrain clearance of the aircraft. During operation it provides an accurate altitude indication up to 20,000 ft. Operating control is provided by a single control knob at the base of the instrument.

1. To turn on, the control knob is rotated clockwise as indicated by the arrow.

2. Further rotation of the control knob adjusts a small movable bug pointer, located just outside the calibrated dial, to the desired flight altitude.

3. The altitude of the airplane may then be easily maintained by observing the position of the needle with respect to the bug pointer without constantly observing the actual scale calibrations. In addition, when flying at or below the selected altitude, warning is provided by a red light which is then energized, illuminating the face of the dial and the pointer. At any time during unreliable operation, the needle pointer of the instrument will assume an off scale position between the 20,000 ft. and 0 points behind a blacked out area of the dial. This is done to provide the pilot with a warning of unreliable operation and to prevent him from following an inaccurate altitude indication.

4. To turn equipment off, turn the single control at the base of the instrument counterclockwise.

OMNIDIRECTIONAL NAVIGATION SYSTEM RADIO RECEIVING SET AN/ARN-14 AND GLIDE PATH APPROACH RADIO AN/ARN-18.

Both of these sets are navigational aids designed to work cooperatively to provide reception of military and commercial (amplitude modulated channels), omnidirectional range channels, 90/150 cycle and phase comparison localizer channels and glide path approach. In airplanes equipped with only one AN/ARN-6 radio compass, two course indicators (radio magnetic indicators) are located on the instrument panel and one on the navigator's panel. In airplanes equipped with two radio compasses, all three indicators are mounted on the instrument panel. In either configuration the control panel is mounted on the pedestal between the pilot's and co-pilot's seats.

1. To operate, set the ON-OFF switch in the ON position, turn the megacycle selector knobs to desired frequency; and turn volume control to desired gain.

2. To stop equipment, set the ON-OFF switch in the OFF position.

LORAN SET AN/APN-9. (ON EARLY AIRPLANES.)

This set is a navigation set which receives, amplifies, and detects loran signals, and displays them on a screen of the receiver-indicator. Information obtained is used for finding the geographical position of the airplane in which it is installed. This set will operate at altitudes up to 40,000 feet and temperatures ranging from −55 to 55 degrees Centigrade. The loran set is equipped with controls for navigator only.

1. To operate, set amplitude balance control and drift control at their center position of rotation, and turn receiver gain control clockwise until station rate identification appears on the screen.

2. To stop, turn receiver gain control to POWER OFF; check to see that pilot light is not illuminated and the pattern on indicator screen has disappeared.

LORAN SET AN/APN-70. (ON LATER AIRPLANES.)

This set is an airborne, long-range navigation set which is used to obtain information for locating the geographical position of the airplane in which it is installed. The receiver and the indicator, independently housed, are mounted on the radio rack at the navigator's station, control of the equipment being available to the navigator only. Capabilities of the equipment are indicated by the following functions: dual, direct reading, time delay measuring systems; dual presentation on low frequency channels allowing two simultaneous readings for a complete fix; automatic drift control; and operation on 100 kc. and 180 kc. channels in addition to four standard Loran channels at 1750-1950 kc. Instructions for starting and stopping the equipment will be supplied when that information becomes available. Due to interference with the radio compass, this equipment should be turned OFF during passage over the "cone of silence" to permit the use of the No. 1 radio compass.

Note

With the monitor bus system installed, this equipment will be automatically de-energized whenever an engine generator failure occurs. Refer to ELECTRICAL SYSTEM, Section I.

RADAR BEACON SET AN/APN-12.

This set is a remotely controlled airborne navigation and recognition unit designed to direct an airplane to a point within 200 yards of a ground beacon, and to identify other airplanes equipped with similar IFF sets.

1. To start equipment, turn transmitter switch to the OFF position.

2. Turn power switch to the ON position.

3. Turn receiver switch to the ON position.

4. To stop equipment, turn all switches to the OFF position.

Note

With the monitor bus system installed, this equipment will be automatically de-energized whenever an engine generator failure occurs. Refer to ELECTRICAL SYSTEM, Section I.

UHF COMMAND SET AN/ARC-27.

This set has been designed to provide AM radio telephone communication in the frequency range of 225.0 to 399.9 megacycles, and for use in conjunction with UHF direction finding equipment. Remote control is provided for the selection of any one of eighteen preset frequencies plus a guard channel frequency. A tone switch on the local control panel at the navigator's station permits continuous tone modulation of the selected UHF frequency for emergency or direction finding purposes. Transmission and reception are accomplished on the same frequency and on the same antenna.

Note

Under present temporary procedure when the AIC-8 interphone system is installed, to obtain UHF reception at any of the four major interphone stations, turn ON (up) the VHF COMM receiver switch. To utilize UHF transmitter, turn microphone selector switch to VHF COMM position.

The pilot's remote control panel located on the pedestal contains an audio volume control, a channel selector switch and a master switch.

1. To operate, place the REMOTE-LOCAL switch on the local control panel at the navigator's station in the REMOTE position.

2. Place the TONE-VOICE switch in the VOICE position.

3. Place the master switch on the pilot's remote control panel in the T/R position, and allow the set to warm up. Placing the switch in the T/R + G REC position permits transmission on the selected frequency and the guard frequency. To transmit on the guard frequency it is necessary to select the G position with the channel selector knob. The ADF position of the master switch is provided for use of the set in conjunction with UHF direction finding equipment (when installed).

4. Select the desired frequency with the channel selector knob.

5. To stop the equipment, turn OFF the master switch.

UHF DIRECTION FINDING EQUIPMENT, AN/ARA-25 (SOME AIRPLANES).

This equipment, designed to provide ADF capabilities in the UHF frequency range, utilizes the AN/ARC-27 Command Set as a receiver. By placing the master selector switch on the pilot's control panel in the ADF position, the receiver is coupled to a UHF sensing antenna and the bearing information is displayed on the number one needle of all three radio compass indicators, simultaneously. This will automatically disconnect the number one low frequency radio compass, AN/ARN-6 from the indicators. The number two radio compass will continue to activate the number two needle of the center indicator.

Frequency selection is made, as for UHF Communications, with the channel selector knob. UHF transmission is not possible while utilizing the ADF equipment.

1. To operate, select the desired frequency with the channel selector knob.

2. Place the master switch in ADF position.

3. Read bearing information on #1 needles of radio compass indicators.

4. To restore UHF transmission, place master switch in T/R position.

EMERGENCY (DINGHY) RADIO SET AN/CRT-3.

This set is an emergency radio transmitter which is stowed in the life raft compartment. It is waterproof, will float, is pretuned to an international distress frequency of 500 kc. and transmits an MCW signal. The set is also equipped with a light by which visual blinker code may be transmitted. Power both for the radio and the light is furnished by a hand-operated generator in transmitter case. Operational instructions may be found in unit.

EMERGENCY KEYER AN/ARA-26.

Used in conjunction with the liaison set AN/ARC-8, Collins 618S-1, or AN/ARC-27, the emergency keyer, when operative, automatically feeds a constant distress signal to the liaison transmitter.

Note

In order that the distress signal can be transmitted on the distress frequency, the remote-local switch on the ART-13 transmitter or on the radio operator's ARC-27 control panel must be placed in the REMOTE position. If the switch is in the LOCAL position, the distress signal will be transmitted on the frequency for which the transmitter controls are set.

The control panel is located above the interphone panel at the radio operator's station; the keying unit, itself, on the utility shelf above the radio operator's station.

automatically turn on the transmitter, channel it to the distress frequency, and set the controls of the transmitter for modulated continuous wave emission. After completion of the channeling, it will transmit the following distress signal in International Morse Code:

1. SOS signal (three times).

2. The last four digits of the airplane's serial number (three times).

3. A series of four-second dashes spaced one second apart (six times).

The emergency keyer will continue to transmit the above signals until the control switch is thrown to the OFF position. The transmitter will then rechannel to its original frequency.

NAVIGATION AND SEARCH RADAR EQUIPMENT AN/APS-42.

Figure 4-11

Radar Set AN/APS-42 is designed for search, beacon, weather, and target-discrimination operations. The radar information is displayed on a PPI-type radar screen, one of which is installed at the pilot's and copilot's stations and another at the navigator's station. The type of operation desired is manually selected by the operator. Inherent characteristics of the equipment allow accurate determination of location of objects in terms of range and azimuth relative to the bearing of the airplane, and afford reasonable differentiation of objects as to their type, shape, and size. Roll and pitch stabilization systems and noise suppression features are provided. The control panel which contains the operating controls for the equipment is located at the navigator's station; however, each indicator is provided with edge-lighting, focusing, intensity, and video-gain controls. The following procedure is to be employed in placing the equipment in operation.

1. Turn the AN/APS-42 inverter switch ON.

2. Place the function switch in the STANDBY position and allow three minutes for a warm-up period. If ambient temperatures require it, the antenna heaters may be utilized.

3. Adjust the intensity control on the indicator so that the sweep line appears plainly on the screen.

4. Adjust the focus control on the indicators so that the sweep line appears sharp and clear. Alternately readjust the focus and intensity controls until a clear sharp sweep line is obtained.

5. Rotate the intensity control slowly counterclockwise until the sweep line is just visible on the screen.

6. Place the function switch in any desired position for operation of the equipment.

When it is desired to stop the equipment, employ the following procedure:

1. Place the scan switch in the STOP position.

2. Place the stabilization switch in the OUT position.

3. Place the function switch in the OFF position, this completely de-energizing the equipment.

4. Turn the AN/APS-42 inverter switch OFF.

Note

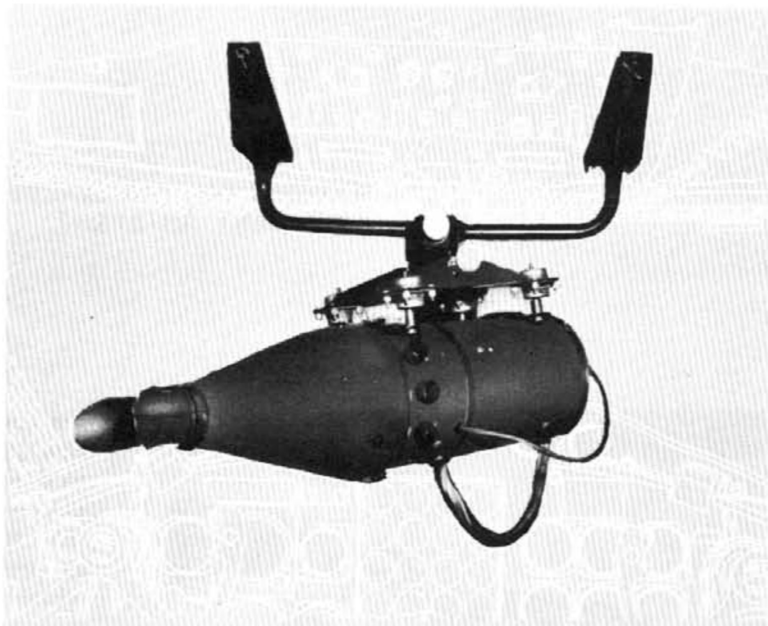
With the monitor bus system installed, this equipment will be automatically de-energized whenever an engine generator failure occurs.

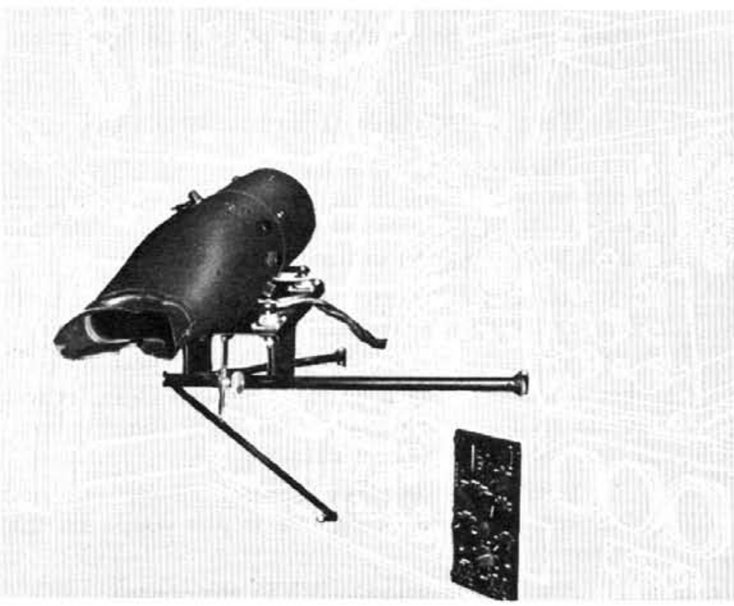
STATIC DISCHARGERS AN/ASA-3.

The static dischargers consist of 10 lengths of cotton wick, each approximately 12 inches long. Three extend from the trailing edge of each wing tip and aileron and two from each rudder. Their function is to dissipate static electricity.

PILOT'S AN/APS 42 INSTALLATION

Figure 4–12.





NAVIGATOR'S AN/APS 42 INSTALLATION

Figure 4–13.

LIGHTING SYSTEM.

EXTERIOR LIGHTING.

Exterior lighting consists of navigation lights, a passing light, formation lights, and a fixed landing light in each wing. The navigation lights include a red light on the left wing tip, a green light on the right wing tip, a white and yellow light on the aft end of the left boom and a white light on the top and the bottom of the fuselage. A passing light is mounted in the left wing. Nine blue formation lights are installed on the top of the wing, fuselage, nacelle, and stabilizer in such a manner as to form a "T." Fixed landing lights are installed in the leading edge of each wing outer panel. 28-volt dc power is used for all external lights.

NAVIGATION LIGHTS SWITCH.

The navigation lights are controlled from the overhead panel by a three-position switch (14, figure 1-6) with STEADY, FLASH, and OFF positions. In the STEADY position the wing and boom lights will emit a steady beam, while the top and bottom fuselage lights remain out. In the FLASH position the wing tip and boom lights will flash intermittently, while the top and bottom fuselage lights will emit a steady beam. The intensity of the navigation light may be controlled from the overhead panel by a switch (15, figure 1-6) with BRIGHT and DIM positions.

PASSING LIGHT SWITCH.

A two-position passing light switch (13, figure 1-6) on the overhead panel, controls the passing light in the left wing.

FORMATION LIGHTS SWITCH.

A three-position switch (16, figure 1-6) on the overhead panel which can be turned to BRIGHT, OFF, or DIM, controls the blue formation lights.

LANDING LIGHT SWITCHES.

Each fixed landing light installed in the outer panel of each wing is controlled by a two-position landing light switch (1, figure 1-5) on the pilot's switch panel.

INTERIOR LIGHTING.

Interior lighting includes dome lights in the crew compartment, the auxiliary equipment compartment, lavatory compartment, and nose wheel well, and floor and dome lights in the cargo compartment. Included in the crew compartment are spotlights with flexible cords. Instrument panel lights consist of eleven ultraviolet and ten red lights, while control pedestal illumination is provided by light diffused through a plexiglas plate on the control quadrant and pilot's switch panel. Additional light for the aft portion of the pedestal is obtained from two spotlights on the overhead panel. Thirty-seven lights, diffused through a plexiglas plate, provide illumination for the overhead panel.

CREW COMPARTMENT DOME LIGHTS RHEOSTATS.

Two rheostats (39, 40, figure 1-6), located on the overhead panel, control the dome light in the crew compartment. This dome light is of the floodlight-type with either a red or clear lamp, one rheostat being for each.

AUXILIARY EQUIPMENT COMPARTMENT LIGHTS SWITCH.

An auxiliary equipment compartment dome lights switch (3, figure 4-19), located on the APP control panel, controls the three dome lights in the auxiliary equipment compartment.

LAVATORY LIGHT SWITCH.

A built-in, two-position switch controls the dome light in the lavatory compartment.

NOSE WHEEL WELL LIGHT.

A nose wheel well dome light switch (13, figure 4-23) is located on the cargo compartment forward bulkhead and controls the dome light in the nose wheel well.

CARGO COMPARTMENT DOME LIGHTS SWITCH AND RHEOSTATS.

A cargo compartment dome lights switch and dimming rheostats (3, 5, figure 4-23), located on the cargo compartment forward bulkhead, control the cargo compartment dome lights. Seven of these lights mounted on each side of the cargo compartment provide light for the entire compartment.

CARGO COMPARTMENT FLOOR LIGHTS SWITCH.

A cargo compartment floor lights switch (8, figure 4-21) on each jumpmaster's panel controls four floor lights on each side of the cargo compartment.

INSTRUMENT PANEL LIGHTS CONTROLS.

The ultraviolet instrument panel lights are controlled by an ON-OFF switch (3, figure 4–14) and three rheostats (2, 4, 7, figure 4–14) located on the instrument lights control panel. The instrument panel red lights are controlled by three rheostats (1, 5, 6, figure 4–14) also located on the instruments lights control panel.

CONTROL PEDESTAL LIGHTS RHEOSTAT.

A rheostat (12, figure 1–5) on the pilot's switch panel, controls illumination of the pedestal lights.

OVERHEAD PANEL RHEOSTAT.

Diffused light illuminating the overhead panel is controlled by a rheostat (37, figure 1–6) located on the overhead panel.

COMPASS LIGHT RHEOSTAT.

The compass light, located in the magnetic compass, is controlled by a rheostat (11, figure 1–6) on the overhead panel.

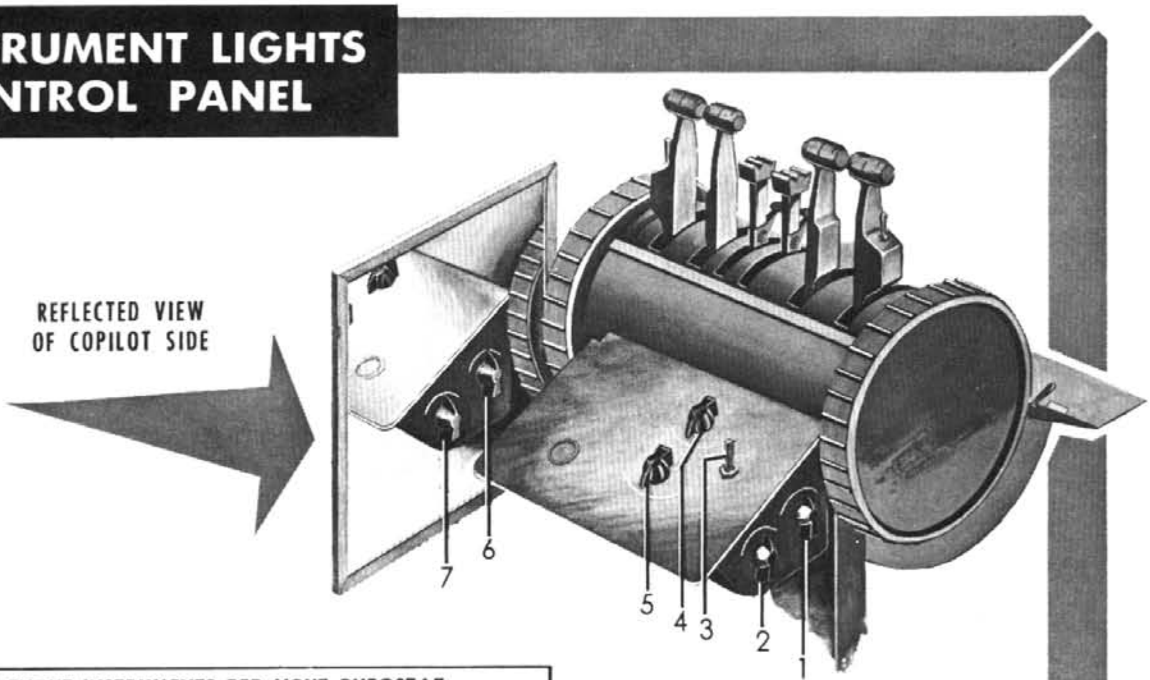
SPOT LIGHTS.

Three spot lights with built-in switches and flexible cords are provided for auxiliary lighting at the navigator's and radio operator's stations. Two similar lights are also provided at the pilot's and copilot's stations on earlier airplanes.

Note

> On airplanes with emergency and monitor bus installation, the pilot's spot light is wired through the left oleo switch and will not operate when the left strut is compressed.

INSTRUMENT LIGHTS CONTROL PANEL



1. PILOT'S FLIGHT INSTRUMENTS RED LIGHT RHEOSTAT
2. PILOT'S FLIGHT INSTRUMENTS ULTRA VIOLET LIGHT RHEOSTAT
3. INSTRUMENT LIGHTS CONTROL SWITCH
4. ENGINE INSTRUMENTS ULTRA VIOLET LIGHT RHEOSTAT
5. ENGINE INSTRUMENTS RED LIGHT RHEOSTAT
6. COPILOT'S FLIGHT INSTRUMENTS RED LIGHT RHEOSTAT
7. COPILOT'S FLIGHT INSTRUMENTS ULTRA VIOLET LIGHT RHEOSTAT

Figure 4-14

NAVIGATOR'S SWIVEL LIGHT.

A full swivel light which is controlled by a rheostat located beside the light is provided for the navigator's use.

INTERAIRCRAFT SIGNAL LIGHT.

An interaircraft signal light is located on the right side of the crew compartment and an electrical outlet for plugging in this light is provided on the forward part of the navigator's work table.

OXYGEN SYSTEM.

A low pressure demand-type oxygen system operating at a working pressure of 425 psi, is installed for all crew members. The oxygen flows from eight G-1 cylinders, four installed in each boom aft of the nacelles. The four cylinders in the left boom supply the pilot, radio operator and crew chief, while three of the four in the right boom supply the copilot and navigator. The additional cylinder of oxygen in the right boom (approximately 400 psi) is used to supplement pressure in either section of the system that has the greatest rate of flow. Check valves are installed for safety in combat areas and prevent flow of pressure from one section of the system to the other. Three diluter demand portable oxygen units, consisting of an oxygen cylinder and regulator, are provided in the crew compartment. Before moving about, the user disconnects the hose end of the mask and snaps it into place on the outlet connection of the portable unit regulator. After use, the portable units should be recharged. Recharger assemblies are installed at the pilot's and copilot's stations, and in the cargo compartment on the left and right forward sides and right aft side. To recharge units, connect recharger hose to the filler valve of the portable unit regulator until the portable unit gage reads the pressure prevailing in the main oxygen system.

Note

As an airplane ascends to high altitudes, where the temperature is normally quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes rather rapidly. With a 100° F decrease in temperature in the cylinders, the gage pressure can be expected to drop 20 per cent. This rapid fall in pressure is occasionally a cause for unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descending, is not ordinarily due to falling temperature, of course. When this happens, leakage or loss of oxygen must be suspected.

DILUTER DEMAND OXYGEN REGULATOR.

A diluter demand oxygen regulator is installed at each crew station. This regulator incorporates a diluter lever with two positions, NORMAL OXYGEN and 100% OXYGEN. When in NORMAL it allows automatic mixing of air and oxygen. When in 100%, only pure oxygen is passing through the regulator. A red emergency knob is provided which may be used in event the demand oxygen regulator becomes inoperative. This emergency knob is always safety-wired closed and should be opened only in case of regulator failure. When the emergency valve is turned counterclockwise, it permits a continuous flow of oxygen to bypass the regulator assembly.

OXYGEN INDICATORS.

An oxygen pressure gage is installed at the pilot's and copilot's stations. This pressure gage shows the oxygen pressure available for use. For satisfactory operation of the system, the gage should read from 100 pounds minimum to 425 pounds maximum. An oxygen flow indicator is installed at each crew station.

OXYGEN DURATION CHARTS.

Figure 4-16 shows the approximate duration of the oxygen supply in hours. Since the RIGHT and LEFT sections of the system are isolated by check valves, it is necessary to provide three charts; one for each side, and a third showing the capacity of the supplementary bottle. Note that each chart provides the duration of the supply for only ONE crew member. This means that if more than one man is using oxygen from either side, the chart figures must be divided by the number of men on that side. Oxygen from the supplementary bottle flows to either side of the system depending upon the number and arrangement of crew members, and effectively increases the duration figures shown in the RIGHT and LEFT charts. With a five-man crew aboard, approximately 80% of the supplementary oxygen will go to the RIGHT side, and 20% to the LEFT.

NORMAL OPERATION PROCEDURE.

TO OBTAIN OXYGEN.

Note

Only a demand oxygen mask should be used.

1. The diluter lever on the diluter demand regulator should always be set at the NORMAL OXYGEN position except under emergency conditions.

Oxygen Duration—Man Hours

Left

PILOT
FLIGHT MECHANIC
RADIO OPERATOR

CABIN ALTITUDE—FEET	GAUGE PRESSURE—PSI 400	350	300	250	200	150	100	BELOW 100
25,000	13.2 / 16.8	11.2 / 14.2	9.5 / 12.0	7.5 / 9.5	5.7 / 7.2	3.7 / 4.7	2.0 / 2.5	EMERGENCY Descend to Altitude Not Requiring Oxygen
20,000	10.0 / 18.7	8.7 / 16.1	7.2 / 13.5	5.7 / 10.7	4.2 / 8.0	3.0 / 5.5	1.5 / 2.7	
15,000	8.0 / 23.0	7.0 / 19.5	5.7 / 16.2	4.5 / 13.0	3.5 / 9.7	2.2 / 6.5	1.2 / 3.2	
10,000	6.5 / 30.2	5.5 / 26.0	4.7 / 21.7	3.7 / 17.2	2.7 / 13.0	1.7 / 10.7	1.0 / 4.2	

Extra Bottle

CABIN ALTITUDE—FEET	GAGE PRESSURE—PSI 400	350	300	250	200	150	100
25,000	3.3 / 4.2	2.8 / 3.6	2.4 / 3.0	1.9 / 2.4	1.4 / 1.8	0.9 / 1.2	0.5 / 0.6
20,000	2.5 / 4.7	2.2 / 4.0	1.8 / 3.4	1.4 / 2.7	1.1 / 2.0	0.8 / 1.4	0.4 / 0.7
15,000	2.0 / 5.8	1.6 / 4.9	1.4 / 4.0	1.1 / 3.3	0.9 / 2.4	0.6 / 1.6	0.3 / 0.8
10,000	1.6 / 7.6	1.4 / 6.5	1.2 / 5.4	0.9 / 4.3	0.7 / 3.3	0.4 / 2.7	0.3 / 1.0

NOTE . . . *Figures shown in this chart represent the total man hours of oxygen available from the supplementary bottle only. Depending upon the number and arrangement of crew members, this supplementary supply serves to increase the figures shown in the RIGHT and LEFT side charts.*

Right

CO-PILOT
NAVIGATOR

CABIN ALTITUDE—FEET	GAUGE PRESSURE—PSI 400	350	300	250	200	150	100	BELOW 100
25,000	9.9 / 12.6	8.4 / 10.7	7.1 / 9.0	5.6 / 7.1	4.3 / 5.4	2.8 / 3.5	1.5 / 1.9	EMERGENCY Descend to Altitude Not Requiring Oxygen
20,000	7.5 / 14.0	6.5 / 12.2	5.4 / 10.1	4.3 / 8.0	3.2 / 6.0	2.2 / 4.1	1.1 / 2.1	
15,000	6.0 / 17.2	5.2 / 14.6	4.3 / 12.2	3.4 / 9.7	2.6 / 7.3	1.7 / 4.9	.9 / 2.4	
10,000	4.9 / 22.7	4.1 / 19.5	3.5 / 16.3	2.8 / 12.9	2.0 / 9.7	1.3 / 7.4	.7 / 3.2	

NOTE . . . RIGHT and LEFT chart figures represent estimated man-hours available for ONE crew member. To obtain the actual duration of oxygen when consumed by more than one man, divide the figures on the applicable chart by the number of crew members.

BLACK FIGURES: Diluter lever in "NORMAL." *RED FIGURES: Diluter lever in "100% OXYGEN."*

Figure 4–15. Oxygen Charts

Note

Each crew member should check his oxygen regulator with the diluter valve first at the NORMAL OXYGEN position and then at the 100% OXYGEN position as follows: Remove mask and blow gently into end of the oxygen regulator hose as during normal exhalation. If there is a resistance to blowing, the system is satisfactory. Little or no resistance to blowing indicates a faulty demand diaphragm or diluter air valve.

EMERGENCY OPERATION PROCEDURE.

TO OBTAIN OXYGEN.

Note

Only a demand oxygen mask should be used.

1. With symptoms of the onset of anoxia, or if smoke or fuel fumes should enter the cabin, set diluter lever of the regulator to 100% OXYGEN.

2. If the demand regulator should become inoperative, open the emergency valve of the regulator by breaking safety wire and turning the red emergency knob counterclockwise.

WARNING

When use of 100% OXYGEN or the emergency valve becomes necessary, the pilot should be informed of this action. Use of 100% OXYGEN or opening of the emergency valve will reduce oxygen duration for the crew. After the emergency is over, set diluter lever to NORMAL OXYGEN.

AUTOMATIC PILOT.

A type F-1 electrically operated automatic pilot is installed in the airplane to provide control of the ailerons, rudders, and elevators. It is a system of automatic controls which holds the airplane on any selected magnetic heading, brings it back without overswing when momentary displacements occur, and simultaneously keeps it stabilized in pitch and bank. While under automatic control, the airplane can be made to climb, dive, and execute coordinated turns. With the system operating, the auto pilot is always synchronized with the controls of the airplane, and continues to function even when disengaged. It is, therefore, always ready to take over smoothly, and maintain the heading and attitude of the airplane at the moment of transfer from manual to automatic control. The auto pilot's response to displacement allows corrections to be made with a minimum of surface control movement. An automatic pilot inverter is provided to supply ac power to the automatic pilot circuit. Automatic pilot torque settings are such that they permit manual overriding of the servos to protect the airplane structurally in the event of hard-over signals.

TURN-AND-PITCH CONTROLLER.

The turn-and-pitch controller (13, figure 1-5) may be used to change the attitude of the airplane while the automatic pilot is engaged. It contains a bank-trim adjustment wheel on the face, a turn-control knob on the face of the bank-trim adjustment wheel, and a pitch-trim control on the right side of the controller.

TURN-CONTROL KNOB.

The automatic pilot system utilizes three separate servos, one each for rudder, aileron, and elevator operation respectively. The signals controlling these servos through the turn-control knob (13, figure 1-5) are coordinated to permit the execution of an automatic turn in flight. In straight flight, the turn-control knob remains in a neutral position and is held there by means of a lever which engages a detent on the turn-control knob shaft. When the turn-control knob is moved either right or left, for turning the airplane right or left respectively, the lever is moved out of the detent and operates a switch which controls a clutch solenoid in the master direction indicator. The direction signal is thus disconnected whenever an automatic turn is made, allowing the airplane to turn in the selected direction.

BANK-TRIM ADJUSTMENT WHEEL.

The bank-trim adjustment wheel (13, figure 1-5) is fundamentally a means of adjusting the airplane to a more desirable flight attitude about its longitudinal axis without disengaging the automatic pilot. When it is moved to the right or left, an electrical signal is generated which actuates the aileron servo to move the aileron in the proper direction, thereby resetting the longitudinal trim of the airplane.

PITCH-TRIM CONTROL.

The pitch-trim control (13, figure 1-5) is the means by which the airplane may be placed in a climb or dive, or trimmed to a nose high or nose low attitude, without disengaging the autopilot. When it is moved to the UP or DOWN position, the airplane will nose up or down to an extent corresponding to the amount of movement of the pitch-trim control.

POWER SWITCH.

The power supply for the automatic pilot is controlled by a switch (14, figure 1-5) located on the pilot's switch panel which must be turned to the ON position for two minutes before it is desired to engage the auto pilot to the flight controls. This is necessary to provide sufficient time for the servo amplifier to warm up.

SERVO CLUTCH SWITCH.

The servo clutch switch (11, figure 1-5) on the pilot's switch panel is depressed to engage and may be pulled out to disengage the automatic pilot servo clutch.

SERVO CLUTCH DISENGAGE BUTTONS.

Each control column contains a servo clutch disengage button (7, figure 1-17) (14, figure 1-18) which is depressed to disengage the servo motors from the flight controls. Upon operation of this button, the servo clutch switch is released and must be depressed to again engage the system.

EMERGENCY DISCONNECT HANDLES.

Servo emergency disconnect handles (8, figure 1-17) (13, figure 1-18), one located on each side of the crew compartment at the pilot's and copilot's stations, are used to disconnect the servo clutches from the airplane flight controls in the event the electrical disconnect fails. Resetting the servos should be accomplished on the ground.

CAUTION

On later airplanes, use of either of the automatic pilot disconnect handles will automatically, through a cable connection, position the hydraulic gust lock emergency release valve to EMERGENCY. This renders the elevator gust lock system inoperative until valve is manually repositioned to NORMAL.

AUTOMATIC PILOT INDICATORS.

The auto pilot instruments consist essentially of a master direction indicator (10, figure 4- 9), a turn and bank control (rate gyro control) (16, figure 1-22) and a vertical gyro control (17, figure 1-22), all of which provide conventional instrument readings as long as the battery and autopilot inverter switches are on.

NORMAL OPERATION PROCEDURE.

TO ENGAGE AUTOMATIC PILOT.

1. Automatic pilot inverter switch ON and wait two minutes for the gyros to gain speed.

2. Erect gyro by caging and then uncaging vertical gyro control. (Caging the vertical gyro also erects the flux gate gyro).

3. Automatic pilot power switch ON, and allow two minutes for amplifier to warm up.

4. Center the turn control knob in its detent position; also center pitch trim control and the bank trim adjustment on the controller.

5. Trim airplane for desired attitude of flight.

6. Engage automatic pilot by pushing clutch engage switch.

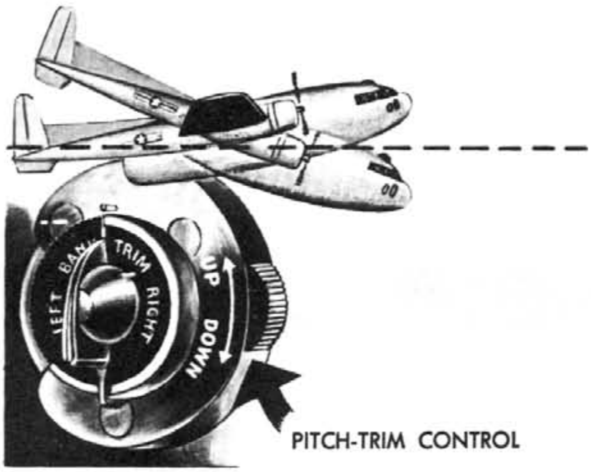
CAUTION

Do not engage the automatic pilot while in any turn, climb, dive, bank, during propeller reversing, or during taxiing.

ADJUSTMENT OF AUTOMATIC PILOT DURING FLIGHT.

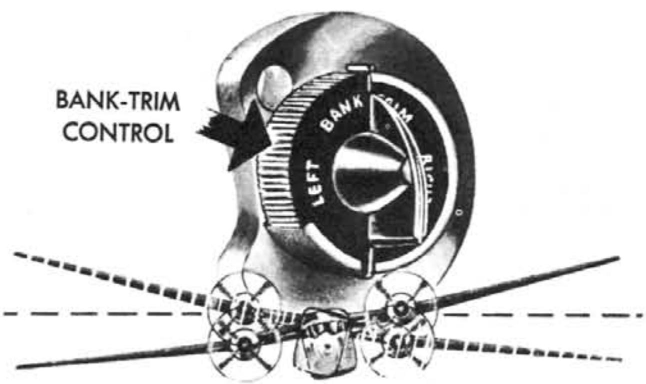
For adjustment of automatic pilot during flight refer to figure 4-16.

AUTO PILOT ADJUSTMENT

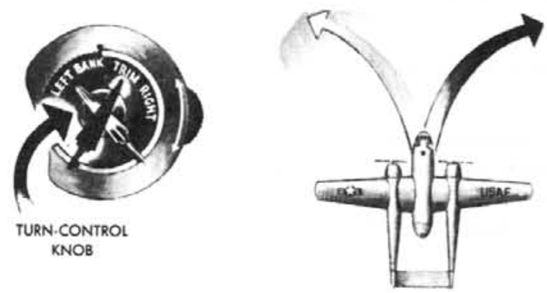


TO CLIMB—Turn pitch-trim control counterclockwise to UP.

TO DIVE—Turn pitch-trim control clockwise to DOWN.



TO TRIM BANK—Turn bank-trim control clockwise to raise left wing; counterclockwise to raise right wing.



TO TURN OR TO TRIM COURSE—Turn the turn-control knob out of its central detent position, either to right or left until desired heading is obtained. To return to straight flight, center turn control knob.

Figure 4-16

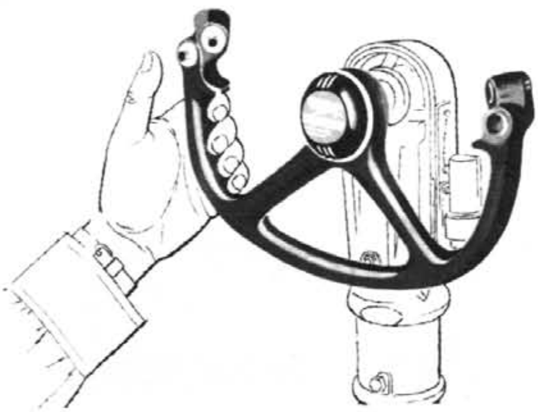
RETRIMMING.

Periodic changes to the trim will be necessary due to the changes in the load caused by consumption of fuel. If it is necessary to retrim the airplane during automatic pilot operation, disengage the automatic pilot, retrim the airplane while under manual control, and then re-engage the automatic pilot.

CAUTION

Do not adjust trim tabs while automatic pilot is engaged since unnecessary strains will be imposed on the flight controls system.

TO DISENGAGE AUTOMATIC PILOT.



1. Push clutch disengage button.
2. Automatic pilot power switch OFF if further use of auto pilot is not desired.

EMERGENCY OPERATION PROCEDURE.

AUTOMATIC PILOT FAILURE

If the automatic pilot servo clutch switches fail to disengage the automatic pilot, pull either servo clutch disconnect handle located at the pilot's and copilot's stations and turn the automatic pilot power switch OFF.

SERVO CLUTCH DISCONNECT

AUTOMATIC PILOT POWER SWITCH **OFF**

ON

OFF

AUTO PILOT

Figure 4-17

NAVIGATION EQUIPMENT.

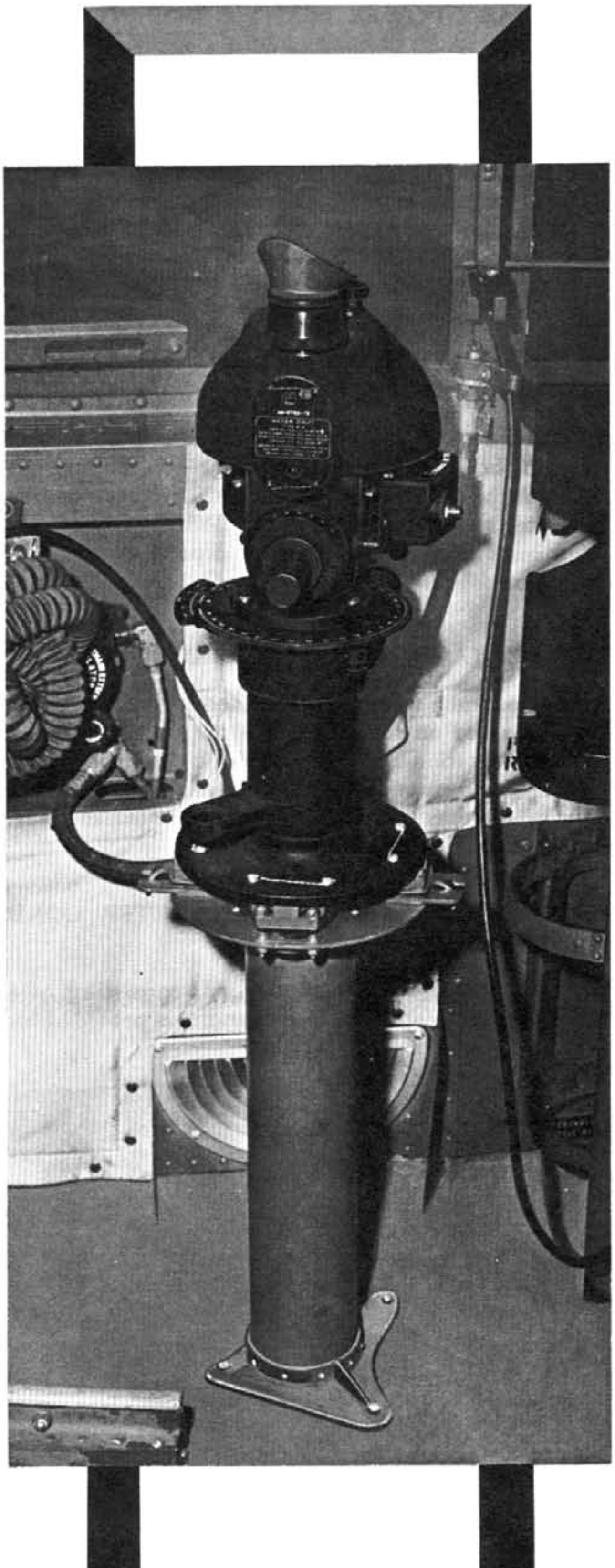
The navigator's station (figure 4-9) is directly aft of the copilot's seat and is equipped with a work table and instrument panel, on which are mounted the navigator's instruments. The location of the navigator's station is such that he is able to view the instruments on the main instrument panel.

CHART AND MAP STOWAGE.

On early airplanes a chart stowage tube (5, figure 4-9) is located above the navigator's instruments. A map case, (3, figure 4-10) is mounted directly above the navigator's work table.

ASTRO COMPASS.

Installation provisions are made for an astro compass within the observation dome. The astro compass is located on a shelf above the radio rack.



DRIFTMETER INSTALLATION

Figure 4-18

NAVIGATOR'S OBSERVATION DOME.

A circular observation dome, approximately 20 inches in diameter, is mounted on top of the crew compartment enclosure, directly above the navigator's and radio operator's stations along the centerline of the airplane.

DRIFTMETER.

Provisions are made for installation of a driftmeter (figure 4-18) on the right side of the crew compartment just forward of the navigator's work table. On early airplanes, single phase ac current for operation of the driftmeter is provided by the main inverter. On later airplanes, three phase ac current is supplied by the spare instrument inverter and controlled by a switch on the navigator's oxygen panel.

Note

> On airplanes with emergency and monitor bus, the driftmeter is wired through the left oleo switch and is inoperable whenever the left oleo strut is compressed.

AUXILIARY POWER PLANT.

A 175-ampere, 28.5 volt auxiliary power plant (APP) is located in the auxiliary equipment compartment. This unit comprises a two cylinder internal combustion engine driving a type P-2 generator, and employs a suction cooling system for both units.

The engine is complete with a governor, a shielded ignition system, a fuel system, and lubrication system.

The controls of the auxiliary power plant are located on the side panel of the radio rack at the flight mechanic's station. Operationally, the auxiliary power plant is used primarily as an emergency source of electrical power for starting the airplane engines. As an emergency precaution, it is operated during takeoffs and landings under night and or instrument conditions to augment the power output of the engine generators so that sufficient electrical power will be available should failure of an engine generator occur. The auxiliary power plant may be operated to perform battery charging and to energize electrical equipment during ground checking procedures when the engines are not running. However, it is desirable to use an external power source when ground checks are being made.

GOVERNOR CONTROL LEVER.

The governor control lever (1, figure 4–19) is movable through 180 degrees travel. This lever, when placed to the left of the IDLE position, controls the choke of the unit, and is moved full left to CHOKE position for starting. The IDLE position is used for warm-up and slow operation. For normal operation at the unit's rated power, the lever is placed full right to the RUN position.

ALTITUDE COMPENSATOR VALVE.

A three-position altitude compensator valve is provided on the carburetor of the auxiliary power plant to compensate for atmospheric conditions at altitude. The positions of this manually-operated valve are 0, 5, and 10 for sea level, 5000 feet and 10000 feet respectively. The pointer should be set directly opposite the setting nearest the altitude of operation.

Note

Do not set pointer between settings as engine will not operate properly.

AUXILIARY POWER PLANT IGNITION SWITCH.

The ignition switch (2, figure 4–19) is a two-position switch for turning ignition of APP unit OFF or ON as the positions imply.

AUXILIARY POWER PLANT STARTER SWITCH.

Current for starting the APP is taken directly from the battery and controlled by the APP starter switch (4, figure 4–19). The starter switch is placed in START position for starting the unit, and moved to ON when the APP is running. By setting this switch to OFF position, the fuel supply to the unit is shut off at the fuel solenoid but the unit will continue to run until the fuel in the line is exhausted.

AUXILIARY POWER PLANT GENERATOR SWITCH.

The APP generator switch is a three-position switch (5, figure 4–19) with the OFF and GEN ON positions functioning as the names imply; it operates directly from battery. The switch is moved to the RESET position momentarily to reset generator field control relay during the starting cycle or when the APP overvoltage indicator light denotes excessive voltages in the APP generator circuit.

APP GENERATOR FIELD CONTROL RELAY MANUAL RESET BUTTON.

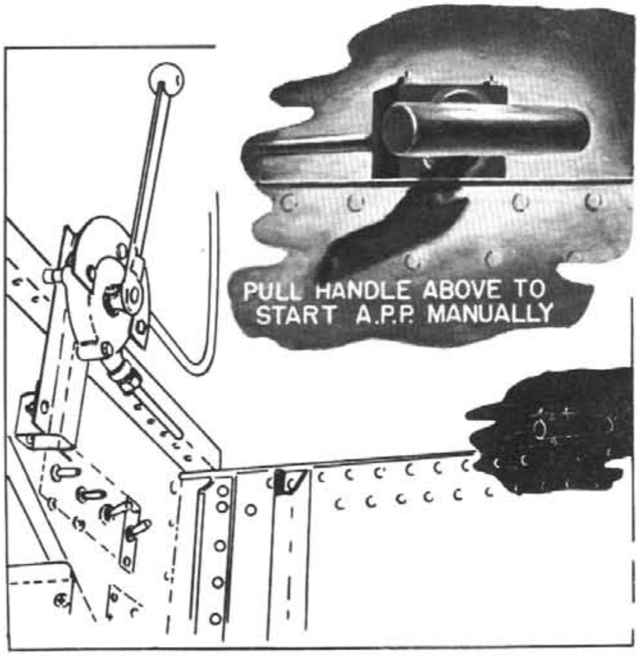
A reset button is incorporated into the field control relay on the auxiliary floor junction box. Should the field control relay fail to reset when its corresponding generator switch is placed in the RESET position, the relay may be manually reset by depressing the reset button on the relay.

APP VOLTAGE REGULATOR RHEOSTAT.

A knurled knob on the APP generator voltage regulator mounted on the side of the cargo compartment, permits operation of a rheostat which controls generator voltage output. The rheostat should be regulated only by qualified personnel except as stated in GENERATOR FAILURE, Section III.

AUXILIARY POWER PLANT STARTER CORD (OR HANDLE).

On early airplanes a starting cord, consisting of a short length of rope with a tee handle, is provided for



manual starting of the APP. When not in use it is stowed in the small stowage box beneath the APP generator. On later airplanes, an APP manual starting handle is mounted aft of the APP control panel on the edge of the auxiliary flight deck. The starting cable is routed from the handle through a guide, to the APP unit. The cable automatically rewinds itself after each use.

AUXILIARY POWER PLANT MANUAL FUEL BYPASS VALVE.

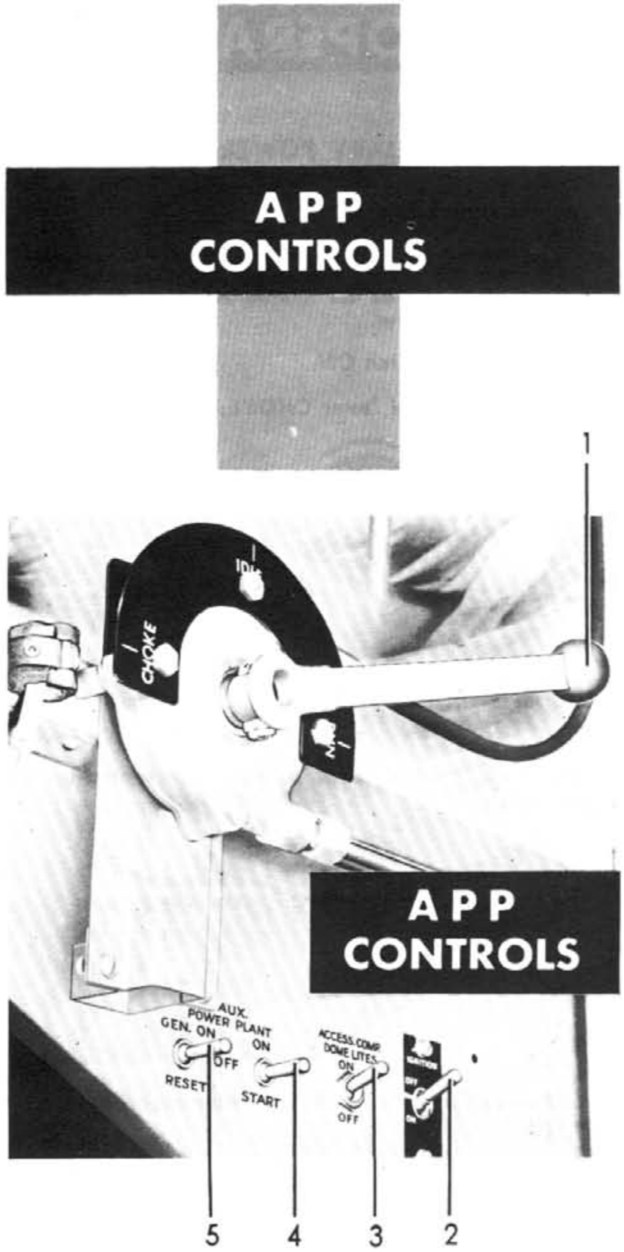
The manual fuel bypass valve permits fuel to be supplied to the auxiliary power plant if the solenoid valve in the APP fuel line should stick in the closed position and during manual starting of the APP. Located on the left hand side of the cargo compartment ceiling, this valve is manually operated by depressing a spring-loaded button which offers an alternate path for the fuel to bypass the solenoid valve. On later airplanes the spring-loaded valve is replaced by a screw-type valve with OPEN and CLOSED positions.

AUXILIARY POWER PLANT VOLTAGE SELECTOR SWITCH AND VOLTMETER.

A dc voltmeter (30, figure 1–22) is installed on the instrument panel to provide voltage readings within various power supply circuits. When the selector switch is set to the APP GEN position, the voltmeter will register the dc voltage in the APP generator circuit.

AUXILIARY POWER PLANT AMMETER (LOADMETER) AND OVERVOLTAGE INDICATOR LIGHT.

An ammeter (loadmeter), (33, figure 1–22), located on the instrument panel, measures the current flow in the circuit but is calibrated to indicate the load assumed by the APP generator in percentage of its rated capacity. An overvoltage indicator light located adjacent to the ammeter (loadmeter), will flash on when the field control relay for the APP circuit has opened because of an overvoltage condition, regardless of the position of the generator switch. When this condition occurs resetting may be accomplished by momentarily placing the APP generator switch to RESET or, if this fails, by pressing the reset button on the field control relay.



1. GOVERNOR CONTROL LEVER
2. IGNITION SWITCH
3. AUXILIARY EQUIPMENT COMPARTMENT LIGHT SWITCH
4. STARTER SWITCH
5. GENERATOR SWITCH

Figure 4-19

APP OPERATION

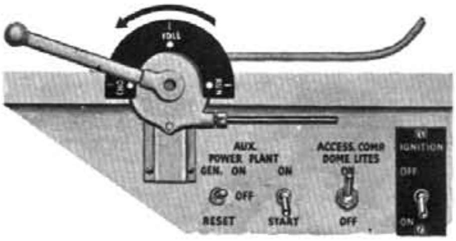
TO START AUXILIARY POWER PLANT.

1. *Battery switch to ON.**

Note — *When the APP is started at altitudes, it is recommended that the altitude compensator valve be placed to the setting nearest the altitude at which the airplane is being operated.*

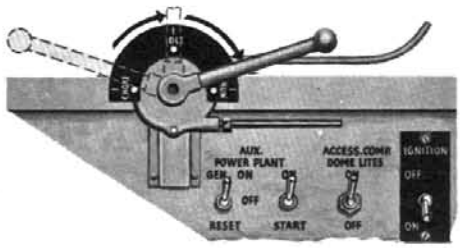
2. *APP ignition switch ON.*

3. *Governor control lever CHOKE, or as required.*



4. *Starter switch to START until engine is firing, then move to ON.*

5. *Governor control lever to IDLE for warm-up and then to RUN.*



6. *Generator switch to RESET momentarily, then to GEN. ON.*

Note — For prolonged engine life, the engine should not be operated at or near rated speed (RUN position of the lever until the engine has warmed up. At temperatures below 30°F(-1°C) the engine should be permitted to operate at IDLE for 15 minutes; at temperatures above 30°F approximately 5 minutes is required. After warm-up, the engine should be operated at rated speed for approximately 2 minutes to assure complete warm-up before the generator switch is turned to GENERATOR ON.

7. *Battery switch to ON.†*

†AF 51-8053 thru 52-5869
AF 52-6000 thru 52-6027

**AF 52-5870 thru 52-5954*
AF 52-6028 thru 53-8156
IK 441 thru 466

Figure 4-20

TO START AUXILIARY POWER PLANT MANUALLY.

This procedure is to be used when there is no electrical power available for starting the auxiliary power plant.

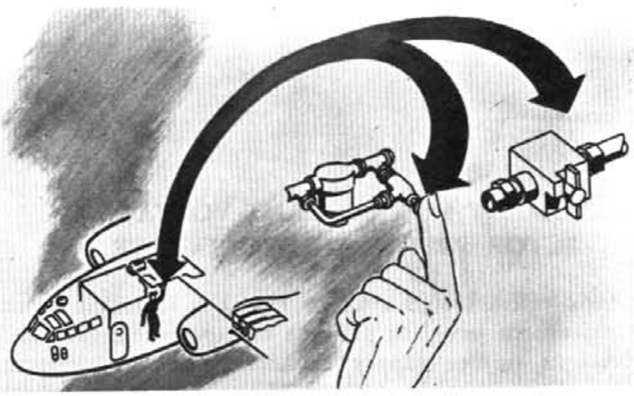
1. *Manually reset generator field control relay which is mounted on top of auxiliary floor junction box, by depressing manual reset button of relay.*

Note — *Although it is not necessary to reset relay before starting APP, it is suggested this sequence be followed to prevent inconvenience of reaching the field control relay with APP running.*

2. *APP ignition switch ON, and governor control lever CHOKE.*

Note — *Varying temperature conditions may require a different governor control lever setting.*

3. *Manual fuel bypass valve OPEN.*



Note — *When the APP is started at altitudes above 3000 feet, the altitude compensator valve must be placed to the setting nearest the altitude at which the airplane is being operated.*

4. *Wind starting cord around starting pulley and give rapid steady pull on cord.*

Note — *On later airplanes, hand starting may be accomplished from the crew compartment by using the starting handle installed aft of the flight mechanics seat on the edge of the auxiliary flight deck.*

5. *When APP starts, place governor control lever in IDLE for warm-up.*

6. *Governor control lever to RUN.*

7. *Starter switch to ON and generator switch to GEN ON after two minutes.*

8. *Release manual fuel bypass valve on early airplanes. Turn valve closed on later airplanes.*

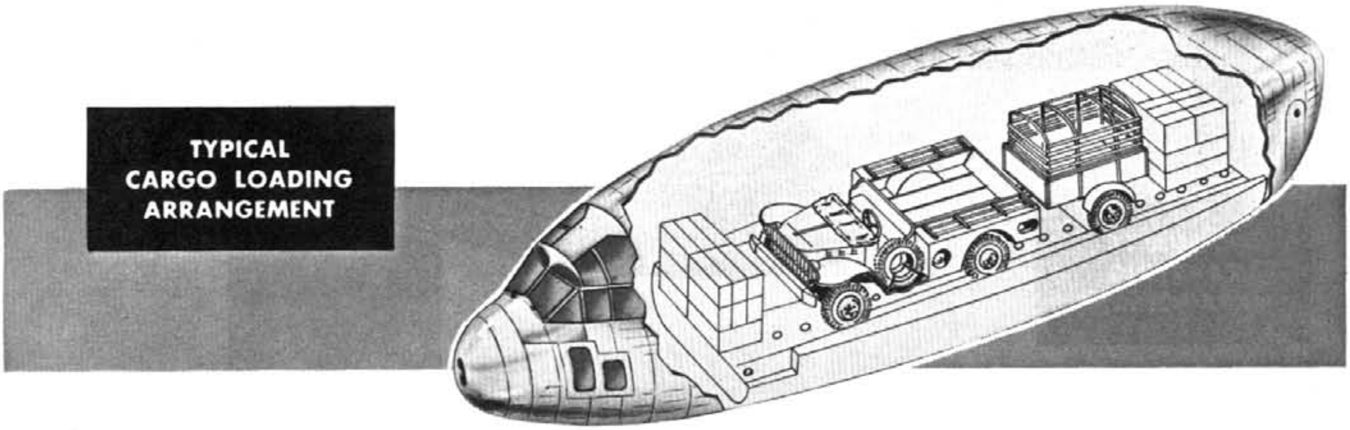
9. *Battery switch ON to place generator output on the bus.*

CARGO LOADING EQUIPMENT.

The cargo loading equipment included on the airplane consists of cargo loading doors, skid strips, a block and tackle fitting, cargo tie-down fittings, loading ramps and a cargo loading roller. For detailed loading instructions, refer to Handbook, of Cargo Loading Instructions, T.O. IC-119B-9 (formerly AN01-115CC-9).

CARGO TIE-DOWN FITTINGS.

A total of 78 cargo-tie-down fittings are installed on the cargo compartment floor. The spacing of these fittings allows equipment of various sizes to be secured to the floor. Refer to chart located on cargo compartment forward bulkhead.



BLOCK AND TACKLE FITTING.

A swivelling hitch for block and tackle, attached either at the front or rear of the cargo compartment, is provided and can be secured to the tie-down fittings at those locations.

CARGO LOADING DOORS.

Loading is accomplished through two hinged cargo doors forming the aft contour of the fuselage. When the doors are opened, a clear loading space, 8 feet high and 9 feet 2 inches wide, is made available. Cables prevent the open doors from striking the booms and rods are provided to hold the doors open.

CARGO TIE-DOWN DEVICES.

A kit containing twenty-eight 10,000-pound tie-down devices (Type C-2) for securing the cargo is located on the left side of the cargo compartment. In addition, twenty 5,000-pound tie-down devices (Type B-1) are stowed in the stowage compartments on either side of the cargo compartment.

LOADING RAMPS.

Two light, metal, treaded, loading ramps with a limit of 9400 pounds per ramp are provided to facilitate loading of wheeled vehicles through the aft cargo doors. Provisions are made for attaching the ramps to the cargo door sill. Rings installed in the ramps permit them to be lashed to the cargo floor when in flight. The ramps, when not in use, are lashed beneath the paratroop seats along either side of the cargo compartment except when paratroops or personnel are being carried. At this time the ramps are lashed down in the center of the cargo compartment. When the airplane's full complement of troops (62) is carried, the cargo loading ramps are removed.

CARGO LOADING ROLLER.

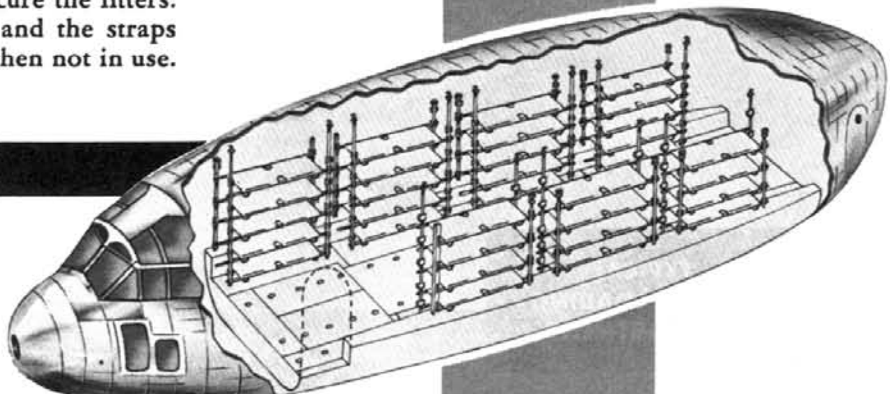
A roller is installed at floor level at the aft end of the cargo compartment to facilitate loading through the cargo doors.

SKID STRIPS.

Four metal skid strips extend the length of the cargo compartment to facilitate loading of bulky cargo.

CASUALTY CARRYING EQUIPMENT.

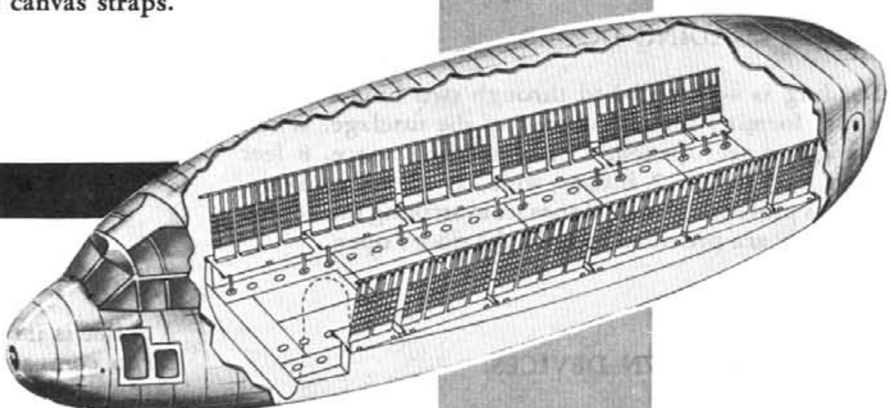
A total of 35 litters can be carried when the airplane is used for ambulance purposes. The litters are mounted along the sides of the cargo compartment in tiers of five, with three tiers on the left side and four on the right. Posts mounted vertically along the sides of the fuselage and straps extending from roof beams to the floor are used to secure the litters. The posts are installed permanently, and the straps are stowed above the soundproofing when not in use.



CASUALTY CARRYING ARRANGEMENT

TROOP CARRYING EQUIPMENT.

Foldable seats are installed along each side of the cargo compartment. The seats are the two-man and four-man type and will accommodate a total of forty-two men. The back and bottoms of the seats are made of canvas fabric supported by tubing. The seats are removable but normally are folded against the side of the fuselage when not in use. Five four-man troop seats may be installed along the center line of the cargo compartment. The back tube for these center seats is supported from the ceiling of the cargo compartment by a series of four adjustable canvas straps. These seats are removable.



TROOP SEATING ARRANGEMENT

AERIAL DELIVERY SYSTEM.

The aerial delivery system, is an automatic, 28-volt dc electrically operated system employed to drop cargo from the plane while in flight. The cargo is usually stowed in special containers, termed paratainers or paracans, which are attached to trolleys and roll along the monorail extending down the center of the cargo compartment ceiling. A canvas duck guide curtain, held in place by cotton webbing straps, is installed on each side of the compartment when the system is to be used. The curtains form a channel down the center of the compartment thus preventing excessive side motion and swaying of the paratainers during flight. An anchor cable is provided for attaching the paratainer static lines to the airplane structure. Prior to a drop the inside doors, forming a section of the cargo floor, are opened and secured in place. When actuated, the monorail system is capable of releasing twenty 500-lb. bundles in 8 to 10 seconds.

JUMPMASTER'S PANELS.

Two panels, one at either end of the cargo compartment for the convenience of the jumpmaster, are provided. The main jumpmaster's panel, located on the center upright of the rear cargo doors, is equipped with the following: trailing antenna warning light, cargo floor lights switch, paratainer doors switch and indicator light, aerial delivery salvo switch, and interphone station controls. The alternate jumpmaster's panel, which is located on the right side of the fuselage immediately aft of the lavatory entrance, provides a convenient station for the jumpmaster when the airplane is operated with the rear cargo doors removed. Except for the trailing antenna warning light and aerial delivery salvo switch, the controls on the alternate jumpmaster's panel are similar to those installed on the main jumpmaster's panel at the rear of the cargo compartment.

MONORAIL CUT-OFF SWITCH.

A monorail cut-off switch is located at the forward end of the monorail. When on, the red arm of the flapper-type switch is facing aft (6 o'clock position). As the number 20 trolley moves forward and contacts the switch, the red arm is turned to the 3 o'clock position, turning the switch off and stopping the driv motor.

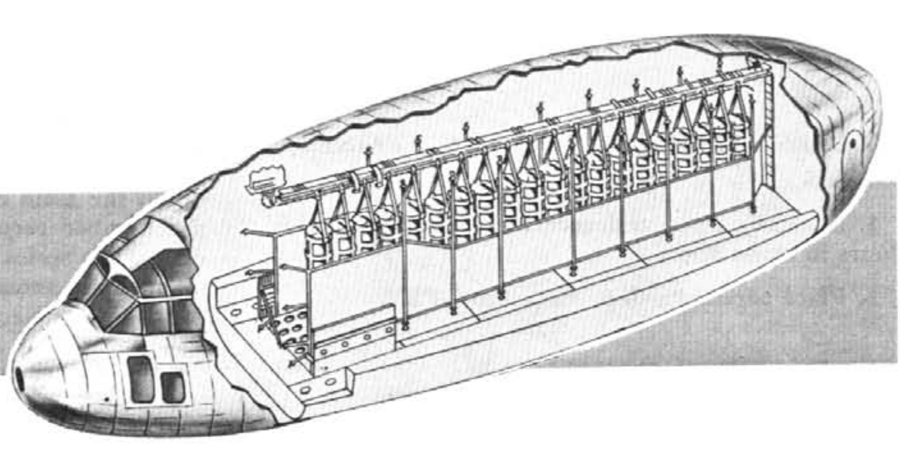
MONORAIL CLUTCH HANDLE.

A monorail clutch handle is located on the aft right hand side of the cargo compartment and is provided for disengaging the monorail drive motor from the cable drum to facilitate loading of the monorail. This handle should be carried in the engaged position during all flight operations to prevent inadvertent unwinding of the cable drum.

AERIAL DELIVERY SALVO SWITCHES.

The system is normally controlled by a salvo switch (12, figure 1-6) on the overhead panel in the crew compartment, or by a similar switch (2, figure 4-21) on the main jumpmaster's panel at the aft end of the cargo compartment. Each switch is the push button-type and, when actuated, opens the paratainer doors and sets the trolleys in motion. By means of a limit switch installed in the door which closes the monorail cable drive circuit when the door is fully open, the cable drive motor is energized. The system thus actuated, the paratainers move forward along the monorail to the opening in the cargo floor where the

AERIAL DELIVERY ARRANGEMENT



trolleys are tripped, releasing the paratainers to fall free. The system is automatically shut off when the last trolley actuates a limit switch upon releasing its paratainer.

Note

If it is desired to shut off system before completion of its operating cycle, the salvo button may be manually pulled out, thereby stopping the system.

AERIAL DELIVERY (PARATAINER) DOOR SWITCH.

The aerial delivery doors switch (3, figure 4-21) is a three-position OPEN, CLOSED, or OFF switch located on both jumpmaster's panels. Independent of the salvo switches, this switch may be used to open the paratainer doors. However, the monorail cable drive motor cannot be energized by throwing this switch; the salvo delivery button must be pushed to effect the operation of the salvo system. The aerial delivery door switch alone, controls the closing of the doors and must be used to close the doors if the salvo button has been employed to effect the aerial delivery.

AERIAL DELIVERY DOOR INDICATOR LIGHT.

When the aerial delivery doors are fully open, a push-to-test amber indicator light (4, figure 4-21) adjacent to the aerial delivery door switch, indicates by glowing, the open position of the doors.

TO USE AERIAL DELIVERY SALVO SYSTEM.

1. Manually open and secure in place the inside doors in cargo floor.
2. Push salvo button.

TO OPEN AERIAL DELIVERY (PARATAINER) DOORS.

1. Manually open and secure in place the inside doors in cargo floor.
2. Place paratainer door switch to OPEN.

Note

When opening doors on the ground, check for clearance of at least 33 inches to prevent damage to doors.

TO CLOSE AERIAL DELIVERY (PARATAINER) DOORS.

Note

Before closing doors, check that static lines have been pulled into the airplane.

1. Place paratainer door switch to CLOSED.
2. Close inside doors to their original position in the cargo floor.

EQUIPMENT DROP SYSTEM.

CAUTION

Do not use the equipment drop system as a glider release system; structural damage may result.

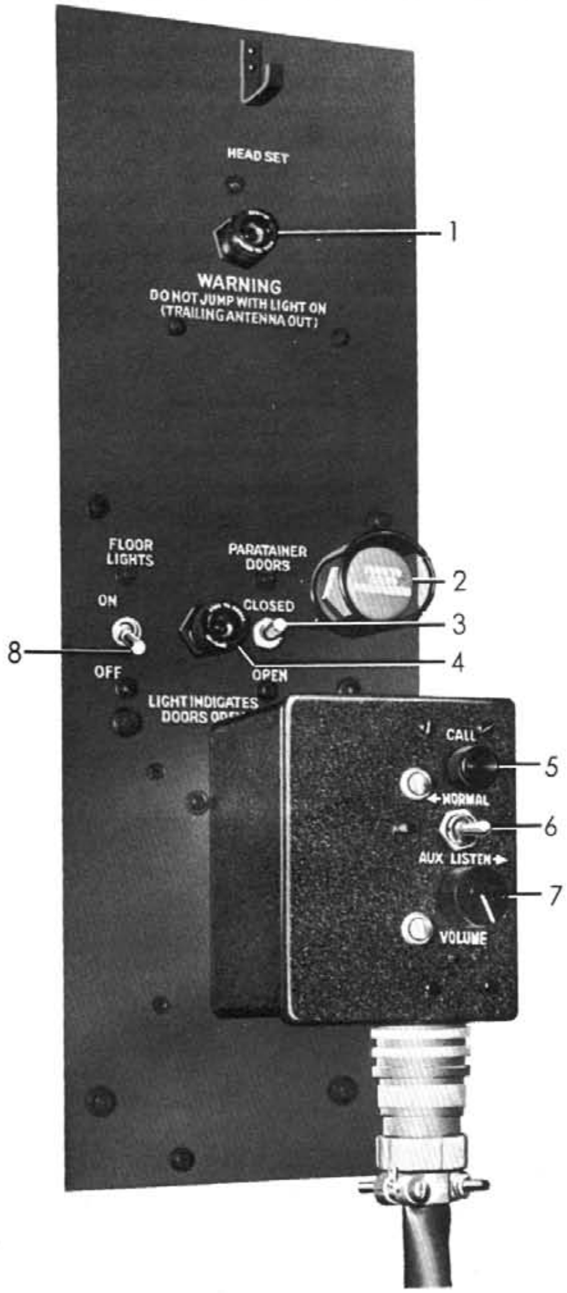
Provisions have been incorporated into the airplane to effect aerial delivery of heavy equipment by the equipment drop system. This system is operable when the rear cargo doors have been removed, or by utilization of the flight operable door on airplanes incorporating the flight operable door feature. For heavy equipment dropping, wheeled conveyors are secured to the cargo floor, and buffer assemblies are installed along the forward bulkhead and sides of the cargo compartment.

Particular attention should be paid to preparing the airplane for a heavy equipment drop since failure to do so may result in damage to the airplane and to the load. A ten-pound shot bag is secured to the release mechanism located in the center of the rear cargo door sill. When either of the two handles, one at the pilot's station and the other at the copilot's station, is pulled, the release mechanism allows the shot bag to fall free. In dropping, the shot bag pulls out a pilot chute which begins the ejection process. The initial opening force of the pilot chute draws out the extraction chute which, in turn, cuts the last remaining shear webs and pulls the platform on which the equipment is secured out of the cargo compartment. When the platform has cleared the airplane, the extraction chute opens the main drop chute or chutes, depending on the number required to retard the descent of the cargo. If a series of platforms are to be released, the main chute actuates a second extraction chute and the course of ejection is repeated.

Note

The release of the cargo load will result in a slight nose-up attitude of the airplane, requiring a readjustment of the trim.

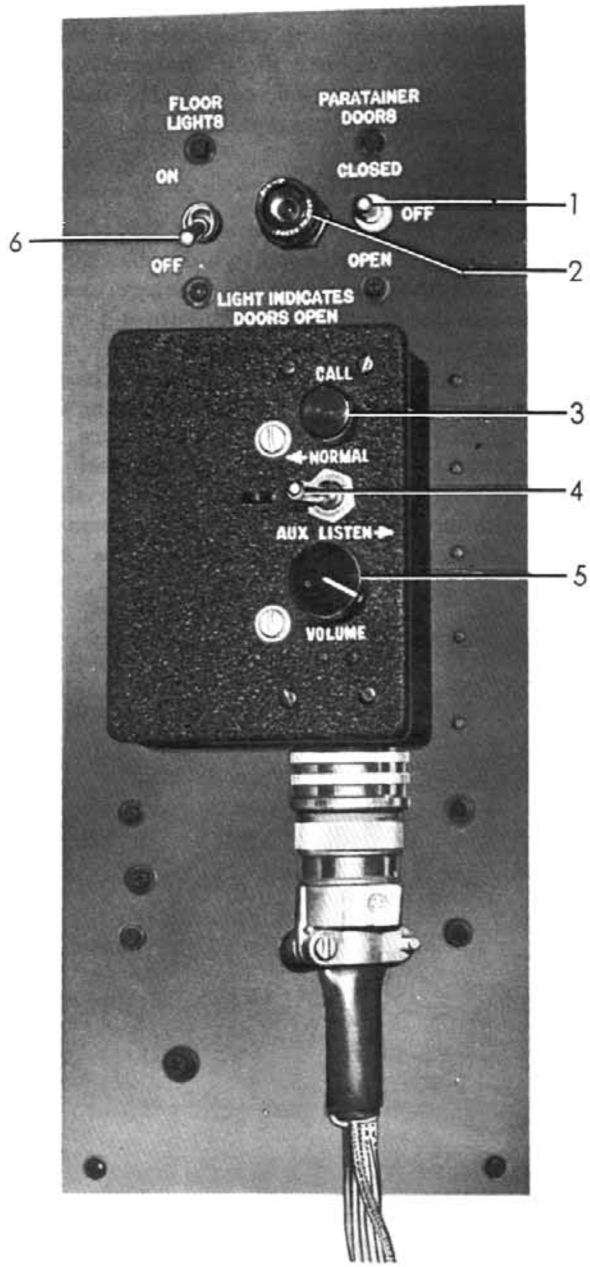
JUMPMASTER'S PANEL (AFT)



1. TRAILING ANTENNA WARNING LIGHT
2. AERIAL DELIVERY SALVO SWITCH
3. AERIAL DELIVERY DOORS SWITCH
4. AERIAL DELIVERY DOORS INDICATOR LIGHT
5. INTERCALL SIGNAL SWITCH
6. SINGLE RECEIVER SWITCH
7. VOLUME CONTROL
8. CARGO COMPARTMENT FLOOR LIGHTS SWITCH

Figure 4-21

JUMPMASTER'S PANEL (FORWARD)



1. AERIAL DELIVERY DOORS SWITCH
2. AERIAL DELIVERY DOORS INDICATOR LIGHT
3. INTERCALL SIGNAL SWITCH
4. SINGLE RECEIVER SWITCH
5. VOLUME CONTROL
6. CARGO COMPARTMENT FLOOR LIGHTS SWITCH

Figure 4-22

FLIGHT OPERABLE DOOR SYSTEM.

Some airplanes are equipped with a flight operable door. Airplanes with this feature are readily identified by the wedge-shaped hood forming the aft end of the fuselage which replaces the pair of rounded clam shell doors. The flight operable door improves the range and heavy equipment drop capabilities of the airplane by counteracting adverse flight characteristics which result from the squared-off, open-ended fuselage contour with clam shell doors removed.

DOOR COMPONENTS.

The flight operable door consists basically of two components: a hinged hood, which fairs out the top and sides of the aft end of the fuselage; and a floor, which fairs out the bottom of the aft end of the fuselage, but which may be retracted within the hood, thus forming a spacious opening larger than the vertical cross section area at any station in the airplane's cargo compartment. Both components are hydraulically-actuated (high pressure system) and normally are electrically controlled (28-volt dc) by any one of three alternate switches. Electrically-operated indicators adjacent to the control switches show the position of floor and hood at any instant provided electrical power is available.

FLOOR RAMP SECTIONS.

Two removable sections of wooden flooring, coated with non-skid compound, serve as ramps between the aft end of the cargo compartment floor and the flight operable door. Each is secured in place by two Dzus fasteners or screws along the aft edge, and pip pins or spring clips at the forward edge. The ramps should be secured in position whenever personnel are transported in the airplane and the use of the paratroop doors is anticipated. When the airplane is loaded with heavy equipment, the ramp sections should be removed and stowed on the aft end of the flight operable doors.

CAUTION

Operation of the flight operable door with ramps attached will result in structural damage.

Figure 4–22A

DESCRIPTION OF OPERATION.

DOOR OPENING CYCLE.

During flight the hood and floor in the closed position complete and enclose the aft end of the fuselage. Preparatory to dropping heavy equipment any one of the flight operable door switches is positioned and held to OPEN. After special safety switches determine that no obstruction exists, the hood solenoid valve moves, permitting hydraulic fluid at 1380 psi to be directed to the locking-pin actuator. Movement of the actuator extracts the locking pins which hold the hood closed. Near the end of its travel, the locking-pin actuator trips a sequence valve permitting flow of hydraulic fluid to the hood actuator. The action of the hood actuator swings the hood aft and upward on the two overhead hinges connecting the hood to the aft end of the fuselage. Electrical switches which the hood contacts in its travel stop the hood at the 7 degrees open position and simultaneously direct current to the floor control mechanism installed in the ceiling of the hood. Hydraulic fluid releases the spring-loaded-to-on brake and, at the same time, begins driving a hydraulic motor. Operation of the motor rotates a threaded shaft along which runs a carriage. Cables connect the carriage to the floor which is hinged to the hood at the aft end. The floor rises into the hood until near the ceiling it contacts an up-limit switch which removes current from the floor solenoid, stopping floor travel and permitting the brake to lock again. At the same time, power is restored to the hood solenoid and the hood completes its travel. Hood travel is ended by mechanical stops in the actuator and the hood is held open by hydraulic fluid locked in the system when the solenoid valve returns to neutral position upon release of the flight operable door switch. The opening of the door requires approximately 35 seconds.

DOOR CLOSING CYCLE.

After ejection of cargo or personnel the flight operable door may be returned to the closed position. To accomplish closing of the door, any one of the switches is positioned and held to CLOSED. Substantially, a reverse sequence of events occurs. The hood closes to the 9 degrees open position, at which time the floor is lowered by action of the floor mechanism. After the floor is in position, the hood continues to close and engages the locking pins, which were released by action of the locking-pin actuator at the beginning of the down cycle. Hood travel is interrupted in both the up and down cycle in order to prevent "air scoop" action of the door assembly with hood fully open.

FLIGHT OPERABLE DOOR SWITCHES AND POSITION INDICATORS.

Any one of three, three-position guarded switches normally control operation of the flight operable door. The switches are mounted on flight operable door control panels mounted one beneath the pilot's side window sill, one beneath the copilot's side window sill, and one on the side wall in the forward right hand corner of the cargo compartment above the alternate jumpmaster's panel (when installed). Switch positions are OPEN, OFF and CLOSED. The switches are spring-loaded to the center OFF position. To operate the door, the guard must be lifted and the switch held in either the OPEN or CLOSED position until the desired position of the door is obtained. The operation of closing the door requires approximately 35 seconds.

INDICATORS. Two electrically-operated position indicators on each control panel inform the operator of the position of the doors at any instant. One indicator is placarded FLOOR POSITION. The words UP, DOWN, or a series of slanted bars appearing in the circular window indicate that the floor is fully up, fully down, or in transit respectively. The other indicator is placarded HOOD POSITION. The words OPEN, CLOSED, or a series of slanted bars appearing in the circular window indicate that the hood is fully open, fully closed, or in transit, respectively. Whenever electrical power is not available the indicators are inoperative and go to the "in transit" position showing slanted bars regardless of the actual position of the floor or hood.

PARATROOP DOORS AND ANCHOR LINES SAFETY SWITCHES.

Damage to the airplane by the attempted raising of the floor while the paratroop doors are open or by the attempted opening of the hood while anchor cables for paratroop static lines are installed is prevented by safety switches which prohibit normal movement of the doors whenever these obstructions exist. Each paratroop door latch incorporates a switch, both of which must be closed before normal operation of the hood or floor solenoid valves is possible. Engaging the latches of the doors depresses the switches and completes the paratroop doors safety portion of the circuit. In series with the paratroop door switches are two paratroop anchor line safety switches. Tension on either link to which the aft end of the anchor cables is connected opens a switch which prevents normal operation of the hood or floor solenoids. Release of tension by disconnecting the anchor cables causes the links to drop and depress the switches completing the anchor line safety position of the circuit.

HOOD POSITION SWITCHES.

The hood position switches are operated mechanically by the attitude of the hood. The hood up-position switch and hood down-lock indicator switches serve only to transmit hood position to the hood position indicators. The hood intermediate position switch interacts with the floor limit switches to coordinate

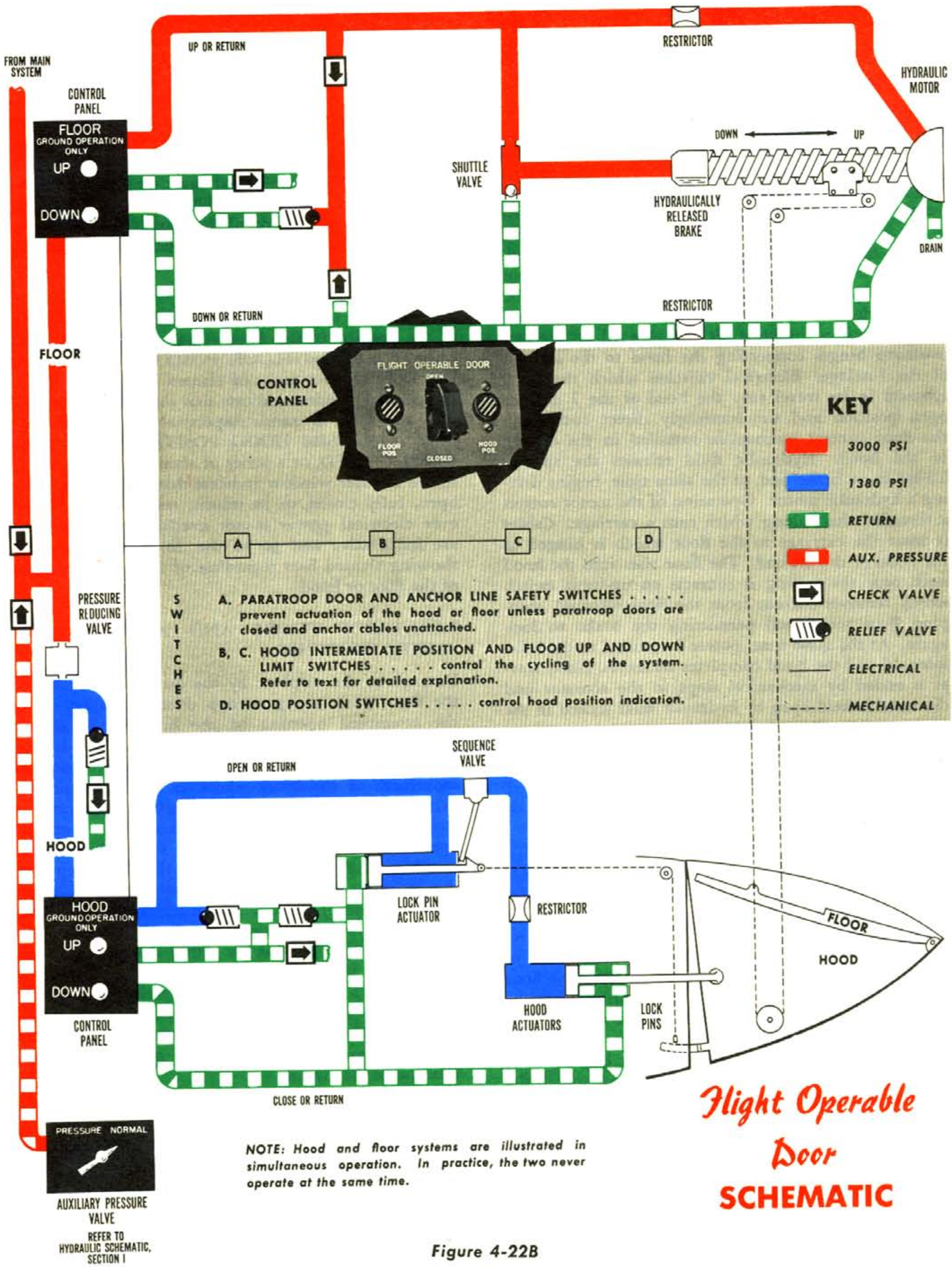

FROM MAIN SYSTEM
CONTROL PANEL
FLOOR
GROUND OPERATION ONLY
UP
DOWN
UP OR RETURN
RESTRICTOR
HYDRAULIC MOTOR
DOWN
UP
SHUTTLE VALVE
HYDRAULICALLY RELEASED BRAKE
DRAIN
DOWN OR RETURN
RESTRICTOR
FLOOR
CONTROL PANEL
FLIGHT OPERABLE DOOR
OPEN
FLOOR POS
CLOSED
HOOD POS
KEY
3000 PSI
1380 PSI
RETURN
AUX. PRESSURE
CHECK VALVE
RELIEF VALVE
ELECTRICAL
MECHANICAL
A
B
C
D
SWITCHES
A. PARATROOP DOOR AND ANCHOR LINE SAFETY SWITCHES . . . . . prevent actuation of the hood or floor unless paratroop doors are closed and anchor cables unattached.
B, C. HOOD INTERMEDIATE POSITION AND FLOOR UP AND DOWN LIMIT SWITCHES . . . . . control the cycling of the system. Refer to text for detailed explanation.
D. HOOD POSITION SWITCHES . . . . . control hood position indication.
PRESSURE REDUCING VALVE
SEQUENCE VALVE
OPEN OR RETURN
HOOD
LOCK PIN ACTUATOR
RESTRICTOR
FLOOR
HOOD
HOOD
GROUND OPERATION ONLY
UP
DOWN
CONTROL PANEL
HOOD ACTUATORS
LOCK PINS
CLOSE OR RETURN
PRESSURE NORMAL
AUXILIARY PRESSURE VALVE
REFER TO HYDRAULIC SCHEMATIC, SECTION I
NOTE: Hood and floor systems are illustrated in simultaneous operation. In practice, the two never operate at the same time.
Flight Operable Door
SCHEMATIC

Figure 4-22B

hood and floor movement. The hood up-position switch is located in the aft end of the fuselage ceiling. A lever connected to the hood depresses the switch when the hood has reached the fully open position. (Hood fully open position forms a 21 degree angle with the fuselage). The hood down-lock indicator switches are mounted on the sidewall of the cargo compartment aft, just above the hood guide rails. Engagement of the hood locking pins securing the hood, depresses the hood down-lock indicator switches. The switches are in series and both must be depressed to complete the circuit to the indicators. The hood intermediate position switch assembly is comprised of four limit switches and a cam mounted on a plunger. The switch assembly is installed in the center of the fuselage overhead. The plunger extends aft through the fuselage frame to contact the forward hood frame. The two upper limit switches stop the hood in the 7 degree open position: one serves to stop the hood in the up-cycle; the other acts as a safety switch and stops hood travel if the 9 degree switch fails when the hood is in the down cycle. The two lower limit switches stop the hood in the 9 degrees open position: one stops the hood down travel to permit the floor to lower, the other acts as a safety switch and stops hood up-travel if the 7 degree switch fails to operate. The switches are opened and closed by roller arms that ride on the cam which moves forward or aft with the plunger.

FLOOR LIMIT SWITCHES.

The floor up-limit and floor down-limit switches act in conjunction with the hood intermediate position switch to coordinate movements of the hood and floor as well as transmit floor position to the floor position indicators.

The floor up-limits switch is installed in the ceiling of the hood. At full up-travel, the floor, by contacting the roller arm of the switch, breaks the circuit to the up position of the floor solenoid, reestablishes the circuit to the hood solenoid, and directs current to actuate the floor indicator to the UP position. The floor down-limit switch is installed at the base of the hood right side wall. The floor when fully down, by contacting the switch, breaks the circuit to the down position of the floor solenoid, reestablishes the circuit to the hood solenoid, and directs currents to actuate the floor position indicator to the DOWN position.

AUXILIARY PRESSURE VALVE.

A two-position auxiliary pressure valve installed on the hydraulic power panel in the auxiliary compartment provides a means of directing hydraulic hand pump pressure to the flight operable door system for ground operation when no power-driven hydraulic pressure source is available. In the NORMAL position, hand pump hydraulic pressure is directed to the emergency selector valve. In the PRESSURE position, hand pump hydraulic pressure is diverted from the emergency selector valve, and is directed to the hood and floor solenoid valves of the flight operable door system. The valve should be safety-wired to the NORMAL position when ground operation of the flight operable door is completed.

WARNING

The auxiliary pressure valve must be in NORMAL position in order to accomplish emergency operation of the landing gear and flaps.

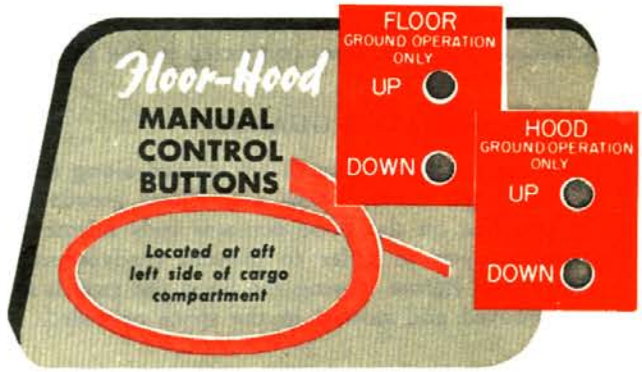


Figure 4–22C

HOOD AND FLOOR SOLENOID VALVE BUTTONS.

The hood and floor solenoid valves may be manually positioned by depressing buttons on the face of the valves located along the aft left side wall of the cargo compartment behind a zipper covering.

WARNING

These buttons should NEVER be used except for ground operation and then only with EXTREME CARE. Use of these buttons bypasses all electrical and sequencing safety devices, permitting operation of the floor before hood clearance is obtained, operation of hood with anchor cables attached, operation of floor with paratroop doors open, or over-operation of the floor. If attempted in flight, improper sequencing of hood and floor operation may result in serious structural damage or adverse flight characteristics due to parachute-like entrapment of air in the door assembly.

Before use of these buttons is attempted during ground operations, anchor cables should be disconnected from the hood ceiling and the troop doors shut and latched. The hood may then be opened, after which the floor may be raised. It is not necessary to interrupt hood operation to raise the floor during ground operation.

PARATROOP ANCHOR LINE ATTACHMENT PROVISIONS.

Two anchor line attachment fittings are installed in the hood ceiling at station 630 for paratrooper drops using the troop-doors. Located above each fitting is a limit switch that prevents flight operable door actuation when the anchor lines are attached. Two booms are installed on the sides of the fuselage, which extend aft into the hood to provide anchor line attachment points during hood and floor operation. Paratroopers accompanying equipment drops may have static lines attached to anchor lines connected to the side booms.

HOOD ACTUATOR GUARDS.

Two hood actuator guards are stowed along the sides of the cargo compartment aft. These guards should be installed on the hood actuator rods whenever the hood is open in order to prevent inadvertent hood operation. Before closing the hood the guards should be removed and stowed in the space provided.

IN-FLIGHT OPERATING PROCEDURE.

WARNING

Operation of the flight operable door, or flight with the door open, should not be attempted above the limiting airspeed quoted in AIRSPEED LIMITATIONS, Section V. Structural damage or adverse flight characteristics may result if this limitation is violated.

Note

Refer to FLIGHT WITH FLIGHT OPERABLE DOOR OPEN, Section VI, for flight characteristics of the airplane with flight operable door open.

TO OPEN THE FLIGHT OPERABLE DOOR.

1. Check that anchor lines are disconnected from the hood, paratroop doors are securely closed, removable floor ramp sections are removed and properly stowed and no obstructions exist.
2. Lift guard on any one of the three flight operable door switches. Toggle the switch to OPEN and hold until indicators show floor UP and hood OPEN.
3. Permit switch to return to spring-loaded OFF position.

TO CLOSE THE FLIGHT OPERABLE DOOR.

1. Lift guard on any one of the three flight operable door switches. Toggle the switch to CLOSED and hold until indicators show floor DOWN and hood CLOSED.
2. Permit switch to return to spring-loaded OFF position.

GROUND OPERATING PROCEDURES.

Ground operation requires a two-man crew. Several methods of operation are possible depending upon the power facilities available. Check the door inside and out for freedom from all obstructions before operating.

GROUND OPERATION WITH HYDRAULIC AND ELECTRICAL POWER AVAILABLE.

If either or both of the airplane's engines are operating; or, if external hydraulic pumps are connected, and some source of electrical power (external power unit or APP) is available, the in-flight procedure for operating the doors may be used. One man of the crew will operate the cargo compartment flight operable door switch while the second man remains outside the airplane to keep personnel and vehicles clear of the door.

GROUND OPERATION WITH ONLY ELECTRICAL POWER AVAILABLE.

If electrical power is available, but no power-driven source of hydraulic pressure is available, one man will place the auxiliary pressure valve on the hydraulic power panel to PRESSURE position and operate the emergency hydraulic hand pump while the other man operates the flight operable door switch in the cargo compartment. After operation of the door cycle is completed the auxiliary pressure valve must be returned to NORMAL position and safety wired.

GROUND OPERATION WITH NEITHER HYDRAULIC NOR ELECTRICAL POWER AVAILABLE.

It is possible to operate the door without electrical power or power-driven hydraulic pumps. However, since all safety, sequencing, and position indicating features will be inoperative, extreme care must be exercised when door operation is attempted without electrical power.

TO OPEN THE FLIGHT OPERABLE DOOR. To open the flight operable door when neither hydraulic nor electrical power is available, the following procedure is recommended:

1. Check that anchor lines are disconnected from the hood, paratroop doors are securely closed, removable floor ramp sections are removed and properly stowed and no obstructions exist.

2. Place the auxiliary pressure valve on the hydraulic power panel to PRESSURE position.

3. Operate the emergency hydraulic hand pump.

4. Unzipper the cover from flight operable door hydraulic panel on aft left side wall of the cargo compartment.

5. Depress hood solenoid valve UP button and hold until hood is fully open. Mechanical stops are provided.

6. Depress the floor solenoid valve UP button and hold until the floor is fully up.

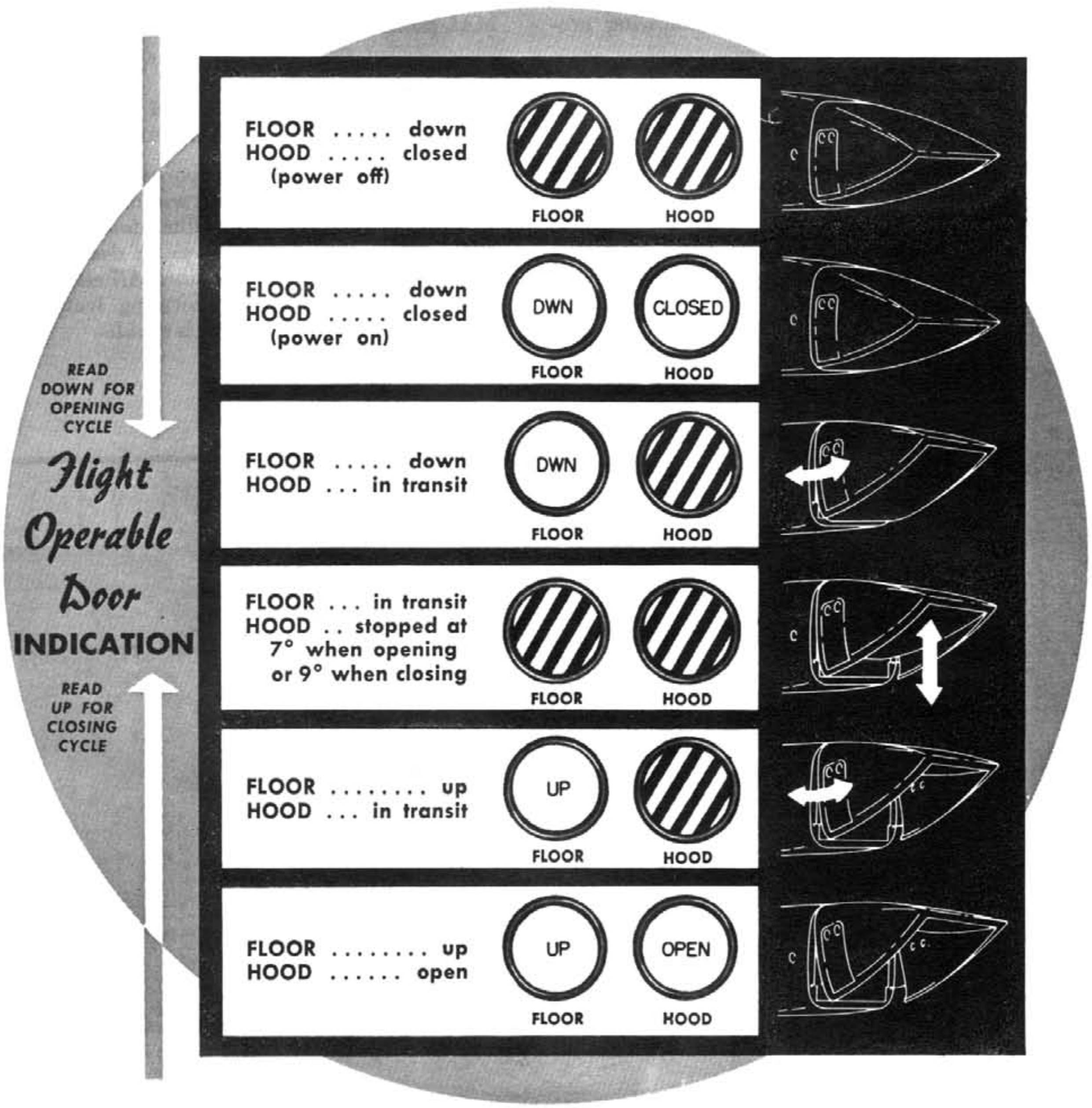


Figure 4–22D

CAUTION

No mechanical stops are provided for the floor. To prevent structural damage, the operator must be careful to stop floor movement at the raised position.

7. Return the auxiliary pressure valve to NORMAL position.

8. Install hood actuator guards.

TO CLOSE THE FLIGHT OPERABLE DOOR. To close the flight operable door when neither hydraulic nor electrical power is available, the following procedure is recommended:

1. Be sure all obstructions are clear of the door.

2. Remove and stow hood actuator guards.

3. Place the auxiliary pressure valve to the PRESSURE position.

4. Operate the emergency hydraulic hand pump.

5. Depress the floor solenoid valve DOWN button and hold till floor is fully down.

CAUTION

No mechanical stops are provided for the floor; to prevent structural damage, operator must be careful to stop floor movement at the fully down position.

6. Depress hood solenoid valve DOWN button and hold until hood is fully closed. Mechanical stops are provided.

7. Check that doors are secure.

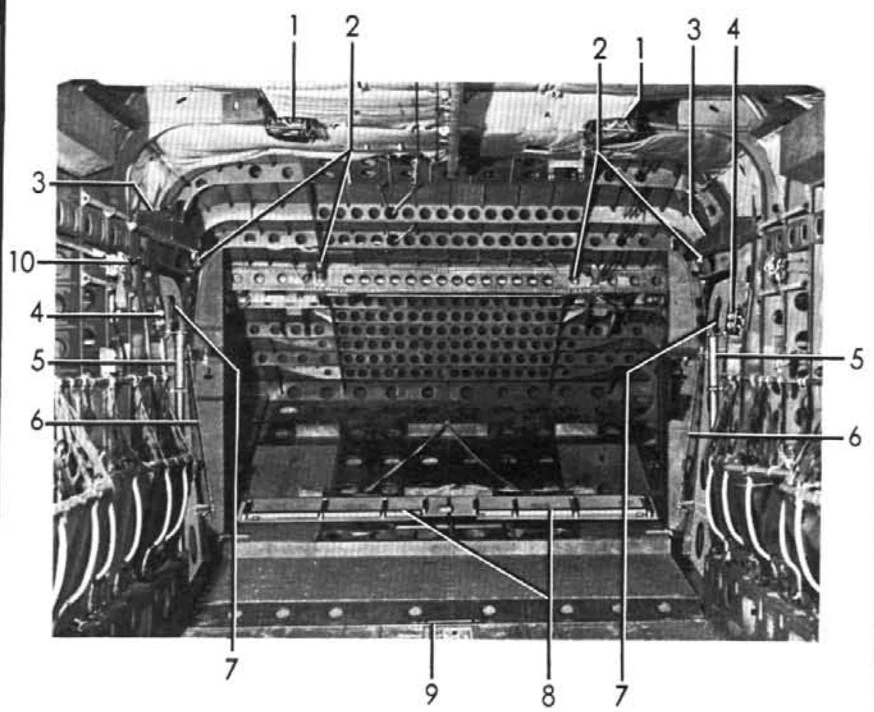
8. Return the auxiliary pressure valve to the NORMAL position and safety wire.

GROUND OPERATION WITH ONLY HYDRAULIC POWER AVAILABLE.

It is possible to operate the door using a power-driven hydraulic pressure source, but without electrical power to operate the flight operable door circuit. This method should be avoided as it demands extreme care on the part of the operator. All electrical safety, sequencing, and position indicating features are inoperative and door movement is rapid.

FLIGHT OPERABLE DOOR — INTERIOR

1. LITTER STRAP STOWAGE
2. ANCHOR CABLE ATTACHMENT LINKS
3. ANCHOR CABLE ATTACHMENT BOOMS
4. TROOP JUMP SIGNAL LIGHTS
5. LOADING JACKS
6. PARATROOP DOORS EMERGENCY RELEASE
7. PARATROOP DOORS
8. FLOOR RAMP SECTIONS (STOWED)
9. CARGO LOADING ROLLER
10. AERIAL DELIVERY CLUTCH RELEASE HANDLE



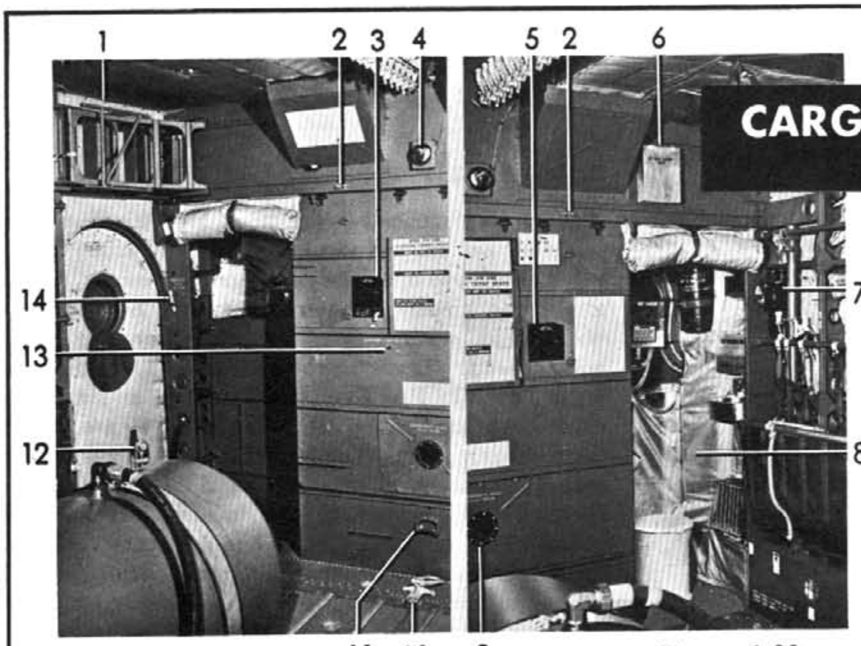
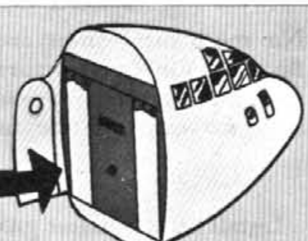
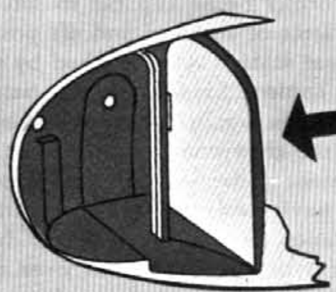


Figure 4-23

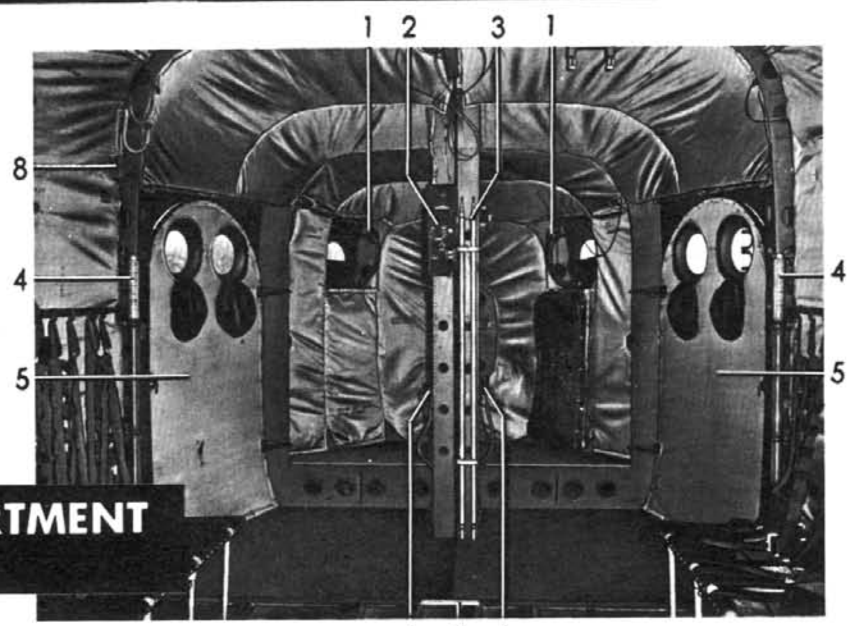
CARGO COMPARTMENT
(FORWARD)

1. FRONT ENTRANCE LADDER STOWAGE
2. ANCHOR CABLE FORWARD ATTACHMENT
3. CARGO DOME LIGHTS AND HEAT CONTROLS
4. ALARM BELL
5. CARGO DOME LIGHTS CONTROL
6. SPARE LAMP STOWAGE
7. JUMPMASTER'S PANEL
8. LAVATORY COMPARTMENT
9. NOSE WHEEL WELL ACCESS PANEL
10. BLOCK AND TACKLE FITTING
11. NOSE LANDING GEAR EMERGENCY UP-LOCK RELEASE HANDLE
12. HAND FIRE EXTINGUISHER
13. NOSE WHEEL WELL LIGHT SWITCH
14. MAIN ENTRANCE DOOR EMERGENCY RELEASE HANDLE





1. PARATROOP ANCHOR CABLE
2. JUMPMASTER'S PANEL
3. CARGO DOOR BAR SUPPORTS
4. LOADING JACKS
5. PARATROOP DOORS
6. RELIEF TUBES
7. CARGO LOADING ROLLER
8. AERIAL DELIVERY CLUTCH RELEASE HANDLE



CARGO COMPARTMENT
(AFT)

Figure 4-24

TO OPEN THE FLIGHT OPERABLE DOOR. To open the flight operable door when hydraulic power only is available, the following procedure is recommended:

1. Check that anchor lines are disconnected from the hood, paratroop doors are securely closed, removable floor ramp sections are removed and properly stowed, and no obstructions exist. One crew man should stand guard outside of the airplane to keep personnel and vehicles clear of the door.

2. Unzipper the cover from the flight operable door hydraulic panel on the aft left side wall of the cargo compartment.

3. Depress the hood solenoid valve UP button and hold until hood is fully open. Mechancial stops are provided.

4. Depress the floor solenoid valve UP button and hold until the floor is fully up.

CAUTION

No mechanical stops are provided for the floor. To prevent structural damage, the operator must exercise extreme care to stop the floor movement at the fully raised position.

5. Install hood actuator guards.

TO CLOSE THE FLIGHT OPERABLE DOOR. To close the flight operable door when hydraulic power only is available, the following procedure is recommended:

1. Be sure all obstructions are clear of the door. One crewman should stand guard outside of the airplane to keep personnel and vehicles clear of the door.

2. Remove and stow hood actuator guards.

3. Depress the floor solenoid valve DOWN button and hold until floor is fully down.

CAUTION

No mechanical stops are provided for the floor. To prevent structural damage, the operator must exercise extreme care to stop the floor movement at the fully closed position.

4. Depress the hood solenoid valve DOWN button and hold until hood is fully closed. Mechanical stops are provided.

5. Check that door is secure.

MISCELLANEOUS EQUIPMENT.

WINDSHIELD WIPERS.

A 28-volt electrically operated windshield wiper is installed on the windshield panel in front of each pilot. Both are operated by an electric motor, installed along the airplane centerline at the bottom of the windshield, with a flexible shaft extending to each wiper head. The control rheostat (1, figure 1–22) with START, FAST, SLOW, PARK, and an unplacarded, spring-loaded off position is located on the instrument panel. When turning the wipers on, the control must be placed in the START position to start wipers before being positioned for the desired speed. This is done to prevent unnecessary load on the wiper motor. To turn off, the control should be turned to the PARK position and released, allowing it to return to the spring-loaded off position.

SEATS.

The navigator's and radio operator's seats are the swivel-type, the former being capable of lateral positioning and the latter of forward and aft positioning. Adjustment of these seats is accomplished by releasing the seat locking control handle on the base of the seat which permits the seat to be repositioned on the tracks secured to the crew compartment floor. Earlier airplanes incorporate provisions for using seat type parachutes at the navigator's and radio operator's seats while later airplanes have provisions for back-type chutes. A bucket type seat that folds over the crew compartment entrance is provided for the use of the flight mechanic with seat type parachute. On late airplanes, a shoulder harness (without inertia reel mechanism), is mounted on the bulkhead aft of the flight mechanic's seat for his use. Seat cushions and lap safety belts are provided for all crew members. No specific seat is provided for the jumpmaster.

SHOULDER HARNESS INERTIA REEL LOCK CONTROL HANDLE.

A two-position (LOCKED-UNLOCKED) shoulder harness inertia reel lock control handle (10, figure 1–18) is located on the left of the pilot's and copilot's seats. A latch is provided for retaining the control handle securely at either position. By pressing down on the top of the control handle, the latch is released and the handle may be moved freely from one position to another. When the control is in the UNLOCKED position, the reel harness cable will extend to allow the pilot to lean forward in his seat; however, the reel harness cable will automatically lock when an impact force of 2 to 3 G's on the airplane is encountered. When the reel is locked in this manner, it will remain locked until the control handle is moved to the LOCKED and then returned to the UNLOCKED position. When the handle is in the LOCKED position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The LOCKED position is used only when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.

On later airplanes, the navigator's and radio operator's seats are also equipped with the same type shoulder harness and inertia reel locks. The control handle is located on the left of the seats.

WINDOW SHADES.

Window shades are provided on the pilot's and co-pilot's overhead canopy and on the navigator's windows.

FLIGHT REPORT HOLDER.

A combination flight report holder and map case, with a cover and latch to retain the contents, is installed on the right sidewall of the crew compartment just above the navigator's work table.

STOWAGE COMPARTMENTS.

A stowage compartment, partitioned to accommodate handbooks, technical orders, and other pertinent data, is installed on the shelf over the radio rack. Stowage compartments are also located in the cargo compartment on each side wall near the aft end.

CHART AND MAP STOWAGE.

A chart stowage tube is located above the navigator's station on the radio rack.

ENGINE AND CREW COMPARTMENT COVERS.

Engine covers, fitted for an external heat duct, and crew compartment covers are stowed in the forward section of the cargo compartment.

PITOT COVERS.

Pitot covers are provided to exclude dust, water, and other foreign matter from the pitot system during the time the airplane is parked on the ground. While in flight the covers may be stowed with the ground lock pins, immediately aft of front entrance door.

DUST EXCLUDERS.

Dust excluders are provided for carburetor air intakes, heater exhausts, manifold exhaust tail pipes, and air cooler scoops. They are stowed in a bag which is located on the left side of the cargo door.

SPARE LAMPS BOX.

A box, containing spare lamps for all interior lamps, is mounted on the cargo compartment forward bulkhead.

PARATROOP DOORS.

Two paratroop doors are provided in the rear cargo doors and are utilized as exits for paratroopers. A hook is provided on the center support of the rear cargo doors to secure the paratroop doors in the open position. In case of emergency, the paratroop doors may be quickly released by removing the safety pin and pulling up on the hinge pin handle, thus extracting the hinge pins and allowing doors to be opened.

CREW COMPARTMENT SLIDING WINDOW.

There is a sliding window on each side of the crew compartment. A handle is provided for moving the window forward and aft, and a lock mechanism locks the window in the closed position. The window should be all the way forward and against the stops before the lock lever is pulled aft.

WARNING

When the paratroop doors are removed in flight it is recommended that doors should be opened slightly to assure release of adverse pressure before pulling the hinge pin handle. Then, standing to rear of the door hinge, pull door inward into the cargo compartment. Failure to do so may result in the door striking and damaging the stabilizer, elevator, and/or rudders.

SPARE LENS STOWAGE.

A box containing spare lenses for fuselage navigation lights is located on the forward bulkhead of the lavatory.

ANCHOR CABLES.

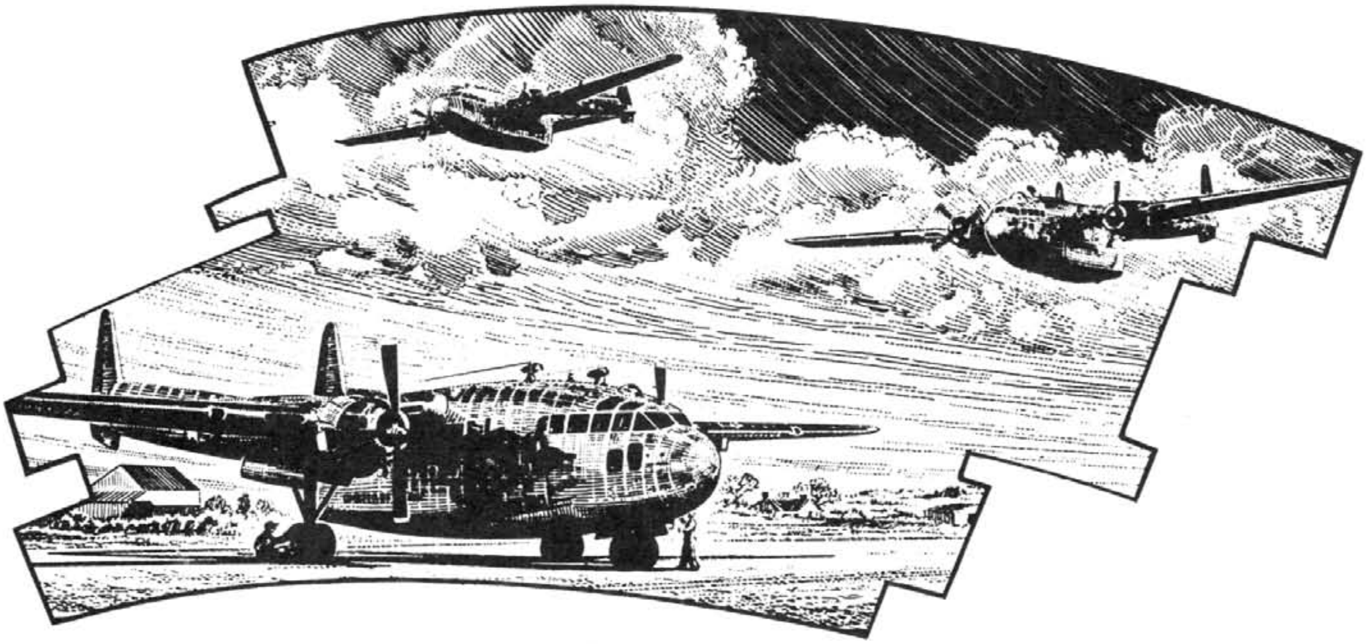
Paratroop anchor cables are provided and extend along each side of the cargo compartment from the forward bulkhead to the aft end of the rear cargo doors. An aerial delivery system anchor cable is provided and extends from the aft end of the cargo compartment along the center line of the floor to a point just aft of the aerial delivery doors. These anchor cables, when not in use, are stowed in the rear cargo doors. Two anchor cables for dropping litter patients are located just forward of each paratroop door. On later airplanes for equipment drop operations an additional length of cable is mated to the aerial delivery cable by a "pip pin" and secured to the overhead anchors provided at the cargo compartment forward bulkhead and the rear of the cargo compartment. This overhead anchor cable is utilized to secure the static lines of the equipment to be ejected.

LAVATORY EQUIPMENT.

In the lavatory compartment at the forward end of the cargo compartment the following items of equipment are located: a chemical dry toilet, toilet paper holder, metal urinal, modesty curtain, drinking water jugs, and drinking cup container. Two relief tubes are located at the rear cargo doors.

SIMULATED INSTRUMENT FLYING EQUIPMENT.

Orange plexiglas panels to clip on the inside surfaces of the crew compartment windows and similar discs for the directional gyro indicator, attitude gyro, master direction indicator and vertical gyro control are provided so that a pilot trainee wearing a headgear containing a blue plastic visor may become familiar with conditions similar to those encountered during instrument flights. This equipment is contained in two stowage bags mounted under the soundproofing at the lavatory entrance.



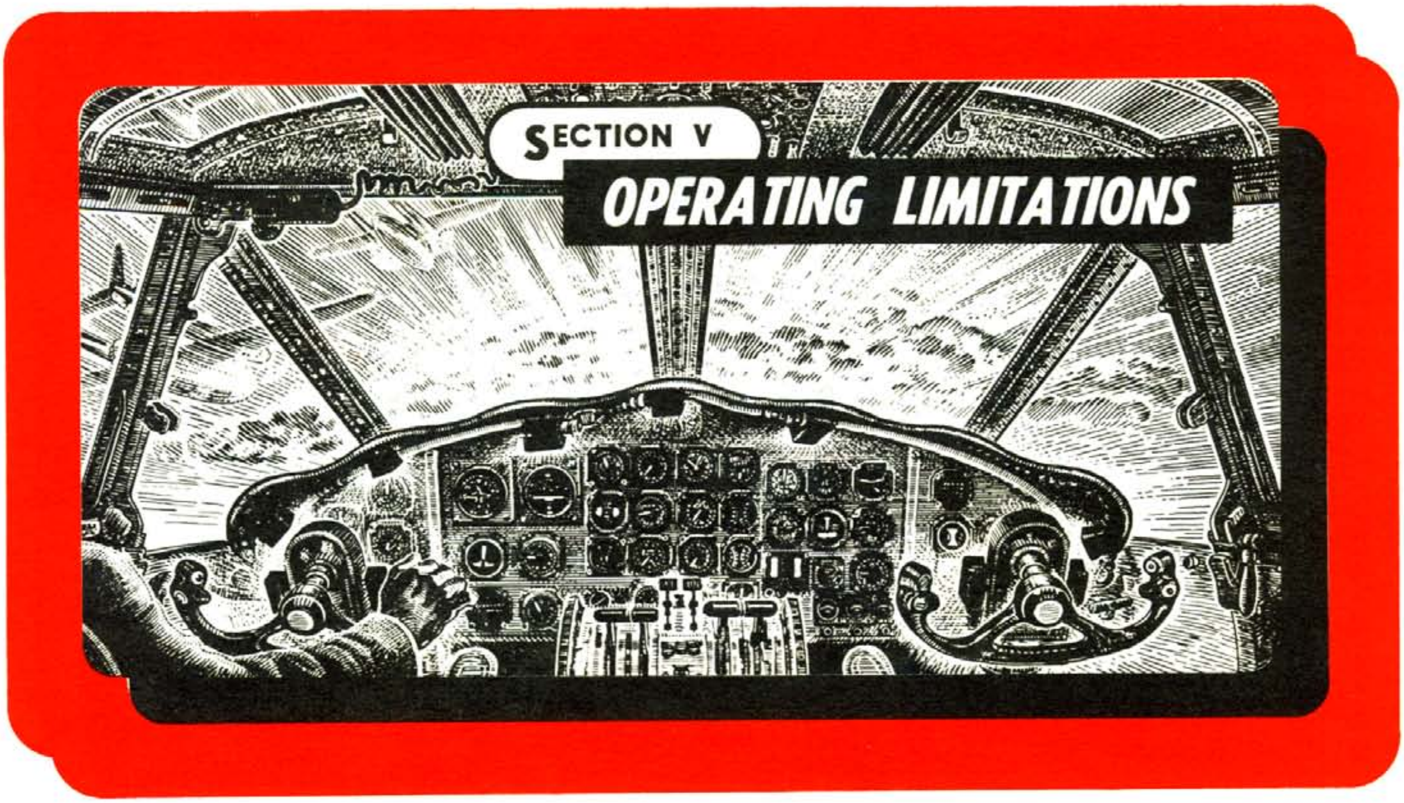


TABLE OF CONTENTS

Note

This section sets forth the various limitations that must be observed when flying this airplane. When these limitations are strictly adhered to the safety of the airplane and personnel is magnified to the fullest extent. The instrument range markings are presented in a pictorial form just as they appear in the airplane and since they are not necessarily repeated in the text, particular attention should be paid to the instrument range marking illustrations.

INSTRUMENT RANGE MARKINGS

Sea Level Standard Conditions

FUEL GRADE 115/145

TORQUEMETER

- (Blue) 75 PSI MINIMUM DESIRABLE FOR FLIGHT
- (Blue) 75 TO 142 PSI NORMAL OPERATION
- (Blue) 142 PSI MAX. CONTINUOUS (OPERATION ABOVE THIS PRESSURE LIMITED TO 30 MINUTES AT MILITARY POWER AND 5 MINUTES AT TAKE-OFF)
- (Red) 159 PSI MAXIMUM DRY OR MILITARY DRY
- (Red) 171 PSI MAXIMUM WET OR MILITARY WET

TACHOMETER

- (Blue) 1350 TO 2600 RPM CONTINUOUS OPERATION
- (Blue) 2600 RPM MAX. CONTINUOUS (OPERATION ABOVE THIS RPM LIMITED TO 30 MINUTES AT MILITARY POWER AND 5 MINUTES AT TAKE-OFF)
- (Red) 2900 RPM MAXIMUM

WATER PRESSURE

- (Red) 28 PSI MINIMUM
- (Green) 29 TO 31 PSI NORMAL PRESSURE
- (Yellow) 31 TO 36 PSI STATIC PRESSURE (INDICATES NO FLOW)
- (Red) 36 PSI MAXIMUM

CYLINDER HEAD TEMPERATURE

- (Blue) 100° TO 245°C CONTINUOUS OPERATION (180°C DESIRABLE)
- (Red) 260°C MAXIMUM

NOTE

WITH ENGINES OPERATING AT 70-100% OF NRP (2600 BHP), THE MAXIMUM CYLINDER HEAD TEMPERATURE PERMISSIBLE IS 245°C. BELOW 70% OF NRP (1820 BHP), THE MAXIMUM PERMISSIBLE IS 230°C.

AIRSPEED

- (Yellow) 140 KNOTS MAXIMUM WHEN WING FLAPS OR LANDING EXTENDED
- (Red) 272 KNOTS MAXIMUM DIVING

MANIFOLD PRESSURE

- (Blue) 30″ TO 46″ CONTINUOUS OPERATION
- (Blue) 46″ MAX. CONTINUOUS (OPERATION ABOVE THIS PRESSURE LIMITED TO 30 MINUTES AT MILITARY POWER AND 5 MINUTES AT TAKE-OFF)
- (Red) 59.5″ TAKE-OFF DRY OR MILITARY DRY
- (Red) 57.5″ TAKE-OFF WET OR MILITARY WET

Figure 5-1

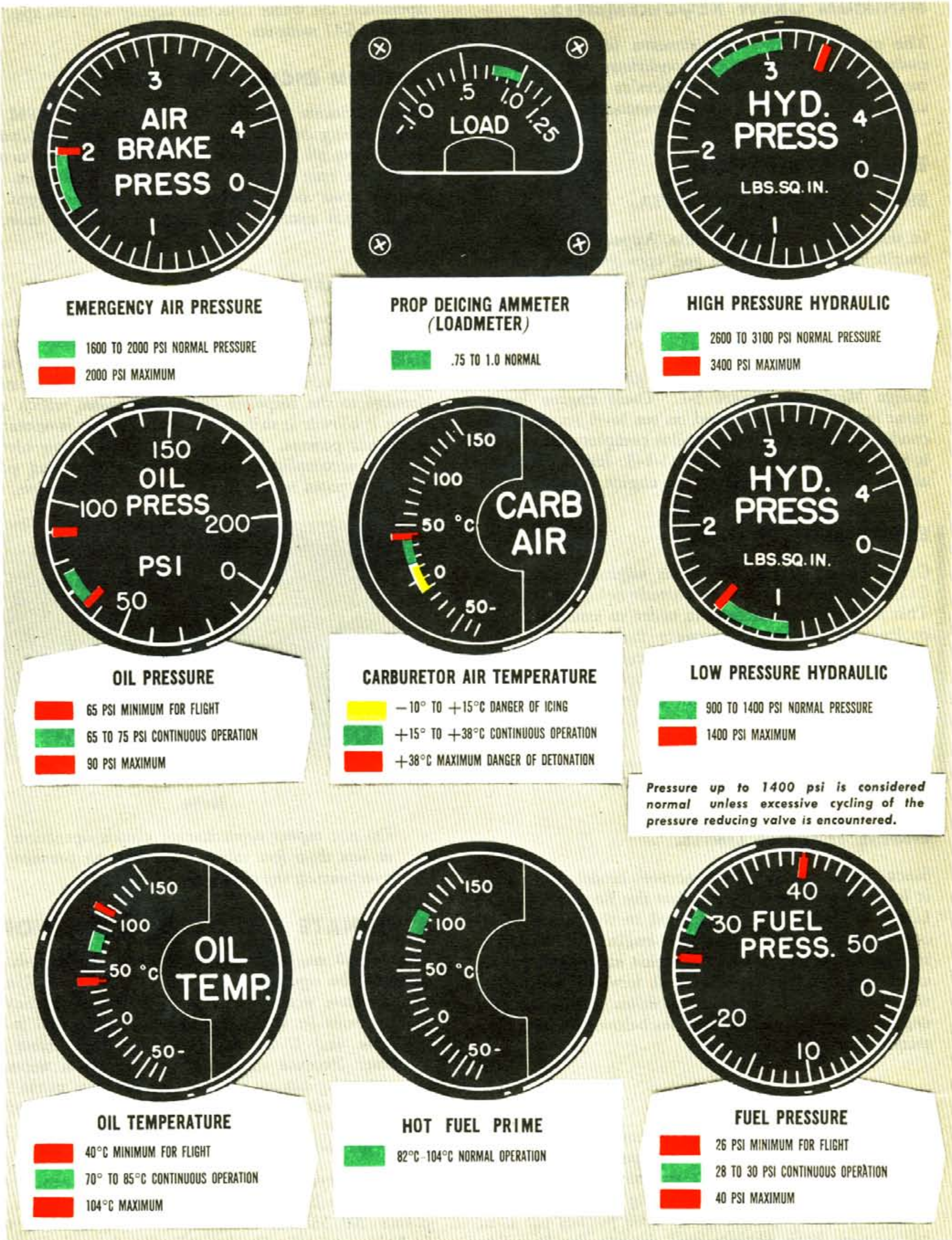

AIR BRAKE PRESS
EMERGENCY AIR PRESSURE
1600 TO 2000 PSI NORMAL PRESSURE
2000 PSI MAXIMUM
LOAD
PROP DEICING AMMETER (LOADMETER)
.75 TO 1.0 NORMAL
HYD. PRESS LBS.SQ.IN.
HIGH PRESSURE HYDRAULIC
2600 TO 3100 PSI NORMAL PRESSURE
3400 PSI MAXIMUM
OIL PRESS PSI
OIL PRESSURE
65 PSI MINIMUM FOR FLIGHT
65 TO 75 PSI CONTINUOUS OPERATION
90 PSI MAXIMUM
CARB AIR °C
CARBURETOR AIR TEMPERATURE
−10° TO +15°C DANGER OF ICING
+15° TO +38°C CONTINUOUS OPERATION
+38°C MAXIMUM DANGER OF DETONATION
HYD. PRESS LBS.SQ.IN.
LOW PRESSURE HYDRAULIC
900 TO 1400 PSI NORMAL PRESSURE
1400 PSI MAXIMUM
Pressure up to 1400 psi is considered normal unless excessive cycling of the pressure reducing valve is encountered.
OIL TEMP. °C
OIL TEMPERATURE
40°C MINIMUM FOR FLIGHT
70° TO 85°C CONTINUOUS OPERATION
104°C MAXIMUM
HOT FUEL PRIME
82°C-104°C NORMAL OPERATION
FUEL PRESS.
FUEL PRESSURE
26 PSI MINIMUM FOR FLIGHT
28 TO 30 PSI CONTINUOUS OPERATION
40 PSI MAXIMUM

Figure 5-1

MINIMUM CREW REQUIREMENTS.

The minimum crew requirements for this airplane under normal non-tactical conditions are pilot and copilot. Additional crew members as required will be added at the discretion of the commander.

ENGINE LIMITATIONS.

ENGINE POWER LIMITS DATA.

In the Engine Power Schedule, Appendix I, values of manifold pressure, torque and rpm are given for the entire power range of the engine when 115/145 fuel is used. Note that for a given power the manifold pressure and torque pressure values are set according to whichever occurs first.

Other engine operating data are given in Instrument Range Markings, Figure 5-1. These engine instrument range markings, based on sea level standard day conditions, should give the pilot complete criteria for low blower operation on 115-145 fuel. Particular attention should be paid to the engine take-off limits.

ENGINE ALTITUDE LIMIT.

Operation of the R-3350 series engines installed in C119 airplanes is limited to altitude below 18,000 feet. This limitation is imposed in order to assure adequate cooling of the power recovery turbines on engines equipped with the original type cooling shields. Although cooling of turbines equipped with the tangential cooling shields is not critical, the limitation applies to all engines of the series, since there is no indication of turbine temperature in the crew compartment, and the flight crew may be unaware of which type cooling shields are installed.

ENGINE TAKE-OFF LIMITS.

Since pilots may be flying several models of C-119's it is of primary importance that the Engine Take-Off Limits be thoroughly entrenched in the minds of all operating personnel. With this engine installation it is possible to overboost the engine at take-off power unless caution is exercised. Full forward position of the throttles will give a condition which exceeds engine take-off limits at altitudes below 4000 feet on a standard day.

WATER INJECTION.

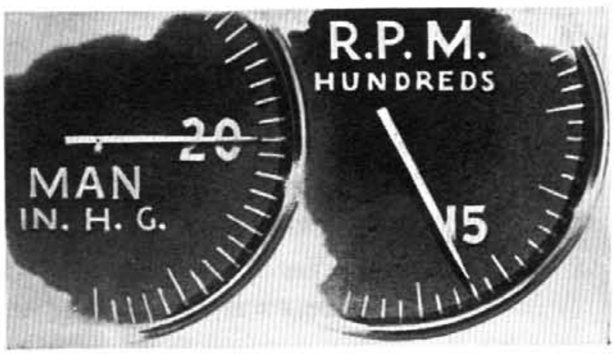
The use of the water injection system at maximum wet power is limited to thirty minutes. However, this engine operational limit is greater than the water injection supply will permit. Using the water-alcohol mixture at a maximum rate of 1400 pounds per hour per engine, both engines will deplete the 56-gallon supply in approximately 8 minutes; on single-engine operation, the water injection supply will last approximately 16-17 minutes.

MAXIMUM ENGINE OVERSPEED.

The maximum engine overspeed is 3120 RPM. If overspeeding occurs, land at nearest suitable landing field. Note all conditions of overspeeding on Form 1. If engine rpm was between 3050 to 3120 rpm, the engine must be inspected before further flight. If engine rpm exceeds 3120 rpm, the engine must be changed.

SUPERCHARGER.

Shifting from low to high blower may be accomplished at any power setting below 20 inches Hg and 1600 rpm. This restriction prevents the overheating of the supercharger clutch plates as well as possible damage to the impeller drive mechanism which may occur if blower is shifted while the engine is operating at higher powers. Shifting from high to low blower may be accomplished at any engine operating point as this imposes no additional loads on the engine.



Note

Do not repeat supercharger clutch operation at less than five minute intervals to prevent overheating the clutch plates.

ALTERNATE FUEL GRADE LIMITATIONS.

The R3350 engines installed on the airplane should normally be operated on grade 115/145 fuel. Use of the alternate grade fuel (100/130) should be limited to situations in which the desired grade fuel is not available and it becomes necessary to operate the airplane. Because of the power reduction necessary when the engines are operated on alternate grade fuel, the performance of the airplane is lessened. *Therefore, operation of the airplane on alternate grade fuel (100/130) should be avoided, if at all possible.*

On some airplanes the vapor return lines return fuel from the carburetor to the outboard tanks. On airplanes AF 53-7840 thru 53-7884, AF 53-8153 thru 53-8156, and IK 450 thru IK 466 the vapor return lines were rerouted at the time of production to return

ALTERNATE FUEL LIMITS CHART

FUEL GRADE 100/130——STANDARD DAY

WET POWER RATING

	Super-charger	Altitude	Mixture	RPM	Map (in. hg.)	Torque (psi)	BHP
TAKE-OFF	LOW	S.L.	RICH	2900	57.4	167.5	3420

Warning *Do not allow manifold pressure to exceed 50 in. hg. at 2900 rpm (at S.L.) if water indicator light does not illuminate or pressure gages (on some airplanes), do not indicate flow. Serious damage to the engine due to detonation may result.*

DRY POWER RATING

	Super-charger	Altitude	Mixture	RPM	Map (in. hg.)	Torque (psi)	BHP
TAKE-OFF	LOW	S.L.	RICH	2900	49.9	127.0	2600
NORMAL	LOW	S.L.	RICH	2600	47.8	139.5	2555
CRUISE	LOW	S.L.	RICH	2300	36.1	104.5	1690
CRUISE	LOW	S.L.	RICH	2100	33.8	96.5	1425
NORMAL	HIGH	8,000 FT.	RICH	2600	39.5	93.5	1710
CRUISE	HIGH	8,000 FT.	RICH	2300	35.5	94.0	1520
CRUISE	HIGH	8,000 FT.	RICH	2100	35.4	97.0	1430

Figure 5-2

fuel to the inboard tanks. Compliance with T. O. 1C–119–538 also will route the vapor return lines to the inboard tanks. These two configurations of the return lines necessitate two procedures for the use of alternate fuel.

ALTERNATE FUEL OPERATIONAL LIMITS (Airplanes with vapor return to OUTBOARD tanks)

Inasmuch as it is desirable to restrict operation on alternate fuel to cruise, as well as to retain fuel in the outboard tanks as long as possible to reduce the bending moment of the wings, the outboard tanks are normally serviced with 115/145 grade fuel and the inboard tanks with 100/130 grade fuel. The fuel management sequence then permits starting, warm-up, take-off and climb to altitude to be accomplished on 115/145 grade fuel which provides space in the outboard tanks for vapor return from the carburetor. However, when operation on the 100/130 fuel in the inboard tanks is commenced after cruising altitude has been reached, the excess 100/130 fuel returned from the carburetors to the outboard tanks contaminates the higher grade (115/145) fuel. When this happens, the limits for the lower grade fuel must apply.

To delay the use of the lower engine power limits as long as possible when two grades of fuel are carried, the following instructions will be adhered to.

1. The engine operating limits for use of grade 100/130 fuel as specified in the ALTERNATE FUEL GRADE LIMITS CHART, Figure 5-2, should not be exceeded because of the danger of detonation.

CAUTION

All alternate fuel operations demand a RICH mixture setting. When using alternate grade fuel (100/130) with water injection, do not allow the manifold pressure to exceed 50 inches Hg at 2900 rpm (sea level) if the water indicator light does not illuminate or the water pressure gages (on some airplanes) do not indicate a flow of water. Serious damage caused by detonation may result.

2. Grade 100/130 fuel should not be used when grade 115/145 is available. However, when it is necessary to use grade 100/130 fuel, grade 115/145

fuel should be carried in the outboard tanks if at all possible.

3. When the outboard tanks are serviced with grade 115/145 fuel and the inboard tanks are serviced with grade 100/130 fuel, use the higher grade fuel from the outboard tanks for starting, warm-up, take-off and climb to altitude. Once grade 100/130 fuel (alternate) from the inboard tanks is used, the limits for grade 100/130 fuel as specified in the ALTERNATE FUEL GRADE LIMITS CHART, Figure 5-2, must be adhered to until such time that, at least, the outboard tanks are drained and reserviced with grade 115/145 fuel.

WARNING

Once the high grade 115/145 fuel has been contaminated, extreme caution must be exercised during landings in view of the power requirements should a go-around become necessary.

4. If grade 100/130 fuel is carried in all tanks, the alternate fuel grade limits apply for the complete mission.

WARNING

When operating solely on grade 100/130 fuel, the take-off gross weight as limited by performance should be computed using the Limit Take-Off Gross Weight Charts For 100/130 Fuel, Appendix I.

ALTERNATE FUEL OPERATIONAL LIMITS (Airplanes with vapor return to INBOARD tanks).

When alternate grade (100/130) fuel is carried in the inboard tanks and 115/145 grade fuel in the outboard tanks, a mission may be accomplished using the higher grade fuel for take-off, landing or single-engine emergency operation in flight and the lower grade fuel for cruise. With vapor return from the carburetors being returned to the inboard tanks, the use of 100/130 grade fuel will not contaminate the higher grade fuel in the outboard tanks. This permits the retention of uncontaminated 115/145 fuel for landing—a particularly desirable feature in view of the power requirements should a go-around become necessary. To make certain that the 115/145 fuel will not be contaminated and to insure that maximum utilization of the airplane may be obtained when alternate grade (100/130) fuel must be carried, the following instructions will be adhered to.

1. The engine operating limits for use of grade 100/130 fuel as specified in the ALTERNATE FUEL GRADE LIMITS CHART, Figure 5-2, should not be exceeded because of the danger of detonation.

CAUTION

All alternate fuel operations demand a RICH mixture setting. When using alternate grade fuel (100/130) with water injection, do not allow the manifold pressure to exceed 50 inches Hg at 2900 rpm (sea level) if the water indicator light does not illuminate or the water pressure gages (on some airplanes) do not indicate a flow of water. Serious engine damage caused by detonation may result.

2. Grade 100/130 fuel should not be used when grade 115/145 is available. However, when it is necessary to use grade 100/130 fuel, the outboard tanks should be serviced with 115/145 if at all possible. This will prevent contamination of the higher grade fuel.

3. When the outboard tanks have been serviced with grade 115/145 fuel and the inboard tanks with grade 100/130 fuel, use the higher grade fuel from the outboard tanks whenever necessary.

CAUTION

When 115/145 grade fuel is carried, always use the 115/145 fuel for starting, warm-up, take-off, climb to cruising altitude. Use the grade 100/130 fuel in the inboard tanks for cruise. Prior to entering the traffic pattern or whenever the grade 100/130 fuel supply in the inboard tanks is completed, use the higher grade fuel in the outboard tanks.

4. If grade 100/130 fuel is carried in all tanks, the alternate fuel grade limits apply for the complete mission.

WARNING

When operating solely on grade 100/130 fuel, the take-off gross weight as limited by performance should be computed using the Limit Take-off Gross Weight Charts for 100/130 Fuel, Appendix I. Extreme caution must be exercised during landings in view of the power requirements should a go-around become necessary.

PROPELLER LIMITATIONS.

GROUND RESTRICTIONS.

During ground operation avoid the following rpm ranges (except for passing through the range) as much as possible because of high blade stresses.

1300 to 1550 RPM
2400 to 2650 RPM

When blades have been replaced in the field or during an overhaul, possible unmatched dynamic characteristics may cause roughness to be encountered in the 850 to 1100 RPM range. Prolonged operation in this range should be avoided.

FLIGHT RESTRICTIONS.

The propeller has no flight restrictions.

MAXIMUM PROPELLER OVERSPEED.

Propellers must be removed for inspection in the event the engine overspeeds in excess of 3500 RPM.

AIRSPEED LIMITATIONS.

Maximum speed with aerial delivery doors open.... 130 knots.

Maximum speed with flight operable door open or operating....150 knots.

Refer to Instrument Range Markings and Turbulent Air and Thunderstorm Flying for additional airspeed limitations.

PROHIBITED MANEUVERS.

Refer to figure 5-3.

CENTER OF GRAVITY LIMITATIONS.

When loading the airplane, particular attention should be paid to keeping the center of gravity within the prescribed limit. A forward center of gravity position tends to require a higher aft column pressure at take-off and on the landing. There is no appreciable effect on taxiing. The effect of a rearward center of gravity is a slightly less stable condition in airplane power configurations. No appreciable effect on taxiing results. Refer to 1C–119B–5 for center of gravity limits.

PROHIBITED MANEUVERS

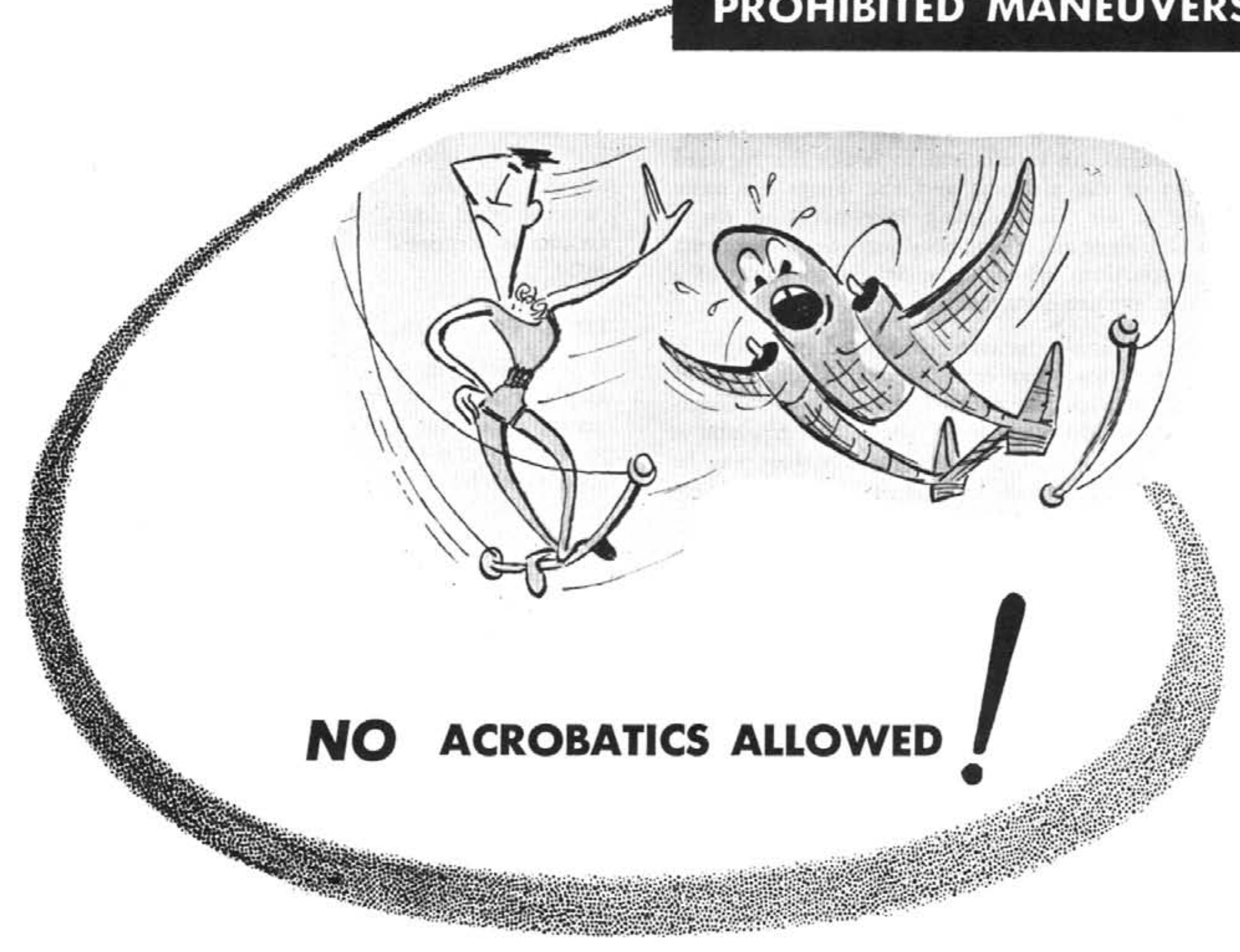


Figure 5–3

TURNING LIMITATIONS.

The maximum turning speed during taxiing is 10 mph for a turning radius of 50 feet. For a turning radius of less than 50 feet, speed must be reduced accordingly. Do not pivot the airplane on one wheel as damage to the landing gear structure may result.

WEIGHT LIMITATIONS.

Weight, more than any other single factor will determine the capability and performance of your airplane. In the designing of an airplane, weight has always been a primary restrictive factor as it has a direct effect on an airplane's configuration, power, and range. An airplane is designed with sufficient strength to accomplish a certain basic mission without undue allowance for overloading or improper weight distribution. Every effort is made to eliminate unnecessary weight; however, the weight penalty for making an airplane foolproof is prohibitive. Weight limitations, therefore, are necessarily involved in the operation of the airplane. If these limitations are exceeded, a loss in the performance of the airplane is inevitable and structural failure is quite probable. When an airplane is loaded beyond the established limits, ceiling and range are decreased, control forces and stalling speeds become higher, and the rate-of-climb falls off rapidly as the maximum gross weight is exceeded. The take-off and landing rolls increase appreciably with an increase in gross weight. Likewise, the brakes are insufficient to brake the forward momentum of the airplane and the wings are more vulnerable to air loads during maneuvers or flight through turbulent air. These resultant effects can reach serious proportions when the weight limitations of a specific airplane are disregarded.

In a cargo airplane, the effect produced by weight is much greater than that encountered in airplanes of other types because the cargo itself, adds a considerable amount to the weight at which the airplane is operated. In order that cargo of various sizes may be accommodated, the cargo hold is of such proportions that space is not a restrictive factor; consequently, overloading is entirely possible and weight limitations must be complied with if the airplane is to be operated efficiently, economically and safely. A consideration of the weight factors involved, particularly as they apply to this airplane, appears in the succeeding paragraphs.

WEIGHT AND LOADS.

Due to the effect of gravity on the mass of your airplane, the airplane possesses weight. More exactly, this weight is a force which gravity exerts on the material used in the fabrication of the airplane and which pulls the airplane toward the earth. In any condition of static equilibrium during straight and level flight or at rest on the ground, the airplane is subjected to this pull of gravity, the strength of which is spoken of as 1g. As fuel, cargo, crew members and additional equipment are added in order that the airplane may accomplish a specific mission, the weight of the airplane correspondingly increases and, the additional weight constitutes a force acting on the airplane structure. The weight of the airplane, or the force which gravity imposes on the airplane, may also be considered as a load. On the ground this load must be sustained by the landing gear; in flight, by the wings. There is a limit to the load which the landing gear is capable of supporting during taxi, take-off, and landing operations; there is likewise a limit to the load which the wings can sustain in flight.

During maneuvering and flight through turbulent air, additional loads are imposed on the airplane. These loads, caused by the acceleration of the airplane, are the result of forces which, in addition to that of gravity, act upon the total mass of the loaded airplane. Both these forces tend to produce undesirable and potentially dangerous loads on the airplane structure and its members. This is particularly true of the wings which must sustain the airplane in flight. When the weight of the airplane is increased, the wings become more and more vulnerable to the loads imposed by sudden changes in air currents or manipulation of the controls. The ultimate strength of the airplane structure is eventually exceeded by the combined forces of weight and air loads. When this condition occurs, structural failure results. As the maximum weight which the airplane can safely carry is dependent upon distribution of the weight throughout the airplane and its capacity to sustain air loads in accelerated flight, an understanding of weight limitations is required to accomplish a mission successfully.

LOAD FACTORS.

A load factor is the ratio of the load imposed on the airplane when accelerated in any direction as compared with the load imposed on the airplane by gravity in any condition of static equilibrium. The load factor denotes the strength of the forces acting on the airplane due to sudden changes in air currents and manipulation of the controls, and is expressed by the term, g, which is the gravitational force. By definition, then, all airplanes at rest on the ground or in straight and level flight possess a load factor of 1g because the force acting upon the airplane under either of these conditions is merely that of gravity. When the airplane enters a region of turbulent air or the pilot elects to maneuver the airplane, additional forces are imposed on the structure. The additional load on the wings resulting from these forces is expressed in relation to the gravitational force and referred to as 0.5g., 2.0g, 3.0g, etc., which mean that the forces exerted on the wing structure and its members are .5, 2, or 3 times the force exerted by gravity. For example, if the normal weight of the airplane is 50,000 pounds and the load factor at some given moment of accelerated flight is 3.0g, the total force which the wings must sustain is 150,000 pounds or three times the normal weight of the plane in straight and level flight. However, this load on the wings is not always symmetrically distributed, as in a rolling pull-out maneuver. When the overall wing load becomes too unequally distributed, excessive shear stresses are applied to one side of the wing mounting structure. Thus it becomes necessary to establish design criteria for specifying the extent of asymmetrical wing loading which the airplane must support. In the case of the C-119F and R4Q-2 airplane, the structure is capable of sustaining 100% of design stress on one wing while simultaneously sustaining not less than 85% on the other. For example, at the design gross weight of 64,000 pounds with a full fuel load, the design wing load factor is 3.0g. In level flight, the load on each wing is 32,000 pounds. However, if a 3.0g load is imposed on one wing because of heavy turbulence or maneuvering flight, the total load on that wing becomes 96,000 pounds. In order, then, to avoid a dangerously unequal load distribution, the other wing must carry at least 85% of that amount or 81,600 pounds. From this example it can readily be seen that it is imperative an excessive rate-of-roll be avoided when establishing a turn in accelerated flight.

MARGIN OF SAFETY.

The margin of safety is the range of forces which exist between two points, one of which is the load factor the airplane is sustaining at any given moment and the other is the load factor at which structural damage will occur. If, for example, the airplane is incapable of sustaining a load factor greater than 3.0g and during flight through turbulent air is subjected to a force of 1.5g., the margin of safety at this particular moment is 1.5g. When fuel and cargo loads are increased, the margin of safety decreases. This increase in weight actually becomes a component of the forces acting on the airplane, and, as such, lessens the capacity of the airplane to sustain further loads due to accelerated flight. For this reason, it is advisable in loading an airplane to maintain a margin of safety which will never be exceeded during any period of flight.

WARNING

If the combined weight of cargo and fuel is such that the airplane is incapable of sustaining a force of 3.0g, turns and pull-outs should be made with caution to minimize the resulting air loads.

EXPLANATION OF THE CHART.

The weight limitations chart is intended to present graphically the weight-carrying capabilities of the airplane as defined by the various criteria which provide limits for safe and efficient operation. Through the use of the chart, the flight planner is aided in recognizing the weight limitations which will restrict operation in a specific mission and in determining what margin of safety may be established.

Note

Although the chart indicates the limitations involved in the loading of the airplane, the authority for operation of the airplane at a given gross weight remains the responsibility of the local authority.

The gross weight performance limits as specified in the weight limitations charts are absolute values based on maximum take-off power and sea level atmospheric conditions. The Limit Take-off Gross Weight Curves in Appendix I supplement the criteria presented on the weight limitations charts by providing limiting gross weights throughout the whole range or altitudes and atmospheric conditions which might conceivably be encountered.

GROSS WEIGHTS.

The data in the weight limitations chart are based on the basic operating weight of the airplane exclusive of the cargo and the fuel required for the mission but including the following items: crew, full oil and water, trapped fuel oil and water, and standard equipment. Any special equipment such as loading ramps, jacks, troop seats, litters, tie-down devices, wheel chocks, tool boxes, etc., are considered to be special load items and, when carried, should be computed as part of the cargo load.

The zero point of the chart at the junction of the fuel and cargo load axis represents a basic operating weight of 43,000 pounds. As individual basic operating weights may vary, it will be necessary to adjust the chart for the specific airplane involved. The basic operating weight plus the fuel and cargo as required in a mission can be shown by gross weight lines which slope at a 45° angle to the axis of the chart. These diagonal lines also indicate various structural and performance limitations. However, any gross weight line may be plotted to obtain a graphic representation of the limitations involved in the fuel-weight combination which a mission may require.

Note

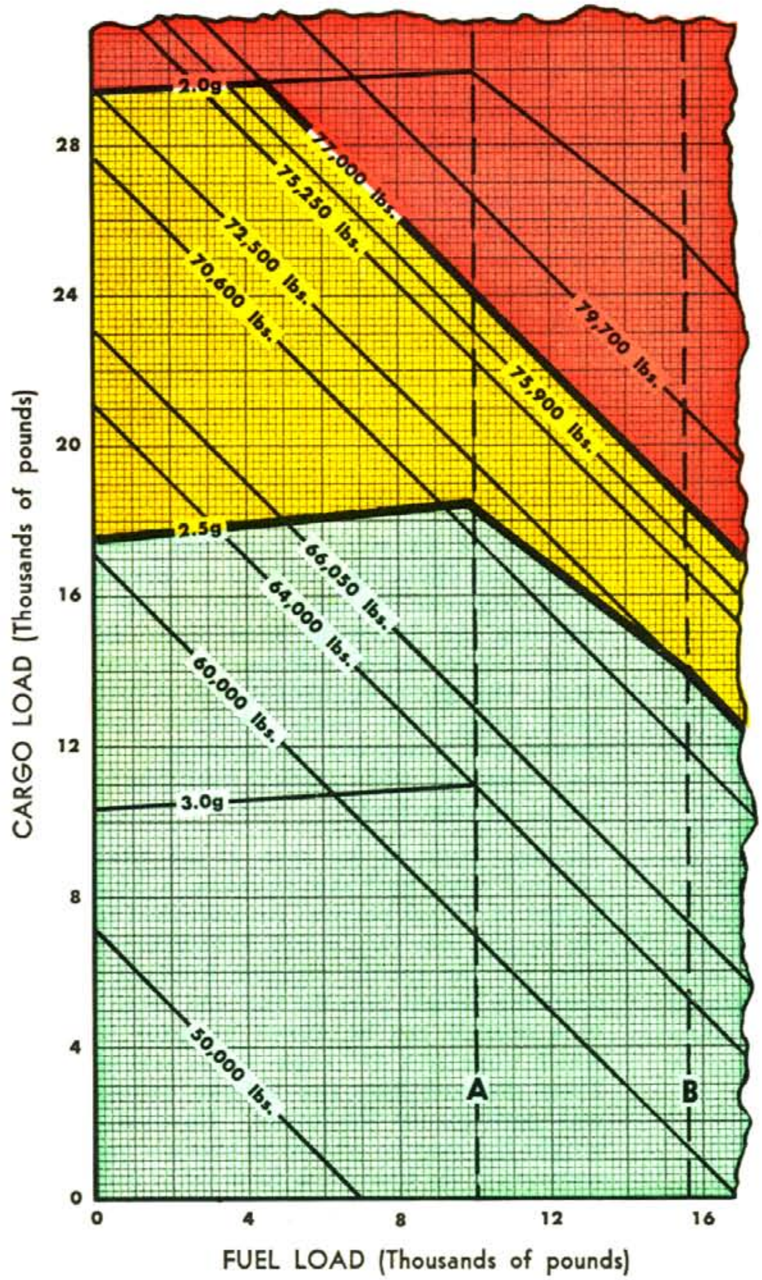
The gross weight of the airplane should never exceed that required for the mission, since unnecessary risk and wear of the equipment will otherwise result. Take-off gross weights must also be considered in light of available runways, surrounding terrain, altitude, atmospheric conditions, mission requirements, and the urgency of the mission.

WEIGHT LIMITATIONS Chart

BASIC OPERATING WEIGHT: 43,000 LBS.

Cargo Doors On

FUEL GRADE 115/145



64,000 lbs	Design gross weight. Load factor of 3.0g.
66,050 lbs	100 fpm R/C at S.L., hot day, feathered propeller, gear up, wing flaps 14°, maximum dry power (3100 BHP).
70,600 lbs	100 fpm R/C at S.L., hot day, feathered propeller, gear up, wing flaps 14°, maximum wet power (3340 BHP).
70,600 lbs	100 fpm R/C at S.L., hot day, feathered propeller, gear and flaps up, maximum dry power (3100 BHP)
72,300 lbs	Maximum landing weight at 12 fps ultimate sinking speed.
72,500 lbs	Marginal wing load factor of 2.5g with total wing fuel.
75,250 lbs	100 fpm R/C at S.L., hot day, feathered propeller, gear and flaps up, maximum wet power (3340 BHP).
75,900 lbs	100 fpm R/C at S.L., standard day, feathered propeller, gear and flaps up, maximum dry power (3250 BHP).
77,000 lbs	Landing gear and nacelle structural strength limitation for taxi and ground handling conditions.
79,700 lbs	100 fpm R/C at S.L., standard day, feathered propeller, gear and flaps up, maximum wet power (3500 BHP).
93,700 lbs	Maximum landing gross weight at 8 fps ultimate sinking speed.

WING FUEL LOADS

A—Outboard self-sealing tanks—9,996 lbs.
B—Total self-sealing tanks—15,540 lbs.

Recommended Loading
Cautionary Loading
Loading Not Recommended

WING LOAD FACTORS

3.0g	Design wing load factor.
2.5g	Marginal wing load factor
2.0g	Minimum wing load factor

Figure 5-4

WEIGHT LIMITATIONS Chart

BASIC OPERATING WEIGHT: 43,000 LBS.

Cargo Doors Off

FUEL GRADE 115/145

59,250 lbs	**100 fpm R/C at S.L., hot day, feathered propeller, gear up, wing flaps 14°, maximum dry power (3100 BHP).**
63,600 lbs	**100 fpm R/C at S.L., hot day, feathered propeller, gear up, wing flaps 14°, maximum wet power (3340 BHP).**
64,000 lbs	**Design gross weight. Load factor of 3.0g.**
64,400 lbs	**100 fpm R/C at S.L., hot day, feathered propeller, gear and flaps up, maximum dry power (3100 BHP).**
69,200 lbs	**100 fpm R/C at S.L., hot day, feathered propeller, gear and flaps up, maximum wet power (3340 BHP).**
69,700 lbs	**100 fpm R/C at S.L., standard day, feathered propeller, gear and flaps up, maximum dry power (3250 BHP).**
72,300 lbs	**Maximum landing gross weight at 12 fps ultimate sinking speed.**
73,000 lbs	**100 fpm R/C at S.L., standard day, feathered propeller, gear and flaps up, maximum wet power (3500 BHP).**
77,000 lbs	**Landing gear and nacelle structural strength limitation for taxi and ground handling conditions.**
93,700 lbs	**Maximum landing gross weight at 8 fps ultimate sinking speed.**

WING FUEL LOADS

A—Outboard self-sealing tanks—9,996 lbs.
B—Total self-sealing tanks—15,540 lbs.

WING LOAD FACTORS

3.0g	**Design wing load factor.**
2.5g	**Marginal wing load factor**
2.0g	**Minimum wing load factor**

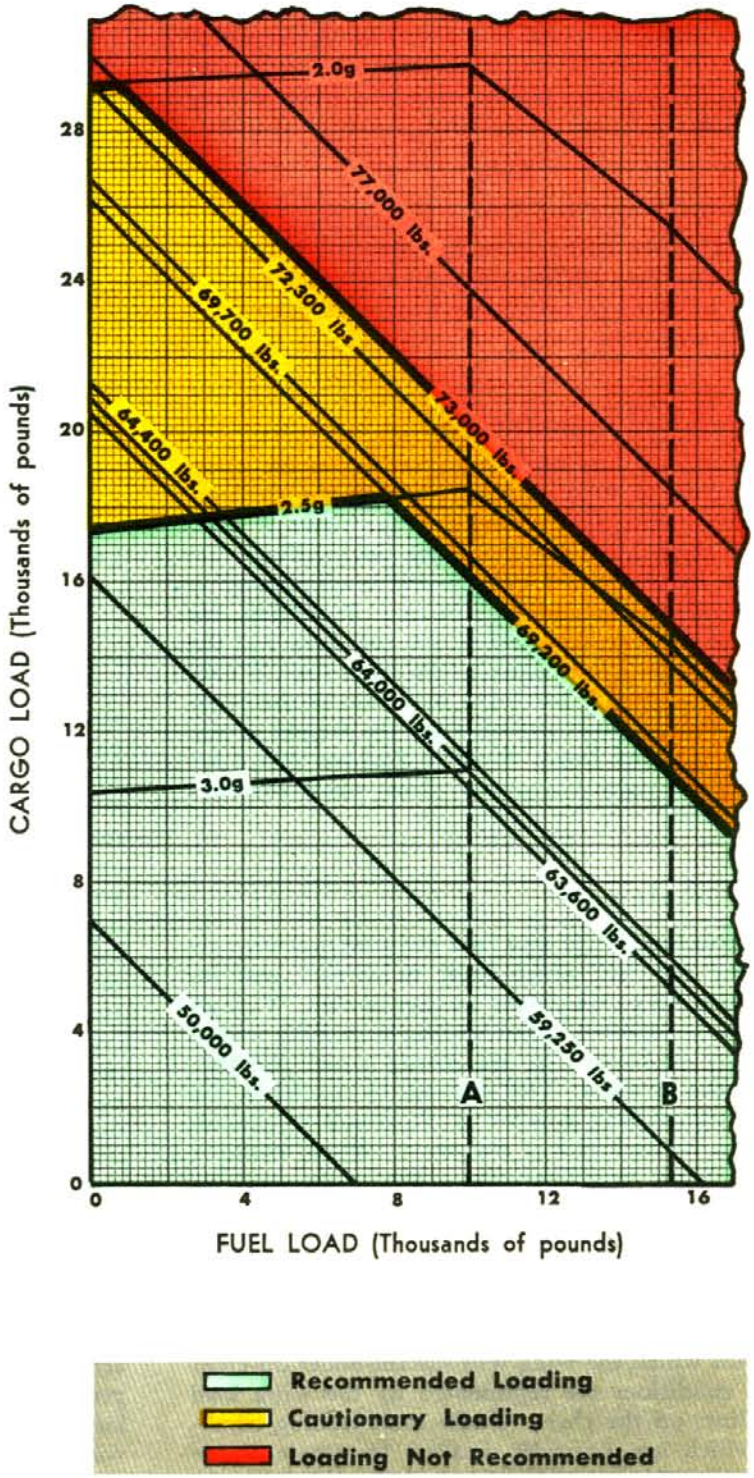


Figure 5-5

WING FUEL LOAD.

At the base of the chart along the horizontal axis, the weight of the fuel normally carried in the wing tanks is indicated in thousands of pounds. Although specific wing fuel markers are provided, any amount of fuel may be carried within the range indicated by the markers. However, as the load-carrying capability of the wing is greatest when the outboard tanks are full, it is desirable to retain fuel in the outboard tanks as long as possible. The fuel management sequence is designed to meet this condition, thus retaining the greatest possible wing load factor as long as possible.

Note

The wing load factor lines on the chart depend on the outboard tanks being filled first and used last. When the outboard tanks are not filled to capacity, the wing load factor lines will vary.

AUXILIARY FUEL LOAD.

When auxiliary fuel tanks are installed in the cargo compartment to increase the range of the airplane, the total weight of this fuel and the tanks is computed as cargo load. In computing the auxiliary fuel as cargo load, detailed chart work is eliminated as are individual calculations involved in adding the weight of the auxiliary fuel to the fuel load and the weight of the auxiliary tanks to the cargo load. Whenever auxiliary fuel is carried, a reduction in the cargo load is necessary to compensate for the weight of the auxiliary fuel and tanks. Refer to Problem No. 3 for use of the weight limitations chart when auxiliary fuel is carried.

CARGO LOAD.

In any mission, range and fuel consumption directly determine the fuel which must be carried, and indirectly the cargo which can be transported. With all wing fuel tanks filled, cargo loading is variable within the limits established by the strength and performance of the airplane. The payload, as carried in the cargo compartment, appears in thousands of pounds along the vertical axis of the chart. When auxiliary fuel is utilized to increase the range of the airplane, the combined weight of the fuel and tanks is computed as cargo load.

WING LOAD FACTORS.

The loads which the wing will sustain under different weight conditions are represented by the wing load factor lines on the chart. Under most loading conditions which are normally limited by single-engine performance, the margin of safety provided by the wing load factors is adequate. However, when flight through turbulent air is anticipated, the highest practical wing load factor is desirable.

Note in the chart that a reduction in the cargo load is necessary to maintain a constant wing load factor as the fuel load is increased beyond that normally carried in the outboard fuel tanks. The addition of fuel in the inboard tanks will not permit an increase in cargo weight without a reduction in the wing load factor resulting. If the cargo weight is increased, the bending moment of the wings increases rapidly and the capacity of the wings to sustain air loads decreases.

Note

The wing load factor lines on the chart are valid only when the fuel sequence (outboard fuel tanks used last) in FUEL MANAGEMENT, Section VII, is followed.

Note also that the 3.0g wing load factor line has been terminated at its intersection with the design gross weight diagonal rather than extended to the full outboard fuel line. This arrangement presents a continuous boundary of the area in which the operation of the airplane at the design gross weight of 64,000 pounds may be accomplished with a wing load factor of 3.0g.

LANDING GEAR AND NACELLE STRENGTH.

The landing gear structure is designed for normal landings at a gross weight of 64,000 pounds. However, tests have proven the gear will withstand a landing gross weight of 72,300 pounds at a contact sinking speed of 12 feet per second ultimate. Extrapolation of this data indicates the landing gear will withstand a landing gross weight of 93,700 pounds at a contact sinking speed of 8 feet per second ultimate. The brakes are satisfactory for continuous operation with reverse pitch propellers at 64,000 pounds and one refused take-off at 74,000 pounds gross weight. As shown on the chart, the 72,300 pounds landing gross weight is only slightly less than the limitation imposed by single-engine performance. However, the landing gear load limitation is not critical except in the case of an aborted mission. Even then, the reserve strength of the airplane at a contact sinking speed of 8 feet per second will allow the landing to be accomplished without danger of structural failure if extra precaution is taken to assure simultaneous and even contact of both main gears. Nacelle and boom strength is of such proportion that it will adequately withstand the landing and taxiing loads outlined above in the discussion of landing gear strength. The maximum gross weight for taxiing and ground handling conditions is 77,000 pounds with zero wing lift acting. An analysis of the main landing gear axles has shown the axles capable of sustaining loads imposed in turning at this gross weight. Likewise, static tests indicate the nose gear to be capable of sustaining loads imposed by asymmetrical braking at a gross weight of 77,000 pounds.

PERFORMANCE LIMITATIONS.

In the case of two-engine airplanes, it is generally inherent that performance rather than structural limitations restrict the weight which the airplane can carry. Obviously, the gross weight must necessarily be limited by the ability of the airplane to take off within available runway length and clear any obstacles. But the primary consideration is the ability of the airplane to fly with partial power. Single-engine performance, then, is the major restrictive factor in the loading of the airplane. Note the gross weight lines on the charts, particularly those which separate the loading areas. Each of these lines defines a specific limitation and several of the lines are wholly performance limitations. These performance limitations are based on the gross weight at which an adequate rate-of-climb can be maintained under various conditions of power, temperature, and configuration.

Note

> The weight limitations charts are based on airplane performance at sea level when 115/145 fuel is used. Reference to the various charts in the Appendix will indicate the performance of the airplane as affected by altitude, non-standard atmospheric conditions, and the use of alternate (100/130) grade fuel.

POWER LOSS AND PERFORMANCE.

In two-engine airplanes, the effect of an engine failure on airplane performance is immediate. The loss of half the total thrust normally developed by both power plants and the asymmetric power condition which results produce a marked decrease in the rate-of-climb. The significance of gross weight and configuration immediately becomes apparent, for the airplane with partial power is unable to maintain an adequate rate-of-climb at high gross weights or in configuration where the landing gear and wing flaps are extended. Power losses due to temperature, humidity, and engine deficiency exert a considerable influence on the rate-of-climb even when both engines are operating. It is not difficult to visualize the effect which engine failure will produce on the rate-of-climb, but it is interesting to note the remarkable difference in airplane performance resulting from a rise in temperature and a corresponding fall in air density. As the weight limitation charts illustrate, the difference between a standard day (15°C at sea level) and a hot day (38°C at sea level) requires a considerable reduction in the cargo load to maintain a 100-fpm rate-of-climb. This reduction reflects the loss in the power output of the engine due to the increase in carburetor air temperature. Naturally, variations of temperature and altitude within this range will give similarly graduated values in brake horsepower and rate-of-climb. The effect of humidity and engine deficiency on brake horsepower and, ultimately, the gross weight at which the airplane may be operated, has not been included in the weight limitations chart because of the extreme number of variable conditions involved. However, the effect of altitude and non-standard conditions is thoroughly examined in the Brake Horsepower Correction Curves and the Limit Take-Off Gross Weight Curves, Appendix I.

Limiting gross weights are supplied for both wet and dry take-off power ratings of the engine which, under standard sea level conditions, develops 3500 BHP when the water injection system is used and 3250 BHP when water is not combined with the fuel/air mixture. On the basis of these criteria, two different designations of the loading areas are required. The weight limitation charts, themselves, illustrate the loading areas as defined by performance at maximum wet power. The loading area limits which apply when maximum dry power is used are indicated in the legend accompanying each chart.

CONFIGURATION AND PERFORMANCE.

The configuration of the airplane also imposes a penalty on performance. In other than clean configurations, the increase in drag produces a decrease in the rate-of-climb and requires a readjustment of the gross weight at which the airplane may be operated. As with power losses, this condition is most critical at take-off when, of necessity, the landing gear is extended, the cowl flaps and oil cooler flaps are open, and the wing flaps at 14° deflection. The effect of the drag produced by the wing flaps is indicated on the weight limitations chart by the gross weights at which airplane performance with one engine inoperative on a hot day will maintain a rate-of-climb of 100 feet per minute. Note that a reduction in the gross weight is required to maintain the rate-of-climb when the wing flaps are used for take-off.

Operation of the airplane with the rear cargo doors removed poses an additional problem performance-wise, as the corresponding increase in drag produces a significant decrease in the rate-of-climb. The new power available-power required calculations necessitated by the increase in drag adversely affect the rate-of-climb and, consequently, reduce the gross weight limits. The weight limitations which apply when the airplane is operated with the rear cargo doors removed are given in Figure 5-5. Compare these gross weight limits with those of the preceding chart, Figure 5-4, which reflects the performance with the cargo doors attached. It can readily be seen that a reduction in the gross weight is required when the performance of the airplane in each configuration is equated for a given set of criteria.

PROPELLER EFFICIENCY AND PERFORMANCE.

Some work done by the engine is lost in the slipstream of the propeller and in the production of noise which cannot be converted into thrust horsepower. Consequently, the thrust horsepower will necessarily be less than the torque horsepower which the engine delivers to the propeller. The efficiency of the propeller is the ratio of the thrust horsepower to the torque horsepower. This efficiency is dependent mainly upon the construction of the propeller blade and the tip speed or velocity at which the tips of the propeller blades strike the air. As the tip speed approaches the speed of sound, the efficiency of the propeller decreases as does the thrust horsepower. On both the C-119F and C-119G airplanes incorporating R3350-85-89 engines, the maximum engine rpm permitted at take-off power is 2900 rpm; however, the construction of the propeller installed on C-119G airplanes is such that a greater thrust horsepower is obtained. Naturally, this is reflected in the rate-of-climb and, ultimately, the maximum gross weight at which the airplane can be operated with a 100 fpm rate-of-climb. The key, then, to the varying weight limitations among the different models of the C-119 incorporating R3350 engines is performance as affected by propeller efficiency.

LOADING AREAS.

Some idea of the direct relationship between weight limitations and performance limitations may be obtained from the discussion of the loading areas in the paragraphs which follow.

Note

These loading areas designated on the charts themselves are based on maximum wet power. The loading areas when redefined on the basis of maximum dry power are indicated in legend accompanying each chart.

RECOMMENDED LOADING AREA.

The green area on the charts represents the loading conditions that present no particular problem in regard to strength or performance of the airplane. Operation of the airplane at weights outside this recommended loading area should be avoided unless the dictates of the mission require it. The green area on the cargo-doors-on chart is limited by the 2.5g wing load factor line. With a full fuel load, the 2.5g wing load factor line falls along the gross weight diagonal defining 72,500 pounds. On the weight limitations chart for the cargo-doors-off configuration, the green area is limited by the 2.5g wing load factor line and the gross weight diagonal (69,200 pounds) which indicates a rate-of-climb of 100 feet per minute at sea level on a hot day with one propeller feathered, gear and flaps up, and maximum wet power on the operative engine.

CAUTIONARY LOADING AREA.

The yellow area on the charts represents loadings of progressively increasing risk as the red area is approached. Caution must be exercised because single-engine performance at these gross weights is marginal depending upon configuration, altitude, and ambient air temperature. The cautionary loading area on the cargo-doors-on chart is limited by the 2.0g wing load factor line and the gross weight diagonal (77,000 pounds) which is a landing gear structural limitation. On the weight limitations chart for the cargo-doors-off configuration, the yellow area is limited by the 2.0g wing load factor line and the gross weight diagonal (73,000 pounds) which indicates a rate-of-climb of 100 feet per minute at sea level on a standard day with one propeller feathered, gear and flaps up, and maximum wet power on the operative engine.

LOADING NOT RECOMMENDED.

Note

Whenever flights are conducted at weights shown in the red area of the chart, entry of this fact in AF Form 1 is required.

The red area represents loadings which are not recommended because the margin of safety from the standpoint of both performance and structural limitations is something less than the most desirable or the best practical. Under conditions of extreme emergency when safety of flight is of secondary importance, the Commanding Officer will determine if the degree of risk warrants operation of the airplane at gross weights appearing in the red zone.

USING THE CHART.

Three sample problems, the solutions of which are obtained through the use of the weight limitations chart for cargo doors on, Figure 5-4, appear below. Note that the basic operating weight of the airplane is assumed to be 43,000 pounds. Should the basic operating weight of a specific airplane under consideration differ from the basic operating weight of the chart, refer to Problem No. 2 which has been designed to illustrate the solution of just such a problem. The third problem is included to demonstrate the use of the chart in computing cargo load when auxiliary fuel and tanks are carried in the cargo compartment. In each case the problems below have been based on arbitrarily selected gross weights. As such, they represent neither recommended nor maximum cargo loads, and have been selected for the sake of convenience to illustrate the use of the weight limitations chart. Should the mission require the use of the equipment drop system, Figure 5-5 is used to reflect cargo-doors-off performance. Calculations of the weight problems are identical in either case.

PROBLEM NO. 1:

What is the cargo load which can be transported and dropped by a C-119G airplane to support an airborne assault force, if the fuel required to complete the mission is approximately 1200 gallons?

SOLUTION:

With the range of the target established, the amount of fuel required to complete the mission can be computed and converted to weight in pounds. Using 6 pounds per gallon as the fuel conversion factor, the weight of the fuel is calculated to be 7200 pounds. Locate this fuel load along the horizontal axis of the weight limitations chart and proceed vertically from that point until the diagonal defining the design gross weight (64,000) of the airplane is reached. From this point at which the fuel weight line and the design gross weight diagonal intersect, move directly across to the cargo load on the vertical axis of the chart. Note that a weight of 13,800 pounds may be carried in the cargo compartment under these conditions. If, however, the exigency of the situation so demands, the limitation imposed by the 2.5g wing load factor may be waived, and the line from the fuel weight of 7200 pounds extended to the point at which it intersects the gross weight diagonal indicating 75,250 pounds. Proceeding left from this point, note that a load of 25,050 pounds may be carried in the cargo compartment under these conditions.

PROBLEM NO. 2:

What is the cargo load which can be transported and dropped to supply an airborne assault force if the basic operating weight of the C-119G airplane is 44,000 pounds and the fuel required to complete the mission is 2000 gallons?

SOLUTION:

The only major difference in this problem and the preceding one is the increase in the basic operating weight of the airplane. Although the weight limitations charts are based on a basic operating weight of 43,000 pounds, it will suffice for airplanes of the same model but which possess a different basic operating weight. As in the solution above, convert the 2000 gallons of fuel to 12,000 pounds and move vertically along the 12,000 pound fuel line to the design gross weight diagonal directly above. Upon interpolation. this point indicates that a cargo load of 9,000 pounds may be transported. When the sum of the airplane's operating weight (44,000), the wing fuel load (12,000) and the cargo load (9,000) is obtained, the total weight exceeds that of the design gross weight (64,000). As the basic operating weight and the fuel load are unalterable because of the requirements of the mission, a suitable adjustment in the cargo load is necessary to assure operation at the design gross weight. A reduction of 1000 pounds from the cargo load, then, must be accomplished to bring the gross weight of the airplane to a figure (64,000) commensurate with the design gross weight of the airplane. In effect, when the basic operating weight of the airplane exceeds that on which the weight limitations chart is based, the additional weight is designated as cargo load and must be subtracted from that cargo load value derived from the chart for any given fuel load. If, as before, the urgency of the mission demands that the limitation imposed by the 2.5g wing load factor be disregarded, proceed along the 12,000 pound fuel weight line until the gross weight diagonal indicating 75,250 pounds is reached. Reading left, a cargo load of 20,250 pounds is obtained which, when added to the basic operating weight (44,000) and fuel load (12,000), exceeds the gross weight limit of 75,250 pounds. In order that the gross weight may be kept within 75,250 pounds, an adjustment of 1000 pounds in the cargo load is necessary to compensate for the increase in the basic operating weight of the airplane. The actual cargo load which may then be carried is 19,250 pounds.

PROBLEM NO. 3:

What is the cargo load which can be transported by a C-119G airplane if the wing and auxiliary fuel tanks are filled to capacity and the basic operating weight of the airplane is 43,000 pounds?

SOLUTION:

The total fuel load which may be carried in the wing tanks is 15,540 pounds. Proceed upward on the chart along the wing fuel line for this value until the gross weight diagonal indicating 75,250 pounds is reached. Reading directly left, a cargo load of 16,710 pounds is obtained. However, the weight of the auxiliary fuel and tanks being carried in the cargo compartment is approximately 6,300 pounds. The actual cargo load which may then be carried is 10,410 pounds.

When auxiliary fuel is carried and operation at higher gross weights are required, proceed as in the problems above. Likewise, simply adapt the above method to those problems which contain an operating weight of the airplane different from that on which the chart is based.