PILOT'S FLIGHT OPERATING INSTRUCTIONS

FLIGHT OPERATIONS

ARMY MODEL

P-47N

AIRPLANE

This publication contains specific instructions for pilots and should be available for Transition Flying Training as contemplated in AAF Reg. 50-16.

Published under joint authority of the Commanding General, Army Air Forces, the Chief of the Bureau of Aeronautics, and the Air Council of the United Kingdom.

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TABLE OF CONTENTS

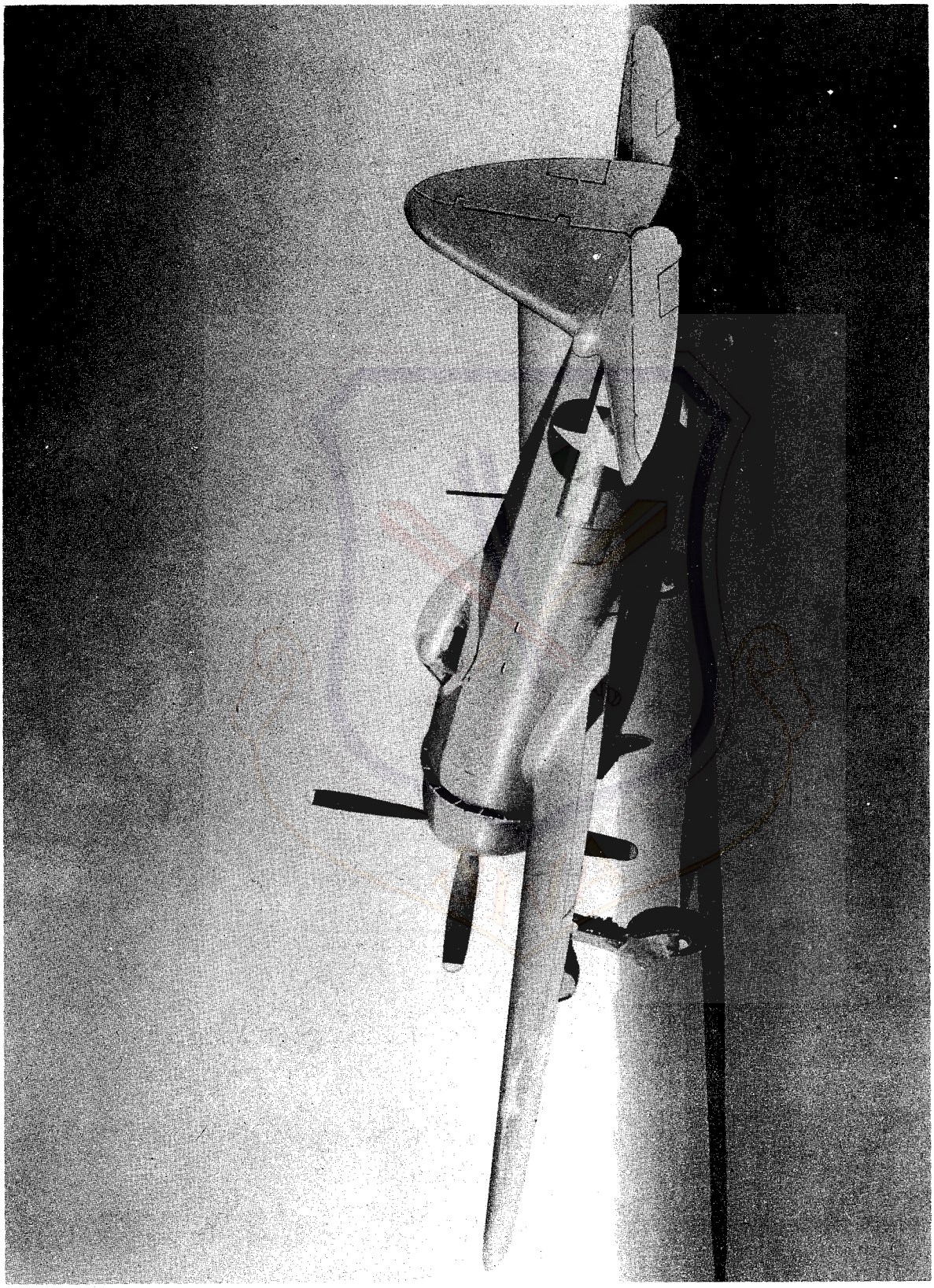


Figure 1—Three-Quarter Rear View

SECTION I
DESCRIPTION

1. AIRPLANE.

a. GENERAL.—The P-47N airplane is a single place, long-range fighter-bomber, built by Republic Aviation. Although basically a fighter-offensive type, provisions are made for carrying additional fuel and up to three 1,000-lb. bombs. All-metal, stressed-skin construction is employed. Approximate dimensions are: length—36 feet, 1¼ inches; height—14 feet, 8⅜ inches; span—42 feet, 7 inches. Gross weight as a fighter offensive without external tanks is approximately 13,800 pounds.

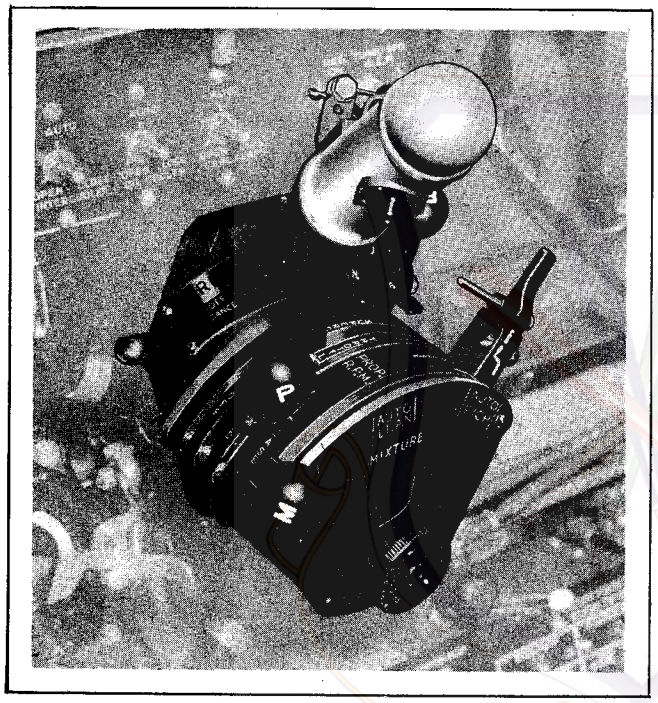


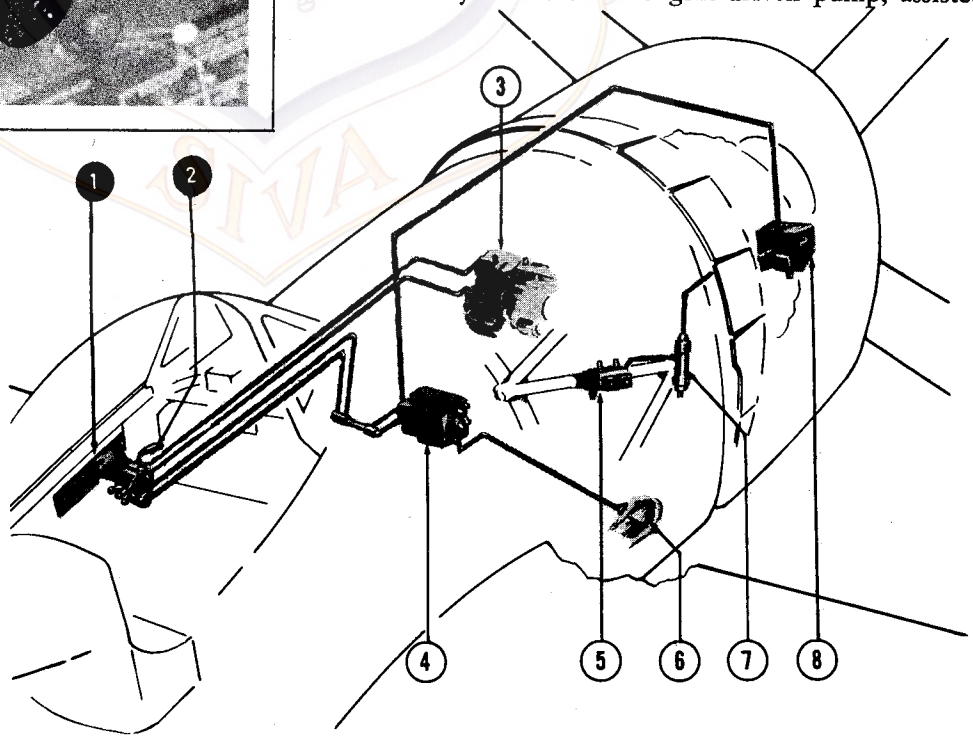
Figure 2—Engine Control Quadrant

b. POWER PLANT.—The power plant is an 18-cylinder, twin-row, Pratt and Whitney R-2800-57, "C-series," air-cooled engine. In addition to the internal blower, a General Electric type CH-5 turbo-supercharger is used, enabling a critical altitude of approximately 42,000 feet at Normal Rated Power. Automatic supercharger, carburetor-air, cylinder-head, and oil temperature controls are provided. An injection-type carburetor equipped for water injection is used. A standard oil dilution system is employed to facilitate cold-weather operation.

c. PROPELLER.—The propeller is a four-bladed Curtiss Electric model C642S with 13-foot diameter paddle-type blades.

d. FUEL SYSTEM.

(1) GENERAL.—The main fuel supply consists of 550 US (458 Imperial) gallons of fuel carried in two self-sealing tanks located under and forward of the cockpit and two internal wing tanks. (See figure 4.) This supply can be supplemented by using external tanks hung from the airplane belly and each wing. (See figure 7.) Fuel is supplied to the carburetor by means of an engine-driven pump, assisted



1. Cowl Flap Control
2. Engine Control Quadrant
3. Carburetor
4. Automatic Supercharger Regulator
5. Cowl Flap Operating Mechanism
6. Waste Gate
7. Cowl Flap Cylinder
8. Propeller Governor

Figure 3—Engine Control System

by an electric-driven, variable-speed, booster pump installed in the sump of each internal tank and controlled by a rheostat on the circuit protector panel. (See 5, figure 20.) When external tanks are used, a tank-pressurizing system is employed to assist the engine-driven pump. Level gages (28, figure 23) in the cockpit indicate the amount of fuel in each internal tank when the airplane is in level flight position. A three-point correction chart is posted on the left wall of the cockpit for calculating amount of fuel aboard when the airplane is on the ground. When only approximately 40 US gallons of fuel remain in the main tank, a low-level warning light (24, figure 23) in the instrument panel will glow. Fuel pressure is read on the lower right scale of the engine gage unit. (See 13, figure 23.) Two selector valves (figure 5) permit operation from each tank individually and must be switched to the tank desired. To facilitate starting and cold-weather operation, an electric engine primer switch (26, figure 23) is located on the right side of the instrument panel. The carburetor is of the fuel-injection type and is equipped with a vapor return line that empties about 10 US gallons of fuel per hour into the main tank.

(2) TANKS.

(a) MAIN TANK.—The main tank, located forward of the cockpit has a total capacity of 270 US (225 Imperial) gallons. The filler neck is on the right side of the fuselage just forward of the windshield.

(b) AUXILIARY TANK.—The auxiliary tank, situated behind the main tank, has a total capacity of 100 US (83 Imperial) gallons. Its filler neck is on the right side of the fuselage above the wing fillet.

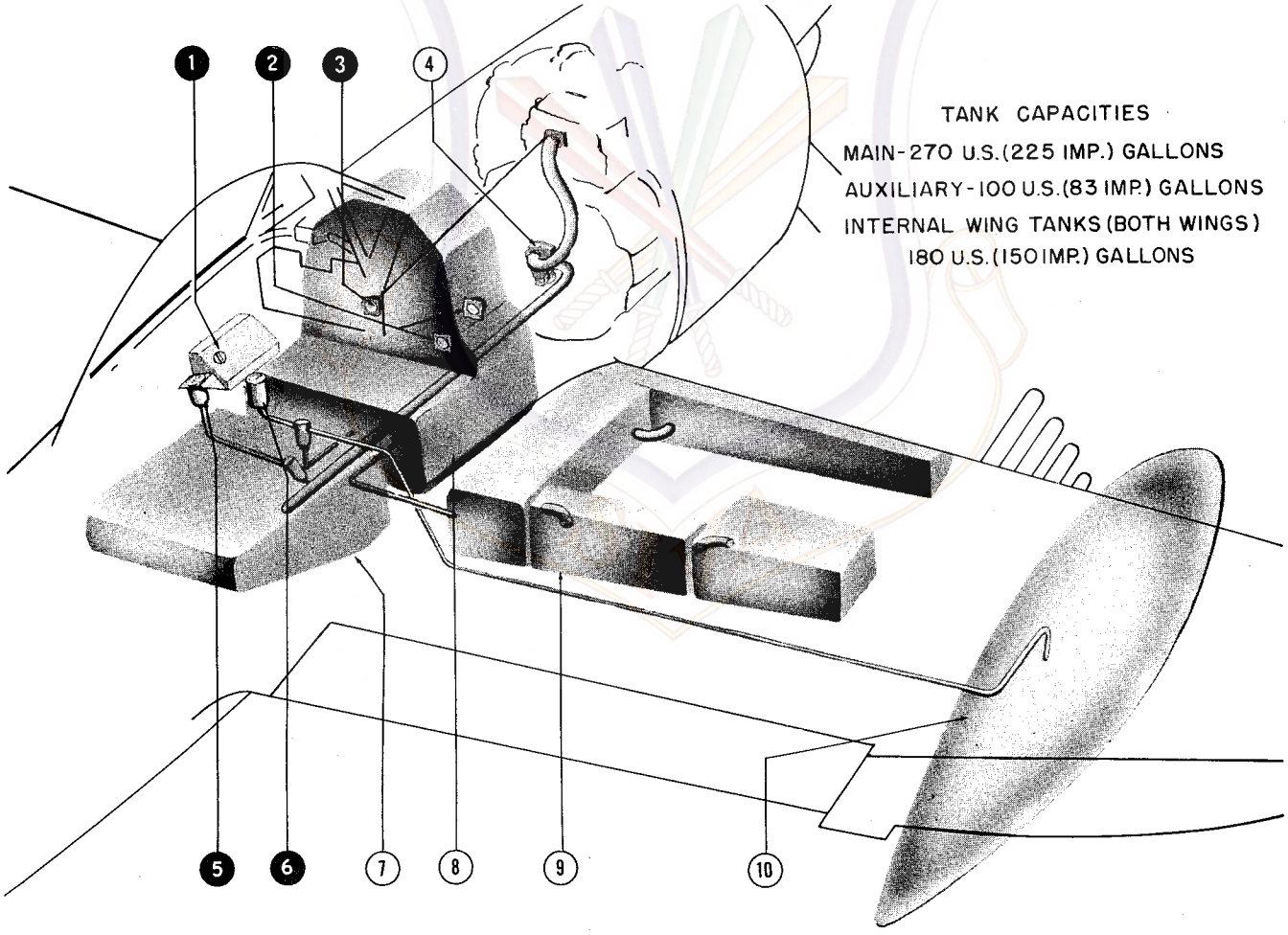


Figure 4—Fuel Control System

1. Booster Pump Emergency Switch
2. Fuel Level Gages
3. Fuel Pressure Gage
4. Main Fuel Pump
5. Main Fuel Selector Valve
6. External Fuel Selector Valve
7. Auxiliary Fuel Tank
8. Main Fuel Tank
9. Internal Wing Tanks
10. External Wing Tank

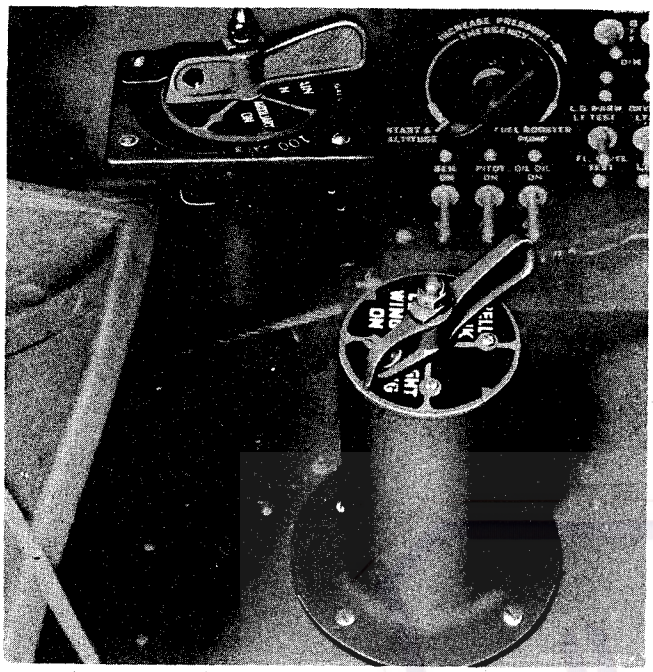


Figure 5—Fuel Selector Valves

(c) INTERNAL WING TANKS.—Self-sealing wing tanks are installed in each wing panel. Their total capacity is 90 US (75 Imperial) gallons in each wing. Filler necks are located in the wing leading edges.

(d) EXTERNAL TANKS. — Provisions are made to hang any of the following external tanks as desired.

75 US (62 Imperial)—gallon belly tank.
110 US (92 Imperial)—gallon belly tank.
165 US (137 Imperial)—gallon wing tanks.
300 US (250 Imperial)—gallon wing tanks.

The tanks are hung from standard army-type bomb shackles (figure 7) mounted in the belly and each wing, just outboard of the landing gear main struts.

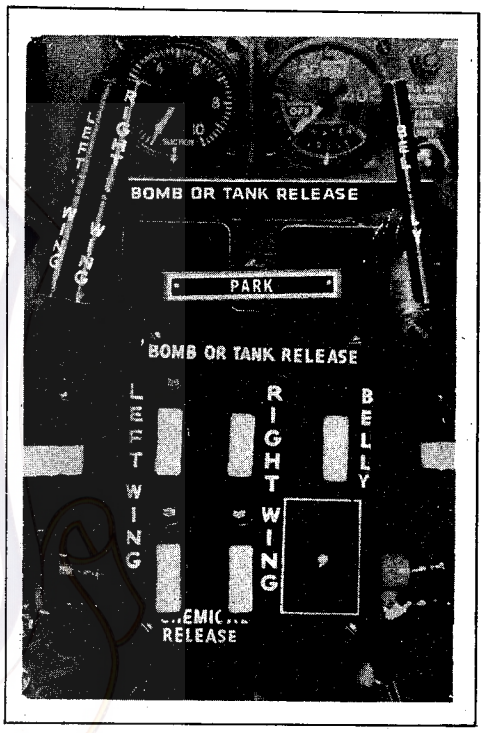


Figure 6—Tank and Bomb Release Controls

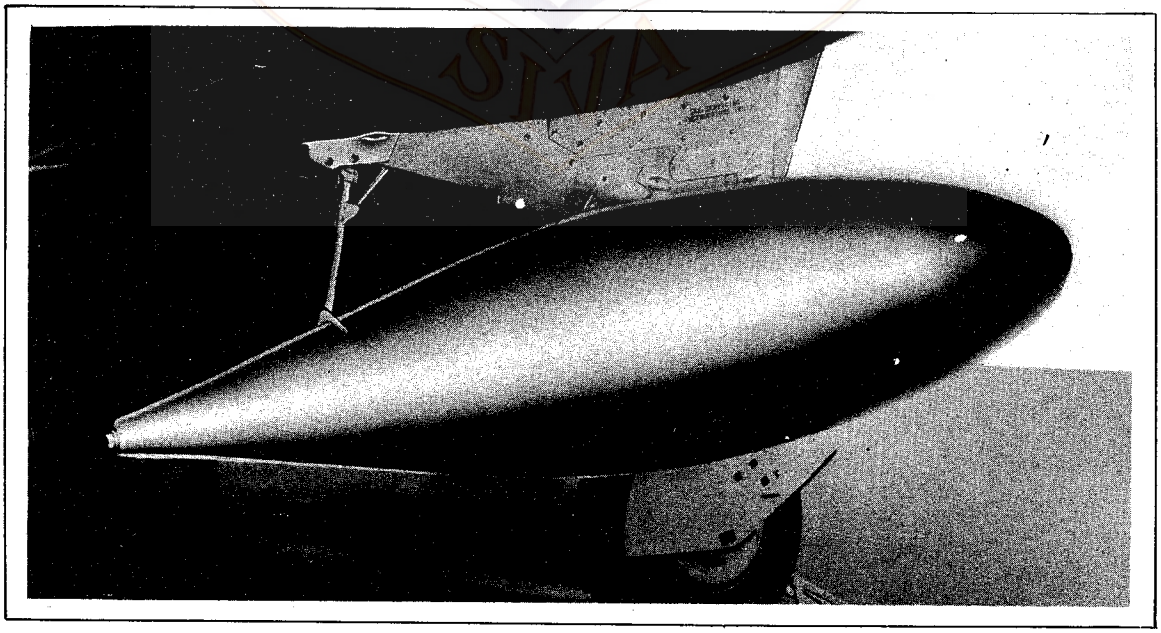


Figure 7—Wing Tank Installation

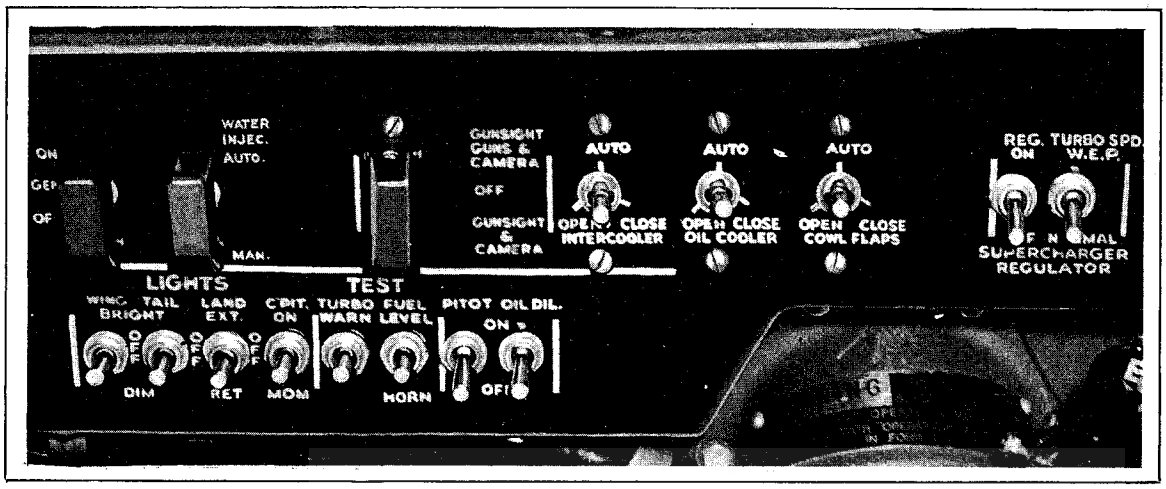


Figure 8—Switch Panel

e. OIL SYSTEM. — The engine oil supply is carried in a pendulum-equipped, hopper-type tank (figure 10) located in the upper part of the engine section. A filler neck is accessible through a cowl door, marked "OIL," in the upper-left side of the secondary cowling. The total capacity of the tank is 40 US (33 Imperial) gallons. Oil temperature is regulated by two oil coolers (figure 10) installed one on each side in the lower part of the engine compartment at the fresh-air scoop. To facilitate cold-weather engine starting, a standard oil dilution system is incorporated. A level gage (14, figure 23) on the instrument panel records the quantity of oil in the tank when the airplane is in level flight position. A correction chart is mounted on the left wall of the cockpit to enable calculating amount of oil aboard when airplane is in a three-point position.

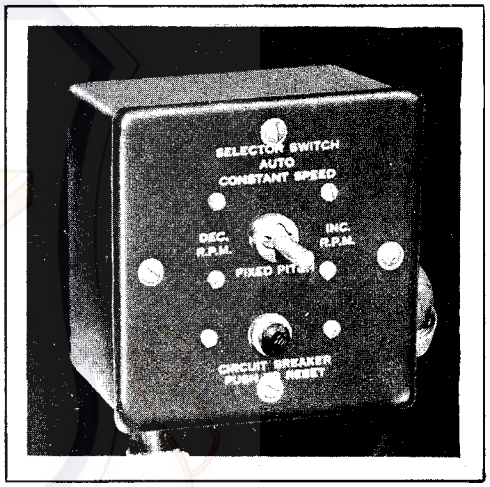
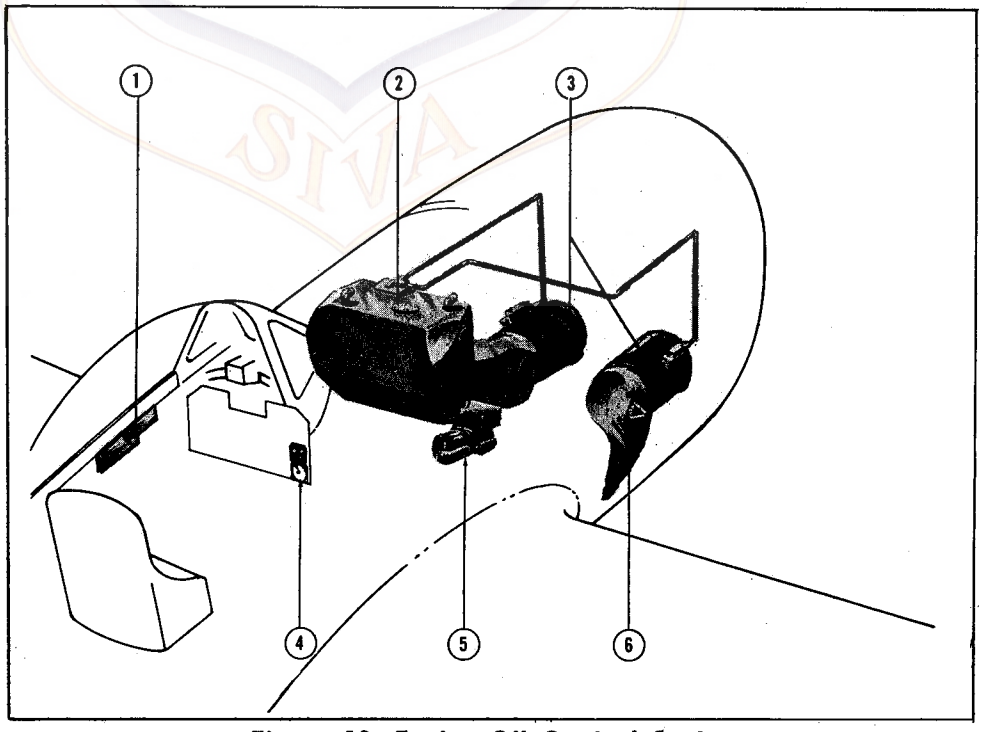


Figure 9—Propeller Switch Panel



1. Oil cooler Control Switch
2. Oil Tank
3. Oil Cooler
4. Pressure and Temperature Gages
5. Oil Cooler Door Operating Mechanism
6. Oil Cooler Door

Figure 10—Engine Oil Control System

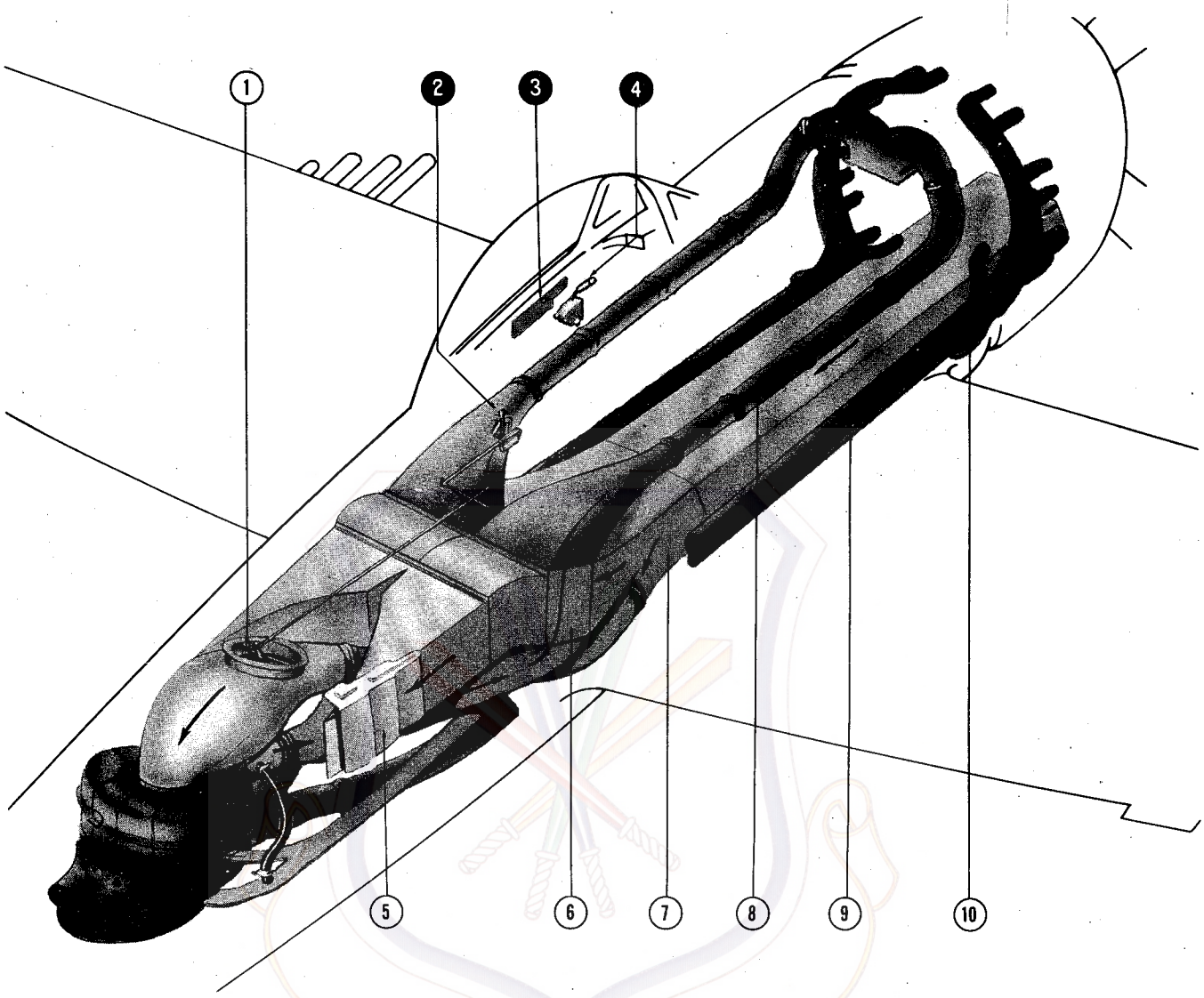


Figure 11—Induction System

1. Air Filter
2. Air Filter Control
3. Intercooler Control Switch
4. Engine Control Quadrant
5. Intercooler Door
6. Intercooler
7. Ram Air to Turbo
8. Pressurized Air to Carburetor
9. Exhaust Pressure to Turbo
10. Waste Gate

f. HYDRAULIC SYSTEM.—The hydraulic system operates the landing gear, wing flaps, and cowl flaps, with pressure supplied by an engine-driven pump. The fluid is drawn from the 1.9 US (1.6 Imperial)-gallon supply tank (4, figure 14) in the upper section of engine compartment, and pumped into the system through a pressure regulator. A hand pump (9, figure 14) is installed at the left of the pilot's seat for use in the event the engine-driven pump fails. A gage on the instrument panel indicates system pressure.

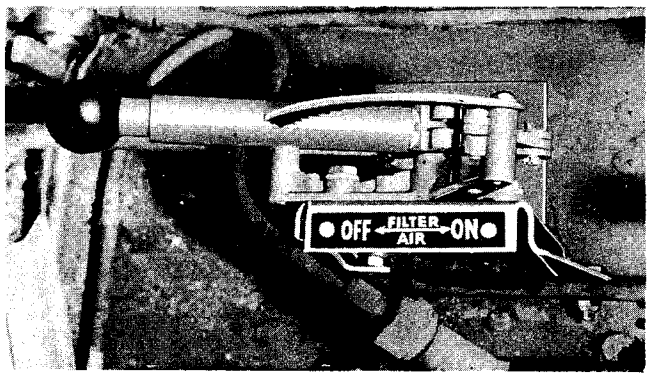


Figure 12—Air Filter Control

g. INDUCTION SYSTEM.—A General Electric, type "CH-5" turbosupercharger (figure 11) is installed in the lower section of the fuselage aft of the cockpit. Engine exhaust gases are directed to the turbine wheel of the supercharger through exhaust pipes on each side of the fuselage. Fresh air is collected in the scoop beneath the engine and conducted to the compression section of the supercharger. Heat generated during compression is dissipated by passing the supercharged air through an intercooler which is cooled by a portion of the fresh air blast. An air filter, which may be bypassed, is installed above the supercharger.

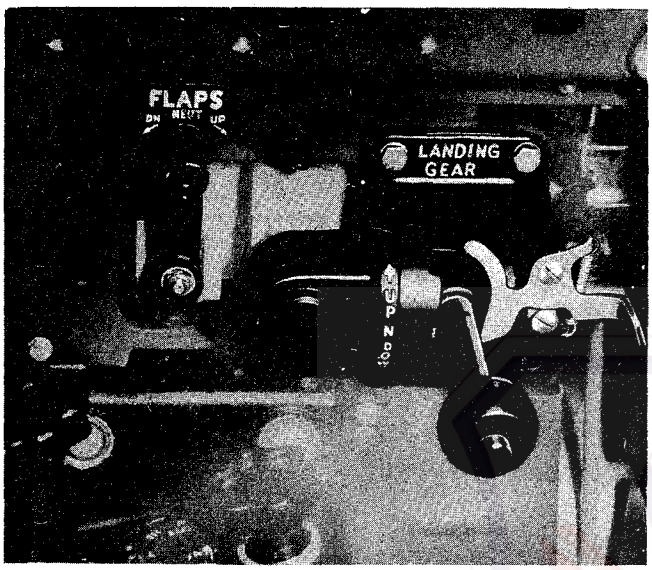


Figure 13—Landing Gear and Wing Flap Control

h. WATER INJECTION SYSTEM.—The water injection system permits operation without detonation at War Emergency Power of 72 in. Hg. manifold pressure. The system consists of a 30 US (25 Imperial)-gallon supply tank, an engine-driven pump, a water regulator, a derichment valve assembly, and an automatic turbo governor overspeed switch. An automatic reset jack is built into the system to retard the throttle setting should water pressure fail or the supply run out. A water pressure gage (23, figure 23) is mounted on the instrument panel.

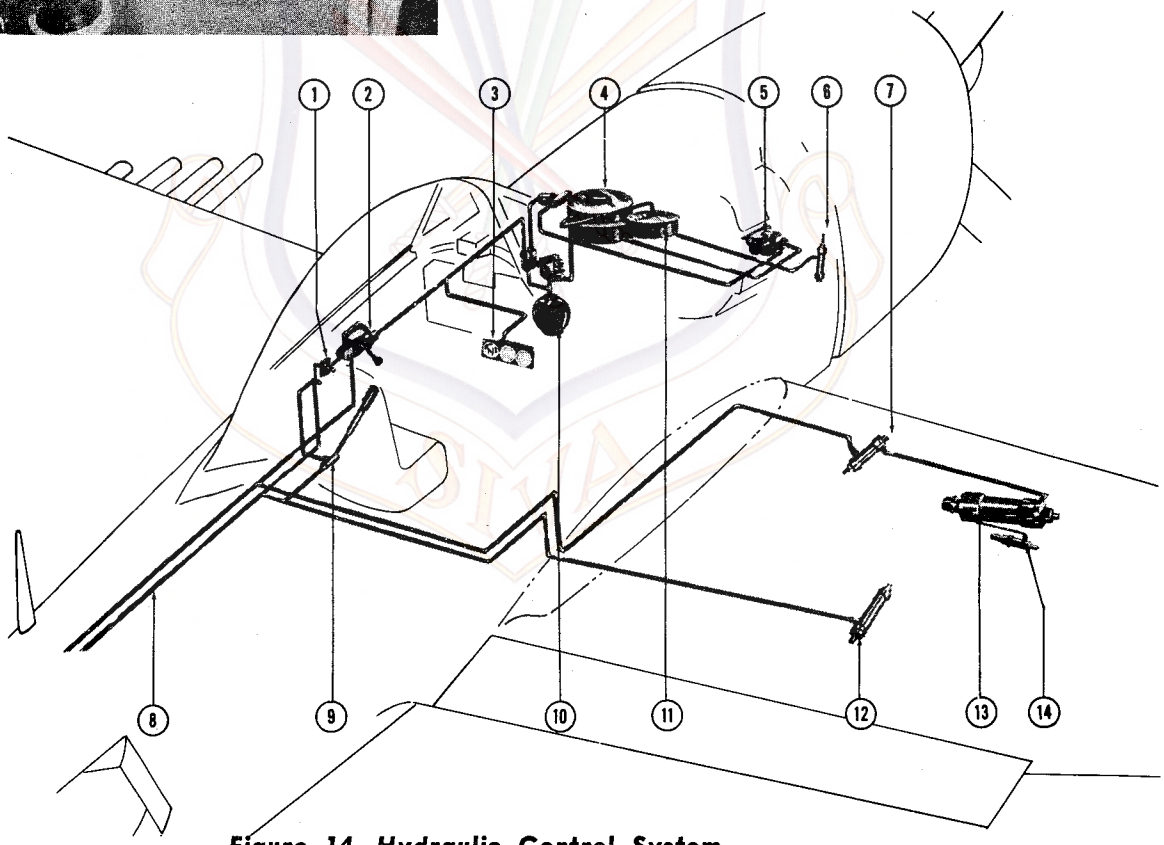


Figure 14—Hydraulic Control System

1. Wing Flaps Control
2. Landing Gear Control
3. Hydraulic Pressure Gage
4. Hydraulic Fluid Reservoir
5. Engine Driven Pump
6. Cowl Flap Cylinder
7. Wheel Well Door Cylinder
8. Tail Wheel Cylinder Lines
9. Emergency Hydraulic Hand Pump
10. Pressure Accumulator
11. Hydraulic Fluid Filter
12. Wing Flap Operating Cylinder
13. Main Landing Gear Retracting Cylinder
14. Landing Gear Downlock Cylinder

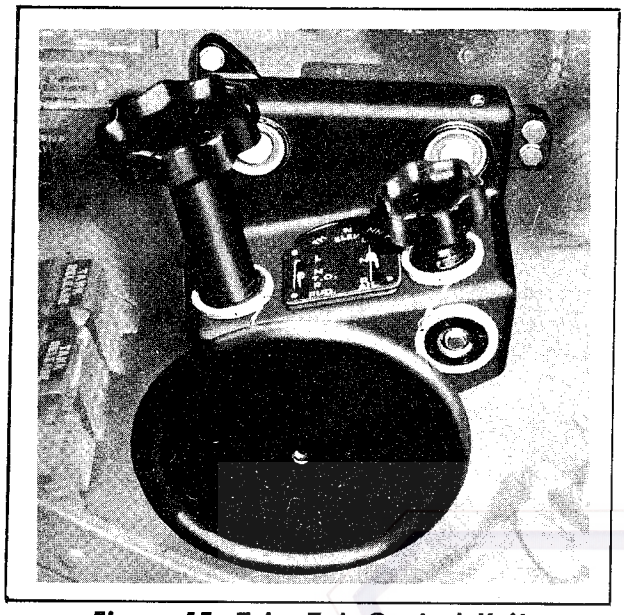


Figure 15—Trim Tab Control Unit

i. ELECTRICAL SYSTEM.—The electrical system is a 24-volt, d-c, single wire grounded type, energized primarily from a 100-amp generator. A storage battery is mounted on the right side of the firewall. An ammeter (15, figure 23) is located on the instrument panel to indicate the charging current. A plug in the right forward engine cowl, reached through an access door, permits the attachment of an external source of power for flight line service.

j. SURFACE CONTROLS. — All-metal, balanced control surfaces, and conventional control stick and pedals are used. Adjustable trim tabs are built into the left aileron, the rudder, and the trailing edges of the elevators. Fixed trim tabs are installed on the right aileron and each elevator. These are adjusted at the factory and provide correction for minor manufacturing tolerances. The control stick and rudder pedals may be locked by a strap-and-latch arrangement (figure 18) at the base of the control stick.

k. LANDING GEAR.—The main landing gear units are two full-cantilever, air-oil shock struts mounted in the wing and retracted hydraulically. Hydraulically controlled downlock mechanism retains the gear in its extended position, and a mechanical uplock assists hydraulic pressure in holding the gear in its retracted position. A warning lamp-and-horn

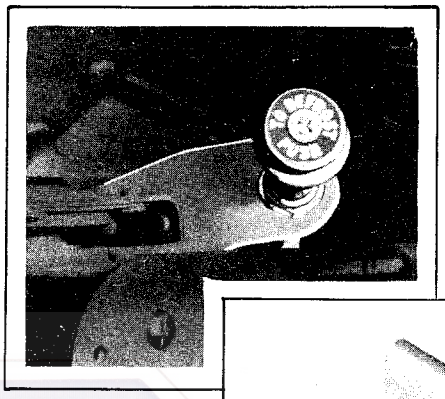


Figure 16—Defroster Control

Figure 17—Cockpit Vent Control

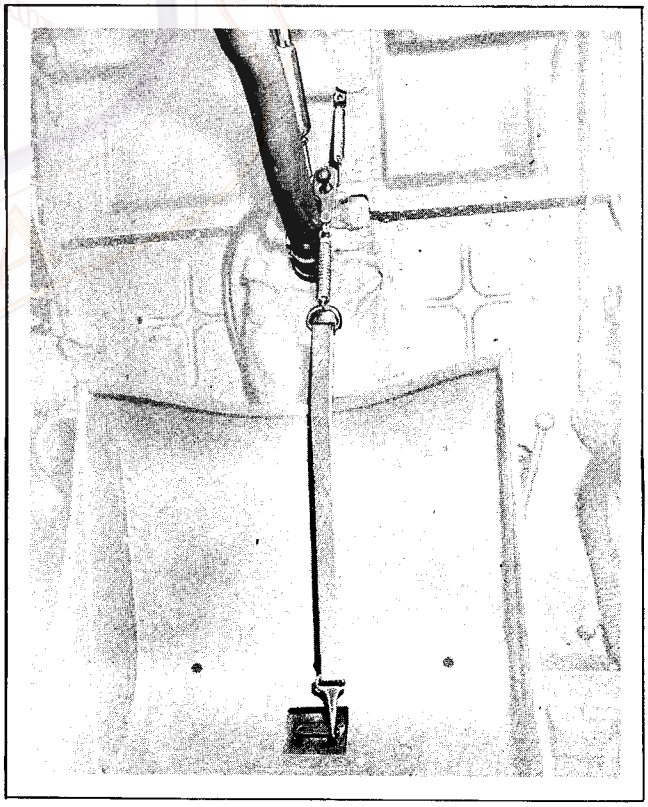


Figure 18— Surface Controls Lock

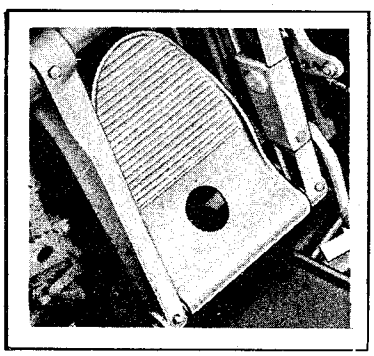


Figure 19—Rudder Pedal Adjustment Latch

system is provided to indicate whenever the gear is unlocked. The tail wheel is a free-swiveling, hydraulically retractable unit. A mechanical uplock aids hydraulic pressure in retaining the gear in a retracted position, and an extension spring maintains a mechanical advantage built into the unit which holds it extended. The tail wheel may be locked in the fore-and-aft position. Multiple disk type hydraulic brakes are operated by individual master cylinders attached to the rudder pedals. The system contains its own fluid and is independent of the main hydraulic system. A parking-brake handle is located at the center of the instrument panel.

l. LIGHTS.—A sealed-beam landing light is installed in the lower surface of the left wing panel. Normally, it is retracted with its lens flush. Extension is automatic. Conventional position lights are installed in each wing tip and the rudder trailing edge. Recognition lights are mounted in the wing. The cockpit is provided with a swivel-mounted spot light (4, figure 22) on the right wall.

2. CONTROLS.

a. THROTTLE.—The throttle is mounted in a conventional control quadrant (3, figure 21) on the left wall of the cockpit. It permits direct operation of the carburetor butterfly valves by a series of push-pull rods and bellcranks.

b. SUPERCHARGER CONTROL. — The turbosupercharger is controlled by an automatic electric regulator. The regulator is set to deliver a desired manifold pressure by positioning the boost lever on the engine control quadrant. (See figure 2.) By means of an electronic system, balanced with carburetor deck pressure, the regulator automatically opens and closes the supercharger waste gates, maintaining constant boost as set at the quadrant. A governor is set to restrict turbo speed to its normal of 20,000 rpm. When the quadrant lever is set to demand more than 54 inches of manifold pressure, the water injection system is operated automatically by a manifold pressure switch. At the same time, a turbo overspeed switch is thrown, permitting turbo operation at its rating of 22,000 rpm.

c. MIXTURE CONTROL.—The fuel mixture is obtained by setting the mixture lever (figure 2) on the engine control quadrant to the desired position. Positions are "IDLE CUT-OFF," "AUTO LEAN," and "AUTO RICH."

d. PROPELLER CONTROL.—The Curtiss electric propeller is controlled in the normal manner by a lever on the engine control quadrant (figure 2), with the full forward position indicating "INCREASE RPM." The lever is equipped with a spring-loaded latch in the path of the throttle lever to insure that the propeller lever will move ahead of the throttle during sudden application of power. In the event

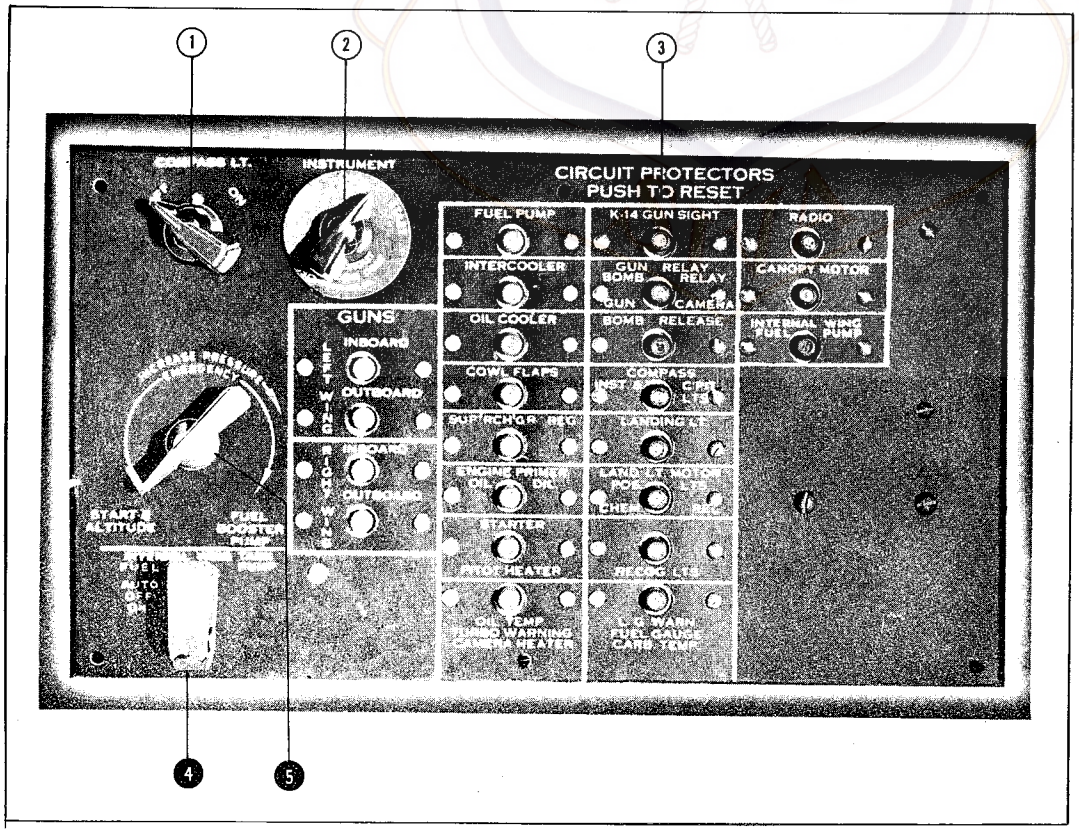


Figure 20— Circuit Protector Panel

1. Compass Light Rheostat
2. Instrument Light Rheostat
3. Circuit Protectors
4. Internal Fuel Tank Pump Switch
5. Fuel Booster Pump Rheostat

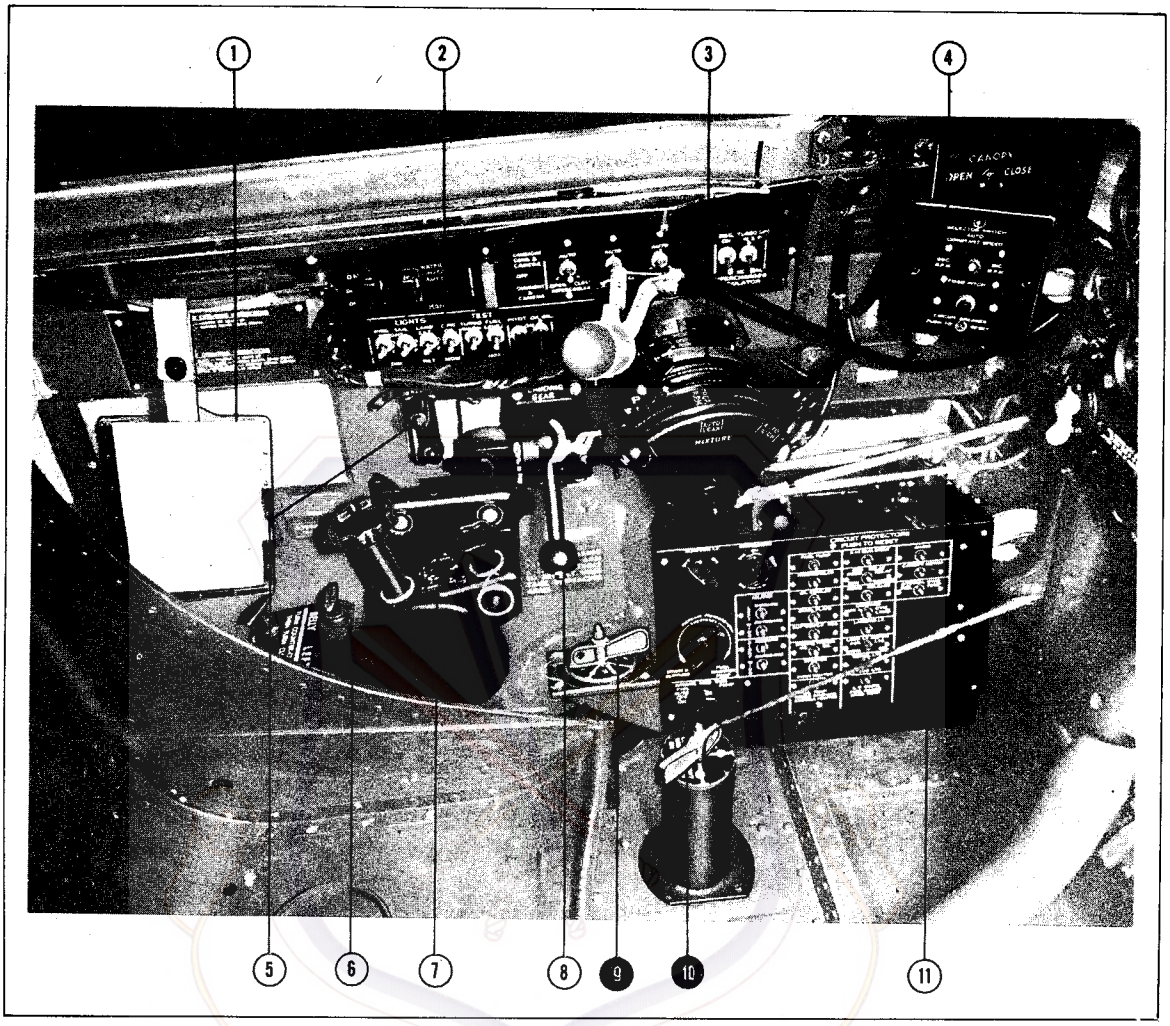


Figure 21—Left Side of Cockpit

1. Pilot's Check List
2. Switch Panel
3. Engine Control Quadrant
4. Propeller Switch Panel
5. Wing Flap Control
6. Arm and Safe Controls
7. Trim Tab Control Unit
8. Landing Gear Control
9. Internal Fuel Selector Valve
10. External Fuel Selector Valve
11. Circuit Protector Panel

of failure of the automatic system, the electric propeller may also be operated manually by use of the selector switch mounted in the propeller switch box (figure 9) in the upper left-hand corner of the cockpit. The selector switch has four positions: "AUTO CONSTANT SPEED," "INC RPM," "DEC RPM," and "FIXED PITCH." "INC RPM" and "DEC RPM" are momentary positions which vary rpm correspondingly and leave the propeller in a fixed-pitch condition when released. The propeller system circuit breaker, a conventional push-type, is also mounted on the panel.

e. CARBURETOR AIR CONTROL.—Carburetor air temperature is controlled by the position of the inter-cooler doors. (See 5, figure 11.) An automatic mechanism, sensitive to carburetor air temperature, controls an electric motor which automatically opens and closes the intercooler doors. An override switch (figure 8) mounted on the left wall of the cockpit provides for manual operation of the intercooler doors in the event of failure of the automatic mechanism. This switch has three positions: "AUTO," "OPEN," and "CLOSE." A carburetor air temperature gage (11, figure 23) is installed on the instrument panel. An air filter control (figure 12) is located to the left of the pilot's seat, on the cockpit floor. It has two positions: "ON" and "OFF."

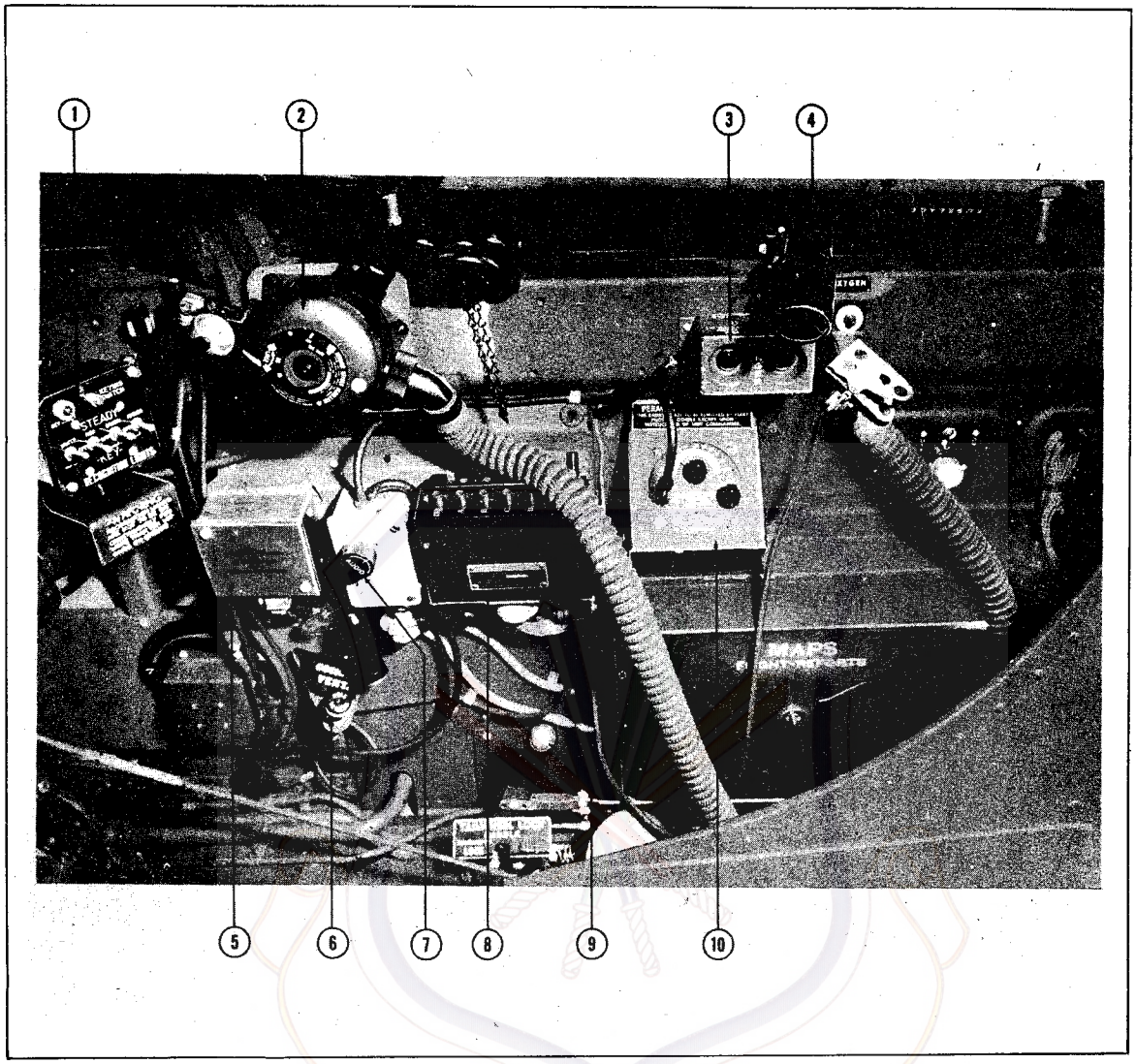


Figure 22—Right Side of Cockpit

1. Recognition Light Switches
2. Oxygen Demand Regulator
3. Secret Radio Detonator
4. Cockpit Swivel Light
5. Radio Junction Box
6. Cockpit Vent Control
7. Radio Volume Control
8. VHF Radio Control Box
9. Tail Wheel Lock Control
10. Beam Receiver

f. COOLING FLAP OPERATION.—Engine cowl flaps are controlled automatically by an electric and hydraulic mechanism. A solenoid valve sensitive to cylinder-head temperature controls the flow of hydraulic fluid to a cylinder which opens or closes the flaps. In addition to the automatic control, a switch (figure 8) is provided on the left wall of the cockpit to permit manual operation of the flaps. The switch has three positions: "AUTO," "OPEN," and "CLOSE." The flaps may be opened to any intermediate position by releasing the switch when the desired opening is obtained.

g. FUEL SYSTEM CONTROL.

(1) SELECTOR VALVES.—The fuel system is controlled primarily by two selector valves. (See figure 5.) The main one is mounted on a bracket aft of the main switch box on the left side of the cockpit. It has four positions: "MAIN ON," "AUXILIARY ON," "EXTERNAL ON," and "OFF." The secondary selector valve is mounted on the left foot trough and has three positions, only: "LEFT WING ON," "RIGHT WING ON," and "BELLY TANK." Moving the main selector valve to "MAIN ON," draws fuel from the main tank which has a capacity of 270 US (225 Imperial) gallons. The auxiliary tank

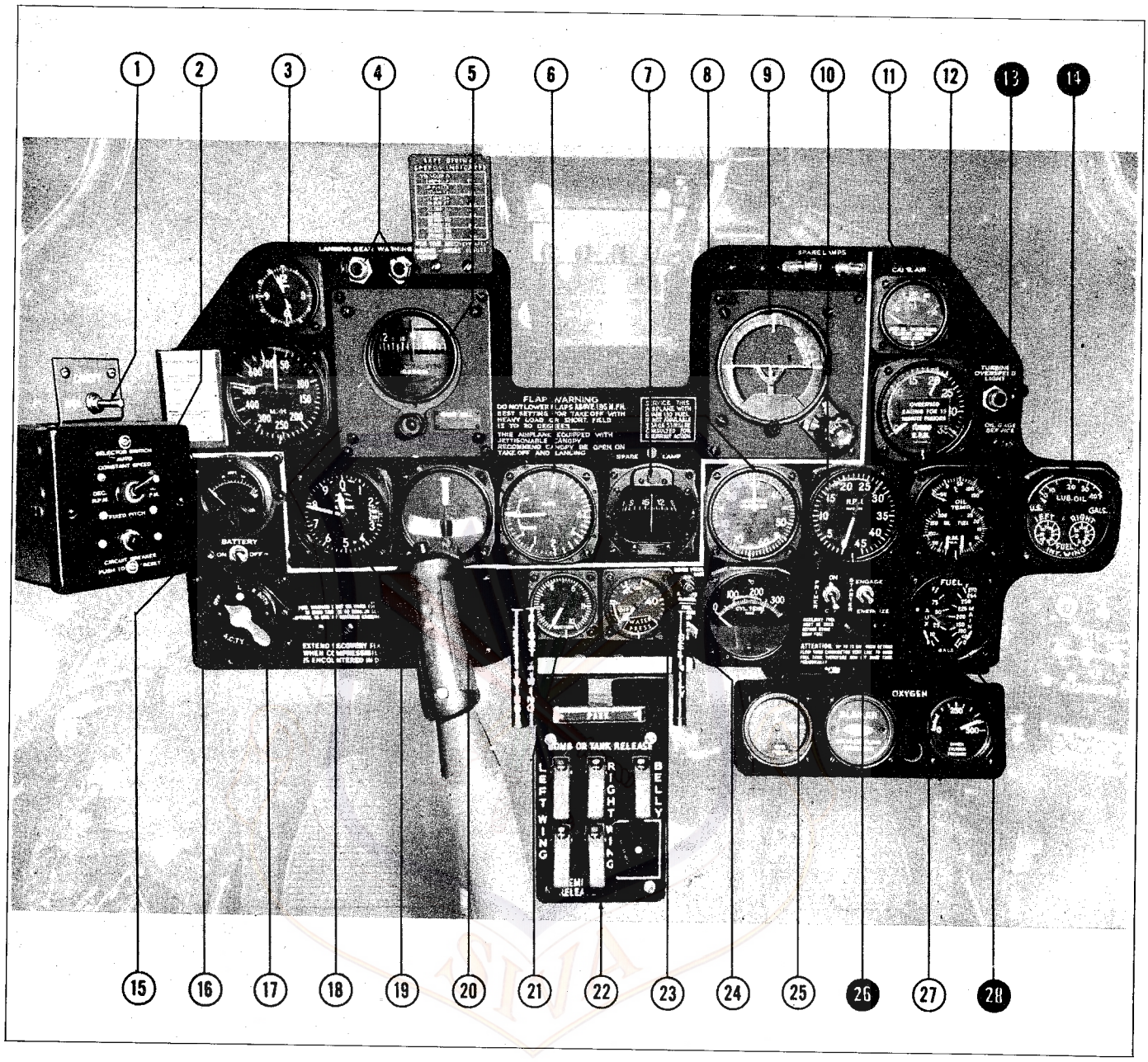


Figure 23—Instrument Panel

1. Canopy Switch
2. Propeller Switch Panel
3. Clock
4. Landing Gear Warning Lamps
5. Directional Gyro
6. Rate of Climb Indicator
7. Compass
8. Manifold Pressure Gage
9. Gyro Horizon
10. Engine Tachometer
11. Carburetor Air Temperature Gage
12. Turbo Tachometer
13. Engine Gage Unit
14. Fuel and Oil Level Gages
15. Ammeter
16. Master Battery Switch
17. Ignition Switch
18. Airspeed Indicator
19. Altimeter
20. Bank and Turn Indicator
21. Suction Gage
22. Bomb and Tank Release Panel
23. Water Pressure Gage
24. Fuel Level Warning Light
25. Cylinder Head Temperature Gage
26. Engine Primer Switch
27. Starter Switch
28. Fuel Quantity Gages

has a capacity of 100 US (83 Imperial) gallons of fuel which is used by turning the main selector valve to "AUXILIARY ON." Fuel from the internal wing tanks is used automatically when the selector valve is on "MAIN." This is achieved by using an internal transfer system which feeds fuel from the wing tanks to the main tank periodically as fuel is drawn from the main tank. Internal tanks in both wing panels have a total capacity of 180 US (150 Imperial) gallons. To draw fuel from the external system, it is necessary to select first the desired external tank by positioning the secondary fuel selector valve and then turn the main selector valve to "EXTERNAL TANK." The amount of fuel available in the external system will depend on the combination of external tanks used. Provisions are made to hang any of the external tanks as described in this section, paragraph 1. *d.* (2) *(d).*

(2) FUEL PUMPS.—In addition to the main fuel pump which is an, engine-driven, positive displacement type, variable speed electric-driven booster pumps are mounted in the sumps of the main and auxiliary tanks. The output of the booster pumps is controlled by a rheostat (5, figure 20) mounted on the circuit protector panel to the left of the pilot. It has two positions: "START & ALTITUDE" and "EMERGENCY." The "START & ALTITUDE" position is suitable for all normal operations. "EMERGENCY" is for use in the event of failure of the main engine-driven pump. To permit manual operation of the internal wing tank transfer pump, a switch (4, figure 20) is provided beneath the booster pump rheostat on the main switch box. This switch must be turned "OFF" when the wing tanks are empty.

(3) TANK RELEASE CONTROL. — External tanks are released by either cable and pulley arrangement or electric solenoids. Control handles and selector switches are mounted on a panel (figure 6) forward of the pilot beneath the instrument panel. The cable system consists of a separate handle for each tank position and they may be pulled individually or simultaneously as desired. The electrical release system employs a set of three selector switches and a release button on the control stick. The tanks selected are dropped when the release button is depressed.

b. OIL SYSTEM CONTROL.

(1) TEMPERATURE CONTROL.—Engine oil temperature is controlled automatically by thermal sensitive unit which operates an electrical mechanism to open and close the oil cooler exit doors, metering the flow of air through the coolers. In addition to the automatic control, a switch (figure 8) is mounted to the left of the pilot to permit manual operation in the event of failure of the automatic system. The switch has three positions: "AUTOMATIC," "OPEN," and "CLOSE." The "AUTOMATIC" is a fixed position and the other two are momentary contacts which

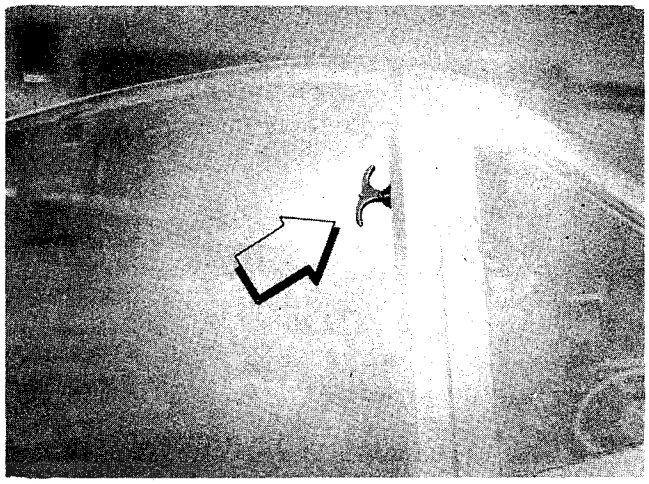


Figure 24—Canopy Jettison Control

leave the doors in a fixed condition when they are released.

(2) OIL DILUTION CONTROL.—The oil dilution system is controlled by a switch (figure 8) on the panel to the left of the pilot. It has two positions: "ON," and "OFF." When the switch is placed in the "ON"-position, a solenoid valve is opened which permits fuel to flow into the engine oil system.

i. LANDING GEAR CONTROL. — The landing gear is retracted and extended by use of the control (figure 13) to the left of the pilot. By depressing the button on the lever knob, the control may be moved to "UP," "N," or "DOWN." A spring loaded safety latch (figure 13) is provided to prevent inadvertent movement from the "DOWN"-position. In changing the position of the gear, it is necessary, except in emergencies, to allow gear to complete its cycle before lever position is changed again. If the engine-driven pump fails, the landing gear may be operated by use of the hand pump (9, figure 14) at the left of the cockpit seat. "N"-position is used in the event of failure of hydraulic system due to loss of fluid, only after the landing gear has been locked down by gravity and it is desired to lower the landing flaps. A warning lamp-and-horn system is provided to indicate whenever the gear is not locked up or down. A switch on the throttle also causes the warning light to glow if the gear is not locked down when the throttle is retarded to a point insufficient to maintain level flight. The warning system consists of red lamp, a green lamp (4, figure 23), and a horn, used in the following manner:

Green on, Red off.—Landing gear locked down.

Red on, Green off.—Landing gear on any unlocked position.

Both lights off.—Landing gear locked up, and throttle beyond minimum cruising position.

Red on, Green off.—Horn sounding.—Landing gear locked up or in any unlocked position when the throttle is below minimum cruising position.

j. FLAP CONTROL.—The landing wing flaps are operated by means of the control (figure 13) on the left wall of the cockpit aft of the landing gear control. Three positions are provided: "DN," "NEUT," and "UP." "NEUT" is used when it is desired to stop the flaps at any intermediate position. Lines marked on the leading edges of the flaps indicate the degree of extension from 0 degrees to 40 degrees in increments of 10 degrees. The hydraulic reservoir is designed so that even in the event of a broken line elsewhere in the system, sufficient fluid will be available in the reservoir for lowering the flaps by hand pump.

k. TRIM TAB CONTROL.—Trim tabs are adjusted from a control unit (figure 15) mounted on the left wall of the cockpit. Three wheels are provided, and indicators denote tab position at all times. A "T. O.," or take-off position, is noted on the rudder tab indicator.

l. ARM AND SAFE CONTROL.—For use when bombs are carried, an arm and safe control panel (6, figure 21) is mounted on the cockpit left wall aft of the trim tab control unit. Three handles are provided, one for each bomb position.

m. GUN BAY HEAT CONTROL. — A "T"-type control handle marked "GUN HEAT CONTROL" is mounted on the same bracket with the arm and safe controls. When the handle is in its normal or depressed position, gun heat is on. To stop gun heat, the handle is pulled upward.

n. COCKPIT HEATING, DEFROSTING, AND VENTILATING CONTROLS.—Cockpit heating and defrosting is managed by a control (figure 16) mounted to the right of the gun sight. Cooling is achieved by operating the cockpit vent control (figure 17) on the right wall of the cockpit.

o. CANOPY CONTROL. — The canopy may be operated either electrically or manually. The electric switch (1, figure 23) is located above the propeller control switch box. Releasing the toggle will lock the canopy in any intermediate position. The canopy may be operated manually by pulling inward on the knobs at the leading edges, and sliding canopy to desired position. In emergencies, the canopy is jettisonable by pulling the "T"-type handle (figure 24) located on the right side of the forward bow.


SIVA

SECTION II
NORMAL OPERATING INSTRUCTIONS

1. BEFORE ENTERING THE COCKPIT.

a. FLIGHT RESTRICTIONS.

Note

These limitations may be supplemented or superceded by instructions included in service publications.

(1) MANEUVERS PROHIBITED.

(a) Intentional spins.

(b) Outside loops.

(c) Whip stalls.

(d) Prolonged inverted flight.

(e) Snap rolls.

(f) Slow rolls (on airplanes without dorsal fins).

(g) With external tanks installed: violent maneuvers, practice landings, and high speed dives.

(h) Tight turns or dives exceeding 225 IAS are prohibited with cowl flaps open. Tail buffeting may result.

(i) On models without a dorsal fin: all maneuvers involving extreme uncoordinated use of rudder and aileron may cause rudder lock.

(2) AIRSPEED LIMITATIONS.

(a) Safe indicated diving speeds must be limited as altitude is increased as indicated on the dive speed limitation chart in the cockpit.

(b) Do not lower landing gear at speeds in excess of 200 IAS.

(c) Do not extend wing flaps at speeds in excess of 190 IAS.

(d) Do not extend landing light at speeds in excess of 165 IAS. Aileron buffeting will occur if the landing light is extended above this speed.

(e) When bombs or external tanks are installed, airspeed and pullout acceleration is restricted as follows:

Installation	*IAS Limit*	*Vertical Acceleration Limit*
75 US—(62.4 Imperial)—	350 IAS	4.67g
110 US—(92 Imperial)— gallon belly tank	325 IAS	4.00g
110 US—(92 Imperial)— gallon wing tanks	300 IAS	4.00g
165 US—(137.2 Imperial)— gallon wing tanks	300 IAS	4.00g
300 US—(250 Imperial)— gallon wing tanks	200 IAS	3.00g
1000 lb. wing bomb	250 IAS	3.67g
1000 lb. belly bomb	300 IAS	3.67g

b. WEIGHT AND BALANCE DATA.

(1) Check Form 1.

(2) Check Form F, weight and balance data, AN 01-1B-40, and determine the take-off gross weight and balance.

c. ENTRANCE.—Entrance to the airplane is made by pulling outward on the canopy-release latch located in the left side of the fuselage below the canopy rail, allowing the canopy to slide rearward. A step is provided above the wing fillet.

2. ON ENTERING THE COCKPIT.

a. FOR ALL FLIGHTS.

(1) Unlock surface controls. (See figure 18.)

(2) Adjust cockpit seat to correct height, by releasing the lock handle on right side of seat.

(3) Adjust the rudder pedals to equal length and to obtain complete control at extreme positions. Rudder pedal latch (figure 19) is located on outboard side of each pedal.

(4) Test-operate the emergency hydraulic hand pump. (See 9, figure 14.) Note increase in system pressure on gage.

(5) Examine safety belt and shoulder harness for security of attachment and operation of safety locks.

(6) Check operation of flight controls and trim tabs (figure 15) through their complete ranges.

(7) Unlock brakes and check for firm and positive action. Reset parking brake. (See figure 6.)

(8) Check the instruments for clean cover glasses. Check altimeter for correct barometric pressure. Check the clock.

(9) Check landing gear control handle (figure 13) in the "DOWN" position.

(10) Check flap handle (figure 13) in "UP" position.

(11) Check that gun switch (figure 8) is "OFF."

(12) Check that airplane ignition switch (17, figure 23) is "OFF."

(13) Turn master battery switch (16, figure 23) "ON," and check that all circuit breakers are set. (See figures 9 and 20.)

Note

Do not use airplane's battery if outside battery cart is available.

(14) Test-operate fuel level, turbo overspeed, and landing gear warning lights. (See figure 8.)

(15) Check quantity of fuel aboard by fuel level gage on instrument panel. (See 14 and 28, figure 23).

Refer to three-point correction chart. Check the quantity of oil by oil quantity gage (14, figure 23) on instrument panel.

(16) Note reading of oxygen system pressure gage (figure 26) indicating quantity of oxygen available.

(17) Set intercooler and oil cooler switches "AUTOMATIC." (See figure 8.)

(18) Check propeller governor lever full forward "INCREASE RPM," and check selector switch (figure 9) in "AUTOMATIC," and circuit breaker set.

(19) Place fuel booster pump rheostat (5, figure 20) on circuit protector panel to "START AND ALTITUDE" (Fully counterclockwise.)

(20) Test-operate gun sight light brilliancy.

b. SPECIAL CHECK FOR NIGHT FLIGHTS.

(1) Turn cockpit swivel light (4, figure 22) "ON."

(2) Test-operate navigation lights.

(3) Test-operate landing light. (See figure 8.) Be sure the light is retracted after test. Do not test landing light for more than 5 seconds on the ground.

3. FUEL AND OIL SYSTEM MANAGEMENT.

a. To draw fuel from the main tank, turn fuel selector valve (figure 5) on "MAIN".

b. To draw fuel from the auxiliary tank, turn fuel selector valve to "AUXILIARY."

c. To use internal wing fuel, place internal wing tank fuel pump switch in "AUTO" and the fuel selector valve on "MAIN."

d. To draw fuel from the external tanks, first turn the external selector valve (figure 5) to the desired position of "LEFT WING," "RIGHT WING," or "BELLY," and then turn the fuel selector valve to "EXTERNAL."

Note

Always set fuel selector valves by "click-and-feel" method to insure firm seating of the valves.

e. When selecting tanks during flight, reduce power while shifting the fuel selector valves. If the fuel pressure gage fluctuates erratically when shifting to "EXTERNAL," keep power reduced and place fuel selector valve at "MAIN" for a few seconds and then back to "EXTERNAL". This operation may have to be repeated several times before fuel pressure will remain constant on external tank operation.

f. Leave fuel booster pump rheostat in the normal position of "START AND ALTITUDE" unless the fuel-pressure gage indicated failure of the engine-driven pump.

g. Fuel tanks are to be used in the following sequence:

(1) Take off and climb to at least 5,000 ft. on "MAIN."

(2) Use the external fuel.

(3) Switch to "AUXILIARY" supply and use all but 25 gallons for a safe known reserve.

(4) Run on "MAIN" with the internal wing tank pump switch (4, figure 20) on "AUTO." This will automatically drain first internal wing tanks, then the main tank.

Note

Check complete drainage of internal wing tanks when nearly empty by placing internal wing tank pump switch to "ON" and after check return to "OFF."

(5) Land on "MAIN" or on the 25 US gallon reserve in "AUXILIARY."

h. When operating on external wing tanks, select "RIGHT WING" and "LEFT WING" at alternate intervals. The external tank pressurizing lines are interconnected and dropping one tank leaves the entire pressurizing system inoperative. Therefore, except in emergencies, jettison external tanks only after the fuel supply is exhausted from all the external tanks.

i. The vapor dilution line from the carburetor is piped to the main tank and will return fuel up to 10 US gallons per hour; it is necessary to run off the main tank at regular intervals to consume this return flow.

j. A fuel-level warning light (24, figure 23) will glow when approximately 40 US gallons remain in the main tank.

4. STARTING ENGINE.

a. With ignition and battery switches "OFF," pull propeller through 16 blades by hand.

Note

Whenever possible, an external source of power should be plugged into the receptacle in the right-secondary engine cowling.

b. Set fuel selector valve to "MAIN."

c. "Crack" throttle open approximately 1 inch.

d. Supercharger control full aft.

e. Check mixture control handle in "IDLE CUT-OFF."

f. Propeller governor control lever "INCREASE RPM" (full forward.)

h. Fuel booster pump rheostat set to "START & ALTITUDE."

i. Air-filter control (figure 12) set to "ON" if dust conditions so indicate.

j. Master battery switch "ON," if battery cart is not installed.

WARNING

See that all personnel are clear of propeller.

k. Prime 2 to 4 seconds if engine is cold. If engine is hot, priming may not be necessary. As much as one-fourth throttle opening and heavy priming may be necessary in extreme cold.

l. Turn ignition switch to "BOTH."

m. Flick starter switch to "ENGAGE" and immediately return to "OFF." (This is to seat starter brushes on commutator.)

n. "ENERGIZE" for not more than 20 seconds. Switch to "ENGAGE" for a maximum period of 30 seconds or until engine fires.

o. If engine fails to start, let starter cool for at least 1 minute before repeating procedure.

p. When engine starts, move mixture control to "AUTO-RICH" and throttle to 900 rpm.

CAUTION

Failure to keep mixture control in "IDLE CUT-OFF" position until engine is running will result in flooding and fire hazard.

q. In the event of fire in the engine section:

(1) Open throttle to about 2000 rpm.

(2) If this does not blow out the fire, place mixture control in "IDLE CUT-OFF."

(3) Turn fuel selector valve to "OFF."

5. WARM-UP AND GROUND TEST.

a. Check oil pressure at once. If not at least 25 psi in 30 seconds, shut off engine.

b. On a cold engine, oil pressure will rise to about 150 to 200 psi. Do not exceed 1000 rpm until oil pressure drops to normal.

c. Run at 800 to 1000 rpm until oil temperature reaches 40°C and oil pressure drops to normal. Leave oil cooler and intercooler in "AUTO." Avoid prolonged running on ground and always keep cowl flaps "OPEN" during ground runs to prevent burning of ignition harness.

d. When the engine oil temperature has risen above 40°C, conduct ground test and, with propeller control set for "INCREASE RPM," check magnetos as follows:

(1) Open throttle to at least 2200 rpm and 30 inches Hg. and test each magneto. Drop in rpm should not exceed 100 on either magneto.

e. Check proper functioning of propeller by operating governor control until decrease in rpm is noted. Return control to full forward.

f. Check for generator charge on ammeter above 1400 rpm.

g. Check oil pressure and temperature. (Refer to Specific Engine Flight Chart, section III.)

h. Check fuel pressure. (Refer to Specific Engine Flight Chart, section III.)

i. Check water pressure: 32 to 34 psi at 2200 rpm on the ground.

j. Check gage for correct hydraulic pressure.

k. Operate engine from each fuel tank including externals, if installed. Operate from external tanks until fuel pressure gage stops fluctuating, to be sure no air is in the fuel lines.

l. Check Flight Indicator: The Gyro Horizon (Flight Indicator) will be uncaged at all times except during maneuvers in the air which exceed the operating limits.

Note

If the horizon bar is not level after the engine is started, momentarily cage the Gyro, if possible, at least 5 minutes before take off.

6. SCRAMBLE TAKE-OFF.

a. Use oil dilution to obtain proper oil pressure at moderate power, and take off. Never attempt to speed warm-up by closing cowl flaps.

CAUTION

Apply throttle slowly but steadily. Too-sudden application of throttle seriously affects torque.

7. TAXIING INSTRUCTIONS.

a. Always unlock tail wheel (9, figure 22) for taxiing. It is necessary to keep swinging the airplane from side to side for visibility directly ahead. Taxiing with flaps down except on prepared runways may cause damaged flaps.

CAUTION

Avoid taxiing through mud holes and tall grass, as the propeller can easily be damaged by small stones, mud clots, or hidden pieces of foreign material.

8. TAKE-OFF.

a. FINAL CHECK.

(1) Trim tabs—set for take-off.

(2) Mixture control—"AUTO-RICH."

(3) Propeller control—"INCREASE RPM" (full forward.) Propeller selector switch "AUTOMATIC."

(4) Fuel selector valve—"MAIN TANK."

(5) Check flaps for desired position.

Note

Partial flaps will assist take-off from abnormally short or muddy fields. See Take Off, Climb, and Landing Chart, Appendix I, for explicit information.

(6) Cowl flap switch—"AUTO."

(7) Canopy open.

(8) Run engine up to 1400 rpm. Check for operation of the generator. Check for radio operation. (Usually contacting the tower is sufficient.)

b. TAKE-OFF PROCEDURE.

(1) Turn down runway, let airplane roll straight to center tailwheel then lock the tail wheel.

CAUTION

Always lock tail wheel prior to take-off. A swing may develop if tail wheel is free.

(2) Push interconnected boost and throttle forward to approximately 30 in. Hg. while holding the airplane with the brakes. Release brakes and with firm and even pressure open throttle to 54 in. Hg. or take-off stop. If air filter control is "ON," switch "WATER" on and the turbo speed switch to "W.E.P." (War Emergency Power) before the take-off run in order to allow high carburetor air temperature.

NOTE

During warm-weather operation when ground temperature is approximately 35°C (95°F) or hotter, it will be necessary to disconnect controls and take off without using the turbosupercharger to avoid excessive carburetor-air temperatures and loss of power. In this case, boost may be used as soon as sufficient altitude is reached and lower carburetor-air temperatures are obtained.

(3) As soon as the airplane is off the ground, move safety latch and raise landing-gear lever to "UP," and leave lever at "UP" until it is desired to lower the landing gear.

WARNING

Braking of overheated brakes after take-off may cause discs to seize, resulting in locked-wheel landing.

(4) Move canopy switch to "CLOSE."

(5) Move cowl flap switch to "AUTO."

9. ENGINE FAILURE DURING TAKE-OFF.

a. Nose down to maintain speed.

b. Turn fuel-boost rheostat full clockwise in attempt to regain power.

c. If engine does not regain power, prepare to land on field *straight ahead.* If too late, retract gear and prepare to land off field *straight ahead.*

WARNING

Do not attempt to turn back into field.

d. Jettison external tanks or bombs.

e. Lower flaps.

f. Move mixture to "IDLE CUT-OFF"

g. Switch ignition and battery switches "OFF." Leave battery switch "ON" if landing light is needed.

h. Jettison canopy.

10. CLIMB.

a. Desired climbing speed is 150 to 165 mph. It will be necessary in prolonged climbs, or in hot weather, to climb at higher speed in order to properly cool the engine. Increase IAS until allowable cylinder-head temperature is obtained. See Specific Engine Flight chart, section III, and Take-off, Climb and Landing Charts, Appendix I.

b. Keep cowl flap switch in "AUTO" check cylinder-head temperature frequently. If over 260°C, check cowl flap switch to "OPEN." Check oil temperature and carburetor-air temperature. Maximum oil temperature is 95°C and maximum carburetor air temperature is 38°C unless water is used.

NOTE

Watch carburetor air closely. Temperature builds up rapidly when air filter is in use.

c. Place air-filter control in "OFF"-position as soon as dust-free altitude is reached and switch water off as soon as carburetor air temperature is within limits.

d. During Military Power climbs it will be necessary to reduce the engine controls setting for increasing altitude in order not to exceed 54 inches of manifold pressure and thereby actuate the water switch. The electric supercharger regulator tends to allow an increase of 1 in. Hg. of manifold pressure for every 6,000 feet of altitude.

11. GENERAL FLYING CHARACTERISTICS.

a. Operate engine within limitations outlined in Specific Engine Flight Chart in section III.

b. To reduce power, first retard interconnected boost and throttle levers; set rpm with propeller control, and then adjust power lever for desired manifold pressure.

c. To increase power, push throttle forward and insure that the latch on the control lever also engages the propeller lever.

d. To operate at War Emergency Power push throttle and boost levers forward and at 54.5 in. Hg, water will cut in automatically. If the automatic switch is inoperative, switch (figure 8) to "W. E. P."

e. Most stable high-altitude operation is obtained when power adjustment is made by boost control alone. However, caution must be observed to prevent two conditions as follows:

(1) TURBO COLLAPSE.—When power is reduced by retarding the throttle or engine speed, leaving the boost well forward, a consequent reduction in exhaust back pressure occurs. When this condition approaches the point where there is insufficient back pressure to maintain the required boost, a further reduction in power and back-pressure results, finally causing complete collapse. Recovery from collapse is achieved by nosing down and advancing throttle and engine to increase exhaust pressure which again sets

the supercharging system in action. Recovery from complete collapse at high altitudes may take as long as 30 seconds.

(2) PULSATION.—At another range of the throttle with the boost lever well forward, when power is reduced by throttle or propeller control, it is possible to "dam" the turbo. In this condition, there is sufficient back pressure to operate the supercharger, but the engine is not absorbing its output, which results in "damming" the pressurized air and causes pulsating pressures in the ducts. Since the fuel pump is balanced against carburetor air, turbo pulsation causes fluctuation in fuel pressure and, if allowed to contine, will cause sufficient fuel-air ratio disruption to result in engine surging. Pulsation is detected by fluctuating fuel pressure and may be corrected by either retarding the boost lever or advancing throttle or engine speed.

e. All models are stable under acceptable loading conditions. The external tanks decrease stability in yaw. A full auxiliary tank decreases stability in pitch. Acrobatics are prohibited with external tanks. On airplanes without dorsal fins, rudder lock may occur at high angles of yaw or in uncoordinated maneuvers involving rudder and ailerons. Recovery from rudder lock is effected by cutting power and applying opposite rudder.

f. The trim tabs are very sensitive and should be handled cautiously. A slight tail-heavy trim may be desirable when the landing gear is lowered. The nose drops appreciably when the flaps are lowered.

g. For economical cruising, set rpm and manifold pressure as indicated on the Flight Operation Instruction Charts in Appendix I.

12. STALLS.

a. If controls are held in neutral, there is no tendency to spin although the left wing drops rapidly and the airplane will dive out and recover. All controls are effective down to stalling speeds; slight buffeting occurs at 3 or 4 mph above stalling speed.

b. Stalling speeds with power on are:

(1) Flaps and landing gear up—115 IAS.

(2) Flaps and landing gear down—100 IAS.

13. SPINS.

Information not yet available.

14. PERMISSIBLE ACROBATICS.

All normal acrobatics are permitted. No outside loops or inverted flight shall be performed. Do not slow roll or perform maneuvers involving uncoordinated rudder and ailerons on models without dorsal fins.

15. DIVING.

a. Due to the compressibility effect, diving at high altitude will produce a tendency for the airplane to "dig-in" or nose down. Therefore, do not enter dives with the airplane trimmed for a more nose-down condition than high-speed level flight. Keep the airplane trimmed so that a forward load must be applied to the stick to keep the airplane in the dive.

b. If extremely high speeds are reached, and the elevator trim tab is used in a small degree to aid recovery, guard against too-rapid pull-out at low altitude. Apply forward stick load to hold down "g's".

c. Apply power to recover from dive. Reducing power makes dives steeper.

d. Safe indicated diving speeds are listed on the instrument panel and must not be exceeded.

WARNING

P-47N models do not have compressibility recovery flaps as installed in late P-47D's.

e. Cowl flaps switch in "AUTO" or "CLOSE".

f. Highest permissible engine overspeed is 3120, therefore, place propeller control at approximately 2600 rpm before entering dive.

16. NIGHT FLYING.

a. All light switches are on the left near canopy rail.

b. The landing light should not be extended until the final approach and should be left on only for the time necessary. Do not extend it at speeds above 165 IAS or aileron buffeting may occur.

CAUTION

Be sure to retract landing light at once after the take-off.

17. APPROACH AND LANDING.

a. APPROACH.

(1) Check for sufficient fuel for landing and select either "MAIN or "AUXILIARY" tank with most fuel.

(2) Reduce speed to 140 to 150 IAS.

WARNING

Make no turns below 150 IAS with wheels and flaps down.

(3) Mixture control: "AUTO RICH."

(4) Propeller: "AUTOMATIC."

(5) Propeller lever: 2600 rpm.

(6) Throttle and boost—Connected.

(7) Cowl flaps: "AUTOMATIC."

Note

During long low power low airspeed approaches, it may be necessary to watch cylinder head temperatures.

(8) Move landing gear handle "DOWN" when airplane slows to 200 IAS.

CAUTION

Never lower landing gear at speeds in excess of 200 IAS.

(9) Landing flaps "DOWN" under 190 IAS. Check their position by observation from cockpit. If partial flaps are desired, return handle to "NEUT" when desired angle is achieved.

(10 Normal approach speeds:

(a) Power on—115 to 120 mph.

(b) Power off—120 to 130 mph.

b. CROSS-WIND LANDING.—Follow normal procedure and keep airplane traveling in straight line with runway. Use minimum flaps. Keep windward wing down.

c. MINIMUM RUN LANDING.—Keep speed down close to stalling speeds, flaps full down. Make 3-point landing at start of runway; keep stick back and apply brakes at the start of the ground run.

d. TAKE-OFF IF LANDING IS NOT COMPLETED.

(1) Advance controls to required power, usually about 40 in. Hg.; first move propeller lever and then supercharger and throttle levers.

WARNING

Watch the tendency to swing due to the sudden application of power.

(2) Raise landing gear at once.

(3) Milk flaps up when above 500 feet.

(4) Do not pull up too steeply, or loss of control may result.

18. STOPPING OF ENGINE.

a. Set parking brakes.

CAUTION

As soon as wheels are chocked, release brakes since overheated brakes may seize.

b. When a cold weather start is anticipated, dilute the oil as follows:

(1) Operate engine at 1000 to 1200.

(2) Maintain oil temperatures below 50°C and oil pressure above 25 psi.

(3) Hold oil dilution switch (figure 8) "ON" as required by ground temperatures:
4° to —12°C (40° to 10°F) for 3 minutes.
—12° to —29°C (10° to —20°F) for 8 minutes.

Note

The dilution period to provide the required dilution for temperatures lower than —29°C (—20°F) is excessive for these aircraft. Therefore, heat must be supplied before the next start in addition to the maximum permissible dilution.

c. Open engine to 1000 rpm and place mixture control in "IDLE CUT-OFF," holding the dilution switch "ON" until the engine stops.

d. After propeller stops rotating, turn ignition switch "OFF."

19. BEFORE LEAVING COCKPIT.

a. Fuel selector valve (figure 5) "OFF."

b. All cockpit light switches, pitot heater switch, master battery switch, etc. "OFF."

c. Lock flight controls.

20. MOORING.

a. Lugs for mooring the airplane are provided in the lower side of each wing, just outboard of the landing-gear leg and concealed by an access door marked "TIE-DOWN." Lashing down the tail may be done by inserting a rope through either the lift tube or the tail wheel yoke.

b. If no stationary mooring points are provided, the portable mooring kit supplied with the airplane may be used.

SECTION III
OPERATING DATA

1. SPECIFIC ENGINE FLIGHT CHART.

a. Engine limitations and operating characteristics are summarized for ready reference. Learn them.

b. Definitions of the engine power ratings shown on the chart are as follows:

(1) TAKE-OFF. — Maximum recommended for take-off under the specified time limit.

(2) WAR EMERGENCY. — The rating established specifically for combat use not over 5 minutes.

(3) MILITARY—Maximum recommended for operation limited to 15-minutes duration unless otherwise specified.

(4) NORMAL RATED. (Maximum Continuous.)—Maximum recommended for unlimited operation with rich mixture in level flight and in climb.

2. AIRSPEED CORRECTION TABLE.

MPH — IAS	MPH Calibrated
310	322.5
290	300.5
260	268.5
230	237.5
200	206.5
170	175.0

SPEC. AN-H-8
DEC. 18, 1942
FORM ASC-512

AIRPLANE MODELS

P-47N

SPECIFIC ENGINE FLIGHT CHART

ENGINE MODELS

R-2800-57 with water injection

CONDITION	FUEL PRESSURE (LB/SQ. IN.)	OIL PRESSURE (LB/SQ. IN.)	OIL TEMP. °C	OIL TEMP. °F	COOLANT TEMP. °C	COOLANT TEMP. °F	Water Pressure (lb./sq. in.)	
DESIRED	24-26	85-90	60-85		AIR COOLED		27-29	
MAXIMUM	26	90	100				29	
MINIMUM	24	55	40				27	
IDLING	23	25					0-8	

MAX. PERMISSIBLE DIVING RPM: 3120 (30 Sec.)

CONDITION	ALLOWABLE OIL CONSUMPTION
MAX. CONT.	32.2 U.S.QT/HR. 53.7 IMP.PT/HR
MAX. CRUISE	15.4 U.S.QT/HR. 25.7 IMP.PT/HR
MIN. SPECIFIC	U.S.QT/HR. IMP.PT/HR

OIL GRADE: (S) 1100 (W) 1100

SUPERCHARGER TYPE:

FUEL GRADE: 100/130 Spec: AN-F-28

OPERATING CONDITION	RPM	MANIFOLD PRESSURE (BOOST)	HORSE-POWER	CRITICAL ALTITUDE WITH RAM	CRITICAL ALTITUDE NO RAM	BLOWER	USE LOW BLOWER BELOW:	MIXTURE CONTROL POSITION	FUEL FLOW (GAL/HR/ENG.) U.S.	FUEL FLOW (GAL/HR/ENG.) IMP.	MAXIMUM CYL. TEMP. °C	MAXIMUM CYL. TEMP. °F	MAXIMUM DURATION (MINUTES)
TAKE-OFF	2800	54.5	2100				Use Turbo	AR	290	242	260	500	5 Min.
WAR EMERGENCY	2800	72	2800				"	AR	276	230	260	500	5 Min.
MILITARY	2800	54.5	2100				"	AR	290	242	260	500	15 Min.
MAXIMUM CONTINUOUS	2600	43.5	1700				"	AR	215	180	260	500	Unlimited
MAXIMUM CRUISE	2250	32	1140				"	AL	92	77	232	450	Unlimited
MINIMUM SPECIFIC CONSUMPTION													

REMARKS: Complete information not yet available.

Figure 25—Specific Engine Flight Chart

SECTION IV
EMERGENCY OPERATING INSTRUCTIONS

1. ENGINE FAILURE DURING FLIGHT.

a. Nose down to maintain speed, switch to other tanks and turn fuel booster pump rheostat fully clockwise in an attempt to regain power. If engine does not regain power prepare to land.

b. Ignition switch "OFF."

c. Jettison canopy.

d. Jettison bombs and/or tanks.

e. Mixture control in "IDLE CUT-OFF."

f. Fuel selector valve "OFF."

g. Flaps: "DOWN" as desired.

h. Master battery switch "OFF" before contact, unless lights are required.

i. If a suitable emergency airfield is available, the landing gear may be lowered. If not, keep landing gear up and land airplane on its belly.

2. BELLY LANDINGS.

In suitably large emergency fields with standard runways a wheel-down landing may be made but in general, belly landings should be made in preference to wheel-down landings under most conditions. Be sure canopy is jettisoned and all switches "OFF" except battery switch if landing light is desired, mixture control in "IDLE CUT-OFF" and if time allows, fuel selector valve "OFF." Approaches should be made as follows:

Windmilling propeller—about 140 IAS
Dead propeller —about 170 IAS

3. FIRE.

Since the P-47 does not have provisions for fire extinguishing, the pilot has no means at his disposal to attempt to save his equipment other than to try "IDLE CUT-OFF"—mixture position. In general, it is necessary to bail out.

4. FAILURE OF ENGINE-DRIVEN FUEL PUMP.

a. If the engine-driven fuel pump fails during flights while drawing fuel from any internal tanks, turn fuel-booster pump rheostat to full clockwise "EMERGENCY" position. If this operation does not result in sufficient fuel pressure, retard supercharger control lever until normal fuel pressure is obtained. When operating with fuel booster pump at high altitudes, pressure should be checked and readjusted with decreasing altitude or fuel pressure will increase.

b. If the engine-driven fuel pump fails while operating on the external tanks, the fuel pressure can not be maintained and it will be necessary to operate on "MAIN" or "AUXILIARY" with the fuel booster pump rheostat in the emergency clockwise position.

c. If the engine-driven fuel pump fails at take-off on during low-altitude flights on internal tank operations, turn the fuel booster pump rheostat full clockwise and maintain full power; it will not be necessary to change the supercharger lever setting.

5. EMERGENCY EXIT DURING FLIGHT.

Pull canopy jettison handle located on forward bow and bail out.

6. WING FLAP OPERATION.

In the event of failure of the engine-driven hydraulic pump, the flaps may be manually lowered by use of the emergency hand pump located at the left of the pilot's seat. The landing gear handle must be at "N" (neutral) before the wing flaps are pumped down.

7. LANDING-GEAR OPERATION.

a. Failure of engine-driven hydraulic pump is indicated by zero reading on the hydraulic pressure gage and the gear may be operated as follows:

(1) To retract landing gear: Move control lever to usual "UP"-position. Operate the hand pump until the warning lamp light shows that the gear is up and locked.

(2) To extend landing gear: Move control lever to the usual "DOWN"-position. This will release the gear which should drop into position and lock due to its own weight. If the signal indicates that the gear is not locked down, operate the hand pump until the "locked" signal is given. If the gear is still not locked down, return to up and repeat the landing cycle. It may be necessary to yaw the airplane from side to side to lock the gear down.

b. If the gear is unlocked when hydraulic pressure is indicated, repeat the landing gear extension and retraction cycle by moving the landing gear handle to up or down. If the landing gear signal still indicates an unlocked position proceed as follows:

(1) If the landing gear is up and not locked the timing valve is probably defective and has allowed the landing gear door to close before the landing gear is in the up position. This condition, although not too serious for operation during emergencies, requires a return to the field for repair. The downlocking feature will be found to be in operating condition when lowering the landing gear.

(2) If the landing gear is down and not locked when hydraulic pressure is indicated, repeat the landing gear retraction and extension cycle a few times and if landing gear is not locked down, a belly landing will be necessary.

c. Failure of entire hydraulic system: Extend the landing gear by moving the control into the "DOWN"-position as usual. This motion releases the gear which drops, due to its own weight, and usually falls to the fully extended and locked "DOWN"-position. In case air pressure prevents one wheel from fully attaining the locked position, it can be shaken into place by yawing the airplane from side to side. Return landing gear handle to "N" before lowering flaps.

8. FAILURE OF THE AUTOMATIC SUPERCHARGER REGULATING SYSTEM.

If water is not delivered when the manifold pressure is above 54.5 Hg, move "WATER" on and turbo speed switch to "W. E. P."

SECTION V
OPERATIONAL EQUIPMENT

1. OXYGEN SYSTEM.

a. GENERAL.—Breathing oxygen is supplied from five type D-2 and two type F-1 cylinders located in the fuselage aft of the cockpit. (See figure 27.) An oxygen demand regulator is located to the pilot's right on the cockpit wall. A pressure gage and flow indicator are mounted on a sub-panel to the right of the instrument panel. (See figure 26.) The cylinders may be charged through the oxygen filler valve located on the fuselage left side aft of the cockpit.

b. OPERATION.

(1) GENERAL.—Before using this equipment, be sure you are familiar with the complete oxygen demand system. Consult your Oxygen Officer and refer to the applicable Technical Orders, Instruction Charts, and Training Films on oxygen equipment. Thoroughly understand the operation, use, and purpose of each instrument and item. Give each part the care and consideration it requires for its proper functioning.

(2) MASK.

(a) The mask must be properly fitted and checked for leakage by the Oxygen Officer. Flights over 30,000 feet must not be made when the mask leak is greater than 5 percent.

(b) Check all parts of the mask to see if it is in good condition and ready for instant use. The mask must be clean and free from all foreign matter.

(c) Try the mask on in the airplane and check for leaks by holding the thumb over the corrugated hose fitting and inhaling normally.

(3) QUICK-DISCONNECT FITTING. — Insert the male fitting (see that the gasket is in place) of the mask into the female end of the tubing from the regulator. Be sure the fit is snug and that a pull of at least 10 pounds is required to separate the two.

(4) MASK-REGULATOR TUBING.

(a) Inspect the mask-regulator tubing for any damages, such as tears, holes, and kinks. Be sure all clamps are firmly in place.

(b) Attach the tubing, by means of the spring clip on the female fitting, to the clothing or parachute harness high up on the chest. It may be desira

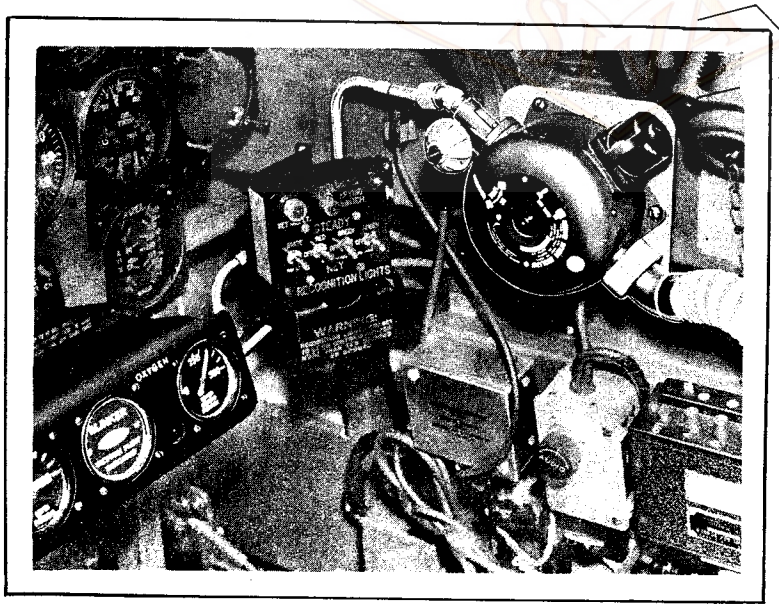


Figure 26—Oxygen System Controls

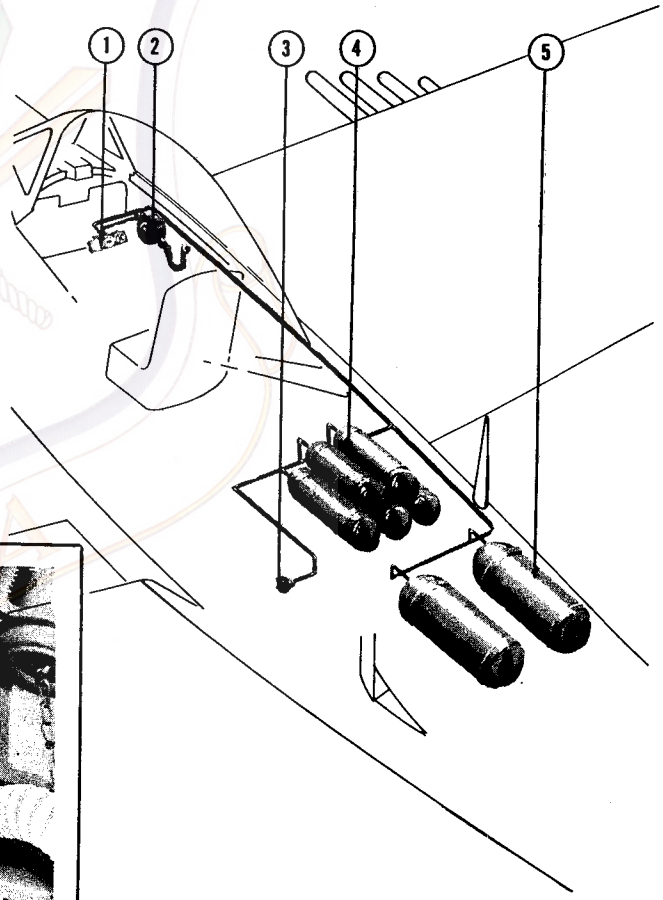


Figure 27—Oxygen System

1. Oxygen Gages
2. Demand Regulator
3. System Filler Valve
4. Type D-2 Bottles
5. Type F-1 Bottles

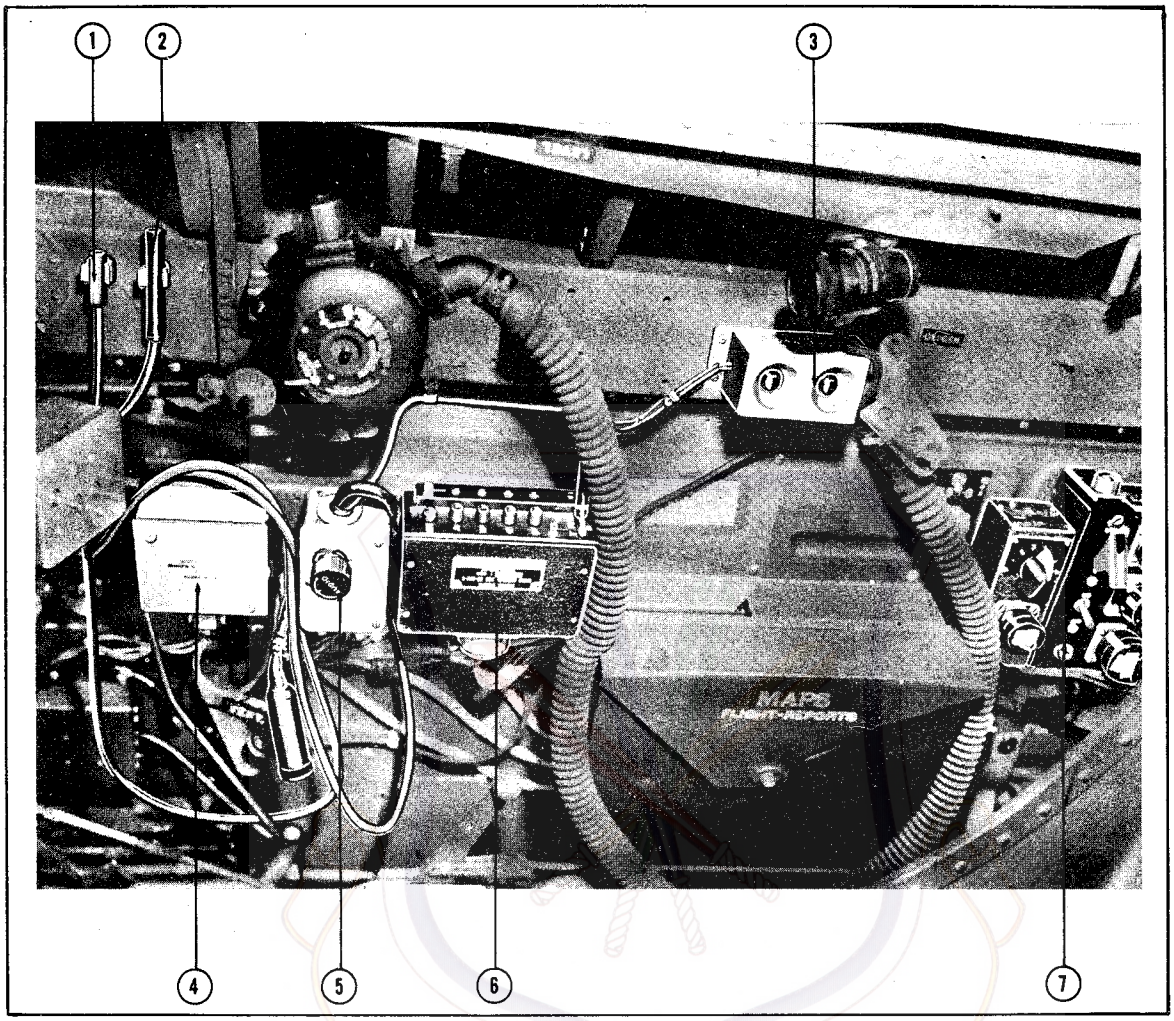


Figure 28—Radio Installation

1. Microphone Plug
2. Headset Plug
3. Secret Radio Detonator
4. Microphone Adapter
5. Volume Control
6. Control Box, SCR 522
7. Controls for Radio SCR 695

to sew a tab of fabric or webbing to the clothing to accomodate the clip. Be sure that the attachment is high enough so that there is free movement of the head without kinking the mask hose. Be sure that the mask hose does not become kinked or twisted in flight.

(5) REGULATOR AND INDICATING INSTRUMENTS.

(a) Be sure that the knurled collar at the outlet end of the regulator is tight. Examine the top diaphragm to see that it is not ruptured or distorted.

(b) Turn "ON" the "EMERGENCY" valve and insure that you get a large flow. Observe the pressure gage; there should be no perceptible pressure drop. Turn the "EMERGENCY" valve "OFF" tightly, and be sure that it does not leak. Leave it in this position.

(c) Turn the "AUTO-MIX" to the "OFF"-position. Notice that on inhalation the top diaphragm goes down and that you get nearly 100 percent oxygen, which will be indicated on the flow indicator. Turn the "AUTO-MIX" to the "ON"-position. Notice that on inhalation you get almost pure air and that there is little or no indication of oxygen flow on the flow indicators. Leave it in this position.

(d) Check the pressure of the system. It must not be less than 400 psi.

(6) IN FLIGHT.

(a) Manipulate the mask to free it of ice, at regular intervals, when temperatures are low enough to cause ice formation in the mask.

(b) Be sure that your mask hose does not become kinked or twisted.

(c) Be sure that your mask does not lose its leak-proof characteristics.

(d) If for any reason you feel you are suffering from lack of oxygen, if your mask should suddenly leak, if the demand mechanism fails, or if no oxygen flow is indicated by the flow indicator, immediately turn on the "EMERGENCY" control on the regulator

(e) Check the oxygen pressure gage frequently.

(f) Check the flow indicator frequently.

(7) AFTER FLIGHT.

(a) Be sure that all oxygen equipment is in proper condition before leaving the airplane. If any difficulties developed during the flight, take necessary steps to have them corrected.

(b) Wash the mask with mild soap and water, dry thoroughly, and leave in a clean, airy place out of the sunlight.

(c) At all times, be sure that the mask is in good condition and is properly fitted for instant use.

c. FILLING CYLINDERS.—The cylinders may be charged through the filler valve located on the fuselage left side aft of the cockpit beneath an access door. The normal full pressure of the system is 400 psi.

WARNING

Extreme care must be observed to prevent oxygen from contacting any oil, grease, or material containing oil, as spontaneous combustion and explosion are certain to occur.

2. COMMUNICATION SYSTEM.

a. GENERAL.—Provisions are made for the installation of either the SCR-274N or the SCR-522A radio set in these airplanes. The command radio equipment is located in the baggage compartment and is accessible through the baggage compartment door. All radios are controlled remotely by the pilot through control boxes located on the right side of the cockpit.

b. COMMAND SET SCR-274N.

(1) DESCRIPTION.—The command set SCR-274N is designed for communicating with nearby aircraft for tactical purposes, and with ground stations for navigational and traffic-control purposes. Three receivers and one transmitter are installed in the rear of the fuselage. All dials and controls are located on remote-control units to the right of the pilot.

(2) RECEIVING.

(a) The receiver remote-control unit is divided into three identical sections, each section controlling the particular receiver to which it is electrically and mechanically connected. Reception of a signal of a specific frequency as indicated on the dial is accomplished by the use of the section of the receiver control box which controls the particular receiver involved.

(b) Plug headset phone jack plug in jack. Turn volume control to right until a faint "frying" noise is heard in the headset.

(c) Set crystal filter selector switch on "BOTH" for all normal (voice or "MCW") reception.

(d) Turn "MCW" and "CW" switch on. This switch, in addition to having an "OFF"-position, has two selective positions marked "CW" and "MCW," each of which is an "ON"-position and indicates the type of signal which is to be received.

Note

When tuning receiver for a definite frequency, always turn dial a little to each side of the frequency calibration mark to find the point where the signal is the strongest.

(e) The "A-B" switches should be left in the "A"-position at all times.

(3) TRANSMITTING.

(a) Before transmitting, adjust the radio receiver to the same frequency as the station with which you desire to talk, and listen in to be sure that the operator is not talking to someone else. If the station is transmitting, take advantage of the opportunity to more accurately set the receiver on the assigned frequency, and when the other operator is finished, proceed with your transmission.

(b) Place transmitter master switch in "ON"-position.

(c) Select type of transmission desired with switch marked "TONE-CW-VOICE."

1. With switch in "VOICE"-position, voice will be transmitted when the "push-to-talk" button is pressed.

2. With the switch in the "CW"-position, a continuous wave, or unmodulated signal, will be transmitted. The microphone is inoperative.

3. With the switch in the "TONE"-position a modulated tone signal is transmitted. The microphone is inoperative.

Note

Greatest effective range can be obtained on "CW." Range is most limited when operating on "VOICE." Transmitting in both the "CW" and "TONE" positions is done by a key located on the top of the transmitter control unit.

(d) To reduce battery drain and to increase dynamotor life, the "TONE-CW-VOICE" switch should be left on "VOICE" unless continued use on "CW" or "TONE" is expected.

c. RADIO SET SCR-522A (VHF.)

(1) GENERAL.

(a) This equipment is a very-high-frequency (VHF) command set designed for voice communication only.

(b) The radio waves from this equipment travel in straight lines, like beams of light, and do not follow the curvature of the earth. Due to this fact, in order to receive signals from a ground station, it is necessary that the airplane be above a certain altitude, the altitude being determined by the distance of the airplane from the ground station.

1. If the airplane is between 35 and 50 miles away from the ground station, it must be above 1,000 feet before reception is possible.

2. If the airplane is between 80 and 100 miles away from the ground station, it must be above 5,000 feet before reception is possible.

3. If the airplane is between 120 and 160 miles away from the station, it must be above 10,000 feet before reception is possible.

Note

If the range differs from any of the above-mentioned distances, altitudes will change proportionately.

CAUTION

Excessive operation of this equipment on the ground must be avoided unless a battery cart is used to prevent running down the airplane's battery.

(2) OPERATION.

(a) Press the proper channel button on the cockpit control box for the frequency upon which you are to transmit and receive. (See figure 28.)

Note

Transmission and reception take place on the same frequency.

(b) The green pilot light, adjacent to the channel button pressed, lights up whenever the set is in operation.

(c) The white pilot light adjacent to the toggle switch should light up, indicating that the set is on "RECEIVE."

(d) For throttle-microphone button transmission, the toggle switch must be in the "REM"-position.

(e) Press microphone button; press the throttle microphone "push-to-talk" button; and speak in a normal voice with the microphone against your lips. The white pilot light goes out, indicating that the set is on "TRANSMIT."

(f) It is also possible to transmit by moving the control-box toggle switch to the "T"-position, instead of pressing the throttle "push-to-talk" button. However, it must be returned to either the "R"- or "REM"-position immediately after transmission is completed, in order to receive.

(g) Indicator lamps on the control box are provided with a dimmer mask for night flying. The mask is operated by moving a small lever beside the "OFF" push-button.

d. DETROLA MODEL 438 BEACON RECEIVER.— This receiver is in addition to the SCR-522 or the SCR-274N radio when the airplane leaves the factory. If it is still installed:

(1) Plug headphones into the jack which is plugged into the face of the radio panel.

(2) Turn the volume control up until the background noise is heard.

(3) Tune to the desired frequency with the tuning knob

(4) Frequencies covered are 200 to 400 kilocycles.

e. RADIO SET SCR-695 (IFF.)

(1) The control box for this radio set is located on the right side of the cockpit. A master switch is located on the box. Operation of the set is automatic and the pilot has only to place the switch in the "ON"-position to place the equipment in operation.

(2) A dual push-button switch, painted red, is located on the right side of the cockpit above the map case. The purpose of the two push buttons is to destroy the IFF equipment should it be necessary to abandon the airplane over unfriendly territory. When both push-buttons are pressed simultaneously, a detonator is set off in the receiver which is located in the aft end of the fuselage in the baggage compartment. The explosion of the detonator will destroy the receiver internally. No damage to the airplane will result at the time of the destruction of the set.

Note

Regeneration adjustment of the IFF set must be made on the ground prior to flight in order to insure correct operation of the equipment.

3. ARMAMENT.

a. GUNSIGHT.

(1) DESCRIPTION. — The K-14 Pilot's Gyro Gun Sight provides for accurate means of firing at a moving target. The sight computes the correct lead angle and makes necessary allowances for target crossing speed at ranges from 800 to 200 yards. Two reticles are provided in this sight, a left reticle which is a fixed cross and ring, and the right reticle known

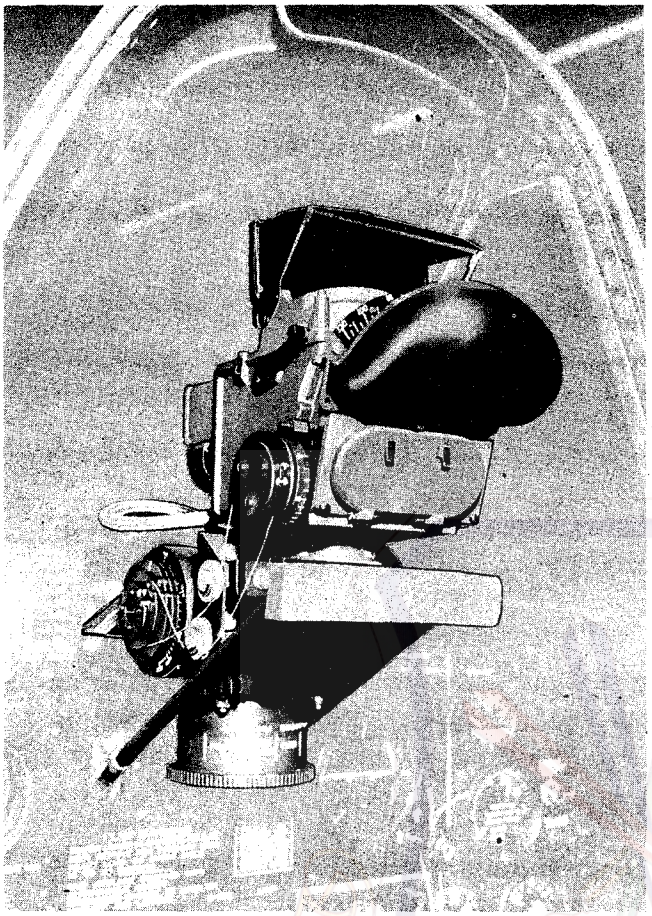


Figure 29—Gun Sight

as the gyro reticle, which is composed of a small dot surrounded by a circle of six small diamonds.

(2) CONTROLS.

(a) BRILLIANCY. — The brilliancy of the reticles may be varied by rotating the knurled ring of the selector dimmer at the lower end of the sight. Right hand rotation of the selector dimmer increases the brilliancy of the reticles.

Note

The lever at the right side of the sight is used to position the sunshade when desired.

(b) RETICLE SELECTION.

(1) A rotary switch located on the selector dimmer under the sight selects the various reticles which are titled "FIXED," "FIXED AND GYRO," "GYRO DAY," and "GYRO NIGHT". "GYRO NIGHT" is inoperative on normal fighter installations.

(2) The normal selection for all combat operations is "FIXED AND GYRO." This selection gives a fixed cross with the dot of the gyro reticle superimposed upon it.

Note

The circle of the fixed reticle may be blanked by operating the lever at the left side of the sight.

(c) POSITIONING OF THE GYRO RETICLE. —The gyro reticle is modifiable for both target size and range and proper positioning for range and wing span will automatically compute for lead and other variables when the reticle spans the target. Positioning for wing span and range is accomplished as follows:

(1) The size of the gyro reticle is positioned for various wing spans by shifting the pointer along the span scale on the face of the sight. The span scale is calibrated so that the largest wing span is at the extreme left of the scale and the smallest at the right.

(2) The gyro reticle is positioned for ranges from target by rotating the handle on the throttle lever. When the handle is in the full counterclockwise position, (aft.), the reticle is in proper position for the selected wing span at 800 yards, and when the handle rotates to full clockwise position, (forward), the reticle is in proper position for the target at 200 yards.

(3) OPERATION.

(a) Keep the sight on "FIXED AND GYRO" and at the proper brilliancy at all times.

(b) When the enemy is sighted and identified, set the span scale on the sight to correspond with the identified wing span and maneuver so that the target appears within the gyro reticle.

(c) Rotate the twist grip until the reticle properly spans the wing span of the target. *Continually span the target by operating the twist grip for a minimum period of 1 second and then fire.*

Note

The gyro sight allows for correction only after the target had been correctly spanned for a minimum period of 1 second.

b. GUNS.—Eight .50 calibre guns, four in each wing, are provided. Only six guns, with ammunition, are included in the design useful load. Two guns and ammunition are alternate load. No round indicators are provided. The maximum load is 425 rounds each. Desired loading with six guns is 267 rounds each and, with eight guns, 200 rounds each. These guns are charged manually on the ground before take-off. Determine the loading for each particular flight in order to estimate the firing time. Three hundred rounds of ammunition is approximately 20 seconds of fire.

c. GUN OPERATION.—Since the guns have been previously loaded and charged on the ground, they are ready to fire immediately when the safety switches, installed on the left wall of the cockpit and on the

circuit protector box are turned "ON." (See figure 20.) The squeeze trigger on the stick fires all guns simultaneously. If one or more guns should jam, the others will continue to operate effectively. The gun safety switch should be in the "OFF"-position, before landing.

d. BORESIGHTING. — The guns may be boresighted in a horizontal plane from a position where each gun is parallel to the other, to a position where all guns converge at 250 yards; and in a vertical plane from intersection with the sightline at 250 yards and 85 percent maximum speed at best performing altitude to intersection at 250 yards at full speed at best performing altitude. Ordinarily the guns are set to converge at 250 yards or 350 yards. Determine the boresighting position of your guns before take-off on a firing mission.

4. GUN CAMERA.

A camera is installed in the leading edge of the wing which operates in conjunction with the guns. It is controlled by a switch (figure 8) in the cockpit. The camera may be operated alone or with the guns depending on the position of the switch.

5. CHEMICAL TANKS.

Electrical provisions are made for operating chemical tanks which may be hung from the bomb shackles in each wing. A selector switch (figure 6) permits operation of either right or left tank or both together.

SECTION VI
EXTREME WEATHER OPERATION

1. ARCTIC CONDITIONS.

a. BEFORE STARTING ENGINE.

(1) The procedure prior to starting is largely dependent upon the extent of the cold weather steps which were taken at the last landing, and upon the outside air temperatures encountered. In temperatures down to —23°C (—10°F), no special procedures are required. When the temperature is at —23°C (—10°F) or below, it is necessary to preheat the engine and accessory compartment prior to attempting a start.

(2) To preheat the engine, the oil temperature regulators, air ducts, and cowl flaps should be closed and the heat applied by means of the sleeves attached to the cowl covers at the nose of the engine and at the accessory compartment. At least 2 hours is usually required to heat an engine at extremely low temperatures. If oil dilution has not been performed, it may be necessary to heat the oil coolers and the lines in the engine accessory compartment to insure satisfactory operation. If the engine oil has been drained, it is necessary to preheat it to 93°C before pouring it back into the tank. This should be done a few minutes prior to the actual starting of the engines. If the electrical immersion heaters have been used in the oil tanks it is assumed that the oil system will be sufficiently warm to permit a start.

b. STARTING THE ENGINE.

(1) Always turn a cold engine over 16 blades before engaging the starter. A battery cart or auxiliary generator unit for starting is almost a necessity in cold weather starting since even fully charged batteries are considerably weakened by low temperatures. The power receptacle is located in the lower right side of the secondary cowl.

(2) To assure successful engine starts in extremely cold weather, considerable priming is necessary. A light priming should be given before the starter is engaged and then while the engine is being turned over the primer should be operated until regularity of firing results. *Do not* prime the engine until actually ready to engage the starter.

(3) Moisture quickly forms on spark plugs during cold starts. After 3 or 4 unsucessful attempts, remove at least one plug from each cylinder to heat plug to 65° to 75°C (149° to 167°F) (comfortably warm in the hand) to dry the points. Make another starting attempt immediately after replacing plugs.

c. OPERATION DURING FLIGHT.

(1) TAKE-OFF.

WARNING

Never take off with snow, ice, or frost on the wings. Even loose snow cannot be depended upon to blow off and only a thin frost layer is necessary to cause loss of lift and unusual flying characteristics.

(a) Where landing or taking off on a narrow strip of clear ice, cross winds are particularly dangerous due to the loss of maneuverability caused by the lack of traction. The airplane may, if the wind is gusty, be blown completely off the ice before control can be regained.

(b) If deep heavy snow interferes with the take off, but permits the airplane to taxi, move slowly up and down a runway before attempting the actual take-off. The depth and hardness of the snow will determine whether take-off or landing is practicable.

(c) Regardless of the degree of cold weather encountered, take-off should be made with the cowl flaps in "AUTO." The hazard of taking off with partially closed cowl flaps is too great a risk, and there is no possibility of an engine cooling off excessively during the take-off and Rated Power climb.

(2) DURING FLIGHT.

(a) Following take-off from snow or slush-covered fields, operate landing gear and flaps through a complete cycle two or three times to preclude freezing in the "UP" position.

(b) Regulate cowl flaps to maintain temperatures within safe limits or leave at "AUTO." Proper carburetor air temperature is maintained by the intercooler doors switch at "AUTO."

(c) If an icing condition is encountered, fire short bursts from the guns every two minutes to remove ice. Operate gun bay heat control if there is evidence of malfunctioning of the guns due to cold or ice.

(d) CANOPY DEFROSTER.—The canopy defroster removes ice accumulation from the canopy by inducting warm air, preheated by the exhaust manifold, over the inner surfaces of the canopy.

(3) LANDING.

(a) Temperature inversions are common in winter, and ground air may be 15° to 30°C (59° to 86°F) colder than that at altitude. Therefore, care must be taken to avoid excessive cooling when letting down. Lower landing gear and use partial flaps to reduce air speed while descending. Keep considerable power, and regulate shutters to eliminate cooling engine excessively. If possible, maintain head tempera-

tures above 100°C, and oil temperatures above 30°C during all let-downs. Lower readings may result in the engine cutting out or failure to "take" when the throttle is advanced.

(b) Watch for a condition known as "Sastrugi," which consists of a series of small tightly packed snow drift resembling ocean waves in appearance. These small drifts are from 10 to 20 inches in depth and are very hazardous to a landing airplane. Safe landing may be effected; however, if landings are made parallel to the drifts rather than into the wind.

(c) Under certain conditions of overcast when the ground is snow covered, light is so diffused that it is impossible to visually determine the difference between land and sky. Such a situation is extremely dangerous to the pilot and when encountered he must immediately rely on instrument flying. In attempting to land under such conditions, it is sometimes necessary to throw overboard smoke candles, engine covers, or other articles which, when resting on top of the snow, will provide a means of accurately locating the ground level.

(4) AFTER FLIGHT.—Before stopping the engine, when a cold weather start is anticipated, hold the oil dilution control in the "ON" position for a period of 3 minutes at 1000 to 1200 rpm, for temperatures of 4 o —12°C (40° to 10°F) and for 8 minutes for ground temperatures of —12° to —29°C (10° to —22°F). A normal dilution period of 4 minutes is recommended unless the engine is being repeatedly stopped and started without flight operation. Dilution should be confined to such times as flight is intended. Cylinder head temperatures should be in the neighborhood of 100° to 150°C. Oil temperatures should be below 50° to 55°C. If oil dilution is to be accomplished and the oil temperatures are too high, stop the engine and after the oil has cooled to 40° or 50°C (104° or 122°F) restart the engine and proceed with oil dilution. After dilution has been accomplished, open the throttle to 1000 rpm and place the mixture control in "IDLE CUT-OFF," continuing to hold dilution valve on until engine stops.

2. TROPIC CONDITIONS.

a. During hot weather when the ground temperature is approximately 35°C (95°F) or hotter, it is necessary to disconnect the engine controls and take off without using the turbosupercharger to avoid increase in carburetor air temperatures and thereby cause detonation and loss of power.

b. As soon as higher altitudes and lowered temperatures are reached, the boost may be used.

c. Where outside temperatures are above the carburetor air temperature limit, use water, and before the take-off run, switch "WATER" on and turbo speed switch to "W. E. P." and take-off. Carburetor air temperature limit with water is 55°C. Switch regulator to "OFF" and turbo speed to "NORMAL" as soon as lower temperature is encountered since the expenditure of water for this purpose decreases the combat effectiveness of the airplane.

d. In order to prevent high ambient temperatures, the canopy should always remain partially opened and covered on the ground.

e. Hot brakes will seize, and it is therefore advisable to use chocks when parking and leave the parking brake off.

f. At take-offs, do not apply brakes after the landing gear is retracted since hot brakes will seize and cause a locked-wheel landing.

3. DESERT CONDITIONS.

a. In desert operations, place the air filter control to the "ON" position, and leave "ON" until dust-free altitude is reached. Take-offs with filter "ON" will be made with water by placing "WATER" switch on and turbo speed switch to "W. E. P.," before the start of the take-off run so that the higher carburetor air-temperature limit may be used. This practice reduces the combat effectiveness of the airplane and must be used only as long as is necessary. When dust-free altitude is reached place filter "OFF," and as soon as carburetor air temperature drops to normal, switch "WATER" off and turbo speed switch to "NORMAL."

b. The canopy is of low-surface hardness, and exposure to dirt and sand wil gradually reduce its optical properties. Therefore, all canopies should remain covered when airplanes are parked; in addition, in warm temperatures it will be necessary to leave the canopy opened slightly in order to avoid high ambient temperatures in the cockpit.

APPENDIX I
FLIGHT OPERATING CHARTS, TABLES, CURVES, AND DIAGRAMS

1. GENERAL.

This section presents diagrams and tables containing a summary of specific characteristics, restrictions, and instructions. Every effort has been made to present complete data in simple, practical, and reliable form. Due to limitations of space, the data appear complex but careful study will reveal a surprising amount of valuable information. Distances shown have been adjusted to account for service conditions and are slightly conservative.

2. TAKE-OFF, CLIMB, AND LANDING CHART.

a. This chart is a general summary of characteristics with a few pertinent instructions. Note the temperature correction under each table.

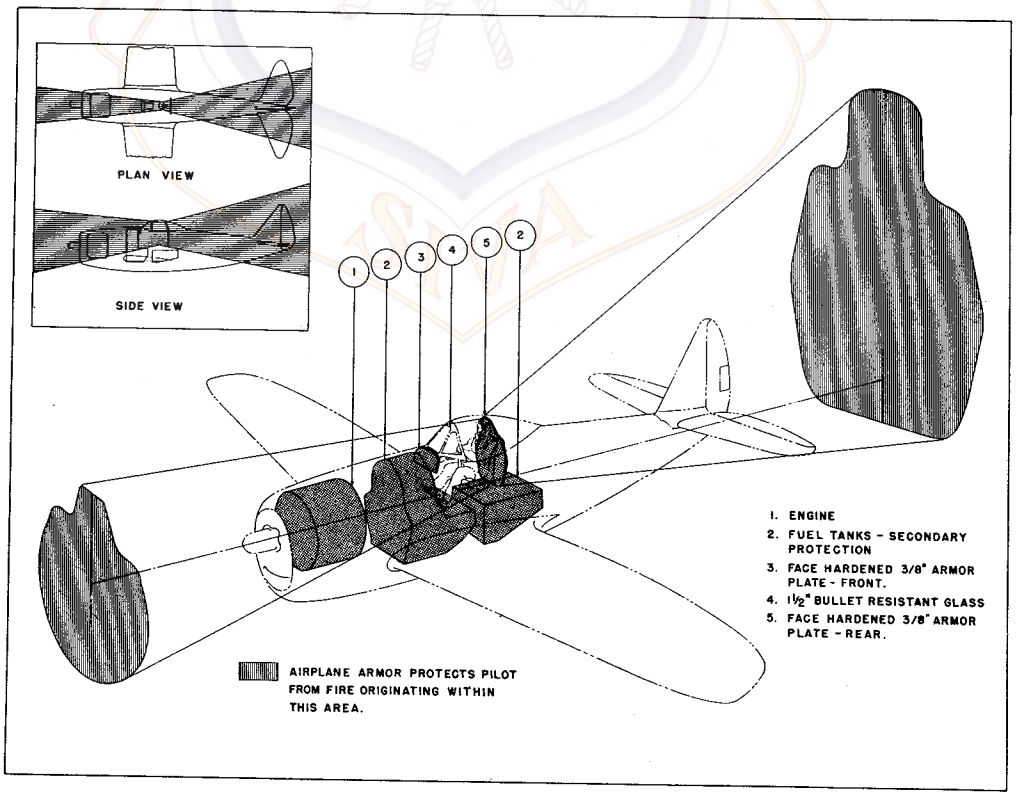
b. The following is a sample take-off problem:

Can a P-47 airplane operate from 5,000 foot clearance surrounded by trees if the elevation is 2,500 feet, no wind, the surface is sod and the average temperature is about 75°F? Refer to chart. The take-off distance table under "Sod-Turf Runway," "At 3,000 feet," "To clear 50-foot object" (on account of trees), and opposite 16,300 pounds gross weight and zero wind (top line), reads 4750; 10 percent is 475 feet which must be added because of the 75°F temperature, gives 5225 feet required for safe operation. Therefore, use of that field is practically out of the question in spite of the fact that a landing in a 12,300 pound condition could be made in 3,880 feet.

c. SAMPLE CLIMB PROBLEM.—With combat loading of 8 guns and 2136 rounds of ammunition, what is the minimum time required to climb to 20,000 feet? Gross weight is about 16,300 pounds and time to climb to 20,000 feet from sea level is 11.25 minutes.

3. FLIGHT OPERATION INSTRUCTION CHARTS.

a. Note the two reference columns which show gallons of fuel in the upper half of the table and altitudes in the lower half. Other columns are in sets with practical ranges (statute and equivalent nautical air-miles) listed in the upper half, and corresponding operation instructions in the lower half. Progressing from left to right these columns are arranged, and when complete, will show increase in range at sacrifice in speed with maximum cruising speeds on extreme left and maximum range on extreme right.



ARMOR PROTECTION

AAFMC-527
4-1-44

AIRCRAFT MODEL(S)
P-47N

TAKE-OFF, CLIMB & LANDING CHART

ENGINE MODEL(S)
R-2800--57 Series

TAKE-OFF DISTANCE FEET

GROSS WEIGHT LB.	HEAD WIND M.P.H.	HEAD WIND KTS.	HARD SURFACE RUNWAY AT SEA LEVEL GROUND RUN	HARD SURFACE RUNWAY AT SEA LEVEL TO CLEAR 50' OBJ.	HARD SURFACE RUNWAY AT 3000 FEET GROUND RUN	HARD SURFACE RUNWAY AT 3000 FEET TO CLEAR 50' OBJ.	HARD SURFACE RUNWAY AT 6000 FEET GROUND RUN	HARD SURFACE RUNWAY AT 6000 FEET TO CLEAR 50' OBJ.	SOD-TURF RUNWAY AT SEA LEVEL GROUND RUN	SOD-TURF RUNWAY AT SEA LEVEL TO CLEAR 50' OBJ.	SOD-TURF RUNWAY AT 3000 FEET GROUND RUN	SOD-TURF RUNWAY AT 3000 FEET TO CLEAR 50' OBJ.	SOD-TURF RUNWAY AT 6000 FEET GROUND RUN	SOD-TURF RUNWAY AT 6000 FEET TO CLEAR 50' OBJ.	SOFT SURFACE RUNWAY AT SEA LEVEL GROUND RUN	SOFT SURFACE RUNWAY AT SEA LEVEL TO CLEAR 50' OBJ.	SOFT SURFACE RUNWAY AT 3000 FEET GROUND RUN	SOFT SURFACE RUNWAY AT 3000 FEET TO CLEAR 50' OBJ.	SOFT SURFACE RUNWAY AT 6000 FEET GROUND RUN	SOFT SURFACE RUNWAY AT 6000 FEET TO CLEAR 50' OBJ.
20,000	0	0	6000	7500	6620	8500	7200	9250	6100	7870	6800	8600	7450	9500	6900	8600	7550	9370	8250	10,250
	20	17	4800	6000	5130	6500	5620	7120	4850	6120	5300	6620	5800	7250	5400	6600	5880	7250	6450	8,000
	40	35	3660	4750	4000	5250	4400	5750	3790	5000	4140	5380	4520	5870	4220	5370	4550	5870	5050	6370
18,000	0	0	3770	5370	4120	5870	4520	6380	3900	5500	4260	6000	4670	6500	4330	5870	4720	6500	5170	7000
	20	17	2450	4120	3220	4620	3540	4860	3030	4250	3310	4750	3630	5000	3380	4500	3700	5120	4060	5500
	40	35	2300	3370	2500	3750	2760	4000	2380	3500	2600	3880	2850	4120	2630	3750	2890	4120	3160	4370
16,300	0	0	2770	4250	3150	4620	3320	5120	2860	4380	3120	4750	3420	5250	3170	4750	3470	5120	3800	5500
	20	17	2160	3250	2360	3620	2590	3880	2240	3380	2450	3750	2670	4000	2490	3500	2720	4000	2970	4250
	40	35	1625	2500	1770	2750	1950	3000	1680	2620	1880	2880	2000	3120	1860	2750	2040	3000	2240	3250

NOTE: INCREASE CHART DISTANCES AS FOLLOWS: 75°F + 10%; 100°F + 20%; 125°F + 30%; 150°F + 40%

OPTIMUM TAKE-OFF WITH 2800 RPM, 54 IN.HG. & 20 DEG. FLAP IS 80% OF CHART VALUES

DATA AS OF 11-13-44 BASED ON: Flight tests and calculations

CLIMB DATA

GROSS WEIGHT LB.	AT SEA LEVEL BEST I.A.S. MPH	AT SEA LEVEL BEST I.A.S. KTS	AT SEA LEVEL RATE OF CLIMB F.P.M.	AT SEA LEVEL GAL. OF FUEL USED	AT 5000 FEET BEST I.A.S. MPH	AT 5000 FEET BEST I.A.S. KTS	AT 5000 FEET RATE OF CLIMB F.P.M.	AT 5000 FEET FROM SEA LEVEL TIME MIN.	AT 5000 FEET FROM SEA LEVEL FUEL USED	AT 10,000 FEET BEST I.A.S. MPH	AT 10,000 FEET BEST I.A.S. KTS	AT 10,000 FEET RATE OF CLIMB F.P.M.	AT 10,000 FEET FROM SEA LEVEL TIME MIN.	AT 10,000 FEET FROM SEA LEVEL FUEL USED	AT 15,000 FEET BEST I.A.S. MPH	AT 15,000 FEET BEST I.A.S. KTS	AT 15,000 FEET RATE OF CLIMB F.P.M.	AT 15,000 FEET FROM SEA LEVEL TIME MIN.	AT 15,000 FEET FROM SEA LEVEL FUEL USED	AT 20,000 FEET BEST I.A.S. MPH	AT 20,000 FEET BEST I.A.S. KTS	AT 20,000 FEET RATE OF CLIMB F.P.M.	AT 20,000 FEET FROM SEA LEVEL TIME MIN.	AT 20,000 FEET FROM SEA LEVEL FUEL USED	AT 25,000 FEET BEST I.A.S. MPH	AT 25,000 FEET BEST I.A.S. KTS	AT 25,000 FEET RATE OF CLIMB F.P.M.	AT 25,000 FEET FROM SEA LEVEL TIME MIN.	AT 25,000 FEET FROM SEA LEVEL FUEL USED
20,000	165		1350	30	165		1360	3.69	48	165		1360	7.37	65	160		1350	11.06	83	155		1320	14.83	101	150		1230	18.76	120
18,000	165		1550	30	165		1560	3.22	46	165		1560	6.43	61	160		1540	9.65	76	155		1510	12.94	92	150		1410	16.36	108
16,300	165		1780	30	165		1790	2.80	44	165		1790	5.59	57	160		1770	8.39	70	155		1730	11.25	84	150		1620	14.23	98

POWER PLANT SETTINGS: (DETAILS ON FIG. SECTION III):

DATA AS OF 11-13-44 BASED ON: Flight tests and calculations

FUEL USED (U.S.GAL.) INCLUDES WARM-UP & TAKE-OFF ALLOWANCE

LANDING DISTANCE FEET

GROSS WEIGHT LB.	BEST IAS APPROACH POWER OFF MPH	POWER OFF KTS	POWER ON MPH	POWER ON KTS	HARD DRY SURFACE AT SEA LEVEL GROUND ROLL	HARD DRY SURFACE AT SEA LEVEL TO CLEAR 50' OBJ.	HARD DRY SURFACE AT 3000 FEET GROUND ROLL	HARD DRY SURFACE AT 3000 FEET TO CLEAR 50' OBJ.	HARD DRY SURFACE AT 6000 FEET GROUND ROLL	HARD DRY SURFACE AT 6000 FEET TO CLEAR 50' OBJ.	FIRM DRY SOD AT SEA LEVEL GROUND ROLL	FIRM DRY SOD AT SEA LEVEL TO CLEAR 50' OBJ.	FIRM DRY SOD AT 3000 FEET GROUND ROLL	FIRM DRY SOD AT 3000 FEET TO CLEAR 50' OBJ.	FIRM DRY SOD AT 6000 FEET GROUND ROLL	FIRM DRY SOD AT 6000 FEET TO CLEAR 50' OBJ.	WET OR SLIPPERY AT SEA LEVEL GROUND ROLL	WET OR SLIPPERY AT SEA LEVEL TO CLEAR 50' OBJ.	WET OR SLIPPERY AT 3000 FEET GROUND ROLL	WET OR SLIPPERY AT 3000 FEET TO CLEAR 50' OBJ.	WET OR SLIPPERY AT 6000 FEET GROUND ROLL	WET OR SLIPPERY AT 6000 FEET TO CLEAR 50' OBJ.
16,300	135	-	125	-	2370	3620	2750	4120	3120	4750	2750	4120	3130	4620	3620	5370	5370	6750	6250	7860	7120	8500
12,300	125	-	115	-	1870	3000	2170	3500	2500	4000	2120	3250	2500	3880	2750	4250	4000	5250	4620	6000	5250	6860

DATA AS OF 11-13-44 BASED ON: Calculations

OPTIMUM LANDING IS 80% OF CHART VALUES

REMARKS:

NOTE: TO DETERMINE FUEL CONSUMPTION IN BRITISH IMPERIAL GALLONS, MULTIPLY BY 10, THEN DIVIDE BY 12

FIGURES HAVE NOT BEEN FLIGHT TESTED SUBJECT TO REVISION

LEGEND
I.A.S. : INDICATED AIRSPEED
M.P.H. : MILES PER HOUR
KTS. : KNOTS
F.P.M. : FEET PER MINUTE

FIG. NO. 30 TAKE-OFF, CLIMB & LANDING CHART

AAFMC-528
4-1-44

AIRCRAFT MODEL(S)
P-47N

ENGINE(S): P & W R-2800-57

FLIGHT OPERATION INSTRUCTION CHART

CHART WEIGHT LIMITS: 16,300 TO 12,300 POUNDS

EXTERNAL LOAD ITEMS
None

NUMBER OF ENGINES OPERATING: One

LIMITS	R.P.M.	M.P. IN.HG.	BLOWER POSITION	MIXTURE POSITION	TIME LIMIT	CYL. TEMP.	TOTAL G.P.H.
WAR EMERG.	2800	72	-	A. R.	5 Min	260°C	276
MILITARY POWER	2800	54	-	A. R.	15 Min	260°C	290

FOR DETAILS SEE POWER PLANT CHART (FIG. 25 SECT. III)

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 (M.P.) AND MIXTURE SETTING REQUIRED.

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. (G.P.H.) AND TRUE AIRSPEED (T.A.S.) ARE APPROXIMATE VALUES FOR REFERENCE. RANGE VALUES ARE FOR AN AVERAGE AIRPLANE FLYING ALONE (NO WIND).[1] TO OBTAIN BRITISH IMPERIAL GAL. (OR G.P.H.): MULTIPLY U.S. GAL. (OR G.P.H.) BY 10 THEN DIVIDE BY 12.

COLUMN I						FUEL	COLUMN II						COLUMN III						COLUMN IV						FUEL	COLUMN V					
RANGE IN AIRMILES						U.S.	RANGE IN AIRMILES						RANGE IN AIRMILES						RANGE IN AIRMILES						U.S.	RANGE IN AIRMILES					
STAUTE		NAUTICAL				GAL.	STATUTE		NAUTICAL				STATUTE		NAUTICAL				STATUTE		NAUTICAL				GAL.	STATUTE		NAUTICAL			
						550	SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING[1]																		550					
605		525				520	705		610				825		715				975		845				520	1040		900			
580		505				500	680		590				795		690				935		810				500	1000		875			
520		455				450	610		530				715		620				840		730				450	900		780			
465		405				400	545		475				640		550				750		650				400	800		695			
405		350				350	475		415				555		485				650		565				350	700		610			
350		300				300	405		350				475		415				560		485				300	605		520			
290		250				250	340		295				400		345				465		405				250	500		435			
230		200				200	270		245				315		275				375		320				200	400		350			
175		150				150	200		175				235		205				280		240				150	300		260			
115		100				100	135		120				160		135				185		160				100	205		175			
60		50				50	65		60				80		65				90		80				50	100		85			
MAXIMUM CONTINUOUS						PRESS	(160 STAT. (139 NAUT.) MI./GAL.)						(187 STAT. (162 NAUT.) MI./GAL.)						(220 STAT. (191 NAUT.) MI./GAL.)						PRESS	MAXIMUM AIR RANGE					
R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	ALT. FEET	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	ALT. FEET	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.
						40000																			40000						
						35000																			35000						
2600	43.5	A.R.	215	388	337	30000																			30000						
2600	43.5	A.R.	215	372	323	25000	2325	36.0	AR	171	273	237	2200	33.0	AL	125	234	203	2100	31.2	AL	98	216	188	25000	2000	30.0	AL	88	207	180
2600	43.5	A.R.	215	357	310	20000	2350	36.5	AR	182	291	253	2200	33.0	AL	135	252	219	2100	31.5	Al	101	221	192	20000	2030	30.5	AL	89	210	182
2600	43.5	A.R.	215	340	295	15000	2350	36.0	AR	171	274	238	2230	33.0	AL	150	280	243	2100	32.0	AL	105	232	201	15000	2100	31.0	AL	93	220	191
2600	43.5	A.R.	215	325	282	10000	2350	36.0	AR	162	259	225	2250	34.0	AL	142	266	231	2150	32.0	AL	102	224	195	10000	2100	31.0	AL	100	235	204
2600	43.5	A.R.	215	308	268	5000	2350	36.0	AR	158	252	219	2250	34.0	AL	128	239	207	2150	32.0	AL	102	225	196	5000	2150	32.0	AL	94	221	192
2600	43.5	A.R.	215	294	255	S.L.	2325	36.0	AR	152	244	212	2250	34.5	AL	125	233	202	2200	33.0	AL	101	223	194	S.L.	2150	32.0	AL	93	218	189

SPECIAL NOTES

(1) MAKE ALLOWANCE FOR WARM-UP, TAKE-OFF & CLIMB (SEE FIG. 30) PLUS ALLOWANCE FOR WIND, RESERVE AND COMBAT AS REQUIRED.

EXAMPLE

AT 16,300 LB. GROSS WEIGHT WITH 450 GAL. OF FUEL (AFTER DEDUCTING TOTAL ALLOWANCES OF 100 GAL.) TO FLY 840 STAT. AIRMILES AT 10,000 FT. ALTITUDE MAINTAIN 2150 RPM AND 32 IN. MANIFOLD PRESSURE WITH MIXTURE SET: A. L.

LEGEND

ALT. : PRESSURE ALTITUDE	F.R. : FULL RICH
M.P. : MANIFOLD PRESSURE	A.R. : AUTO-RICH
GPH : U.S. GAL. PER HOUR	A.L. : AUTO-LEAN
TAS : TRUE AIRSPEED	C.L. : CRUISING LEAN
KTS. : KNOTS	M.L. : MANUAL LEAN
S.L. : SEA LEVEL	F.T. : FULL THROTTLE

DATA AS OF 11-18-44 BASED ON: Flight Tests of P-47D Series Airplanes

FIGURES ARE PRELIMINARY DATA, SUBJECT TO REVISION AFTER FLIGHT CHECK

FIG. NO. 31 FLIGHT OPERATING INSTRUCTION CHART

AAFMC-528 4-1-44

AIRCRAFT MODEL(S)
P-47N

ENGINE(S): R-2800-57

FLIGHT OPERATION INSTRUCTION CHART

CHART WEIGHT LIMITS: 20250 TO 12650 POUNDS

EXTERNAL LOAD ITEMS
2-300 Gallon Wing Tanks

NUMBER OF ENGINES OPERATING: One

LIMITS	R.P.M.	M.P. IN.HG.		MIXTURE POSITION	TIME LIMIT	CYL. TEMP.	TOTAL G.P.H.
WAR EMERG.	2800	72	-	A.R.	5 Min.	260	275
MILITARY POWER	2800	54	-	A.R.	15 Min.	260	290

FOR DETAILS SEE SPECIFIC ENGINE FLIGHT CHART (FIG. 25).

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 (M.P.) AND MIXTURE SETTING REQUIRED.

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. (G.P.H.) AND TRUE AIRSPEED (T.A.S.) ARE APPROXIMATE VALUES FOR REFERENCE. RANGE VALUES ARE FOR AN AVERAGE AIRPLANE FLYING ALONE (NO WIND).[1] TO OBTAIN BRITISH IMPERIAL GAL. (OR G.P.H.): MULTIPLY U.S. GAL. (OR G.P.H.) BY 10 THEN DIVIDE BY 12.

COLUMN I						FUEL	COLUMN II						COLUMN III						COLUMN IV						FUEL	COLUMN V					
RANGE IN AIRMILES						U.S.	RANGE IN AIRMILES						RANGE IN AIRMILES						RANGE IN AIRMILES						U.S.	RANGE IN AIRMILES					
STAUTE		NAUTICAL				GAL.	STATUTE		NAUTICAL				STATUTE		NAUTICAL				STATUTE		NAUTICAL				GAL.	STATUTE		NAUTICAL			
MAXIMUM CONTINUOUS						PRESS	(101 STAT. (88 NAUT.) MI./GAL.)						(STAT. (NAUT.) MI./GAL.)						(STAT. (NAUT.) MI./GAL.)						PRESS	MAXIMUM AIR RANGE					
R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	ALT. FEET	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.	ALT. FEET	R.P.M.	M.P. INCHES	MIX-TURE	APPROX. TOT. G.P.H.	APPROX. T.A.S. MPH.	APPROX. T.A.S. KTS.
						40000																			40000						
						35000																			35000						
2600	43.5	A.R.	215	333	290	30000																			30000						
2600	43.5	A.R.	215	312	272	25000	2325	36.0	A.R.	208	252	219													25000	2300	34.5	A.L	170	281	244
2600	43.5	A.R.	215	292	254	20000	2350	36.0	A.R.	215	243	211													20000	2300	33.5	A.L	164	257	224
2600	43.5	A.R.	215	270	235	15000	2360	36.5	A.R.	220	235	204													15000	2350	34.0	A.L	160	236	205
2600	43.5	A.R.	215	250	218	10000	2360	36.5	A.R.	220	226	196													10000	2250	33.0	A.L	150	217	189
2600	43.5	A.R.	215	228	198	5000	2350	36.0	A.R.	215	218	190													5000	2100	33.0	A.L	110	192	167
2600	43.5	A.R.	215	209	182	S.L.	2325	36.0	A.R.	208	210	183													S.L.	2000	32.0	A.L	90	180	156

1070	930	1150	SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING[1]										1150								
1070	930	1100	1090	950									1100	1600	1390						
975	845	1000	990	860									1000	1450	1260						
875	760	900	890	775									900	1305	1135						
775	675	800	790	690									800	1160	1010						
680	590	700	695	600									700	1015	880						
585	505	600	595	515									600	870	755						
485	425	500	495	430									500	725	630						
390	340	400	395	345									400	580	505						
290	255	300	295	260									300	435	380						
195	170	200	200	170									200	290	250						
95	85	100	100	85									100	145	125						

SPECIAL NOTES

(1) MAKE ALLOWANCE FOR WARM-UP, TAKE-OFF & CLIMB (SEE FIG. 30) PLUS ALLOWANCE FOR WIND, RESERVE AND COMBAT AS REQUIRED.

(2) If External Tanks Are Dropped, See Sheet 1.

EXAMPLE

AT 20,300 LB. GROSS WEIGHT WITH 1,000 GAL. OF FUEL (AFTER DEDUCTING TOTAL ALLOWANCES OF 150 GAL.) TO FLY 1450 STAT. AIRMILES AT 5000 FT. ALTITUDE MAINTAIN 2100 RPM AND 33 IN. MANIFOLD PRESSURE WITH MIXTURE SET: A.L.

LEGEND

ALT. : PRESSURE ALTITUDE
M.P. : MANIFOLD PRESSURE
GPH : U.S. GAL. PER HOUR
TAS : TRUE AIRSPEED
KTS. : KNOTS
S.L. : SEA LEVEL
F.R. : FULL RICH
A.R. : AUTO-RICH
A.L. : AUTO-LEAN
C.L. : CRUISING LEAN
M.L. : MANUAL LEAN
F.T. : FULL THROTTLE

DATA AS OF 12/1/44 BASED ON: Calculations

FIGURES ARE PRELIMINARY DATA, SUBJECT TO REVISION AFTER FLIGHT CHECK

FIG. NO. 31 FLIGHT OPERATING INSTRUCTION CHART (SHEET 2 OF 2 SHEETS)

216-5