AN 01-60FFB-

FLIGHT HANDBOOK

USAF SERIES
T-6D
AIRCRAFT

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE AND THE CHIEF OF THE BUREAU OF AERONAUTICS.

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5 MARCH 1953

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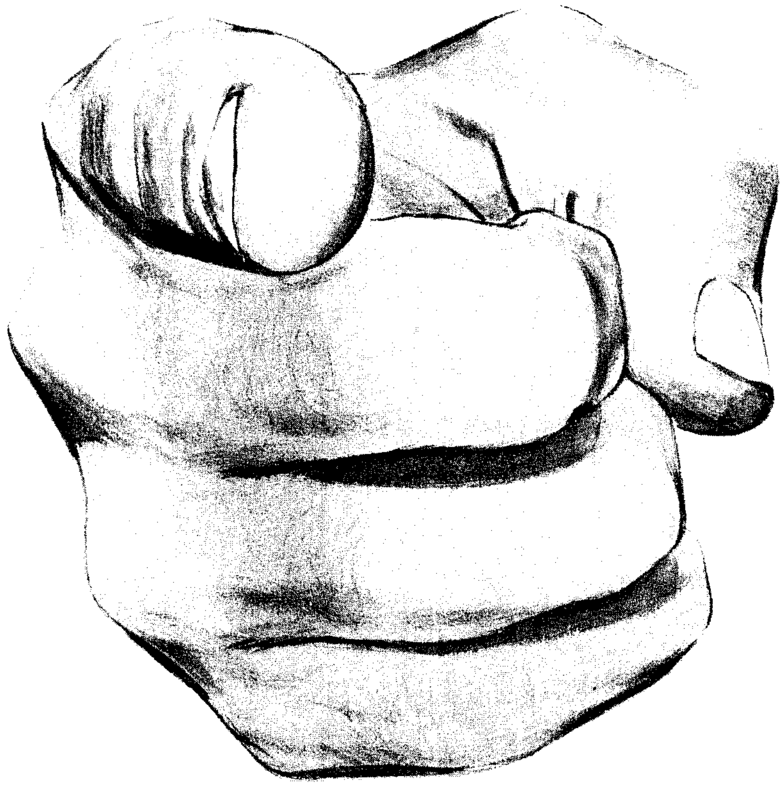


DON'T

READ THIS BOOK

without first reading these two pages

This handbook contains all information necessary for safe and efficient operation of the T-6D Airplane. These instructions are not intended to teach the basic principles of flight, but are designed to provide you with a general knowledge of this airplane, its flight characteristics, and specific normal and emergency procedures to be used in operating the airplane and its related equipment.

The only source of technically accurate and constantly current information is contained in your Flight Handbook. These instructions are based on the best technical knowledge of the aircraft manufacturer and the Air Force as well as the experience of the using commands. Every effort has been made to make the handbook easy to read and assimilate. Read and study the complete book for an over-all picture of the airplane; use it as a reference manual to answer specific questions. The Flight Handbook will be continuously revised to reflect each change that is made on the airplane. Your comments concerning any data to be added or suggested changes are invited.

Every pilot is entitled to his own personal copy of the Flight Handbook. The Air Inspector at your base will provide you with your handbook and keep it up-to-date. The information in this handbook is kept current throughout the life of the airplane by frequent revisions. Since the incorporation of this revision material takes time, it is imperative that you stay abreast of the short Technical Orders of the 01-60FF series, which frequently cover critical flight restrictions or new operating techniques not yet incorporated in the handbook.

The handbook is divided into nine sections and an appendix as follows:

Section I, DESCRIPTION—a detailed picture of the airplane, its equipment, systems, and all controls that are essential to flight. Also included is a description of all emergency equipment that is not part of the auxiliary equipment.

Section II, NORMAL PROCEDURES—operating instructions arranged in proper sequence from the time the airplane is approached by the pilot until it is left parked on the ramp after completion of a routine flight.

Section III, EMERGENCY PROCEDURES—concise instructions to be followed in meeting any emergency (except those in connection with auxiliary equipment) that could reasonably be expected.

Section IV, DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT—description of, and normal and emergency operating instructions for, all equipment not essential for flying the airplane, such as heating, ventilating, communication, lighting, oxygen, and armament.

Section V, OPERATING LIMITATIONS—covers all important limitations that must be observed during normal operation. Some limitations that are covered along with specialized phases of operation are not included in this section.

Section VI, FLIGHT CHARACTERISTICS—advantageous as well as any dangerous flight characteristics are summarized. Complete descriptions of stalls, spins, dives, and recovery techniques are emphasized to cover all phases of basic maneuvers.

Section VII, SYSTEMS OPERATION—a discussion of the operation and characteristics of the various systems of the airplane as they are affected by normal flight conditions such as varying altitude and air temperature. Emphasis has been given to those special problems which must be considered in the operation of a system.

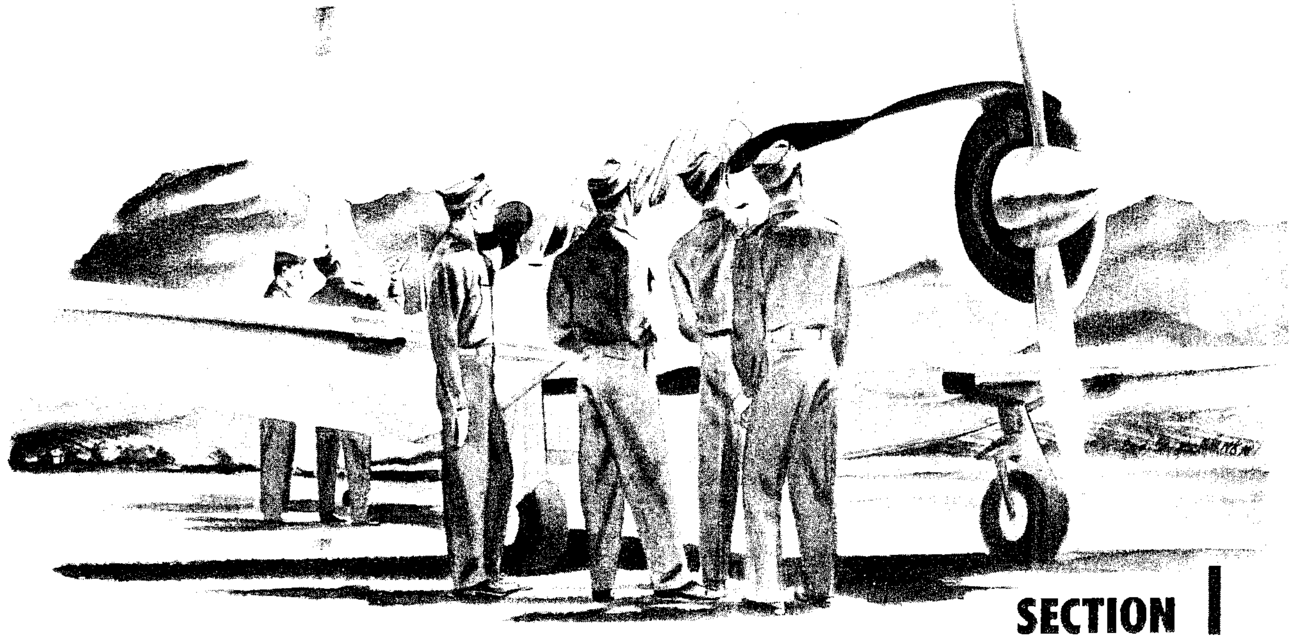
Section VIII, CREW DUTIES—omitted as not applicable to this airplane.

Section IX, ALL-WEATHER OPERATION—proper technique and procedure to follow under various weather conditions. This section is designed to serve as a supplement to normal operating procedures and provides all necessary instructions to be followed, in conjunction with the procedures contained in Section II, for satisfactory all-weather operation.

Appendix I, OPERATING DATA—all operating data charts for efficient preflight and in-flight mission planning. Complete data is supplied for obtaining best climb speeds, necessary cruise control information, and take-off and landing distances at various field altitudes.

Figure 1-1

DESCRIPTION



SECTION I

AIRPLANE.

Few airplanes in this country are more familiar to military pilots than the T-6. In addition to training our own Air Force, Navy, and Marine pilots in precision flying, the T-6 is used in the Air Forces of a majority of the United Nations. More than 15,000 of the T-6 Series Airplanes have been built, and most of them are still in active service.

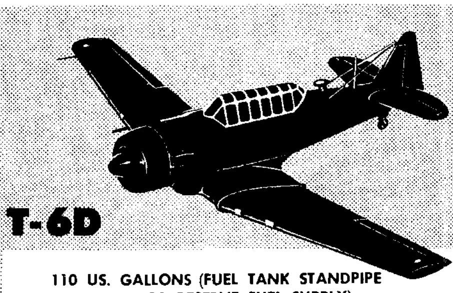
The T-6 (formerly the AT-6), which is designated the SNJ by the Navy and is known by a host of other names in the Air Forces of the world, is an outgrowth of the NA-16, the prototype of the entire series of famed training planes. The NA-16 was the first airplane designed and built by North American Aviation. It took off from Logan Field at Dundalk, Maryland, in 1934 after being designed and built in less than 9 weeks.

The T-6D, the fourth in the T-6 series, is essentially the same airplane as the original T-6. Its career began in 1940 when the first model rolled off the North American assembly lines. Known as the "Texan," it helped teach thousands of American and Allied pilots their flying ABC's during World War II. Today, the T-6 is still in the forefront of training pilots to defend America. Its flying, maintenance, and training qualities have proved so impressive that even these many years after it was first built, the T-6 is still teaching men throughout the world to fly a military airplane. The airplane is a two-place, dual-controlled, single-engine trainer. (See figure 1-3.) Solo flight is permitted only from the front cockpit because of restricted visibility from the rear seat and inadequate controls in the rear cockpit. On training flights, the student uses the front cockpit while the instructor occupies the rear, except for instrument training, during which the student occupies the rear seat. Provisions for armament—which consist of bombing equipment, a flexible gun in the rear cockpit, a wing gun, and a cowl gun—are incorporated in all airplanes. The airplane also incorporates a steerable tail wheel. The main differences between the T-6D Airplane and the T-6G Airplane are outlined in figure 1-2.

AIRPLANE DIMENSIONS.

Approximate over-all dimensions of the airplane are:

- Length ....29.0 feet
- Wing span ....42.0 feet
- Height (to top of rudder in level-flight attitude) ....13.0 feet




	T-6D	T-6G
FUEL CAPACITY	110 US. GALLONS (FUEL TANK STANDPIPE PROVIDED FOR RESERVE FUEL SUPPLY)	140 US. GALLONS (NO PROVISIONS FOR RESERVE FUEL SUPPLY)
ELECTRONICS	AN/ARC-3, AN/AIC-2, AN/ARN-7, RC-193A.	SCR-522A, CONTRACTOR-DESIGNED INTERPHONE (PART OF SCR-522A), AN/ARC-3, AN/ARN-6, USAF COMBAT INTERPHONE, AN/ARN-12, PROVISIONS FOR AN/ARN-5A, AN/ARA-26, AND RC-103A
REAR COCKPIT INSTRUMENTS	FLIGHT INSTRUMENTS ONLY ARE IDENTICAL TO THOSE IN FRONT COCKPIT.	FULL COMPLEMENT OF INSTRUMENTS IDENTICAL TO THOSE IN FRONT COCKPIT, EXCEPT HYDRAULIC PRESSURE GAGE.
ARMAMENT	TWO FIXED FORWARD-FIRING .30-CALIBER GUNS, BOMBING EQUIPMENT, ONE FLEXIBLE .30-CALIBER GUN (PROVISIONS)	NONE
HYDRAULIC SYSTEM	ACTUATED BY POWER CONTROL LEVER IN EITHER COCKPIT	ACTUATED AUTOMATICALLY BY GEAR OR FLAP CONTROL HANDLE
OXYGEN SYSTEM	HIGH-PRESSURE SYSTEM (EARLY AIRPLANES) LOW-PRESSURE (DEMAND) SYSTEM (LATE AIRPLANES)	NONE

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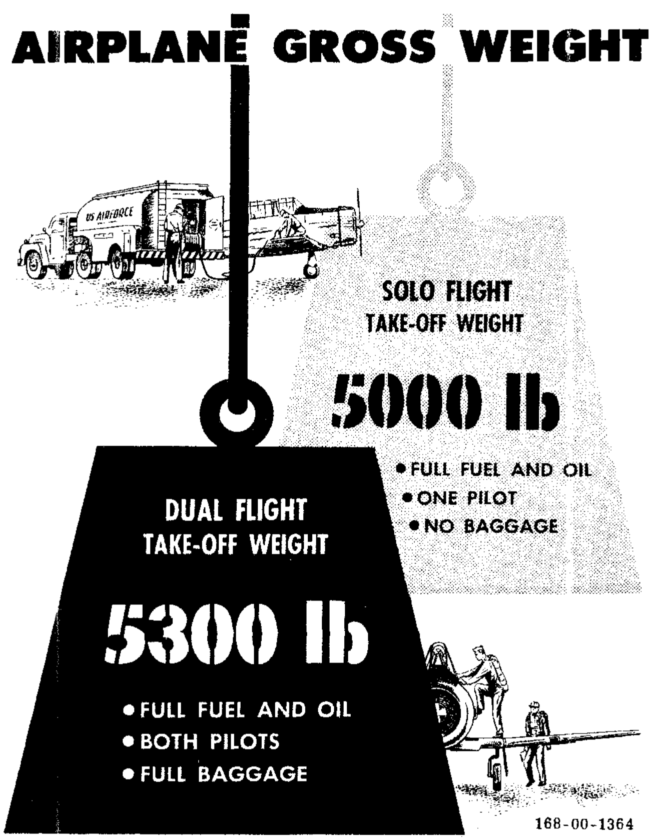
Figure 1-2. Main Difference Table



GENERAL ARRANGEMENT

GENERAL ARRANGEMENT

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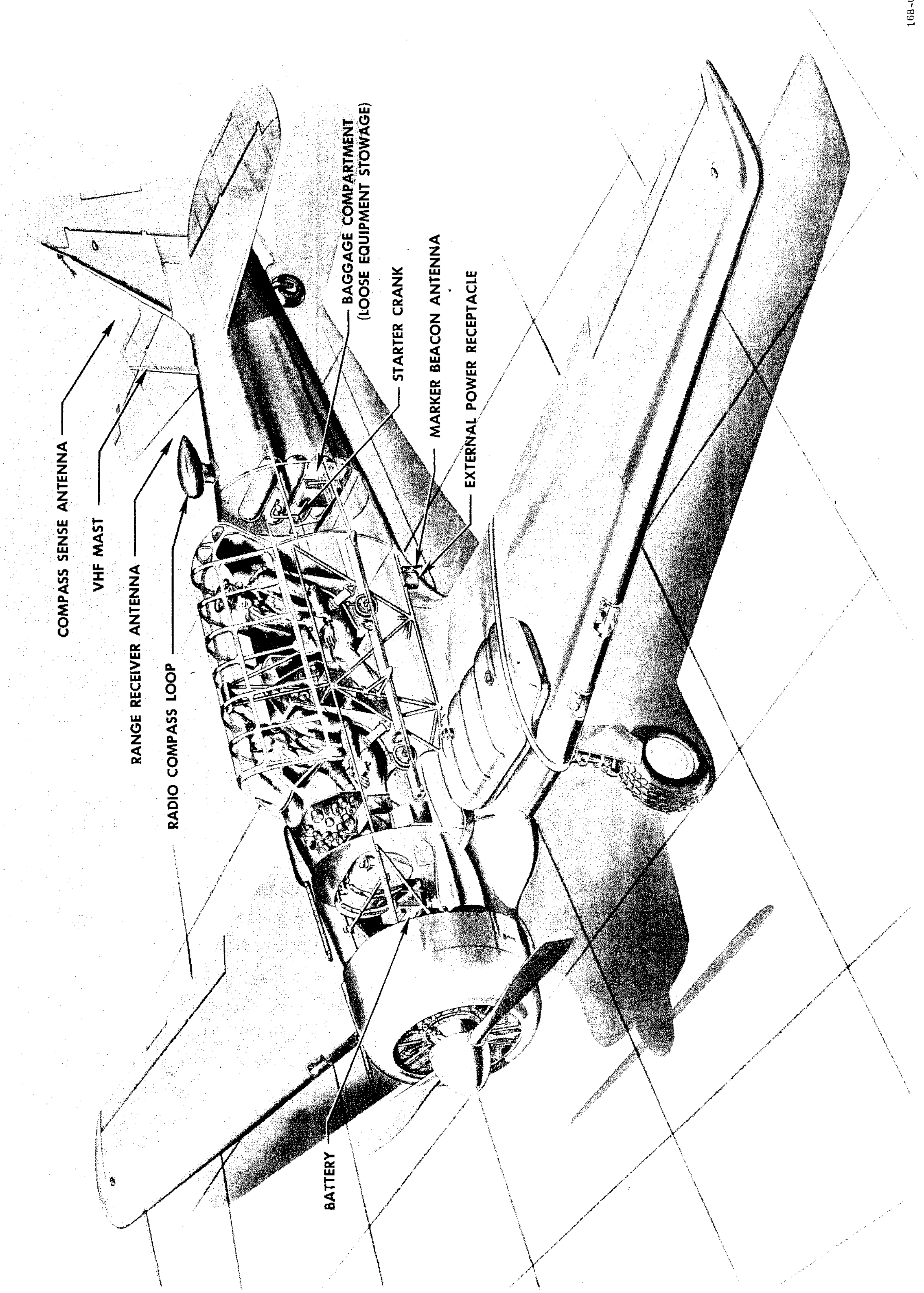
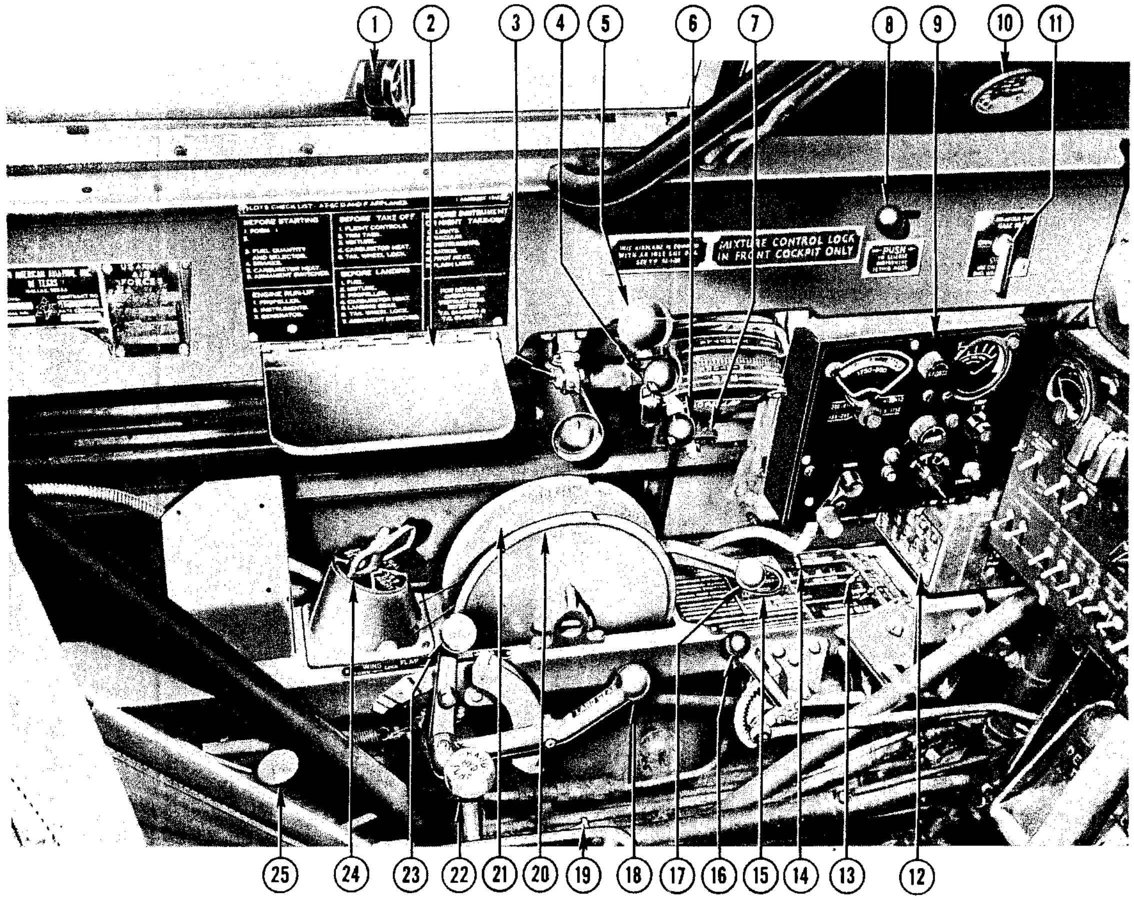


Figure 1-3



FRONT COCKPIT LEFT SIDE

1. Canopy Handle
2. Armrest
3. Cockpit Light Control Knob
4. Mixture Control
5. Throttle
6. Propeller Control
7. Throttle Quadrant Friction Lock
8. Instrument-flying Hood Release Handle
9. Radio Compass Control Panel
10. Free Air Temperature Gage
11. Manifold Pressure Gage Drain Valve Handle
12. Circuit Breakers
13. Landing Gear Position Indicators
14. Wing Flap Position Indicator
15. Hydraulic Pressure Gage
16. Carburetor Air Control Handle
17. Hand Fuel Pump Handle
18. Landing Gear Handle
19. Shoulder Harness Lock Handle
20. Elevator Trim Tab Control Wheel
21. Rudder Trim Tab Control Wheel
22. Hydraulic Hand-pump Handle
23. Wing Flap Handle
24. Fuel Selector
25. Hydraulic Power Control Lever

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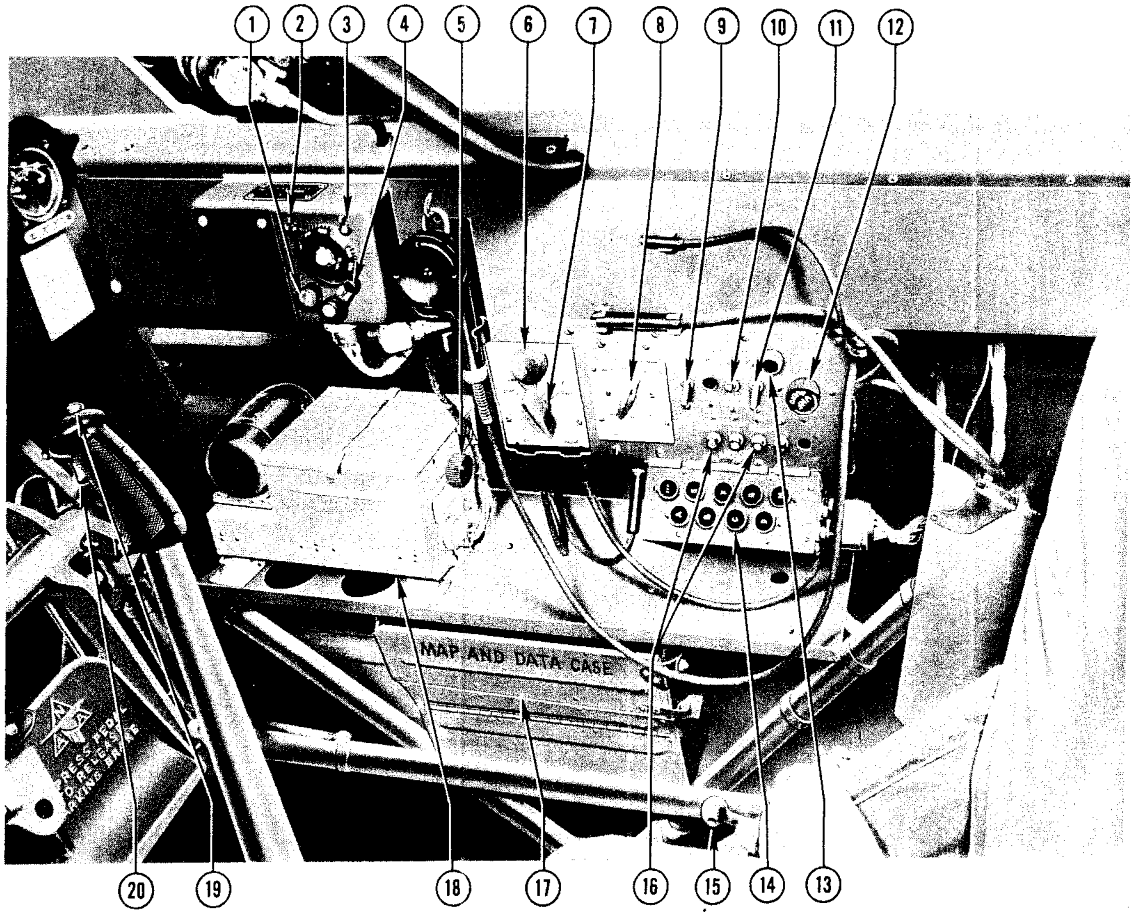
Figure 1-4



1. Range Receiver Volume Control
2. Range Receiver A-B Switch
3. Range Receiver Power Switch
4. Range Receiver Tuning Crank
5. Interphone Amplifier Altitude Compensation Switch
6. Master Volume Control Knob
7. Master Selector Switch
8. Radio Range Filter Switch
9. VHF Audio Switch
10. Range-Volume Switch
11. VHF Control Transfer Switch
12. VHF Audio Control Knob
13. VHF Control Indicator Light
14. VHF Channel Selector Buttons
15. Seat Adjustment Lever

FRONT COCKPIT RIGHT SIDE

16. Circuit Breakers
17. Map and Data Case
18. Interphone Amplifier
19. Bomb Release Button
20. Gun Trigger

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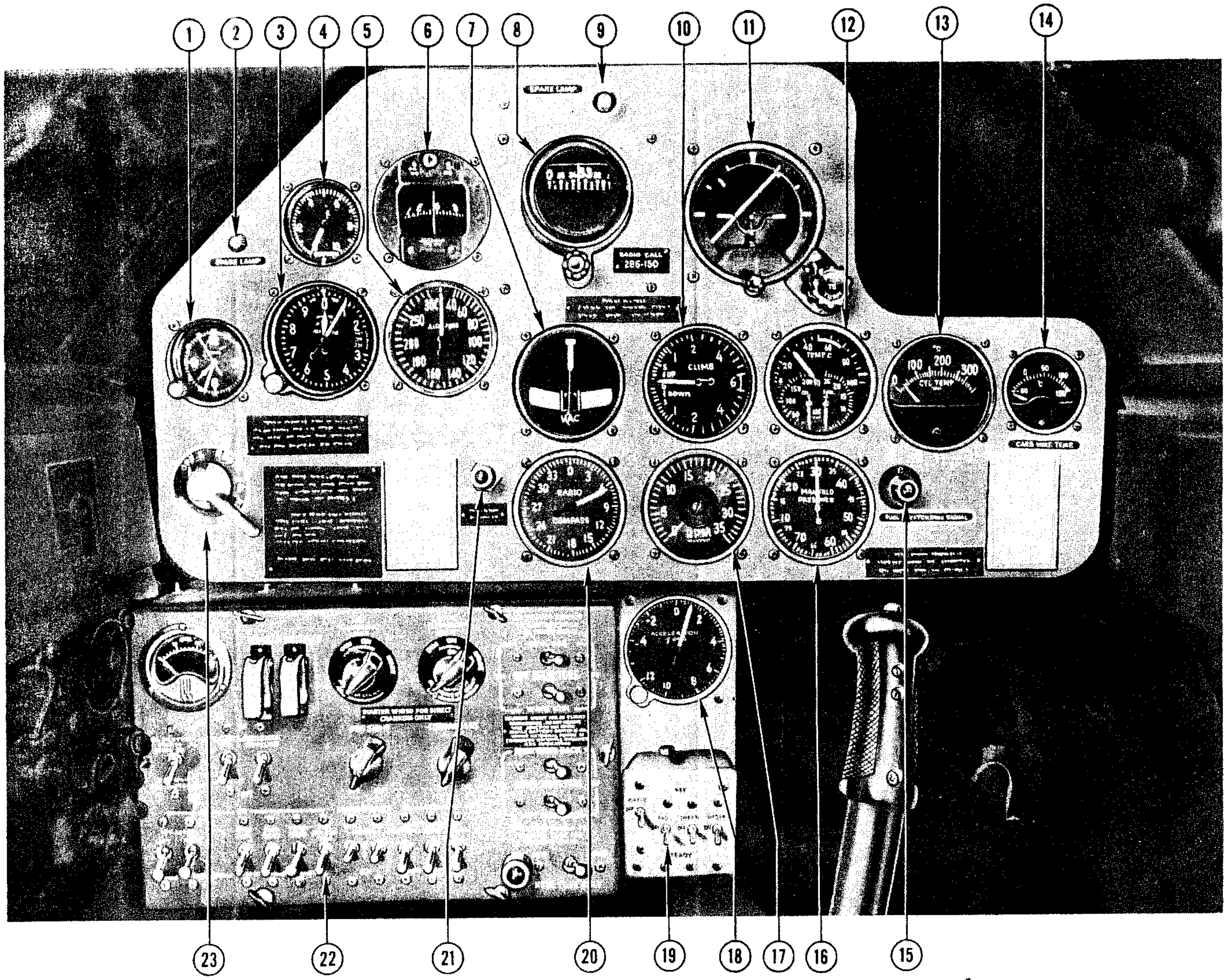
Figure 1-5



1. Clock
2. Spare Lamp
3. Altimeter
4. Suction Gage
5. Airspeed Indicator
6. Magnetic Compass
7. Turn-and-Bank Indicator
8. Directional Gyro
9. Spare Lamp
10. Rate-of-Climb Indicator
11. Gyro Horizon
12. Engine Gage Unit
13. Cylinder Head Temperature Gage
14. Carburetor Mixture Temperature Gage
15. Fuel Switch-over Signal Light
16. Manifold Pressure Gage
17. Tachometer
18. Accelerometer (Some Airplanes)
19. Recognition Light Switches
20. Radio Compass Indicator
21. Marker Beacon Signal Light
22. Instrument Subpanel
23. Ignition Switch

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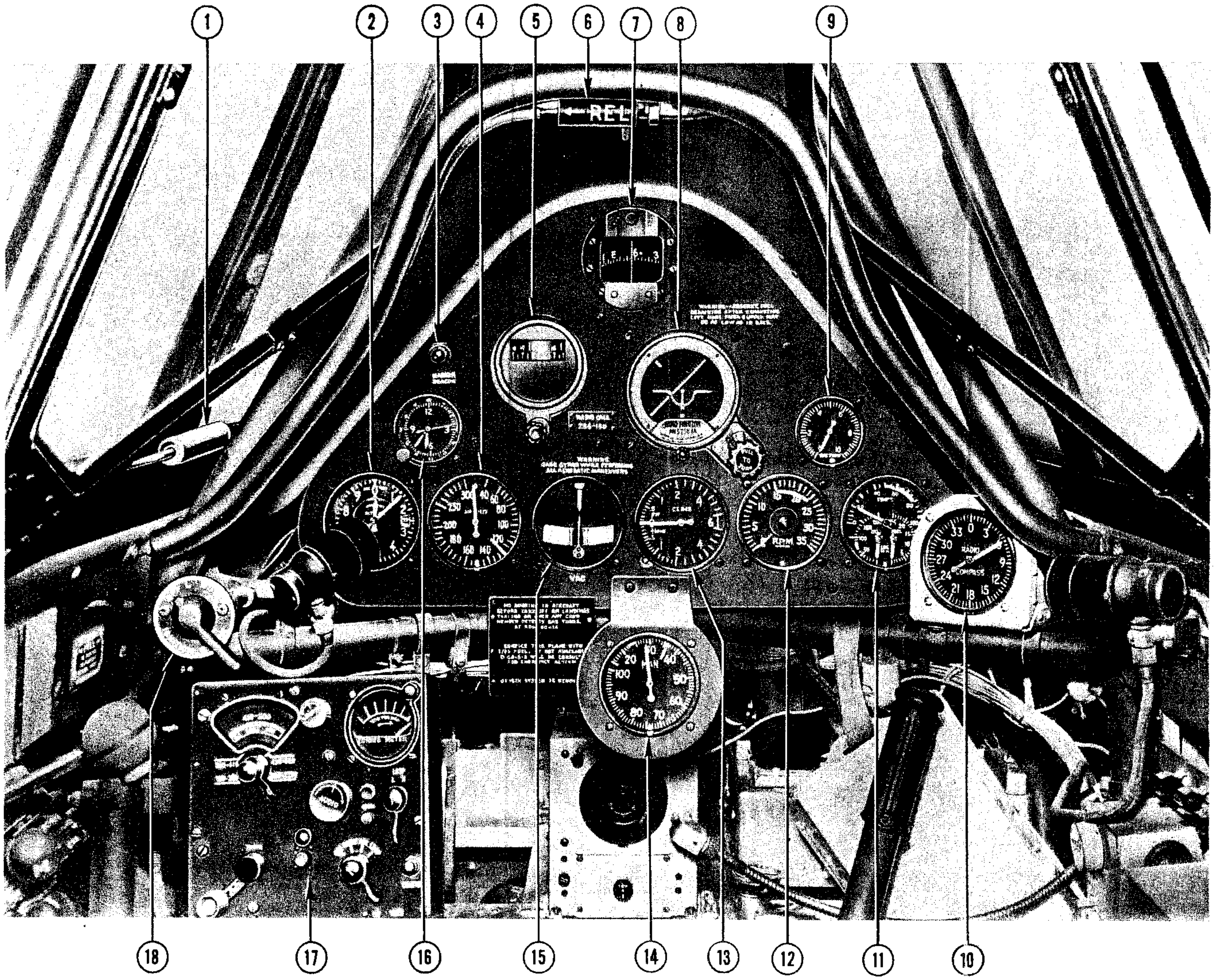
Figure 1-6



1. Canopy Handle
2. Altimeter
3. Marker Beacon Signal Light
4. Airspeed Indicator
5. Directional Gyro
6. Instrument-flying Hood Latch
7. Magnetic Compass
8. Gyro Horizon
9. Suction Gage
10. Radio Compass Indicator
11. Engine Gage Unit
12. Tachometer
13. Rate-of-Climb Indicator
14. Manifold Pressure Gage (Some Airplanes)
15. Turn-and-Bank Indicator
16. Clock
17. Radio Compass Control Panel
18. Ignition Switch

REAR COCKPIT FORWARD VIEW

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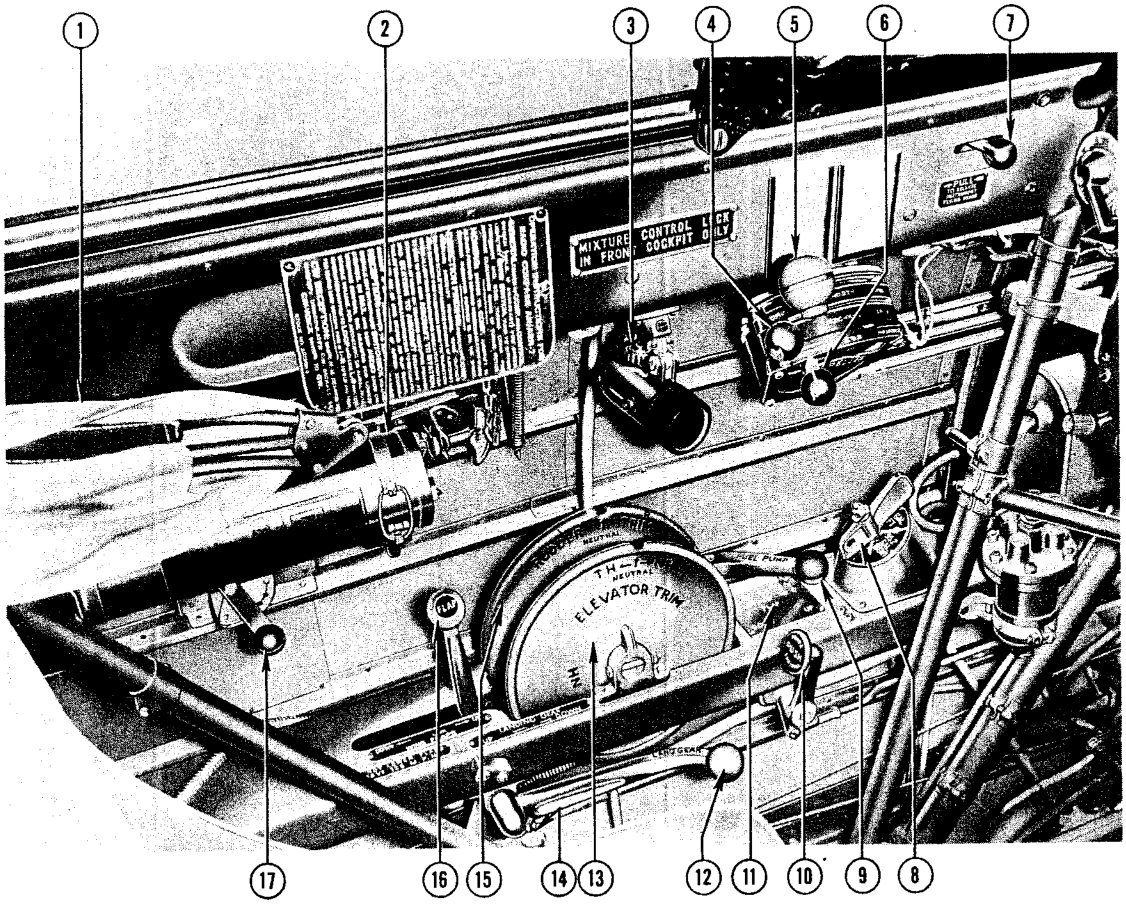
Figure 1-7



REAR COCKPIT LEFT SIDE

1. Instrument-flying Hood
2. Fire Extinguisher
3. Cockpit Light Control Knob
4. Mixture Control
5. Throttle
6. Propeller Control
7. Instrument-flying Hood Release Handle
8. Fuel Selector
9. Hand Fuel Pump Handle
10. Hydraulic Power Control Lever
11. Wing Flap Position Indicator (Some Airplanes)
12. Landing Gear Handle
13. Elevator Trim Tab Control Wheel
14. Shoulder Harness Lock Handle
15. Rudder Trim Tab Control Wheel
16. Wing Flap Handle
17. Ventilating-air Handle

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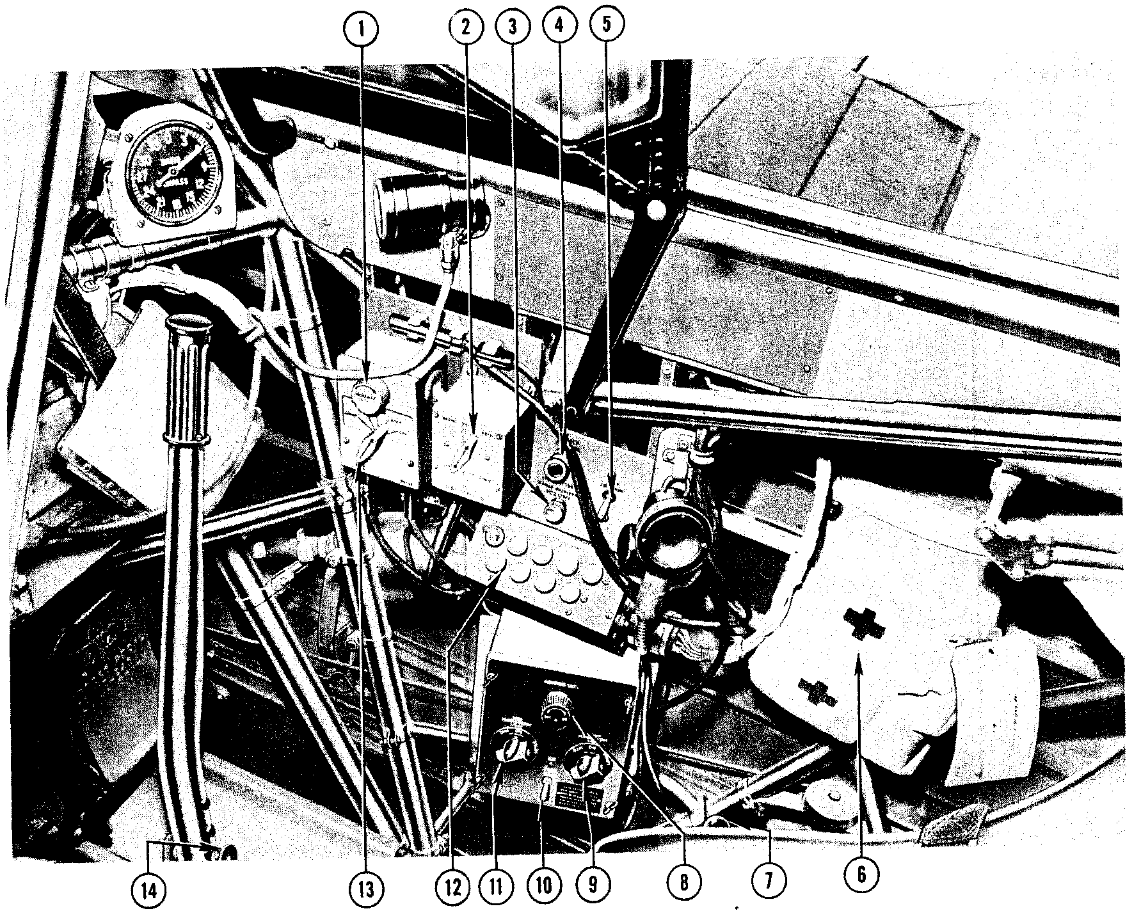
Figure 1-8



1. Master Volume Control Knob
2. Radio Range Filter Switch
3. Range Receiver Volume Control
4. VHF Control Indicator Light
5. VHF Control Transfer Switch
6. First-aid Kit
7. Seat Adjustment Lever
8. Compass Light Rheostat
9. Fluorescent Light Rheostat
10. Fuel Quantity Gage Light Switch
11. Fluorescent Light Rheostat
12. VHF Channel Selector Buttons
13. Master Selector Switch
14. Control Stick Release Knob

REAR COCKPIT RIGHT SIDE

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Figure 1-9

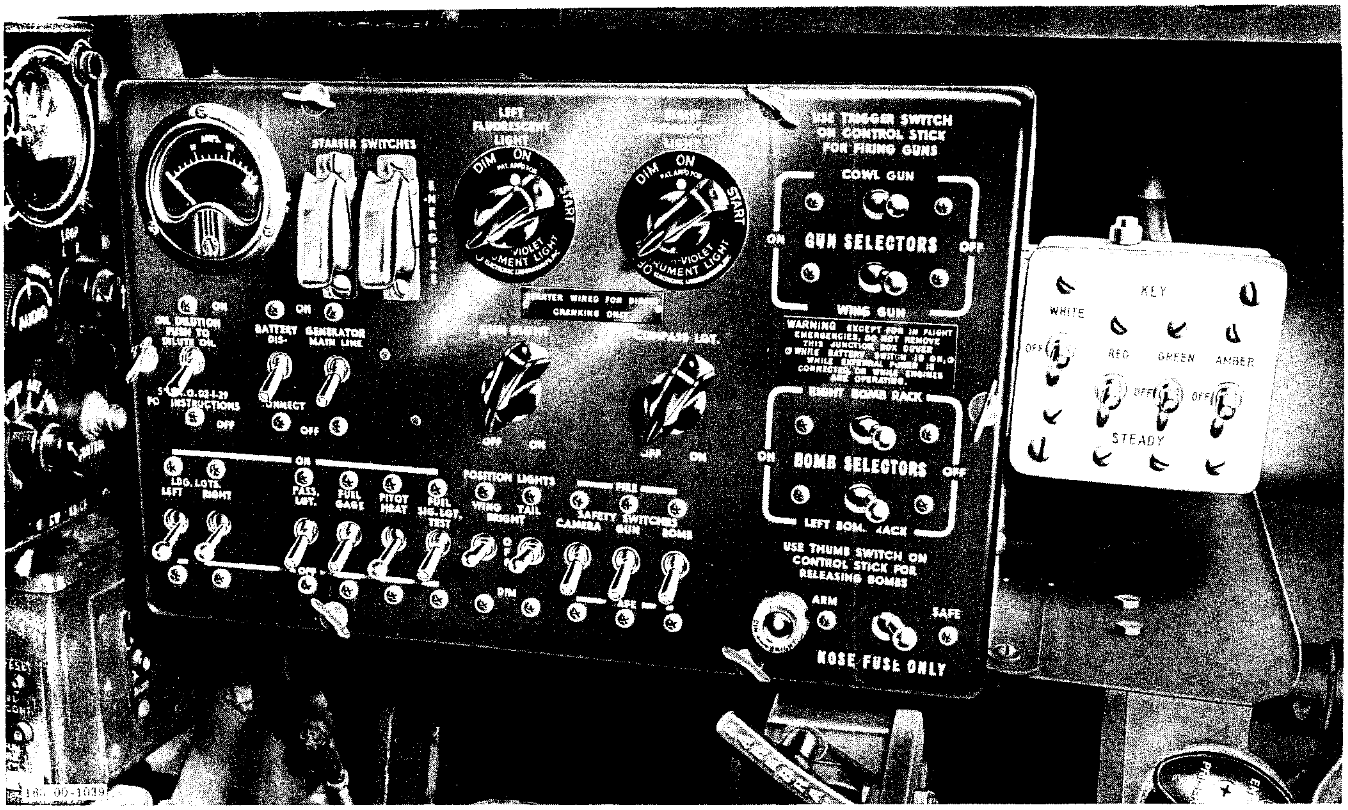


Figure 1-10. Instrument Subpanel

ENGINE.

The airplane is powered by a 600-horsepower (Take-off Power), nine-cylinder Pratt & Whitney radial engine, Model R-1340-AN-1. The engine is equipped with an updraft float-type carburetor and a direct-cranking starter.

ENGINE CONTROLS.

Throttle and mixture controls are located on the throttle quadrant on the left side of each cockpit. A friction lock (7, figure 1-4) on the inboard face of the quadrant, in the front cockpit only, is rotated to increase friction of the throttle, mixture, and propeller controls. Carburetor mixture temperature is controlled by a carburetor air control in the front cockpit.

THROTTLE.

A throttle (5, figures 1-4 and 1-8) is located on the quadrant on the left side of each cockpit. A take-off stop is provided in the quadrant so that the pilot can feel when

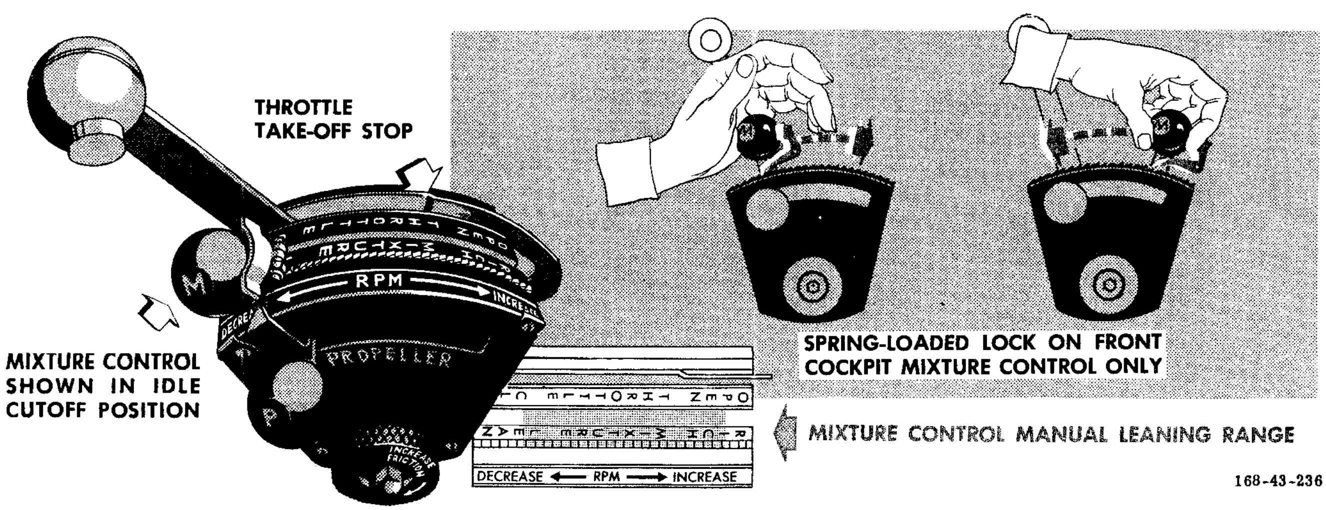


Figure 1-11. Throttle Quadrant

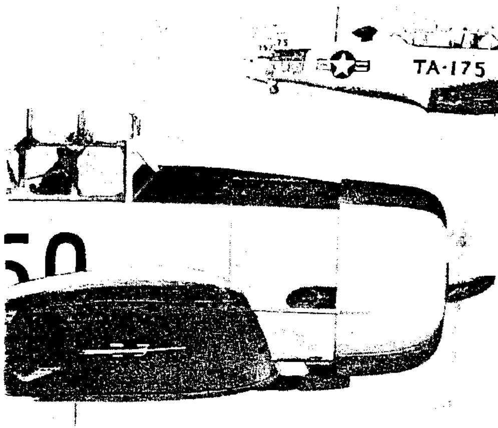


Figure 1-12

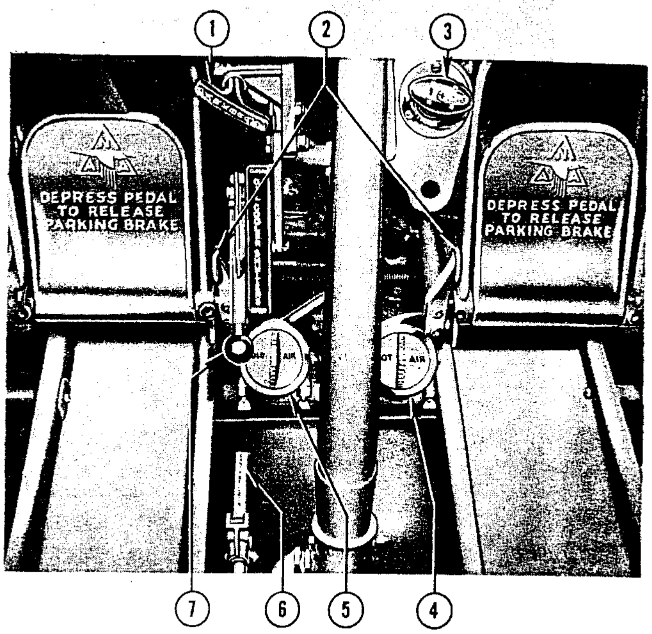
he has reached Take-off Power, at sea level. (See figure 1-11.) The throttle in the front cockpit can be pushed through the stop to obtain full throttle travel when additional power is needed at altitudes above sea level. When the throttle is retarded near the closed position, the landing gear warning horn will blow if the gear is not down and locked.

MIXTURE CONTROL.

The mixture control (4, figures 1-4 and 1-8) on the throttle quadrant in each cockpit enables the pilot to control the fuel-air mixture to the engine, to obtain efficient engine operation and maximum fuel economy. Positions on the quadrant are RICH (full forward) and LEAN (aft—idle cutoff). Any position between RICH and LEAN is in the manual leaning range. (See figure 1-11.) The front cockpit mixture control is equipped with a spring-loaded lock and ratchet. When the mixture control in either cockpit is moved forward, the lock is automatically released. However, before the mixture control can be moved aft toward LEAN, the lock must be released by pressing forward on the lock lever. The idle cutoff position shuts off all fuel flow at the carburetor to stop the engine.

CARBURETOR AIR CONTROL HANDLE.

The carburetor air control handle (16, figure 1-4) is located on the left console of the front cockpit. When the control is at COLD, ram air is admitted to the carburetor through the ram-air inlet on the left side of the engine cowl. (See figure 1-13.) The ram-air inlet is fitted with a filter. As the control is moved toward the HOT position, it gradually closes the ram-air inlet while opening a duct that allows warm air from inside a muff surrounding the exhaust collector ring to mix with the cold ram air before being delivered to the carburetor. When the control is at the full HOT position, the ram-air inlet is fully closed and hot air only is drawn into the carburetor. A carburetor mixture temperature gage



1. Parking Brake Handle
2. Rudder Pedal Adustment Levers
3. Engine Primer
4. Hot-air Temperature Control Valve
5. Cold-air Temperature Control Valve
6. Control Lock Handle
7. Oil Cooler Shutter Control

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FRONT COCKPIT CONTROLS

(14, figure 1-6), mounted on the instrument panel in the front cockpit, indicates the temperature of the fuel-air mixture as it enters the engine.

IGNITION SWITCH.

A standard ignition switch (23, figure 1-6; 18, figure 1-7) is located on the left side of the instrument panel in the front cockpit and forward of the throttle quadrant in the rear cockpit. Switch positions are OFF, L, R, and BOTH. The L and R positions are provided to check engine operation on the left or right magneto individually.

STARTER SWITCH.

A guarded, toggle-type switch (figure 1-10), located on the front instrument subpanel, provides control of the starter. Originally the airplane was delivered with the starter wired to be energized by one switch and engaged

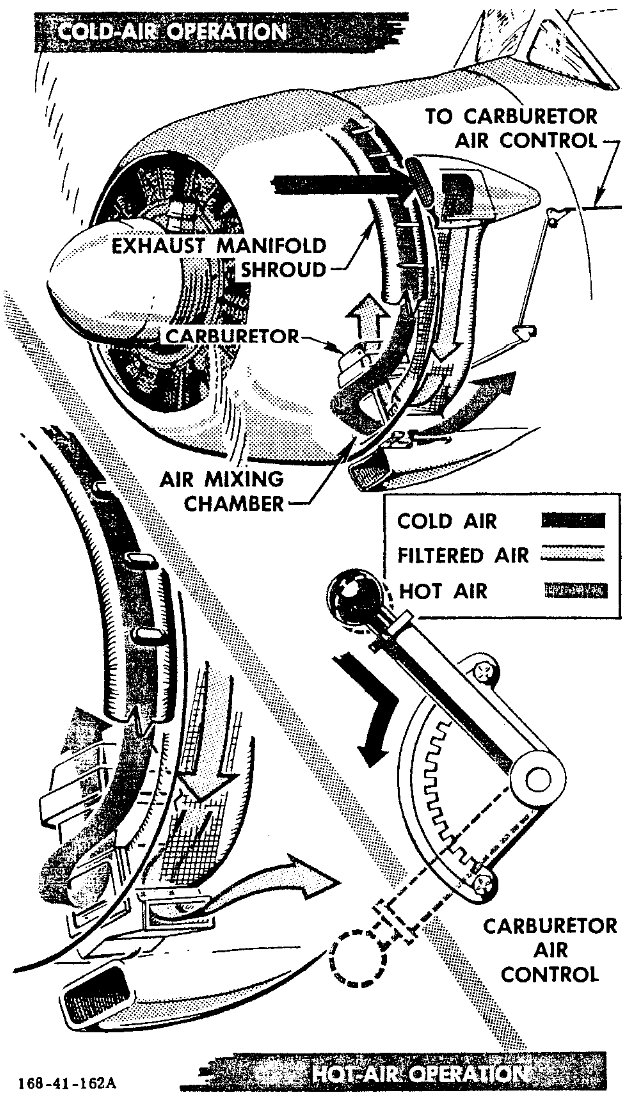


Figure 1-13. Air Induction System

(after coming up to speed) by another switch. However, the starter has been wired for direct cranking, so the switch marked "ENERGIZE" is inoperative. The switch marked "ENGAGE" will both energize and engage the starter to the engine. Power for energizing the starter can be derived from the airplane battery, although an external power source should be connected for this purpose, whenever possible, to conserve battery life.

ENGINE PRIMER.

The engine priming system is controlled by a push-pull hand primer (3, figure 1-12), located below the instrument panel in the front cockpit. The primer pumps fuel from an outlet in the hand fuel pump directly into the five top cylinders to aid in starting. When not in use, the pump should be pushed in and turned to the right to the locked-closed position.

ENGINE CRANK.

An engine crank, stowed in the baggage compartment, is provided for emergency use to hand-crank the starter when electrical power is not available.

ENGINE INDICATORS.

A complete set of engine instruments is mounted in the front cockpit. The oil pressure, fuel pressure, and manifold pressure gages indicate pressure directly from the engine. When the engine is inoperative, the manifold pressure gage reading should correspond to barometric pressure. The tachometer and cylinder head temperature gage readings are self-generated and therefore do not require power from the electrical system of the airplane. Oil temperature and carburetor mixture temperature gages, however, depend upon the 28-volt d-c system. The engine gage unit (containing the oil temperature, oil pressure, and fuel pressure gages) and the tachometer are duplicated on the rear cockpit instrument panel. A manifold pressure gage is also installed in the rear cockpit of some airplanes.

MANIFOLD PRESSURE GAGE DRAIN VALVE.

A manifold pressure gage drain valve is provided to clear the manifold pressure instrument lines of moisture and vapors so that accurate indications can be obtained on the gage. The drain valve is opened by turning a handle (11, figure 1-4), located forward of the front cockpit throttle. The differential between atmospheric pressure and manifold pressure enables flow through the instrument lines to clear them of vapors when the drain valve is opened. The valve should be opened only when the engine is operating below 30 inches manifold pressure so that the vapors will be carried into the engine instead of toward the gage. Also, a greater differential between atmospheric and manifold pressures exists at low power than at full power.

PROPELLER.

The engine drives a two-bladed, constant-speed, all-metal propeller. A propeller control is provided to select an engine rpm that is desired to be held constant. For information concerning propeller operation, refer to Section VII and see figure 7-2. The airplanes were originally delivered with a spinner covering the propeller hub, but most of the spinners have since been removed during service.

PROPELLER CONTROL.

Engine rpm is determined by the setting of a propeller control (6, figures 1-4 and 1-8), located on the throttle quadrant in each cockpit. The propeller control may be placed at any intermediate position between DECREASE and INCREASE rpm, depending upon the engine rpm desired. Positioning the propeller control mechanically adjusts the setting of a propeller governor mounted on the nose section of the engine. The propeller governor maintains the selected rpm, regardless of varying air loads or flight attitudes, by regulating engine oil pressure to change blade angle.

OIL SYSTEM.

Oil for engine lubrication is supplied from a 10.8-gallon tank. Lubrication is accomplished by a pressure system with a dry sump and scavenge pump return. Oil flows from the tank to the engine pressure pump, which forces it through the engine, and is pumped back to the tank by the scavenge pump either directly or through the oil cooler, depending upon the temperature of the oil. The oil temperature is regulated by a thermostatic valve in the oil cooler which automatically controls the flow of oil through the cooler. Most airplanes incorporate a surge valve in the return line to enable oil to by-pass the cooler, preventing flow stoppage in case the oil congeals in the cooler. (See figure 1-23 for oil specification and grade.)

OIL SYSTEM CONTROLS.

OIL COOLER SHUTTER CONTROL.

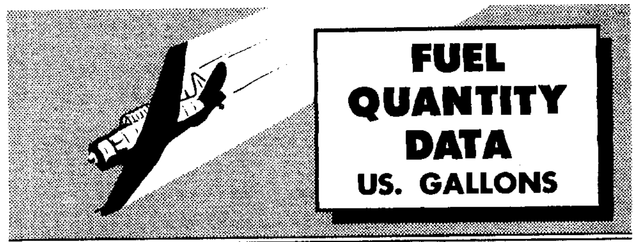
The airplane is equipped with an oil cooler, which is located at the bottom of the engine mount. Oil cooler shutters, provided on the top side of the cooler, can be adjusted from the front cockpit only. The oil cooler shutter control (7, figure 1-12) is located in the front cockpit, below the instrument subpanel, just forward of the control stick. The shutter control can be set at OPEN, CLOSED, or various intermediate positions to regulate the flow of air through the oil cooler.

OIL DILUTION SWITCH.

An oil dilution system is provided for diluting the oil with gasoline before engine shutdown whenever a cold-weather start is anticipated. The oil dilution switch (figure 1-10), located on the instrument subpanel in the front cockpit, is spring-loaded to the OFF position and must be held ON to dilute the oil. When the switch is held in the ON position, fuel from the carburetor (under pressure) is allowed to enter the oil line to the engine to lower the viscosity of the oil.

FUEL SYSTEM.

The fuel system (figure 1-16) incorporates two all-metal fuel tanks, which are located in the center section of the wing. See figure 1-14 for fuel quantity data. A fuel outlet with an extended standpipe is installed in the left tank to provide a 20-gallon reserve fuel supply. However, under certain conditions (figure 7-1), maneuvering flight can result in a reduction of the available reserve to a quantity as low as 10 gallons. Each tank is constructed so as to trap fuel around the tank outlets during maneuvering flight. An engine-driven fuel pump supplies fuel under pressure to the carburetor. In event of failure of the engine-driven pump, sufficient fuel pressure can be supplied to the carburetor by means of a hand fuel pump to enable full-power engine operation. Fuel flow by gravity is available only to the fuel selector valve and hand fuel pump. See figure 1-23 for fuel grade and specification.



TANKS	NO.	USABLE FUEL IN LEVEL FLIGHT	FULLY SERVICED	EXPANSION SPACE	TANK VOLUME
L WING TANK	1	54.8	55.2	1.7	56.9
R WING TANK	1	54.8	55.2	1.7	56.9
TOTAL	2	109.6	110.4	3.4	113.8

NOTE:
Multiply gallons by 6.0 to obtain pounds gasoline (MIL-F-5572).
Estimated data shown in red. 168-48-1121A

Figure 1-14

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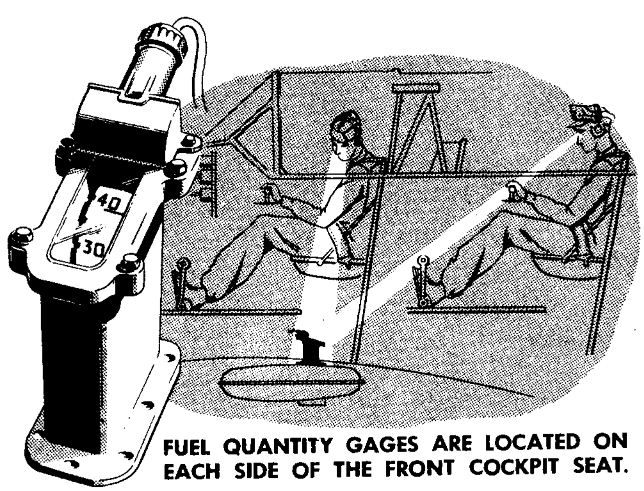


FUEL QUANTITY GAGES

Figure 1-15

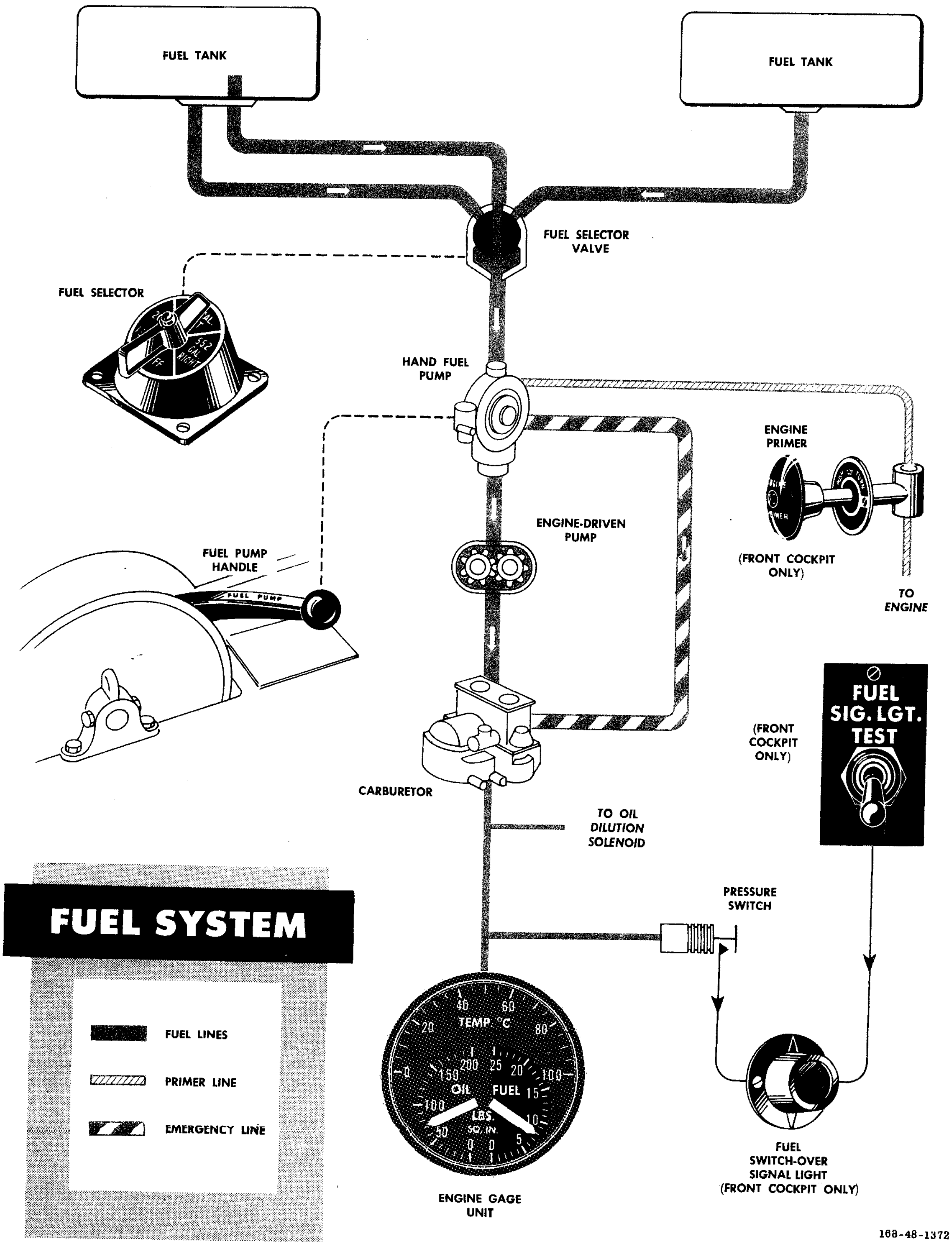
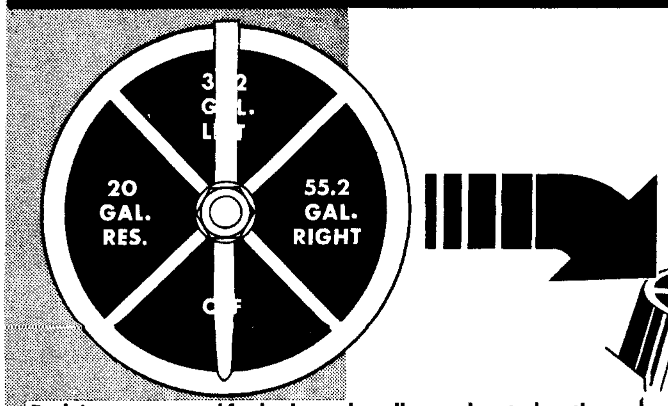
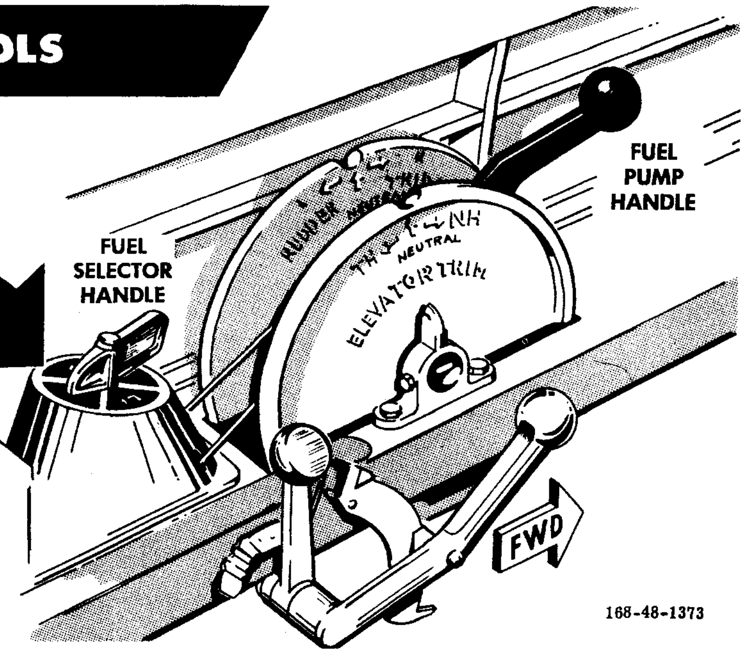

FUEL TANK
FUEL TANK
FUEL SELECTOR VALVE
FUEL SELECTOR
HAND FUEL PUMP
ENGINE PRIMER
(FRONT COCKPIT ONLY)
TO ENGINE
ENGINE-DRIVEN PUMP
FUEL PUMP HANDLE
FUEL PUMP
FUEL SIG. LGT. TEST
(FRONT COCKPIT ONLY)
CARBURETOR
TO OIL DILUTION SOLENOID
FUEL SYSTEM
FUEL LINES
PRIMER LINE
EMERGENCY LINE
PRESSURE SWITCH
TEMP. °C
OIL
FUEL
LBS. SQ. IN.
ENGINE GAGE UNIT
FUEL SWITCH-OVER SIGNAL LIGHT (FRONT COCKPIT ONLY)
168-48-1372

Figure 1-16

FUEL SYSTEM CONTROLS





Both interconnected fuel selector handles are located on the left console of each cockpit. Each selector handle position has a detent to provide a distinct stop. When the selector is at ***55.2 GAL. RIGHT,*** all the fuel in that tank may be used; with the selector at ***35.2 GAL. LEFT,*** fuel will be consumed until the level of the extended standpipe is reached. The approximately 20 gallons remaining may be used only when the selector is placed at ***20 GAL. RES.*** The ***OFF*** position shuts off all fuel flow. A hand fuel pump, operated by interconnected handles, one in each cockpit, is provided to maintain fuel pressure if the engine-driven pump fails.

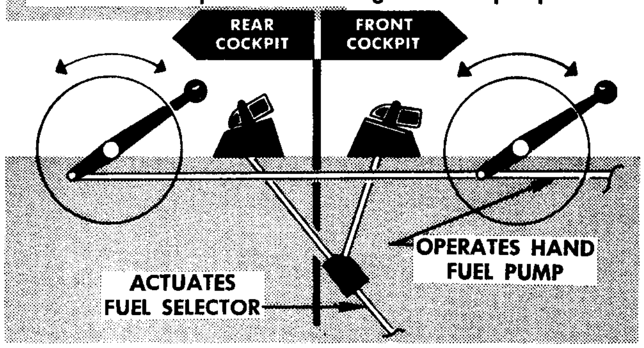


Figure 1-17

FUEL SYSTEM INDICATORS.

FUEL QUANTITY GAGES.

A float-type fuel quantity gage (figure 1-15) is located on each side of the pilot's seat in the front cockpit. The gages are visible from the rear cockpit seat, with approximately a 5-gallon increase because of parallax error. The fuel gages are not sufficiently accurate for exact readings; therefore, the values should be regarded as approximate. The left gage reading includes the amount in reserve, so when the quantity indicated approaches (RES) 20 gallons, the selector should be moved from the 35.2 GAL. LEFT position; otherwise, engine failure from lack of fuel will result.

FUEL PRESSURE GAGE.

Fuel pressure is indicated on the engine gage unit. (See 12, figure 1-6; 11, figure 1-7.) The fuel pressure gage is the direct-reading type and indicates fuel pressure in the carburetor.

FUEL SWITCH-OVER SIGNAL LIGHT.

A signal light (15, figure 1-6) on the right side of the front cockpit instrument panel will illuminate when the fuel pressure drops below 3 psi. Should the fuel flow stop completely, as during a pump failure or in a restricted line, the light will illuminate approximately 10 seconds before the engine stops. A fuel signal light test switch (figure 1-10) is located on the instrument subpanel.

ELECTRICAL POWER SUPPLY SYSTEM.

Electrical power is supplied by a 50-ampere, engine-driven generator through a 28-volt, direct-current system. (See figure 1-18.) A 24-volt battery serves as a stand-by power source for use when the generator is inoperative or not supplying sufficient voltage. A reverse-current relay is incorporated to automatically control the generator. The generator "cuts in" at approximately 1250 rpm and "cuts out" when engine speed is reduced to approximately 1000 rpm. Full rated output of the generator is developed above 1650 rpm. Two inverters change direct current to alternating current to power the radio compass and remote-indicating compass.

CIRCUIT BREAKERS AND FUSES.

All d-c circuits are protected from overloads by push-to-reset circuit breakers. The panel mounting the circuit breakers (12, figure 1-4) is located in the front cockpit, on the left forward console. The communication equipment is protected by circuit breakers (12, figure 1-4; 16, figure 1-5), located in the front cockpit, on the left and right sides. Fuses are used to protect the communication equipment on early airplanes.

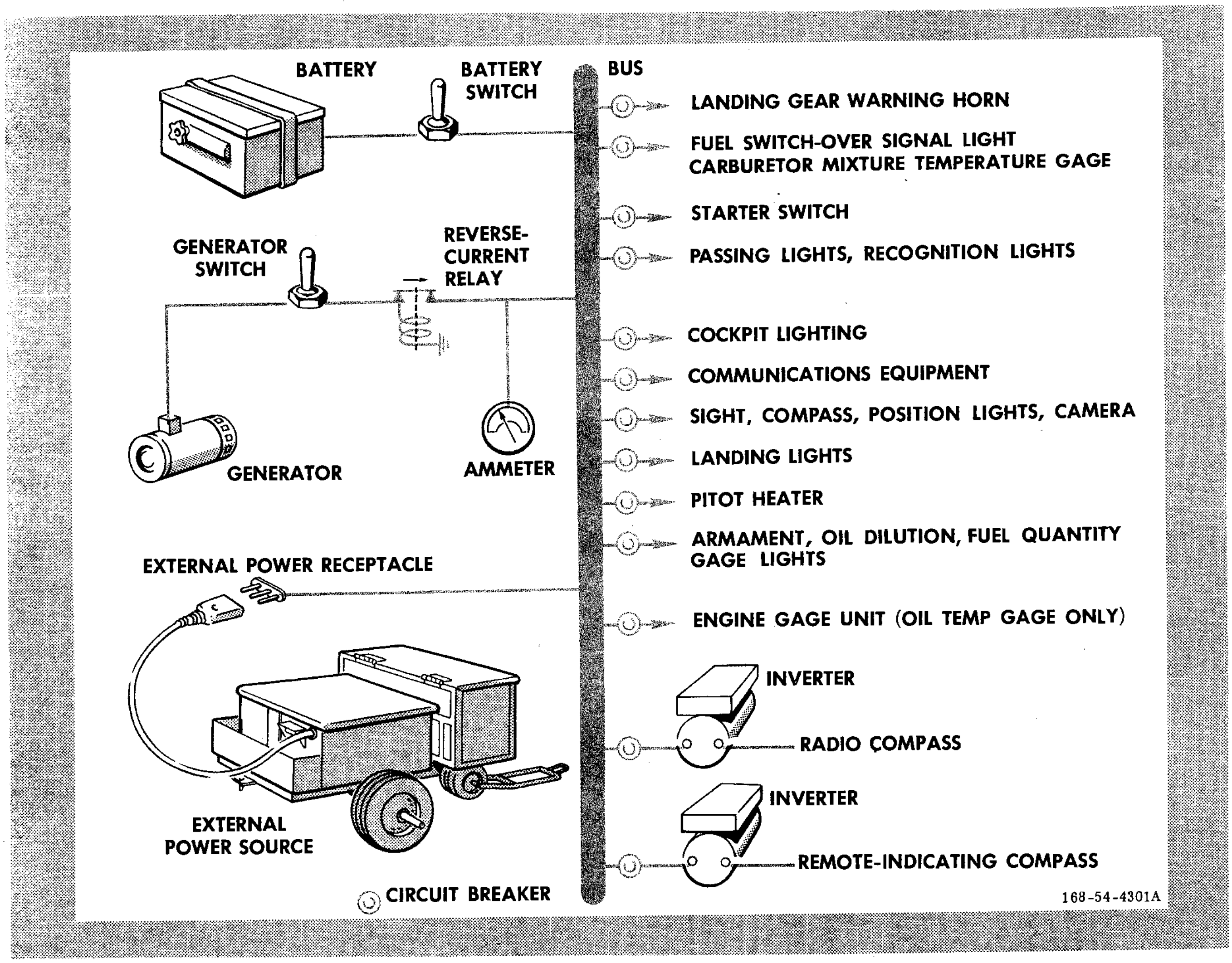


Figure 1-18. Electrical System

EXTERNAL POWER RECEPTACLE.

An external power receptacle is located on the lower left side of the fuselage, near the wing trailing edge. External power, whenever available, should always be used for engine starting or electrical ground checks to conserve battery life for use during in-flight emergencies.

ELECTRICAL POWER SUPPLY SYSTEM CONTROLS AND INDICATOR.

BATTERY-DISCONNECT SWITCH.

A battery-disconnect switch (figure 1-10) is located on the instrument subpanel. All electrical equipment is inoperative when the switch is OFF unless the generator is operating or an external power supply is connected to the airplane. The battery will supply current to all electrical equipment when the battery-disconnect switch is ON and no other power source is being used. The switch should be OFF when the engine is not running, to prevent unnecessary discharge of the battery.

GENERATOR MAIN LINE SWITCH.

A generator main line switch (figure 1-10), located on the instrument subpanel, provides a means of turning off the generator circuit in case the reverse-current relay fails to operate. The switch should be left ON at all times except in an emergency.

AMMETER.

An ammeter (figure 1-10), located on the instrument subpanel, indicates the amount of current being delivered by the generator.

HYDRAULIC POWER SUPPLY SYSTEM.

The hydraulic system (figure 1-19) is utilized to operate the landing gear and flaps. An engine-driven pump supplies hydraulic pressure for operation of these units. However, when no hydraulic units are being operated in flight, the entire output of the pump is diverted to the reservoir. The hydraulic pressure gage (15, figure 1-4),

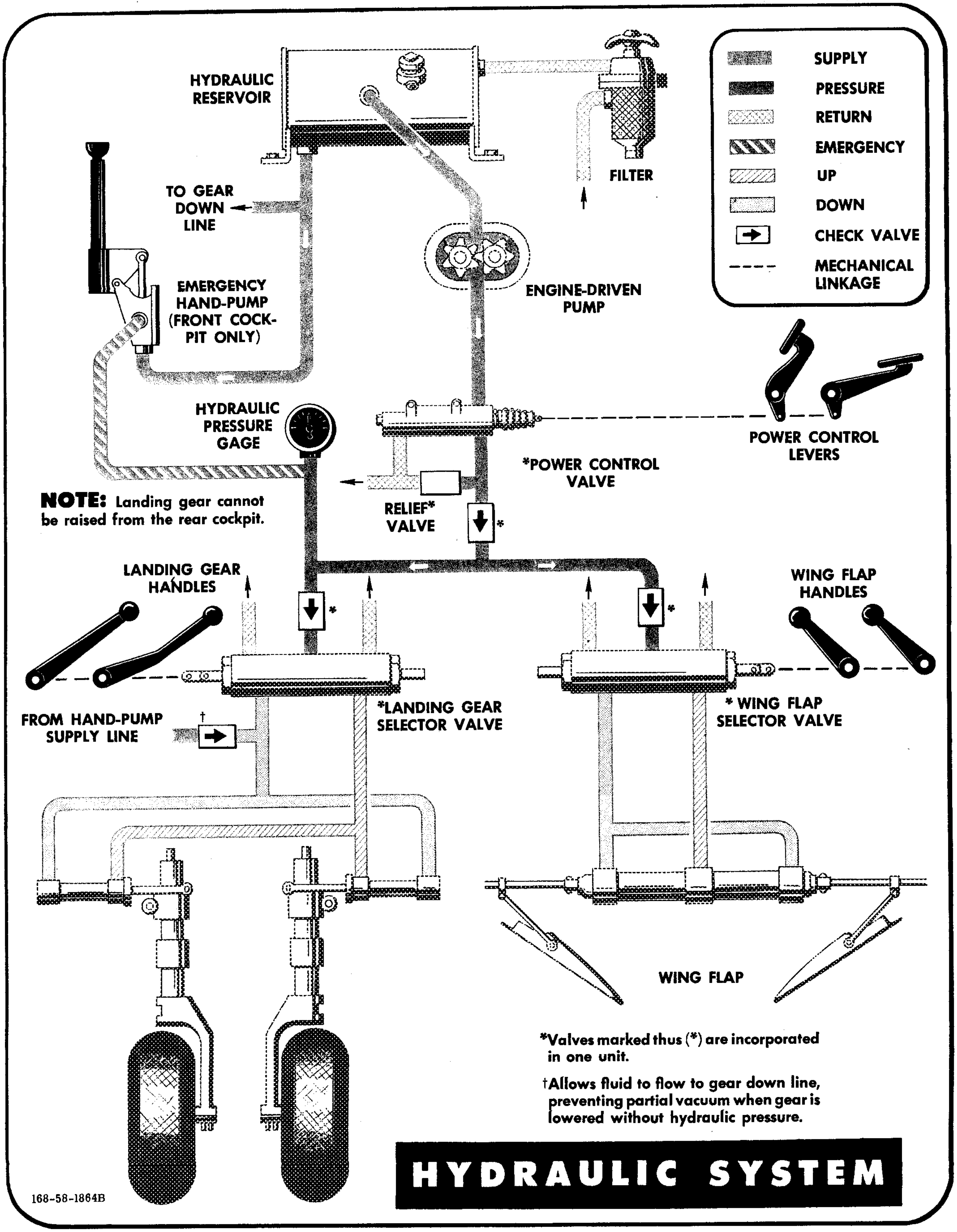

HYDRAULIC RESERVOIR
FILTER
SUPPLY
PRESSURE
RETURN
EMERGENCY
UP
DOWN
CHECK VALVE
MECHANICAL LINKAGE
TO GEAR DOWN LINE
EMERGENCY HAND-PUMP (FRONT COCK-PIT ONLY)
ENGINE-DRIVEN PUMP
HYDRAULIC PRESSURE GAGE
POWER CONTROL LEVERS
*POWER CONTROL VALVE
NOTE: Landing gear cannot be raised from the rear cockpit.
RELIEF* VALVE
LANDING GEAR HANDLES
WING FLAP HANDLES
FROM HAND-PUMP SUPPLY LINE †
*LANDING GEAR SELECTOR VALVE
* WING FLAP SELECTOR VALVE
WING FLAP
*Valves marked thus (*) are incorporated in one unit.
†Allows fluid to flow to gear down line, preventing partial vacuum when gear is lowered without hydraulic pressure.
HYDRAULIC SYSTEM
168-58-1864B

Figure 1-19

located on the left console in the front cockpit, indicates pressure only when a unit is being operated. For hydraulic fluid grade and specification, see figure 1-23.

HYDRAULIC POWER SUPPLY SYSTEM CONTROLS.

POWER CONTROL LEVER.

Hydraulic pressure is controlled by a power control lever (25, figure 1-4; 10, figure 1-8), located on the side of the left console in each cockpit. When the power control lever is depressed, with the engine-driven pump operating, hydraulic pressure is available to operate the landing gear and flaps. The power control lever operates on a time-lag principle and automatically disengages after a set length of time, which is approximately twice that necessary to operate the flaps and landing gear. After the power control lever disengages, fluid is diverted back to the reservoir.

HYDRAULIC HAND-PUMP.

A hand-pump, incorporating a spring-loaded extension handle (22, figure 1-4), is located to the left of the pilot's seat in the front cockpit. The hand-pump is provided for emergency operation of the landing gear and flaps. When the engine-driven pump is in operation, the power control lever must be disengaged before the hand-pump will build up pressure; otherwise, system hydraulic pressure will impose a force in opposition to the hand-pump.

FLIGHT CONTROL SYSTEM.

The primary flight control surfaces (ailerons, rudder, and elevator) may be operated from either cockpit by conventional stick and rudder pedal controls. Rudder pedals, which are also used to apply the brakes and for tail wheel steering, are adjustable fore and aft. Trim tabs on the elevator and rudder are mechanically operated from either cockpit. Aileron trim tabs are adjustable on the ground only. The rudder pedals and control stick can be locked by a mechanical lock in the front cockpit.

FLIGHT CONTROLS.

CONTROL STICK.

The control stick grip in the front cockpit incorporates a gun trigger and a bomb release button. The rear cockpit control stick, which can be stowed in a bracket at the left side of the cockpit, is removed by actuating a release knob (14, figure 1-9) at the lower rear side of the stick. In addition to conventional use of the control stick (for ailerons and elevators), it also unlocks the tail wheel (to free-swiveling) when placed full forward.

RUDDER PEDAL ADJUSTMENT.

A rudder pedal adjustment lever (2, figure 1-12) is located on the inboard side of each rudder pedal in both cockpits. Adjustment of the pedals is accomplished by moving the individual rudder pedal lever inboard and adjusting the rudder pedal until the desired position is obtained. The lever is then released to lock the pedal in the selected position.

TRIM TAB CONTROLS.

Rudder and elevator trim tab control wheels (20 and 21, figure 1-4; 13 and 15, figure 1-8) are located on the left console of each cockpit. Trim tab position may be determined from a pointer at each control wheel.

CONTROL LOCK HANDLE (AILERONS, RUDDER, AND ELEVATOR).

All surface controls are locked by means of a control lock handle (6, figure 1-12), located forward of the control stick in the front cockpit. In order for the controls to be locked, the rudder pedals must be in neutral and the stick forward of center. After the lock handle is raised from the forward (stowed) position, the control stick is moved into the lock recess and the handle is depressed rearward. When not in use, the lock should be stowed (full forward and down).

WING FLAPS.

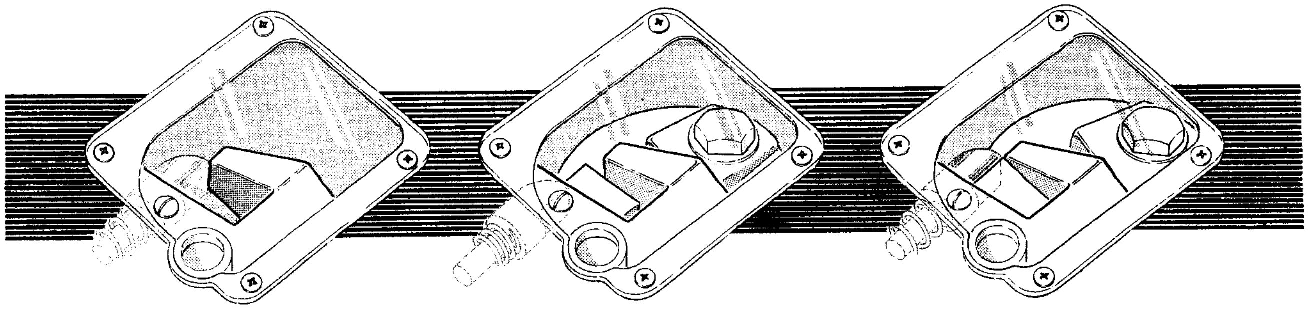
Hydraulically operated, split-type wing flaps extend from aileron to aileron. The flaps, operable from either cockpit, travel 45 degrees to the full down position. The hydraulic system power control lever must be actuated in conjunction with the flap handle to operate the flaps.

WING FLAP HANDLE.

The wing flaps are operated by means of a handle (23, figure 1-4; 16, figure 1-8), located on the left side of each cockpit. The flap handle has three positions: UP, DOWN, and LOCK. The LOCK position is used only to lock the flaps in an intermediate position. The flaps are held in the respective up, down, or intermediate positions by trapped fluid in the lines.

WING FLAP POSITION INDICATOR.

A mechanical wing flap position indicator (14, figure 1-4) is located forward of the front cockpit trim tab control wheels. In some airplanes, a locally manufactured mechanical wing flap position indicator (11, figure 1-8) is provided in the rear cockpit, behind the fuel selector.



GEAR EXTENDING (GEAR HANDLE DOWN). DOWNLOCK PIN IN EXTENDED POSITION.

GEAR DOWN BUT UNSAFE. DOWNLOCK PIN NOT ENGAGED.

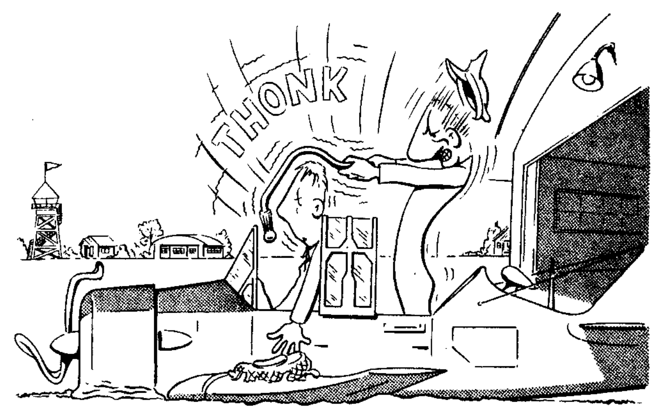
GEAR FULLY DOWN WITH DOWNLOCK PIN PROPERLY ENGAGED.

168-33-949A

Figure 1-20. Landing Gear Downlock Pin Engagement

LANDING GEAR SYSTEM.

The retractable main landing gear is hydraulically operated, and mechanical locks hold the gear in both the down and up positions. The locks are mechanically released by initial movement of the landing gear handle. In order to operate the gear, the hydraulic system power control lever must be engaged when the gear handle is actuated. In case of hydraulic failure, the gear can be unlocked by the landing gear handle and will extend by its own weight. The downlock pins will then snap in place. A means is provided to mechanically engage the downlock pins in an emergency. A plastic window (figure 1-20) on each wing, above the respective strut, makes possible a visual check of the downlock pin engagement. The tail wheel does not retract.



Do not operate the front cockpit landing gear handle when the airplane is on the ground, as there is no safety provision to prevent retraction of the gear.

LANDING GEAR HANDLE.

The landing gear handle (18, figure 1-4; 12, figure 1-8) is mounted on the left console of each cockpit. The handle in the front cockpit has three positions: UP, DOWN, and EMERGENCY. The EMERGENCY position is used to manually force the downlock pins into place should the pins fail to automatically lock the gear down. However, the handle must never be positioned to EMERGENCY *before* the gear is completely down; otherwise, the downlock pins, while manually forced into place, may not allow the gear to extend fully. The EMERGENCY position is reached by moving the handle to the extreme end of the sector, past a detent at the DOWN position. There is no neutral position, so the handle must remain in the selected position. The landing gear handle in the rear cockpit has an UP and a DOWN position, but will only extend the gear. Although the rear handle can be raised, it will not cause the gear to retract, because the front handle is engaged in a detent when at DOWN. (See figure 1-21.)

LANDING GEAR INDICATORS.

LANDING GEAR POSITION INDICATOR.

A mechanical landing gear position indicator (13, figure 1-4) is located on the left forward console of the front cockpit. The indicator shows the approximate position of each gear at all times.

LANDING GEAR DOWNLOCK INDICATOR LIGHTS.

Locally manufactured downlock indicator lights (figure 4-3), on the leading edge of each wing near the wheel

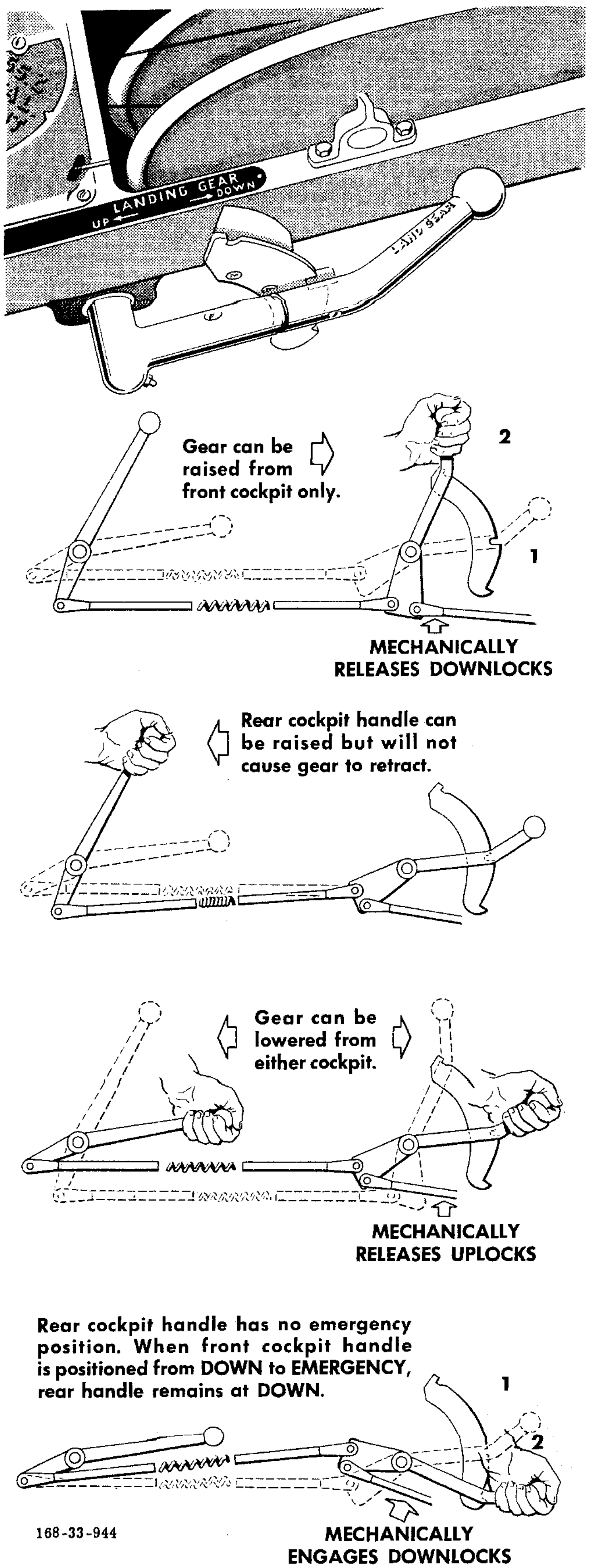


Figure 1-21. Landing Gear Handle

well, are incorporated on some airplanes. Although these indicator lights are not visible to the pilot, they enable ground-observer verification of gear position as a safety feature for night flight training.

LANDING GEAR WARNING HORN.

A warning horn is located in the overturn structure above the rear instrument panel. If the landing gear is not locked in the down position, the horn will blow when the throttle is retarded.

STEERING SYSTEM.

The nonretractable tail wheel can be steered or allowed to free-swivel, as determined by the position of the control stick. With the control stick in any position except full forward, the tail wheel can be steered by the rudder pedals up to a maximum of 15 degrees either side of center. Moving the control stick to the full forward position allows the tail wheel to free-swivel, and the airplane must be steered by the brakes. If the tail wheel is not aligned with the rudder when the control stick is moved back from the full forward position, the wheel will not be controllable. However, subsequent alignment with the rudder will automatically engage the tail wheel for steering.

BRAKE SYSTEM.

Hydraulic brakes on the main wheels are operated by application of toe pressure on the rudder pedals. No emergency method of applying the brakes is provided. The brake system (figure 1-22) incorporates a master brake cylinder with an integral reservoir. A parking brake handle (1, figure 1-12) is installed in the front cockpit. Parking brakes are set by depressing the toe brakes, pulling the parking brake handle out, and then releasing the toe brakes. The parking brakes are released by depressing the toe brakes in either cockpit. See figure 1-23 for grade and specification of brake fluid.

INSTRUMENTS.

A complete set of engine and flight instruments is installed in the front cockpit. The rear cockpit is equipped with duplicate flight instruments for instrument flight training purposes, but the tachometer and engine gage unit are the only engine instruments installed. A manifold pressure gage is also installed in the rear cockpit of some airplanes. A suction gage is provided in each cockpit. The gyro horizon, directional gyro, and turn-and-bank indicator are operated by the engine-driven vacuum system. The airspeed indicator, altimeter, and rate-of-climb indicator are operated by the pitot-static system. This system measures the difference between impact air pressure entering the pitot tube, mounted on the right wing, and static air pressure obtained at vent ports in the side of the pitot head. The airspeed indicator is connected to both the impact and static lines of the system. The altimeter and rate-of-climb indicator are connected to the static ports only. To keep the pitot tube opening clean, a cover is placed over the pitot head whenever the airplane is parked. An accelerometer (18, figure 1-6) is installed in the front cockpit, below the instrument panel, in some airplanes. The free air temperature gage (10, figure 1-4) is installed either in the windshield near the top or on the left side of the front cockpit.

EMERGENCY EQUIPMENT.

HAND-OPERATED FIRE EXTINGUISHER.

A carbon techtrachloride fire extinguisher (2, figure 1-8) is installed on the left side of the rear cockpit. The extinguisher can also be reached from outside the cockpit through an access door above the wing trailing edge. (See figure 3-5.)

FIRST-AID KIT.

A first-aid kit (6, figure 1-9), installed on the right side of the rear cockpit, is provided for emergency use.

CANOPY.

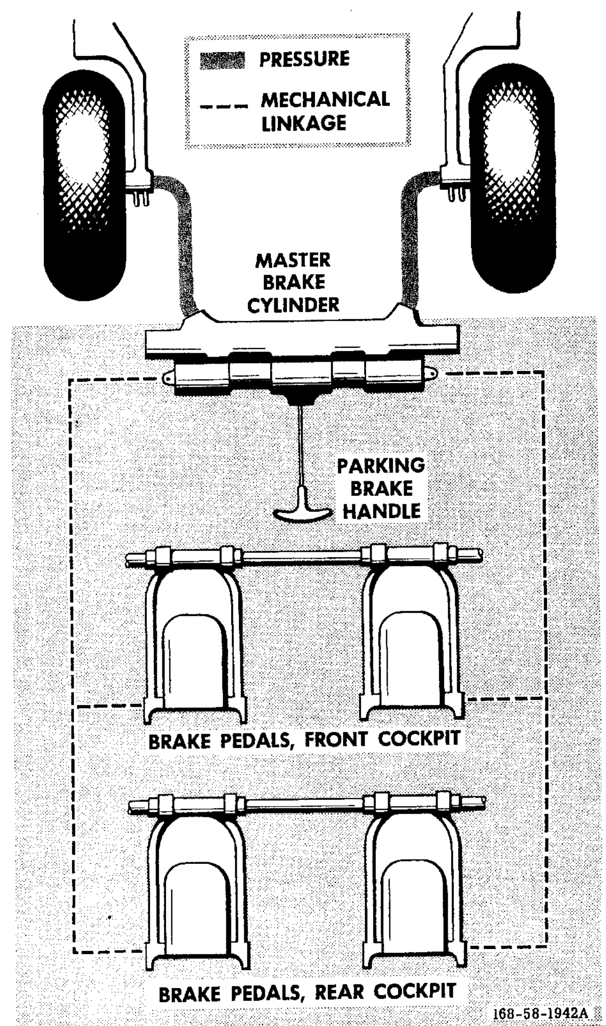
The canopy has two sliding sections, one over each cockpit, which are controlled separately by handles (1, figures 1-4 and 1-7), located on the left side of each cockpit, on the exterior and interior. The front sliding section can be locked at four positions: open, closed, and two intermediate positions. The rear sliding section can be locked at three positions: open, closed, and an intermediate position. Both side panels on each sliding section can be forcibly pushed out free from the canopy to provide an emergency exit from the airplane. Each side panel incorporates an emergency release handle (figure 3-6), which is safetied by fine wire to prevent accidental release.

SEATS.

The seats are adjusted by means of a seat adjustment lever (15, figure 1-5; 7, figure 1-9) at the right side of each seat. Pulling the lever back allows the seat to be raised or lowered. When the lever is pulled, the occupant is assisted in raising the seat by a bungee cord which tends to pull the seat up. A seat cushion is provided in each seat.

SHOULDER HARNESS LOCK HANDLE.

A two-position (locked and unlocked) shoulder harness lock handle (19, figure 1-4; 14, figure 1-8) is located on the left side of each seat. A latch is provided for positively retaining the handle at either position of the quadrant. When the top of the handle is pressed down, the latch is released and the handle may be moved freely from one position to another. The shoulder harness will lock automatically when you lean full back in the seat, provided the lock handle is forward and the harness is adjusted for proper fit. The shoulder harness should be locked for all take-offs and landings (crash or otherwise) and during acrobatics.



BRAKE HYDRAULIC SYSTEM

Figure 1-22

CAUTION

All switches not readily accessible with the harness locked should be "cut" before the harness lock handle is moved forward to the locked position.

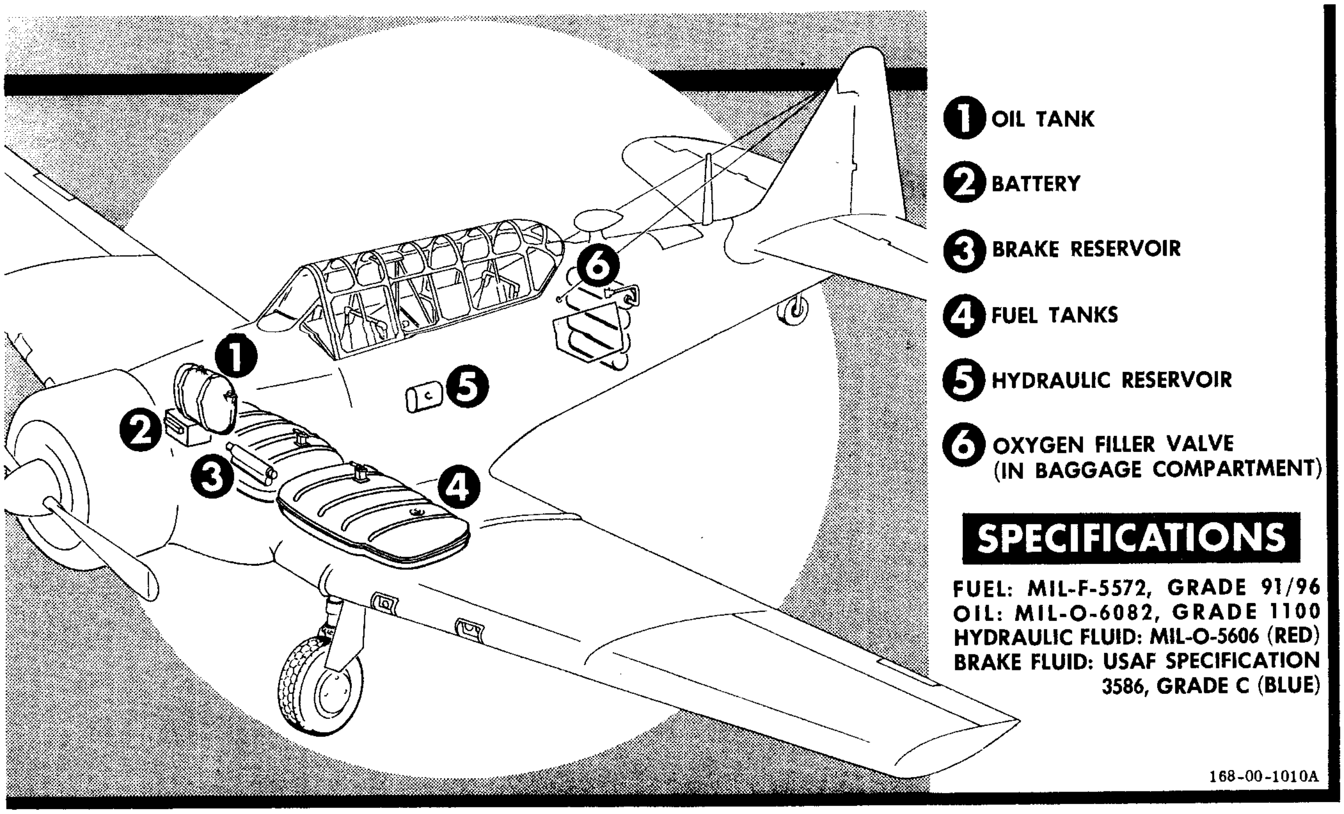
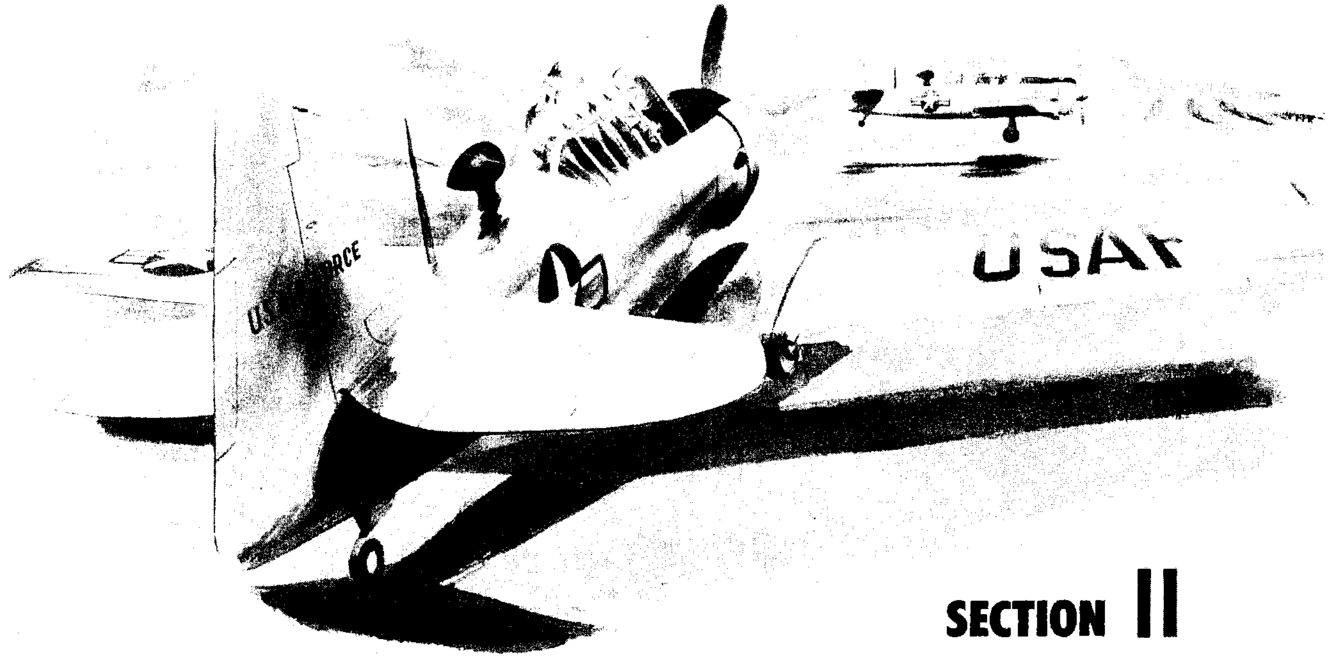


Figure 1-23. Servicing Diagram

AUXILIARY EQUIPMENT.

Section IV contains all information pertaining to the description and operation of auxiliary equipment. Included in Section IV are the heating and ventilating systems, communication and associated electronic equipment, lighting equipment, oxygen system, armament equipment, and miscellaneous equipment.

NORMAL PROCEDURES



SECTION II

STATUS OF THE AIRPLANE.

FLIGHT RESTRICTIONS.

Detailed airplane and engine limitations are listed in Section V.

PREFLIGHT PLANNING.

From the operating data contained in the Appendix, determine fuel consumption, correct airspeed, and power settings as necessary to accomplish the intended mission. The Appendix data will enable you to properly plan your flight so that you can obtain the best possible performance from the airplane.

WEIGHT AND BALANCE.

Refer to Section V for weight and balance limitations. Refer to Handbook of Weight and Balance Data (AN 01-1B-40) for loading. Before each mission, make the following checks:

1. Check take-off and anticipated landing gross weight and balance.
2. Make sure fuel, oil, armament, and special equipment carried are sufficient for the mission to be accomplished.
3. Make sure weight and balance clearance (Form F) is satisfactory.

ENTRANCE.

The cockpits are accessible from the left side of the airplane only. To open canopy, pull up on canopy handle, and slide front cockpit section aft and rear cockpit section forward.

EXTERIOR INSPECTION.

Make an exterior inspection, starting at the front cockpit and going clockwise around the airplane. See figure 2-1 for complete inspection procedure.

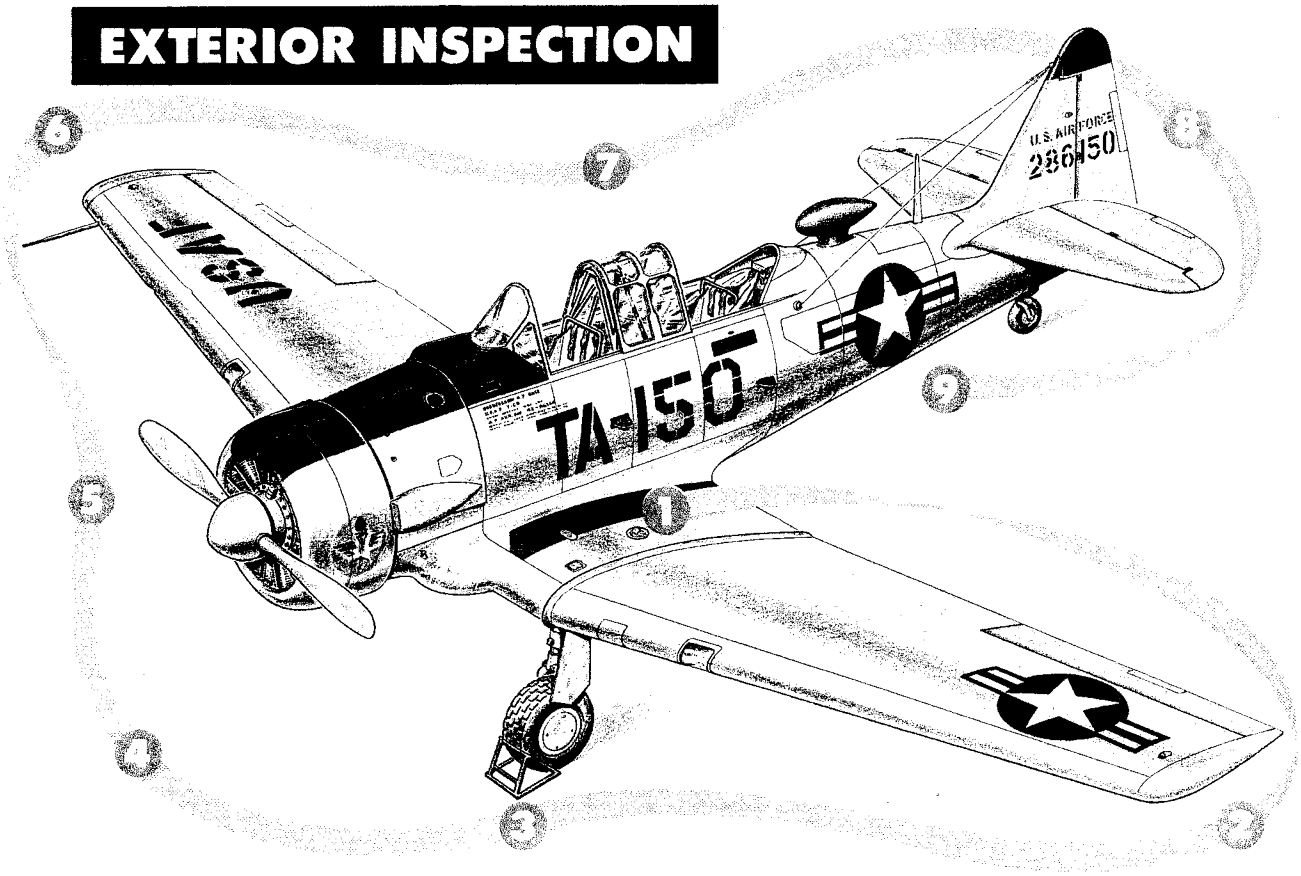
ON ENTERING THE AIRPLANE.

INTERIOR CHECK (ALL FLIGHTS).

Make the following checks before starting the engine:

1. Check rear cockpit for presence of first-aid kit.
2. Fill out Form 1.
3. Unlock flight controls and check for free movement with correct response.
4. Fasten safety belt and shoulder harness. Check operation of shoulder harness lock.
5. Adjust seat and rudder pedals.

EXTERIOR INSPECTION



Starting at the front cockpit, make the following checks:

NOTE: During this preflight check, inspect entire exterior for wrinkles, loose rivets, dents, and loose access doors.

1. COCKPIT
   Ignition and battery-disconnect switches ***OFF.***
   Gun safety switch ***SAFE.***
   Check form 1.
   Verify that airplane has been serviced with required quantities of fuel, oil, hydraulic fluid, and oxygen.
   Oil and hydraulic reservoir caps secure.
   Controls locked and trim tabs neutral.
   Wing flap handle and indicator up.
   If flying solo, rear cockpit control stick stowed and safety belt, shoulder harness, oxygen equipment, microphone, headset, and canopy secured.
2. LEFT WING
   Visually check fuel quantity.
   Check wing flaps for full up position.
   Aileron and trim tab neutral and hinges secure.
   Condition of position lights and wing tip.
3. LEFT LANDING GEAR
   Condition of landing light, downlock light, torque linkage, and uplock.
   Wheel chocked.
   Extension of gear strut (1 to 2 inches).
   Tire for proper inflation, condition, and slippage.
   Hydraulic leaks.
4. POWER PLANT SECTION
   Propeller free of nicks and oil leaks.
   Cowling secure and free of foreign objects.
   Carburetor air and oil cooler scoops clear.
5. RIGHT LANDING GEAR
   Same as opposite side.
6. RIGHT WING
   Same as opposite side.
   Pitot head cover removed.
7. FUSELAGE RIGHT SIDE
   Condition of fuselage lights.
8. EMPENNAGE
   Rudder, elevators, and respective trim tabs neutral, and hinges secure.
   Condition of position lights.
   Extension of tail wheel strut (approx 6 in. from top of tire to bottom of fuselage).
   Tire for proper inflation, condition, and slippage.
   Grounding wire secure.
9. FUSELAGE LEFT SIDE
   Baggage and loose equipment secured if carried.
   Baggage compartment locked closed.
   Fire extinguisher serviceable.

168-00-1011B

Figure 2-1

6. Set parking brakes.

7. Adjust headset.

8. Check fuel quantity gages. Fuel selector 20 GAL. RES.

Note

Steps for starting engine and subsequent ground operation include checking all positions of fuel selector.

9. Check that hydraulic hand-pump handle is not extended.

10. Wing flap handle UP. Check flap position indicator.

11. Landing gear handle DOWN. Check gear position indicator.

12. Carburetor air control COLD.

13. Oil cooler shutter control OPEN.

14. Radio compass power switch OFF.

15. Manifold pressure drain valve handle CLOSED.

16. Check generator switch ON.

17. Check all remaining switches at OFF or SAFE.

18. Circuit breakers in.

19. Altimeter and clock set.

20. Gyros UNCAGED.

Note

The gyro instruments should be uncaged at all times except during maneuvers which exceed operating limits. If gyro horizon bar is not level after engine is started, cage and uncage the gyro 5 minutes before take-off.

21. Note manifold pressure reading (field barometric pressure) for subsequent use during engine power check.

22. Test oxygen equipment for operation and check pressure gage. Low-pressure system (400 psi)—high-pressure system (1800 psi).

23. Communications equipment off and related circuit breakers in.

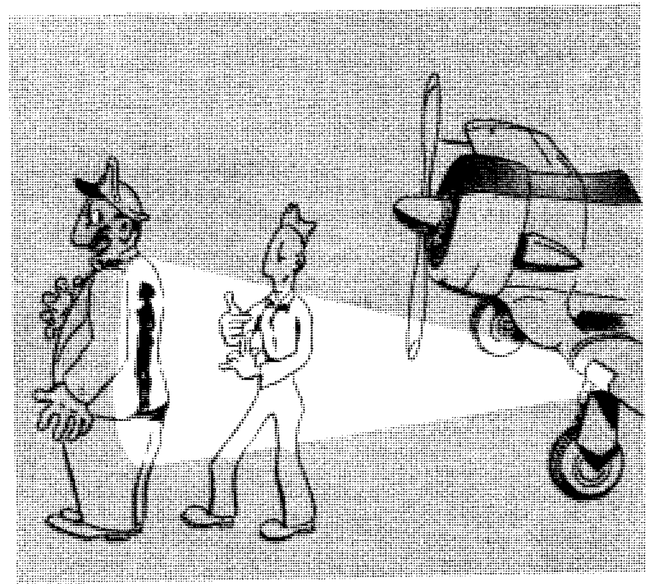
24. Adjust cockpit air temperature control valves as desired.

INTERIOR CHECK (NIGHT FLIGHTS).

If night flying is anticipated, the following additional checks should be made:

1. Have external power source connected. To prevent unnecessary discharge of battery, leave battery-disconnect switch OFF unless external power is not available.

2. With the aid of outside observer, test operation of position, passing, recognition, and landing lights. Check that landing gear downlock lights are illuminated.



Do not leave landing, passing, or recognition lights on for more than 10 seconds when airplane is on the ground, as excess heat may seriously damage the light.

3. Check operation of cockpit (fluorescent and incandescent), fuel quantity gage, and compass lights.

4. Push to test and adjust intensity of all indicator and warning lights.

5. Check for reliable flashlight on board.

STARTING ENGINE.

Start the engine as follows:

1. Check that propeller has been pulled through at least two revolutions.

2. Post fire guard and check propeller clear.

3. Throttle open approximately ½ inch.

4. Mixture control full RICH.

5. Check propeller control full DECREASE.

CAUTION

Since engine is normally shut down with propeller at decrease rpm, it must be started with propeller in same position so that full oil pressure will be available for engine lubrication during starting.

6. Unlock and operate primer three or four strokes to eliminate excessive cranking when starting engine.

7. Call "Switches On!"

8. Have external power source connected. To prevent unnecessary discharge of battery, leave battery-disconnect switch OFF unless external power is not available.

9. Call "Clear?" and wait for assurance from ground crew before actuating starter switch. After the propeller turns over about two revolutions, turn ignition switch to BOTH.

10. Operate primer with slow, even strokes until the engine starts firing. If necessary, continue priming until engine runs smoothly. Lock primer. Do not prime a hot engine.

Do not use the hand fuel pump when starting engine, as fire may occur if engine backfires.

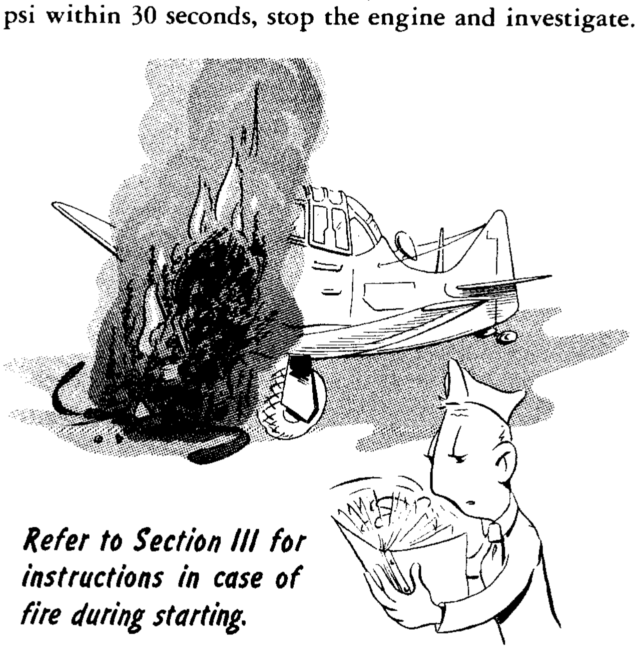
11. As the engine starts, release starter switch.

Note

Should a backfire result, retard the throttle slightly. Do not pump the throttle.

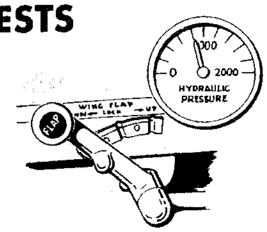
12. Adjust throttle to obtain 500 to 600 rpm as quickly as possible.

13. Check oil pressure; if gage does not indicate 40 psi within 30 seconds, stop the engine and investigate.

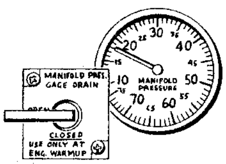


Refer to Section III for instructions in case of fire during starting.

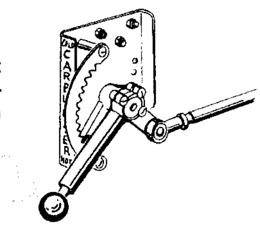
GROUND TESTS



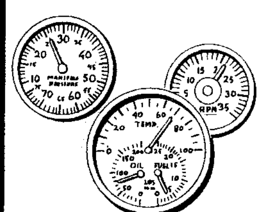
Hydraulic system—check as follows: lower flaps with emergency hand-pump; then depress power control lever and check hydraulic pressure gage for normal pressure; finally raise flaps (with system pressure) in increments to check *LOCK* position. (Flaps should not creep with handle at *LOCK*.)



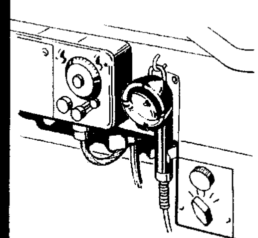
With manifold pressure below 30 in. Hg, open manifold pressure gage drain valve for 3 seconds.



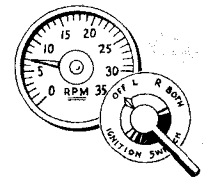
Carburetor air control–check operation. Note drop in manifold pressure with increase in mixture temperature.



Instruments–check for readings in desired ranges.



Communications equipment–check operation.



Ignition switch–check at 700 rpm, turn ignition switch *OFF* momentarily. If engine does not cease firing completely, shut down engine and warn personnel to remain clear of the propeller.

CAUTION

Perform this check as rapidly as possible to prevent severe backfire when ignition switch is returned to *BOTH*.

168-00-1036B

Figure 2-2

14. Have external power supply disconnected and turn battery-disconnect switch ON.

15. Check operation of pitot heater with aid of ground crew.

WARM-UP PROCEDURE.

1. As soon as oil pressure indicates 40 psi, move propeller control to full INCREASE.
2. Throttle adjusted to obtain the smoothest rpm between 1200 and 1400 for warm-up.
3. VHF radio turned to proper channel.
4. Fuel selector 55.2 GAL. RIGHT.
5. Check that generator "cuts in" at approximately 1250 rpm and "cuts out" at approximately 1000 rpm.

GROUND TESTS.

While the engine is warming up, perform the tests outlined in figure 2-2.

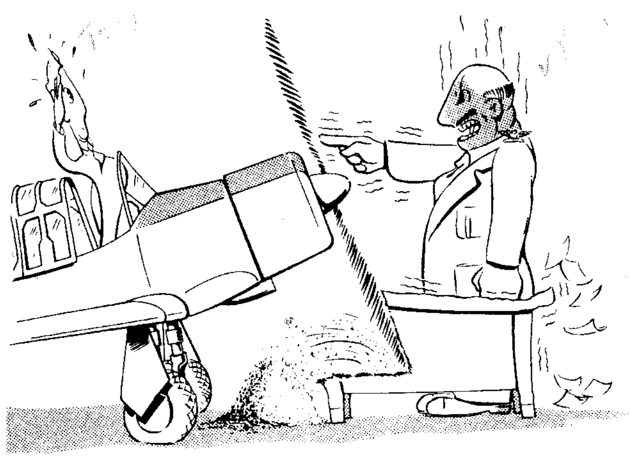
TAXIING INSTRUCTIONS.

Primary controls for taxiing the airplane are the throttle, steerable tail wheel, and brakes. Coordinate these controls for easy taxiing. Observe the following instructions and precautions for taxiing:

CAUTION

Don't "jockey" the throttle; if you do, the resultant sudden acceleration and deceleration will decrease the life and reliability of the engine.

1. Fuel selector 35.2 GAL. LEFT.
2. Have chocks pulled, allow airplane to roll forward slightly, and check the brakes.



Never allow taxi speed to build up before checking brakes.

3. The tail wheel, being steerable by use of the rudder pedals, provides ample control of the airplane under all normal taxiing conditions.
4. The throttle is the main taxi speed control, and most taxiing can be accomplished with it in the closed or slightly open position. Brake usage should be kept to a minimum.
5. To make sharp turns, slow the airplane down, position control stick full forward to disengage tail wheel, and use the brakes to control the airplane. Never allow the inside wheel to stop during a turn. Turning with one wheel stopped may damage the wheel, tire, or strut.
6. Tail wheel engaged. To engage the tail wheel for steering, the tail wheel and rudder must be aligned and the control stick must be back from full forward position. Alignment can be readily accomplished by allowing the airplane to roll forward slightly with the rudder neutral.

Note

Because of restricted forward visibility, S-turn the airplane well to both sides of the desired track to provide a clear, unrestricted view.

UPWIND TAXIING.

The stick should be held fully aft to hold the tail of the airplane on the ground and to ensure positive steering action of the tail wheel.

DOWNWIND TAXIING.

The stick should be held forward to keep the tail from lifting off the ground because of wind pressure being built up beneath the elevators.

Note

If the stick is *full* forward, the tail wheel will free-swivel.

CROSS-WIND TAXIING.

Hold stick into the wind to keep wings level. The primary means of airplane control will be by use of rudder, which is adequate even in extremely strong winds. If necessary, a slight amount of downwind brake may be used but should be held to a minimum.

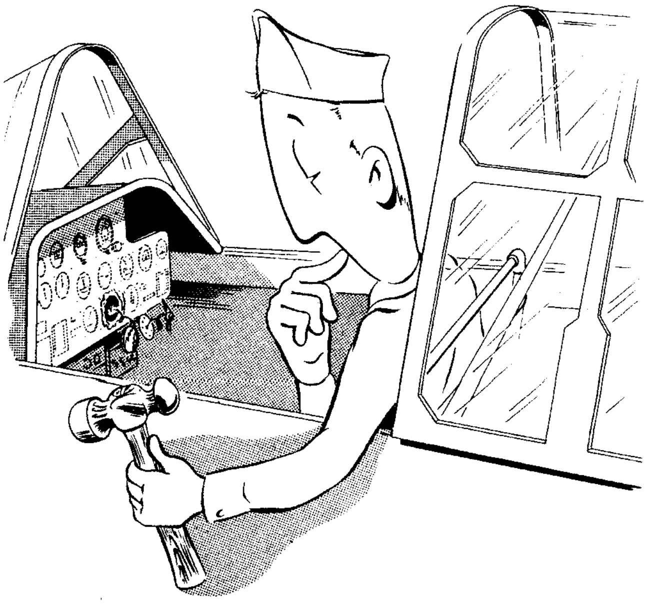
BEFORE TAKE-OFF.

After taxiing to run-up position, face into the wind, hold brakes, and make the following airplane and engine checks.

PREFLIGHT AIRPLANE CHECK.

1. Primary Controls:
   Check surface controls for free movement.
2. Instruments and Switches:
   Altimeter set.
   Directional gyro set.
   Gyro horizon set.
   All instrument readings in desired ranges.
   All switches at desired positions.
3. Fuel System:
   Fuel selector on proper tank (35.2 GAL. LEFT if airplane fully serviced, 55.2 GAL. RIGHT or 20 GAL. RES. if not). Refer to Section VII for instructions concerning fuel selection during flight.
   Mixture control full RICH.
   Primer locked.
4. Flaps:
   Flaps set for take-off (UP for normal take-off).
5. Trim:
   Trim tabs set for take-off (elevator—11 o'clock; rudder—2 o'clock).

PREFLIGHT ENGINE CHECK.

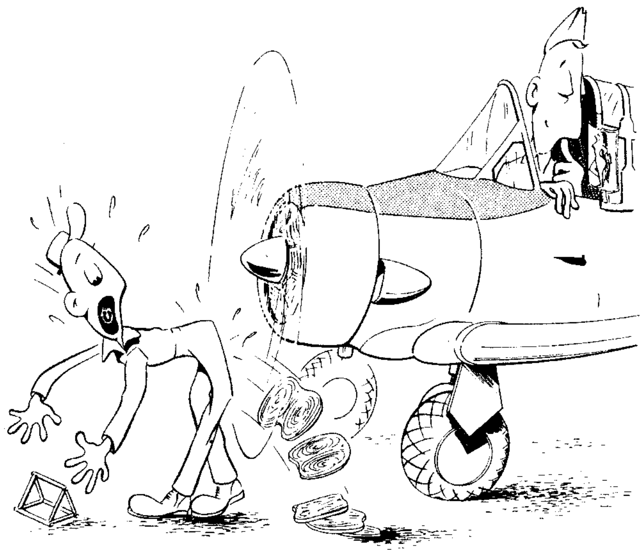


While performing checks requiring rpm reading, tap the instrument panel to prevent tachometer sticking.

1. Check propeller control at full INCREASE.
2. Propeller check—at 1600 rpm, pull propeller control back to full DECREASE position and note rpm drop of approximately 200 rpm; then return control to full INCREASE position.
3. Power check—adjust manifold pressure to field barometric pressure (as read on manifold pressure gage before starting engine) and check for 2000 ($\pm$50) rpm.

Note

If less than the prescribed rpm is obtainable for given manifold pressure, engine is not developing sufficient power and should be corrected before flight.



When running engine up to high power, be careful to have stick back and brakes applied.

4. Ignition system check—with throttle adjusted to 2000 rpm, position ignition switch to L and R and, in each position, check for maximum drop of 100 rpm. The absence of *any* rpm drop indicates that the opposite magneto is not being electrically grounded during the test as it should be. Between checks, return ignition switch to BOTH to allow speed to stabilize. If drop exceeds 100 rpm, return ignition switch to BOTH and run engine up to Take-off Power for a few seconds to clear spark plugs; then recheck ignition system at 2000 rpm. Return ignition switch to BOTH at completion of test.

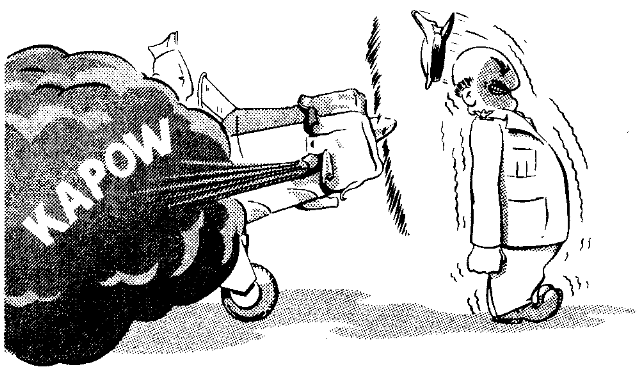
Note

During the test, observe the ring cowl for excessive vibration; a faulty ignition wire or one or more bad spark plugs will cause the cowl to vibrate excessively.

5. Cruising fuel-air mixture check—with propeller control at full INCREASE and mixture control full RICH, allow engine speed to stabilize at 1800 rpm. Move mixture control into the manual leaning range until an approximate 100 rpm drop is noted; then return to RICH. The engine speed should increase very slightly before it decreases. An immediate decrease indicates the mixture is set too lean. A momentary increase in excess of 25 rpm indicates the mixture is set too rich.

6. Idle speed check—with throttle against the idle stop, the engine should idle at 450 rpm.

7. Acceleration and deceleration check—with the mixture control at RICH, advance throttle from idle to 2000 rpm. Engine should accelerate and decelerate smoothly with no tendency to backfire.



Rapid reversal or sudden throttle movements must be avoided.

8. Check oil cooler shutter control OPEN.

9. Check carburetor air control full COLD.

TAKE-OFF.

Plan your take-off according to the following variables affecting take-off technique: gross weight, wind, outside air temperature, type of runway, and height and distance of the nearest obstacles. See figure A-5 for required take-off distances.

NORMAL TAKE-OFF.

In order to perform a take-off within the distance specified in the Take-off Distances chart (figure A-5), the following procedure must be used:

1. Visually check final approach for aircraft; then roll into take-off position and line up airplane with runway.

2. Shoulder harness locked.

3. Canopy locked open for improved visibility and to permit immediate escape in case of sudden emergency.

4. Tail wheel engaged for steering.

5. Advance throttle smoothly to Take-off Power.

6. Use elevator control to permit the airplane to assume a tail-low attitude. With proper trim setting for the load condition, the elevator will be in an approximately neutral position.

7. Allow the airplane to fly itself off the ground, using only slight back pressure on the control stick.

8. Normal take-off speed is approximately 80 mph.

Note

For procedure to follow if engine fails during take-off, refer to Section III.

MINIMUM-RUN TAKE-OFF.

A minimum-run take-off is a maximum performance maneuver with the airplane near stalling speed. It is directly related to slow flying and flaps-down stalls; consequently, you should be familiar with these maneuvers before attempting to make a minimum-run take-off. Complete all normal "before take-off" checks and follow the procedure outlined in figure 2-3 for a minimum-run take-off. →

CROSS-WIND TAKE-OFF.

The following procedure is recommended for cross-wind take-off:

1. Advance throttle to Take-off Power setting and maintain directional control with rudder.

2. Continue as in a normal take-off, applying sufficient aileron control to keep the wing level, or even enough aileron to effect a slightly wing-low attitude into the wind.

3. As airspeed increases, compensate for the increase in aileron effectiveness and perform a normal take-off with a slightly wing-low attitude into the wind.

4. After becoming air-borne, counteract drift by making a coordinated turn into the wind.

NIGHT TAKE-OFF.

Night take-off procedure is the same as for daylight operation. However, a thorough knowledge of switch and light location is essential. The following additional checks are recommended for night take-off:

1. Turn cockpit lights low.

2. Tune radio carefully and loud, as it will fade during take-off and flight.

3. Hold airplane steady on a definite reference point during the take-off run.

4. Don't be alarmed by exhaust flame.

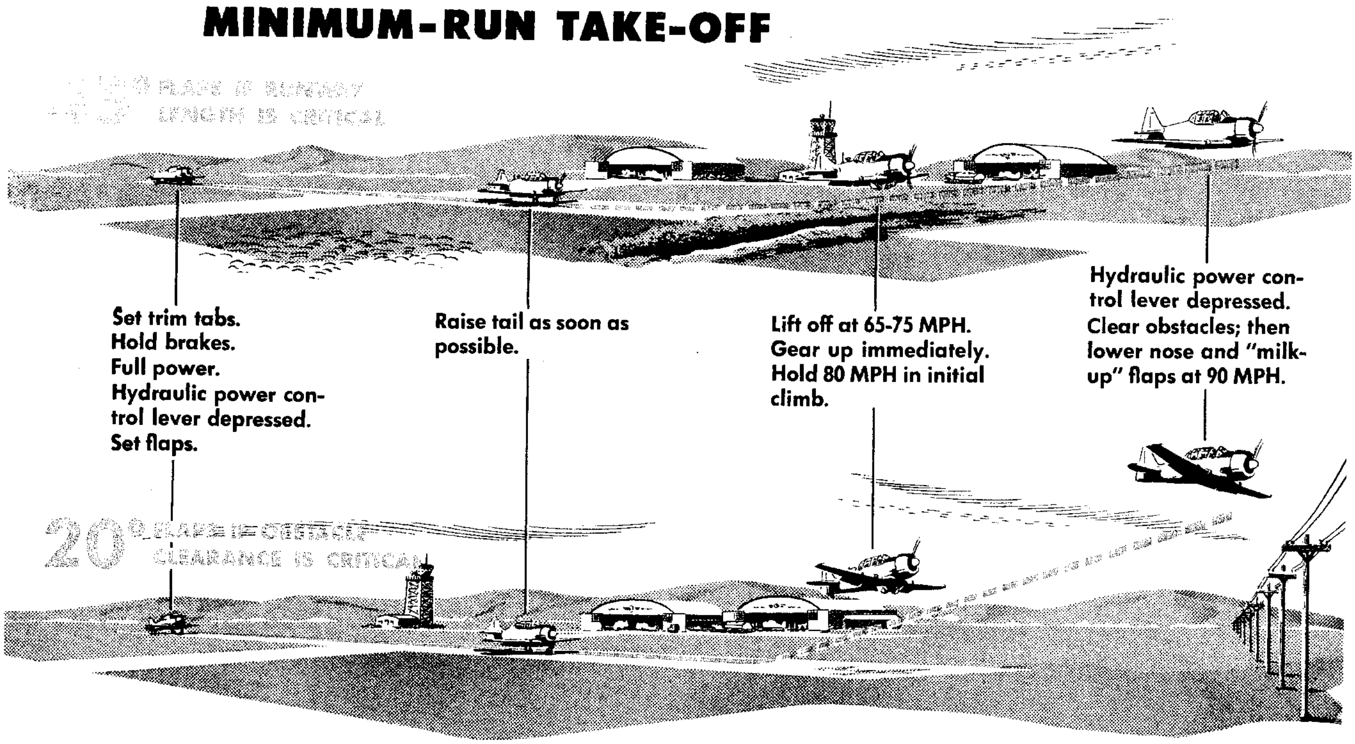


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Figure 2-3

AFTER TAKE-OFF.

1. When the airplane is definitely air-borne, depress hydraulic power control lever and move landing gear handle to UP. Approximately 15 seconds is required for gear retraction.

2. Reduce engine output to Maximum Continuous Power by first retarding throttle, then propeller control.

Note

For training purposes, reduce power to 30 inches manifold pressure at 2000 rpm.

3. Establish a constant climb attitude.

CLIMB.

1. Advance throttle to maintain manifold pressure during climb.

Note

For training purposes, maintain 110 mph, 30 inches mainfold pressure, and 2000 rpm.

2. Adjust oil cooler shutter control as necessary to maintain correct oil temperature.

3. Close canopy upon reaching 3000 feet, and lean mixture for smooth operation.

4. Refer to Normal Power Climb chart (figure A-6) for power settings, recommended airspeed, rate of climb, and fuel consumption.

FLIGHT CHARACTERISTICS.

All data on flight characteristics is incorporated in Section VI.

SYSTEMS OPERATION.

Information pertaining to use of Take-off Power, manual leaning of carburetor mixture, propeller operation, carburetor icing, detonation, preignition, and fuel system operation is included in Section VII.

DESCENT.

Descending with throttle closed, gear and flaps up, the airplane can cover long distances with a comparatively small loss of altitude. Lowering either the flaps or landing gear greatly steepens the gliding angle and increases the rate of descent. Before entering a descent, close throttle and move mixture control toward RICH to provide smooth engine operation at the reduced rpm. Because the engine cools rapidly during a descent with the throttle retarded, clear the engine approximately every half minute by advancing the throttle slowly and smoothly to 25 inches manifold pressure to prevent fouled plugs.

CAUTION

Do not allow cylinder head temperature to drop below 100°C during descent.

For training purposes, the following should be accomplished:

1. Open canopy as a safety precaution upon reaching 3000 feet.

2. Mixture control full RICH to prevent engine roughness and possible cutout during descent.

TRAFFIC-PATTERN CHECK.

Traffic-pattern procedure and check are shown in figure 2-4.

LANDING.

FINAL APPROACH AND TOUCHDOWN.

In order to obtain the results stated in the Landing Distances chart (figure A-4), accomplish the approach and landing procedures outlined in figure 2-4. In addition, observe the following precautions and techniques: Just before reaching end of runway, start flare. Use smooth, continuous back pressure on the stick to obtain a tail-low attitude for landing. Change attitude evenly and slowly; don't jerk the controls or go down in steps. Note that the attitude for this landing is similar to that attained in a gear- and flaps-down stall. Touch down in three-point attitude. The ailerons are only partially effective at low speeds but can still be used advantageously during the round-out and touchdown. Since the vertical stabilizer is offset to the left almost 2 degrees to counteract propeller torque at cruising speeds, a slight amount of left rudder pressure should be applied throughout the round-out and touchdown to prevent swerving to the right when landing in calm wind or straight into the wind. After touchdown, hold the stick back to help keep the tail down for positive tail wheel steering. Refer to Section III for information regarding emergency landings.

LANDING ROLL.

Since most landing accidents in this airplane occur during the landing roll, it is during this operation that you must be extremely alert. Immediately on touchdown, the airplane might swerve suddenly or skip on the runway. This sudden swerve is sometimes caused by landing in a slight drift or skid. Use ailerons, as necessary, to counteract a wing-low condition. Remain alert for a tendency to swerve to the right. When possible, take advantage of runway length to save brakes. Test brakes carefully before their use becomes a necessity and apply them soon enough to avoid abrupt braking action. Since the rudder, which is the main directional control, will be less effective as you slow down, you must be particularly alert as you near the end of the landing roll.

CROSS-WIND LANDING.

Use the wing-low method of landing in a cross wind.

1. Allow for drift while turning on final approach so that you won't overshoot or undershoot the approach leg.

2. Establish drift correction on final approach as soon as drift is detected. Use the wing-low method; i.e., lower the wing into the wind and apply opposite rudder to maintain the longitudinal axis parallel with the runway.

3. Velocity and direction of the wind will determine the amount of flaps used for the landing.

Note

Since an airplane acts like a weather vane, it attempts to swing into the wind. Flaps increase this weather-vaning tendency, so use a minimum degree of flaps in a cross wind.

4. Maintain drift correction throughout the round-out, touchdown, and landing roll. Apply additional aileron control into the wind to compensate for the loss of aileron effectiveness as airspeed decreases. Actual touchdown should be two-point (upwind main gear and tail wheel).

NIGHT LANDING.

The same techniques and procedures used for day landings will be applied. Don't turn on the landing lights at too high an altitude and avoid using them at all if landing in fog, smoke, or thick haze, as reflection from the lights impedes vision and may distort depth perception. Alternate the use of landing lights while taxiing after landing.

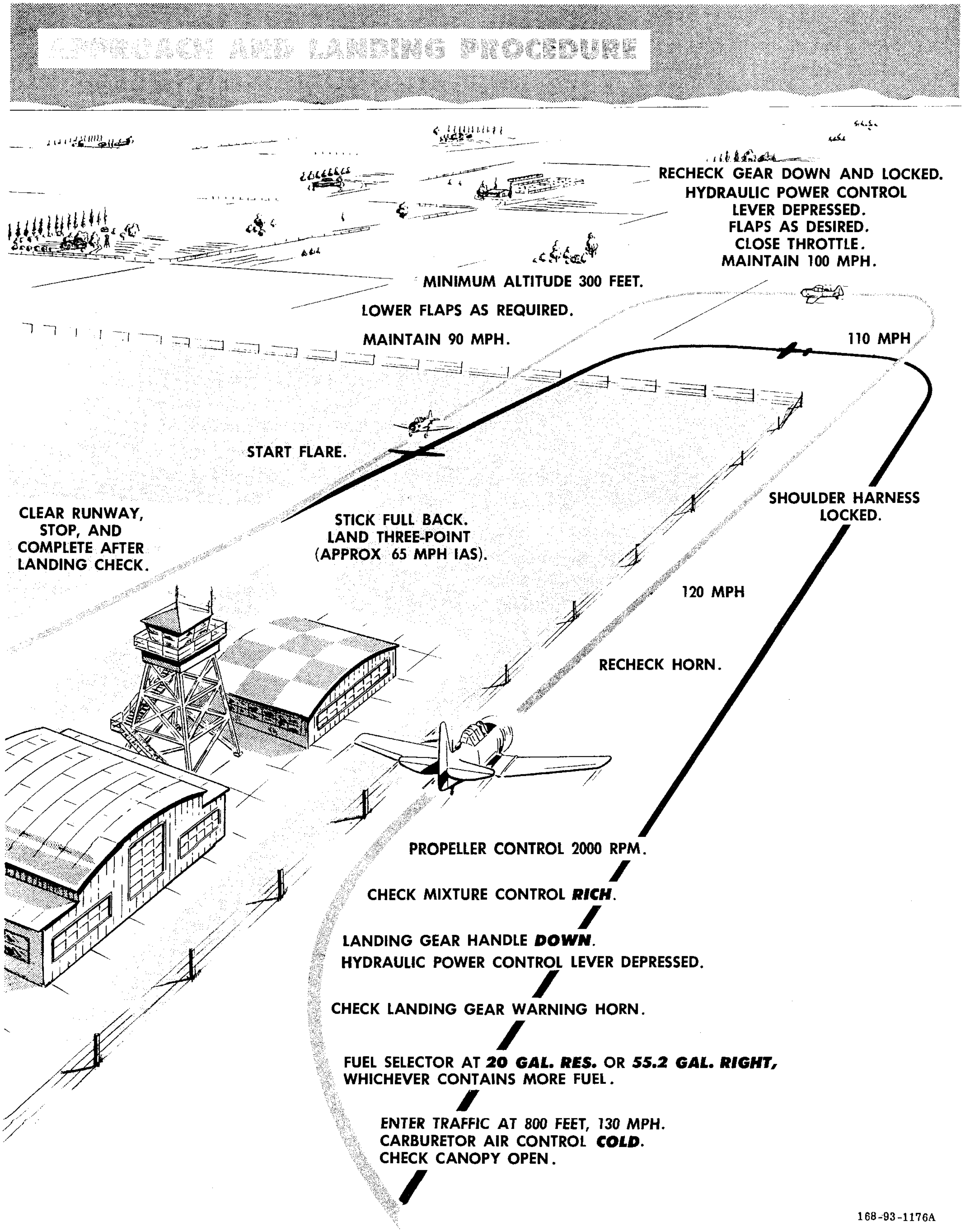

APPROACH AND LANDING PROCEDURE
RECHECK GEAR DOWN AND LOCKED.
HYDRAULIC POWER CONTROL
LEVER DEPRESSED.
FLAPS AS DESIRED.
CLOSE THROTTLE.
MAINTAIN 100 MPH.
MINIMUM ALTITUDE 300 FEET.
LOWER FLAPS AS REQUIRED.
MAINTAIN 90 MPH.
110 MPH
START FLARE.
SHOULDER HARNESS
LOCKED.
CLEAR RUNWAY,
STOP, AND
COMPLETE AFTER
LANDING CHECK.
STICK FULL BACK.
LAND THREE-POINT
(APPROX 65 MPH IAS).
120 MPH
RECHECK HORN.
PROPELLER CONTROL 2000 RPM.
CHECK MIXTURE CONTROL **RICH**.
LANDING GEAR HANDLE **DOWN**.
HYDRAULIC POWER CONTROL LEVER DEPRESSED.
CHECK LANDING GEAR WARNING HORN.
FUEL SELECTOR AT **20 GAL. RES.** OR **55.2 GAL. RIGHT,**
WHICHEVER CONTAINS MORE FUEL.
ENTER TRAFFIC AT 800 FEET, 130 MPH.
CARBURETOR AIR CONTROL **COLD**.
CHECK CANOPY OPEN.
168-93-1176A

Figure 2-4

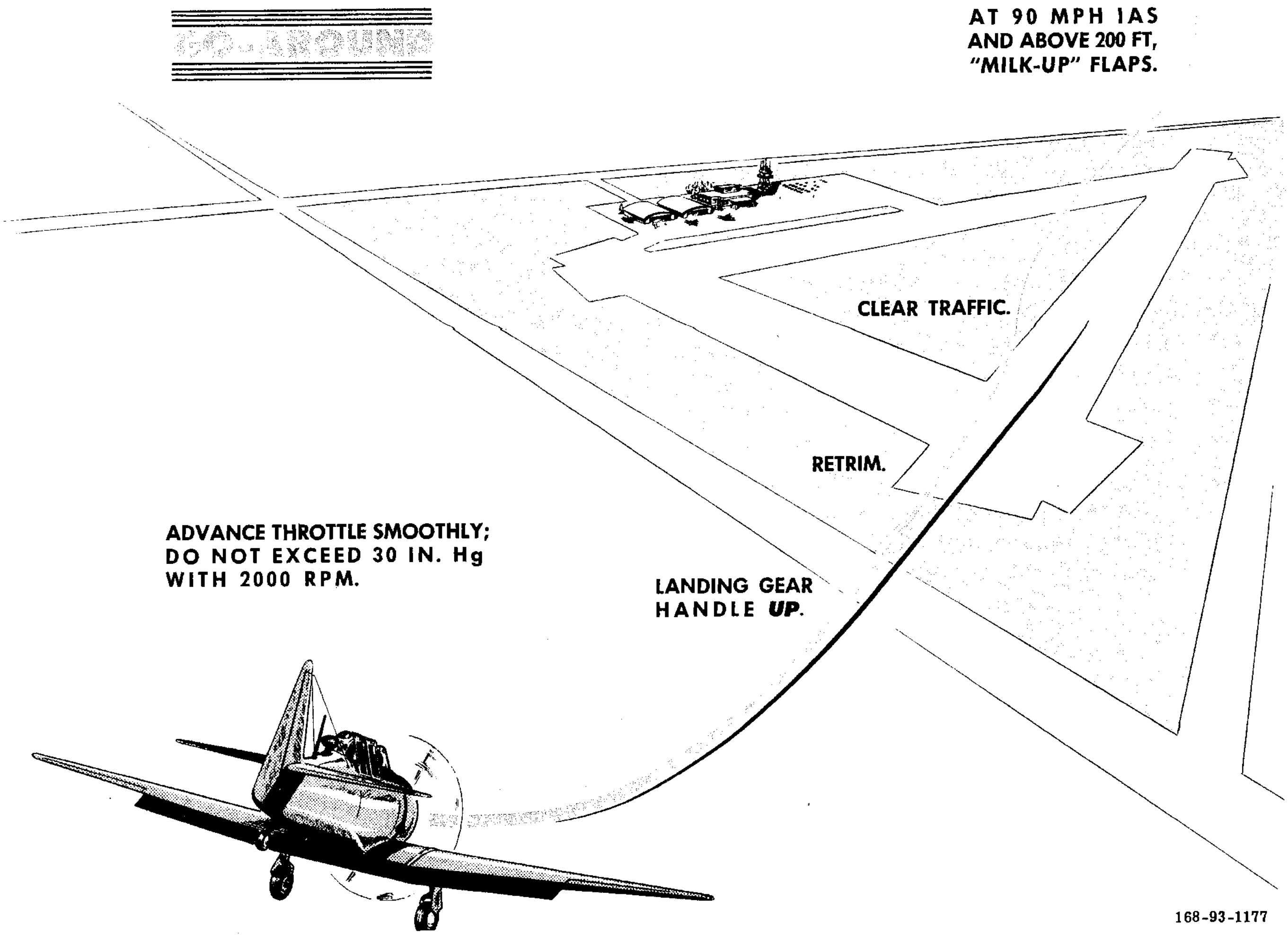


Figure 2-5

GO-AROUND.

A typical go-around procedure is shown in figure 2-5. Decide early in the approach whether it is necessary to go around, and start before you reach too low an altitude.

AFTER LANDING.

After the landing roll, clear the runway immediately and come to a complete stop. Before taxiing to the line:

1. Wing flap handle UP.
2. Trim tab controls neutral.
3. Propeller control full INCREASE.
4. Oil cooler shutter control OPEN.

POSTFLIGHT ENGINE CHECK.

After the last flight of the day, make the following checks:

Note

While performing checks requiring rpm reading, it may be necessary to tap the instrument panel to prevent tachometer sticking, especially in cold weather.

1. Check propeller control at full INCREASE.

2. Ignition switch check—at 700 rpm, turn ignition switch OFF momentarily. If engine does not cease firing completely, shut down engine and warn personnel to remain clear of the propeller until the ignition discrepancy has been corrected.

CAUTION

Perform this check as rapidly as possible to prevent severe backfire when ignition switch is returned to BOTH.

3. Idle speed and mixture check—with throttle against idle stop, the engine should idle at 450 rpm. When engine idle speed is stabilized, move the mixture control slowly and smoothly toward idle cutoff. Carefully observe the manifold pressure gage for any change during the leaning procedure. The manifold pressure should decrease slightly before it increases. An immediate increase indicates the mixture is set too lean. A momentary decrease in excess of 1/4 in. Hg indicates the mixture is set too rich. Return mixture control to RICH before engine cuts out.

4. Power check—adjust manifold pressure to field barometric pressure (as read on altimeter with elevation set to zero) and check for 2000 ($\pm$50) rpm.

Note

If less than the prescribed rpm is obtainable for given manifold pressure, engine is not developing sufficient power and should be corrected before the next flight.

CAUTION

When running engine up to high power, be careful to have stick back and brakes applied.

5. Ignition system check—with throttle adjusted to 2000 rpm, position ignition switch to L and R and, in each position, check for rpm drop (not to exceed 100 rpm). Return ignition switch to BOTH between checks to allow speed to stabilize. If drop exceeds 100 rpm, return ignition switch to BOTH and run engine up to Take-off Power for a few seconds; then recheck ignition system at 2000 rpm. Return ignition switch to BOTH at completion of test.

6. Cruising fuel-air mixture check—with propeller control at full INCREASE and mixture control full RICH, allow engine speed to stabilize at 1800 rpm. Move mixture control into the manual leaning range until an approximate 100 rpm drop is noted; then return to RICH. The engine speed should increase very slightly before it decreases. An immediate decrease indicates the mixture is set too lean. A momentary increase in excess of 25 rpm indicates the mixture is set too rich.

Note

Any discrepancies detected during the post-flight check should be entered on Form 1.

STOPPING ENGINE.

When a cold-weather start is anticipated, dilute oil as required by the lowest expected temperature. For oil dilution instructions, refer to Section IX.

1. Parking brakes set.
2. Open throttle to approximately 1450 rpm, place propeller control in full DECREASE, and allow engine to run for approximately one minute to allow the oil from the propeller to be scavenged back to the oil tank.
3. Stop engine by pulling mixture control full aft (idle cutoff).
4. When propeller stops, close throttle completely and turn ignition switch to OFF.
5. Radio off.
6. All electrical switches off.
7. Battery-disconnect switch OFF. Leave generator switch ON.
8. Fuel selector OFF.

BEFORE LEAVING AIRPLANE.

1. Have the wheels chocked; then release brakes.
2. Lock the surface controls.
3. Complete Form 1.
4. Close canopy.

EMERGENCY PROCEDURES

SECTION III

ENGINE FAILURE.

Engine failures fall into two main categories: those occurring instantly, and those with ample indication prior to failure. The instant failure is rare and usually occurs only if the ignition or fuel flow completely fails. Most engine failures are gradual and afford the alert pilot ample indication that he may expect a failure. An extremely rough-running engine, loss of oil pressure, excessive cylinder head temperature under normal flight conditions, loss of manifold pressure, and fluctuating rpm are indications that a failure is imminent. When indications point to an engine failure, the pilot should make a landing immediately.

PROCEDURE ON ENCOUNTERING PARTIAL ENGINE FAILURE.

Should engine failure appear imminent, and if altitude permits and it is reasonably safe to attempt to regain normal engine operation, proceed as follows:

1. Fuel selector 55.2 GAL. RIGHT or 20 GAL. RES., depending on which tank contains more fuel.

Note

Fuel switch-over signal light will usually illuminate approximately 10 seconds prior to complete failure of engine if difficulty is caused by fuel starvation.

2. If necessary, maintain adequate fuel pressure with hand fuel pump.
3. Mixture control full RICH.
4. Propeller control full INCREASE.
5. Check ignition switch at BOTH.
6. Carburetor air control HOT, if icing conditions exist.

PROCEDURE ON ENCOUNTERING COMPLETE ENGINE FAILURE.

Should the engine fail completely, and if there is still sufficient altitude and it is reasonably safe to restart the engine, accomplish the foregoing procedure (partial engine failure) and then proceed as follows:

1. Move mixture control to idle cutoff.
2. Advance throttle to full OPEN for a few seconds to clear engine.
3. Readjust throttle to ½ inch open.
4. Mixture control full RICH.
5. Prime engine if necessary.

Should this procedure fail to restart the engine, shut down engine as follows:

1. Mixture control to idle cutoff.
2. Throttle CLOSED.
3. Ignition switch OFF.

4. Fuel selector OFF.

5. Battery-disconnect and generator switches OFF except when power is desired to operate lights or communication equipment.

ENGINE FAILURE UNDER SPECIFIC CONDITIONS.

ENGINE FAILURE DURING TAKE-OFF.

Should the engine fail during the take-off run, immediately close throttle and apply brakes. If remaining runway is insufficient for stopping and it becomes necessary, collapse the landing gear; then, if time permits, move the mixture control to idle cutoff. Get clear of airplane immediately.

ENGINE FAILURE AFTER TAKE-OFF.

If the engine fails immediately after take-off, proceed as follows:

1. Lower nose immediately to maintain airspeed above stall.

2. Landing gear handle UP. (Even if there is not sufficient time or hydraulic pressure to completely raise gear, it is better to have it unlocked so that it will collapse on landing. Judgment should be used on long runways where a gear-down landing could be accomplished.)

3. Fuel selector OFF.

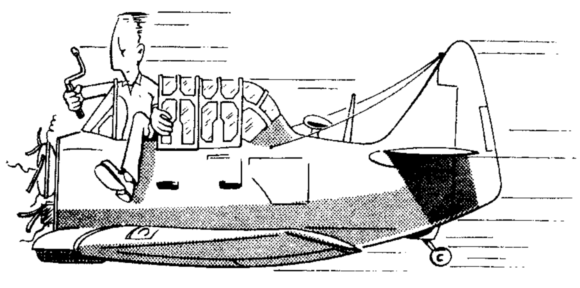
4. Land straight ahead, changing direction only enough to miss obstacles. Don't try to turn back to the field—making a crash landing straight ahead with airplane under control is much better than turning back and taking the chance of an uncontrolled roll into the ground. (See figure 3-1.)

ENGINE FAILURE DURING FLIGHT.

If the engine fails during flight:

1. Lower nose as speed drops, to maintain glide at approximately 95 mph.

2. If altitude permits, attempt to restart engine.



Do not attempt restart if engine stopped because of obvious mechanical failure.

3. If it is impossible to restart engine, make a forced landing if possible; otherwise, bail out.

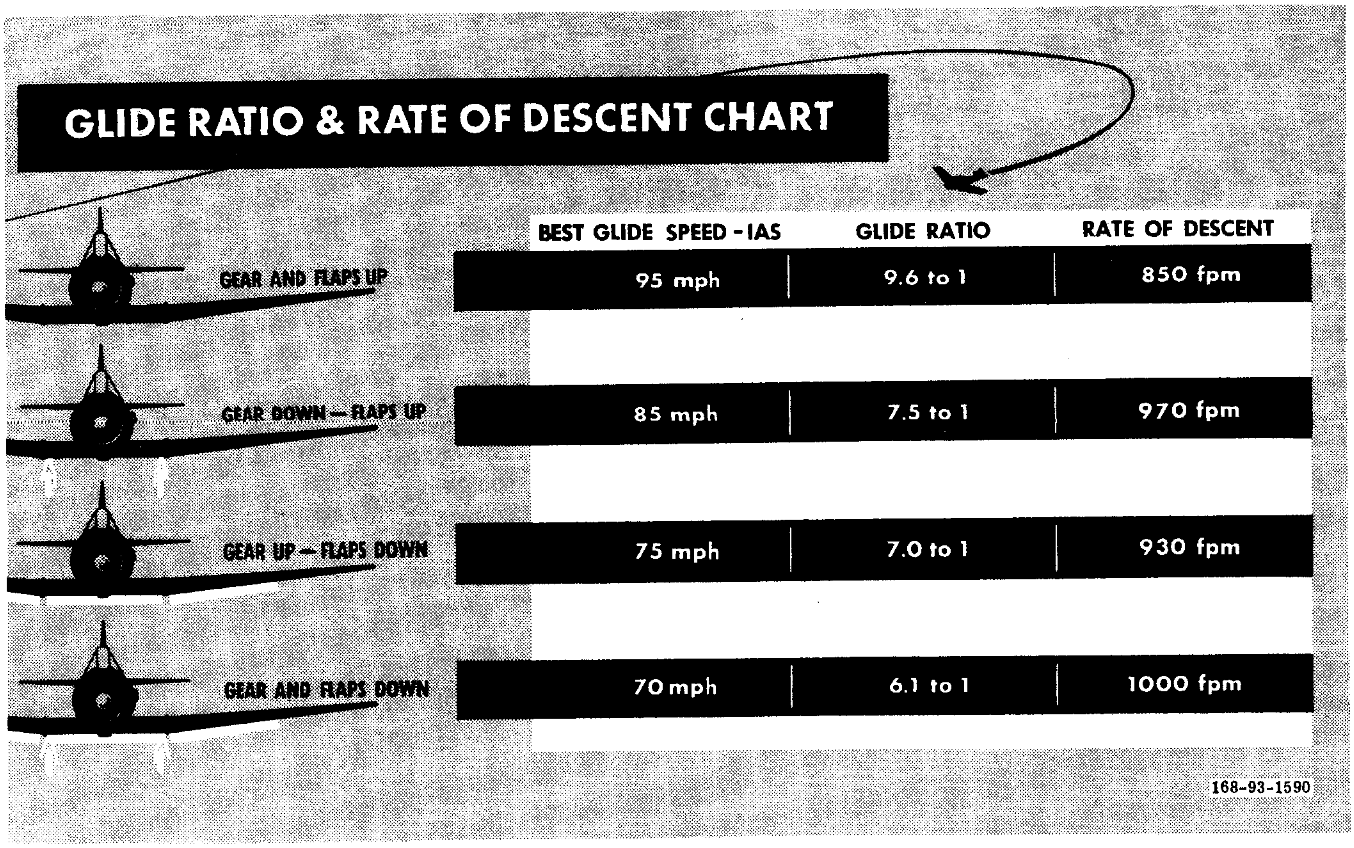
MAXIMUM GLIDE.

Maximum glide distance can be obtained by maintaining a speed of 95 mph with gear and flaps up and with propeller control at full DECREASE rpm to minimize drag. See figure 3-3 for optimum glide path. Glide ratio and rate of descent at best glide speed under varying conditions are shown in figure 3-2.

DEAD-ENGINE LANDING.

See figure 3-4 for procedure to follow in case of a forced landing (power off) with gear up or down.

Figure 3-1



	BEST GLIDE SPEED - IAS	GLIDE RATIO	RATE OF DESCENT
GEAR AND FLAPS UP	95 mph	9.6 to 1	850 fpm
GEAR DOWN — FLAPS UP	85 mph	7.5 to 1	970 fpm
GEAR UP — FLAPS DOWN	75 mph	7.0 to 1	930 fpm
GEAR AND FLAPS DOWN	70 mph	6.1 to 1	1000 fpm

Figure 3-2

PROPELLER FAILURE.

A runaway condition of the propeller caused by excess power and decreased load on the engine can occur in a prolonged dive, and the engine may exceed the overspeed limit of 2800 rpm. At first evidence of a runaway or overspeeding propeller:

1. Retard throttle.

2. Adjust propeller control in an attempt to bring propeller within limits.

3. Pull airplane up in a climb to increase load on engine.

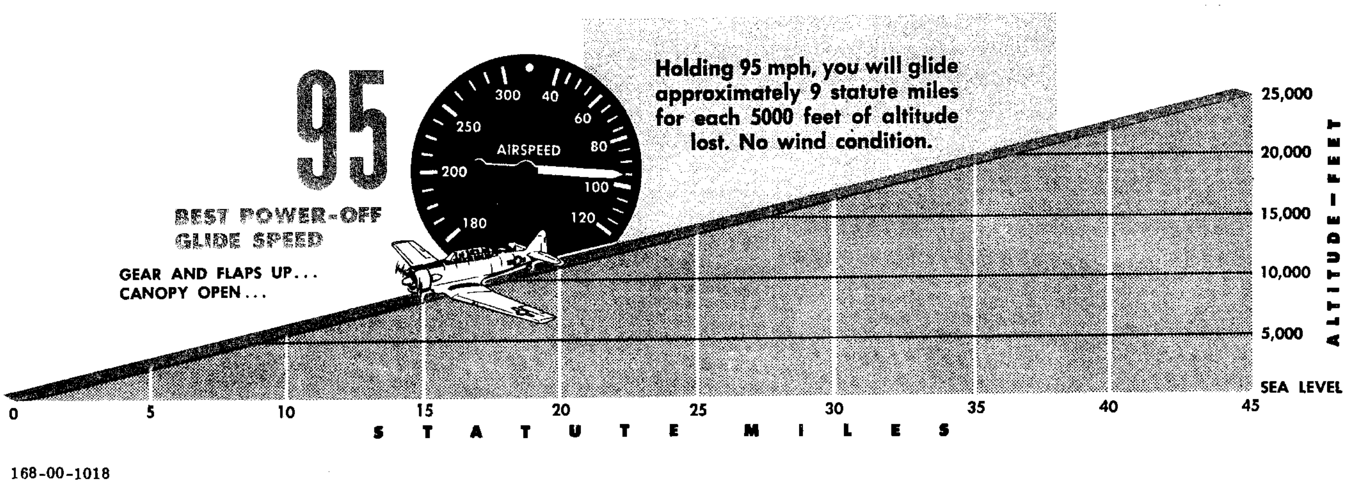


Figure 3-3. Maximum Glide

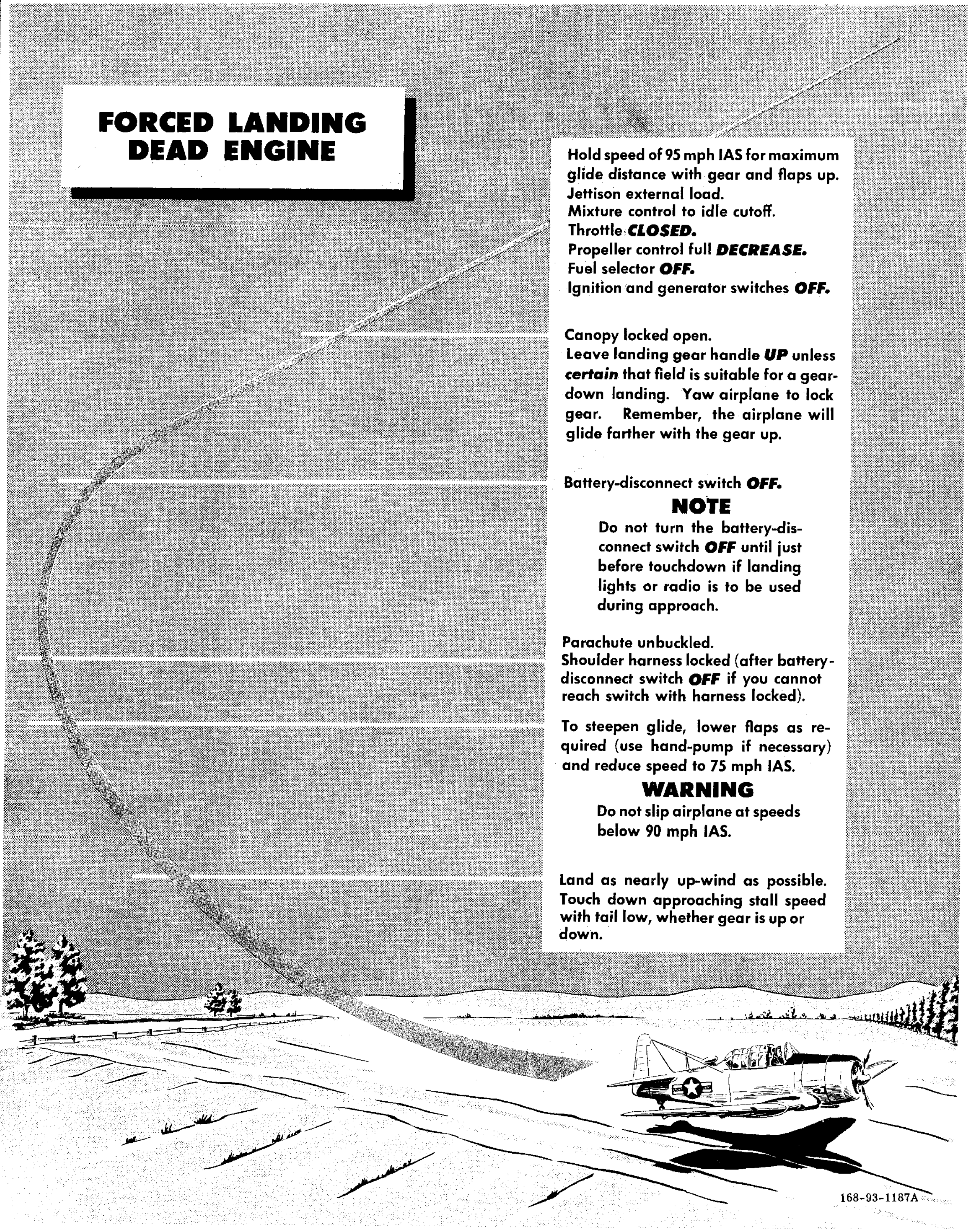

FORCED LANDING DEAD ENGINE
Hold speed of 95 mph IAS for maximum glide distance with gear and flaps up.
Jettison external load.
Mixture control to idle cutoff.
Throttle **CLOSED.**
Propeller control full **DECREASE.**
Fuel selector **OFF.**
Ignition and generator switches **OFF.**
Canopy locked open.
Leave landing gear handle **UP** unless ***certain*** that field is suitable for a gear-down landing. Yaw airplane to lock gear. Remember, the airplane will glide farther with the gear up.
Battery-disconnect switch **OFF.**
NOTE
Do not turn the battery-disconnect switch **OFF** until just before touchdown if landing lights or radio is to be used during approach.
Parachute unbuckled.
Shoulder harness locked (after battery-disconnect switch **OFF** if you cannot reach switch with harness locked).
To steepen glide, lower flaps as required (use hand-pump if necessary) and reduce speed to 75 mph IAS.
WARNING
Do not slip airplane at speeds below 90 mph IAS.
Land as nearly up-wind as possible. Touch down approaching stall speed with tail low, whether gear is up or down.
168-93-1187A

Figure 3-4

FIRE.

During starting, engine fire can occur in the induction system or in the exhaust system. However, pilot technique is the same in combating both types of fires. Should a fire occur in the engine accessory section, the engine should be stopped immediately.

Note

No fire extinguishing system is installed on this airplane.

ENGINE FIRE DURING STARTING.

1. Continue cranking in attempt to clear or start engine, as fire may be drawn through engine or blown out the exhaust stacks and extinguished. Do not prime engine again.
2. If engine does not start, continue cranking, mixture control to idle cutoff, and fuel selector, ignition, and generator switches OFF.
3. If fire continues, stop cranking and turn battery-disconnect switch OFF.
4. Get clear of airplane and signal ground crew to use portable fire extinguishing equipment.

ENGINE FIRE AFTER STARTING.

1. Keep the engine running, as the fire may be drawn through the engine and extinguished.
2. If fire continues to burn, shut down engine.
3. Get clear of the airplane and signal the ground crew to use the portable fire equipment.
4. Do not restart engine until the cause of the fire has been determined.

ENGINE FIRE DURING FLIGHT.

Depending upon the severity of the fire, either bail out immediately or shut down the engine as follows in an attempt to extinguish the fire:

1. Mixture control to idle cutoff.
2. Throttle CLOSED.
3. Ignition switch OFF.
4. Fuel selector OFF.
5. Battery-disconnect and generator switches OFF except when power is desired to operate lights or communication equipment.

FUSELAGE FIRE DURING FLIGHT.

1. Reduce airspeed immediately, in preparation for bail-out (if it becomes necessary) and to lessen possibility of fire spreading.

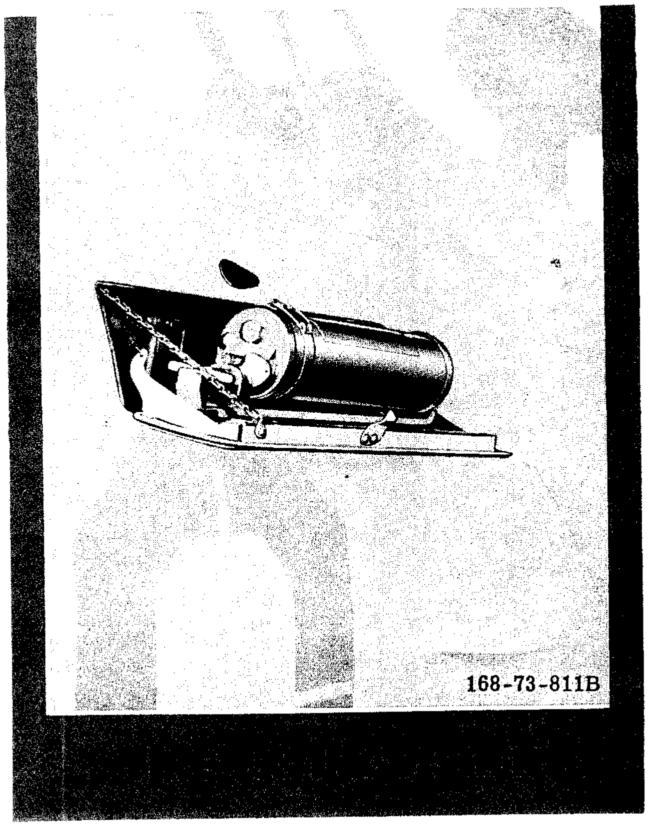


Figure 3-5

2. If smoke or fumes enter cockpit, use oxygen (if carried) or open canopy.
3. Generator and battery-disconnect switches OFF.
4. If fire persists, shut down engine as outlined in the foregoing procedure.
5. If possible, use hand fire extinguisher (figure 3-5), located on left side of rear cockpit.

WARNING

Toxic fumes can be generated where fire extinguisher fluid (carbon tetrachloride) contacts hot metal.

6. If fire is not extinguished immediately, bail out.

WING FIRE.

1. Turn off all wing light switches (position, passing, and landing), armament switches, and pitot heater switch.
2. Attempt to extinguish fire by sideslipping airplane away from flame.
3. If fire is not extinguished immediately, bail out.

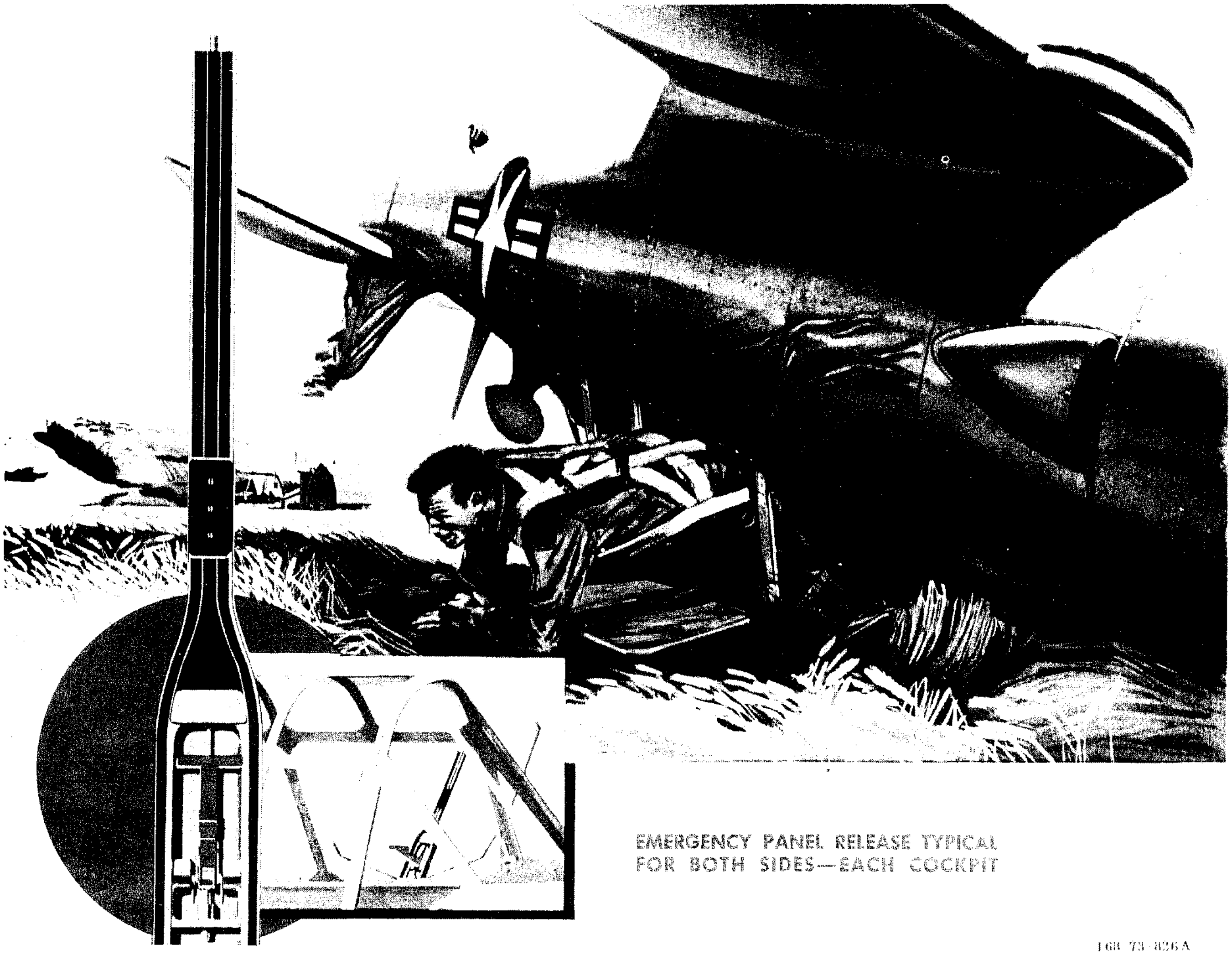


Figure 3-6. Emergency Escape on the Ground

ELECTRICAL FIRE.

Circuit breakers isolate most electrical circuits and automatically interrupt power to prevent a fire when a "short" occurs. If necessary, however, turn generator and battery-disconnect switches OFF to remove power from all electrical equipment, and land as soon as possible. If electrical power is essential, as during instrument flight, an attempt to identify and isolate the shorted circuit may be feasible. This can be accomplished as follows:

1. With generator and battery-disconnect switches OFF, turn off all remaining switches (except ignition, of course).

2. Turn generator switch ON. If generator circuit is shorted, return switch to OFF and place battery-disconnect switch ON instead.

3. Individually turn each circuit on again, allowing a short period of time before proceeding to the next, until the shorted circuit is identified.

SMOKE ELIMINATION.

Should smoke or fumes enter the cockpit, proceed as follows:

1. Reduce airspeed immediately, in preparation for bail-out (if it becomes necessary) and to minimize spreading of fire.
2. Open cold-air outlets.
3. Use oxygen (if carried) or open canopy.

LANDING EMERGENCIES.

GEAR RETRACTED.

If the gear fails to extend, a wheels-up landing can be made on either hard or soft ground as follows:

1. Establish a normal flaps-down approach.
2. Flare out as in a normal landing (with tail low). This will enable tail wheel to absorb the initial shock.
3. Mixture control to idle cutoff.
4. Get clear of airplane immediately.

ONE WHEEL RETRACTED.

Ordinarily a wheels-up landing is preferable to a landing with only one wheel extended. However, if one wheel is extended and cannot be retracted, proceed as follows:

1. Make normal flaps-down approach, with wing low on the extended-gear side.
2. Touch down on main wheel and tail wheel simultaneously. Use ailerons to hold up wing with retracted gear.
3. Shut down engine.
4. Maintain controlled ground roll by use of steerable tail wheel and brake.
5. When wing tip strikes the ground, apply maximum brake pressure possible without raising the tail.

FLAT TIRE.

If a tire is flat at the time of landing or a blowout occurs during the ground roll, proceed as follows:

1. Hold stick full back to keep tail down and apply full aileron opposite the flat tire.
2. Apply brake hard to wheel opposite the flat tire and use steerable tail wheel to try to maintain a controlled landing roll.
3. Shut down engine.

EMERGENCY ENTRANCE.

The canopy lever on the exterior left side of each canopy is used for entrance to either cockpit in an emergency.

EMERGENCY ESCAPE ON THE GROUND.

If the canopy cannot be opened, emergency escape can be accomplished through a removable canopy panel (figure 3-6) on each side of both cockpits.

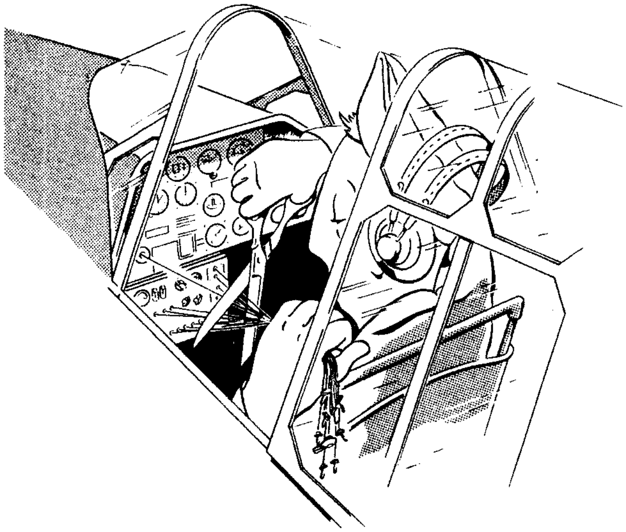
DITCHING.

The airplane should be ditched only as a last resort. Since all emergency equipment is carried by the pilots, there is no advantage in riding the airplane down. However, if for some reason bail-out is impossible and ditching is unavoidable, proceed as follows:

WARNING

Be sure to ditch while fuel is still available.

1. Follow radio distress procedure.
2. Turn battery-disconnect switch OFF.
3. See that no personal equipment will foul when you leave the airplane.
4. Unbuckle parachute and release the life raft from the parachute harness. Tighten and lock safety belt and shoulder harness, as there is a violent deceleration of the airplane upon final impact.



Before a forced landing, all switches not readily accessible with the harness locked should be "cut" before the harness lock handle is moved forward to the locked position.

5. Check landing gear handle UP.
6. Canopy full open and locked.
7. Lower wing flaps 20 degrees if sufficient hydraulic pressure is available.
8. Make normal approach with power if possible and flare out to a normal landing attitude. Touch down, approaching stalling speed with tail low. Unless the wind is high or the sea is rough, plan the approach heading parallel to any uniform swell pattern and try to touch down along a wave crest or just after a crest has passed. If the wind is as high as 40 mph or the surface is irregular, the best procedure is to approach into the wind and touch down on the falling side of the wave.
9. Just before impact, turn ignition switch OFF.
10. The back cushion of each cockpit seat is filled with kapok and may be used as a life preserver.
11. When leaving airplane, be sure to carry life raft with you.

BAIL-OUT.

In the event the decision has been made to abandon the airplane in flight, the following steps should be taken:

1. Reduce airplane speed as much as possible; trim it slightly nose-down and head for an uninhabited area.
2. Warn the other pilot to bail out and receive his acknowledgment.
3. See that no personal equipment will foul when you bail out.
4. Raise seat to top position.
5. Canopy full open and locked.

Note

If the canopy cannot be opened, raise the red release handle at the bottom center of either panel, breaking the safety wire, and push the panel clear of the airplane.

6. From either cockpit, dive toward trailing edge of wing. (See figure 3-7.)

WARNING BAIL OUT ON OUTSIDE OF A SPIN TO MINIMIZE DANGER OF BEING STRUCK BY AIRPLANE.

Figure 3-7. Bail-out

FUEL SYSTEM EMERGENCY OPERATION.

If the engine-driven fuel pump fails, fuel can be supplied to the engine by operating the hand fuel pump on the left side of each cockpit.

ELECTRICAL POWER SYSTEM EMERGENCY OPERATION.

If the ammeter shows zero current during flight, it may indicate failure of the generator system. In such case, the battery will supply the electrical load for a short time only. Turn the generator switch OFF and conserve the battery by using electrical equipment sparingly. If a complete electrical failure should occur or if it becomes necessary to turn off both the generator and battery-disconnect switches, landing should be made as soon as possible. In case of a complete electrical failure, the oil temperature gage and carburetor mixture temperature gage will both be inoperative and will register zero. See figure 1-18 for electrically operated equipment.

HYDRAULIC POWER SYSTEM EMERGENCY OPERATION.

Hydraulic hand-pump can be used to operate the landing gear or flaps, should the engine-driven pump fail. It is not necessary to move the power control lever when the hand-pump is used, since a check valve in the system separates the hand-pump from the power control valve. To operate landing gear or flaps by means of the hand-pump:

1. Place the landing gear handle or wing flap handle in the desired position.
2. Raise the hand-pump handle to the extended position, turn handle clockwise until it locks, and operate the pump.

The wing flaps cannot be operated in case of complete hydraulic failure. The landing gear, however, can be lowered by gravity when hydraulic pressure is unavailable.

LANDING GEAR SYSTEM EMERGENCY OPERATION.

LANDING GEAR EMERGENCY LOWERING.

The procedure for lowering the landing gear in case of complete hydraulic failure is given in figure 3-8.

LANDING GEAR EMERGENCY DOWNLOCK.

Should the landing gear fail to automatically lock in the down position, move the front cockpit landing gear handle down to the extreme end of the sector (EMERGENCY position). This manually forces the downlock pins in place to lock the gear down. However, the handle must never be positioned to EMERGENCY *before* the gear is completely down; if it is, while the handle is at EMERGENCY, the downlock pins may prevent the gear from extending fully.

Note

The landing gear downlock pins can be visually checked for locked position through a window in the wing, above the landing gear strut.

HAND-CRANKING ENGINE.

If electrical power is not available, the starter can be energized manually by a handcrank as follows:

1. Move the brush-spring release handle on the back of the starter to OFF (clockwise). The handle can be reached through an access door on the upper left side of the engine compartment cowling.
2. Insert handcrank into opening provided forward of the access door and rotate at approximately 80 rpm.
3. When this speed has been attained, remove handcrank and pull manual engaging ring, located above crank opening.
4. After engine starts, release engaging ring, return brush-spring release handle to ON, and safety with wire; then stow crank in baggage compartment.

Figure 3-8

DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

SECTION IV

HEATING SYSTEM.

Ram air from a duct opening on the top front of the engine is heated in a shroud around the exhaust manifold and is then introduced into the front cockpit. The cockpit hot-air temperature control valve (4, figure 1-12) is located inboard of the right rudder pedal. A butterfly valve in the outlet can be rotated by the pilot's foot to regulate the volume of hot air entering the cockpit.

VENTILATING SYSTEM.

Cold air for ventilating is obtained from an opening in the leading edge of the left wing center section and is discharged in the front cockpit from a cold-air temperature control valve (5, figure 1-12), located inboard of the left rudder pedal. The outlet, which incorporates a butterfly valve, can be adjusted by the pilot's foot to control the volume of air entering the cockpits. A ventilator on the left side of the rear cockpit can be manually opened by a handle (17, figure 1-8) to provide fresh air for the rear cockpit. Additional ventilation may be obtained by opening the sliding sections of the canopy to any one of the intermediate positions.

PITOT HEATER.

A heater in the pitot head is controlled by the pitot heat switch (figure 1-10), located on the instrument subpanel in the front cockpit only.

CAUTION

> To prevent burning out heater elements, the pitot heat switch should be OFF when the airplane is on the ground.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

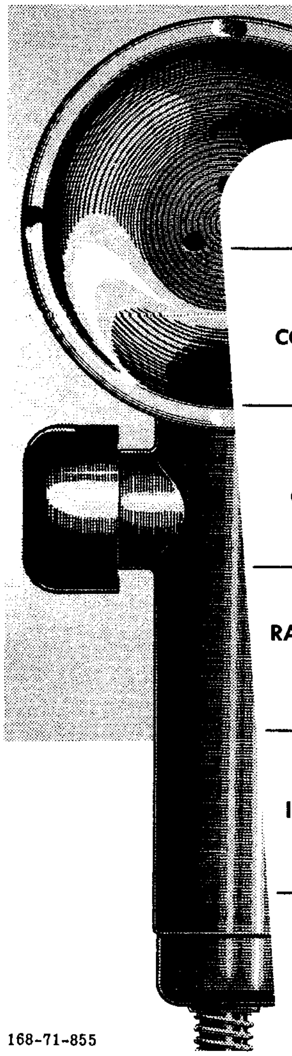
See figure 4-1.

COMMUNICATION MASTER CONTROLS.

COMMUNICATION CONTROL JACK BOX.

A jack box for control of the communication equipment, located on the right side of each cockpit, incorporates a master volume control knob (6, figure 1-5; 1, figure 1-9) and a master selector switch (7, figure 1-5; 13, figure 1-9). Moving the selector switch to COMP, VHF, RANGE, or INTER selects the radio compass, command set, radio range receiver, and interphone, respectively. The selector switch is spring-loaded from CALL to INTER. The CALL position is used to interrupt any

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT



TYPE	DESIGNATION	USE	HORIZONTAL RANGE	LOCATION OF CONTROLS
VHF COMMAND	AN/ARC-3	Two-way communication	30 miles at 1000 feet 135 miles at 10,000 feet	Right side each cockpit
RADIO COMPASS	AN/ARN-7	Reception of voice and code communication, position finding, homing	50 to 100 miles for range signals, 100 to 250 miles for broadcast signals	Left forward side each cockpit
RADIO RANGE RECEIVER	BC-453	Radio range reception	50 to 70 miles	Right forward side front cockpit
INTERPHONE	AN/AIC-2	Intercockpit communication		Right side each cockpit
MARKER BEACON	RC-193A	Reception of location marker beacon signals (fan marker)		Indicator light on each instrument panel

168-71-855

Figure 4-1

radio reception in the airplane to enable immediate interphone communication without transmitting the conversation. The master volume control knob, marked "INCREASE OUTPUT," increases reception volume when rotated clockwise.

RADIO RANGE FILTER SWITCH.

The radio range filter switch (8, figure 1-5; 2, figure 1-9) is mounted on a panel in each cockpit, aft of the communication control jack box. Placing the selector in the RANGE position subdues voice reception to bring out range reception. Moving the selector to the VOICE position causes radio range signals to be subdued to bring out voice reception. In the BOTH position, voice and range receptions are received in equal volume.

VHF COMMAND RADIO CONTROL AND INDICATOR.

In addition to the conventional controls, the vhf command radio also incorporates control transfer switches and control indicator lights.

VHF CONTROL TRANSFER SWITCH.

A control transfer switch (11, figure 1-5; 5, figure 1-9), mounted on the vhf control panel in each cockpit, is provided to enable either pilot to control channel selection of the vhf command radio. This switch has no effect on reception of radio signals.

VHF CONTROL INDICATOR LIGHT.

A control indicator light (13, figure 1-5; 4, figure 1-9) is located on the vhf control panel in each cockpit. The light illuminates in the cockpit from which the command set can be controlled as determined by the vhf control transfer switch.

OPERATION OF VHF COMMAND RADIO.

1. Position vhf control transfer switch so that the vhf control indicator light illuminates.
2. Depress desired channel selector button.

3. Allow 30 to 40 seconds for set to warm up. Near the end of warm-up period, an audio tone will be heard in the headset. When the tone stops, the set is ready for operation and may be tuned.

4. Adjust vhf audio control knob for desired output. Rotate control clockwise to increase volume.

5. Depress press-to-talk button, on the microphone, to transmit; release the button to receive. Reception will be cut off at both crew stations whenever either microphone button is depressed.

Note

Do not turn command radio off immediately after depressing a channel selector button. If the automatic selector has not had sufficient time to complete its change cycle, the set will be inoperative when it is again turned on. Should this occur, turn the set on by pressing any channel selector button and run through the complete number of selections. Then depress the desired selector button, and the set will resume normal operation.

OPERATION OF RADIO COMPASS.

1. Position cw selector switch, at bottom of radio compass control panel, at VOICE. For reception of continuous wave transmission, place cw selector switch to CW position.

2. With master selector switch, on the control jack box, at COMP, turn radio compass power switch, on radio compass control panel, to ANT.

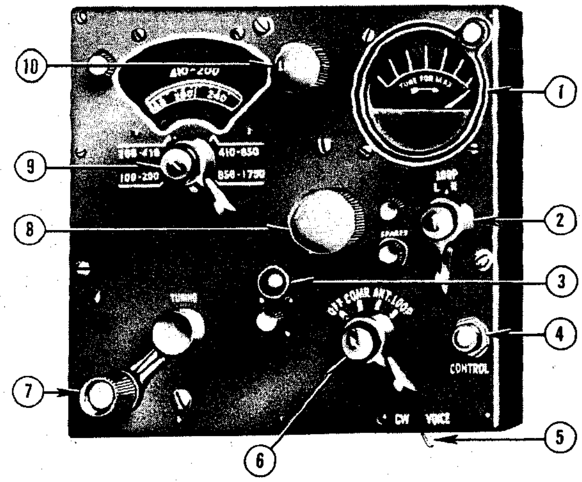
3. Depress control button, on radio compass control panel, to obtain control of set. When control is complete, the indicator on the tuning meter fluctuates and the green control indicator light illuminates.

4. Rotate frequency band selector, on radio compass control panel, to desired frequency band.

5. Rotate tuning crank to tune in desired frequency as indicated by maximum deflection of the indicator on the tuning meter. Proper station is identified by published call sign.

6. Place radio compass power switch at COMP to actuate indicator hand on radio compass.

7. When using the radio compass for aural-null procedures, the set should be tuned for maximum readability rather than maximum deflection of the tuning meter. For maximum reception or aural-null orientation and homing, the loop antenna can be rotated by using the loop adjustment switch, on the radio compass control panel. Pushing the switch in against a spring load and moving it to L or R causes the loop antenna to revolve rapidly for large adjustments. In the normal position to which the switch is spring-loaded, movement of the switch to L or R causes the loop to revolve slowly for fine adjustments. The radio compass power switch should be at LOOP for adjustment of the loop antenna.



1. TUNING METER
2. LOOP ADJUSTMENT SWITCH
3. CONTROL INDICATOR LIGHT
4. CONTROL BUTTON
5. CW SELECTOR SWITCH
6. POWER SWITCH
7. TUNING CRANK
8. AUDIO CONTROL KNOB
9. FREQUENCY BAND SELECTOR
10. LIGHT CONTROL KNOB

168-71-856

RADIO COMPASS CONTROL PANEL

Figure 4-2

RADIO RANGE RECEIVER CONTROL.

The range receiver can be tuned from the front cockpit only. In addition to the conventional controls, the range receiver also includes a range-volume switch.

RANGE-VOLUME SWITCH.

A range-volume switch (10, figure 1-5), located in the front cockpit, has two positions—FORWARD COCKPIT and AFT COCKPIT. The switch enables the radio range receiver volume to be individually controlled from the selected cockpit.

OPERATION OF RADIO RANGE RECEIVER.

1. Place master selector switch, on control jack box, to RANGE.

2. Move range receiver power switch, on range receiver control box, from OFF to MCW for voice or radio range reception.

3. Place range receiver A-B switch, on range receiver control box, at A.

4. Rotate tuning crank, on range receiver control box, to tune set to desired frequency as indicated by revolving dial.

5. Rotate master volume control knob, on control jack box, fully clockwise for maximum output.

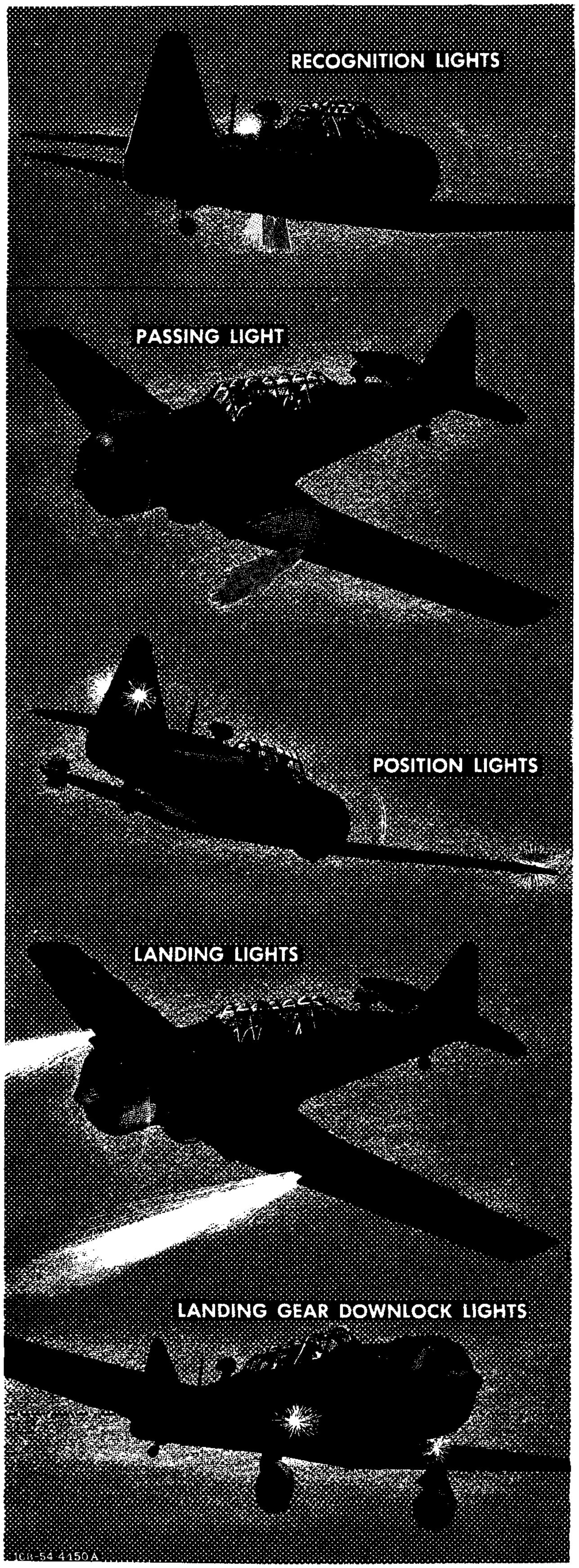


Figure 4-3

6. Set range-volume switch (in front cockpit) at FORWARD COCKPIT and AFT COCKPIT, respectively, so that radio range volume can be adjusted as desired by each pilot.

7. Adjust volume of range reception with volume control, marked "INCREASE OUTPUT." The volume control increases volume as it is rotated clockwise.

OPERATION OF INTERPHONE.

1. Place master selector switch, on control jack box, at INTER.

2. Use microphone as in normal radio transmission.

3. To receive vhf command set signals while using interphone, place vhf audio switch, on vhf control panel, at ON. This allows reception of selected frequency channel without transmitting interphone conversation.

OPERATION OF MARKER BEACON.

The marker beacon receiver operates automatically when the battery-disconnect switch is turned ON.

LIGHTING EQUIPMENT.

EXTERIOR LIGHT CONTROLS.

All exterior lights (landing, position, passing, and recognition) are controlled from the front cockpit only. See figure 4-3 for location of all exterior lights.

CAUTION

Do not leave landing, passing, or recognition lights on for more than 10 seconds when airplane is on the ground, as excess heat may seriously damage the lights.

LANDING LIGHT SWITCHES.

Landing lights, installed in the leading edge of each outer wing panel, are individually turned ON and OFF by switches (figure 1-10) located on the instrument subpanel in the front cockpit.

POSITION LIGHT SWITCHES.

Position lights, located on the wing tips and tail, are controlled by switches (figure 1-10) located on the instrument subpanel in the front cockpit. Individual switches for the wing lights and taillights have BRIGHT, DIM, and OFF positions. The left wing lights are red, the right wing lights are green, and the taillights are white.

PASSING LIGHT SWITCH.

A passing light, installed in the leading edge of the left wing panel, beside the landing light, is turned ON and OFF by a switch (figure 1-10) located on the instrument subpanel in the front cockpit.

RECOGNITION LIGHT SWITCHES.

Three recognition lights (red, green, and amber) are installed on the lower side of the fuselage, just aft of the rear cockpit. A white recognition light is located aft of the rear cockpit, on the top of the fuselage. The lights are turned ON and OFF by individual switches (figure 1-10) located on the panel adjacent to the instrument subpanel in the front cockpit. Each individual switch can be placed in the KEY, STEADY, or OFF position. With any switch on the KEY position, the push button on the top of the switch panel can be used to flash the related light as desired. The recognition lights are disconnected on most airplanes.

INTERIOR LIGHT CONTROLS.

INSTRUMENT PANEL LIGHT RHEOSTAT.

The instrument panels are illuminated by fluorescent lights, one on each side of each cockpit. The lights are controlled by individual rheostats (figure 1-10; 9 and 11, figure 1-9) located on the instrument subpanel in the front cockpit and on the electrical control panel in the rear cockpit, respectively.

COCKPIT LIGHT CONTROL KNOB.

A cockpit light is mounted on the left side of each cockpit. The light beam can be adjusted from a small spotlight to a floodlight beam. Light brilliancy is controlled by a knob (3, figures 1-4 and 1-8) on the side of the lamp housing. A push-button switch, on the back of the lamp housing, provides a means of instantaneous control of the light so that it may be used for signaling. The head of the lamp housing, which contains a red lens, can be removed to obtain a white light. The lamp can be removed from its bracket and held in any desired position.

FUEL QUANTITY GAGE LIGHT SWITCH.

Lights above each fuel quantity gage can be turned ON or OFF from either cockpit. The fuel quantity gage light switch (figure 1-10) in the front cockpit is located on the instrument subpanel; the switch (10, figure 1-9) in the rear cockpit is on the electrical control panel.

COMPASS LIGHT RHEOSTAT.

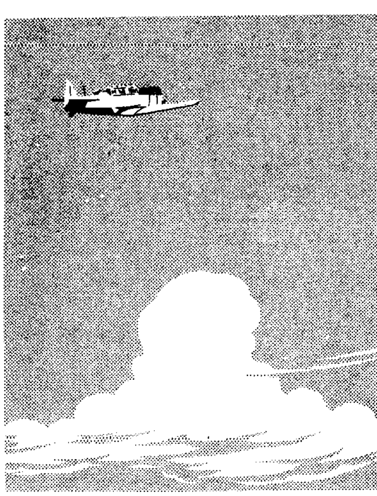
Illumination of each magnetic compass is controlled by a rheostat (figure 1-10; 8, figure 1-9) in each cockpit. The rheostat in the front cockpit is located on the instrument subpanel; in the rear cockpit, the rheostat is on the electrical control panel.

RADIO COMPASS CONTROL PANEL LIGHT RHEOSTAT.

A rheostat (figure 4-2), labeled "LIGHTS," is located at the top of the radio compass control panel in each cockpit. The rheostat turns on and regulates the brilliance of the self-contained radio compass control panel lights. The rheostat moves clockwise from its off position, which is marked by a white radial line.

OXYGEN SYSTEM.

The airplanes were originally delivered with either a high-pressure or a low-pressure oxygen system. The oxygen system on most airplanes has since been rendered inoperative.



HIGH-PRESSURE SYSTEM
OXYGEN DURATION
(HOURS)

ALTITUDE—FEET	GAGE PRESSURE—PSI 1800	1600	1400	1200	1000	800	600	400	BELOW 400
25,000	3.5	3.0	2.6	2.2	1.7	1.3	0.9	0.4	EMERGENCY
20,000	4.2	3.6	3.1	2.6	2.1	1.5	1.0	0.5	DESCEND TO ALTITUDE
15,000	4.9	4.3	3.7	3.1	2.5	1.8	1.2	0.6	NOT REQUIRING
10,000	5.7	5.0	4.3	3.6	2.9	2.2	1.4	0.7	OXYGEN

CYLINDERS: ONE TYPE B-1 FOR EACH COCKPIT (NOT INTERCONNECTED)

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Figure 4-4

HIGH-PRESSURE OXYGEN SYSTEM.

An individual, high-pressure oxygen system is provided for each cockpit. A separate Type B-1 oxygen cylinder supplies each system. The oxygen cylinders, installed behind the baggage compartment, must be removed from the airplane to be serviced. An oxygen regulator, incorporating a flow indicator and pressure gage, is installed in each cockpit. The approximate duration of the oxygen supply in man-hours for each separate system is given in figure 4-4.

HIGH-PRESSURE OXYGEN SYSTEM CONTROL.

OXYGEN REGULATOR.

A Type A-8 oxygen regulator (figure 4-5) is located below the instrument panel on the right side of each cockpit. The regulator supplies a continuous flow of oxygen, the concentration of which is determined by the setting of an incorporated control knob. The control knob should be set so that the flow indicator reading corresponds to the altitude at which the airplane is flying.

HIGH-PRESSURE OXYGEN SYSTEM INDICATORS.

OXYGEN PRESSURE GAGE.

A pressure gage (figure 4-5), located on the lower half of the regulator dial, registers the pressure in the oxygen cylinder for the respective cockpit.

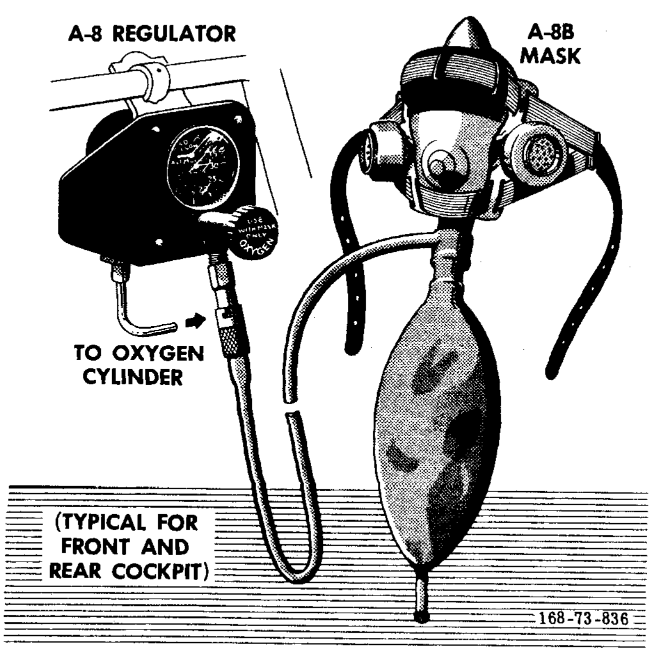


Figure 4-5

OXYGEN FLOW INDICATOR.

A flow indicator (figure 4-5) is located on the upper half of the regulator dial. The indicator is set by the regulator control knob to a reading that corresponds to the airplane altitude. This setting will provide oxygen in sufficient quantity for the particular altitude.

HIGH-PRESSURE OXYGEN SYSTEM OPERATION.

PREFLIGHT CHECK.

Prior to each flight requiring use of oxygen, check system as follows:

1. Check oxygen pressure gage for normal pressure of 1800 psi.
2. Check oxygen mask for fit and absence of leakage.
3. Attach mask tube to regulator outlet and check connection for security.
4. Open regulator control knob until the flow indicator registers 15,000 feet. Restrict the mask outlet valves by hand and note that rebreather bag inflates to verify that oxygen is being supplied.
5. Remove mask and close regulator control knob.

NORMAL OPERATION.

During flight, check oxygen system as follows:

1. Open regulator control knob until reading on flow indicator corresponds with altitude at which the airplane is flying.
2. Check connection of mask tube to regulator outlet.
3. Check cylinder pressure frequently for oxygen system pressure, and determine duration from figure 4-4.
4. Check flow indicator frequently, especially during changes in altitude, to verify that reading corresponds with airplane altitude.

Note

To ensure an adequate supply of oxygen during ascent or periods of unusual activity, the flow indicator reading should be set about 5000 feet higher than airplane altitude.

LOW-PRESSURE OXYGEN SYSTEM.

The low-pressure oxygen system is supplied by four Type D-2 oxygen cylinders installed behind the baggage compartment. A filler valve, also located in the baggage compartment, is provided to service the cylinders. A diluter-demand oxygen regulator, flow indicator, and pressure gage are installed in each cockpit. The approximate oxygen duration for each pilot is given in figure 4-6.

LOW-PRESSURE OXYGEN SYSTEM CONTROL.

OXYGEN REGULATOR.

A Type A-12 diluter-demand oxygen regulator (figure 4-7) is located below the instrument panel on the right side of each cockpit. The regulator automatically supplies a proper mixture of air and oxygen at all altitudes when set at NORMAL OXYGEN. The diluter lever of the regulator should always be set at NORMAL OXYGEN except under emergency conditions; if it is not, the duration of the oxygen system will be considerably reduced. With the diluter lever at 100% OXYGEN, undiluted oxygen is supplied at any altitude whenever the user inhales. The emergency valve of the regulator is safety-wired closed and should be opened only if the regulator becomes inoperative. The valve, when opened (by turning the knob counterclockwise), directs a steady stream of oxygen into the mask.

LOW-PRESSURE OXYGEN SYSTEM INDICATORS.

OXYGEN PRESSURE GAGE.

A pressure gage (figure 4-7), located adjacent to the regulator in each cockpit, registers oxygen cylinder pressure.

OXYGEN FLOW INDICATOR.

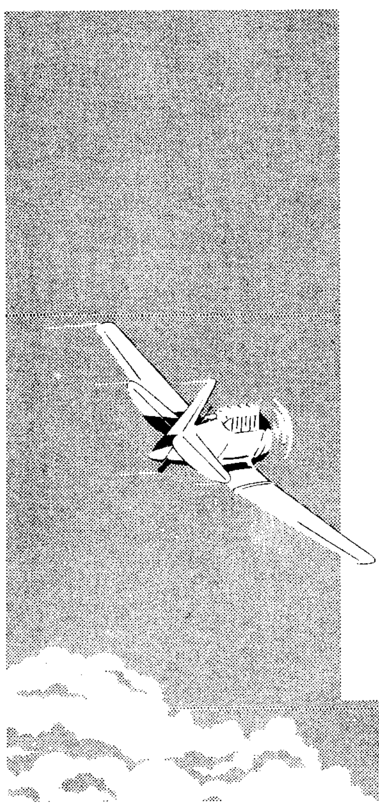
A flow indicator (figure 4-7) is located adjacent to the regulator and pressure gage in each cockpit. The flow indicator shows that oxygen is flowing through the regulator, but not how much oxygen is flowing. The "eye" of the indicator blinks with each breath of the user. When the emergency valve is opened, the indicator does not blink.

LOW-PRESSURE OXYGEN SYSTEM OPERATION.

PREFLIGHT CHECK.

Prior to each flight requiring use of oxygen, check system as follows:

1. Check oxygen pressure gage for indication between 400 and 450 psi.
2. Check oxygen mask for fit and absence of leakage.
3. Connect mask tube to regulator outlet. Check connection for tightness. Attach tube clip to parachute harness, high enough to permit free movement of head without pinching or pulling hose.
4. Breathe normally on oxygen regulator several times with diluter lever at NORMAL OXYGEN and then at 100% OXYGEN to check flow from oxygen regulator and operation of flow indicator.
5. Check oxygen regulator to see that emergency valve is safety-wired closed and the diluter lever is in NORMAL OXYGEN position.



LOW-PRESSURE SYSTEM

OXYGEN DURATION

(HOURS)

ALTITUDE—FEET	GAGE PRESSURE—PSI 400	350	300	250	200	150	100	BELOW 100
25,000	1.6	1.4	1.1	0.9	0.7	0.5	0.2	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
	2.0	1.7	1.4	1.1	0.9	0.6	0.3	
20,000	1.2	1.0	0.9	0.7	0.5	0.3	0.2	
	2.2	1.9	1.6	1.3	1.0	0.6	0.3	
15,000	1.0	0.8	0.7	0.5	0.4	0.3	0.1	
	2.7	2.3	1.9	1.6	1.2	0.8	0.4	
10,000	0.8	0.7	0.6	0.4	0.3	0.2	0.1	
	3.6	3.1	2.6	2.1	1.5	1.0	0.5	

RED FIGURES INDICATE DILUTER LEVER ***100% OXYGEN.***

BLACK FIGURES INDICATE DILUTER LEVER ***NORMAL OXYGEN.***

CYLINDERS: 4 TYPE D-2. CREW: 2.

168-73-781

Figure 4-6

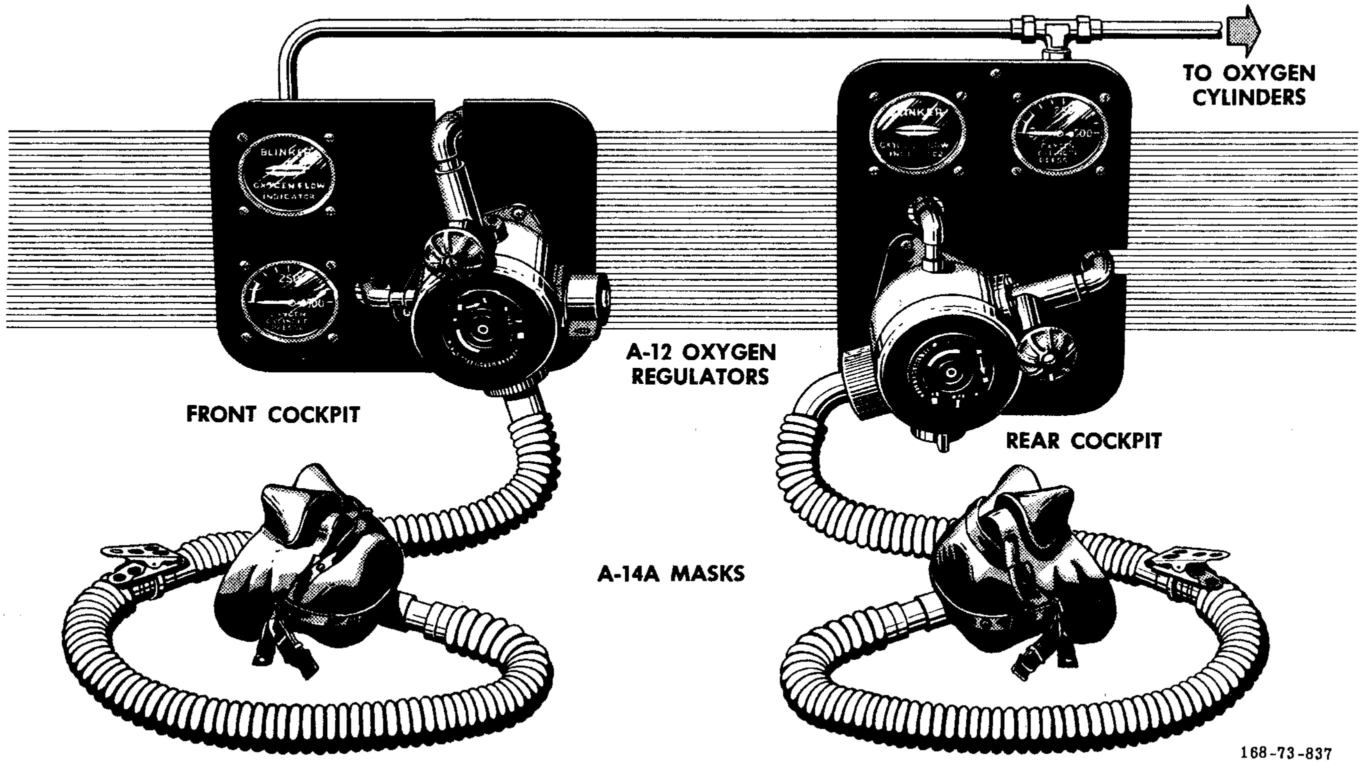


Figure 4-7

NORMAL OPERATION.

During flight, check oxygen system as follows:

1. Diluter lever at NORMAL OXGYEN.
2. Check connection of mask tube to regulator tube.
3. Check flow indicator frequently for flow of oxygen.
4. Check pressure gage frequently for oxygen system pressure, and determine duration from figure 4-6.

EMERGENCY OPERATION.

Should drowsiness indicate the onset of anoxia, or if smoke or fuel fumes should enter the cockpit, set the diluter lever of the oxygen regulator to 100% OXYGEN. If the oxygen regulator should become inoperative, open the emergency valve by turning the red emergency knob counterclockwise.

After emergency is over, set diluter lever of oxygen regulator to NORMAL OXYGEN, and check to ascertain that emergency valve is closed.

ARMAMENT EQUIPMENT.

All airplanes have provisions for armament, which includes bombing equipment, machine guns, gun sight, and camera. The armament equipment derives its electrical power from the 28-volt direct-current system. Although provisions are made for armament equipment in all airplanes, only a few are utilized for gunnery.

BOMBING EQUIPMENT.

Bombing equipment includes provisions for a flush-type bomb rack on the lower surface of each outer wing panel. The bomb rack will carry five 30-pound or five 20-pound bombs. Auxiliary bomb shackles can be added to these racks for carrying two 100-pound bombs under each wing. The bomb release button, selector switch, safety switch, and nose fuse switch are incorporated in all airplanes, but are inoperative. The bomb-arming handle, release handle, and emergency salvo handle have been removed.

GUNNERY EQUIPMENT.

Gunnery equipment consists of complete provisions for installation and operation of two fixed machine guns (one on the fuselage and one on the wing). A gun camera is provided for recording marksmanship proficiency when firing on a target. Provisions have been made in the rear cockpit to install, operate, and stow a flexible machine gun.

GUNS.

The fixed Type M-2 .30-caliber fuselage machine gun (figure 4-8), mounted in the top of the engine cowl, is synchronized to fire through the propeller arc and is supplied with 200 rounds of ammunition. The other fixed Type M-2 .30-caliber machine gun is mounted

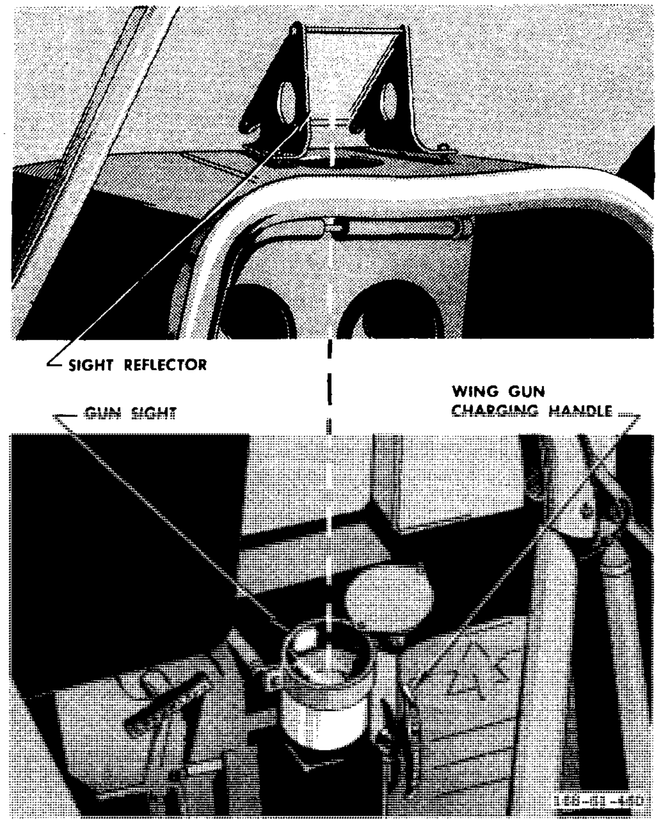


Figure 4-9

in the right outer wing panel and is supplied with 250 rounds of ammunition. The rear cockpit incorporates provisions for installation of a Type M-2 .30-caliber flexible machine gun for azimuth and elevation firing. The flexible gun is supplied with 500 rounds of ammunition. There are no automatic provisions incorporated to prevent inadvertent damage to the airplane from firing the flexible gun.

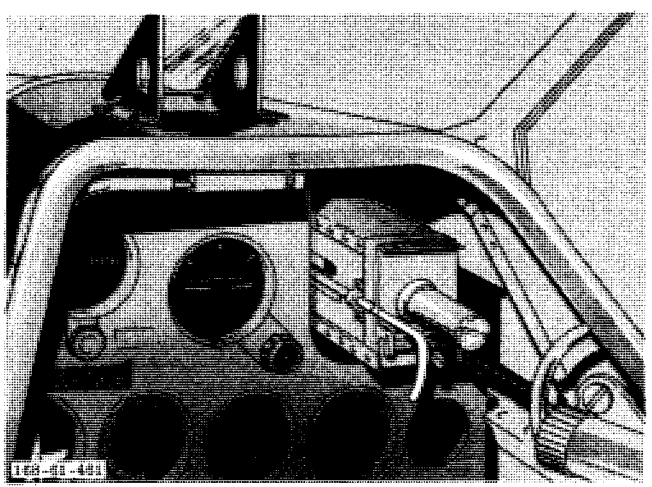


Figure 4-8

GUN CONTROLS.

GUN SAFETY SWITCH. Electrical power to operate the fixed guns is controlled by a gun safety switch (figure 1-10), located on the instrument subpanel in the front cockpit. The switch has two positions, FIRE and SAFE.

GUN SELECTOR SWITCHES. Two selector switches (figure 1-10), located on the front cockpit instrument subpanel, are provided for the fixed guns. Electrical power to the guns is interrupted when the switches are OFF. Either or both fixed guns may be selected for firing by placing the respective switches to ON.

GUN TRIGGER. A gun trigger (20, figure 1-5), located on the control stick grip, is provided to fire the fixed guns.

GUN CHARGING HANDLES. The wing gun charging handle (figure 4-9) is located in the front cockpit, below the instrument panel. The cowl gun charging handle (figure 4-8) is located near the upper right corner of the instrument panel in the front cockpit. Pulling the charging handle of either gun back to the limit of travel will charge the respective gun or eject a defective cartridge.

GUN SIGHT.

The N-3B gun sight is a fixed-reticle sight. Early airplanes incorporate the sight reflector above the center of the front instrument panel shroud and the main gun sight directly below the front instrument panel. (See figure 4-9.) Later airplanes incorporate the sight and sight reflector in the center of the instrument panel shroud in the front cockpit. (See figure 4-10.) The intensity of the sight reticle illumination may be adjusted from full brilliance to OFF, by means of the gun sight rheostat (figure 1-10) on the instrument subpanel in the front cockpit. The sight reflector is installed for a gun sighting position, in which the line of sight is parallel to the flight path of the airplane. The principle of operation is the apparent projection of the reticle image in space, which is similar to having the reticle image superimposed on the target. The old-style ring-and-bead sight required the pilot to keep his eye carefully fixed in relation to the ring and bead; however, on the N-3B sight reflector, slight movement of the pilot's head does not cause misalignment of the sight reticle image and the target.

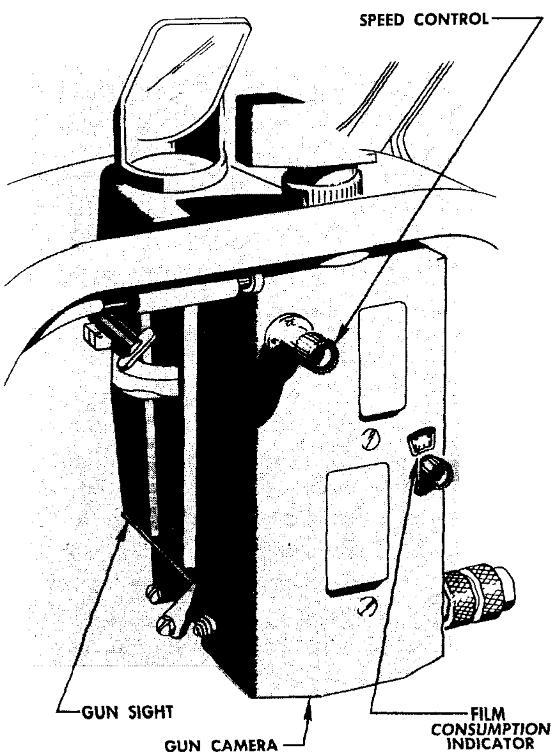


Figure 4-10

GUN CAMERA.

Early airplanes incorporate a W-7B gun camera installed in the leading edge of the left wing. Later airplanes incorporate an N-2 GSAP camera (figure 4-10) installed adjacent to the gun sight in the front cockpit. The camera is electrically driven when the trigger on the control stick grip is depressed and the camera switch (figure 1-10), located on the instrument subpanel, is at the FIRE position. A speed control is provided on the camera to select the desired number of frames per second. A film consumption indicator is also provided to register the feet of unused film remaining.

FIRING FIXED GUNS.

1. Adjust gun sight rheostat for desired brilliancy.
2. Charge guns.
3. Respective gun selector switch ON.
4. Gun and camera safety switches FIRE.
5. Depress trigger.

MISCELLANEOUS EQUIPMENT.

INSTRUMENT-FLYING HOOD.

Both cockpits incorporate provisions for an instrument-flying hood (figure 4-11), but only the rear cockpit is enclosed for instrument-flight training. The hood is stowed at the back of the cockpit when not in use. The cockpit can be enclosed for instrument-flight training by pulling the hood forward and engaging it with the latch at the top of the instrument panel shroud. The hood is provided with an elastic bungee to facilitate release.

INSTRUMENT-FLYING HOOD CONTROLS.

Each cockpit is provided with an instrument-flying hood release handle and latch lever. The release handle (8, figure 1-4; 7, figure 1-8), located at the forward left side of the cockpit, can be actuated for normal release of the hood or, in an emergency, for release of the hood in the other cockpit. A latch lever (figure 4-11), incorporated in the engaging latch (below the top of the instrument panel shroud), can also be used as a normal release for the instrument-flying hood. The latch lever cannot release the hood in the adjoining cockpit.

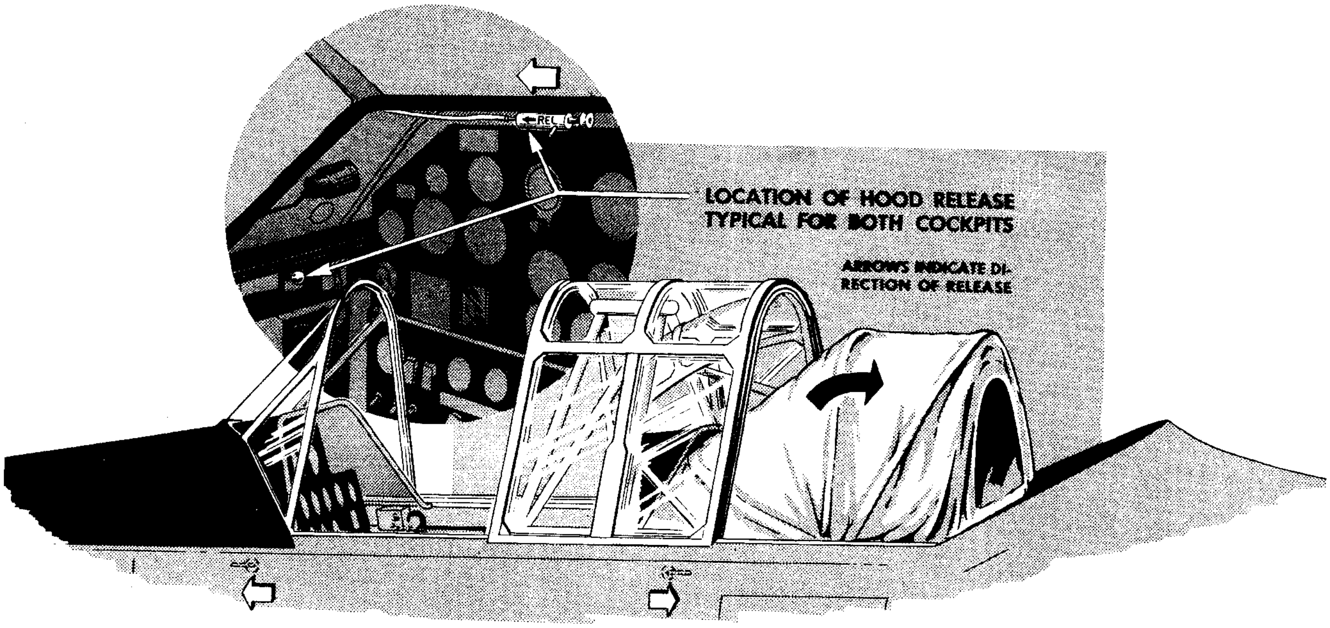
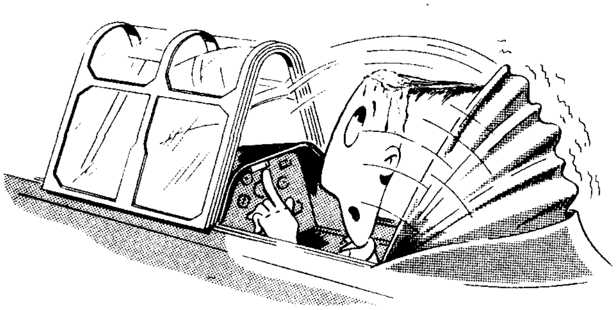


Figure 4-11



Be sure that there is adequate head clearance before releasing instrument flying hood.

MAP, DATA, AND FLIGHT REPORT CASES.

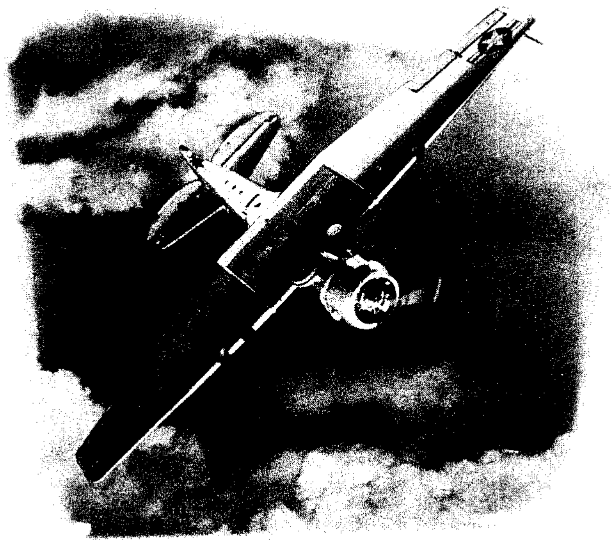
A map and data case is provided on the right side of the front cockpit, on the left side of the rear cockpit, and in the baggage compartment. A flight report case is installed on the right side of the front cockpit.

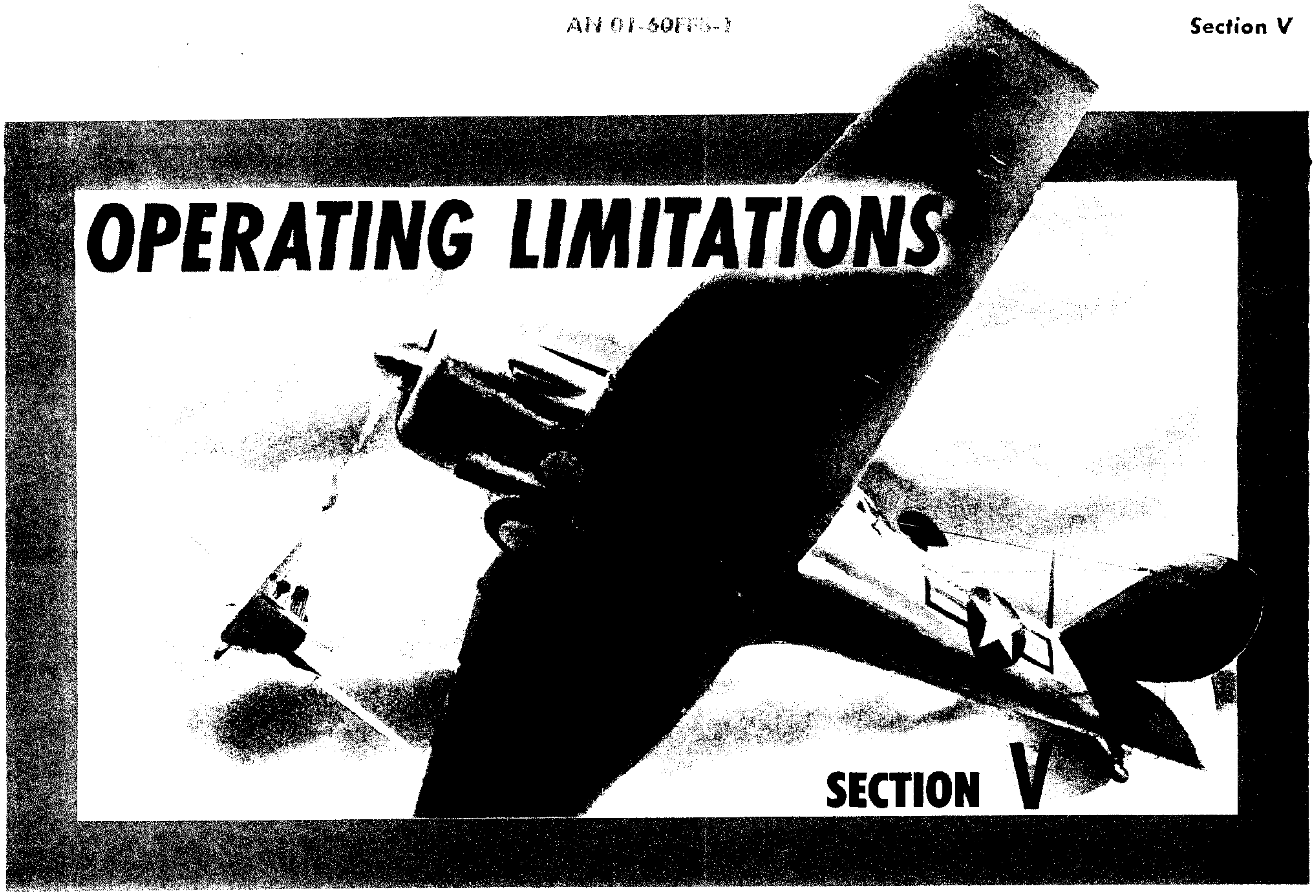
RELIEF TUBE.

A relief tube is attached to a bracket at the bottom of each seat.

CHECK LISTS.

A Pilot's Amplified Check List is provided in each cockpit in a location that is convenient and has adequate clearance with all controls to prevent interference.





GENERAL.

Some of the recommended operating conditions of the airplane or its component systems can be exceeded in the air or on the ground. The gages that indicate these operating ranges are marked in red to show the maximum safe limit. Instrument markings showing the various operating limits are illustrated in figure 5-1. In some cases, the markings represent limitations that are self-explanatory and therefore are not discussed in the text. Operating restrictions or limitations which do not appear as maximum limits on the cockpit instruments are completely discussed in the following paragraphs.

MINIMUM CREW REQUIREMENTS.

Solo flight is permissible in this airplane; however, on solo flights, the airplane must be flown from the front cockpit. Solo flight from the rear cockpit is prohibited because of insufficient controls and visibility restrictions.

ENGINE LIMITATIONS.

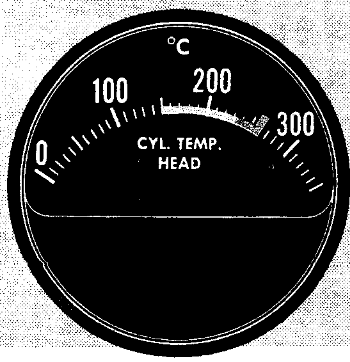
All normal engine limitations are shown in figure 5-1. The maximum allowable engine overspeed is 2800 rpm for 30 seconds.

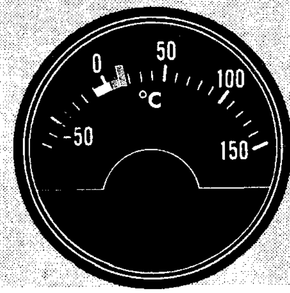
WARNING

Whenever engine speed exceeds the operating limits, the airplane should be landed immediately at the nearest base. The reason for the overspeed (if known), the maximum rpm, and duration will be entered in Form 1 and reported to the maintenance officer. Overspeed between 2800 and 2900 rpm will necessitate an inspection of the engine before further flight. If the rpm exceeded 2900, the engine will be removed for overhaul.

PROPELLER LIMITATIONS.

Because of undesirable harmonic vibration frequencies, prolonged ground operation between 1450 and 1800 rpm is prohibited. This restriction does not apply during flight, because airflow through the propeller is directly from the front and therefore does not set up any harmonic vibrations.



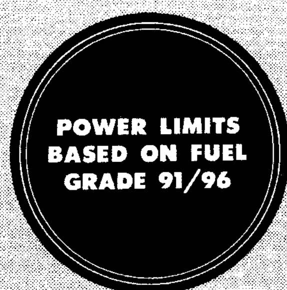


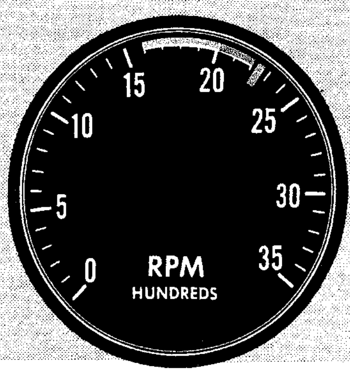
CARBURETOR MIX. TEMP

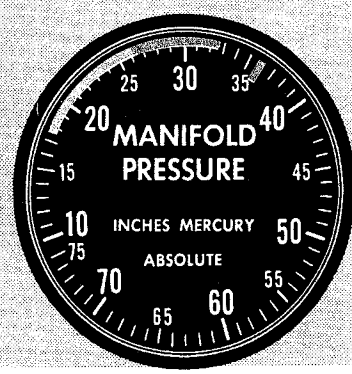
−10° to +3°C	Danger of Icing
3° to 15°C	Continuous Operation
15°C	Maximum – Danger of Detonation

CYLINDER HEAD TEMP

150°-232°C	Manual Lean Permitted
232°-260°C	RICH Required
260°C	Maximum







TACHOMETER

1600 rpm	Minimum Recommended in Flight
1600-2000 rpm	Manual Lean Permitted
2000-2200 rpm	RICH Required
2200 rpm	Maximum Continuous (Operation above this rpm limited to 5 min)
2250 rpm	Take-off and Military

MANIFOLD PRESSURE

17.5 in. Hg	Minimum Recommended in Flight
17.5-26 in. Hg	Manual Lean Permitted
26-32.5 in. Hg	RICH Required
32.5 in. Hg	Maximum Continuous (Operation above this point limited to 5 min)
36 in. Hg	Take-off and Military

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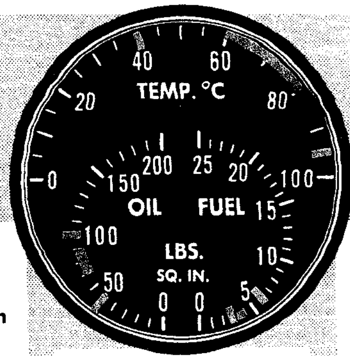
Figure 5-1. Instrument Markings (Sheet 1 of 2)

OIL TEMPERATURE

40°C	Minimum for Flight
60°-80°C	Continuous Operation
95°C	Maximum



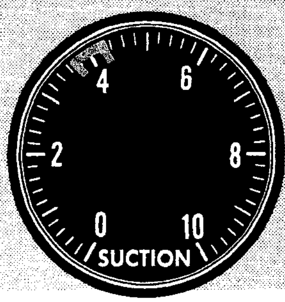
OIL PRESSURE

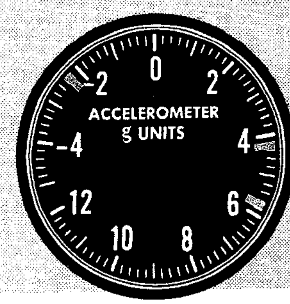
50 psi	Minimum for Flight
70-90 psi	Continuous Operation
100 psi	Maximum

FUEL PRESSURE

3 psi	Minimum
3-4 psi	Continuous Operation
6 psi	Maximum

ENGINE GAGE UNIT



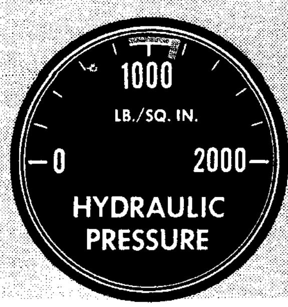


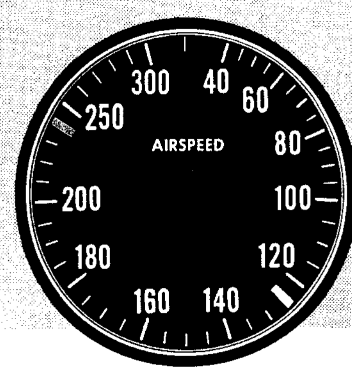
SUCTION

3.75 in. Hg	Minimum
3.75-4.25 in. Hg	Normal
4.25 in. Hg	Maximum

ACCELEROMETER

5.67 G	Max Positive at 5300 Lb
4.3 G	Max Positive With Any External Load
-2.33 G	Max Negative at 5300 Lb





HYDRAULIC PRESSURE

900-1150 psi	Normal
1150 psi	Maximum

AIRSPEED

240 mph	Maximum
125 mph	Full Flaps (Landing Gear – 150 mph)

168-51-554A

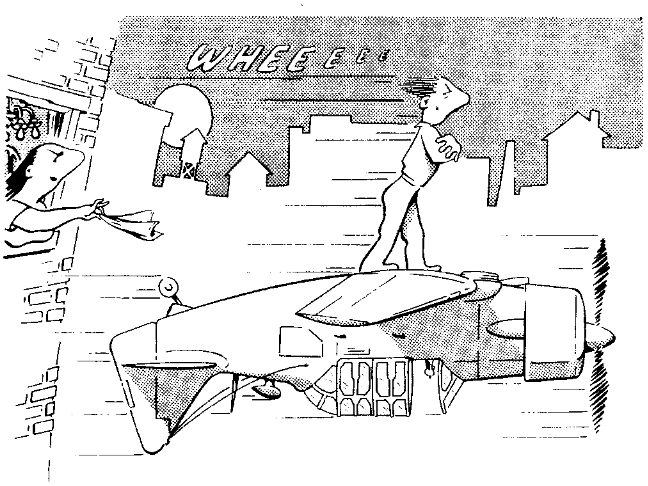
Figure 5-1. Instrument Markings (Sheet 2 of 2)

AIRSPEED LIMITATIONS.

The red line on the airspeed indicator marks the limit dive speed at any altitude. The limit dive speed for the airplane with external loads is the same as for the clean airplane. However, the airplane should not be dived to airspeeds in excess of those where light to moderate airplane or surface control buffet is experienced. The yellow line indicates the maximum airspeed at which the flaps may be lowered to the full down position. The maximum airspeed for landing gear down is not marked on the airspeed indicator but is given below the indicator on figure 5-1. Lowering either the flaps or gear at speeds in excess of the flaps-down or gear-down limit airspeeds may cause structural damage to the airplane. Because of the danger of accidental stalls, the minimum permissible indicated airspeed during sideslips is 90 mph.

PROHIBITED MANEUVERS.

Outside loops, inverted spins, snap rolls in excess of 130 mph, and slow rolls in excess of 190 mph are prohibited. Inverted flight must be limited to 10 seconds, as there is no means of ensuring a continuous flow of fuel or oil in this attitude. Also, prolonged inverted flight can cause an accumulation of hydrogen gas in the battery at sufficient pressure to continuously hold the vents closed until the battery eventually explodes. Since altitude is lost rapidly during a sideslip, this maneuver should not be attempted below 200 feet.



All acrobatic maneuvers performed during training flights should be completed at least 5000 feet above the ground.

ACCELERATION LIMITS.

The airplane is limited to a maximum positive G-load of 5.67 and a maximum negative G-load of –2.33. These limits apply only when the clean airplane gross weight does not exceed 5300 pounds (design gross weight). When airplane gross weight is greater than 5300 pounds, the maximum allowable G-load is less than the maximum limit marked on the accelerometer. Remember that when you pull the maximum G-load (5.67 G), the wings of your airplane must support 5.67 times their normal load. This means that during a maximum G pull-out the wings of the airplane (at design gross weight) are supporting 5.67 times 5300 pounds, or a total of approximately 30,000 pounds (maximum that the wings can safely support). Therefore, when your airplane weighs more than 5300 pounds, the maximum G-load that you can safely apply can be determined by dividing 30,000 by the new gross weight. When external loads are carried, the maximum allowable G-load is limited to 4.3 G. The maximum G-loads we have been talking about apply only to straight pull-outs. Rolling pull-outs are a different story, however, since they impose considerably more stress upon the airplane. The maximum allowable G-load in a rolling pull-out is limited to two-thirds the maximum G-load for a straight pull-out.

OPERATING FLIGHT STRENGTH.

The Operating Flight Strength diagram (figure 5-2) shows the strength limitations of the airplane. Various G-loads are shown vertically along the left side of the chart, and various indicated airspeeds are shown horizontally across the center of the chart. The horizontal red lines at the top and bottom of the chart represent the maximum positive and maximum negative allowable G-loads. The vertical red line indicates the limit dive speed of the airplane. The curved lines show the G-load at which the airplane will stall at various airspeeds. The upper curved line shows, for example, that at 100 mph the airplane will stall in a 2 G turn, while at 150 mph the airplane will not stall until more than 4 G is applied. The upper and lower limits at the right side of the chart illustrate that the maximum positive and negative limit load factors (+5.67 G and –2.33 G) can be safely applied up to the limit dive speed of the airplane.

CENTER-OF-GRAVITY LIMITATIONS.

Any configuration of external load that the airplane is designed to carry may be installed without exceeding the CG limits. There is only one possible loading condition that could cause the airplane CG to exceed its

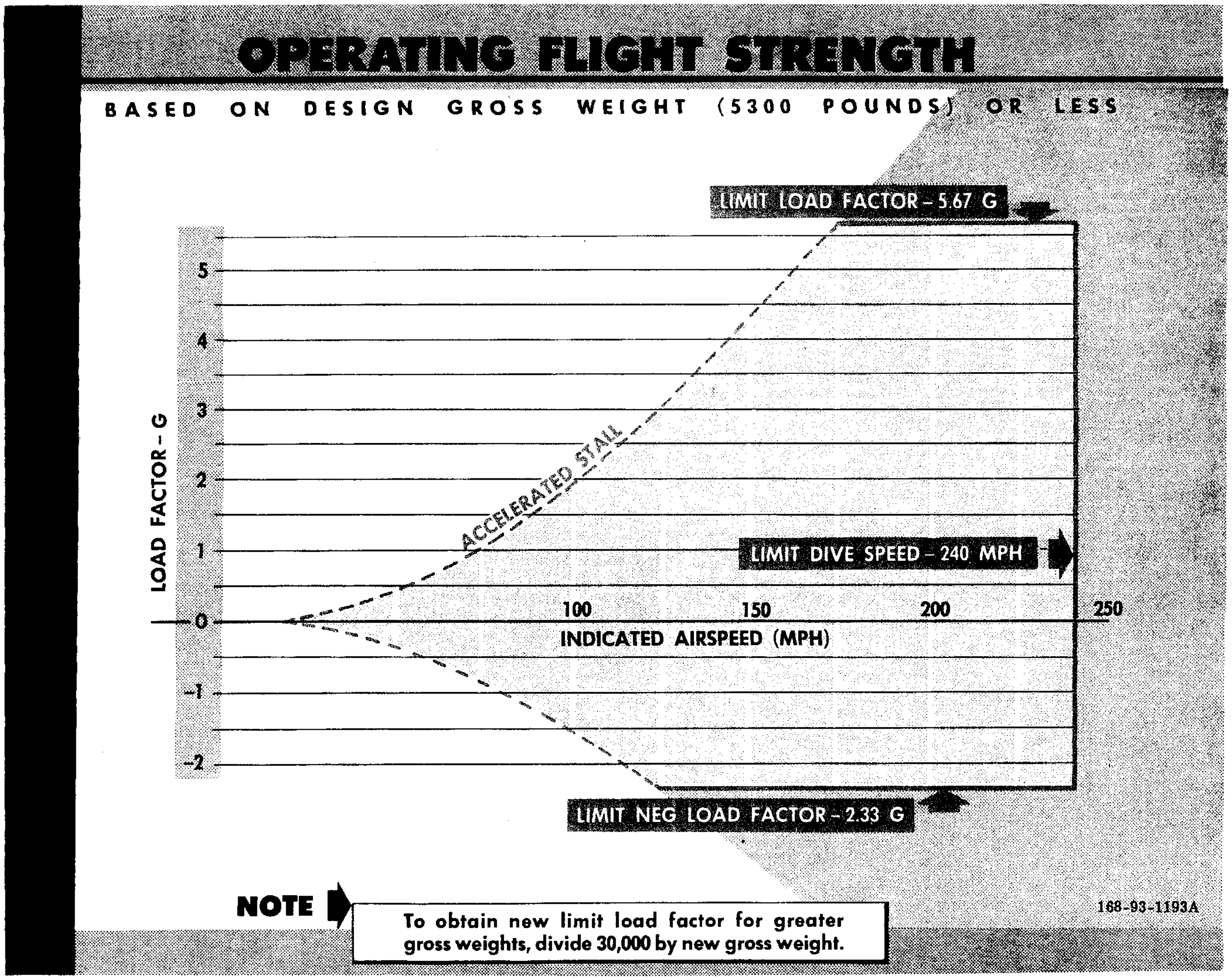
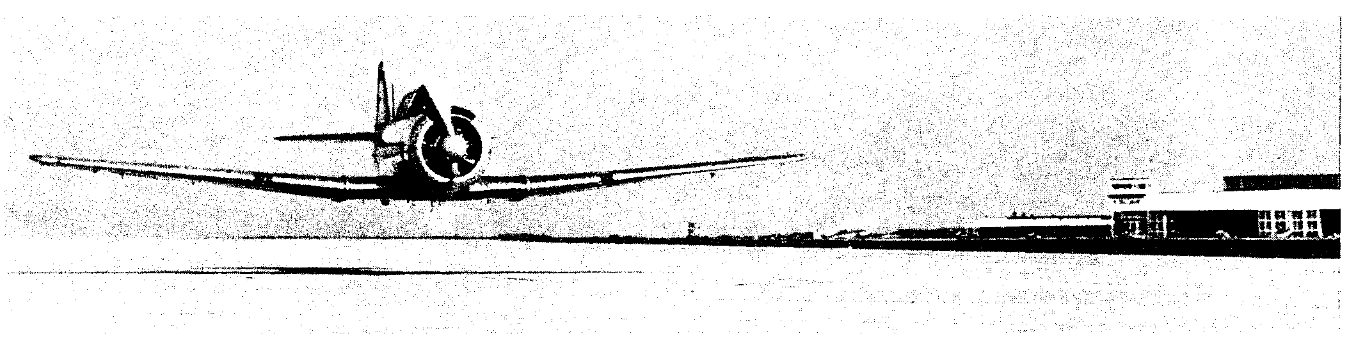


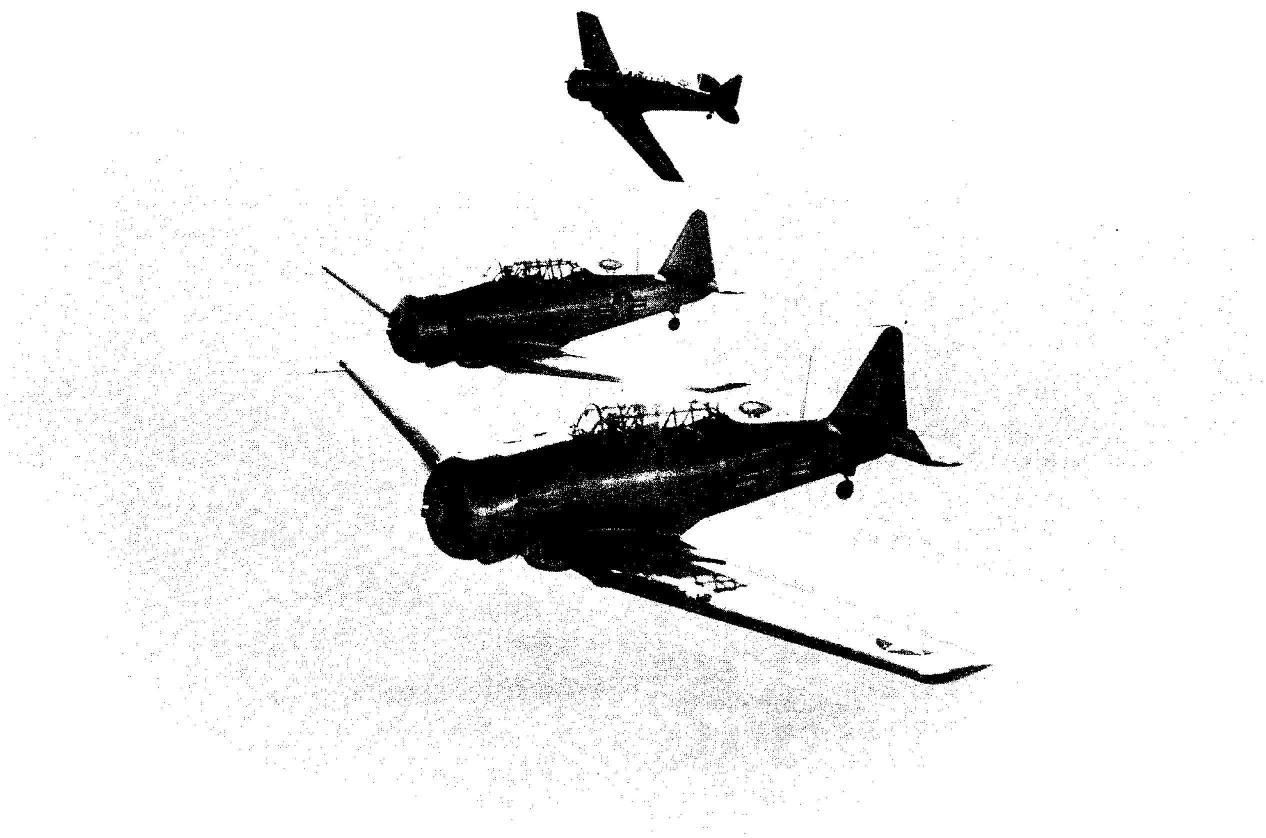
Figure 5-2

limitation. This could occur when fuel supply is low on a solo flight with no baggage. The result would be a slightly nose-heavy condition. Therefore, when this situation is encountered, additional care must be exercised during the flare-out (to prevent a two-point touchdown with the possibility of striking the propeller) and immediately after the touchdown (to prevent nosing over). However, this nose-heavy condition can be prevented by carrying a load of approximately 100 pounds in the baggage compartment to keep the CG within limits.

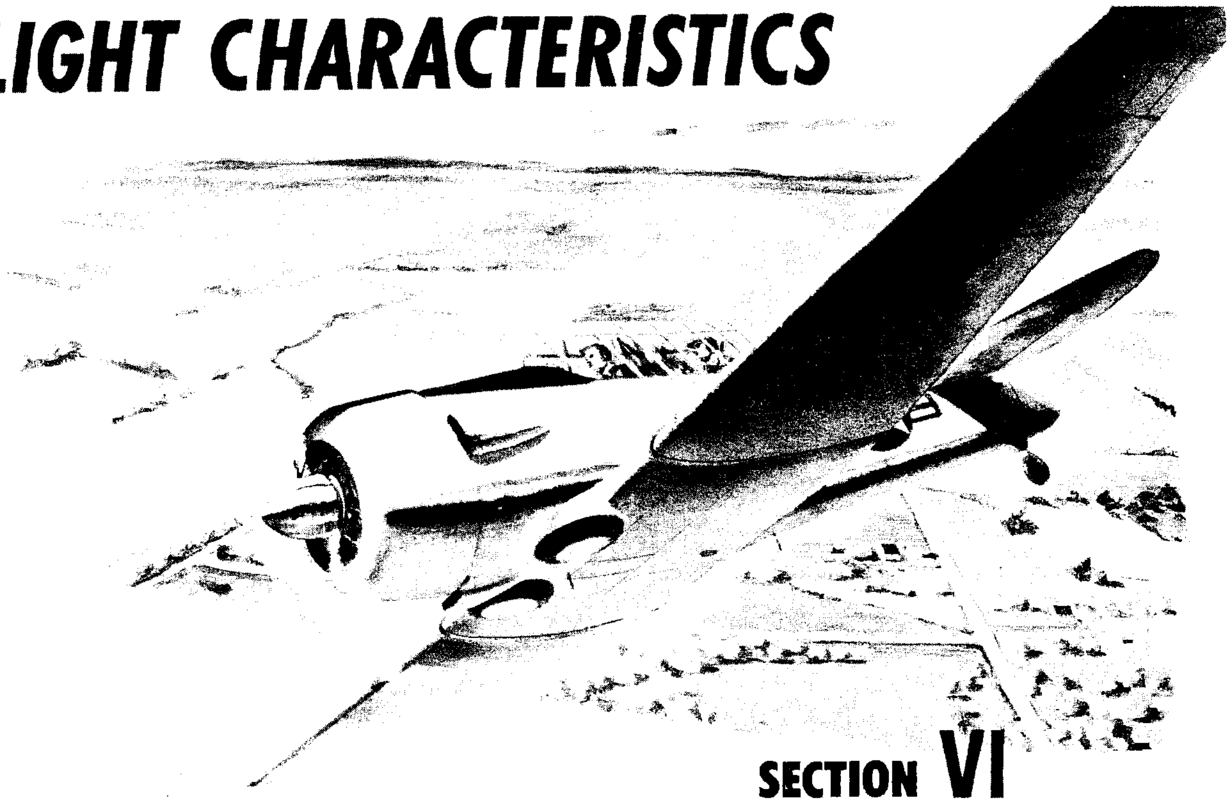
WEIGHT LIMITATIONS.

The maximum allowable gross weight of the airplane cannot be exceeded. However, the baggage compartment should not be loaded in excess of its maximum capacity of 100 pounds.





FLIGHT CHARACTERISTICS



SECTION VI

GENERAL.

The airplane has good stability and control characteristics and when properly trimmed will tend to maintain level flight.

STALLS.

Stalls in this airplane are not violent. You can feel a normal stall approaching as the controls begin to loosen up and the airplane develops a sinking "mushy" feeling. In addition, you can see the stalling attitude. When the stall occurs, there is a slight buffeting of the elevator and a vibration of the fuselage, and the nose or a wing drops. Stalling speeds with gear and flaps up or down—power on or off—with different gross weights at varying degrees of bank are given in figure 6-2. Conditions that affect stalling speeds and characteristics are shown in figure 6-1.

STALL RECOVERY.

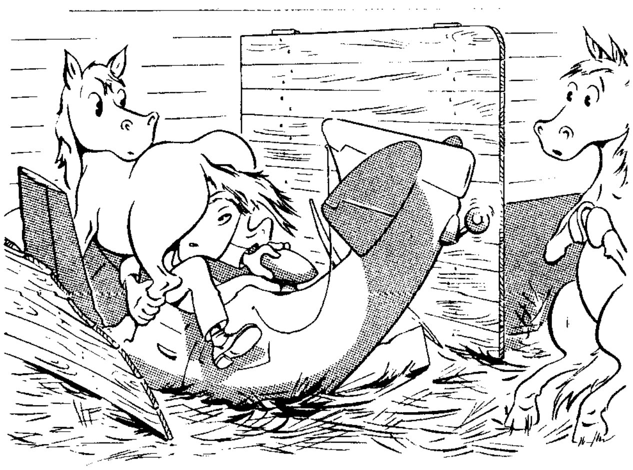
The importance of proper stall recovery technique cannot be stressed too much. Because the elevator is very effective at stalling speeds, recovery is quick and positive. However, rough elevator use or failure to regain sufficient flying speed following a normal stall can cause an accelerated or high-speed stall. You can recover from partial stalls by reducing back pressure on the stick or by adding sufficient power to maintain control of the airplane. The standard procedure for recovering from a stall is as follows:

1. Move stick forward quickly and smoothly. Avoid jamming or snapping the stick forward abruptly, to prevent an undesirable nose-low attitude and momentary engine stoppage.
2. At the same time, advance the throttle in a smooth movement to the sea-level stop.

Note

Be sure to move the stick and throttle together smoothly. Do not allow the nose to drop too far below the horizon.

3. Use rudder to maintain directional control. Ignore wing attitude until the stall is broken, at which time aileron effectiveness will return.
4. As soon as the stall is broken, utilize all controls in a coordinated manner to resume normal flight.
5. When you attain safe flying speed, raise the nose to level flight with steady back pressure on the stick. Avoid abrupt changes of attitude.
6. Retard throttle to cruising power after leveling off.



Enter all stalls at a safe altitude above the ground. Recoveries should be completed at 4000 feet or higher above the terrain. Remember that considerable altitude can be lost in a stall maneuver.

ITEMS AFFECTING STALLING SPEEDS AND CHARACTERISTICS

ITEM	STALL CHARACTERISTICS	STALL SPEEDS
ABRUPT CONTROL MOVEMENT	✓	✓
ALTITUDE		
CG LOCATION	✓	
COORDINATION	✓	✓
GROSS WEIGHT		✓
LANDING GEAR		
POWER	✓	✓
TURNS	✓	✓
WING FLAPS	✓	✓

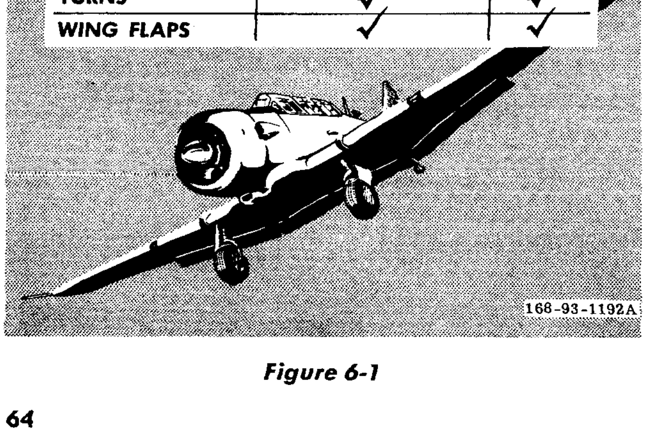


Figure 6-1

PRACTICE STALLS.

The following practice maneuvers will acquaint you with the stall traits and speed of the airplane under various flight conditions. For both power-on and power-off stalls, set the propeller control to obtain 1850 rpm. This setting will prevent engine limitations from being exceeded inadvertently during recovery. Retard the throttle smoothly for power-off stall; set manifold pressure at 25 inches for power-on stalls. Canopies should be closed during practice stalls to prevent exhaust flame from entering cockpit in case of backfire.

PRACTICE STALL—GEAR AND FLAPS DOWN, POWER OFF, STRAIGHT AHEAD.

Set propeller control for 1850 rpm and mixture control for smooth operation. Close the throttle and maintain altitude. When airspeed approaches approximately 110 mph, lower full flaps. Establish a 90 mph glide and trim the airplane. Pull the nose up to a three-point attitude and hold until the stall occurs. Observe the qualities of the airplane in the stall. Note the *feel.* After the airplane breaks to the right or left, or stalls straight ahead, perform a standard stall recovery as the nose passes through the horizon. Raise the landing gear and raise the flaps in slow stages as soon as possible. Retard the throttle to 25 inches manifold pressure.

PRACTICE STALL—GEAR AND FLAPS UP, POWER ON, STRAIGHT AHEAD.

Raise nose to approximately 40 degrees above the horizon. Hold this attitude with wings level and nose steady. As the stall approaches, observe the looseness of the controls, attitude of the airplane, and the tone of the engine. Notice how the airplane shudders when the stall occurs. As the stall occurs, apply brisk forward pressure to the stick and, at the same time, advance the throttle to the sea-level stop. Use rudder to maintain directional control; then blend in aileron as it becomes effective with the increase in airspeed. When flying speed is reached, ease airplane out of dive and back to cruising attitude, and reduce throttle to 25 inches manifold pressure.

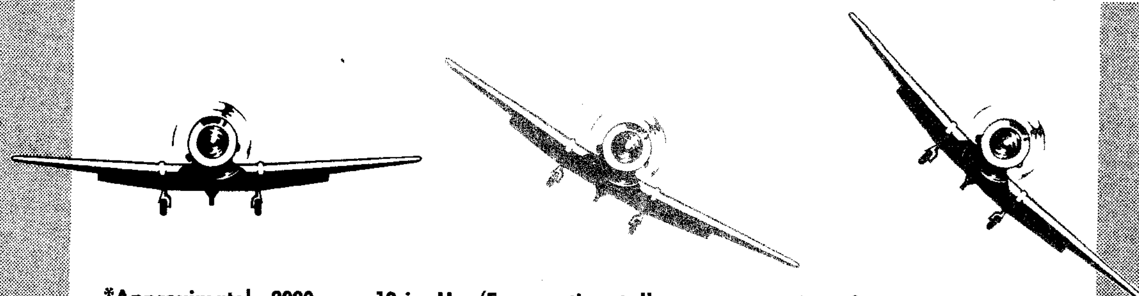
PRACTICE STALL—GEAR AND FLAPS UP, POWER ON, 20-DEGREE BANK.

Enter a coordinated climbing turn with a bank of approximately 20 degrees. Raise the nose approximately 40 degrees above the horizon. Keep the nose turning at a steady rate until the stall occurs. When the stall occurs, apply brisk forward pressure to the stick and advance the throttle to the sea-level stop. When you have enough flying speed to make ailerons effective, make a coordinated roll out of the turn and dive. Return to level flight as in straight-ahead stalls. Reduce throttle to 25 inches manifold pressure.

INDICATED STALLING SPEEDS—MPH

POWER-ON STALLING SPEEDS ARE BASED ON ESTIMATED DATA

GROSS WEIGHT LB	GEAR AND FLAPS UP						GEAR AND FLAPS DOWN					
	POWER ON (MAX CONTINUOUS POWER)			POWER OFF (WINDMILLING PROP)			POWER ON (APPROACH POWER)*			POWER OFF (WINDMILLING PROP)		
	LEVEL	30° BANK	45° BANK	LEVEL	30° BANK	45° BANK	LEVEL	30° BANK	45° BANK	LEVEL	30° BANK	45° BANK
6000	72	78	88	78	84	92	63	70	79	67	72	81
5500	67	74	84	75	80	89	60	66	75	63	69	77
5000	61	70	79	71	76	84	55	62	71	59	65	73
4500	54	64	74	66	72	80	51	57	66	55	61	69



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*Approximately 2000 rpm, 18 in. Hg. (For practice stalls, a power setting of 1850 rpm, 25 in. Hg will result in stalls at approximately the same airspeeds.)

Figure 6-2

PRACTICE STALL—GEAR DOWN, FLAPS UP, POWER OFF, STRAIGHT AHEAD.

Close throttle completely, reduce airspeed to 100 mph IAS, and establish a normal glide. Retrim. Raise the nose to a landing attitude and hold it on a point straight ahead until the stall occurs. As you approach the stall, observe the looseness of controls, the "mushy" feeling of the airplane, and the dwindling airspeed. Remember, this is like a landing stall. Use standard recovery procedure. Reduce throttle to 25 inches manifold pressure and raise the landing gear.

PRACTICE STALL—GEAR DOWN, FLAPS UP, POWER OFF, 40-DEGREE BANK.

This maneuver will help you recognize the stalls which may occur in power-off turns in traffic or landings. Assume a normal glide of 100 mph; then roll into a medium gliding turn with about 40 degrees of bank. Maintain a steady turn, raising the nose slightly until it is just above the horizon. It is necessary to increase back pressure on the stick to hold this attitude until the stall occurs. Make a standard recovery. After recovering speed, use coordinated controls to level the airplane. Reduce the throttle to 25 inches manifold pressure and raise the landing gear.

SPINS.

The airplane spin characteristics are illustrated in figure 6-3. The spin characteristics remain essentially the same whether the gear and flaps are up or down or whether the spin is to the left or the right. Some slight difference in the magnitude of the oscillations and canopy vibration may be noted. Normal spin entry is accomplished in the conventional manner by application of full rudder in the desired direction at point of stall and simultaneous application of full back stick with ailerons neutral. These control positions must be held with the spin until the desired number of turns has been completed. The minimum altitude for intentionally entering a spin is 10,000 feet above the terrain. (Inverted spins are prohibited.)

SPIN RECOVERY.

Recovery from normal or inverted spins is effected by vigorous application of full opposite rudder followed by stick movement (slightly forward of neutral for normal spins and slightly aft of neutral for inverted spins). Leave ailerons neutral. Immediately following application of recovery controls, the nose of the airplane will drop and the spin will accelerate rapidly for approximately one-half to three-fourths turn. Hold the

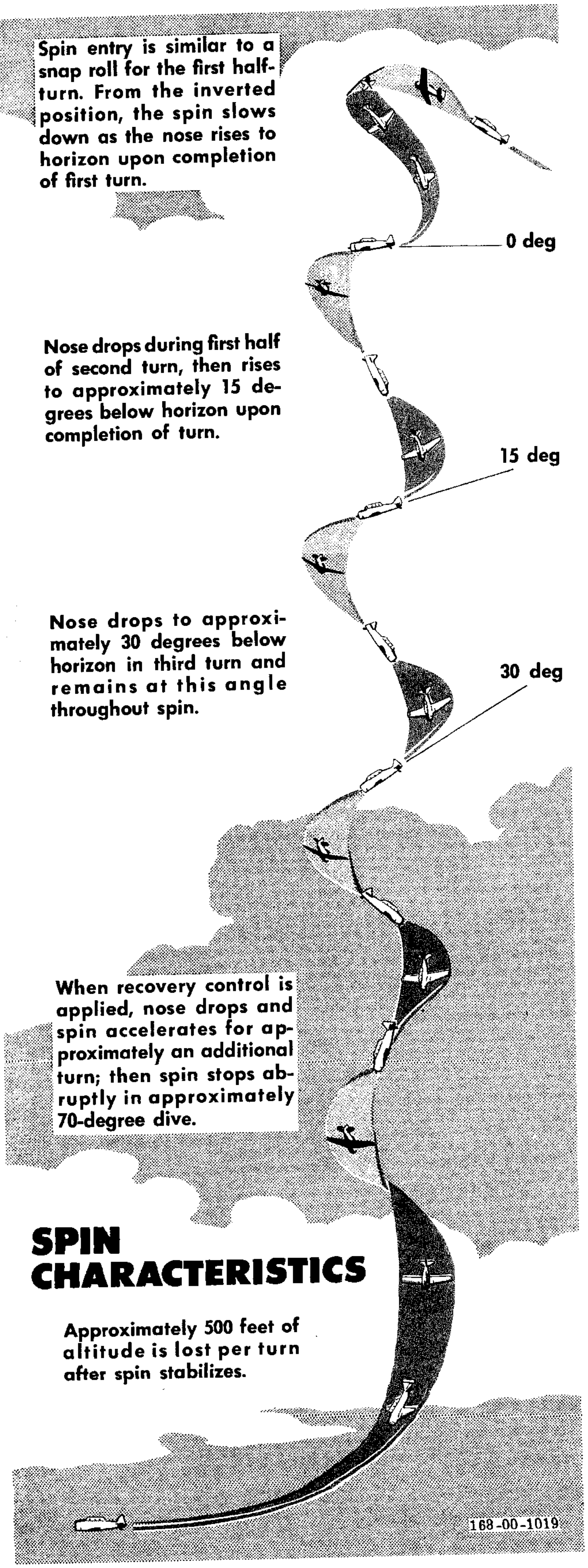


Figure 6-3

controls in this position until the spin stops; then immediately relax rudder pressure to neutral. Slowly apply back pressure on the stick to round out the dive and regain level-flight attitude. During the final recovery from an inverted spin, you may half-roll from the inverted dive before applying back pressure on the stick to round out the dive. Move throttle slowly to cruise setting after level-flight attitude is attained. Elevator stick forces during recovery will be lighter if the elevator trim adjustment is maintained for the level-flight cruise condition.

FLIGHT CONTROL EFFECTIVENESS.

All flight controls are very effective throughout the normal speed range, and only moderate stick movement is required to maneuver the airplane. At high speeds, the airplane response to control movement is greater than at cruise speeds, and abrupt movement of the controls must be avoided to prevent exceeding the G-limit of the airplane. Near stalling speeds, the ailerons are least effective, the rudder is fairly effective, and the elevator is very effective. Rapid elevator movements at low speed should be avoided to prevent an inadvertent stall. Elevator and rudder trim tab adjustments are sufficient to trim elevator stick forces and rudder pedal forces to zero throughout the normal speed range. Right rudder pedal force may be required during low-speed full-power conditions. The aileron trim tab is not adjustable from the cockpit.

MANEUVERING FLIGHT.

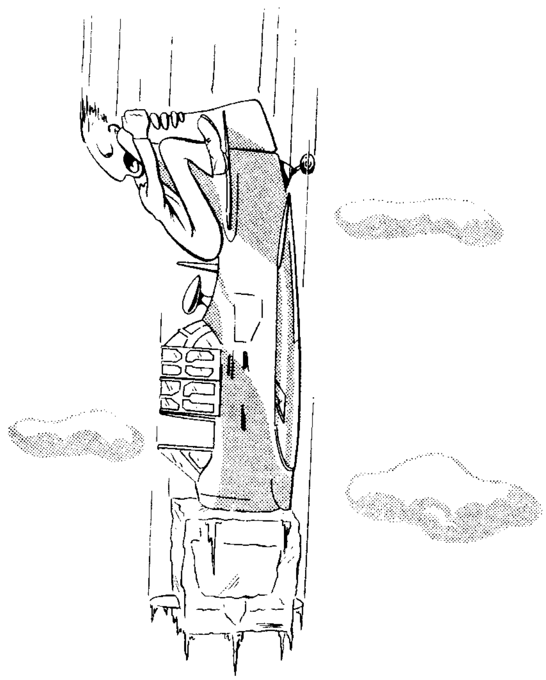
Rapid airplane response to flight control movement during the normal speed range provides good acrobatic characteristics in this airplane. However, elevator stick forces in turns and pull-outs are purposely higher than elevator stick forces in fighter-type airplanes. This feature is to help you prevent imposing an excessive G-load on the airplane during acrobatics.

CAUTION

Do not trim the airplane during any acrobatic maneuvers in an attempt to reduce stick forces, as only small elevator stick forces are then required to exceed the structural limits for the airplane.

DIVES.

The handling characteristics in dives to the limit airspeed are good. All control movement is easy and effective, and the airplane responds rapidly. If you trim the airplane for level flight at Maximum Continuous Power, the tab settings will be satisfactory for diving, although some adjustment of rudder tab may be desired during the dive so that you will not have to hold rudder. The amount of forward stick pressure required to hold the airplane in a dive is relatively small, as is the amount of aileron pressure needed to keep the wings level. To determine the altitude lost in a constant 4 G pull-out dive recovery, see figure 6-4. Prior to entering a dive, close the canopy, and, to prevent excessive oil cooling, adjust oil cooler shutter control as necessary. Decrease rpm as necessary during the dive to prevent exceeding maximum engine overspeed.



At completion of dive, open throttle slowly to prevent partly cooled engine from cutting out.

FLIGHT WITH EXTERNAL LOADS.

Flight characteristics of the airplane with external loads are similar to those encountered with the clean airplane.

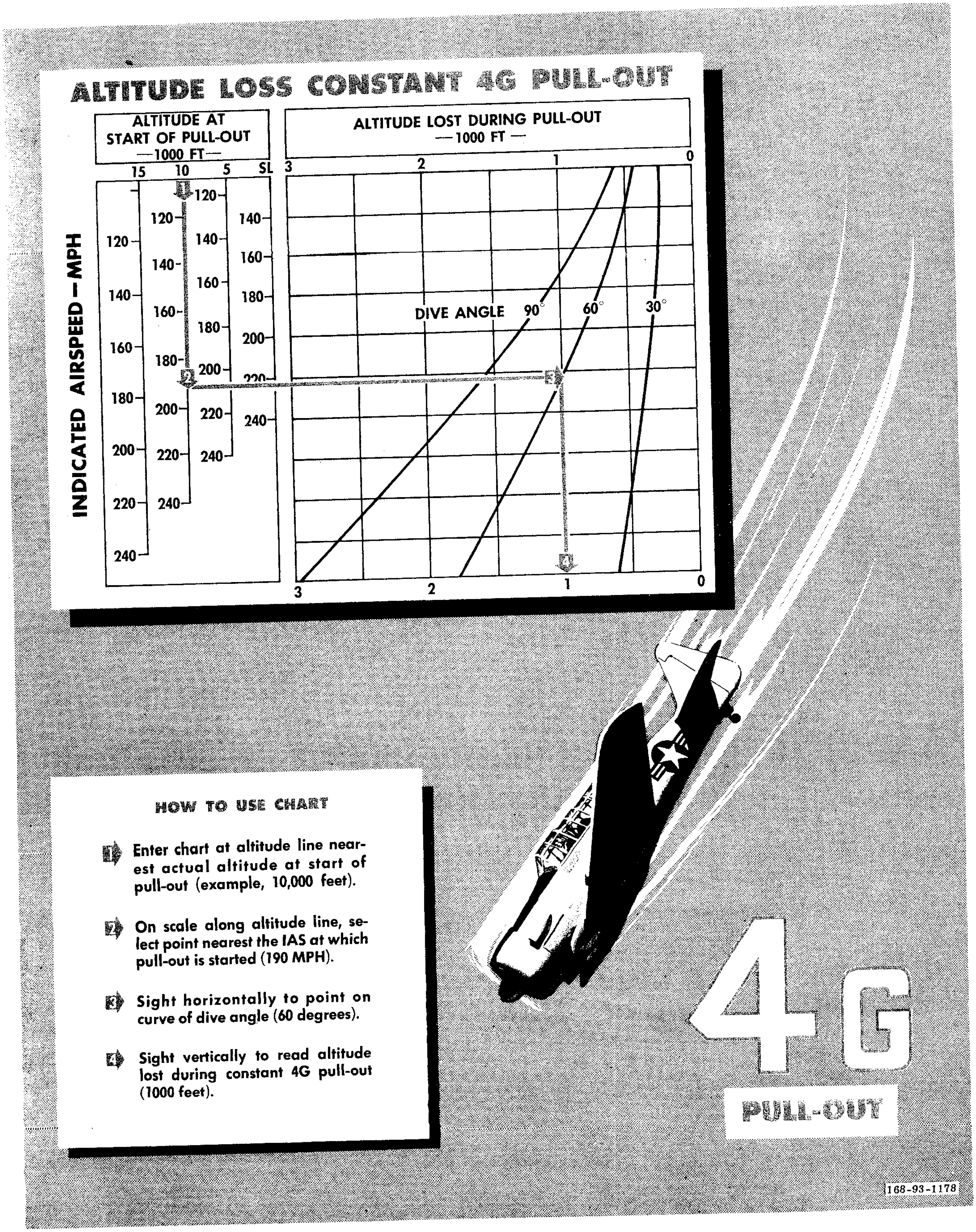
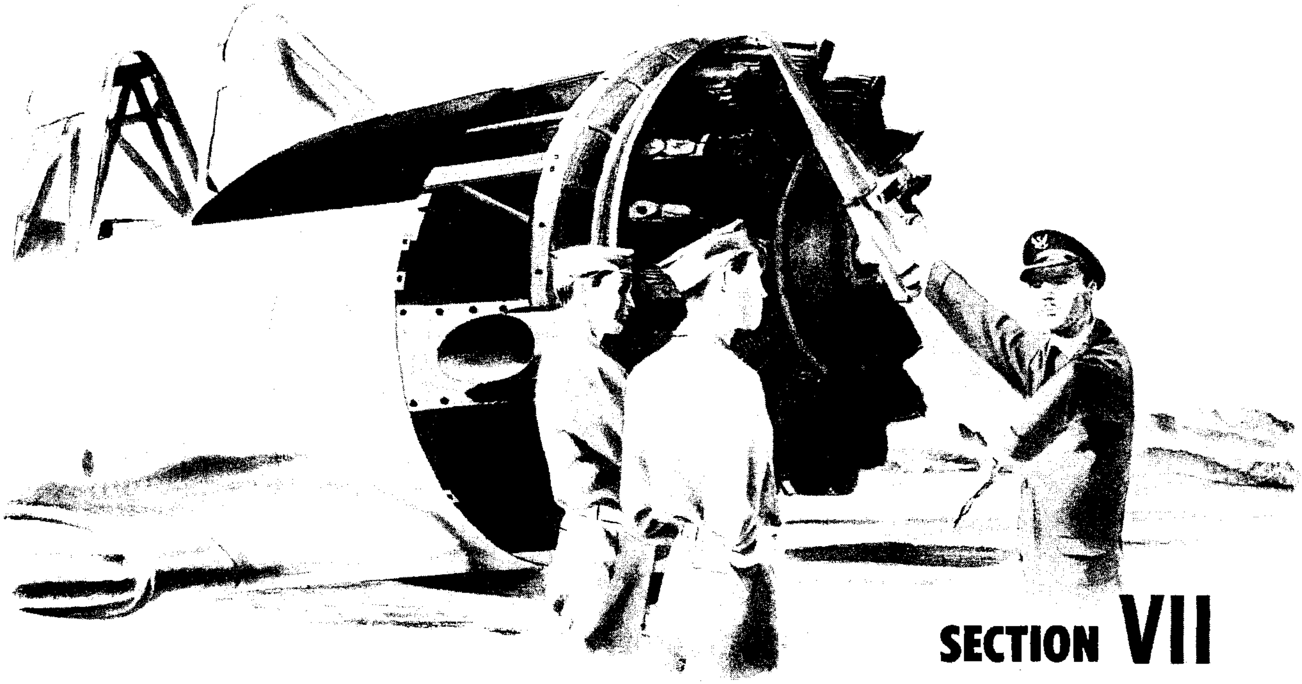


Figure 6-4. Altitude Loss and Dive Recovery

SYSTEMS OPERATION



SECTION VII

ENGINE.

USE OF TAKE-OFF (MILITARY) POWER.

It is often asked what the consequences would be if the 5-minute limit at Take-off Power were exceeded. Another frequent inquiry is how long a period must be allowed after the specified time limit has elapsed until Take-off Power can again be used. These questions are difficult to answer, since the time limit specified does not mean that engine damage will occur if the limits are exceeded, but means more to keep to a reasonable minimum the total operating time at high power, in the interest of prolonging engine life.

It is generally accepted that high-power operation of an engine results in increased wear and necessitates more frequent overhaul than low-power operation. However, it is apparent that a certain percentage of operating time must be at full power. The engine manufacturer allows for this in qualification tests in which much of the running is done at Take-off Power to prove ability to withstand the resulting loads. It is established in these runs that the engine will handle sustained high power without damage. Nevertheless, it is still the aim of the manufacturer and to the best interest of the pilot to keep within reasonable values the amount of high-power time accumulated in the field. The most satisfactory method for accomplishing this is to establish time limits that will keep pilots constantly aware of the desire to hold high-power periods to the shortest period that the flight plan will allow, so that the total accumulated time and resulting wear can be kept to a minimum. How the time at high power is accumulated is of secondary importance; i.e., it is no worse from the standpoint of engine wear to operate at Take-off Power for one hour straight than it is to operate in twelve 5-minute stretches, provided engine temperatures and pressures are within limits. In fact, the former procedure may even be preferable, as it eliminates temperature cycles which also promote engine wear. Thus, if flight conditions occasionally require exceeding time limits, this should not cause concern so long as constant effort is made to *keep the over-all time at Take-off Power to the minimum practicable period.*

Another factor to be remembered in operating engines at high power is that full Take-off Power is to be preferred over take-off rpm with reduced manifold pressure. This procedure results in less engine wear for two reasons. First, the higher resulting brake horsepower decreases the time required to obtain the objective of such high-power operation. At take-off, for example, the use of full power decreases the time required to reach an altitude and airspeed where it is safe to reduce power, and shortens the time required to reach the airspeed that will provide more favorable cylinder cooling.

Second, high rpm results in high loads on the reciprocating parts due to inertia forces. As these loads are partially offset by the gas pressure in the cylinder, the higher cylinder pressures resulting from use of full take-off manifold pressure will give lower net loads and less wear. Sustained high rpm is a major factor producing engine wear. It requires more "rpm minutes" and "piston ring miles" to take off with reduced manifold pressure. In addition to the engine wear factor, a take-off at reduced power is comparable to starting with approximately one-third of the runway behind the airplane. Therefore full power should *always* be used on all take-offs.

MANUAL LEANING.

An important factor affecting engine power output is the fuel-air ratio of the inlet charge going to the cylinders. Since air density decreases with altitude, the mixture control must be manually adjusted to maintain a proper mixture. However, lean mixtures must be avoided, especially when the engine is operating near its maximum output. It is well to closely observe the cylinder head temperature whenever lean mixtures are used. If the mixture is too lean, one or more of the following operational difficulties may result: rough engine operation, backfiring, overheating, detonation, sudden engine failure, or appreciable loss in engine power. Adjusting the mixture for smooth operation is accomplished by slowly pulling the mixture control toward LEAN until the engine definitely falters; immediately push the control slightly forward until the engine is again running smoothly. Then slowly push the control approximately 1/16 inch toward RICH.

THROTTLE "JOCKEYING."

Since there is no advantage to "jockeying" the throttle, and because it can result in damage to the engine, it should be avoided. "Jockeying" the throttle when the engine is cold frequently causes backfire with accompanying fire hazard. When the engine is hot, "jockeying" the throttle will tend to "load up" and possibly choke the engine.

CHANGING ENGINE POWER SETTINGS.

One of the basic limitations placed on engine operation is imposed by the amount of pressure developed in the cylinders during combustion. If this pressure becomes excessive, it can cause detonation and will result in eventual engine failure. Since improper coordination in the use of the throttle and propeller control can cause these limitations to be exceeded, it is important to learn the correct sequence in which these controls should be used. *Whenever the engine power is to be reduced, retard the throttle first—then retard the propeller control. Conversely, when increasing engine power, advance the propeller control first—then advance the throttle.*

CARBURETOR ICING.

A characteristic of carburetor icing is that ice will form more readily when the *mixture* temperature in the carburetor is between −10°C and +30°C. Carburetor icing usually occurs during times when the *free air* temperature is about +4°C to +8°C. Ice will also form more readily when the engine is operated under a low-power cruise condition; therefore, a higher power setting should be selected when icing conditions are prevalent. The formation of ice can be detected by a gradual decrease of manifold pressure, but rpm will remain constant, as the propeller governor will automatically maintain the existing rpm setting. Moving the carburetor air control to HOT will eliminate the ice in the carburetor, and the manifold pressure will return to almost the original setting. During operation in cold, clear, nonicing air where cylinder head and carburetor mixture temperatures drop to values sufficiently low to cause rough engine operation, carburetor heat should be increased just enough to eliminate the roughness.

DETONATION.

Detonation is the result of one type of abnormal combustion of part of the fuel-air mixture. The other prevalent form of abnormal combustion is preignition. When detonation occurs, combustion is normal until approximately 80 percent of the charge is burning. At that point, the rate of combustion speeds up tremendously, resulting in an explosion or nearly instantaneous combustion. This explosion actually pounds the cylinder walls, producing "knock." This "knock," or pounding of the cylinder walls, can cause an engine failure. In an airplane, the "knock" is not heard because of other engine and propeller noises. However, detonation can be detected by observing the exhaust for visible puffs of black smoke, glowing carbon particles, or a small, sharp, whitish-orange flame. In addition, a rapid increase in cylinder head temperatures often indicates detonation. When detonation is evident, throttle reduction is the most immediate and surest remedy. *When detonation occurs, power is lost.* Contributing causes of detonation are as follows:

1. Low-octane fuel.

2. High cylinder head temperature caused by too long a climb at too low an airspeed or by too lean a mixture.

3. High mixture temperature caused by use of carburetor heat or by high outside air temperature.

4. Too high manifold pressure with other conditions favorable to detonation.

5. Improper mixture caused by faulty carburetor or too lean a mixture.

PREIGNITION.

Preignition is closely related to detonation. In fact, detonation often progresses into preignition. When the engine gets too hot, the mixture is ignited before the spark occurs. When this happens, much of the power is wasted trying to push the piston down while it is still rising in the cylinder. The power impulses are uneven, horsepower falls off, and the engine can be damaged from excessive pressures and temperatures. Preignition may be detected by backfiring through the carburetor and possibly by a rapid increase in cylinder head temperatures. When preignition is encountered, the throttle setting should be reduced immediately.

FUEL SYSTEM FLIGHT OPERATION.

During flight, the fuel selector should be moved alternately between 35.2 GAL. LEFT and 55.2 GAL. RIGHT to keep the fuel level in the wing tanks within 10 gallons of each other. When flying below 3000 feet above the ground, it is advisable to use 20 GAL. RES. or 55.2 GAL. RIGHT as a safety precaution to prevent inadvertent fuel starvation. Maneuvering flight, under certain conditions (figure 7-1), can cause a reduction in the available reserve to an amount as low as 10 gallons.

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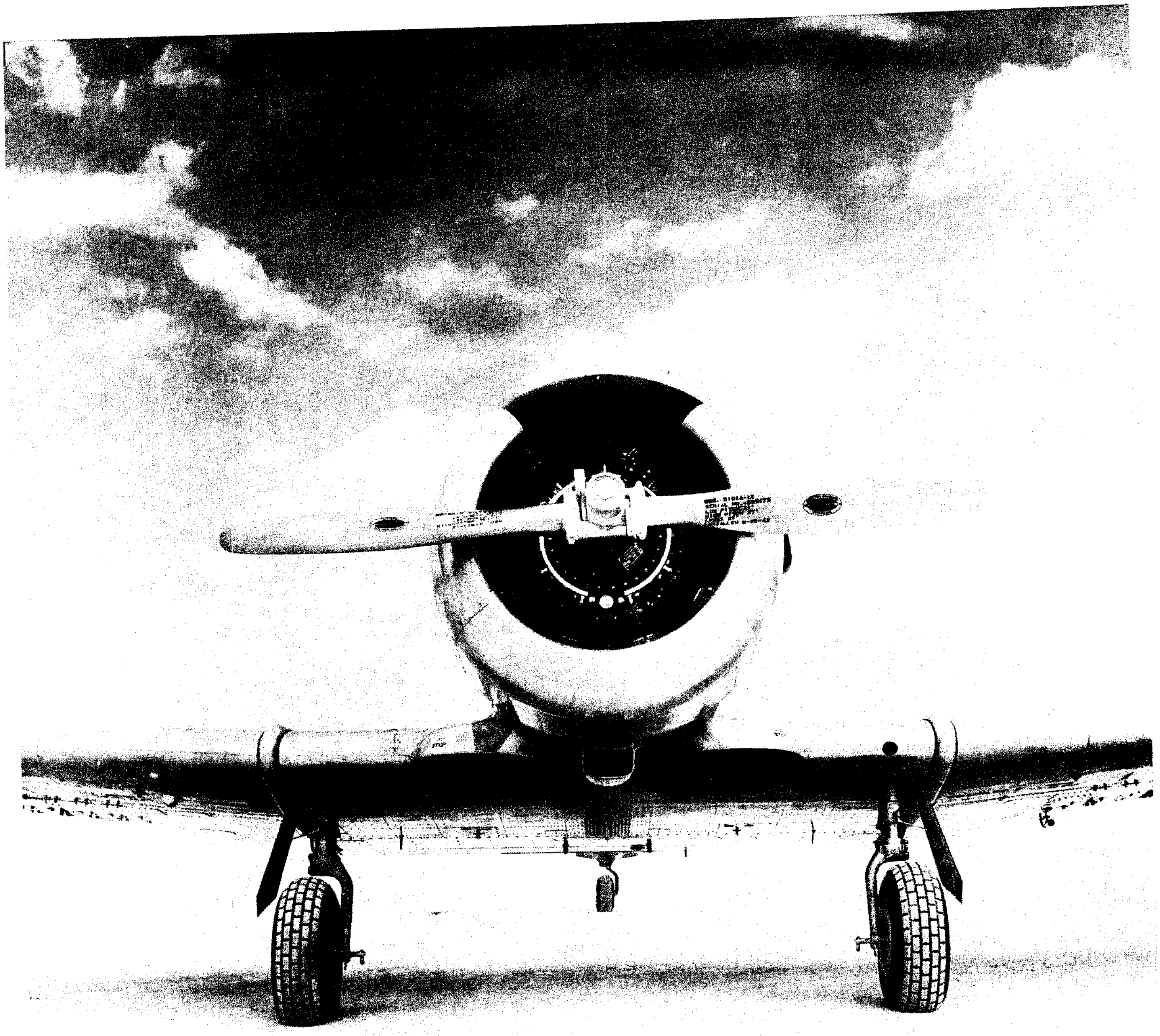
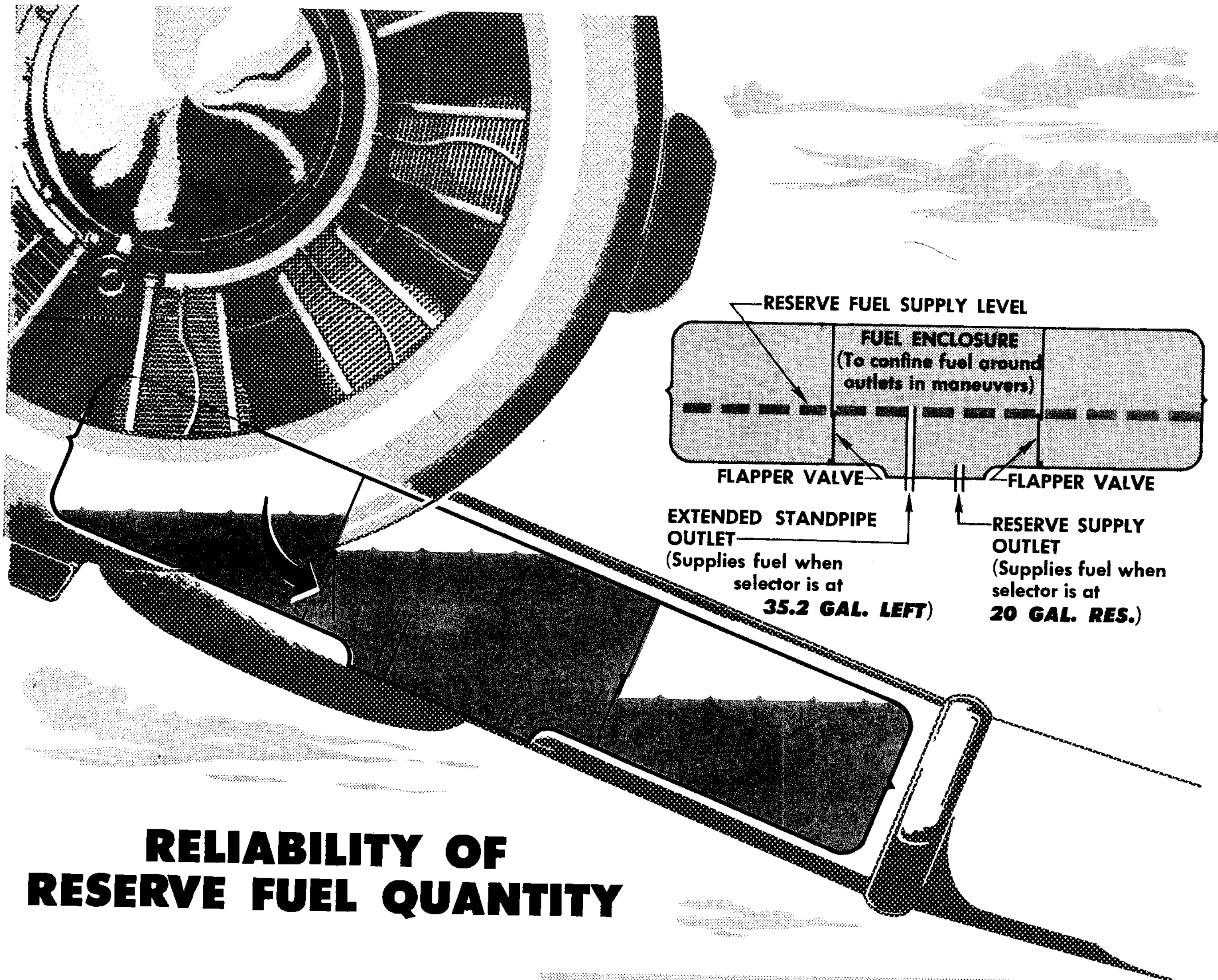
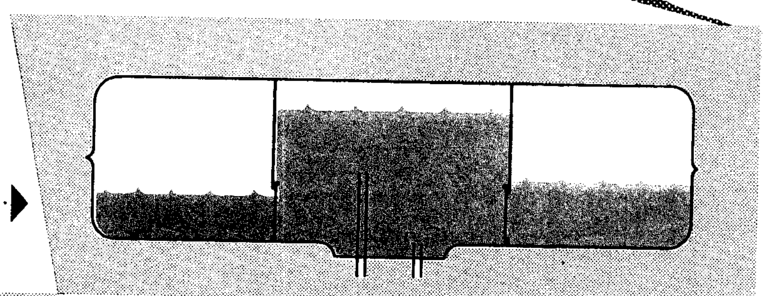
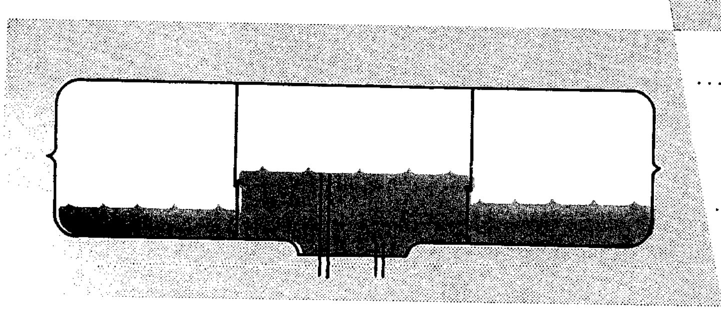




RELIABILITY OF RESERVE FUEL QUANTITY

Normally, the fuel levels will be equal throughout the tank; however, if the airplane is maneuvered when the fuel level approaches 20 gallons, fuel will be forced into the enclosure and the fuel levels will no longer be equal. ....





.... If these "tank-stuffing" maneuvers are continued, a condition can easily be reached where the fuel in the tank proper is appreciably below the 20-gallon reserve line.

...... In this condition, when fuel ceases to flow through the extended standpipe, there will be less than the expected 20-gallon reserve supply.

.... Therefore, when fuel can no longer be drawn with the selector in the **35.2 GAL. LEFT** position, 10 gallons of reserve fuel is the maximum that should be relied upon.

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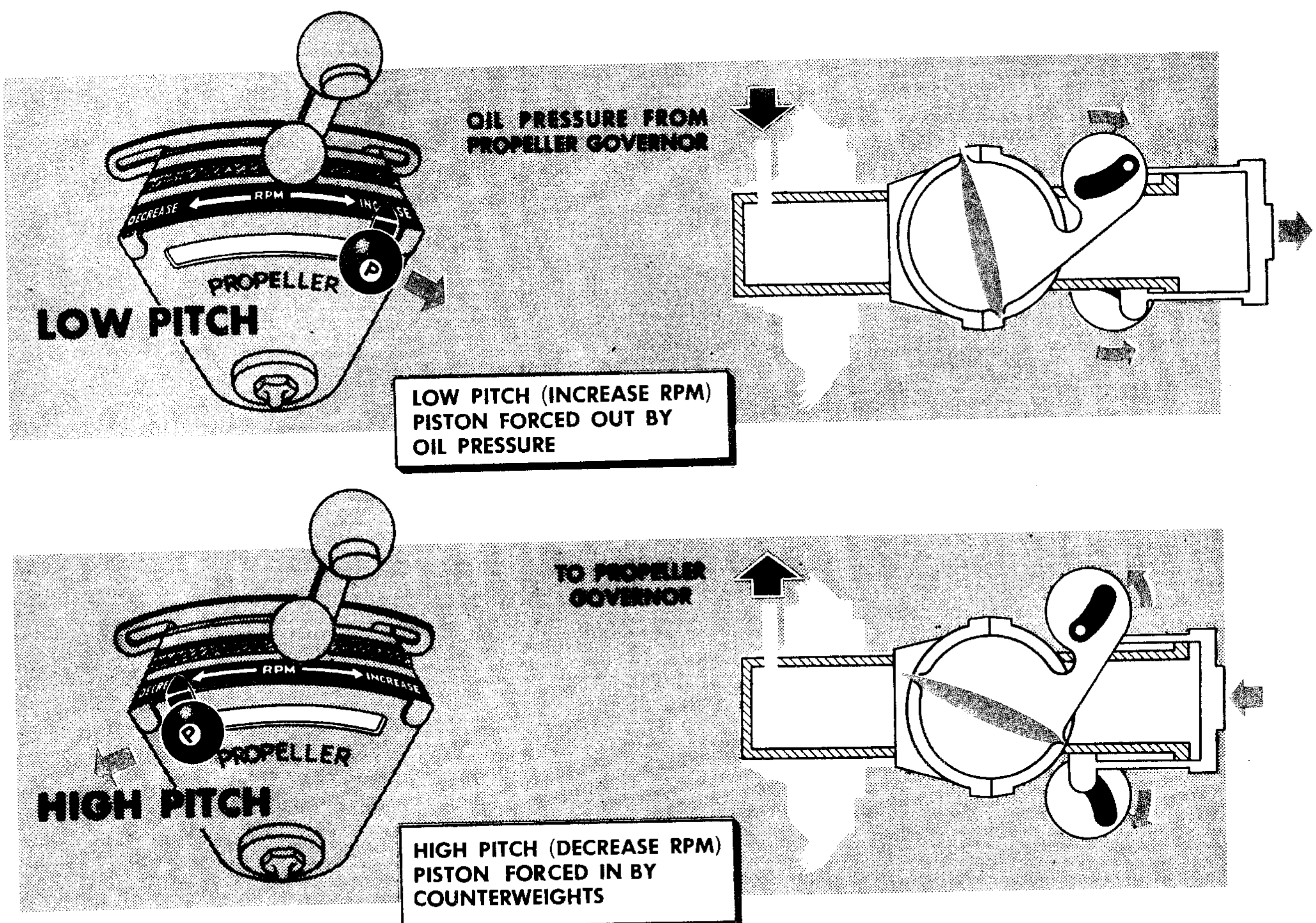
Figure 7-1

PROPELLER OPERATION.

The relationship between propeller pitch (blade angle), counterweight and propeller piston position, and function of engine oil pressure is schematically shown in figure 7-2. The engine speed is maintained constant by a governor which regulates the engine oil pressure to a piston incorporated in the propeller hub. A counterweight at the shank of each blade provides a force (proportionate to rpm) in opposition to engine oil pressure to effect a balance. The resultant action of the piston varies the propeller blade angle or pitch, thereby maintaining a constant engine rpm. To enable maximum rated horsepower to be obtained for take-off, the propeller control is positioned to full INCREASE rpm. During a landing, the propeller control is set to obtain 2000 rpm to ensure immediate availability of power in case a go-around becomes necessary. The engine is shut down with the propeller at decrease rpm (high pitch) so that the oil in the hub piston will be returned to the oil tank. Therefore, the propeller control must be at DECREASE rpm when the engine is again started; otherwise, the immediate demand for oil to change the propeller pitch will decrease the available oil pressure necessary for engine lubrication during the start.



Since the engine is shut down with propeller at ***DECREASE*** rpm, it must be started at ***DECREASE*** rpm to ensure proper engine lubrication during starting.

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Figure 7-2

CREW DUTIES

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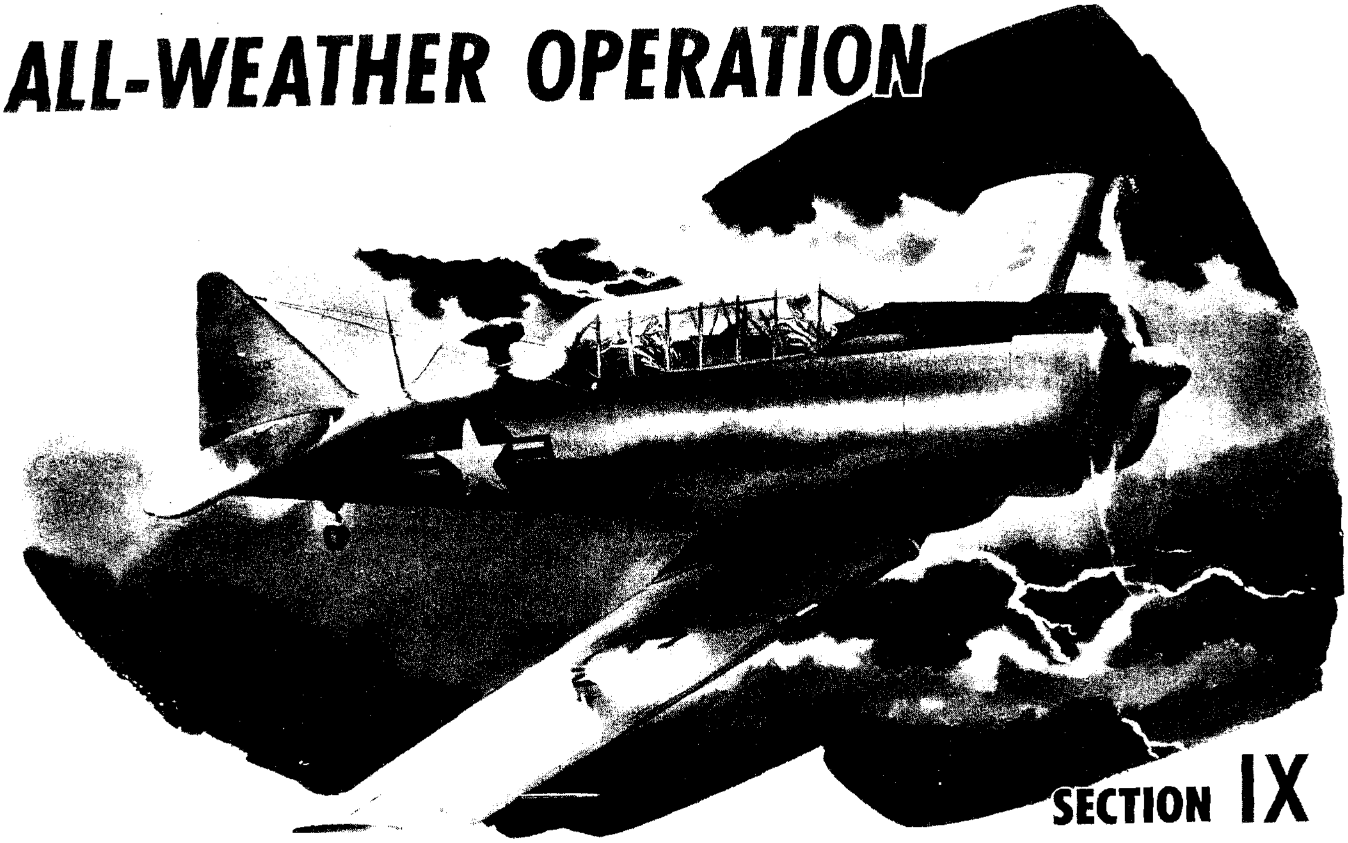
ALL-WEATHER OPERATION



SECTION IX

Except for some repetition necessary for emphasis or continuity of thought, this section contains only those procedures that differ from, or are in addition to, the normal operating instructions contained in Section II.

INSTRUMENT FLIGHT PROCEDURES

Stability and rapid acceleration or deceleration are the outstanding instrument-flight characteristics of the airplane. All the necessary flight instruments are provided. In an emergency, flight on the basic flight instruments (turn-and-bank indicator and airspeed indicator) can be safely accomplished. Radio compass, range reception, vhf transmission, and vhf reception are all provided in addition to interphone communication between cockpits. Remember, since power settings are somewhat higher during certain phases of instrument flight, the airplane range will be slightly decreased.

Note

All turns are single-needle-width standard-rate (3 degrees per second) turns.

PRIOR TO TAKE-OFF.

1. Check G file for inclusion of AN 08-15-1 (Radio Facilities Charts), AN 08-15-2 (USAF Radio Data and Flight Information), and Pilot's Handbooks—Continental United States.
2. Check suction gage for proper indication.
3. Check that the pitot head cover has been removed. Turn pitot heater on and have outside observer verify its operation. Turn pitot heater off until just prior to take-off.
4. Check airspeed indicator needle at zero. Check airspeed correction card for any deviation at the speed range to be flown.
5. If the directional gyro has been actuated for at least 5 minutes, the rotor will have attained proper operating speed. Cage the gyro and then, while turning the knob, uncage it. The dial card should revolve with the knob when the gyro is caged, but not when the gyro is uncaged. Set the directional gyro so that it corresponds to the reading of the magnetic compass.
6. If the gyro horizon has been actuated for at least 5 minutes, the rotor will have attained proper operating speed. Cage the instrument and then uncage it. After the instrument is uncaged, the horizon bar should return

to the correct position for the attitude of the airplane. Temporary vibration of the horizon bar is permissible.

Note

If the horizon bar temporarily departs from horizontal position while the airplane is being taxied straight ahead, or if the bar tips more than 5 degrees during taxiing turns, the instrument is not operating properly.

7. Obtain station altimeter setting (sea-level barometric pressure) from control tower operator. When the altimeter is set, the pointers should indicate local field elevation. If the altimeter registers within 75 feet, it may be used, provided the error is properly considered when the instrument is reset during flight.

8. Check operation of turn-and-bank indicator by observing proper response of needle and ball when turns are made during taxiing.

9. Check rate-of-climb indicator needle at zero.

Note

If the needle does not indicate zero, tap the instrument panel. If it still indicates incorrectly, readjust it by use of the screw in the lower left corner of the instrument.

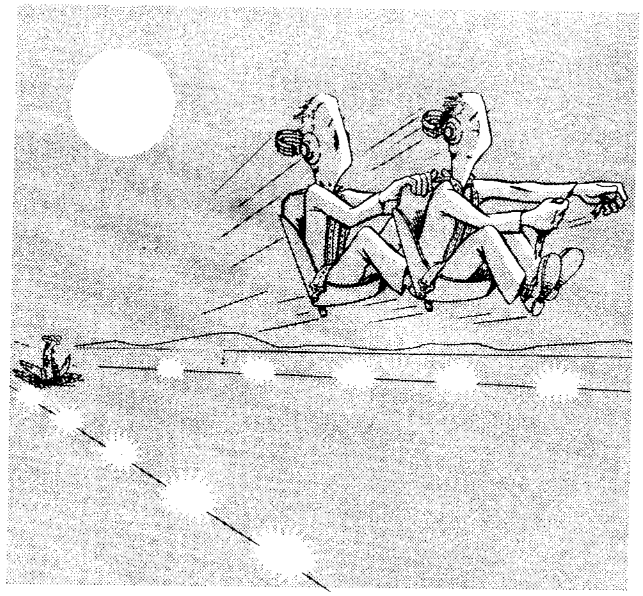
10. Check accuracy of the magnetic compass by comparing its reading to the published runway heading.

11. Check that clock is operating and set to correct time.

12. Move the carburetor air control handle to HOT. Proper operation is verified by a resultant drop in manifold pressure as the mixture temperature increases. Return carburetor air control handle to COLD.

13. Check instruments for readings within proper ranges.

14. Check operation of all radio equipment. Adjust tuning as desired.



Prior to take-off under instrument conditions, special attention should be given to gyro instruments and airplane trim. Any irregularity could have serious consequences.

INSTRUMENT TAKE-OFF.

Preparation, power settings, and take-off and climb speeds are identical to those used in normal take-off. Since use of flaps reduces rate of climb, they should not be used for instrument take-offs.

1. When cleared for take-off, taxi to the center of the runway and align the airplane, as nearly as possible, straight down the centerline of the runway. Hold the airplane with the brakes. Set directional gyro to the published runway heading.

2. When ready, advance throttle to obtain 1000 to 1200 rpm. Release brakes and, as the airplane starts to roll, advance throttle smoothly to the sea-level stop.

3. Maintain directional control by reference to directional gyro. When elevator control becomes effective, raise the tail slightly and allow the airplane to leave the ground with the nose slightly lower than in a three-point attitude, as indicated on the gyro horizon.

4. Hold this pitch attitude and, as the airplane breaks ground, hold the wings level by reference to the gyro horizon. Hold direction by reference to the directional gyro.

5. As soon as the altimeter and rate-of-climb indicator begin to register a climb, retract the landing gear.

6. Reduce the throttle setting and propeller control setting to give approximately 30 in. Hg manifold pressure and 2000 rpm only after climbing airspeed is reached.

INSTRUMENT CLIMB.

1. Establish a rate of climb to obtain approximately 500 feet per minute on the rate-of-climb indicator until normal climbing speed is reached; then trim airplane to maintain this airspeed.

2. Leave traffic and climb to assigned flight altitude in accordance with local air traffic regulations. Do not exceed a 30-degree bank during climbing turns.

INSTRUMENT CRUISING FLIGHT.

Since trim of the airplane will change rapidly when increasing or decreasing speed, adjustment of the trim tabs will be necessary until speed is stabilized. Since no aileron trim facilities are provided, balance the airplane laterally by maintaining an even fuel level. While *changing* cruising airspeed, momentarily overpower or underpower (3 to 5 in. Hg) beyond the desired power setting for a quicker response. The recommended airspeeds, shown in figure 9-1, will provide a safe margin above stall and good controllability for practice instrument flight. The power settings in the chart will normally give the standard airspeeds listed.

Note

If landing gear is extended, the power settings should be slightly higher.

DESCENT.

Normal descent procedures are followed.

HOLDING.

If holding for an extended period is necessary, fuel can be conserved by using a power setting of 1600 rpm and enough manifold pressure to maintain an airspeed of 100 mph IAS.

INSTRUMENT APPROACHES.

Radio range letdown and low-visibility approaches are standard.

GROUND CONTROLLED APPROACH.

Procedure for landing under instrument conditions by use of directions from ground controlled approach radar equipment after letdown on a radio range is as follows:

1. Establish contact with GCA over GCA pickup point.
2. Hold 110 mph IAS until final turn is completed, running through GCA prelanding cockpit check as instructed by the GCA controller.
3. After completing turn to final approach and prior to intercepting the glide path, lower flaps 20 degrees.
4. As glide path is intercepted, reduce throttle setting to obtain 17 in. Hg manifold pressure and descend as directed by the GCA final controller.

ICE AND RAIN.

During a winter fog or rain, watch for icing on wings from propeller blast during engine run-up. Don't take off in sleet if you can avoid it because it may freeze on the wings before you can gain altitude. If carburetor ice has formed during ground operation, use carburetor heat to remove ice prior to take-off and as necessary during take-off.

WARNING

The carburetor is susceptible to icing and may ice up at any time under actual instrument-flight conditions. Except in extreme cases, carburetor mixture temperatures of approximately 3°C will be sufficient to clear the carburetor or prevent icing.

INSTRUMENT CRUISING FLIGHT

RECOMMENDED AIRSPEEDS	RPM	APPROX MAN. PRESS. (In. Hg)	MIXTURE
Climb to cruising altitude — 110 mph IAS	2000	30	Mixture adjusted for smoothest operation above 3000 feet.
Slow cruise — 110 mph IAS	1850	18	
Normal cruise — 130 mph IAS	1850	21	
Fast cruise — 140 mph IAS	1850	24	
Climb — 500 fpm — 110 mph IAS	1850	25	
Descent — 500 fpm — 110 mph IAS	1850	13	
GCA airspeed — 20 degree flaps — 100 mph IAS	2000	16-18	RICH

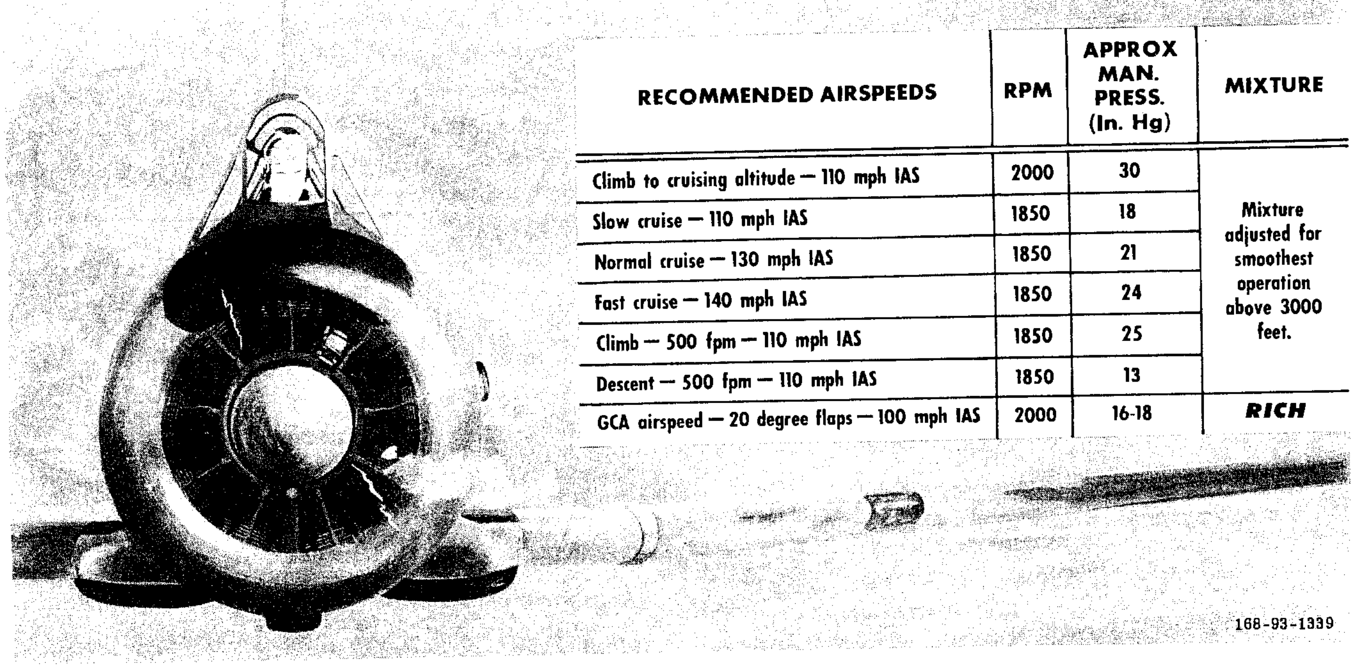


Figure 9-1

Engine roughness and a slight drop in manifold pressure are indications of ice forming in the carburetor. If carburetor icing is indicated, carburetor heat should first be applied at a somewhat higher temperature than is normally used and then readjusted as necessary to prevent further icing. Fuel consumption will increase slightly with the application of carburetor heat. If icing is encountered during low rpm operation, increase the engine speed and manifold pressure and enrich the mixture.

If ice has accumulated on wings, make wide, shallow turns at a speed greater than normal, especially during the approach. Use flaps with care. Remember, stalling speed increases with ice. The only units that incorporate provisions to prevent icing are the pitot head and carburetor. Additional information concerning carburetor icing is given in Section VII.

FLIGHT IN TURBULENCE AND THUNDERSTORMS.

A pilot, using modern equipment and possessing a combination of proper experience, common sense, and instrument flying proficiency, can safely fly thunderstorms. However, flight through a thunderstorm should be avoided if it is at all possible.

Since circumstances may force you at some time to enter a zone of severe turbulence, you should be familiar with the techniques recommended for flying this airplane under such circumstances. Power setting and pitch attitude are the keys to proper flight technique in turbulent air. The power setting and pitch attitude for the desired penetration airspeed should be established before entrance into the storm and, if maintained throughout the storm, should result in a constant airspeed regardless of any false indications by the airspeed indicator. Instructions for preparing to enter a storm and flying in it are given in the following paragraphs.

BEFORE TAKE-OFF.

Perform the following checks before take-off when flight through a storm is anticipated:

1. Check turbulent air penetration speed chart (figure 9-2) for best penetration speed.
2. Make a thorough analysis of the general weather to determine thunderstorm areas, and prepare a flight plan that will avoid thunderstorm areas whenever possible.
3. Be sure to check proper operation of all flight instruments, navigation equipment, pitot heater, carburetor air heater, and panel lights before attempting flight through thunderstorm areas.

APPROACHING THE STORM.

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. Prepare the airplane as follows:

1. Accurately fix position prior to actual entry into thunderstorm area.
2. Propeller control set to obtain 1900 rpm gyroscopic stability.
3. Mixture control adjusted for smooth engine operation.
4. Pitot heat switch ON.
5. Carburetor air control adjusted as required.
6. Throttle adjusted as necessary to obtain desired penetration speed.
7. Check suction gage for proper reading and gyro instruments for correct settings.
8. Tighten safety belt. Lock shoulder harness.
9. Turn off any radio equipment rendered useless by static.
10. To minimize blinding effect of lightning at night, turn cockpit lights full bright, adjust seat low, and don't stare outside airplane.

CAUTION

When flying through turbulent air, do not lower gear and flaps, as they decrease the aerodynamic efficiency of the airplane.

IN THE STORM.

While flying through the storm, observe the following precautions:

1. Maintain, throughout the storm, the power setting and pitch attitude established before entering the storm. Hold these constant and your airspeed will be constant, regardless of the airspeed indicator.

2. Maintain attitude. Concentrate principally on holding a level attitude by reference to the gyro horizon.

3. Maintain original heading. Do not make any turns unless absolutely necessary.

4. Don't chase the airspeed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while the airplane is in a nose-high attitude, a stall might easily result. Because of rapid changes in vertical gust velocity or rain clogging the pitot tube, the airspeed may momentarily fluctuate as much as 70 mph.

5. Use as little elevator control as possible to maintain your attitude in order to minimize the stresses imposed on the airplane.

6. The altimeter and rate-of-climb indicator may be unreliable in thunderstorms because of differential barometric pressure within the storm. A gain or loss of several thousand feet may be expected. Altitude must be allowed to vary, to let the airplane ride out the storm. Make allowance for this condition in determining a minimum safe altitude.

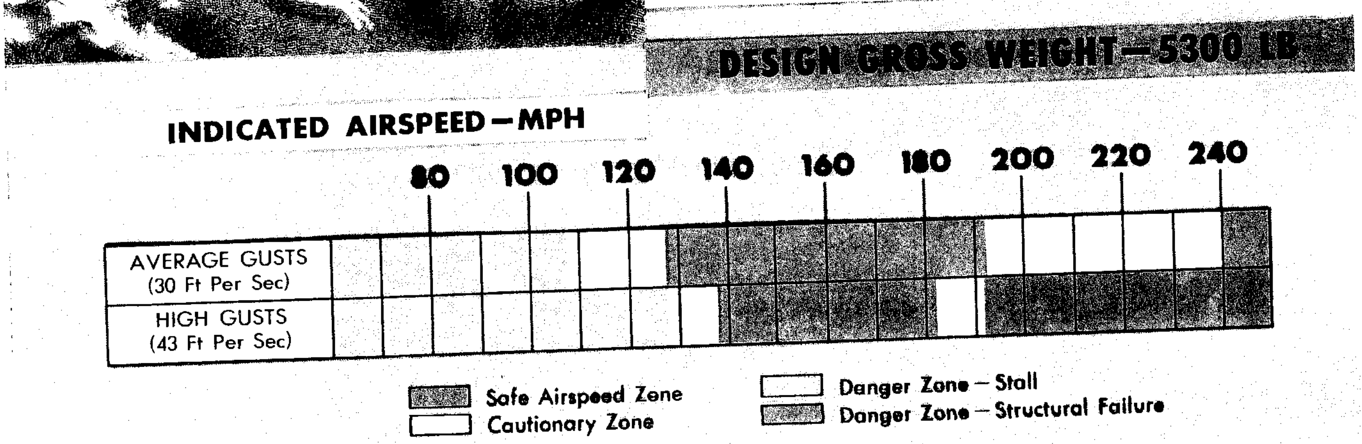
Note

> Normally, the least turbulent area in a thunderstorm will be at altitudes between 6000 and and 8000 feet above the terrain. Altitudes between 10,000 and 20,000 feet are usually the most turbulent.

7. Maintain a constant power setting and pitch attitude unless airspeed falls off to 60 percent above power-on stalling speed, or unless airspeed increases to approximately 30 percent above maximum penetration airspeed.

NIGHT FLYING

There are no predominant differences between night-flying procedures and day-flying procedures. Exhaust glare will obviously be more pronounced during night flights, however, but should be no cause for alarm. Refer to Section II for night-flight interior check, take-off, and landing procedures.



168-93-1204A

Figure 9-2

COLD-WEATHER PROCEDURES

The success of low-temperature operation depends greatly on the preparation made previously during engine shutdown and postflight procedures as outlined in the following paragraphs. Icing conditions, however, are covered in the instructions for instrument flight.

BEFORE ENTERING THE AIRPLANE.

1. Have "Y" drain and oil tank sump checked for free flow. If no oil flow is obtained, heat should be applied.

Note

If oil was not diluted when the engine was previously shut down, heating will be necessary at temperatures below 2°C (35°F). At temperatures below −18°C (0°F), heat should be applied to the engine and accessories. Below −30°C (−22°F), it may be necessary to apply heat also to the battery, cockpits, master brake cylinder, and actuating cylinders.

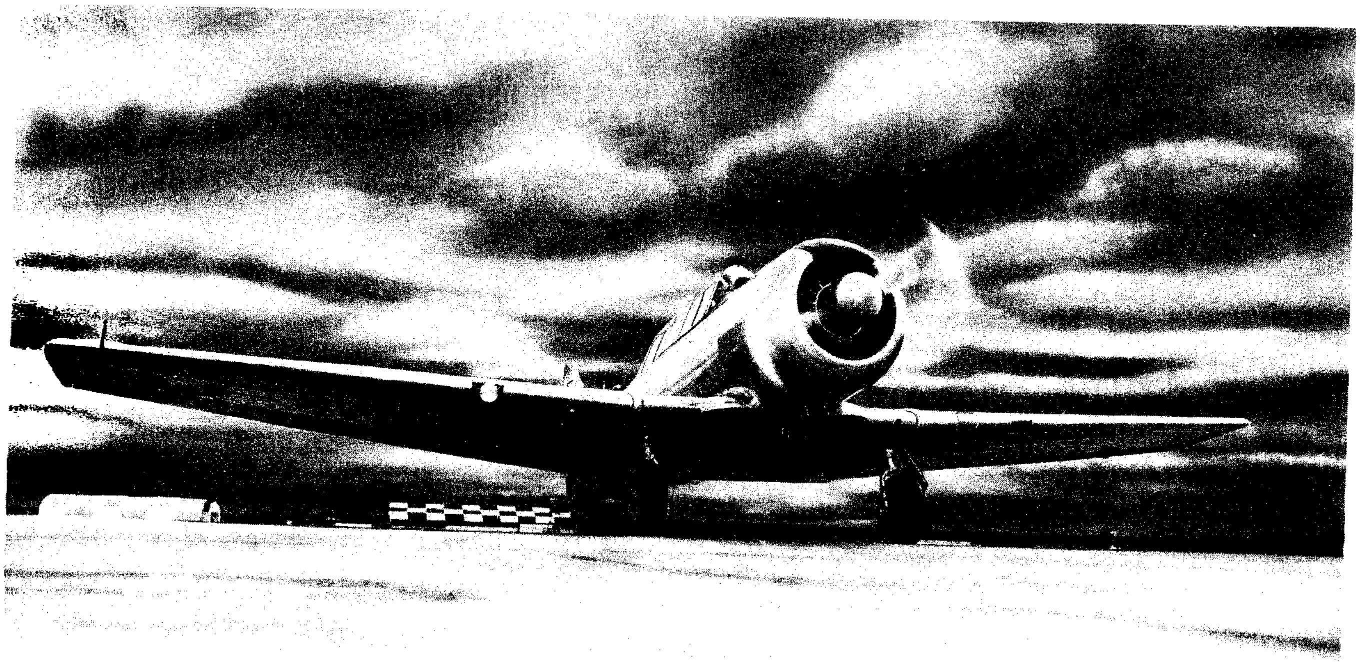
2. Have moisture drained from all fuel tanks and fuel system sumps; if they are frozen, heat should be applied first. Check fuel and oil tank vent lines for free passage.
3. Check gear and shock struts free of dirt and ice.
4. Have protective covers removed from airplane and any snow or ice removed from surfaces, control hinges, propeller, pitot tube, fuel and oil vents, and crankcase breather outlet.
5. Check freedom of propeller periodically to determine engine stiffness. If propeller cannot be moved easily, continue preheat.
6. Have engine cover and ground heater removed.

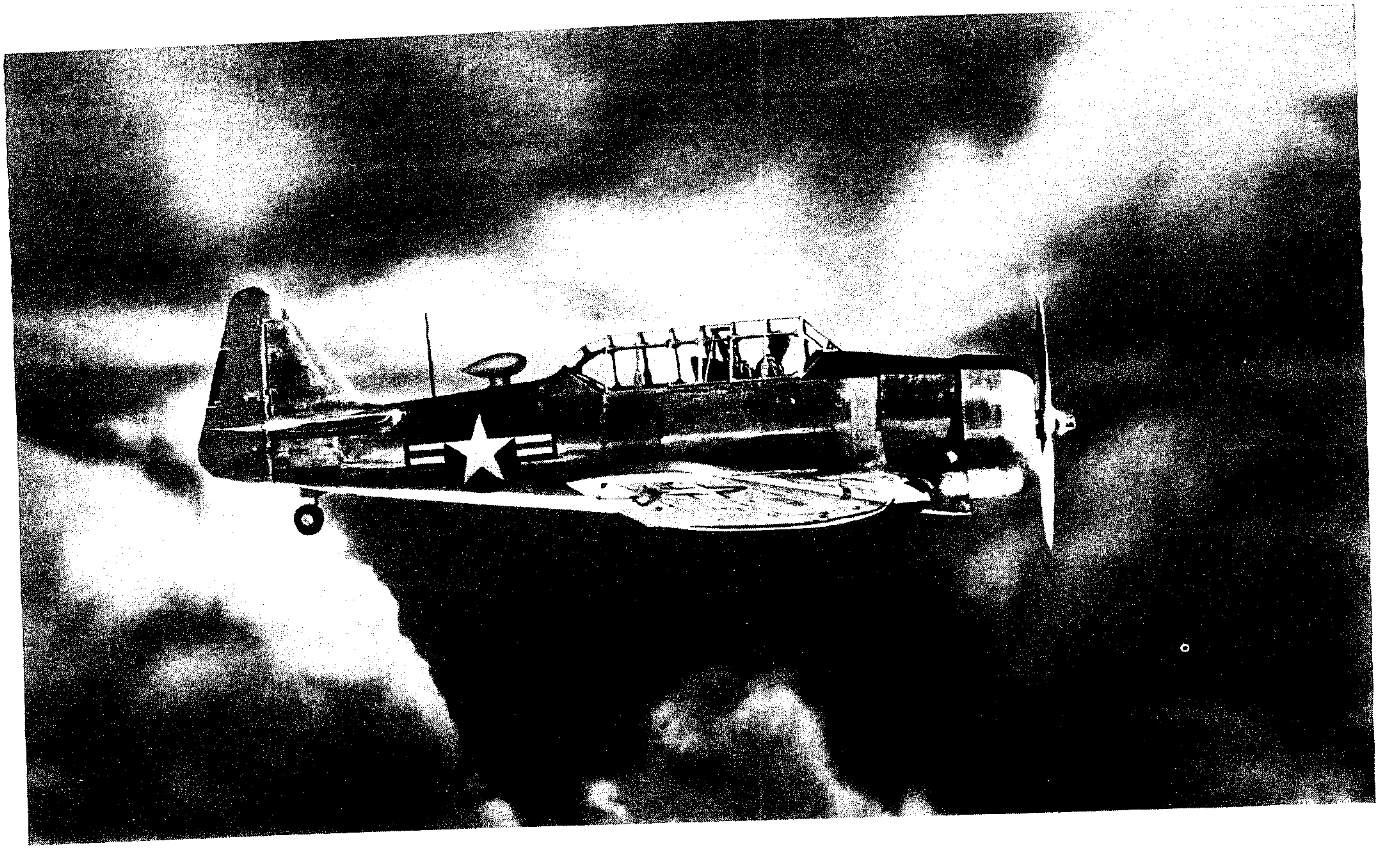
BEFORE STARTING ENGINE.

1. Have external power source connected, to conserve battery life for use during in-flight emergencies.
2. Have oil immersion heater removed.
3. Have propeller pulled through at least two revolutions.
4. Prime engine four to six strokes.

Note

Rapid priming action may be necessary to vaporize the fuel sufficiently.





STARTING ENGINE.

1. After engine starts, continue priming until engine is running smoothly.
2. If there is no indication of oil pressure after 30 seconds running, or if pressure drops after a few minutes of ground operation, stop engine and investigate.
3. Use carburetor heat to assist fuel vaporization.

WARM-UP AND GROUND TESTS.

1. Check all instruments for normal operation.
2. When oil temperature and pressure are normal, advance the throttle to 1400 rpm, and pull propeller control to full DECREASE position until a drop of 200 rpm is obtained; then return control to full INCREASE position. Repeat procedure three times to ensure that hot oil is in propeller dome.
3. Operate wing flaps through at least one complete cycle.
4. Perform all ground tests requiring electrical power before disconnecting external power source.

Note

The battery cannot carry the electrical load imposed by ground operation of pitot heater and radios. Minimize load on the electrical system until the generator "cuts in."

5. Have external power source disconnected and turn battery-disconnect switch ON.

TAXIING INSTRUCTIONS.

Use only essential electrical equipment to conserve battery life while taxiing at low engine speeds. Avoid slushy and icy areas. Apply brakes cautiously to prevent skidding. Avoid taxiing in deep snow, as steering and taxiing are extremely difficult and frozen brakes are likely to result.

BEFORE TAKE-OFF.

1. Check controls very carefully for free and proper movement.
2. Hold brakes and run up engine to 2000 rpm until spark plugs have burned clean and engine is operating smoothly. Then check magnetos.
3. Apply carburetor heat as necessary to maintain carburetor mixture temperature within limits during take-off.
4. Place pitot heat switch ON just before rolling into position for take-off.

TAKE-OFF.

At start of take-off run, advance throttle rapidly to take-off setting and check that full power is available. If full power is not obtained, immediately discontinue take-off. Since cold, dry air has a greater density, engine power output and airplane lift are increased.

AFTER TAKE-OFF.

After take-off from a wet snow- or slush-covered field, operate the landing gear and flaps through several complete cycles to prevent their freezing in the retracted position. Expect considerably slower operation of the landing gear and flaps in cold weather.

CLIMB.

1. Adjust carburetor air control as necessary to prevent carburetor icing.
2. Adjust oil cooler shutter control as necessary to maintain correct oil temperature.

DURING FLIGHT.

1. At low outside air temperatures, especially during low-power cruising operation, the fuel-air mixture ratio may be too cold for proper vaporization and fuel economy. Use carburetor heat as necessary to obtain smooth engine operation and to eliminate plug fouling.
2. Operate propeller control every 30 minutes, obtaining approximately 300 rpm increase and decrease from cruising position; then return to cruise rpm.
3. Adjust cockpit heat as necessary.

DESCENT.

1. Use power during the descent to prevent engine from being cooled too rapidly.
2. Increase carburetor heat as necessary.
3. Mixture control RICH.

APPROACH.

1. Make a longer, lower approach than normal so that some power is needed to reach the runway. Use carburetor heat.
2. Pump brake pedals several times.

LANDING.

Use normal landing procedure.

STOPPING ENGINE.

OIL DILUTION.

Before shutdown, the engine oil should be diluted unless the entire oil system is to be drained. If it is necessary to service the oil tank, shut down the engine and have it serviced before diluting. Then restart the engine and dilute as follows:

1. Run engine at 1000 rpm.
2. During dilution, maintain oil temperature from 5°C to 50°C and oil pressure above 15 psi. Reset throttle, if necessary, to maintain these conditions. If oil temperature is above 50°C, shut down engine and allow oil to cool below 40°C; then restart and dilute.
3. Hold oil dilution switch ON, as required by lowest expected temperature, for time indicated in the following table:

ANTICIPATED TEMPERATURE	TIME—MINUTES
4°C to −12°C (40°F to 10°F)	3
−12°C to −29°C (10°F to −20°F)	6
−29°C to −46°C (−20°F to −50°F)	9

[Add one minute of dilution for each further drop of 5°C (9°F) below −46°C (−50°F).]

4. Dilute the oil in the propeller by operating the propeller control during the latter part of the dilution time interval. Advance throttle to 1400 rpm and move propeller control back until a decrease of approximately 200 rpm is obtained; then return control to full INCREASE. Repeat operation three times.

BEFORE LEAVING THE AIRPLANE.

1. Release the brakes.
2. Check dirt and ice removed from shock struts.
3. Inspect oil and fuel tanks and engine breather to verify absence of any accumulated ice.
4. Leave canopy partially open to prevent cracking of transparent areas due to differential contraction. Air circulation also retards formation of frost.
5. Have protective covers installed.
6. Have oil tank sump, "Y" drain, and fuel sumps drained of condensation approximately 30 minutes after stopping the engine. If the airplane is to be idle for several days, the oil may be drained.
7. If specific gravity of battery is less than 1.250, have battery removed for service. If layover of several days is anticipated, or if temperature is below −29°C (−20°F) and airplane will be idle more than 4 hours, have the battery removed.

OPERATING DATA

APPENDIX I

TABLE OF CONTENTS. PAGE

INTRODUCTION

There are two ways to perform a mission. The *correct* method can be determined from the information presented in the charts on the following pages. If a pilot chooses to ignore the charts, he can fly any mission confident that the airplane is capable of greater performance than he is capable of obtaining from it. These charts, which are easy to interpret, enable you to fly a greater distance at better cruising speed and arrive at your destination with more reserve fuel. A description of each chart and a sample problem to illustrate a typical training mission are also included.

AIRSPEED INSTALLATION CORRECTION TABLE.

An Airspeed Installation Correction Table (figure A-1) is provided for computing calibrated airspeed (CAS) from indicated airspeed (IAS). Indicated airspeed is the airspeed indicator reading. Calibrated airspeed is indicated airspeed corrected for installation error. Equivalent airspeed (EAS) is calibrated airspeed corrected for compressibility error. (Within the airspeed range of the airplane, the compressibility error is negligible, and CAS may be considered as EAS). True airspeed is equivalent airspeed corrected for atmospheric density.

EXAMPLE—USE OF CORRECTION TABLE.

An airplane is flying at 5000 feet pressure altitude, free air temperature is +16°C, and airspeed indicator reading is 130 mph. What is the true airspeed?

Airspeed indicator reading .... 130 mph
Correction for installation error........ +3 mph
Calibrated airspeed .... 133 mph

Use this value of CAS with a Type D-4 or Type G-1 airspeed computer, or a Type AN5835-1 dead-reckoning computer, to determine the true airspeed of 146 knots.

Note

When the dead-reckoning computer is used, CAS usually must be corrected for compressibility error; however, since this correction is not considered on this airplane, CAS may be considered as EAS.

AIR TEMPERATURE CORRECTION.

Air temperature correction for compressibility is negligible (less than 5°C in level-flight cruising) and is not considered. Indicated free air temperature may be considered as true free air temperature.

ALTIMETER INSTALLATION CORRECTION TABLE.

An Altimeter Installation Correction Table (figure A-2) is provided for obtaining true pressure altitude from the altimeter reading.

TAKE-OFF DISTANCES.

A Take-off Distances chart (figure A-5) gives take-off ground run distances and total distances to clear a 50-foot obstacle, tabulated for several different altitudes and temperatures on a hard-surface runway. Distances given are for standard flaps-up take-offs. For a minimum-run take-off, refer to Section II.

AIRSPEED INSTALLATION CORRECTION TABLE

ADD CORRECTION TO INDICATED AIRSPEED TO OBTAIN CALIBRATED AIRSPEED

GEAR AND FLAPS UP – CANOPY CLOSED		GEAR AND FLAPS DOWN – CANOPY OPEN	
IAS (MPH)	CORRECTION (MPH)	IAS (MPH)	CORRECTION (MPH)
80	0	60	0
100	1	70	0
120	2.5	80	0
140	4.0	90	0.5
160	5.5	100	1.0
180	7.0	110	2.0
200	8.5	120	2.5
220	10.0		
240	11.0		

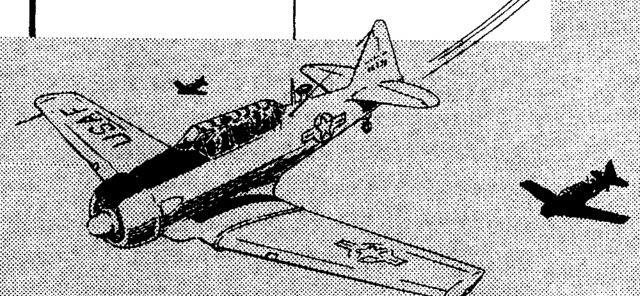


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Figure A-1

NORMAL POWER CLIMB.

Best climb speed, fuel consumption, time to climb, and rate of climb (all at Maximum Continuous Power) can be determined from the Normal Rated Power Climb chart. (See figure A-6.) A fuel allowance for warm-up, taxi, and take-off is listed in the column labeled "SEA LEVEL." Fuel requirements listed at other altitudes include this allowance plus the fuel required to climb from sea level. Fuel required for an in-flight climb from one altitude to another is the difference between the tabulated fuel required to climb to each altitude from sea level.

LANDING DISTANCES.

The Landing Distances chart (figure A-4) shows the distances required for ground roll and for landing over a 50-foot obstacle. Distances are furnished for several altitudes and gross weights, for landings on a hard-surface runway. Best speeds are shown for both power-on and power-off approach. Distances given are airplane requirements under normal service conditions with no wind and with flaps full down.

MAXIMUM ENDURANCE.

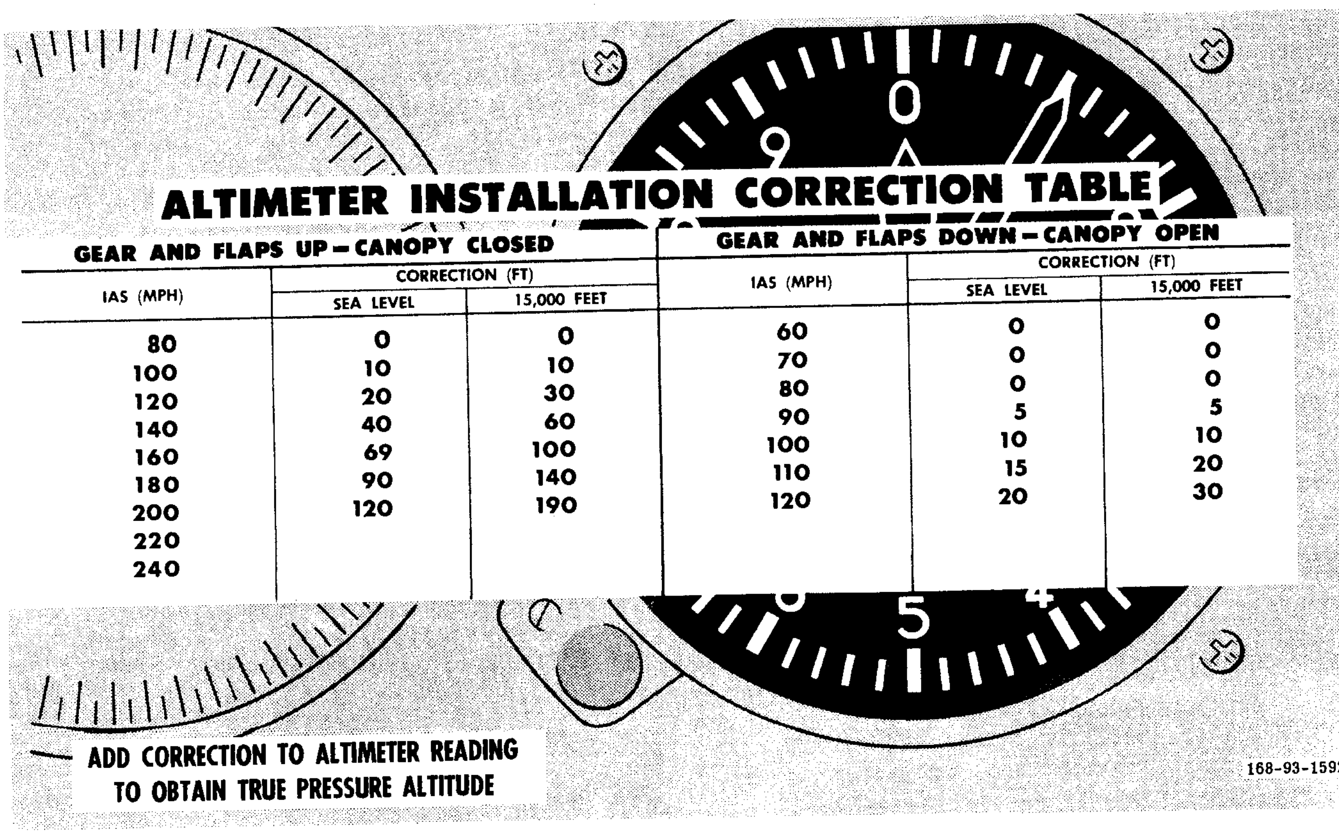
Airspeeds, power settings, and fuel flow rates for maximum endurance flight are shown in the Maximum Endurance chart (figure A-7) for several gross weights and altitudes. The Maximum Endurance chart giving the power settings and fuel flows for maximum *time* in the air should not be confused with the "MAXIMUM AIR RANGE" section of the Flight Operation Instruction Charts in which the power settings and fuel flows are for maximum *distance*, not maximum time.

COMBAT ALLOWANCE.

The Combat Allowance chart (figure A-8) shows the variation with altitude in manifold pressure and fuel flow at Take-off Power (Military Power).

FLIGHT OPERATION INSTRUCTION CHARTS.

To assist in selecting the engine operating conditions required for obtaining various ranges, Flight Operation Instruction Charts (figures A-9 and A-10) are provided for each airplane loading condition, one with external load and one without. Each chart is divided into five main columns. Data listed under Column I is for emergency high-speed cruising at Maximum Continuous Power. Operating conditions in Columns II, III, IV, and V give progressively greater ranges at lower cruising speeds. Ranges shown in any column for a given fuel quantity can be obtained at various altitudes by



ALTIMETER INSTALLATION CORRECTION TABLE

GEAR AND FLAPS UP—CANOPY CLOSED			GEAR AND FLAPS DOWN—CANOPY OPEN		
IAS (MPH)	CORRECTION (FT) SEA LEVEL	CORRECTION (FT) 15,000 FEET	IAS (MPH)	CORRECTION (FT) SEA LEVEL	CORRECTION (FT) 15,000 FEET
80	0	0	60	0	0
100	10	10	70	0	0
120	20	30	80	0	0
140	40	60	90	5	5
160	69	100	100	10	10
180	90	140	110	15	20
200	120	190	120	20	30
220					
240					

— ADD CORRECTION TO ALTIMETER READING TO OBTAIN TRUE PRESSURE ALTITUDE

168-93-1592

Figure A-2

using the power settings listed in the lower half of the chart in the same column. The chart pertaining to the condition with wing bombs is based on estimated data, whereas the other (with no external load) is based on flight-tested data. The speeds quoted on the charts are those obtained with gross weight equal to the high limit of the chart weight band. No allowances are made for wind, navigational error, simulated combat, formation flights, etc; therefore, such allowances must be made as required.

USE OF CHARTS.

To use the charts, first select the Flight Operation Instruction Chart applicable to your flight plan, determined in this airplane by gross weight at take-off and external load. Then enter the chart at a fuel quantity equal to, or less than, the total amount in the airplane minus all allowances. (Ranges listed for each fuel quantity are based on using the entire quantity in level flight, cruising at the recommended operating conditions.) Fuel allowance for warm-up, taxi, take-off, and climb is obtained from the Normal Rated Power Climb chart. (See figure A-6.) Other allowances based on the type of mission, terrain over which the flight is to be made, and weather conditions are dictated by local policy. If your flight plan calls for a continuous flight at reasonably constant cruising power and no change in external load items, compute the fuel required and flight time as a single-section flight. Otherwise, the flight must be broken up into sections and each leg of the flight planned separately. The flight plan may be changed at any time en route, and the charts will show the balance of range available at various cruising powers and altitudes if the instructions printed at the top of each chart are followed.

SAMPLE PROBLEM—TRAINING MISSION.

A triangular cross-country training mission is to be flown according to the flight plan illustrated in figure A-3. After take-off, climb to 5000 feet altitude and cross the air base. Fly the first leg of 120 miles at 5000 feet. Fly the second leg at 10,000 feet altitude to avoid mountainous terrain. Fly the third leg at 15,000 feet back to the home station. Write down the conditions of the problem.

Required range	360 statute miles
Weather	CAVU
Airplane basic weight (includes trapped fuel, oil, and miscellaneous equipment)	4166 pounds
Crew weight (2)	400 pounds
Oil (10.2 gallons)	76 pounds
Maximum fuel (111 gallons)	666 pounds
Total gross weight	5308 pounds

Winds are considered 0 mph for all legs of the mission; therefore, no fuel allowance is made for wind.

Now that the conditions of the flight are determined, it is necessary to establish a flight plan. The charts give only cruise ranges and do not include any reserves, so it is necessary to first compute all allowances and reserves that will be required to cover warm-up, take-off, climb, and reserve for unexpected difficulties. Since Maximum Continuous Power and Take-off Power are not used during flight on this mission, no additional fuel allowance for these power settings is considered.

DETERMINATION OF FUEL ALLOWANCES AND RESERVES.

Determine the fuel available for flight planning by deducting the necessary fuel allowances and reserves from the actual fuel aboard as follows:

General reserve for unexpected difficulties .... 26 gallons

Note in Column V of figure A-9 that at 15,000 feet, 26 gallons of fuel represents one hour's flying time. A one-hour fuel reserve is considered sufficient for this mission.

Take-off and climb from sea level to 5000 feet .... 12 gallons

The Normal Rated Power Climb chart (figure A-6) shows 12 gallons required for warm-up, take-off, and climb from sea level to 5000 feet.

Climb from 5000 feet to 10,000 feet.... 5 gallons

The Normal Rated Power Climb chart (figure A-6) shows that 5 gallons is required to climb from 5000 feet to 10,000 feet (17 gallons minus 12 gallons). A distance of 9 miles is covered during the climb (16 miles minus 7 miles).

Climb from 10,000 feet to 15,000 feet.. 5 gallons

The Climb chart shows that 5 gallons is required to climb from 10,000 feet to 15,000 feet (22 gallons minus 17 gallons). A distance of 15 miles is covered during the climb (31 miles minus 16 miles).

Collecting all the required fuel allowances:

General reserve for unexpected difficulties	26 gallons
Take-off and climb from sea level to 5000 feet	12 gallons
Climb from 5000 feet to 10,000 feet	5 gallons
Climb from 10,000 feet to 15,000 feet	5 gallons
Total fuel allowance	48 gallons

DETERMINATION OF FUEL REQUIRED FOR CRUISING.

Because of the foregoing fuel allowances, the actual fuel available for cruising is 63 gallons (111 gallons minus 48 gallons). In calculating climbing allowance, 24 miles of range (9 miles climbing from 5000 feet to 10,000 feet

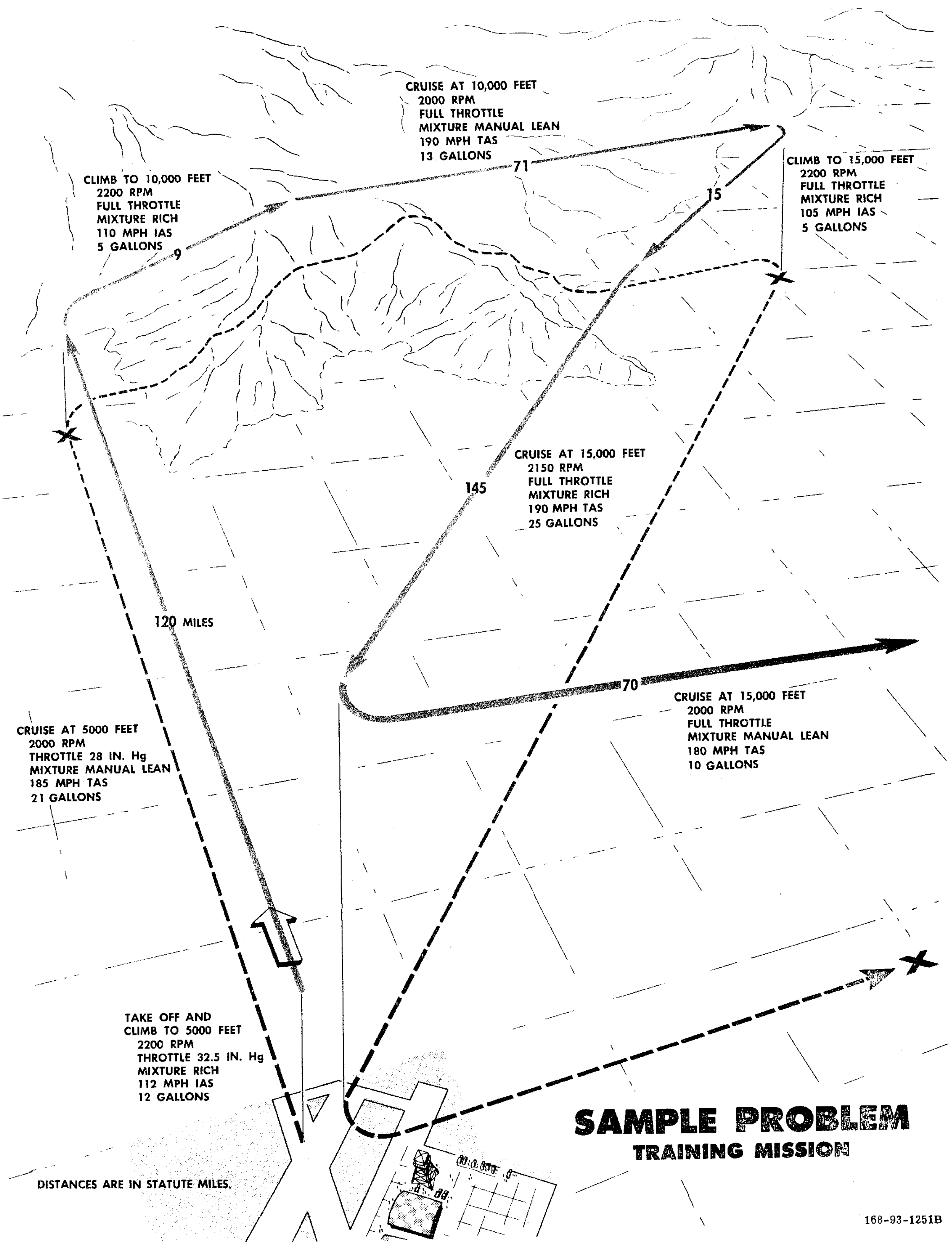

CRUISE AT 10,000 FEET
2000 RPM
FULL THROTTLE
MIXTURE MANUAL LEAN
190 MPH TAS
13 GALLONS
71
CLIMB TO 10,000 FEET
2200 RPM
FULL THROTTLE
MIXTURE RICH
110 MPH IAS
5 GALLONS
9
15
CLIMB TO 15,000 FEET
2200 RPM
FULL THROTTLE
MIXTURE RICH
105 MPH IAS
5 GALLONS
CRUISE AT 15,000 FEET
2150 RPM
FULL THROTTLE
MIXTURE RICH
190 MPH TAS
25 GALLONS
145
120 MILES
70
CRUISE AT 15,000 FEET
2000 RPM
FULL THROTTLE
MIXTURE MANUAL LEAN
180 MPH TAS
10 GALLONS
CRUISE AT 5000 FEET
2000 RPM
THROTTLE 28 IN. Hg
MIXTURE MANUAL LEAN
185 MPH TAS
21 GALLONS
TAKE OFF AND
CLIMB TO 5000 FEET
2200 RPM
THROTTLE 32.5 IN. Hg
MIXTURE RICH
112 MPH IAS
12 GALLONS
DISTANCES ARE IN STATUTE MILES.
SAMPLE PROBLEM
TRAINING MISSION
168-93-1251B

Figure A-3

and 15 miles climbing from 10,000 feet to 15,000 feet) was taken care of, so the total range for normal cruising is 360 miles minus 24 miles, or 336 statute miles. Assuming that the instructions in Column III of the Flight Operation Instruction Chart will be followed for all cruising conditions, the fuel required for 340 miles of cruise is 60 gallons, which is 4 miles greater than the 336 miles to be flown and 3 gallons less than the fuel available. This margin may be considered as an added safety feature, or the mission may be replanned around slightly higher power settings.

SAMPLE PROBLEM—ALTERNATE FLIGHT PLAN.

Should an emergency arise during flight, an alternate flight plan would have to be used. Suppose that arrival over the home field at the completion of the training mission is made after dark and, because of a malfunction of field lighting facilities, a landing cannot be made. An alternate air base 70 miles away must be used. Suppose, because of circumnavigation of weather on the training mission, the 26-gallon reserve allowed for contingencies has been depleted to 14 gallons. Reference to Column V of the Flight Operation Instruction Chart (figure A-9) shows 20 gallons required to travel 140 statute miles; therefore, 10 gallons is required to fly the 70 statute miles to the alternate field, assuming a no-wind condition. The remaining 4 gallons (14 gallons minus 10 gallons) will permit a go-around procedure or may be used in the event it is necessary to hold over the alternate field prior to entry into the traffic pattern. The remaining 4 gallons constitutes a 14-minute time limit for holding at 5000 feet. Reference to the Maximum Endurance chart (figure A-7) for 5600 pounds shows 18 gallons per hour used for maximum endurance at 15,000 feet. A descent to 5000 feet will give 17 gallons per hour; 4 gallons divided by 17 gallons per hour is .24 hours, or 14 minutes.

WADC
Form 241Q
(11 Jun 51)

LANDING DISTANCES

(FEET)

STANDARD DAY

MODEL: T-6D

ENGINE(S): (1) R-1340-AN-1

GROSS WEIGHT (LB)	BEST CAS FOR APPROACH		HARD-SURFACE—NO WIND							
	* POWER ON	POWER OFF	AT SEA LEVEL		AT 2000 FT		AT 4000 FT		AT 6000 FT	
	(MPH)	(MPH)	GROUND ROLL	TO CLEAR 50 FT OBST.	GROUND ROLL	TO CLEAR 50 FT OBST.	GROUND ROLL	TO CLEAR 50 FT OBST.	GROUND ROLL	TO CLEAR 50 FT OBST.
4500	65	70	600	1300	700	1400	700	1500	800	1600
5000	65	75	700	1400	800	1500	800	1600	900	1700
5500	70	80	800	1500	800	1600	900	1700	900	1800
6000	75	80	900	1600	900	1700	1000	1800	1000	1900

REMARKS: 1. Landing distances are airplane requirements under normal service conditions.
2. Flaps down 45 degrees.

*Approach power (at sea level) - 2000 rpm, 22 in. Hg.

LEGEND
CAS – CALIBRATED AIRSPEED
OBST. – OBSTACLE

DATA AS OF 9-24-51
BASED ON FLIGHT TEST

FUEL GRADE: MIL-F-5572, 91/96
FUEL DENSITY: 6.0 LB/GAL

168-93-1246

Figure A-4. Landing Distances

WADC
Form 241G
(11 Jun 51)

TAKE-OFF DISTANCES
(FEET)
HARD-SURFACE RUNWAY

MODEL: T-6D　　　ENGINE (S): (1) R-1340-AN-1

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE	−5 DEGREES CENTIGRADE				+15 DEGREES CENTIGRADE				+35 DEGREES CENTIGRADE				+55 DEGREES CENTIGRADE			
		ZERO WIND		30-MPH WIND		ZERO WIND		30-MPH WIND		ZERO WIND		30-MPH WIND		ZERO WIND		30-MPH WIND	
		GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.	GROUND RUN	TO CLEAR 50 FT OBST.
5000 LB	SL	650	1200	250	600	750	1300	300	650	800	1450	350	750	900	1550	400	800
	1000	700	1250	250	600	750	1350	300	700	850	1500	350	750	950	1600	400	850
	2000	700	1300	300	650	800	1400	350	700	900	1550	400	800	1000	1650	450	900
	3000	750	1350	300	700	850	1500	350	800	950	1650	450	850	1050	1750	500	950
(CLEAN)	4000	850	1450	350	750	900	1600	400	850	1050	1750	450	950	1150	1900	550	1050
	5000	900	1550	400	800	1000	1700	450	900	1150	1850	500	1000	1250	2050	600	1100
5500 LB	SL	800	1400	350	700	900	1550	400	800	1050	1700	450	900	1150	1850	500	1000
	1000	850	1450	350	750	950	1600	400	850	1050	1750	500	950	1150	1900	550	1000
	2000	900	1500	400	800	1000	1650	450	900	1100	1850	500	1000	1250	2000	600	1100
	3000	950	1600	400	850	1050	1750	500	950	1200	1950	550	1050	1300	2100	650	1150
(CLEAN)	4000	1000	1700	450	900	1150	1900	550	1000	1300	2050	600	1150	1400	2250	700	1250
	5000	1100	1850	500	950	1250	2000	600	1100	1400	2250	700	1250	1550	2450	800	1350
6000 LB	SL	1000	1650	400	850	1100	1850	500	950	1250	2000	600	1100	1400	2200	650	1200
	1000	1000	1700	450	900	1150	1900	500	1000	1300	2050	600	1150	1400	2250	700	1250
	2000	1050	1750	500	950	1200	1950	550	1050	1350	2150	650	1200	1500	2400	750	1300
	3000	1150	1900	550	1000	1300	2100	600	1100	1450	2250	700	1250	1600	2500	800	1400
(CLEAN)	4000	1250	2000	600	1100	1400	2200	700	1200	1550	2400	750	1350	1750	2700	900	1550
	5000	1350	2150	650	1200	1500	2400	750	1350	1700	2600	850	1500	1900	2900	950	1700
	SL																
	1000																
	2000																
	3000																
	4000																
	5000																

REMARKS:
1. Take-off distances are aircraft requirements under normal service conditions.
2. Flaps up (0°).
3. RPM = 2250.
4. Manifold pressure = 36.0 in. Hg.

DATA AS OF 10-10-51
BASED ON FLIGHT TEST

168-93-1244

FUEL GRADE: MIL-F-5572 91/96
FUEL DENSITY: 6.0 LB/GAL

Figure A-5. Take-off Distances

WADC Form 241I (11 Jun 51)

NORMAL POWER CLIMB CHART

STANDARD DAY

MODEL: T-6D

ENGINE(S): (1) R-1340-AN-1

CONFIGURATION: CLEAN | GROSS WEIGHT: 5000 LB (left) — CONFIGURATION: CLEAN | GROSS WEIGHT: 5500 LB (right)

APPROXIMATE										APPROXIMATE		
RATE OF CLIMB (FPM)	FROM SEA LEVEL			MP (IN. Hg)	CAS (KNOTS)	PRESSURE ALTITUDE (FEET)	CAS (KNOTS)	MP (IN. Hg)	FROM SEA LEVEL			RATE OF CLIMB (FPM)
	DISTANCE	TIME	FUEL						FUEL	TIME	DISTANCE	
1350	0	0	8	32.5	112	SEA LEVEL	112	32.5	8	0	0	1150
1350	6	4	12	32.5	113	5,000	113	32.5	12	5	7	1150
1000	14	8	15	F.T.	108	10,000	108	F.T.	17	9	16	800
650	25	14	19	F.T.	101	15,000	101	F.T.	22	17	31	500
300	45	25	25	F.T.	94	20,000	94	F.T.	30	35	62	150
						25,000						
						30,000						
						35,000						
						40,000						
						45,000						

CONFIGURATION: BOMBS | GROSS WEIGHT: 6000 LB (left) — CONFIGURATION: | GROSS WEIGHT: (right)

APPROXIMATE										APPROXIMATE		
RATE OF CLIMB (FPM)	FROM SEA LEVEL			MP (IN. Hg)	CAS (KNOTS)	PRESSURE ALTITUDE (FEET)	CAS (KNOTS)	MP (IN. Hg)	FROM SEA LEVEL			RATE OF CLIMB (FPM)
	DISTANCE	TIME	FUEL						FUEL	TIME	DISTANCE	
1000	0	0	8	32.5	112	SEA LEVEL						
1000	8	5	13	32.5	113	5,000						
650	19	11	18	F.T.	108	10,000						
350	38	21	25	F.T.	101	15,000						
						20,000						
						25,000						
						30,000						
						35,000						
						40,000						
						45,000						

REMARKS:

1. Warm-up, taxi, and take-off allowance: 8 gallons.
2. Recommended climb power - 2200 rpm.
   - 32.5 in. Hg MP (below 5000 feet).
   - F.T. (above 5000 feet).
   - mixture RICH.

LEGEND

RATE OF CLIMB - FEET PER MINUTE
DISTANCE - STATUTE MILES
TIME - MINUTES
FUEL - US. GALLONS
MP - MANIFOLD PRESSURE
CAS - CALIBRATED AIRSPEED
F.T. - FULL THROTTLE

DATA AS OF 11-15-51
BASED ON FLIGHT TEST

FUEL GRADE: MIL-F-5572, 91/96
FUEL DENSITY: 6.0 LB/GAL

168-93-1245B

Figure A-6. Normal Power Climb

WADC
Form 241U
(11 Jun 51)

MAXIMUM ENDURANCE CHART

STANDARD DAY

MODEL: T-6D

ENGINE(S): (1) R-1340-AN-1

CONFIGURATION: CLEAN GROSS WEIGHT: 4500 LB						CONFIGURATION: CLEAN GROSS WEIGHT: 5600 LB				
APPROXIMATE							APPROXIMATE			
GAL/HR	MIXTURE	RPM	MP (IN Hg)	CAS (MPH)	PRESSURE ALTITUDE (FEET)	CAS (MPH)	MP (IN Hg)	RPM	MIXTURE	GAL/HR
16	M. L.	1600	18	85	SEA LEVEL	95	20	1600	M. L.	17
16	M. L.	1600	17	85	5,000	95	20	1600	M. L.	17
16	M. L.	1600	15	85	10,000	95	19	1600	M. L.	17
16	M. L.	1600	14	85	15,000	95	18	1600	M. L.	18
17	M. L.	1600	14	85	20,000	95	18	1800	M. L.	19
17	M. L.	1900	FT	85	25,000					
					30,000					
					35,000					
					40,000					
					45,000					

CONFIGURATION: BOMBS GROSS WEIGHT: 5000 LB						CONFIGURATION: BOMBS GROSS WEIGHT: 6000 LB				
APPROXIMATE							APPROXIMATE			
GAL/HR	MIXTURE	RPM	MP (IN Hg)	CAS (MPH)	PRESSURE ALTITUDE (FEET)	CAS (MPH)	MP (IN Hg)	RPM	MIXTURE	GAL/HR
16	M. L.	1600	19	90	SEA LEVEL	98	21	1600	M. L.	17
16	M. L.	1600	18	90	5,000	98	21	1600	M. L.	18
16	M. L.	1600	17	90	10,000	98	20	1600	M. L.	18
17	M. L.	1600	16	90	15,000	98	F. T.	1600	M. L.	19
17	M. L.	1650	F. T.	90	20,000	98	F. T.	1950	M. L.	20
20	*RICH	2050	F. T.	90	25,000					
					30,000					
					35,000					
					40,000					
					45,000					

REMARKS: *Rich mixture above 2000 rpm.

LEGEND
GAL/HR - FUEL CONSUMPTION
CAS - CALIBRATED AIRSPEED
M. L. - MANUAL LEAN
F. T. - FULL THROTTLE

DATA AS OF 7-19-51
BASED ON FLIGHT TEST

FUEL GRADE: MIL-F-5572, 91/96
FUEL DENSITY: 6.0 LB/GAL

168-93-1247

Figure A-7. Maximum Endurance

COMBAT ALLOWANCE CHART

MILITARY POWER

STANDARD DAY

MODEL: T-6D

ENGINE(S): (1) R-1340-AN-1

PRESSURE ALTITUDE (FEET)	RPM	MP (IN. Hg)	BLOWER POSITION	MIXTURE POSITION	TIME LIMIT (MIN)	LIMIT CYLINDER TEMP(°C)	FUEL FLOW GAL/MIN/ENG
SEA LEVEL	2250	36.0		RICH	5	260	1.20
2,000	2250	36.0		RICH	5	260	1.30
4,000	2250	F.T.		RICH	5	260	1.20
6,000	2250	F.T.		RICH	5	260	1.04
8,000	2250	F.T.		RICH	5	260	.91
10,000	2250	F.T.		RICH	5	260	.81
12,000	2250	F.T.		RICH	5	260	.72
14,000	2250	F.T.		RICH	5	260	.65
16,000	2250	F.T.		RICH	5	260	.59
18,000	2250	F.T.		RICH	5	260	.54
20,000	2250	F.T.		RICH	5	260	.50
22,000							
24,000							
26,000							
28,000							
30,000							
32,000							
34,000							
36,000							
38,000							
40,000							

REMARKS: 1. F.T. = full throttle.

DATA AS OF 8-29-51
BASED ON FLIGHT TEST

FUEL GRADE: MIL-F-5572, 91/96
FUEL DENSITY: 6.0 LB/GAL

168-93-1248

Figure A-8. Combat Allowance

WADC Form 241K (11 Jun 51)	AIRCRAFT MODEL (S)	FLIGHT OPERATION INSTRUCTION CHART	EXTERNAL LOAD ITEMS
	T-6D	STANDARD DAY	NONE
	ENGINE(S): (1) R-1340-AN-1	CHART WEIGHT LIMITS: 5600 POUNDS OR LESS	NUMBER OF ENGINES OPERATING: ONE

POWER LIMITS	RPM	MP IN. HG	BLOWER POSITION	MIXTURE POSITION	TIME LIMIT	CYL TEMP	TOTAL GPH
TAKE-OFF	2250	36.0		RICH	5 MIN	260° C	72.0 (SL)

INSTRUCTIONS FOR USING CHART: Select figure in FUEL column equal to or less than amount of fuel to be used for cruising(1). Move horizontally to right or left and select RANGE value equal to or greater than the statute or nautical air miles to be flown. Vertically below and opposite value nearest desired cruising altitude (ALT), read rpm, manifold pressure (MP), and MIXTURE setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at a sacrifice in speed. Air miles per gallon (MI/GAL) (no wind), gallons per hr (GPH), and true airspeed (TAS) are approximate values for reference. Range values are for an average airplane flying alone (no wind)(1).

COLUMN I		FUEL(1) US. GAL	COLUMN II		COLUMN III		COLUMN IV		FUEL(1) US. GAL	COLUMN V	
RANGE IN AIR MILES			RANGE IN AIR MILES		RANGE IN AIR MILES		RANGE IN AIR MILES			RANGE IN AIR MILES	
STATUTE	NAUTICAL		STATUTE	NAUTICAL	STATUTE	NAUTICAL	STATUTE	NAUTICAL		STATUTE	NAUTICAL
			SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING(1)								
340	290	111 100	450	390	570	500	650	570	111 100	700	600
270 200	230 170	80 60	360 270	310 230	460 340	400 300	520 390	450 340	80 60	560 420	480 360
130 70	120 60	40 20	180 90	150 80	230 110	200 100	260 130	230 110	40 20	280 140	240 120

MAXIMUM CONTINUOUS						PRESS. ALT FEET	(4.50 STAT. (3.90 NAUT.) MI/GAL)						(5.75 STAT. (4.98 NAUT.) MI/GAL)						(6.57 STAT. (5.70 NAUT.) MI/GAL)						PRESS. ALT FEET	MAXIMUM AIR RANGE					
RPM	MP INCHES	MIX-TURE	APPROX TOTAL GPH	APPROX TAS MPH	APPROX TAS KN		RPM	MP INCHES	MIX-TURE	APPROX TOTAL GPH	APPROX TAS MPH	APPROX TAS KN	RPM	MP INCHES	MIX-TURE	APPROX TOTAL GPH	APPROX TAS MPH	APPROX TAS KN	RPM	MP INCHES	MIX-TURE	APPROX TOTAL GPH	APPROX TAS MPH	APPROX TAS KN		RPM	MP INCHES	MIX-TURE	APPROX TOTAL GPH	APPROX TAS MPH	APPROX TAS KN
						40,000																			40,000						
						35,000																			35,000						
						30,000																			30,000						
						25,000																			25,000						
2200	F.T.	RICH	27	180	155	20,000							2200	F.T.	RICH	27	180	155							20,000	2000	F.T.	M.L.	21	160	140
2200	F.T.	RICH	35	195	170	15,000	2200	F.T.	RICH	35	195	170	2150	F.T.	RICH	33	190	165							15,000	2000	F.T.	M.L.	26	180	155
2200	F.T.	RICH	45	205	175	10,000	2200	F.T.	RICH	45	205	175	2000	F.T.	M.L.	32	190	165	1850	F.T.	M.L.	28	180	155	10,000	1700	F.T.	M.L.	24	170	145
2200	32.5	RICH	60	215	185	5,000	2050	29	RICH	43	195	170	2000	28	M.L.	32	185	160	1650	28	M.L.	26	170	145	5,000	1600	26	M.L.	23	155	135
2200	32.5	RICH	54	200	170	SL	2000	30	RICH	41	185	160	1900	30	M.L.	26	175	150	1600	28	M.L.	24	155	135	SL	1600	25	M.L.	20	140	120

SPECIAL NOTES

(1) Make allowance for warm-up, take-off, and climb plus allowance for wind, reserve, and combat as required.

EXAMPLE

At 5400 lb gross weight with 80 gal of fuel (after deducting total allowances of 31 gal) to fly 460 stat. air miles at 15,000 ft altitude, maintain 2150 rpm and FULL THROTTLE with mixture set: RICH.

LEGEND

ALT : PRESSURE ALTITUDE
MP : MANIFOLD PRESSURE
GPH : GALLONS PER HOUR
TAS : TRUE AIRSPEED
KN : KNOTS
SL : SEA LEVEL
F.T. : FULL THROTTLE
M.L. : MANUAL LEAN

DATA AS OF 9-11-51 BASED ON FLIGHT TEST

168-93-1249A

FUEL GRADE: MIL-F-5572, 91/96 FUEL DENSITY: 6.0 LB/GAL

Figure A-9. Flight Operation Instruction Chart—No External Load—5600 Pounds or Less

WADC Form 241K (11 Jun 51)	AIRCRAFT MODEL (S): T-6D; ENGINE(S): (1) R-1340-AN-1	FLIGHT OPERATION INSTRUCTION CHART — STANDARD DAY; CHART WEIGHT LIMITS: 6000 POUNDS OR LESS	EXTERNAL LOAD ITEMS: WING BOMBS; NUMBER OF ENGINES OPERATING: ONE

POWER LIMITS	RPM	MP IN. HG	BLOWER POSITION	MIXTURE POSITION	TIME LIMIT	CYL TEMP	TOTAL GPH
TAKE-OFF	2250	36.0		RICH	5 MIN	260° C	72.0 (SL)

INSTRUCTIONS FOR USING CHART: Select figure in FUEL column equal to or less than amount of fuel to be used for cruising(1). Move horizontally to right or left and select RANGE value equal to or greater than the statute or nautical air miles to be flown. Vertically below and opposite value nearest desired cruising altitude (ALT), read rpm, manifold pressure (MP), and MIXTURE setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at a sacrifice in speed. Air miles per gallon (MI/GAL) (no wind), gallons per hr (GPH), and true airspeed (TAS) are approximate values for reference. Range values are for an average airplane flying alone (no wind)(1).

COLUMN I Statute	COLUMN I Nautical	FUEL US. GAL (1)	COLUMN II Statute	COLUMN II Nautical	COLUMN III Statute	COLUMN III Nautical	COLUMN IV Statute	COLUMN IV Nautical	FUEL US. GAL (1)	COLUMN V Statute	COLUMN V Nautical
			RANGE IN AIR MILES — SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING(1)								
		111							111		
340	290	100	450	390	550	480	620	540	100	650	570
270	230	80	360	310	440	380	500	430	80	520	450
200	170	60	270	230	330	290	370	320	60	390	340
130	120	40	180	150	220	190	250	210	40	260	230
70	60	20	90	80	110	100	120	110	20	130	110

	COLUMN I: MAXIMUM CONTINUOUS						COLUMN II: (4.50 STAT. (3.90 NAUT.) MI/GAL)						COLUMN III: (5.54 STAT. (4.80 NAUT.) MI/GAL)						COLUMN IV: (6.22 STAT. (5.40 NAUT.) MI/GAL)							COLUMN V: MAXIMUM AIR RANGE					
RPM	MP INCHES	MIX-TURE	TOTAL GPH	TAS MPH (APPROX)	TAS KN (APPROX)	PRESS. ALT FEET	RPM	MP INCHES	MIX-TURE	TOTAL GPH	TAS MPH	TAS KN	RPM	MP INCHES	MIX-TURE	TOTAL GPH	TAS MPH	TAS KN	RPM	MP INCHES	MIX-TURE	TOTAL GPH	TAS MPH	TAS KN	PRESS. ALT FEET	RPM	MP INCHES	MIX-TURE	TOTAL GPH	TAS MPH	TAS KN
						40,000																			40,000						
						35,000																			35,000						
						30,000																			30,000						
						25,000																			25,000						
						20,000																			20,000						
2200	F.T.	RICH	35	185	160	15,000	2200	F.T.	RICH	35	185	160	2100	F.T.	RICH	32	175	155							15,000	2000	F.T.	M.L.	26	170	150
2200	F.T.	RICH	45	195	170	10,000	2150	F.T.	RICH	43	195	170	2000	F.T.	M.L.	32	185	160	1850	F.T.	M.L.	28	170	150	10,000	1700	F.T.	M.L.	25	165	145
2200	32.5	RICH	60	200	175	5,000	2050	29	RICH	40	180	155	1900	28	M.L.	32	175	150	1600	28	M.L.	26	160	140	5,000	1600	26	M.L.	23	150	130
2200	32.5	RICH	54	190	155	SL	2050	30	RICH	40	175	150	1900	30	M.L.	30	165	145	1600	28	M.L.	24	150	130	SL	1600	25	M.L.	21	140	120

SPECIAL NOTES

(1) Make allowance for warm-up, take-off, and climb plus allowance for wind, reserve, and combat as required.

EXAMPLE

At 5800 lb gross weight with 60 gal of fuel (after deducting total allowances of 51 gal) to fly 330 stat. air miles at 15,000 ft altitude, maintain 2100 rpm and FULL THROTTLE with mixture set: RICH

LEGEND

ALT : PRESSURE ALTITUDE
MP : MANIFOLD PRESSURE
GPH : GALLONS PER HOUR
TAS : TRUE AIRSPEED
KN : KNOTS
SL : SEA LEVEL
F.T. : FULL THROTTLE
M.L. : MANUAL LEAN

DATA AS OF 11-1-51 BASED ON ESTIMATED DATA

RED FIGURES HAVE NOT BEEN FLIGHT CHECKED.

168-93-1250 FUEL GRADE: MIL-F-5572, 91/96 FUEL DENSITY: 6.0 LB/GAL

Figure A-10. Flight Operation Instruction Chart—Wing Bombs—6000 Pounds or Less

ALPHABETICAL INDEX

PAGE NUMBERS IN BOLDFACE DENOTE ILLUSTRATIONS

PAGE NUMBERS IN BOLDFACE DENOTE ILLUSTRATIONS