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AN 01-25CN-2

ERECTION AND MAINTENANCE INSTRUCTIONS

FOR

ARMY MODEL

P-40N Series

BRITISH MODEL

KITTYHAWK IV

AIRPLANES

This publication replaces AN 01-25CN-2 dated 25 July 1943.

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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30 AUGUST 1944

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General.

These instructions permit the issue of restricted publications to civilian contract and other accredited schools engaged in training personnel for Government work, to civilian concerns contracting for overhaul and repair of aircraft or aircraft accessories, and to similar commercial organizations.

LIST OF REVISED PAGES ISSUED

NOTE: A heavy black vertical line, to the left of the text on revised pages, indicates the extent of the revision. This line is omitted where more than 50 percent of the page is revised.

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INTRODUCTION

This Handbook covers all maintenance instructions from minor adjustments, test and inspections to major disassembly and repair (except structural repair) for all P-40N series airplanes in the following blocks:

P-40N-1-CU	AF42-104429 through AF42-104828
P-40N-5-CU	AF42-104829 through AF42-105928
P-40N-10-CU	AF42-105929 through AF42-106028
P-40N-15-CU	AF42-106029 through AF42-106405
P-40N-20-CU	AF42-106406 through AF42-106428 and AF43-22752 through AF43-24251

The following technical orders form a part of the complete instructions for operation, maintenance, and repair of the P-40N series airplanes:

01-25C-3	Structural Repair Instructions—P-40 Series
01-25C-4	Airplane Parts Catalog—P-40M and P-40N
01-25CN-1	Pilot's Flight Operating Instructions—P-40N
01-25CN-30	Cold Weather Operation and Maintenance Instructions—P-40N Series

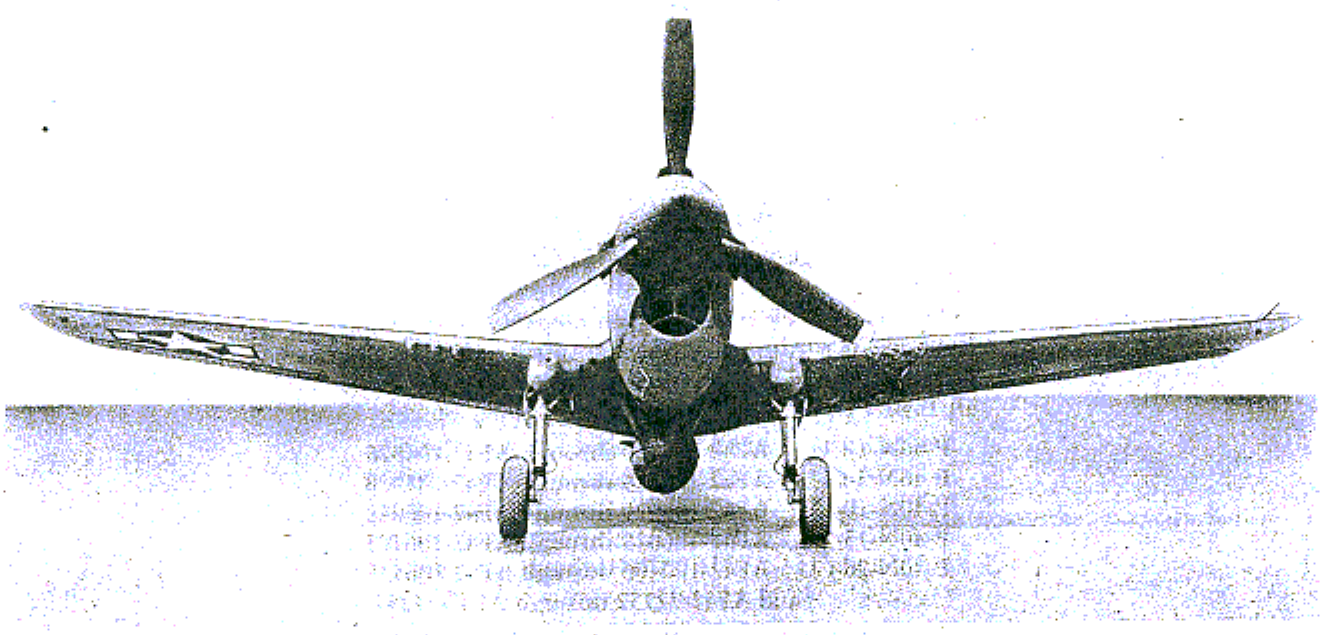


Figure 1—Front View of P-40N Airplane

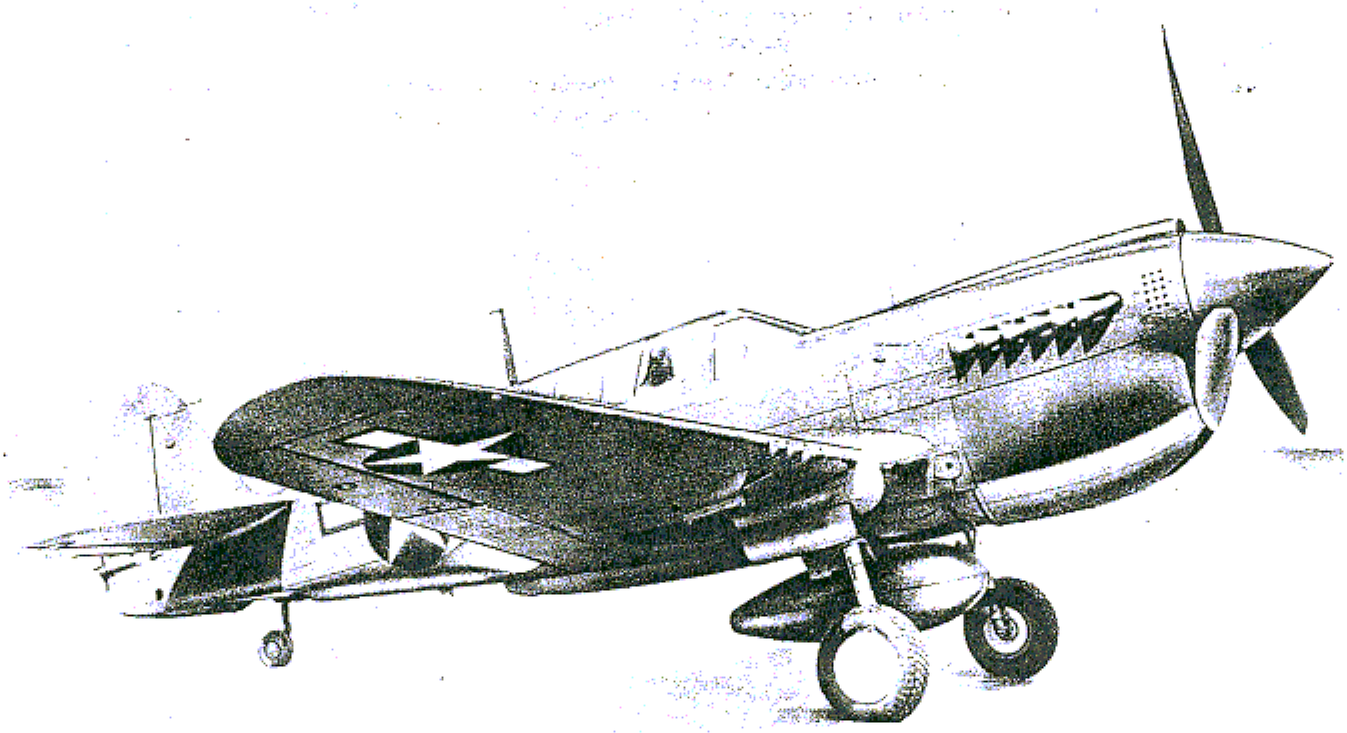


Figure 2—One-Quarter Right Front View of P-40N Airplane

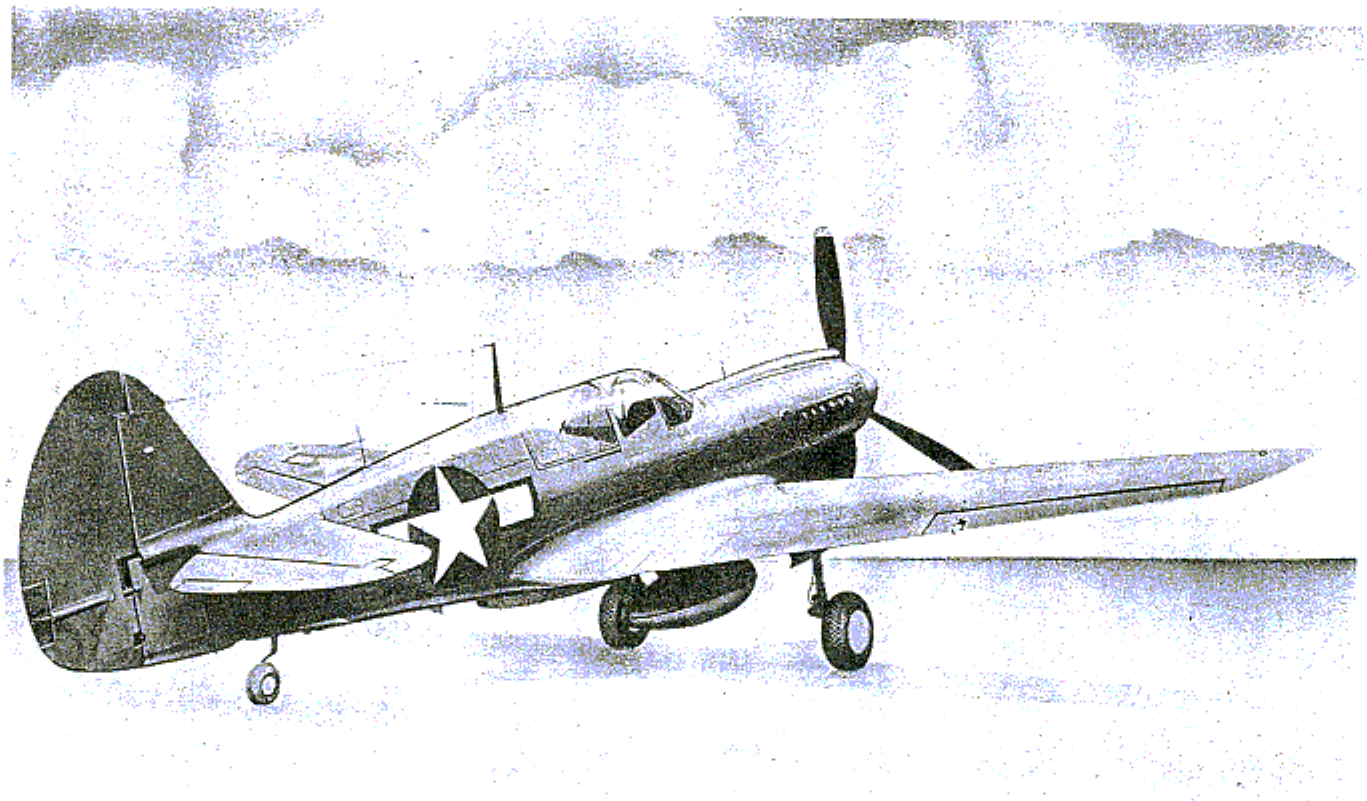


Figure 3—Three-Quarter Right Rear View of P-40N Airplane

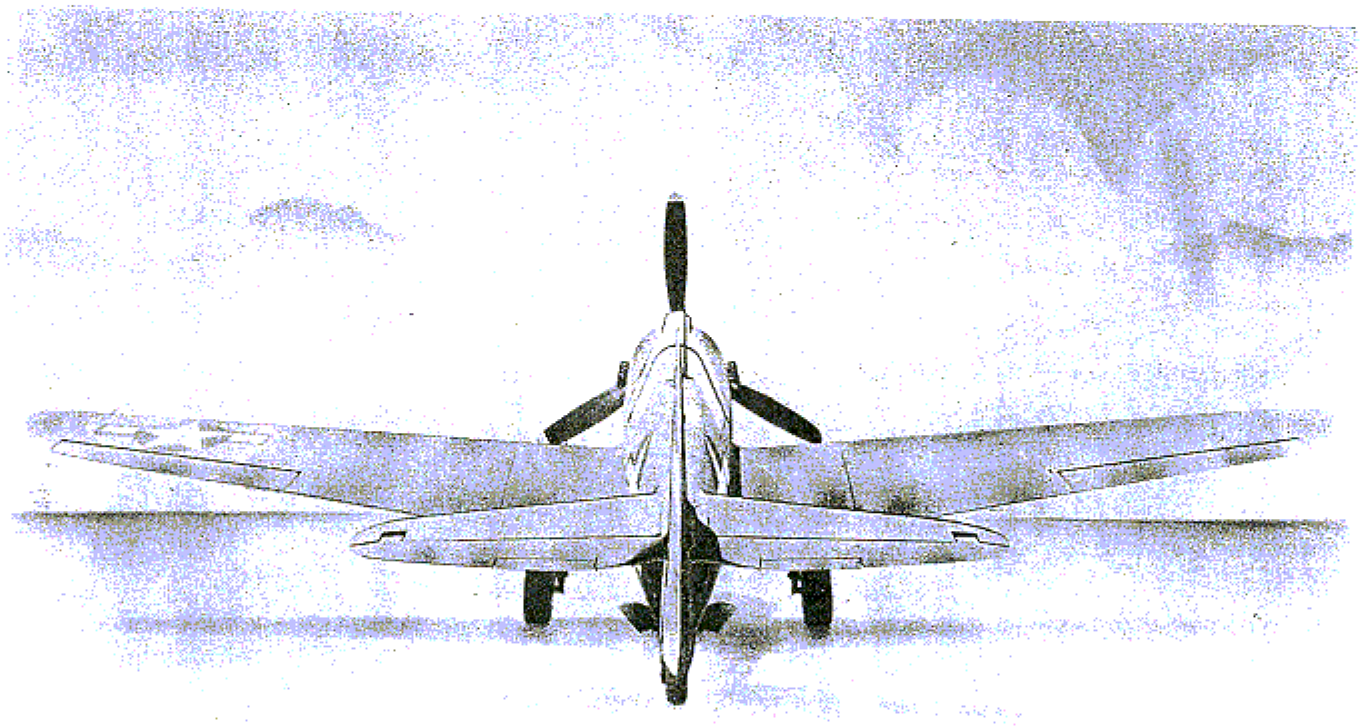


Figure 4—Rear View of P-40N Airplane

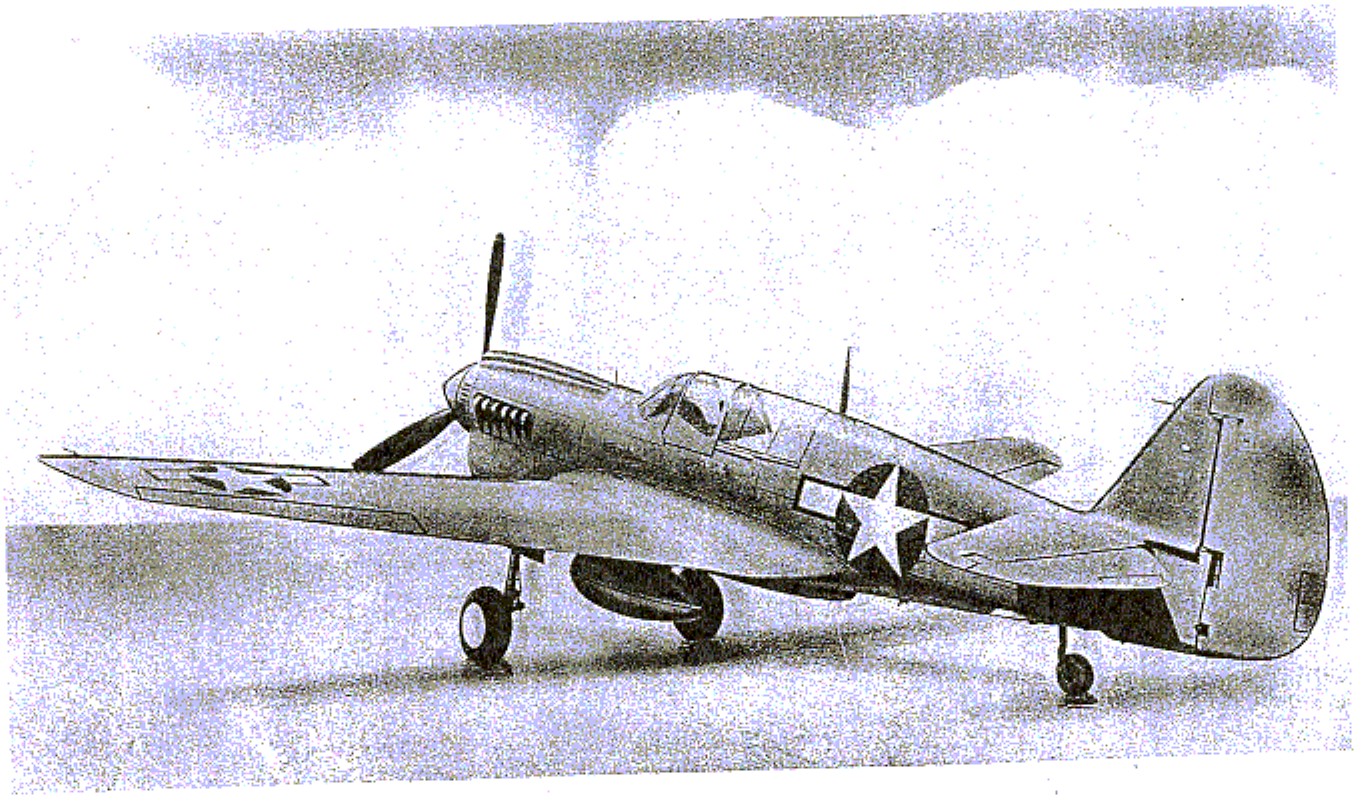


Figure 5—Three-Quarter Left Rear View of P-40N Airplane

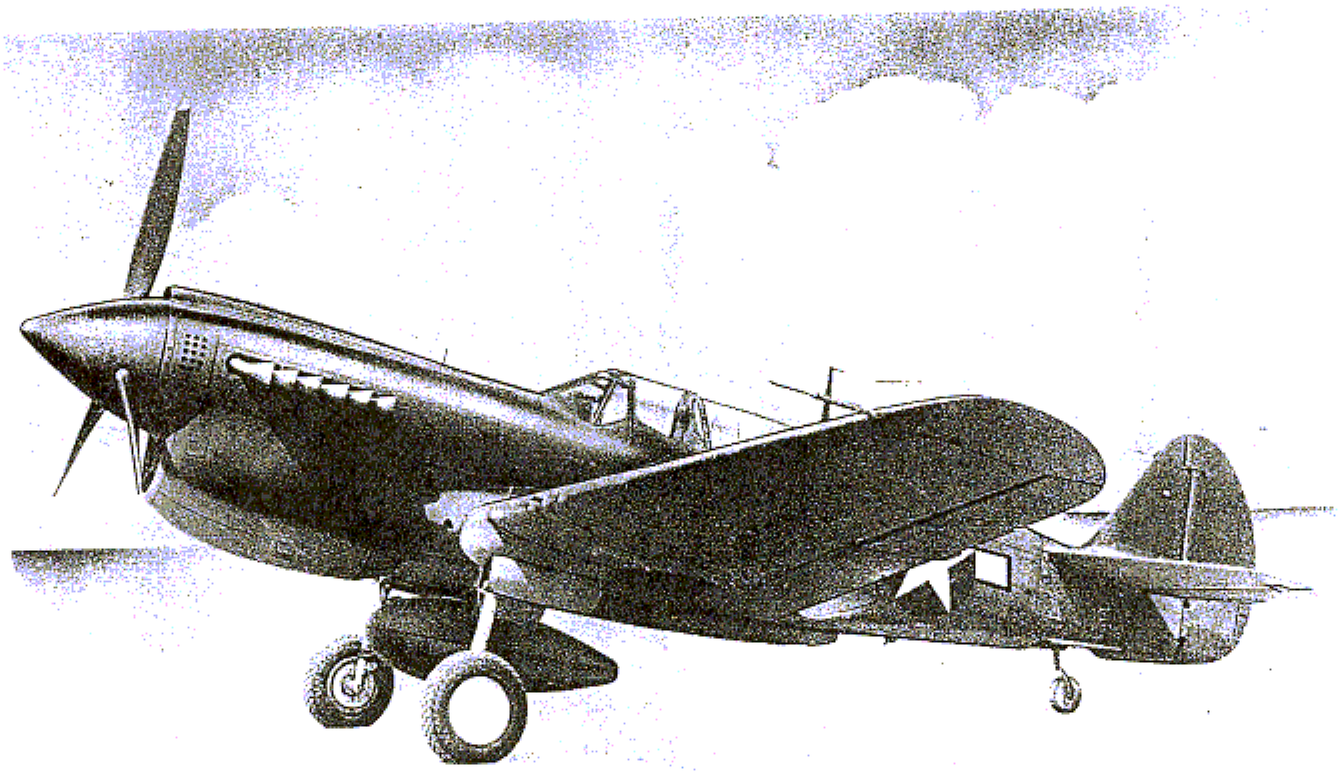
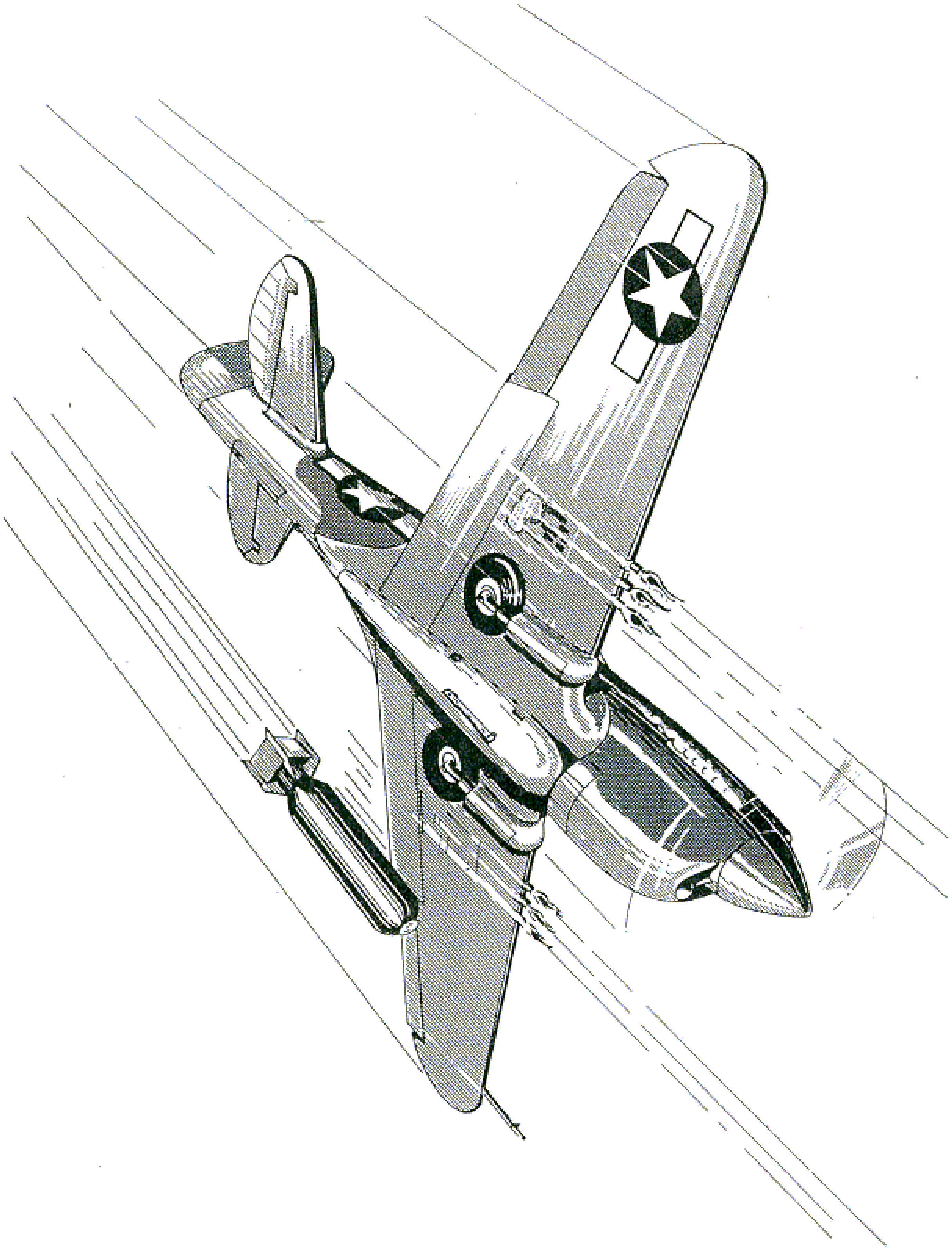


Figure 6—One-Quarter Left Front View of P-40N Airplane

TABLE OF CONTENTS



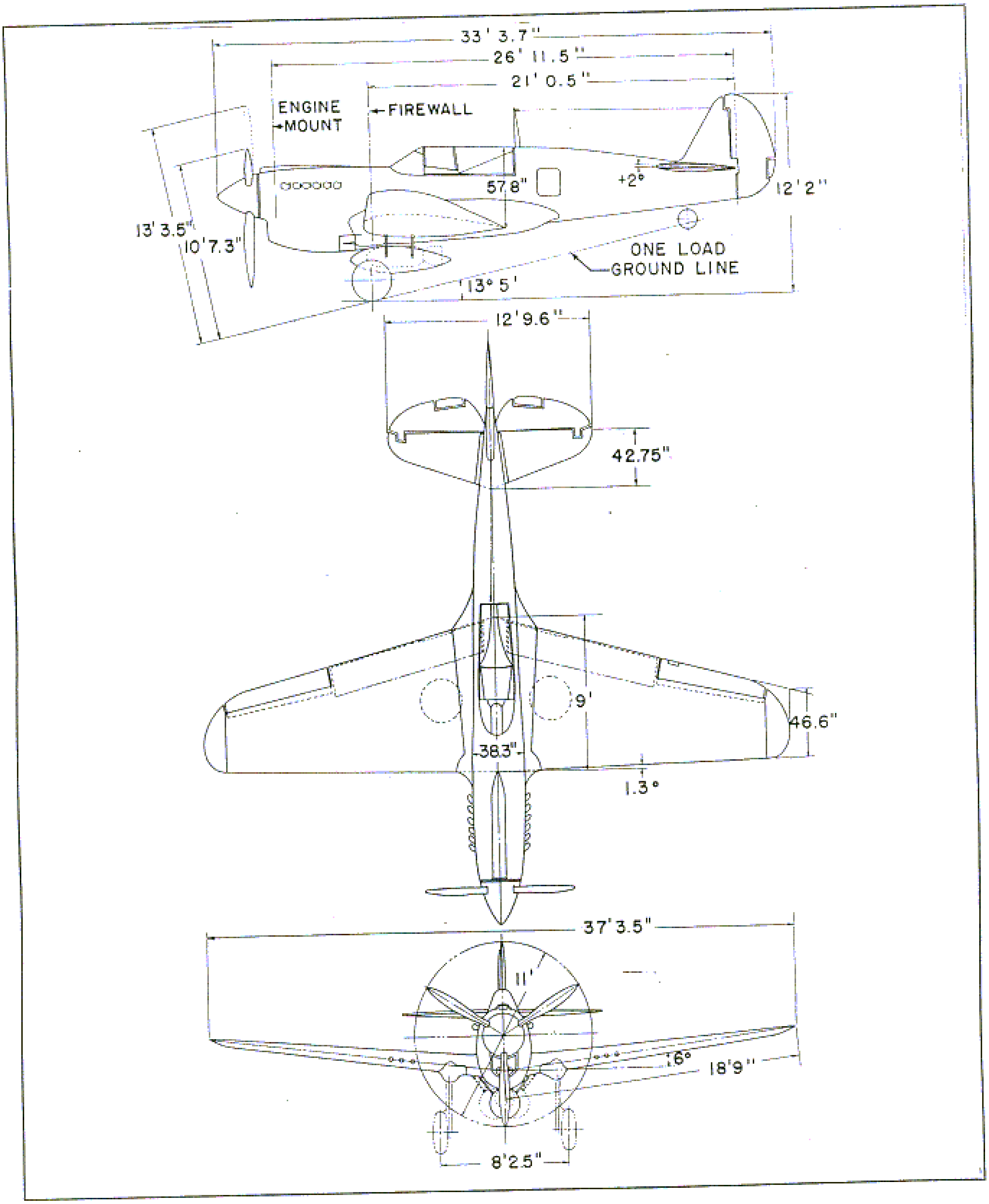


Figure 7—Three View Dimensions

SECTION I
DESCRIPTION, DIMENSIONS AND LEADING PARTICULARS

1. DESCRIPTION

The P-40N airplane is a single seat, low wing monoplane, designed for medium altitude pursuit and interception of hostile aircraft. It is powered with one 12-cylinder V-1710-81 (F-20R) Allison engine for airplanes AF42-104429 through AF42-106405, and one 12-cylinder V-1710-99 (F-26R) Allison engine for airplanes AF42-106406 and subsequent. Its armament consists of six .50 caliber machine guns. All guns fire outside the propeller disc.

2. DIMENSIONS.

Figure 7 gives the principal overall dimensions with the airplane in normal position at rest.

3. LEADING PARTICULARS.

The principal dimensions and data pertaining to the airplane are given in the following table:

PRINCIPAL DIMENSIONS

(Aircraft in level flight position unless otherwise stated.)

GENERAL	
Span	37 ft 3.5 in.
Length (overall)	33 ft 3.7 in.
Height	12 ft 7 in.
Height (tail wheel on ground, propeller blade vertical at top)	13 ft 3.5 in.
WINGS	
Airfoil Section (curve identification)	
N.A.C.A. 2215 at root	
N.A.C.A. 2209 at 197 in. from fuselage center line	
Chord at root	9 ft
Chord at wing tip	46.6 in.
Incidence	+ 1°
Dihedral (measured at leading edge of wing)	6°
Sweepback	1.3°
STABILIZER	
Span	12 ft 9.62 in.
Maximum Chord	42.75 in.
Incidence	+ 2°
FUSELAGE	
Width (maximum)	38.32 in.
Height (maximum)	57.81 in.
Length (without engine mount)	21 ft 0.5 in.
Length (with engine mount)	27 ft 11.5 in.

AREAS

WINGS (less ailerons)	217.70 sq ft
WINGS (total)	236 sq ft
AILERONS (total)	18.3 sq ft
FLAPS (total)	34.8 sq ft
STABILIZERS (including elevators)	30.86 sq ft
ELEVATORS (two) (including tabs)	17.44 sq ft
ELEVATOR TRIM TABS (total)	1.68 sq ft
FIN	7.0 sq ft
RUDDER (including tab)	13.74 sq ft
RUDDER TRIM TAB	.55 sq ft

SETTINGS AND RANGES OF MOVEMENT OF CONTROL SURFACES

STABILIZER	2° up from thrust line
FIN, OFFSET (measured from fuselage center line)	0°
AILERONS	
Up (from neutral)	18-3/4°
Down (from neutral)	10-1/2°
FLAPS	
Up	0°
Down	45°
ELEVATORS	
Up (from streamline with stabilizer)	30°
Down (from streamline with stabilizer)	20°
RUDDER	
Right (from streamline with fin)	30°
Left (from streamline with fin)	30°
TRIM TABS	
Elevators—Up (from elevator trailing edge)	3° ± 1°
Down (from elevator trailing edge)	26° ± 1°
Rudder—Right (from rudder trailing edge)	15° + 5° − 2°
Left (from rudder trailing edge)	15° + 5° − 2°
Aileron (AF42-104429 through AF43-24251)	
Left (fixed type)	Bent to suit on ground
Right (fixed type)	Bent to suit on ground

Aileron (AF43-24252 and subsequent)
  Left (one fixed and one electric type) .... Fixed type, bent to suit on ground; electric type, adjusted electrically from cockpit.
  Right (fixed type) .... Bent to suit on ground

TOLERANCE ON CONTROL SURFACE MOVEMENTS, UNLESS OTHERWISE SPECIFIED .... ± 2°

ALIGHTING GEAR

WHEEL TYPE ALIGHTING GEAR
  Type .... Hydraulically retractable
  Tread (width from center of tire to center of tire) .... 8 ft 2.5 in.
  Shock Struts (main)
    Type .... Single strut, pneumatic oleo
    Part No. .... 87-311-1000 (for 27-inch wheels)
    87-31-910-10 (for 30-inch wheels)
  Fluid Required
    Trade name identification (commercial) .... Lockheed No. 5
    AAF Specification 3586

WHEELS (main)
  (For airplanes AF42-104429 through AF42-104828) .... Hayes
  Type .... Hayes, 30 inch smooth contour drop center rim type, part No. H-3-159A
  Tire .... 30 inch, 8-ply Nylon casing, smooth contour, drop center type.
  Tire Pressure .... Inflate to inflation mark

WHEELS (main)
  (For airplanes AF42-104829 and subsequent)
  Type .... Hayes, 27 inch smooth contour, drop center rim type, part No. G-3-297M
  Tire .... 27 inch, 8-ply Nylon casing, smooth contour, drop center type
  Tire Pressure .... Inflate to inflation mark

BRAKES
  Type .... Hayes reversible, hydraulically operated, single shoe

TAIL WHEEL
  Type .... Hydraulically retractable
  Shock Strut
    Type .... Single strut pneumatic oleo
    Part No. 87-37-510
  Fluid Required
    Trade name, identification (commercial) .... Lockheed No. 5
    AAF Specification 3586

WHEEL
  Type .... Firestone 12.5 in. diameter, smooth contour, part No. CO 220-M
  Tire .... 12.5 in. diameter, 6-ply rayon smooth contour static conductor
  Tire Pressure .... Inflate to inflation mark

ENGINE

AAF Designation .... V-1710-81 (airplanes AF42-104429 thru AF42-106406)
  V-1710-99 (airplanes AF42-106407 and subsequent)

Gear Ratio (engine to propeller) 2 to 1

Fuel .... Specification AN-F-28 Amendment No. 1 100 octane

Oil .... Specification AN-VV-O-466
  Summer grade 1120
  Winter grade 1100

PROPELLER

Manufacturer .... Curtiss Propeller Division, Caldwell, New Jersey
Type (three blades) .... Electrically controlled Constant speed
Model No. C532D-F84
Hub Assembly No. 111107-3
Blade No. 89303-24W
Diameter .... 11 ft 0 in.
Governor Control No. 100,008-1G
Pitch Setting (measured at 42 inch station)
  Low (fine) .... 24.5°
  High (coarse) .... 54.5°

TANK CAPACITIES

	GALLONS (EACH)
FUEL TANKS	
Front Wing Tank	34 US (28.3 Imperial)
Rear Wing Tank	54 US (44.9 Imperial)
Fuselage Tank	66 US (54.9 Imperial)
*Belly Tank	75 US (62.4 Imperial)
*Belly Tank	150 US (125 Imperial)
Total Fuel (with 75 US (62.4 Imperial) gallon belly tank)	229 US (190.6 Imperial)
Total Fuel (with 150 US (125 Imperial) gallon belly tank)	304 US (253.1 Imperial)

*Either tank installed depending upon flight mission.

OIL TANK (service capacity)	8.7 US (7.3 Imperial)
Expansion space	1.3 US (1.04 Imperial)
Total Oil	8.7 US (7.3 Imperial)
COOLANT EXPANSION TANK	3.5 US (2.9 Imperial)

SECTION II
SHIPMENT AND ERECTION PROCEDURE

1. SHIPMENT OF AIRCRAFT.

a. CRATING.—Each airplane is shipped in two wooden crates. The larger crate contains one complete wing panel with landing gear installed. (See figure 8.) The wing panel crate also contains the following items: wing tips, pilot's seat, wing fillets, rudder, stabilizers and elevators, fin, tail fillet, propeller nose cone, propeller, a small box of propeller parts, another small box containing the propeller power unit, a box of loose equipment, box of SCR-274-N radio parts, box of SCR-522-A radio parts, drain line casting screws, Shortage Form CWB497, and a 150 US (125 Imperial) gallon belly tank.

The small crate (figure 9) contains the fuselage with engine installed including engine and radiator cowling attached, the windshield and cabin enclosure assembled. The fuselage is bolted to a stand which in turn is bolted to the floor of the crate. The fuselage crate also includes the following items: engine oil, ethylene glycol (coolant fluid), station 5 armor plate, hydraulic fluid, 75 US (62.4 Imperial) gallon belly tank, radiator exit air duct, special repair material, two blister fillets, engine and cockpit covers, a box of loose equipment and the keel cowl.

b. UNCRATING THE PANEL BOX.—The first crate to be dismantled is the wing panel crate. There are severals ways the panel crate may be disassembled, and the contents removed, but the following procedure is recommended: Remove the upper and lower halves of one side in the order mentioned, and then take off the upper half of the other side. Take out as much of the equipment as possible, which should include the wing fillet units since they are fastened to both the sides and top of the crate. Next, remove the top and take out the 150-gallon belly tank. After removing the belly tank, take off the lower half of the remaining side and remove the remaining equipment.

CAUTION

Use care to avoid striking exposed nails or bolts when removing parts from the crate.
Be very careful not to drop the 150-gallon belly tank. This tank is not made of metal and is easily damaged.
All parts should be tagged immediately after removal from the crate. The tag should contain the name, part number, and number of airplane to which they should be assembled.
Use care to avoid misplacing small parts such as screws, bolts, nuts, washers, etc.

Take off both ends of the crate, and the wing panel is ready for removal.

c. WING HOISTING.—Attach the wing hoisting sling (part No. 87-88-509) to the panel. One hoisting sling is sent with every fifth airplane and the case containing the sling is marked on the outside. To attach the sling, secure the two sliding plates marked "REAR" to the rear of the panel tee sections. There are two studs in each plate. Match the stud marked "24TH HOLE" with the 24th hole from the front of the tee section. (See figure 10.) Do NOT attach the other two plates marked "FRONT". Hoist the wing clear of the crate in a vertical position. With about 20 men holding the leading edge, the wing may be lowered to a horizontal position and the two "FRONT" plates of the hoisting sling fastened in their respective positions. The stud marked "4th HOLE" should be inserted in the 4th hole from the front of the panel tee section. The wing should then be lowered to a wing cradle or some other support that will retain it in a horizontal position. The weight of the wing assembly is approximately 2600 pounds.

d. UNCRATING THE FUSELAGE BOX. — Remove the top and both sides in the order mentioned. Remove the two blister fillets from the aft end of the crate, and the engine and cockpit covers from the forward end. Remove both ends of the crate. Take out all the loose equipment.

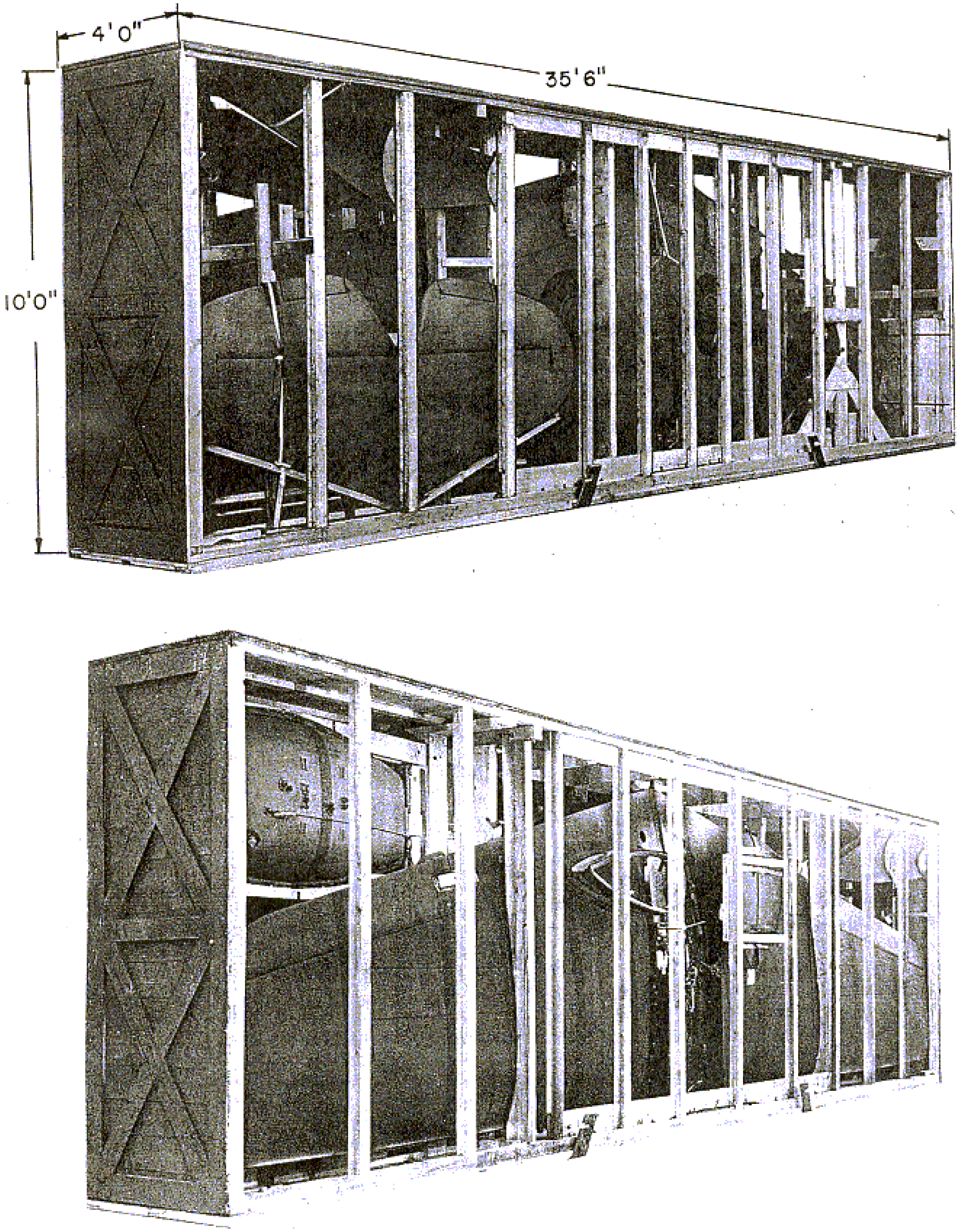


Figure 8—Wing Panel Crate—Left and Right Views

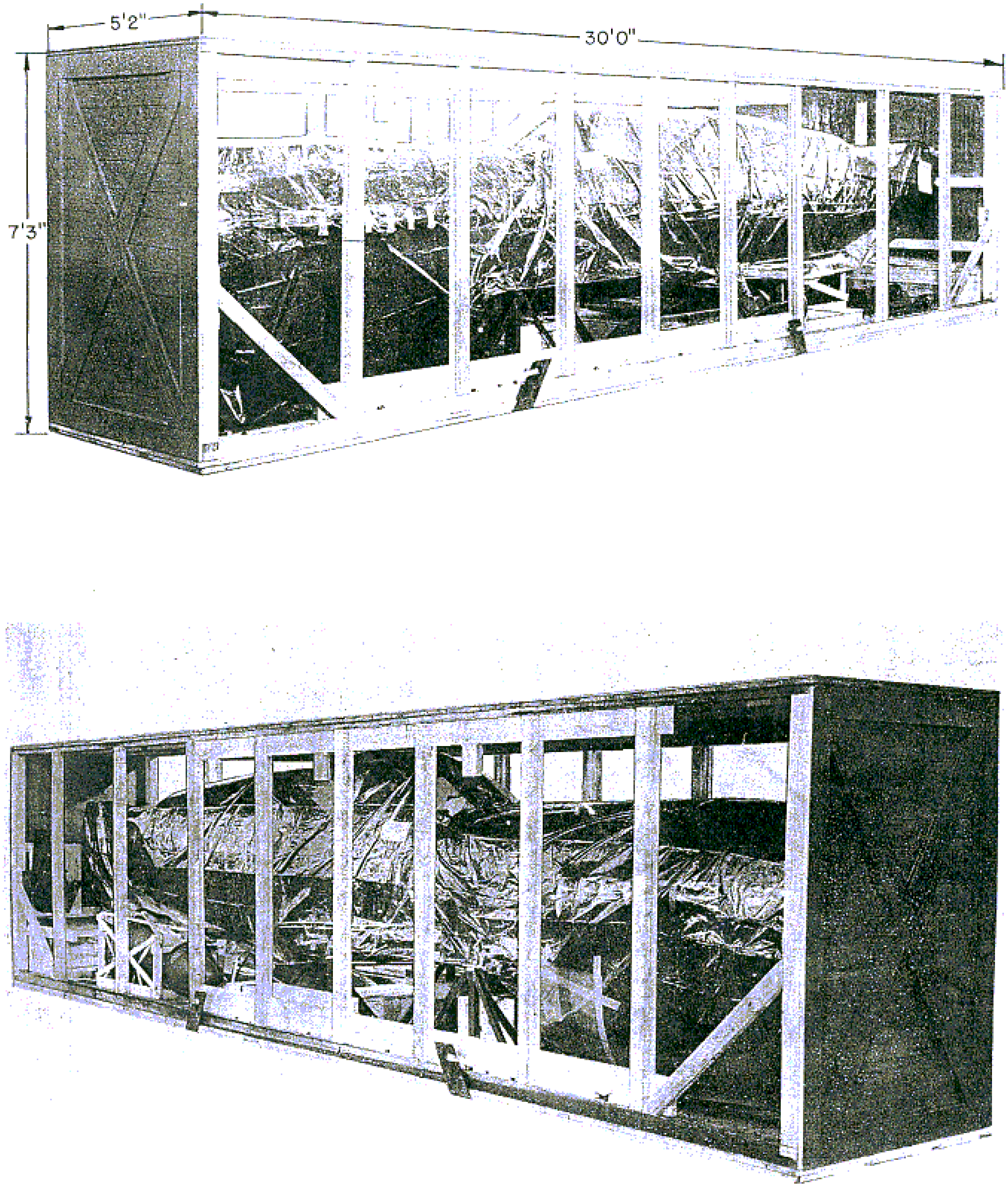


Figure 9—Fuselage Crate—Left and Right Views

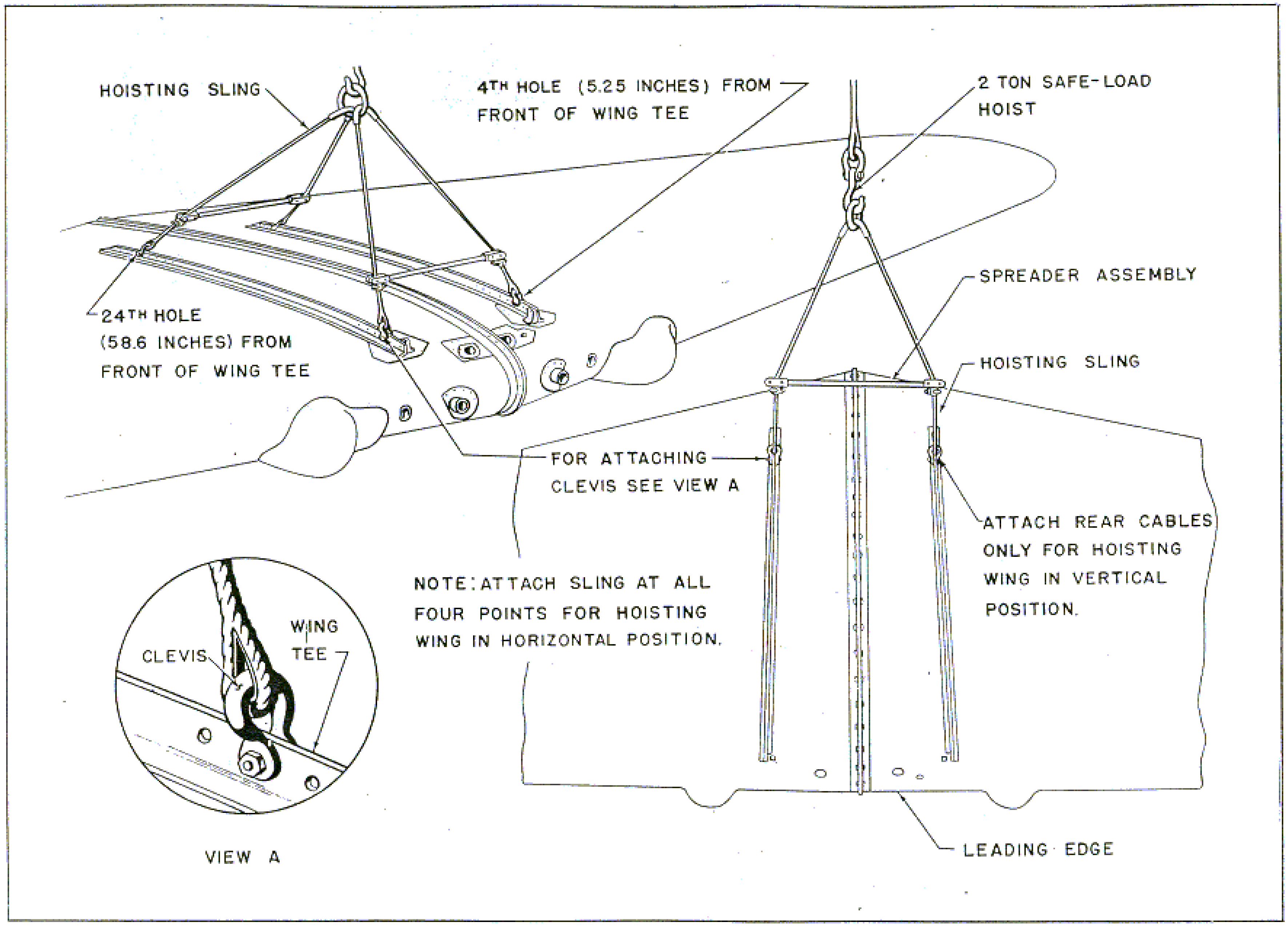


Figure 10—Wing Hoisting

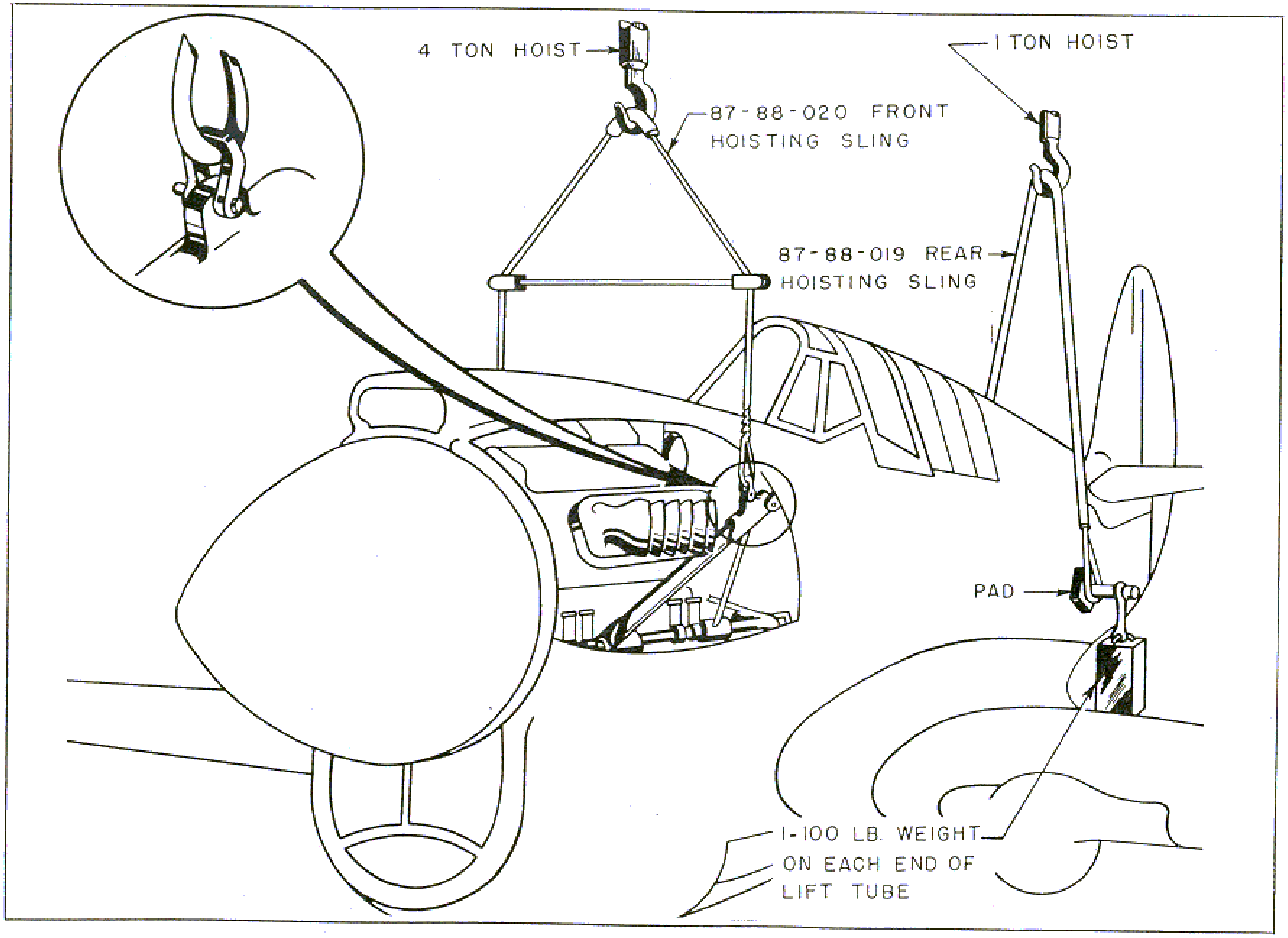


Figure 11—Fuselage Hoisting

e. FUSELAGE HOISTING.—Remove the side engine cowl from both sides of the fuselage and attach the front hoisting sling to the lugs provided on the engine mount. (See figure 11.) Insert a bar about 3-1/2 feet long through the lift tube at the rear of the fuselage, attach the rear hoisting sling, and hang a 100-pound weight on each side of the bar. Attach the front and rear hoisting slings, each to a hoist, and take up the slack in both sling assemblies. Remove the bolts holding the fuselage to the metal stand, and hoist the fuselage clear of the crate.

Two traveling hoists at least 18 feet high should be available for hoisting the fuselage. The hoist at the forward end of the fuselage should have a capacity of two tons if only the fuselage is to be hoisted, and four tons if the complete airplane is to be hoisted. The hoist at the aft end should have a capacity of one ton.

WARNING

The tail lifting bar must be passed completely through the lift tube in the fuselage and the tail raised by lifting both ends of the bar, otherwise serious strain and damage to the fuselage may occur.

Never use the stabilizer for lifting the aft end of the airplane.

If the tail is raised to flight position, two 100-pound weights should be hung on the lifting bar, one on each side of the fuselage. Do not weight the tail of the airplane by putting sand bags on the fuselage itself.

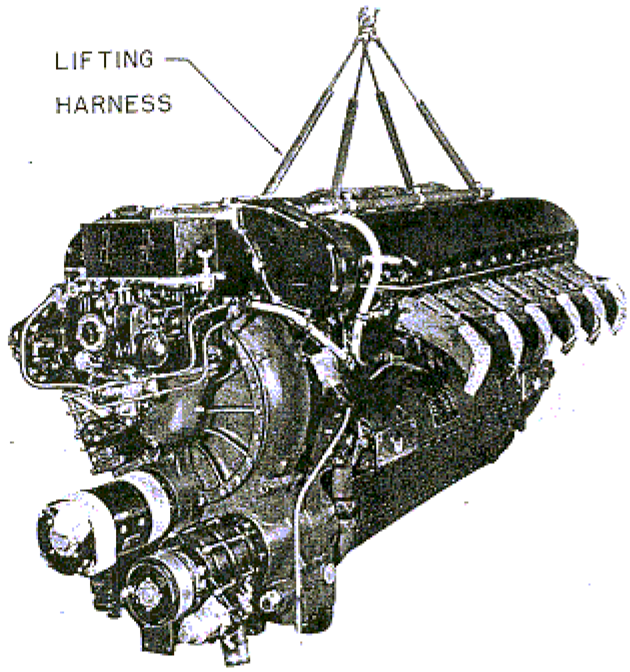


Figure 12—Engine Hoisting

An engine hoisting sling is furnished by the engine manufacturer. By attaching the sling to the studs which hold the cylinder heads to the crankcase, the engine may be raised. (See figure 12.) Do not attempt, under any circumstances, to hoist the airplane by means of the engine hoisting sling attached to the engine. This sling is for the installation and removal of the engine only.

2. ERECTION.

a. When lowering the fuselage onto the wing, exercise great care to avoid damage to contacting parts. Three men are required to insure proper handling.

b. The inside surface of the tee sections on the wing and the corresponding surface of the fuselage should be coated with a light grease before assembly.

c. One man should be placed on top of the wing and the fuselage lowered over him. He should watch the front and the rear to see that the various units in the cockpit are not damaged as the fuselage is lowered onto the wing.

d. Units to be watched carefully are:

(1) ELECTRICAL WIRING.—Make sure that none of the electrical wiring is caught between the tee sections of the wing and fuselage.

(2) HYDRAULIC, FUEL AND OIL LINES.—Watch all hydraulic, fuel, and oil lines to see that they are not pinched or damaged in any way, if the fuselage should swing or sway when it is being lowered onto the wing.

(3) FIREWALL. — The firewall should be watched to see that it does not strike the wing.

(4) OIL "Y" DRAIN COCK.—Do not let the fuselage swing back far enough so that the "Y" drain will strike the wing. If it does, the "Y" drain may be bent or torn loose from its hose connections.

(5) HEATING AND VENTILATING INTAKE DUCTS.—Be careful that the intake ducts are not damaged in any manner while the fuselage is being lowered into position.

(6) MATCH ANGLE.—Be careful of the small part of the match angle which extends beyond the trailing edge of the wing, to insure that it is not damaged in any way.

e. Lower the forward end of the fuselage slightly in advance of the rear, so the front fittings at station 1 may be engaged first. Then align and insert the bolts. Next, lower the fuselage until the remainder of the holes are aligned. Insert a pair of trailing-edge bolts, and the intermediate station (bulkhead) bolts. Insert and tighten evenly the remainder of the bolts. Insert the three bolts attaching the trailing edge of the wing to the fuselage (center).

Note

The nut for the last bolt may be tightened through a hole in the surface of the wing by opening the wing flaps.

f. The tail of the airplane may now be supported from the lift tube bar by two stands, one on each side of the fuselage, leaving the weights in place, and then removing the rear hoist. Next, the front hoist may be removed and the front supported by jacks.

g. The following is a list of installations and connections to be made after the wing and the fuselage are assembled:

Note

Complete instructions for installing the following items are contained in section IV.

(1) Install the stabilizer.

(2) Install the fin.

(3) Install the rudder and elevators.

(4) Connect the elevator push-pull link to the elevator horn and attach the rudder control cables to the rudder horn.

(5) Connect the rudder and both elevator trim tab control flexible shafts at their disconnect fittings at the rudder and elevators.

(6) Connect the navigation light wire from the fin to the terminal block on the bulkhead at fuselage station 13.

(7) Check all cable tensions after rigging the tail surface controls. (See figure 215.)

(8) Connect the hydraulic lines to the hand pump.

(9) Connect the hydraulic lines from the brake master cylinders to the brake hydraulic lines at their disconnect fittings on the top surface of the wing.

(10) Connect the hydraulic lines from the hydraulic system control valve to the wing flap, and the landing-gear hydraulic lines at their disconnect fittings on the top surface of the wing.

(11) Fill the hydraulic reserve tank in the fuselage, aft of the fuselage access door, with hydraulic fluid, AAF Specification 3586. A container of hydraulic fluid is shipped in a separate box packed in the fuselage crate. Substitutes may be a mixture of 50 percent castor oil and 50 percent butyl monohydroxyethyl ether or, if not available, use 50 percent castor oil and 50 percent diacetone alcohol.

(12) Check the landing-gear and tail-wheel retracting units.

(13) Make the electrical connections for the wing at the junction boxes, one on each side of the cockpit.

(14) Install the propeller. (See section IV, paragraph 6, for complete instructions.)

(15) Connect the air-speed indicator lines.

(16) Install the pitot tube and make the necessary electrical connections.

(17) Install the fuel selector valve control rod through the leading edge of the wing panel. When installing the fuel selector valve control rods, be certain the rods line up before fastening them in position. Each rod link is marked with a scribed line or a red painted line running lengthwise of the rod. When installing the control rod links, these marks should line up before fastening the rods in position.

(18) Connect the aileron cables and check the cable tension and aileron travel.

(19) Install the wing tips.

(20) Install the tail fillets.

(21) Install the wing fillets.

(22) Clean the cockpit thoroughly of all foreign matter.

(23) Remove all engine cowling.

(24) Remove the protective oil coating from the power plant with kerosene in a spray gun.

(25) To completely remove the corrosion preventive agent (CLO Mix) from the inner parts of the engine, it will be necessary to clean the oil screens and pre-oil the engine in accordance with section II, paragraph 5.

(26) Install the air exit duct.

(27) Attach the engine cowling.

(28) Attach the keel fairing beneath the wing.

(29) Give the airplane a complete "Preflight", "25 Hour", and "50 Hour" inspection before its original "Test Flight".

3. RIGGING.

a. WING RIGGING.—The following items need not be checked as they have to do with characteristics that are rigidly built into the structure and cannot be altered: dihedral, incidence, and sweepback.

b. LANDING GEAR ALIGNMENT.—The landing wheels should be checked for excessive toe-in, and any correction that is necessary should be accomplished.

4. ENGINE—PACKING AND UNPACKING.

a. GENERAL.—The engine is shipped from the engine contractor's plant in a wooden shipping crate of the following dimensions 36-1/2 x 55-5/16 x 112 inches. The crate consists of two parts: the upper section or cover, and the lower section or base which supports the engine. It also contains cartons of spark plugs and a tool kit as indicated by the packing list. The weight of the crate alone is 850 pounds; shipping weight of engine and crate is 2200 pounds.

b. PACKING.

(1) These engines are packaged for shipment and storage in a pliofilm envelope. As a precautionary measure, 12 bags and numerous dehydrator plugs containing MOISTURE ABSORBING SILICA-GEL, Specification AN-O-S-366, are placed at various points around the engine within the envelope. The seal must not be broken on the envelope until the engine is to be placed in the airplane for service, unless inspection of the humidity indicator within the envelope has shown the necessity of replacing the silica-gel.

Visual inspection of the humidity indicator must be made just prior to shipment and every two weeks thereafter. Whenever the color indicates a moisture content of over 20 percent as shown on figure 13, replacement of silica-gel containers will be necessary.

(2) The engine is securely bolted with eight engine hold-down bolts to the engine cradle which is part of the engine crate base. The cover or upper section of the crate is lowered over the engine. Extreme care must be used not to damage the envelope or engine's protruding parts. The cover is securely attached to the base by four bolts passing through the lower ends of lifting straps and the upper ends of mating straps on the base.

Note

When a lifting hoist is not available, the lifting loops on each end of the crate permit the use of two bars to lower or raise the cover manually.

(3) In the accessory end of the upper section of the shipping crate, an inspection window is provided for view of the humidity indicator. Whenever placed in storage, the crate will be so positioned as to make the window accessible for bi-weekly inspection of the coloring progress of the cobalt chloride impregnated silica-gel in the humidity indicator. (See figure 13.)

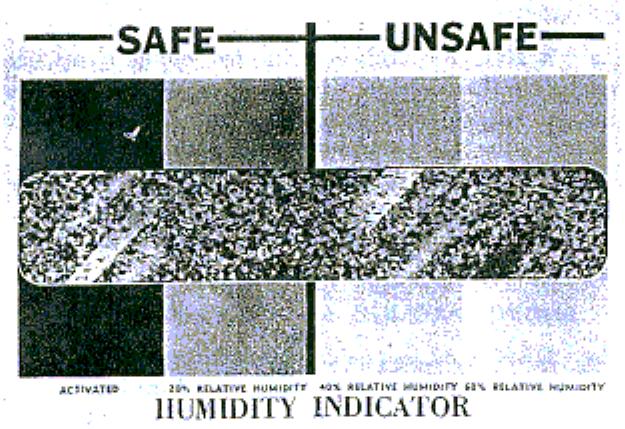


Figure 13—Humidity Indicator

Record the date of the original inspection and each subsequent re-preservation in the spaces provided on the end of the crate.

c. UNPACKING.

(1) To remove cover from the base of the engine shipping crate, unscrew the four clamp bolt nuts on both ends, thereby separating the two sections of the crate. Attach a lifting harness to the four hooks at the top of the lifting straps as shown in figure 14. Lift cover off the base slowly, using extreme care to avoid damaging any part of the engine.

(2) Remove the pliofilm envelope and the canvas shipping cover. Remove the 12 silica-gel bags from around the engine. Remove silica-gel bags from carburetor. Remove the carton of spark plugs, tool kit and packing list from the crate base. (See figure 15.)

(3) Attach a four-legged engine harness to engine in the following manner: Hook the lifting ring to the hoist, then pass two of the harness cables forward through the vee space between the right and left cylinder banks, extending them out and around the front end of the cylinder blocks and hook them down to the front outer cylinder hold-down bolts of each block. The same procedure will be followed with the other two harness cables, passing them out through the vee space to the rear of, and around the two rear cylinders, and hooked down to the rear outer cylinder hold-down bolt of each cylinder block. (See figure 12.)

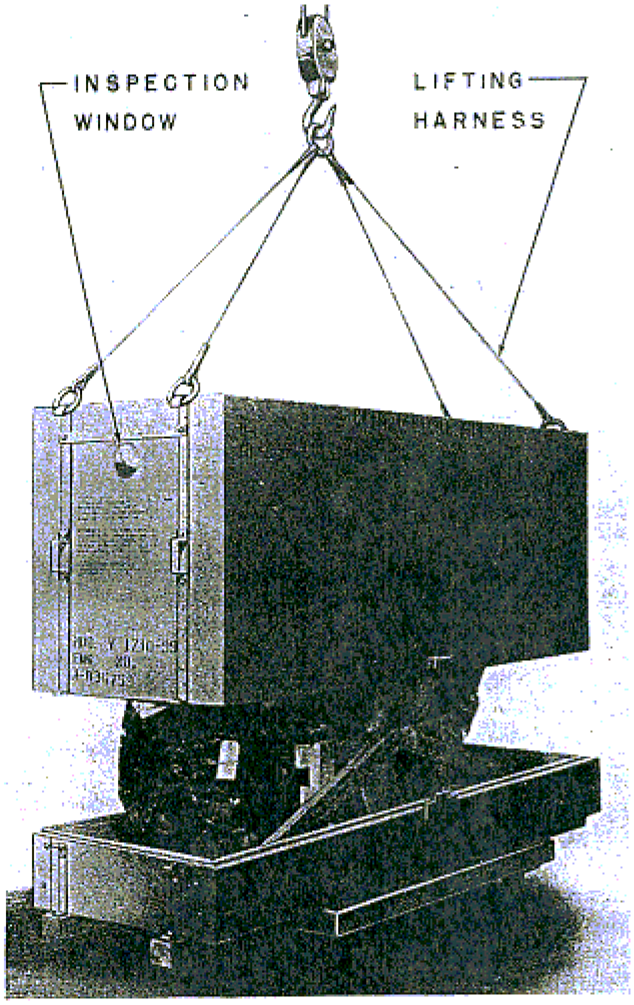


Figure 14—Removing Cover From Engine Crate

(4) Remove engine hold-down bolts and slowly hoist engine out of the cradle. Prevent the engine from swaying to avoid damage.

While suspended, and before transferring the engine to the engine mount, carefully inspect for possible damage that may have occurred in transit or during unpacking.

5. PREPARATION OF ENGINE FOR SERVICE.

a. GENERAL.—Engines which have been unpacked and are to be installed in the airplane and placed in service, will be prepared for service in accordance with this paragraph. It will be more convenient to perform operations (one through eight), before the engine is installed in the airplane.

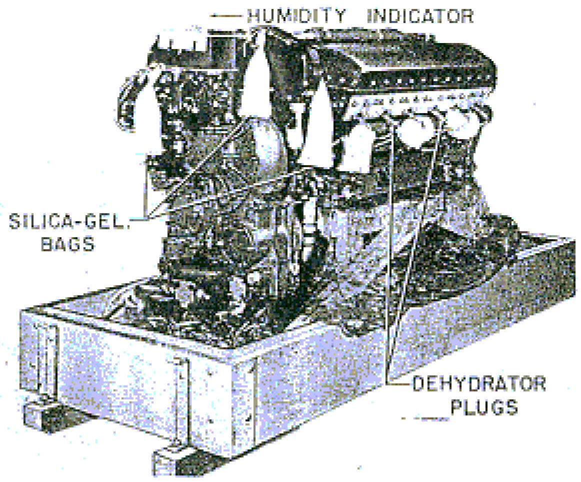


Figure 15—Pliofilm Bag Removed Showing Dehydrating Units

b. PREPARATION.

(1) Remove cylinder bore dehydrator plugs from the spark plug holes. Before installing the spark plugs, slowly rotate the crankshaft three or four revolutions, and with valve covers removed, observe for proper operation of the valve mechanism. Any valves that are found to be sticking shall have the stems generously lubricated with a mixture of gasoline and lubricating oil. Continue to turn the engine over by hand until all evidence of sticking valves has been eliminated. Also, make certain that there is no evidence of CLO mix in the cylinders.

Note

CLO mix is the designation of a corrosion preventive mixture that is used by the engine contractor in preparing the engine for storage during shipment. CLO mix consists of corrosion-preventive compound, Specification AN-VV-C-576 one part, and lubricating oil, Specification AN-VV-O-446, grade 1120, three parts.

(2) If all valve mechanisms are operating properly, the valve covers will be reinstalled, using new gaskets to prevent possible oil leaks.

(3) Install the exhaust stacks and shrouds on the outside of each cylinder block exhaust port, making sure the stack gaskets are properly placed.

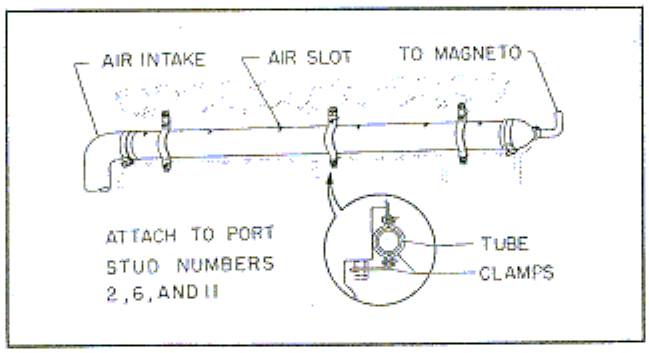


Figure 16—Installation of Spark Plug Cooling Manifold

(*a*) Mount the right and left exhaust spark plug cooling manifolds on the engine by securing them to the three right and three left hand bracket assemblies respectively. These brackets will be secured to the lower flange studs of numbers two, six, and eleven exhaust ports by the brass flange nuts, and to the three long studs in the coolant jacket upper flange by plain and pal nuts. (See figure 16.) The six air exit slots in each of these air manifolds will be lined up with each of the six exhaust spark plugs in each cylinder bank. The magneto cooling tube extensions will be attached to the rear end of each spark plug cooling manifold and through their brackets, to the dual magneto for cooling purposes.

CAUTION

Use care in the removal of dehydrating plugs. If any are broken and the silica-gel therefrom falls into the engine, the affected section of the engine must be disassembled and cleaned.

(4) Remove the dehydrator plug from the reduction gear front case, and replace with the standard 3/4-inch pipe plug which is supplied with the engine. Safety wire the plug.

(5) Remove all other dehydrator plugs, covers, etc., which have been used to seal the various engine openings.

(6) Wipe off the breaker mechanism of the magneto thoroughly. Then lubricate the magneto breaker mechanism felt pad with light engine oil until the felt barely oozes when squeezed with the fingers.

(7) Remove the oil strainer, immerse in unleaded gasoline, wash without rotating the strainer, and then blow out with compressed air. Repeat this operation until the strainer is thoroughly clean. Following this cleaning procedure, the discs of the strainer should be lubricated by immersing in clean engine oil, and blowing with compressed air. Then reimmerse the cartridge in engine oil. Clean the oil strainer compartment of the engine and then install the strainer using new strainer gasket.

CAUTION

Some engines are equipped with the Cuno oil strainer. This oil strainer must not be rotated while removed from the engine, as damage may result from possible twisting of the strainer cartridge. The cartridge may be rotated several revolutions after installation, by means of turning the shaft nut.

(8) The engine oil screens, located in the front and rear oil drain elbows on late model engines, require removal of the elbows to clean the screens. Both screens and elbows will be cleaned in unleaded gasoline.

(*a*) Replace screen. Install through bolt, washer and castellated nut, tighten and safety nut with cotter pin.

(*b*) Before reinstalling the elbow, the rear flange of the oil pan and oil pump adapter should have the old gaskets removed and thoroughly cleaned.

(*c*) Install new gaskets and locate drain elbow into position. The four cap screws and the four plain nuts should be tightened finger tight.

Note

It is important that the following tightening procedure be followed closely to prevent the elbow from being misaligned with resultant possible oil leakage.

(*d*) First, tighten the four cap screws into the oil pan to approximate final tension.

(*e*) Fill carburetor with fuel by careful inter- nuts on the oil pump adapter studs to a torque reading of 70 to 80 inch-pounds.

(*f*) After the stud nuts are tightened, release tension on all four cap screws in oil pan, and retighten to a torque reading of 90 to 100 inch-pounds. Safety the cap screws with lock wire and install pal nut over the plain nuts.

Note

The same general procedure of removal and installation applies to the front or reduction gear case oil drain elbow.

The remaining operations of engine preparation will be performed after the engine has been installed in the airplane.

(9) After all controls and fittings are connected on the carburetor, the carburetor will be filled with fuel and vented in the following manner:

(*a*) Turn the fuel tank selector valve to full tank.

(*b*) Set mixture control in "AUTO RICH" and advance the throttle to half open position on the engine control quadrant in the cockpit.

(*c*) Fill carburetor with fuel by careful intermittent use of the boost pump. Only short bursts of fuel pressure, not over five pounds per square inch, should be applied so that cracking of the carburetor diaphragms will be avoided. Operate the boost pump until fuel appears at the supercharger drain. (See figure 17.)

(*d*) Any air which was trapped during the carburetor filling operation will be vented by removing the 1/8-inch pipe plug on top of the regulator nearest to the carburetor throttle body. Continue to operate the fuel pump until fuel stands level with plug opening. Then replace the plug. (See figure 18.) Immediately return the fuel selector valve to "OFF" to prevent possibility of fuel draining back from the carburetor into the tank.

(*e*) Allow carburetor to set from 8 to 10 hours to permit the diaphragms to become flexible.

(10) The following pre-oiling procedure must be performed on all engines being placed in service to insure proper lubrication at the initial start.

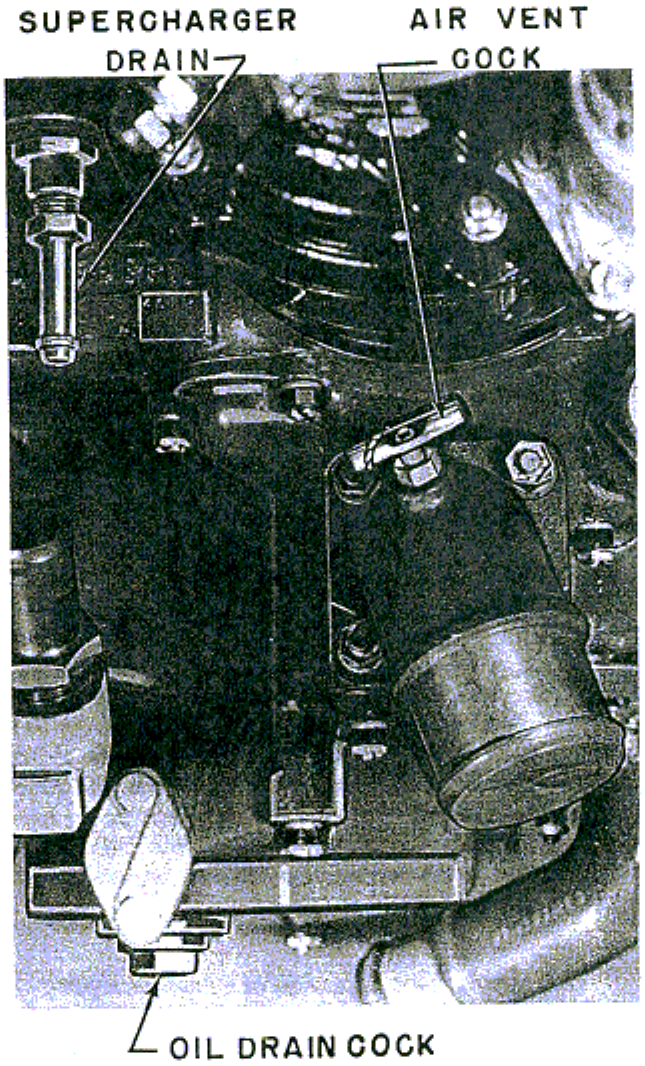


Figure 17—Supercharger and Oil Pump Drain

(*a*) Fill oil tank to proper level.

(*b*) Open air vent cock on oil inlet connection at the oil pump. Bleed the air and establish a steady oil flow to that point. (See figure 17.)

(*c*) Close oil line vent cock and remove drain plug from bottom of rear oil drain elbow. (See figure 17.)

(*d*) Remove all exhaust (outside) spark plugs from both cylinder banks, if they have been previously installed.

(*e*) Place mixture control in "IDLE CUT-OFF" position.

(*f*) Place fuel valve in "OFF" position.

(*g*) Make sure the ignition switch is "OFF".

(*h*) Make "dummy" starts of engine using a portable energizer or external battery source until approximately one gallon of oil drains from the drain plug opening.

(*i*) Replace drain plug and safety wire.

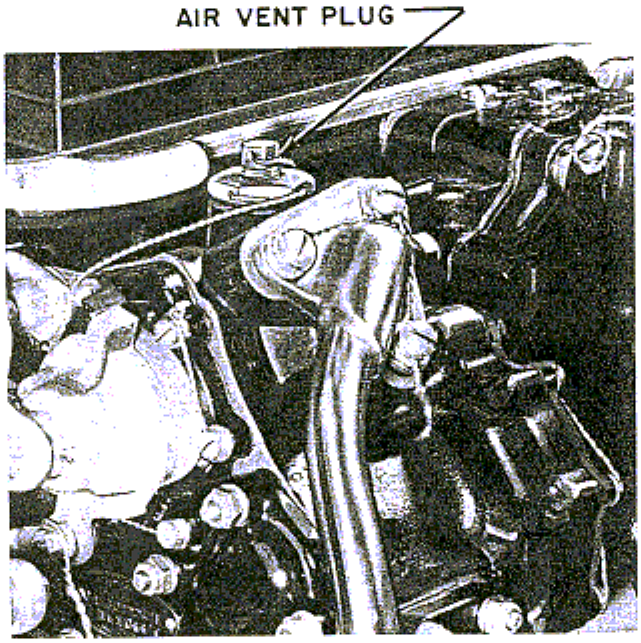


Figure 18—Carburetor Air Vent Plug

(11) Install propeller and hub assembly on the new engine, and tighten and prepare for test flight in accordance with section IV, paragraph 6.

(12) Install all spark plugs, using only solid copper gaskets. Lubricate plug threads with lubricant, Specification AN-VV-C-566.

(13) Fill the coolant expansion tank and system to the proper level. Check all connections for leaks.

(14) Recheck the oil tank level for sufficient oil to operate the engine safely during warm-up. In general, one-half of the tank capacity will be sufficient for the purpose.

(15) After the engine has been properly pre-oiled, it will be started, warmed up, and ground tested in accordance with procedure in section III, paragraph 3.

(16) Upon completion of ground tests and while the engine is still warm, the engine oil system, including the oil cooler, oil supply tank and lines, will be completely drained. This oil drainage is made to clean the engine of excess CLO mix and sludge that may have accumulated during the period of shipment or storage. The oil, drained out after the ground test, is not suitable for further use because the CLO mix in the oil would cause rapid sludging during subsequent engine operation.

(17) Refill the system and prepare the airplane for a flight test of one hour duration in the vicinity of the air base. The first 50 minutes will be at reduced power and the final 10 minutes at normal rated power, followed by a careful inspection for evidence of any visible defects, or malfunctioning parts.

SECTION III
HANDLING AND GENERAL MAINTENANCE INSTRUCTIONS

1. ACCESS AND INSPECTION PROVISION.

a. Access doors and their relative station positions are shown in figures 19 and 20. These doors provide access for inspection, adjustment and servicing purposes.

2. GROUND HANDLING.

a. TOWING.—Two tow rings are provided for handling the airplane on the ground, one located on the forward side of each landing gear axle. (See figure 21.) If a tow bar is not at hand, a rope may be used. The rope should be 30 feet long and at least one inch in diameter. During the towing operation, one or more men will be placed at the tail and at each wing tip to insure that the airplane will clear any obstructions that may be in its path. When towing the airplane with a rope, there must be a man in the cockpit to operate the brakes.

b. HOISTING.—Refer to section II, paragraph 1. *c.* and 1. *e.*

c. JACKING ARRANGEMENT.

(1) There are three jacking points to support the airplane while checking the landing gear and tail wheel retracting mechanism. One jack point stud is located on the under surface of each wing panel inboard of the landing gear and one jack point on the bottom of the fuselage aft of the tail wheel.

(2) Additional jacking points are located on the bottom of each towing ring, on the inboard side of the landing gear axle, to support the forward end of the airplane while servicing the wheels and brakes.

d. LEVELING.

Six leveling lugs are located on the two longerons which form the cockpit sill. Two lugs for longitudinal leveling are located in the longeron on the right side, and two lugs for gun leveling are similarly located on the left side. The two lugs for lateral leveling are located on the sill, right and left sides immediately aft of the windshield. (See figure 22.) A 1/8-inch hole is drilled in the nose cone of the propeller spinner, concentric with the center line of the spinner, and a nut plate having No. 10-32 threads is located on the center line of the fuselage just forward of the tail wheel doors, for plumb bob attachment when sighting the guns or leveling the airplane. The leveling operation is accomplished by using the spirit level laterally and longitudinally on the specified leveling lugs.

1 INSPECTION ACCESS DOOR
2 CANOPY CRANK ACCESS DOOR
3 BRAKE CYLINDER ACCESS DOOR
4 FUSELAGE FORWARD COVER PLATE
5 HEATING BOOT DOOR—OIL
6 COOLANT TANK FILLER CAP
7 STARTER BRUSH LIFTING KNOB ACCESS DOOR
8 CUNO OIL FILTER ACCESS DOOR
9 CARBURETOR AIR FILTER
10 PROPELLER BLADE COVER ASSEMBLY
11 INSPECTION DOOR
12 TAIL WHEEL ACCESS DOOR
13 TAIL WHEEL DOOR
14 LIFT TUBE
15 OIL DRAIN
16 STARTER CRANK & PULL ACCESS DOOR
17 COOLANT DRAIN
18 HEATING BOOT ACCESS DOOR
19 OIL AND COOLANT DRAIN
20 EXTERNAL POWER RECEPTACLE ACCESS DOOR
21 OIL TANK FILLER ACCESS DOOR
22 INSPECTION DOOR
23 FUSELAGE FUEL TANK FILLER CAP
24 HANDHOLD DOOR
25 FUSELAGE ACCESS DOOR
26 HYDRAULIC TANK ACCESS DOOR
27 INSPECTION DOOR
28 RUDDER HINGE ACCESS DOOR

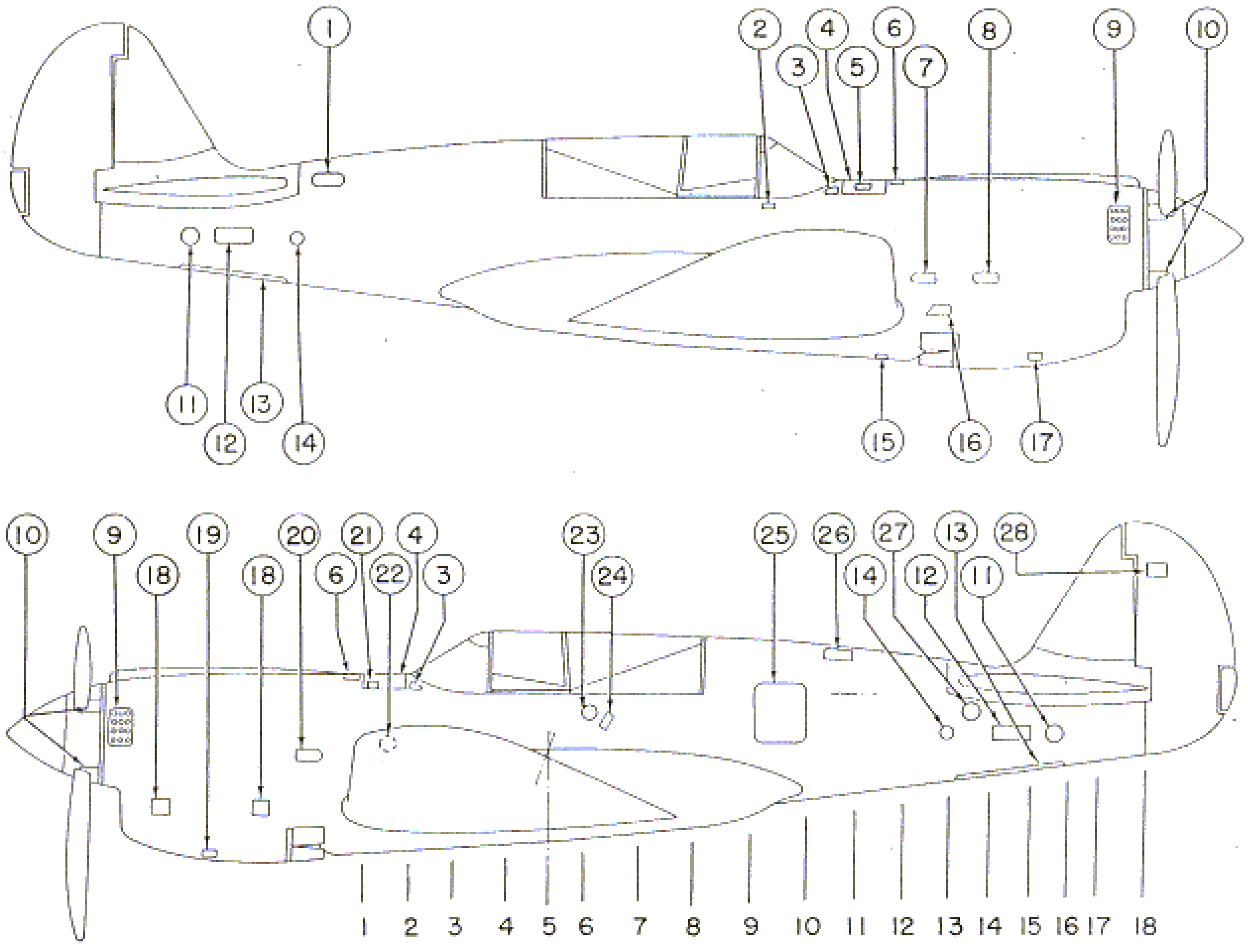
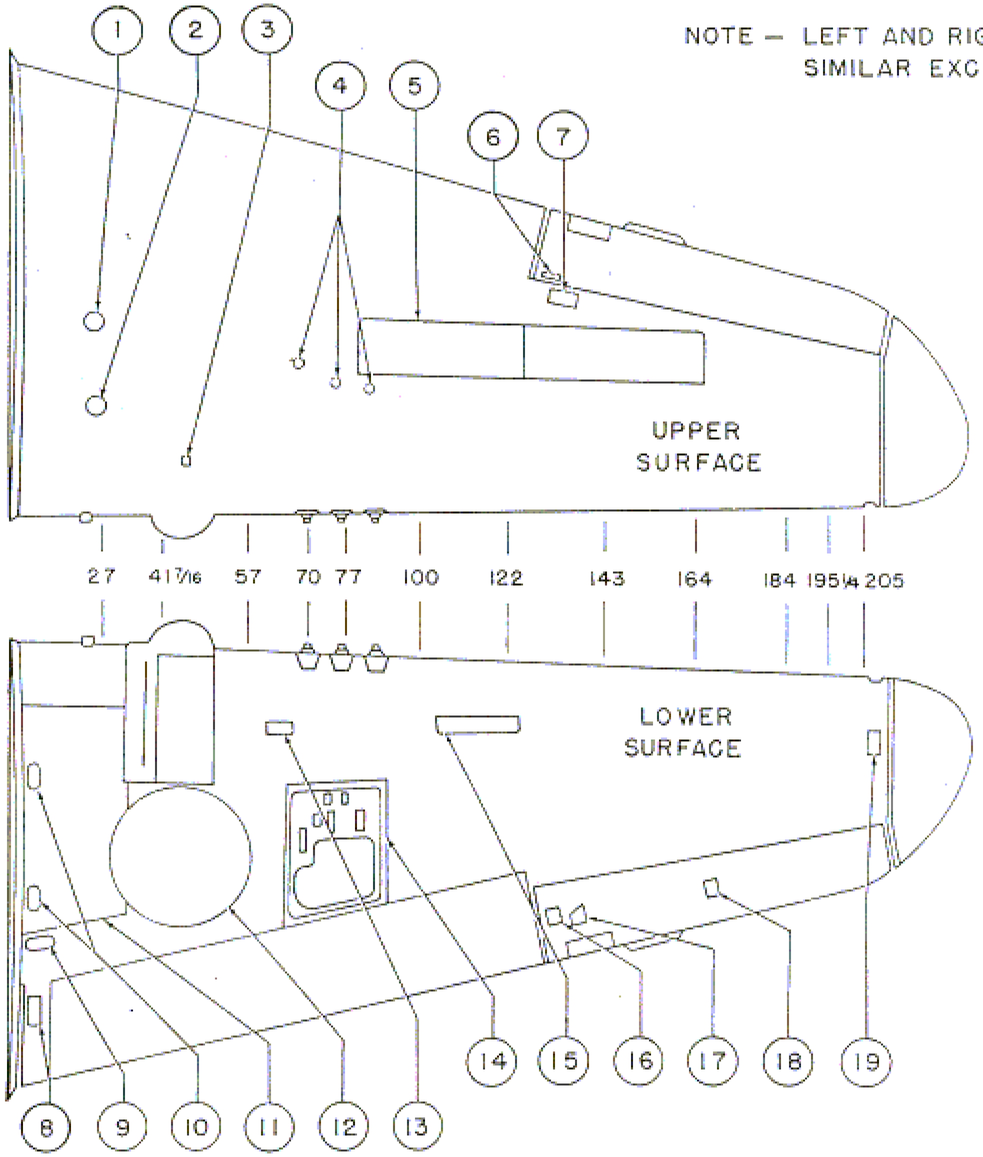


Figure 19—Fuselage Access Doors and Stations

NOTE — LEFT AND RIGHT WING PANELS ARE SIMILAR EXCEPT AS NOTED.



1. REAR WING TANK FILLER NECK (L. H. ONLY)
2. FRONT WING TANK FILLER NECK (L. H. ONLY)
3. INSPECTION DOOR—RETRACTING STRUT
4. GUN TRUNNION ADJUSTMENT PORT COVERS
5. AMMUNITION ACCESS DOORS
6. AILERON CONTROL ARM ACCESS DOOR
7. AILERON CONTROL DRUM ACCESS DOOR
8. FLAP CYLINDER ACCESS DOOR
9. AILERON BELLCRANK ACCESS
10. FUEL SUMP CUTOUTS (L. H. ONLY)
11. FUEL TANK DOORS
12. WHEEL POCKET
13. INSPECTION DOOR-GUN JUNCTION BOX
14. GUN ACCESS DOOR
15. BOMB RACK COVER PLATE
16. INSPECTION DOOR-AILERON CONTROL ARM
17. TRIM TAB ACCESS DOOR (L. H. ONLY) AF43-24252 AND SUBSEQUENT
18. INSPECTION DOOR-AILERON CENTER HINGE
19. INSPECTION DOOR-AIRSPEED LINES AND PITOT HEATER WIRES (L. H. ONLY) AND WING TIP LIGHT WIRES.

Figure 20—Wing Access Doors and Stations

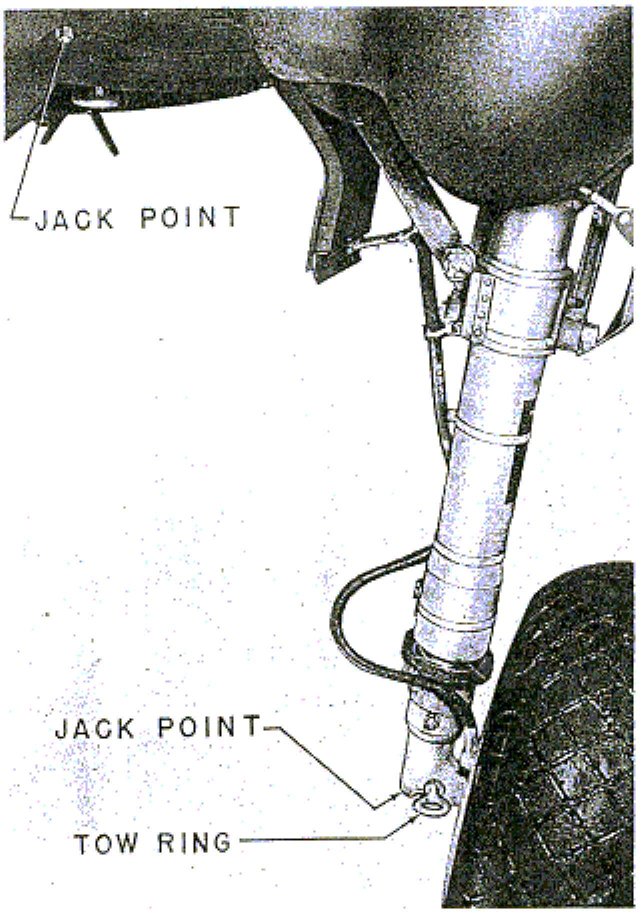


Figure 21—Jack Points and Tow Rings

e. TIE-DOWN AND MOORING INSTRUCTIONS.

(1) Tie-down rings are located in the under surface of each wing between the outboard bulkhead and the removable wing tip. These rings are held in the retracted position in the wing by springs and are pulled down through slots by small tabs which protrude through the bottom surface of the wing. Decalcomanias inscribed "TIE-DOWN" indicate the location of these tabs.

(2) The aft end of the airplane will be tied down by passing the tail lifting bar through the lifting tube in the fuselage, and tied down to an anchor point in the ground. Adjust the tension of the tie-down cable equally on each end of the bar so as not to apply any twisting force to the fuselage.

Note

During engine run-up tests, the above method of tail tie-downs should be used and two 100-pound weights should be suspended, one from each end of the tail lifting bar.

(3) A type D-1 mooring kit is carried in the baggage compartment and should be used when no fixed mooring anchorage is provided. The anchor rod is screwed into the arrow and the driving rod slipped over the anchor rod and into the socket of the arrow.

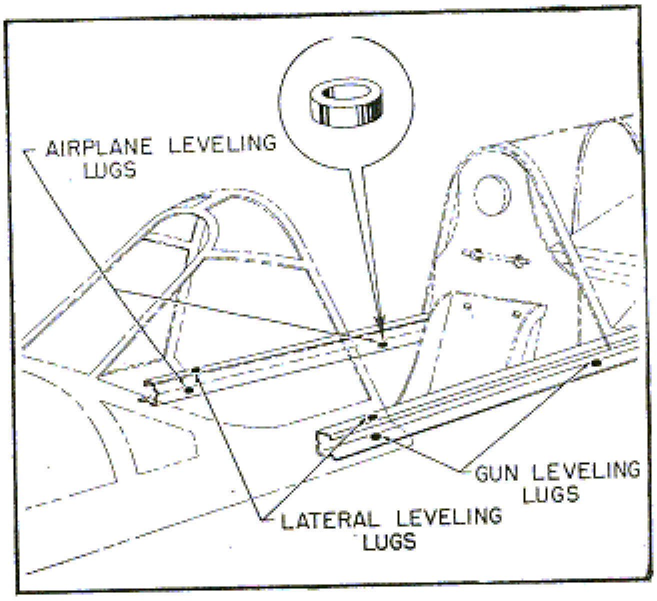


Figure 22—Leveling Lugs

The cam on the driving rod must be turned so that the prongs of the arrow will not be spread while driving. If the ground is hard, the hardened surface will first be broken by using the ground breaking pin. Align the rod with the point of attachment on the airplane and drive the arrow into the ground until the driving rod handle is within three inches of the ground. Then rotate the handle 90 degrees, and strike the driving rod a sharp blow to spread the prongs of the arrow. Return the driving rod to the driving position and withdraw it from the ground. Align the squared end of the anchor rod, fit into place, and secure the knurled nut. Attach the mooring rope to the eye assembly and give an upward pull to the anchor to spread and set the anchor prongs. Then secure the mooring ropes, and unscrew anchor rods by turning the ring of the eye assemblies counterclockwise, leaving the arrows buried in the ground. Arrows for these kits are expendable and will be replaced upon return to the home station.

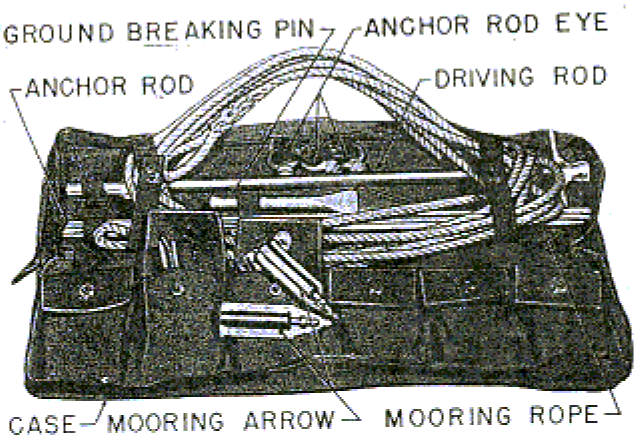


Figure 23—Type D-1 Mooring Kit

Type D-1 mooring kit consists of the following items:

Name	*Quantity per kit*
Driving rod	1
Anchor rod	6
Anchor rod eye	3
Ground breaking pin	1
Mooring arrow	18
Mooring rope	3
Case	1

(See figure 23.)

f. PARKING INSTRUCTIONS.

(1) PARKING BRAKES.—The parking brakes are set by pulling on the parking brake control button, located beneath the instrument panel on the left side, while holding both brake treadles depressed. Release the parking brakes by depressing the brake treadles.

(2) PARKING HARNESS.—The control surfaces are locked by rigging the parking harness around the control stick and attaching the hooks on the harness cables to the lugs on the rudder pedals and the pilot's seat. (See figure 24.)

Parking harness, part No. 87-64-570 is furnished with airplanes AF42-104429 through AF42-104828 which have the readily adjustable pilot's seat. This parking harness is *not* provided with turnbuckles for taking up slack in the cables. Attach the cables as shown in figure 24. If the hooks are painted, attach the green hooks to the pilot's seat and the red hooks to the rudder pedals. If the cables seem too short, adjust the rudder pedals to the full aft position and lower the pilot's seat. Attach the cables and raise the seat to remove the slack. In some rare cases, it may be necessary to wrap the harness around the stick below the electrical conduit on the control stick so that slack is obtained to engage the hooks.

Parking harness, part No. 87-530-1010 is furnished with airplanes AF42-104829 and subsequent, which are equipped with the pilot's seat that is not readily adjustable. This parking harness is provided with turnbuckles to take up cable slack. Attach the cables as shown in figure 24, and adjust turnbuckles to remove any slack.

(3) SAND PLUGS.—Plugs for sealing the vent lines, cooling air intake scoop, and exhaust stacks are all tied together on a long rope to prevent loss and to be sure all are removed from the airplane when preparing the airplane for flight. These plugs must be installed when the airplane is to be left in the open. It is also necessary to place the carburetor air filter control in the "FILTERED" position and the cowl flaps in the "CLOSED" position. This will close the carburetor air intake and exit air duct.

g. SERVICING FUEL, OIL, COOLANT, HYDRAULIC FLUID, BRAKE FLUID AND OXYGEN.

(1) FUEL.—Specification AN-F-28 Amendment No. 1, 100 octane fuel is carried in four tanks. A front wing tank within the forward center of the wing has a capacity of 34 US (28.3 Imperial) gallons. A rear wing tank within the rear center of the wing with a capacity of 54 US (44.9 Imperial) gallons. A fuselage tank located immediately behind the cockpit with a capacity of 66 US (54.9 Imperial) gallons and an auxiliary belly tank suspended in the bomb shackle on the center line of the airplane beneath the wing with a capacity of 75 US (62.4 Imperial) gallons.

WARNING

Starting with airplanes AF42-105129 and subsequent, the front and rear wing tanks are interconnected. The rear tank must be filled before the front tank. The fuel cap of the rear tank must not be removed while there is fuel in the front tank. Both front and rear tanks will be controlled by a single position on the fuel selector valve.

Note

A belly tank of 150 US (125 Imperial) gallons capacity may be installed in the bomb shackle if a larger fuel supply is required for the mission.

The front and rear wing fuel tank filler caps are located beneath the left wing fillet and are accessible through doors in the fillet. (See figure 25.)

The fuselage fuel tank filler cap is located on the left side of the fuselage aft of the fuselage station 5.

The belly tank filler cap is located on the left front side of the tank. Sump drains are provided in the bottom of all fuel tanks.

WARNING

The airplane must be thoroughly grounded before attempting the refueling operation. If fuel is supplied from an underground tank, an electrical ground must be made near the gasoline pit. If the airplane is refueled from a truck, both airplane and truck must be grounded. Failure to apply proper grounding will permit the accumulation of static electricity with the consequent hazard of explosion or fire. Since the use of a covering ordinarily insulates a man from the structure, thus permitting static charges to build up in the body, it will be positively necessary in every case to drag a hand over the metal surface of the wing for a considerable distance before touching the airplane adjacent to an open filler neck.

(2) OIL.—The engine lubricating oil used in this airplane must conform with Specification AN-VV-O-446. Grade 1100 should be used for winter operation, and grade 1120 for summer operation.

The oil supply tank is located immediately aft of the fire wall and forward of the armor plate installation at fuselage station 2. It has a capacity of 8.75 US (7.3 Imperial) gallons and drains through the "Y" drain and the tank sump drain.

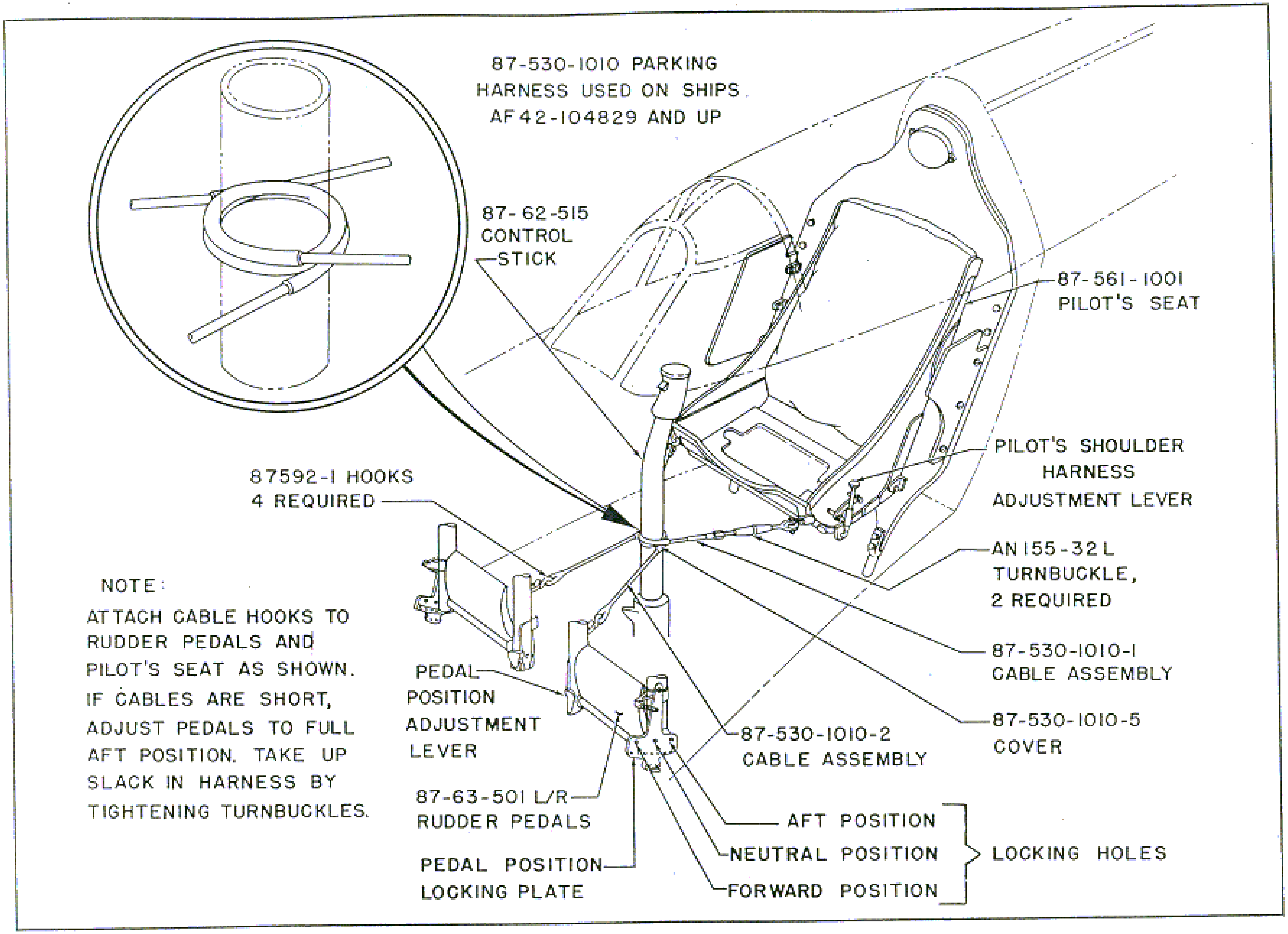


Figure 24—Attaching the Parking Harness

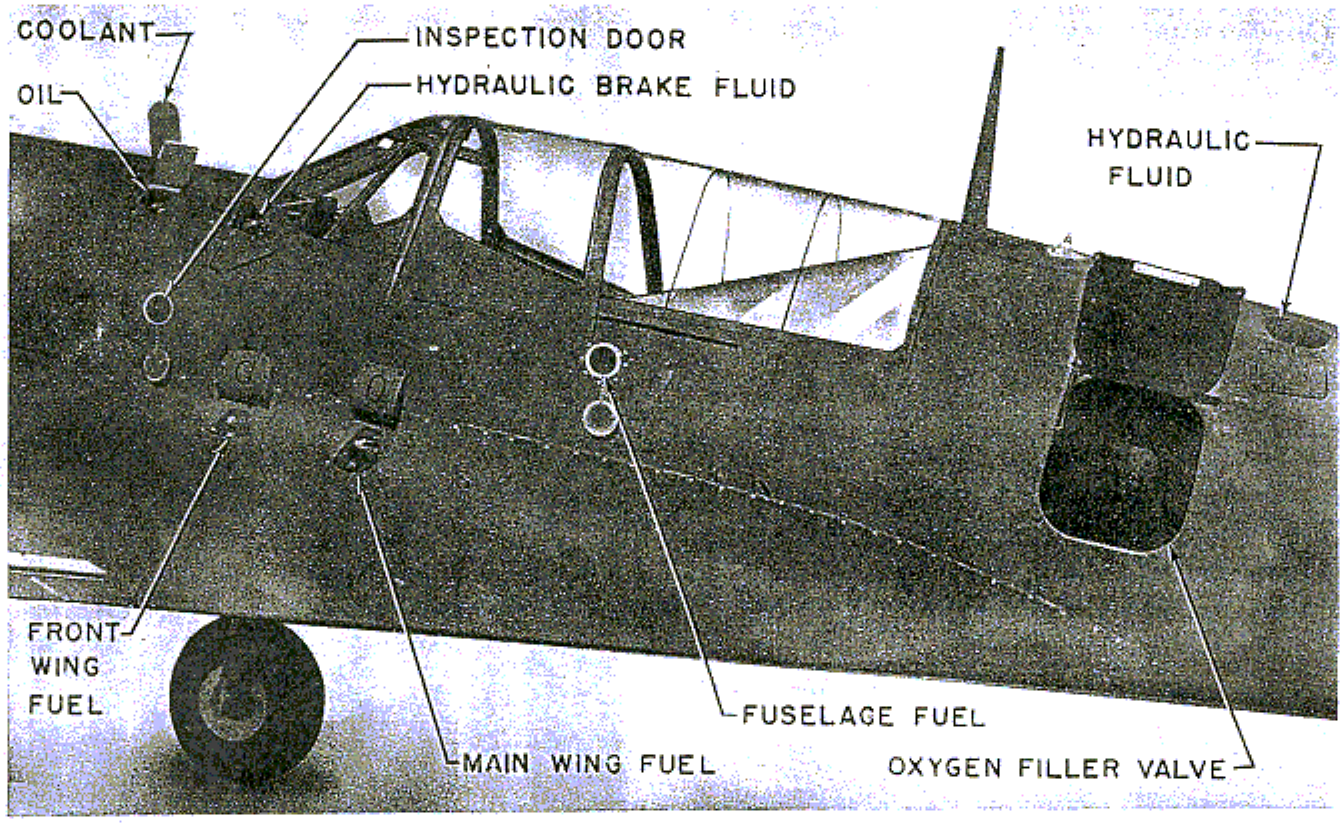


Figure 25—Fuel, Oil and Coolant Filler Ports

The oil supply tank filler cap is located inside a door in the left top side of the fuselage, forward of the windshield and aft of the firewall.

(3) COOLANT.—The coolant expansion tank is installed on the top forward side of the firewall. The filler cap is in the top of the expansion tank and is accessible through a door in the top engine cowl. The capacity of the coolant tank is 3.5 US (2.9 Imperial) gallons. The capacity of the entire system is 15.5 US (12.9 Imperial) gallons. The expansion tank overflow vent line extends out through the right engine cowl. The coolant used in the cooling system for summer operation is 100 per cent ethylene glycol, Specification AN-E-2; and for winter operation, a coolant mixture of 80 per cent ethylene glycol and 20 per cent water is used.

Ethylene glycol coolant liquid (100 per cent) expands approximately 10 per cent by volume when the temperature is raised from 0° C (32° F) to 121° C (250° F), which is the operating temperature of the Allison engine. This expansion of coolant should be taken into consideration when checking the coolant tank level for proper supply and additions of coolant liquid. This check should preferably be made when the coolant liquid is warm. The correct coolant liquid level and supply can then be compared to previous checks at the same temperature as when the coolant supply and level was known to be correct.

(4) HYDRAULIC FLUID.—The hydraulic fluid tank is located aft of the fuselage access door, on the left side of the fuselage. The access door to the filler neck for the hydraulic fluid tank is located aft of the fuselage access door, at the top of the fuselage at station 10. Use hydraulic fluid, AAF Specification 3586. The capacity of the entire system is 2 US (1.7 Imperial) gallons.

(5) BRAKE FLUID.—The brake hydraulic systems are serviced with hydraulic fluid, AAF Specification 3586. The brake master cylinders are accessible through the doors that are located just forward of the windshield, one on each side of the fuselage. Separate hydraulic systems are installed for each main wheel brake. For servicing details, see figure 143.

(6) FILLING THE OXYGEN SYSTEM.—The oxygen cylinders may be filled without removing them from the airplane, by pushing the filler valve adapter from the recharging cylinders into the filler valve of the airplane. Push the adapter into the valve until it snaps into place. The filler valve is located just inside the fuselage access door. (See figure 25.) Be sure the emergency valve on the regulator is closed tightly, and that no leaks exist in the system. Fill the oxygen system to 425 pounds per square inch. Do not exceed 450 pounds per square inch. To disconnect the filler line from the filler valve assembly, trip the filler valve handle clockwise about one eighth of a turn. Since pressure will blow the adapter out, securely hold the end of the hose near the filler valve before tripping the handle.

The airplane oxygen cylinders will become quite warm during the filling operation. After the cylinders cool to normal temperature, pressure in the oxygen system will drop 20 to 30 pounds per square inch. After about one hour, pressure in the system will be approximately 400 pounds per square inch, depending upon initial charging pressure and atmospheric temperature.

WARNING

Extreme caution must be exercised in the use of oxygen equipment to insure that none of it becomes contaminated with oil or grease. Fire or explosion may result when slight traces of oil or grease are in contact with oxygen under pressure. Be sure that all lines, fittings, instruments and other items are free from oil, grease, and other foreign matter.

3. GROUND OPERATING INSTRUCTIONS.

a. STARTING THE ENGINE.

(1) ELECTRIC STARTING.—Always use external power—24 volt dc when it is available, for starting the engine. Plug cart battery into external power cart receptacle (figure 26). The battery line switch should be "OFF" when external power is employed.

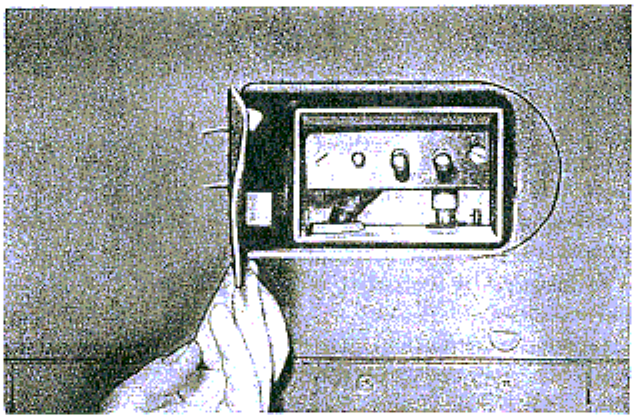


Figure 26—External Power Cart Receptacle (AF42-106029 and Subsequent)

(a) Make sure the ignition switch (figure 27) is "OFF".

(b) Pull engine through. If engine has been idle for more than two hours, turn the propeller at least four complete revolutions by hand with the throttle open, before using the starter.

(c) Place the carburetor air control in the "COLD" position if normal clean air conditions prevail, or in the "FILTERED" position if dusty conditions exist. (See figure 28.)

(d) Place cowl flaps as conditions require. (See figure 29.)

(e) Turn battery line switch "ON" (figure 30) if external cart battery is not used.

(f) Place propeller selector switch in "AUTO CONSTANT SPEED" and circuit breakers "ON". (See figures 31 and 32.)

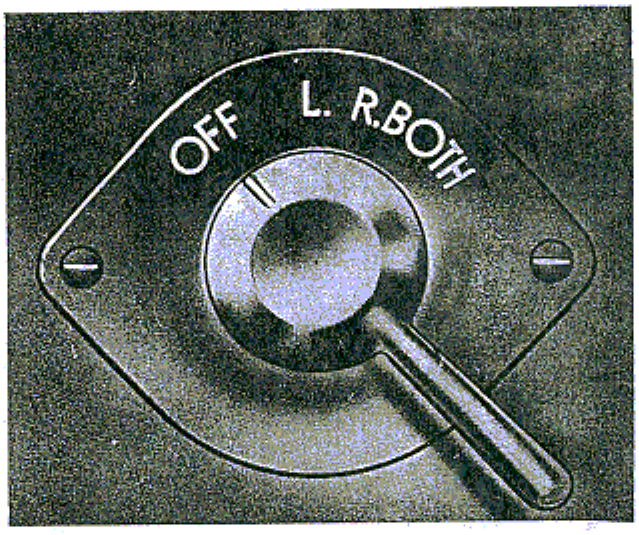


Figure 27—Ignition Switch

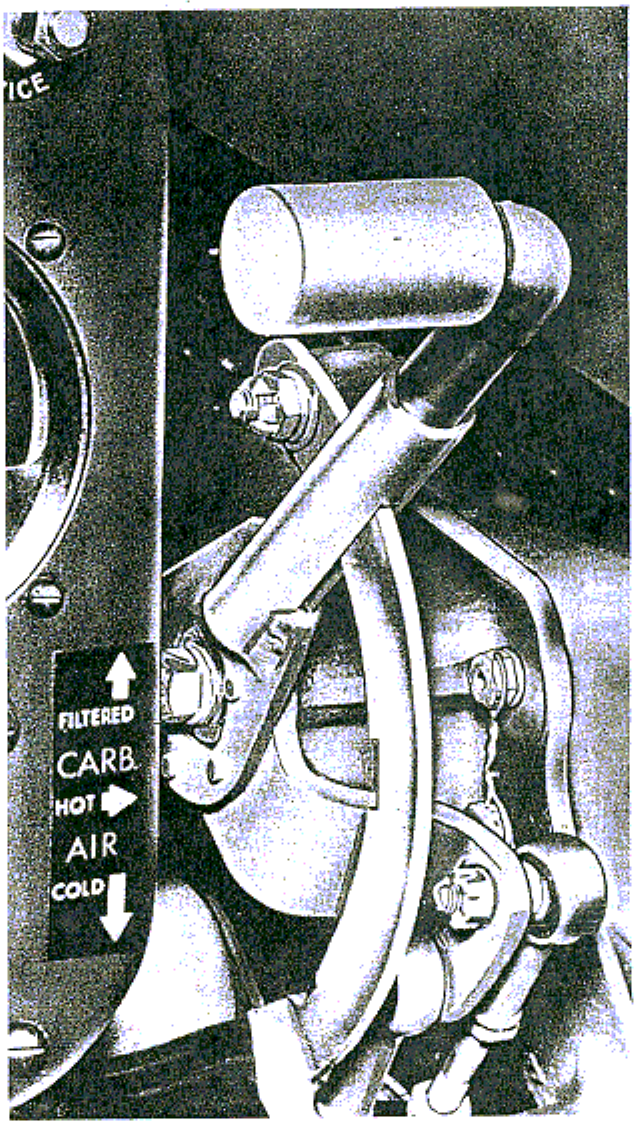


Figure 28—Carburetor Air Control

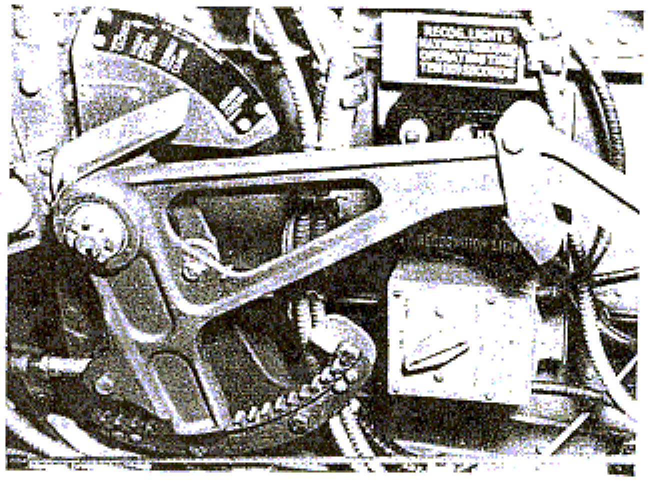


Figure 29—Cowl Flap Control

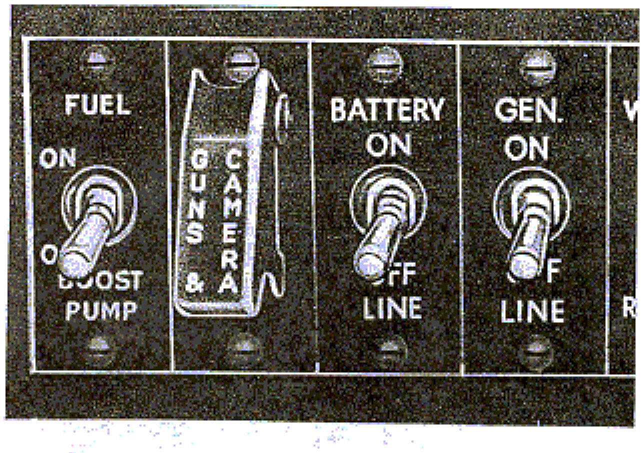


Figure 30—Switches—Main Switch Panel

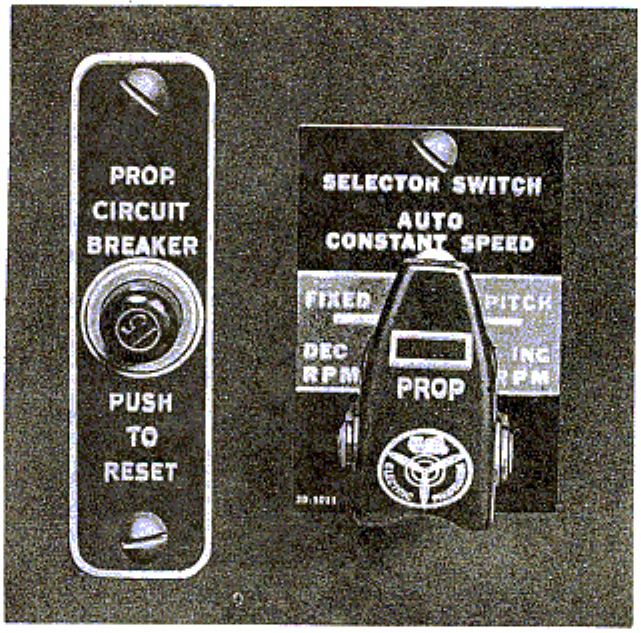


Figure 31—Propeller Switches

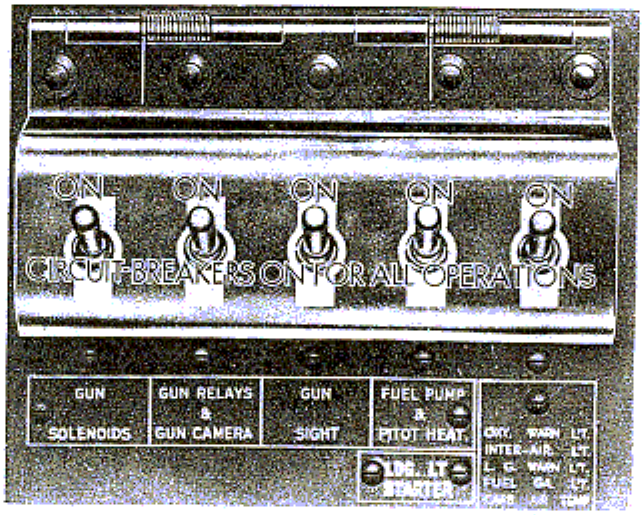


Figure 32—Circuit Breakers—Main Switch Panel

Note

On airplanes equipped with manually operated propeller governor control, place propeller governor control lever in full "INCREASE" rpm position.

(*g*) Turn generator line switch "ON" (figure 30.) Be sure generator circuit breaker (figure 34) is set. Push button in to reset circuit breaker.

(*h*) Place the throttle control about 1/10 open.

(*i*) Set mixture control to "IDLE CUT-OFF".

(*j*) Turn the fuel selector valve to "FUSELAGE TANK". Never turn the valve pointer through "BELLY" position when a belly tank is not installed.

(*k*) Operate the electric fuel boost pump to obtain 16 to 18 pounds per square inch fuel pressure. (See figure 30.)

(*l*) Use hand engine primer to inject two to four strokes of fuel into induction manifold. (See figure 33.)

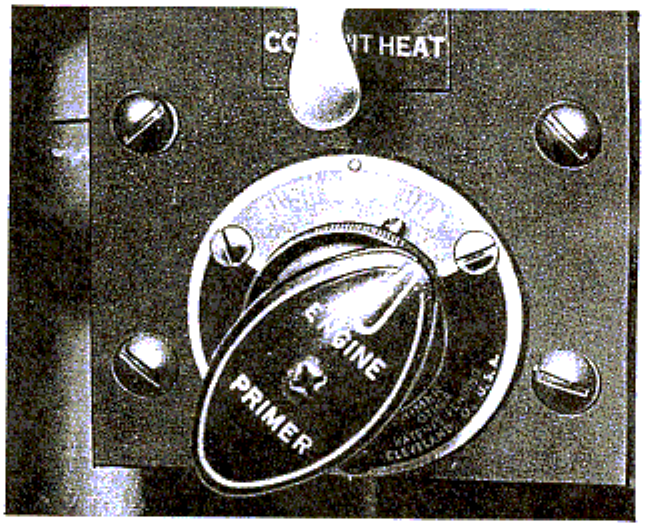


Figure 33—Engine Primer

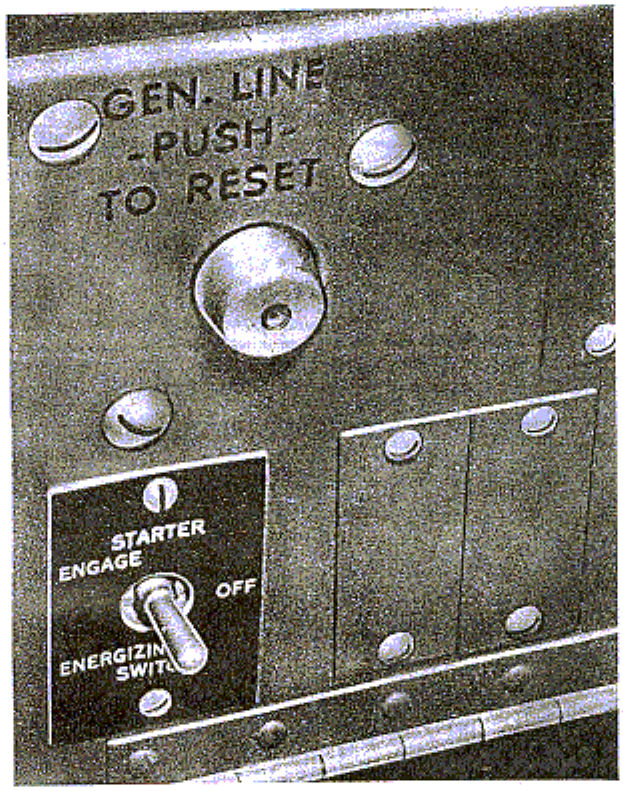


Figure 34—Starter Switch

(m) Turn the electric boost pump "OFF" to conserve the battery.

(n) Energize starter. Hold the starter switch (figure 34) in "ENERGIZING" for 12 to 15 seconds (normal temperature). Turn the ignition switch (figure 27) to "BOTH", and then hold the starter switch in "ENGAGE".

(o) When the engine begins to fire, move the mixture control to "AUTO RICH". Operate the hand primer slowly, as required to keep the engine from stalling.

(p) When the engine is firing regularly, close and lock the primer. Turn the electric booster pump "ON".

Note

Do not operate the electric fuel boost pump when the mixture control is out of "IDLE CUT-OFF" and the engine is not firing.
Do not pump throttle. Pumping the throttle does not prime the engine.

WARNING

If normal oil pressure is not established within 15 seconds after starting, stop the engine and correct the cause of oil pressure failure.

(2) HAND STARTING.—Hand starting of the engine is accomplished in the same manner as electric starting except no electric power is employed. The starter is hand cranked and engaged with the engine according to the following procedure:

(a) Obtain the hand crank and the hand crank extension from its position on the right side of the fuselage opposite the fuselage access door.

(b) Open the access door in the lower rear section of the right side engine cowl (figure 35), thereby making accessible the electric starter motor brush lifting knob on the aft end of the starting motor. (See figure 36.)

(c) Lift the electric starting motor brushes by sliding the lift knob in the slot to the "OFF" position.

(d) Open the "STARTER, CRANK, AND PULL" access door in the right side of engine rear bottom cowl (figure 37), thereby making accessible the starting crank extension support bayonet type coupling and the start-pull button. (See figure 38.)

(e) Insert the crank extension through the support and into the coupling. Attach the crank to extension.

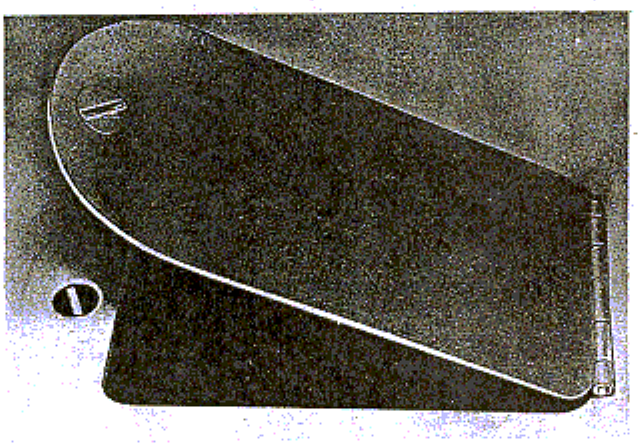


Figure 35—Starter Access Door

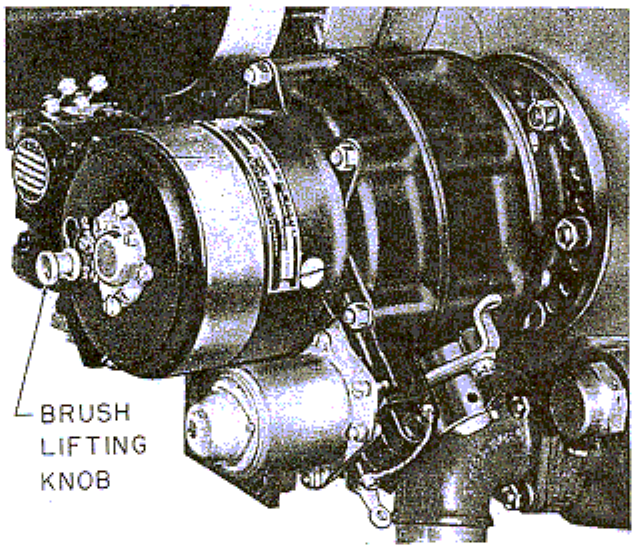


Figure 36—End View of Starting Motor

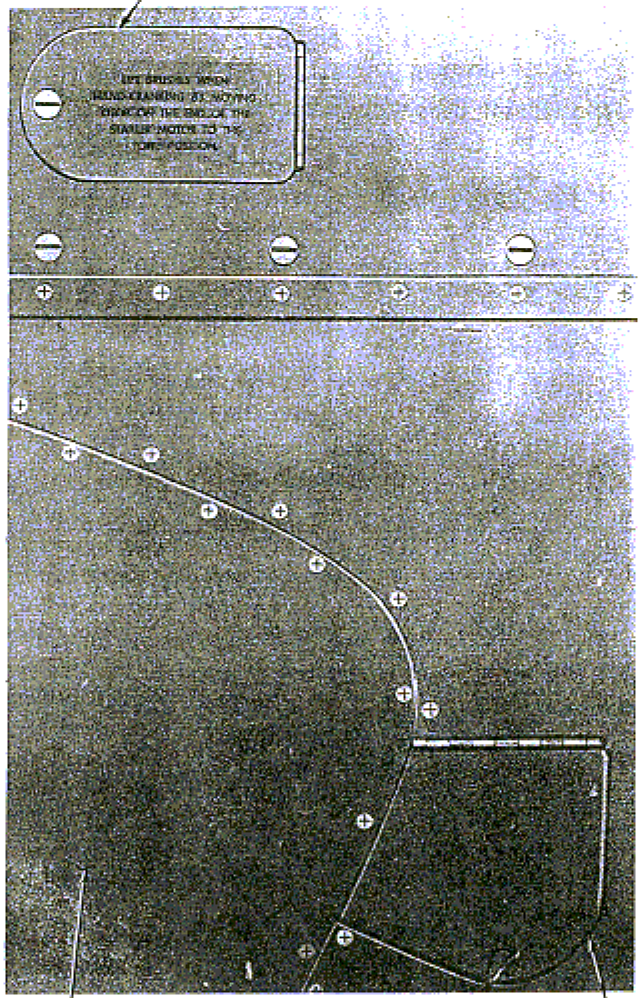


Figure 37—Starter Crank and Pull Access Door

(f) Crank the fly wheel until the hand crank is rotating at least 60 revolutions per minute. Remove the crank and extension. Pull on the starter engage button located beside the hand crank extension support. This engages the starter with the engine.

(g) If the starter fly wheel has lost its momentum, and the engine has not fired, release the engagement button and again bring the starter up to speed by using the starter crank, and re-engage the starter to the engine with the pull button.

(h) When the engine starts, release the pull button and lower the electric motor brushes by sliding the knob on the aft end of the starting motor to its "ON" position.

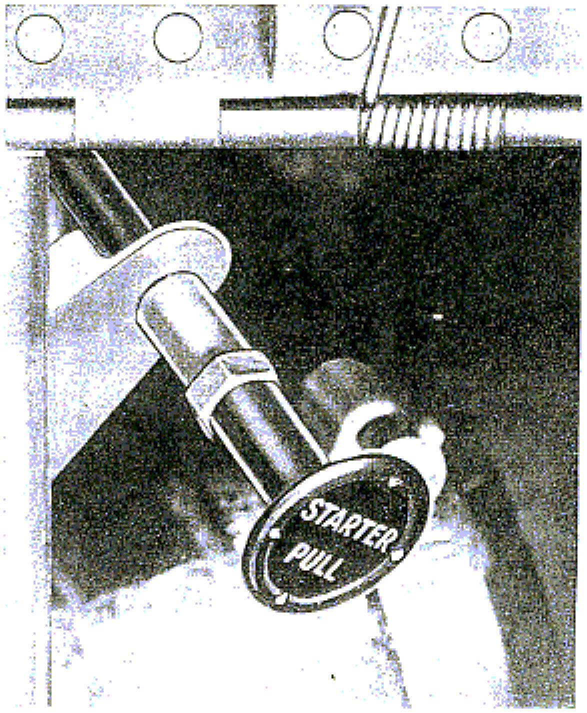


Figure 38—Starter Pull Button

b. ENGINE WARM-UP.

(1) Start warming up the engine at 1000 to 1200 rpm until the oil pressure stabilizes at 60 or 70 pounds per square inch pressure. When the oil pressure no longer fluctuates and the temperature begins to rise, gradually increase to approximately 1400 rpm. The minimum oil temperature for 1400 rpm is 20° C (68°F). If known icing conditions exist, move the carburetor air control to "HOT". The maximum coolant temperature will be 125° C (257°F). During warm-up, the oil pressure should not exceed 120 pounds per square inch, and the normal oil temperature should be 60° C to 80°C (140° F to 176° F) with a maximum of 95° C (203° F).

(2) Fuel pressure for idling and operating should be 16 to 18 pounds per square inch.

(3) Set the cowl flaps to the temperature requirements.

(4) In sandy areas, be sure the carburetor air control is in the "FILTERED" position.

(5) When the required engine oil and coolant temperatures and oil pressure are obtained, increase the engine power to 2300 rpm and 27 in. Hg with the propeller selector switch in "FIXED PITCH" and the mixture control in "AUTO RICH".

(6) Test the functioning of the dual magneto when the engine is operating under the conditions given in step (5).

(a) With ignition switch on "BOTH" position, note the rpm and manifold pressure readings. Then momentarily turn the ignition switch to the "R" position. Note the loss in engine rpm while operating only on the right magneto.

(b) Return the switch to the "BOTH" position, until the original rpm is regained.

(c) Move the switch to the "L" position and note the loss in rpm. Return the switch to the "BOTH" position after the test is completed.

(d) The maximum drop-off must not exceed 80 rpm. The magneto test must be made in as short a time as possible, and should not exceed 15 seconds, to avoid undue cylinder heat and detonation.

(7) Return the propeller selector switch to "AUTO CONSTANT SPEED" position. Adjust the throttle to obtain 2400 rpm and note the manifold pressure. Vary the engine speed from 2400 to 2200 rpm by manually increasing the propeller pitch. The manifold pressure should remain constant within one inch of mercury.

(8) Recheck the fuel and oil pressure, and coolant temperature.

(9) Recheck the generator to be sure that it is cutting in at approximately 950 rpm and is charging.

4. LUBRICATING REQUIREMENTS.

The points of lubrication of the airplane are shown on the lubrication diagram. (See figure 39.) The lubricants used are:

- Low Temperature Lubricating Grease, Specification AN-G-3
- High Melting Point Grease, Medium Grade, AAF Specification 3560
- General Purpose, Low Temperature, Lubricating Oil, Specification AN-0-6
- Special Preservative Lubricating Oil, Ordnance Department Specification AXS 777
- Aluminum Soap Grease, Grade AA (Special), Specification AN-G-4
- Gyro Instrument Lubricating Oil, Specification AN-0-4
- Hydraulic Fluid, AAF Specification 3586

Note

The following commercial lubricants may be used for propeller lubrication:

For speed reducer: Curtiss Speed Reducer Oil No. 2; Gargoyle Aircraft Instrument Oil; Aero Shell Fluid No. 6

For propeller hub: Texaco Propeller Lubricant No. 1; Mobile Grease Zero; Aero Shell Grease No. 3

GENERAL INSTRUCTIONS.

Grease all control rods full length of travel through firewall. Grease propeller governor control rod full length of travel through fairlead between cylinder banks. Use grease, AAF Specification AN-G-3—25 hours.

All sealed bearings contain grease, Specification AN-G-3, and require no lubrication in service. At overhaul periods, bearings should be inspected for free rolling. If bearings bind or contain grit, replace with new bearing.

All control cables are pre-greased by manufacturer.

Check battery semi-weekly for charge and proper electrolyte level.

Wipe and lubricate all Zerk fittings every 25 hours.

CAUTION

Do not lubricate cabin track.
Do not lubricate aileron ball and socket joint.
Keep oil and grease away from all electric wiring, shock chord, rubber packings, electrical and oxygen equipment, and tires.

KEY TO FIGURE 39 (Sheet 1 of 3 sheets)

Ref. No.	Item	Lubricant Specification	Frequency
1	Carburetor Filter Control Links	AN-0-6	Twice in 25 Hours
2	Carburetor Heat Control Links	AN-0-6	Twice in 25 Hours
3	Master Brake Cylinders	3586	Daily
4	Engine Oil	AN-VV-0-466	Daily
5	Cockpit Heater Push-Pull Rod	AN-G-3	25 Hours
6	Canopy Crank Handle	AN-G-3	25 Hours
7	Emergency Canopy Release Pulley Bearing	AN-0-6	25 Hours
8	Emergency Canopy Release Cables	AN-0-6	25 Hours
9	Trim Tab Control Unit	AN-G-3	25 Hours
10	Elevator Control Push Rod Bearing	AN-G-3	100 Hours
11	All Turnbuckle Ends	AN-0-6	25 Hours
12	All Hinges — Flaps, Landing Gear Doors, Tail Wheel Doors, Ammunition and Gun Access Doors, and Fuselage Access Door	AN-0-6	50 Hours
13	Access Door Latch	AN-0-6	25 Hours
14	Hydraulic Reserve Tank	3586	Daily
15	Tab Control Chain — Coating	AN-G-3	25 Hours

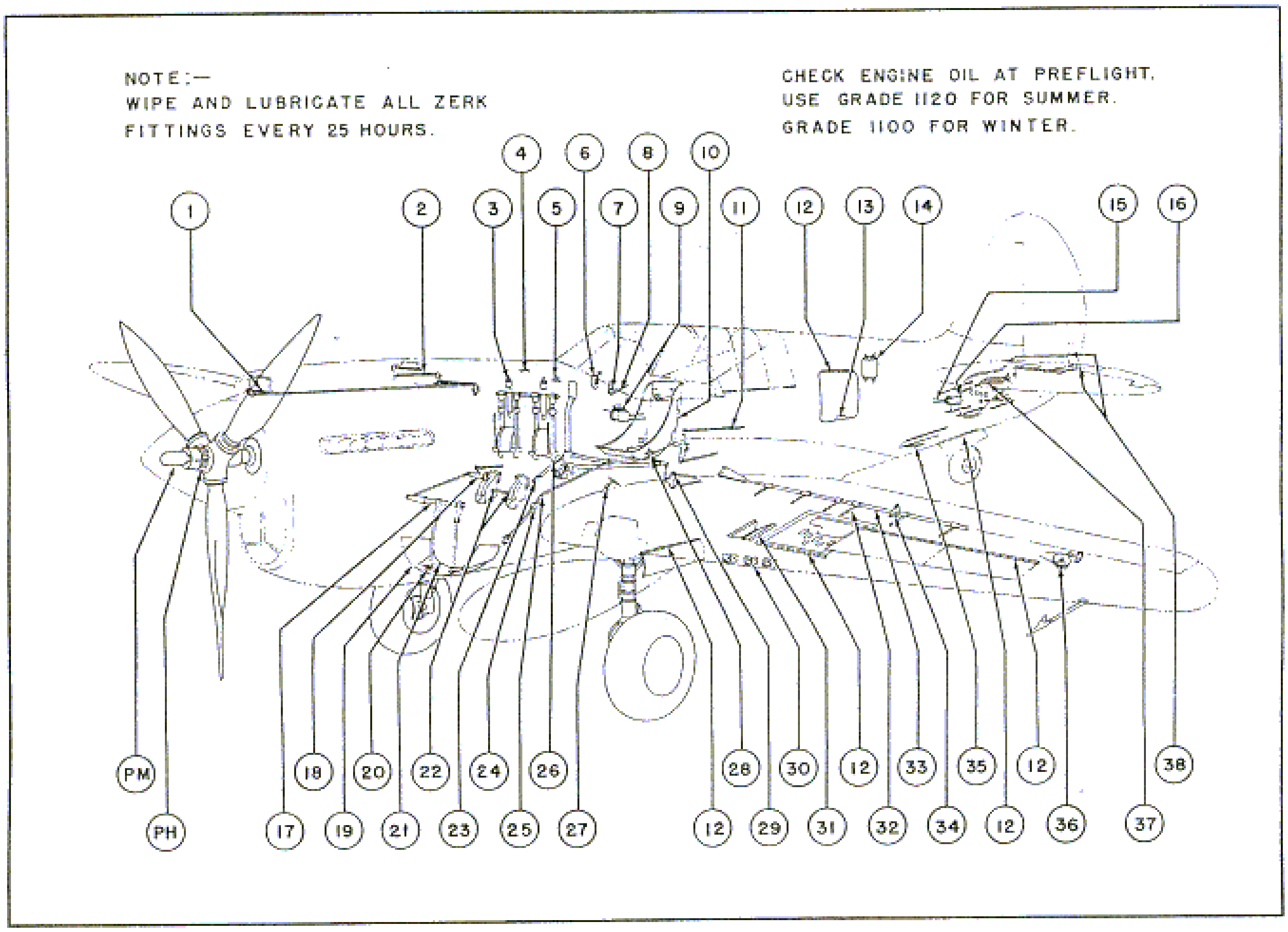


Figure 39 (Sheet 1 of 3 Sheets)—Lubrication Diagram

Ref. No.	*Item*	*Lubricant Specification*	*Frequency*
16	Trim Tab Drive Shaft Connection	AN-0-6	50 Hours
17	Jackshaft Bearings — Cowl Flap	AN-G-3	100 Hours
18	Bellcrank—Cowl Flap Control	AN-G-3	50 Hours
19	Cowl Flap Hinge	AN-0-6	25 Hours
20	"A" Frame Connection—Cowl Flaps	AN-G-3	25 Hours
21	Feather — Cowl Flaps — Surface	AN-0-6	Daily
22	Cockpit Heater Valve Bearings	AN-0-6	25 Hours
23	Control Stick Stop	AN-0-6	25 Hours
24	Fuel Selector Valve—Gear Box	AN-G-3	25 Hours
25	Fuel Selector Valve—Rods — Universal Joints	AN-0-6	25 Hours
26	Brake Pedal Bearings	AN-0-6	25 Hours
27	Belly Tank Release Control	AN-0-6	25 Hours
28	Bungee Control Lever	AN-0-6	25 Hours
29	All Control Cable Ends	AN-0-6	25 Hours
30	Machine Guns	AXS-777	Daily
31	Wing Bomb Release Control	AN-0-6	25 Hours
32	Flap Control Rod Turnbuckles	AN-0-6	25 Hours
33	Flap Push Rod Surface	AN-0-6	25 Hours
34	Flap Push Rod Rollers	AN-0-6	25 Hours
35	Tail Wheel Door Turnbuckles	AN-0-6	25 Hours
36	Aileron Drum and Cable Attachment	AN-G-3	25 Hours
37	Elevator Push-Pull Link	AN-G-3	50 Hours
38	Trim Tab Rod Connections	AN-G-3	25 Hours
PM	Propeller Motor Speed Reducer	AN-0-4	50 Hours
PH	Propeller Hub	AN-G-4 Grade AA	50 Hours

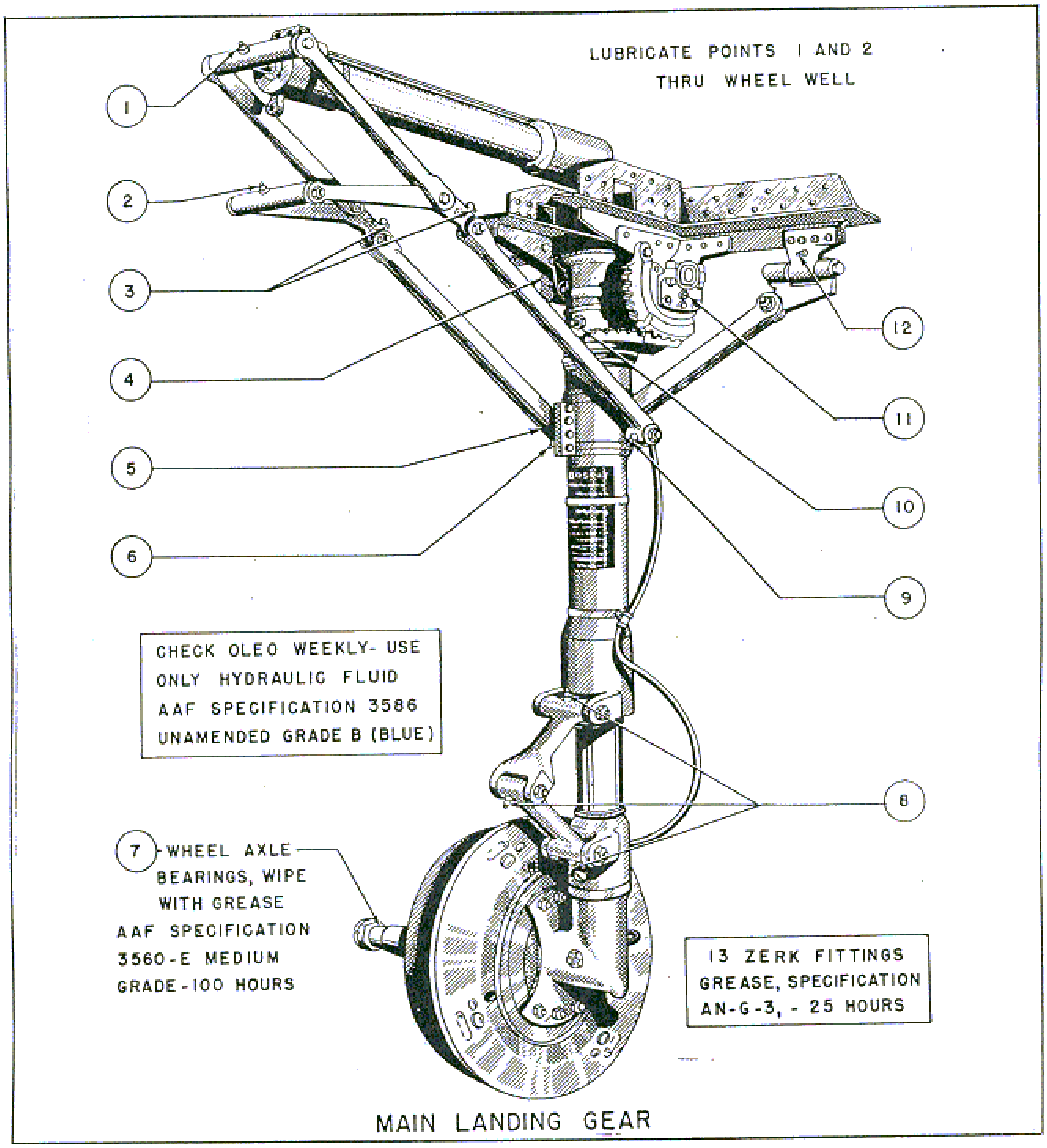


Figure 39 (Sheet 2 of 3 Sheets)—Lubrication Diagram

KEY TO FIGURE 39 (Sheet 2 of 3 sheets)

Ref. No.	*Item*	*Lubricant Specification*	*Frequency*
1	Retracting Strut Piston End Tee Head	AN-G-3	25 Hours
2	Retracting Arms Through Bolt	AN-G-3	25 Hours
3	Retracting Arms	AN-G-3	25 Hours
4	Hinge and Upper Trunnion	AN-G-3	25 Hours
5	Lower Retracting Link	AN-G-3	25 Hours
6	Lower Trunnion	AN-G-3	25 Hours
7	Axle Bearings	3560	100 Hours
8	Scissor Links	AN-G-3	25 Hours
9	Lower Retracting Link	AN-G-3	25 Hours
10	Oleo Strut Filler	3586	Weekly
11	Upper Trunnion Hinge	AN-G-3	25 Hours
12	Side Brace Hinge	AN-G-3	25 Hours

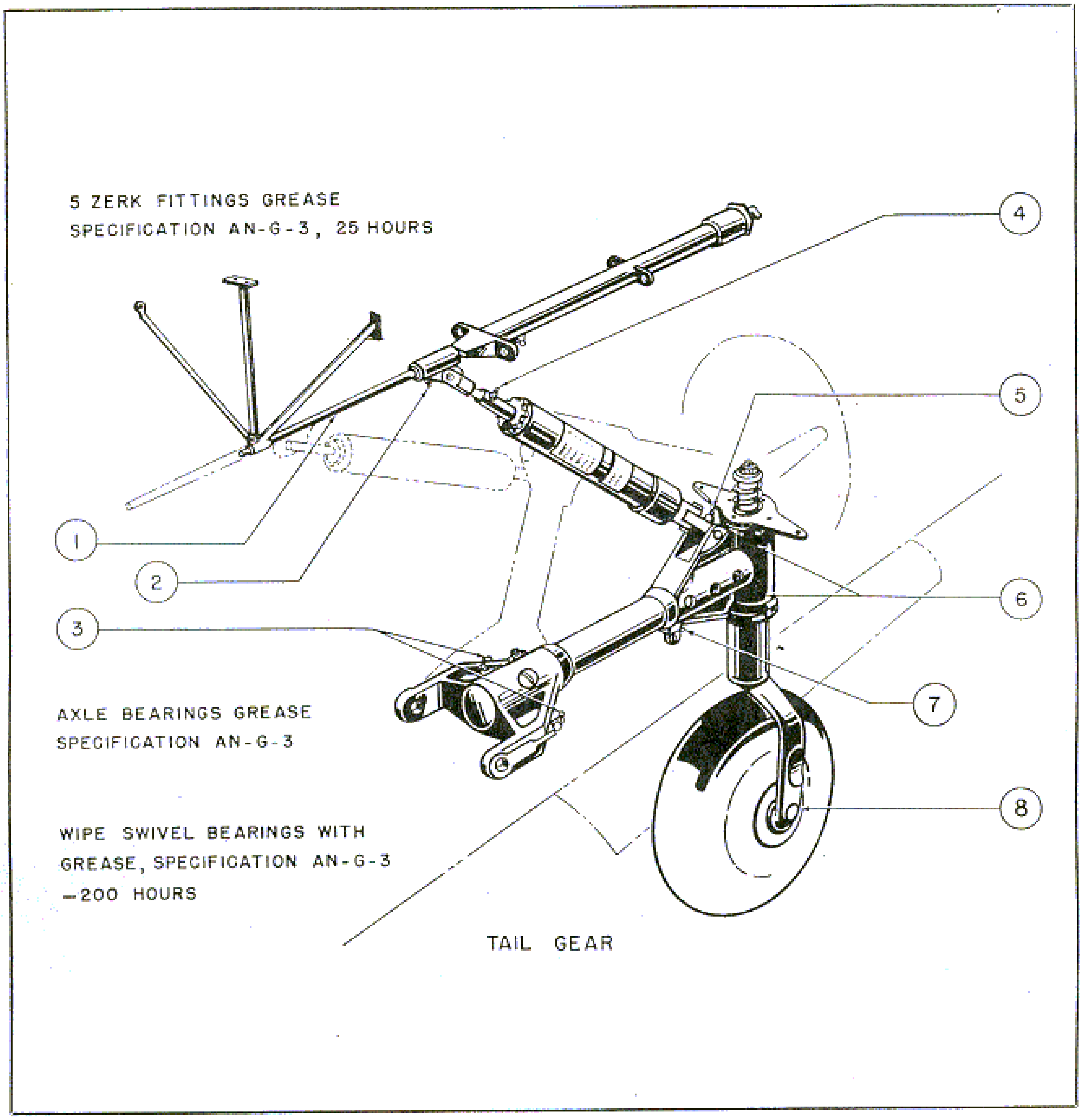


Figure 39 (Sheet 3 of 3 Sheets)—Lubrication Diagram

KEY TO FIGURE 39 (Sheet 3 of 3 sheets)

Ref. No.	*Item*	*Lubricant Specification*	*Frequency*
1	Retracting Strut Piston Guide	AN-O-6	25 Hours
2	Retracting Strut Piston Lug	AN-G-3	25 Hours
3	Drag Truss Front Fitting	AN-G-3	25 Hours
4	Oleo Strut Filler	3586	Weekly
5	Universal Joint	AN-G-3	25 Hours
6	Swivel Bearings	AN-G-3	200 Hours
7	Door Trunnion	AN-G-3	25 Hours
8	Axle Bearings	AN-G-3	100 Hours

5. SPECIAL TOOLS AND EQUIPMENT.

a. GENERAL.—Following is a list of the special tools and handling equipment used in the maintenance of the model P-40N series airplane. The tools and equipment in this list are the airplane manufacturer's part numbers.

Part No.	*Part Name*	
P-10197	Adapter—Air valve and Pressure Gage	(See figure 40.)
P-16244	Blocks—Wooden Vise	(See figure 49.)
P-16245	Blocks—Wooden Vise	(See figure 42.)
87-69-738	Drift Pin—Wing Gun	(See figure 41.)
P-10209	Guide—Metering Pin Wrench	(See figures 42 and 123.)
87-69-988	Gun Charger	(See figure 41.)
87-88-020	Hoisting Sling—Front	(See figure 11.)
87-88-019	Hoisting Sling—Tail	(See figure 11.)
87-88-509	Hoisting Sling—Wing	(See figure 10.)
87-88-524	Pad—Gun Servicing	(See figure 43.)
87-88-525-L	Pad—Walkaway	(See figure 43.)
87-88-525-R	Pad—Walkaway	(See figure 43.)
87-88-587	Puller Assembly—Engine Mount Bolt	(See figure 44.)
87-69-737-1	Ratchet Handle—Gun Mounting Wrench	(See figure 41.)
87-69-737-2	Socket—5/8-inch—12 point	(See figure 41.)
87-69-737-3	Sockets—7/8-inch—12 point	(See figure 41.)
87-69-737-4	Socket—1-1/16-inch—12 point	(See figure 41.)

Part No.	*Part Name*	
P-17522	Stud Driver—1/2-inch—Landing Gear Hinge Fitting	(See figure 45.)
87-88-030	Wrench—Flap	(See figure 46.)
87-88-031	Wrench—Landing Gear and Tail Wheel Oleo Metering Pin	(See figure 123.)
87-88-032	Wrench—Hand Hydraulic Pump	(See figure 47.)
P-12770	Wrench—Landing Gear Upper Trunnion Nut	(See figure 48.)
P-14845	Wrench—Cylinder Bearing Nut Spanner	(See figure 49.)
P-10195	Wrench—Tail Wheel	(See figure 50.)
P-14835	Wrench—Ball-Piston End Retaining Nut	(See figure 51.)
P-15765	Wrench—Plunger Assembly Installation Spanner	(See figure 52.)
P-13171	Wrench—Plunger End Spanner	(See figure 53.)
P-10189	Wrench—Tail Gear Retracting Strut Cylinder Bushing Spanner	(See figure 54.)
P-20233	Wrench—Elevator Trim Tab Control	(See figure 55.)
P-10188	WrenchAdjustable Face Spanner	(See figure 56.)

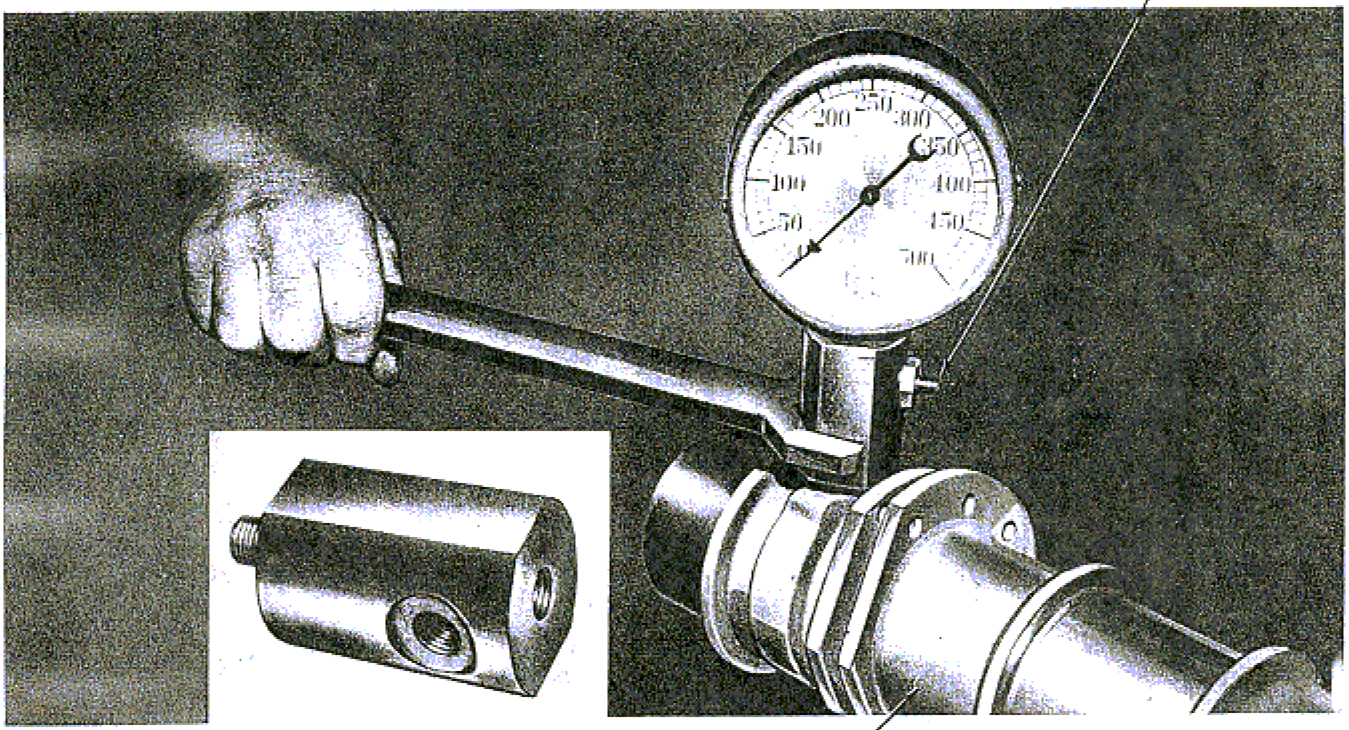


Figure 40—Air Valve and Pressure Gage Adapter, P-10197

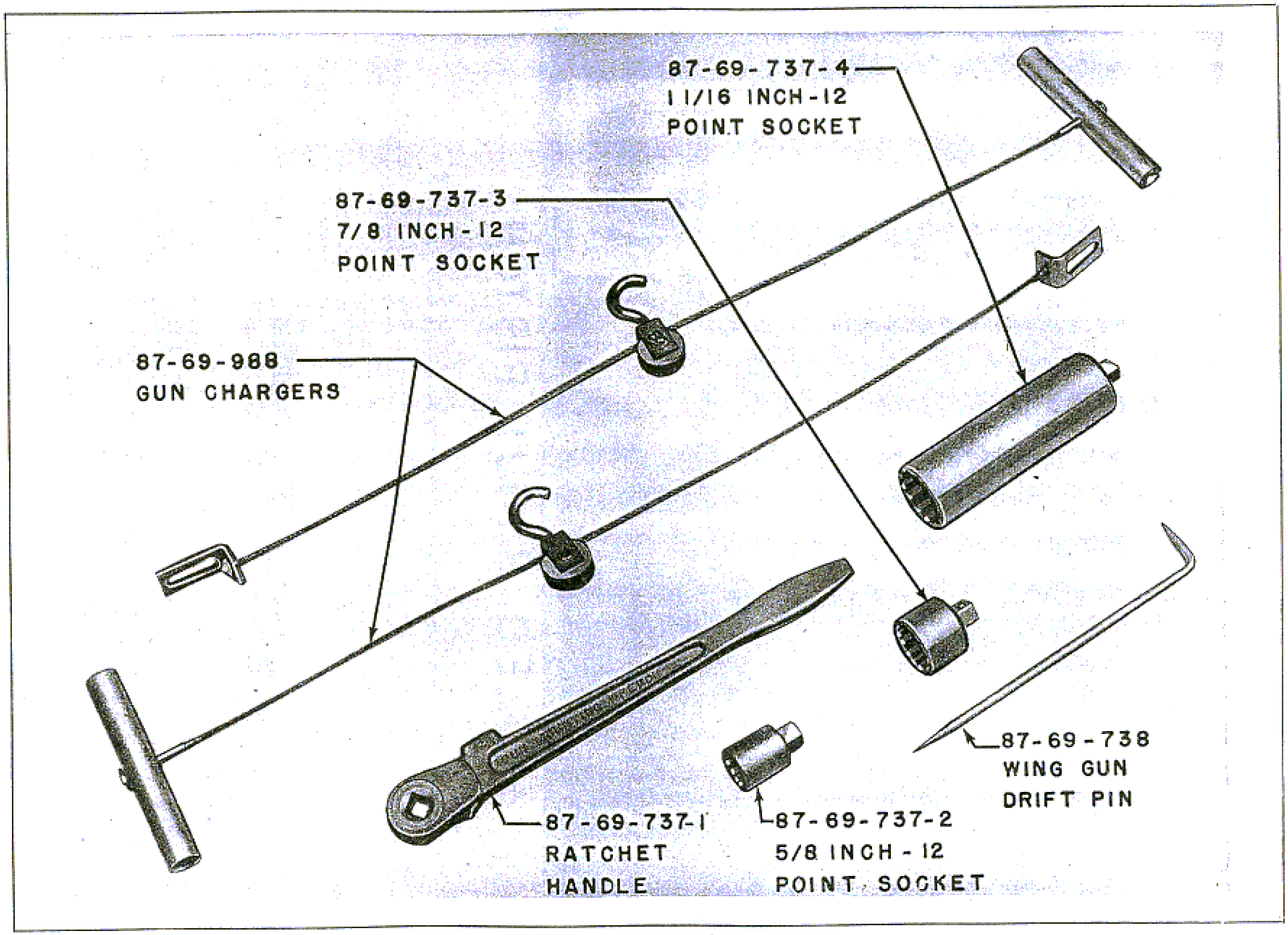


Figure 41—Gun Mounting Tools and Gun Chargers

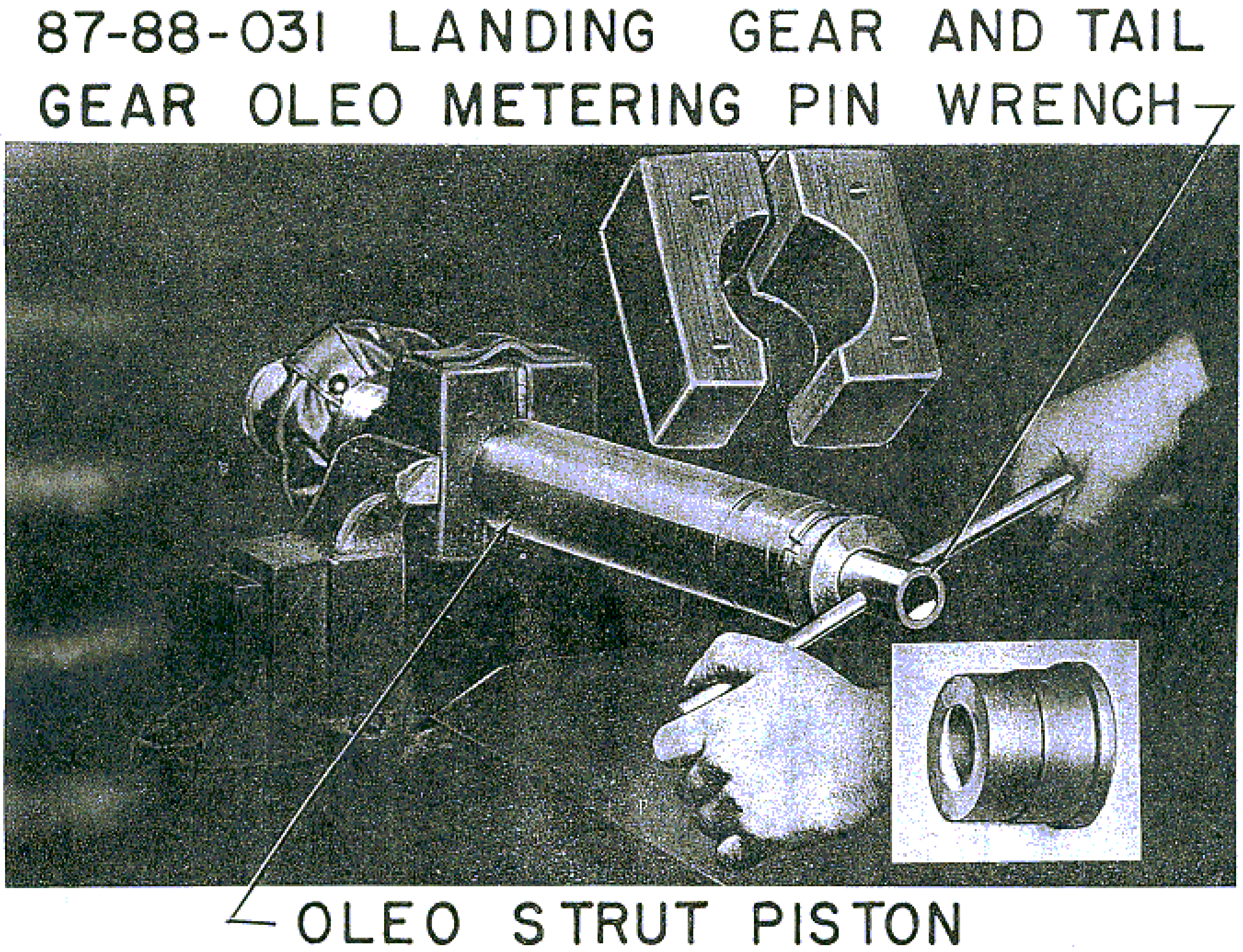


Figure 42—Vise Blocks, P-16245 and Metering Pin Wrench Guide, P-10209

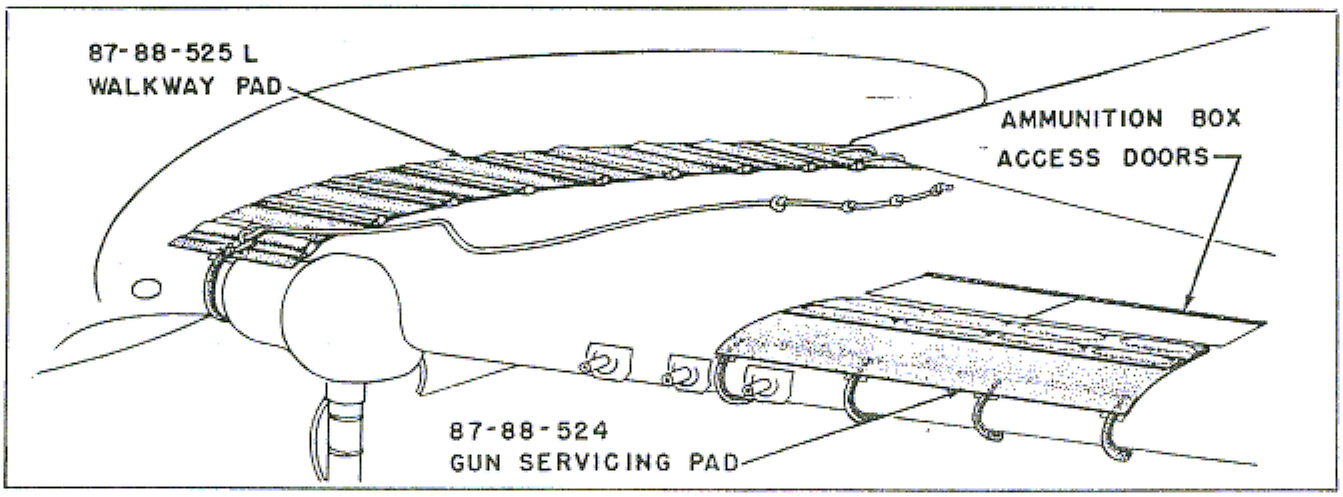


Figure 43—Walkway and Gun Servicing Pads

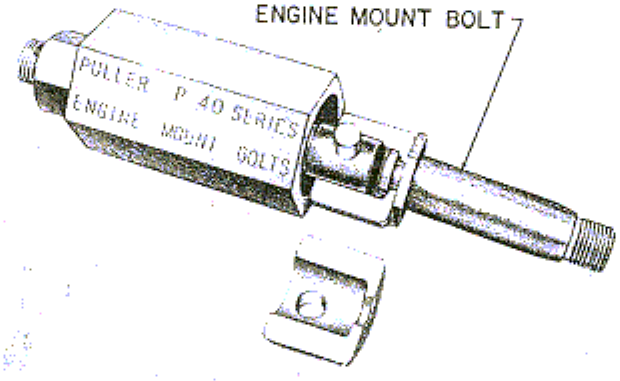


Figure 44—Engine Mount Bolt Puller Assembly Showing Bolt Engaged in Clamp

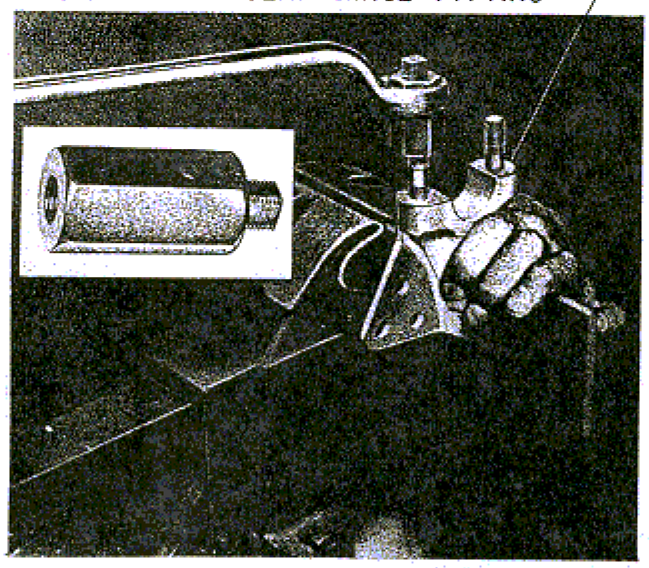


Figure 45—Stud Driver—Landing Gear Hinge Fitting, P-17522

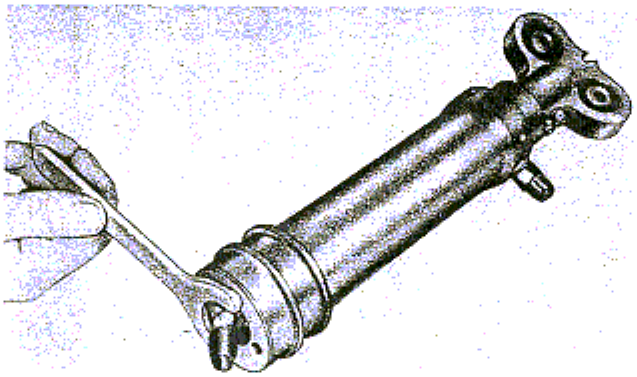


Figure 46—Wing Flap Cylinder Wrench

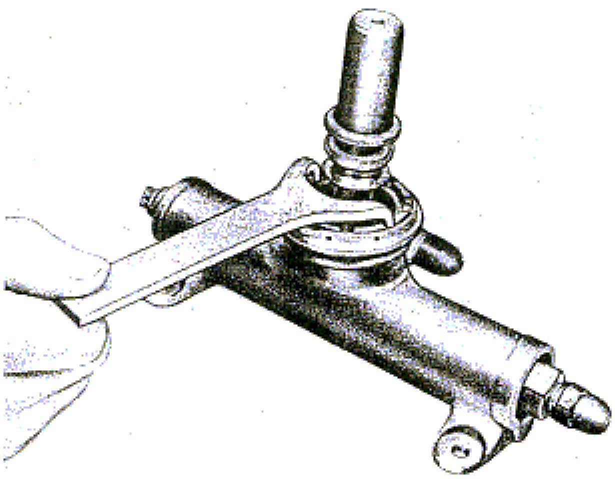


Figure 47—Hand Hydraulic Pump Wrench

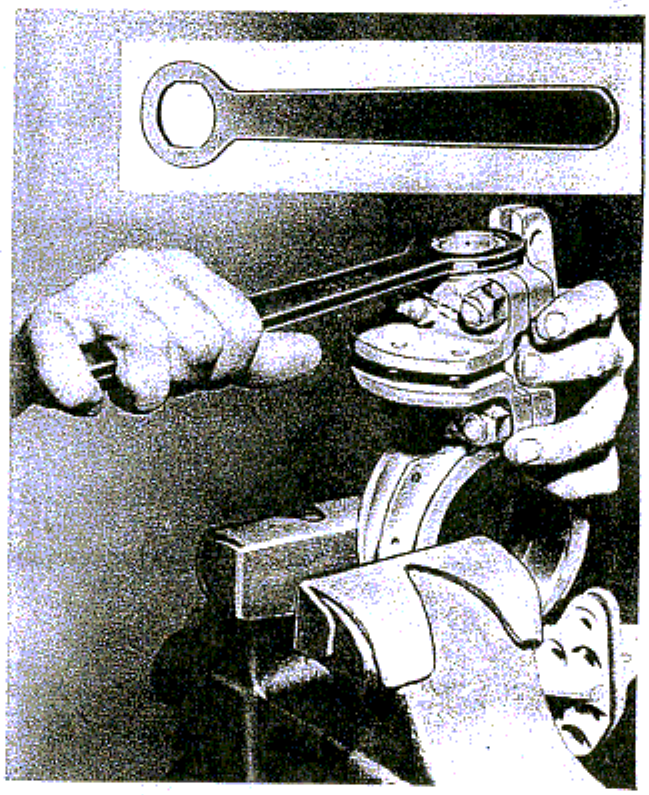


Figure 48—Landing Gear Upper Trunnion Nut Wrench, P-12770

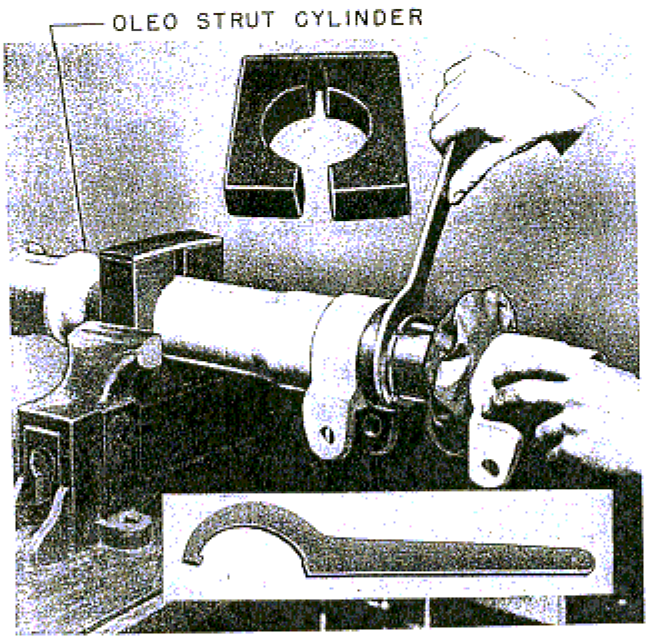


Figure 49—Vise Blocks, P-16244, and Cylinder Bearing Nut Spanner Wrench, P-14845

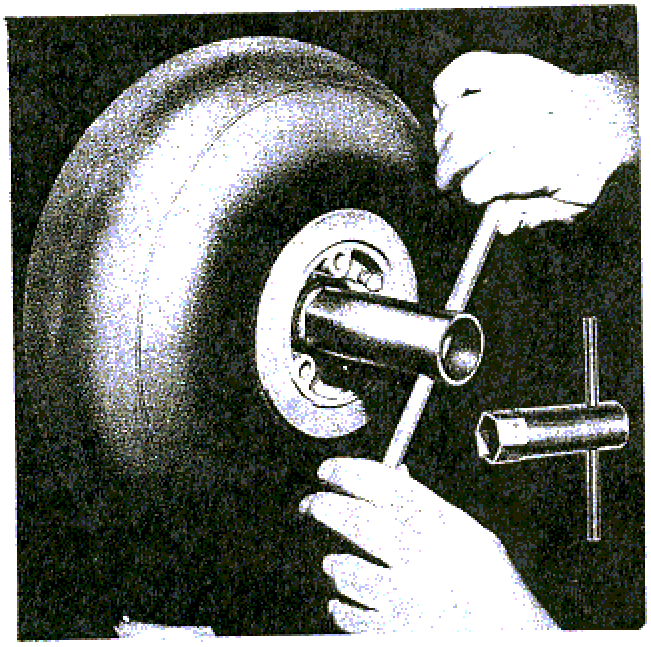


Figure 50—Tail Wheel Wrench, P-10195

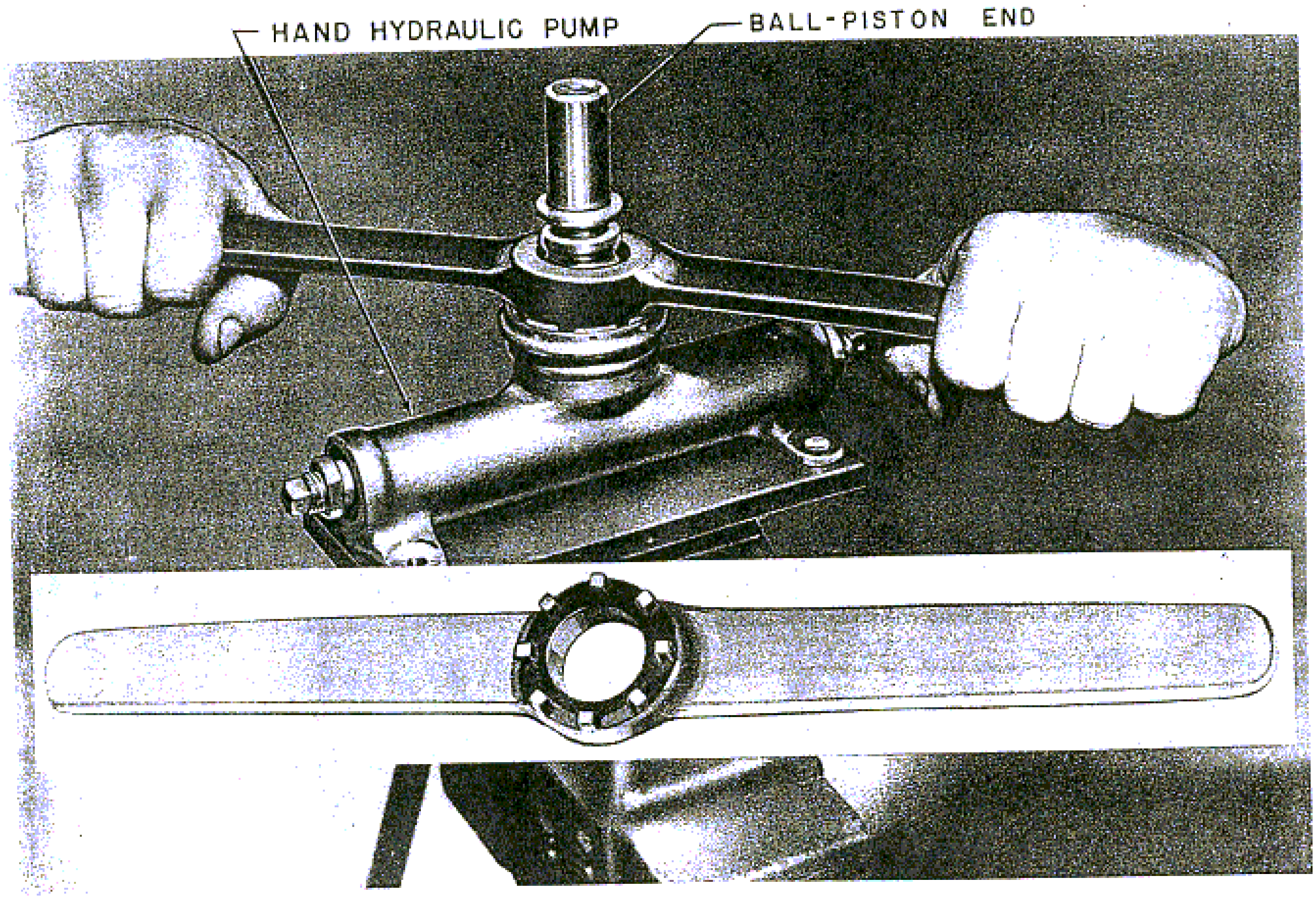


Figure 51—Ball-Piston End Retaining Nut Wrench, P-14835

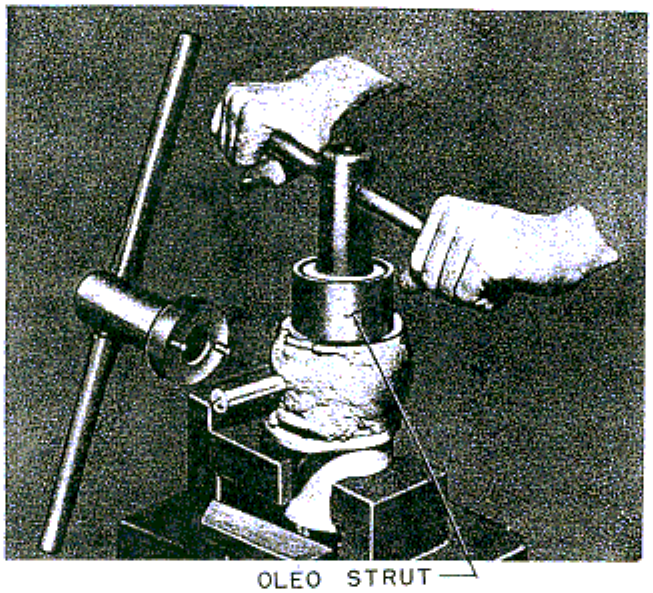


Figure 52—Plunger Assembly Installation Spanner Wrench, P-15765

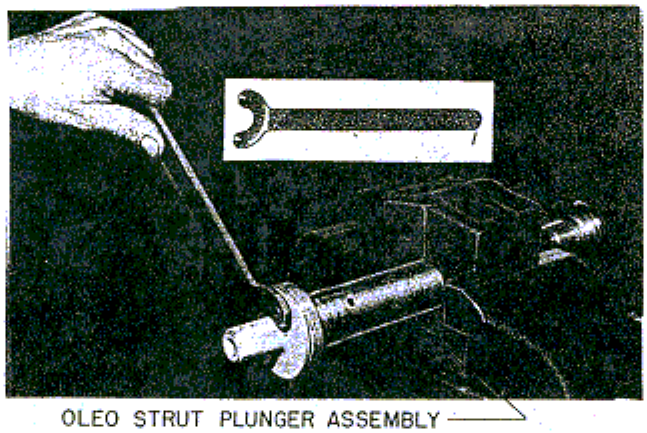


Figure 53—Plunger End Spanner Wrench, P-13171

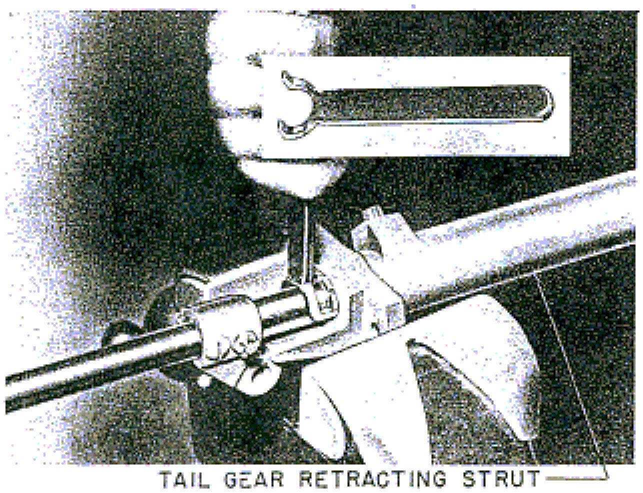


Figure 54—Cylinder Bushing Spanner Wrench, P-10189

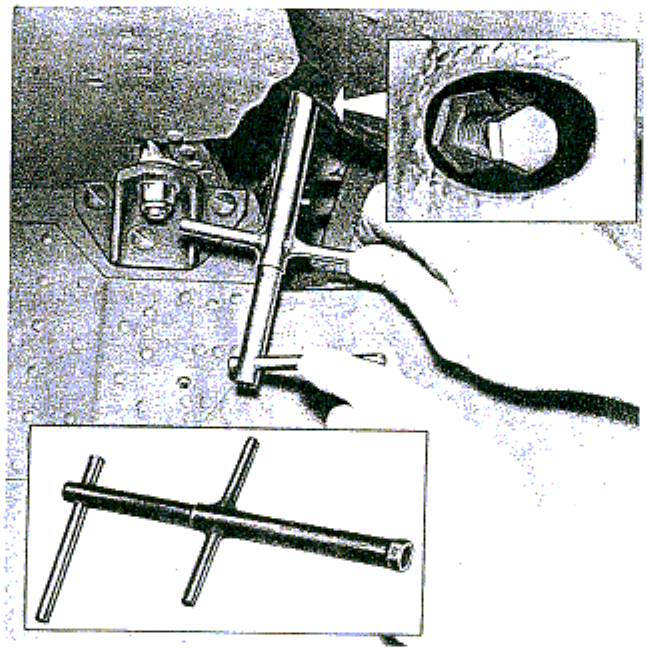


Figure 55—Elevator Trim Tab Control Wrench, P-20233

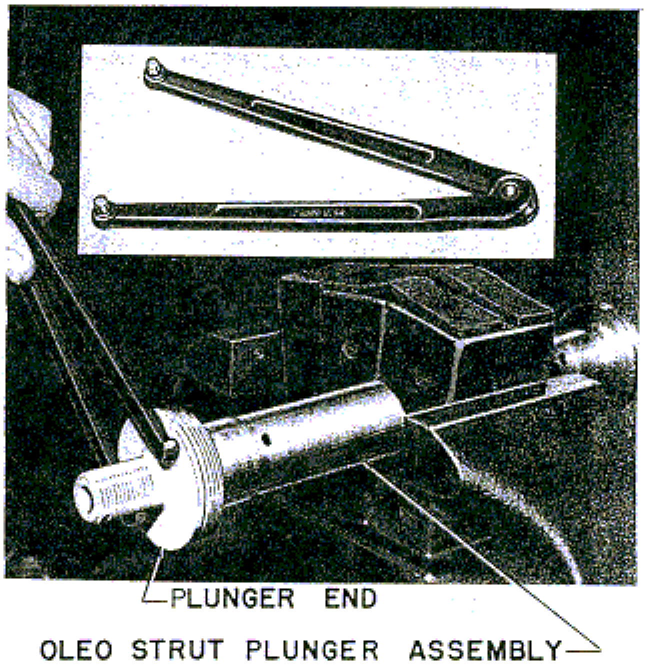


Figure 56—Adjustable Face Spanner Wrench, P-10188

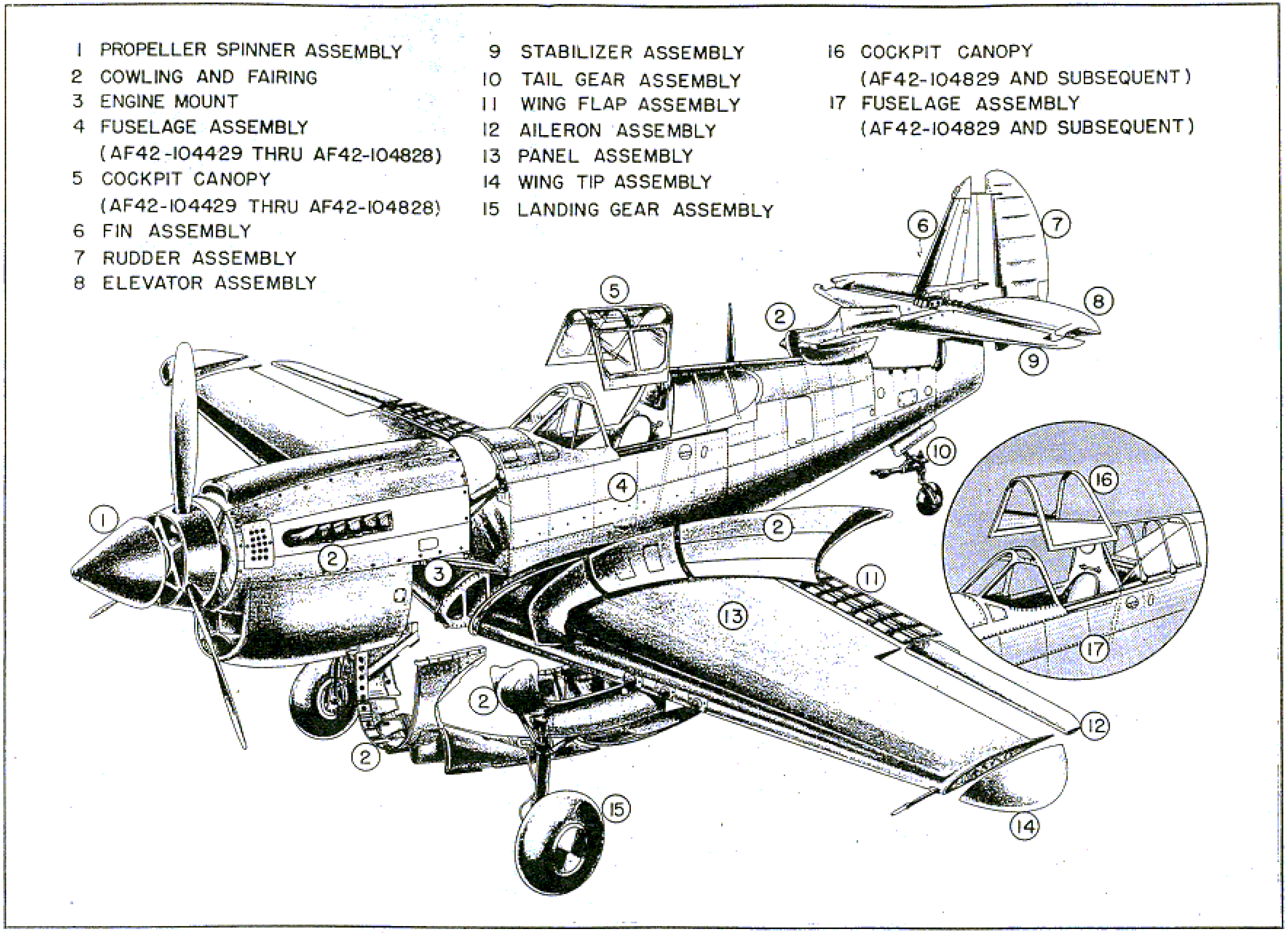


Figure 57—Main Assembly Breakdown

SECTION IV
MAJOR COMPONENT PARTS AND INSTALLATION

1. WING GROUP.

a. WING.

(1) DESCRIPTION.

(*a*) The wing is an internally braced, full cantilever, multi-cellular, stressed-skin type, consisting of two panels which are joined together at the airplane center line by a series of bolts through the match angles and the center line bulkhead. The match angles are riveted to the skin and stringer assemblies of each panel. (See figure 59.) The wing is attached to the fuselage by a series of bolts through the lower fuselage longerons and the wing attachment tees which are attached to the upper surface of the wing on each side of the airplane center line. (See figure 60.) Aluminum alloys 24SO and 24ST are the major materials used in the construction of the wing.

(*b*) Wells are built into the underside of the wing for the wing fuel tanks and landing gear wheels. A skid rail is provided at the joint where the two wing sections connect to serve as a skid in case of an emergency landing with the wheels retracted. (See figure 61.)

(2) REMOVAL AND DISASSEMBLY.

(*a*) REMOVAL OF WING.

WARNING

If removal of the wing from the fuselage is to be accomplished indoors, drain all fuel tanks (fuselage, wing, auxiliary wing and belly tanks) before the airplane is hangared to minimize the danger from fire. When the tanks are properly drained, close and lockwire the drain cocks to prevent dust and foreign material from entering the tanks.

1. Drain and remove the belly tank and the auxiliary wing tanks from the airplane if installed. The sway braces will be jettisoned with the tanks.

2. Remove the forward, intermediate, and rear keel fairings from the airplane, and drain the wing and fuselage tanks.

3. Remove the attaching screw and nut located adjacent to the fuselage tank sump drain, which attaches the battery vent line to the fuselage at this point.

4. Loosen the hose clamp around the fuselage fuel tank line at the trailing edge of the wing. Remove the attaching screw which holds the fuel line support clamp to the fuselage and disconnect the fuel line hose from the fuselage tank line at this point. Remove the support clamp from the hose and reinstall on fuselage for safe keeping.

5. Remove the three 5/16-inch bolts from the fuselage-to-wing trailing edge match angles.

6. Remove the front, intermediate, and rear wing fillets from both sides of the airplane. Remove the aft fairing of the front wing fillet, which is installed on the lower surface of the wing near the jack points.

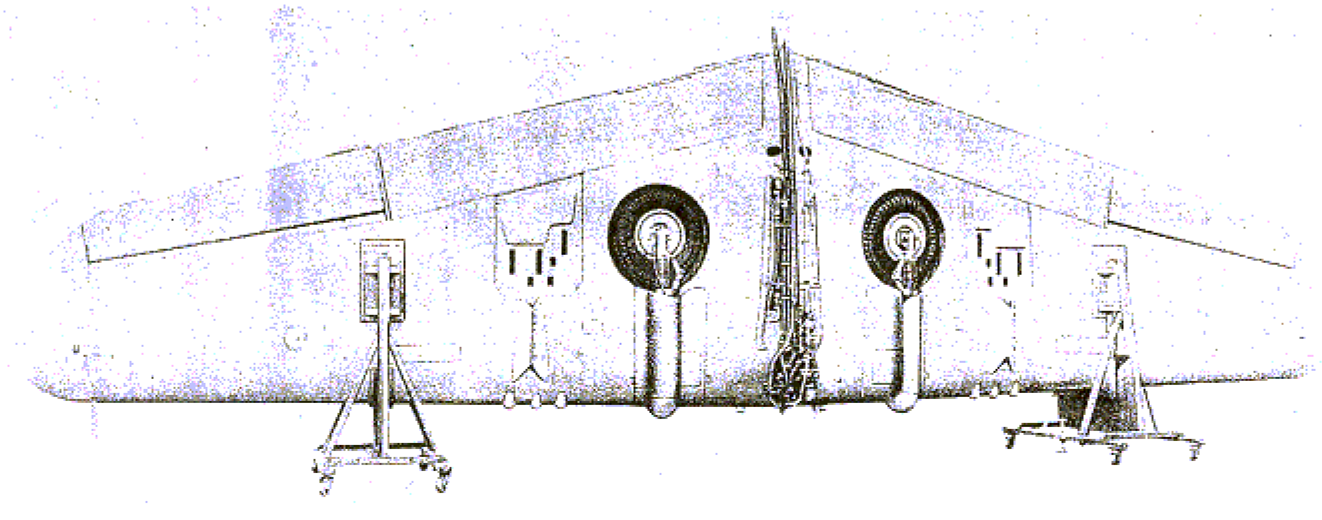


Figure 58—Wing Supported in Dollies

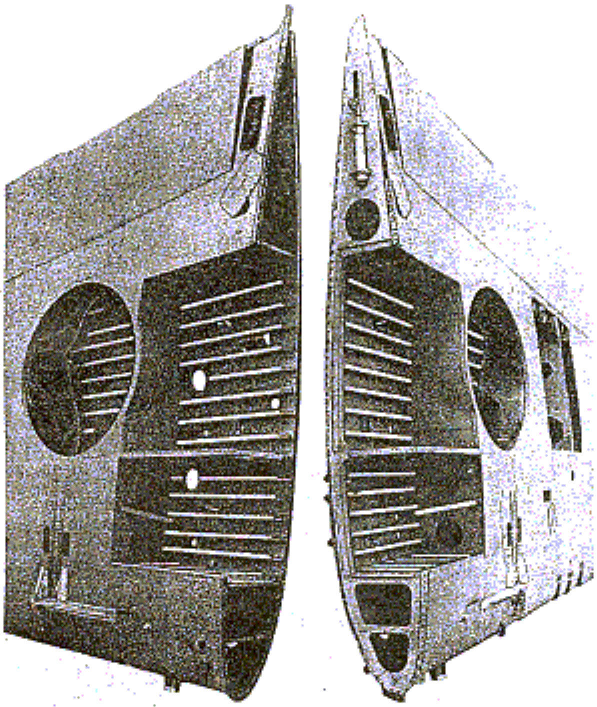


Figure 59—Wing Panels Separated

Note

The breather line from the propeller reduction gear housing is connected to the large vent fitting in the left front wing fillet. When all the attaching screws have been removed from the fillet, pull the fillet sufficient distance away from the airplane to reach in and loosen the hose clamp at the hose connection to the fitting. Then remove the fillet.

7. Remove the two side sections of engine cowl.

8. Remove the bottom engine cowl. Be sure to remove the safety pins and loosen the turnbuckles on the air seals between the coolant radiators and oil cooler and the intake ducts of the bottom engine cowl. The turnbuckles are accessible through the intake ducts in front of the bottom cowl. Push the canvas seals away from the cowl and then remove the cowl.

9. Remove the two sections of rear side cowl, one on each side of the fuselage.

Note

On airplanes with the battery installed forward of the firewall, the Reed and Prince screw at the top aft side of the rear left side cowl must be removed before the battery access door can be removed.

10. Remove the cowl flap assembly. Instructions for removal are given in paragraph 5, *b* of this section.

11. Remove the air exit duct. Instructions for removal are given in paragraph 5, *b* of this section.

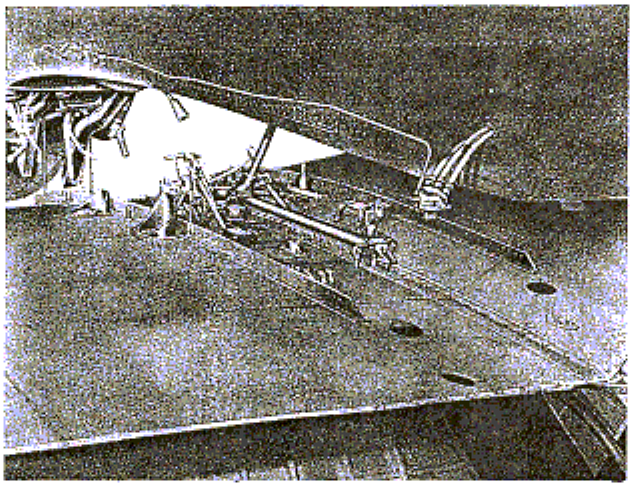


Figure 60—Lifting Fuselage Off Wing

12. Disconnect the oil "Y" drain valve from the support on the leading edge of the wing by removing the two attaching screws (figure 62).

13. Loosen the hose clamp on the engine fuel supply line at the point near the wing leading edge where the self-sealing hose is joined to the metal fuel line. Separate the hose from the metal fuel line.

14. Disconnect the 1/4-inch primer line at the hose connection to the fuel selector valve.

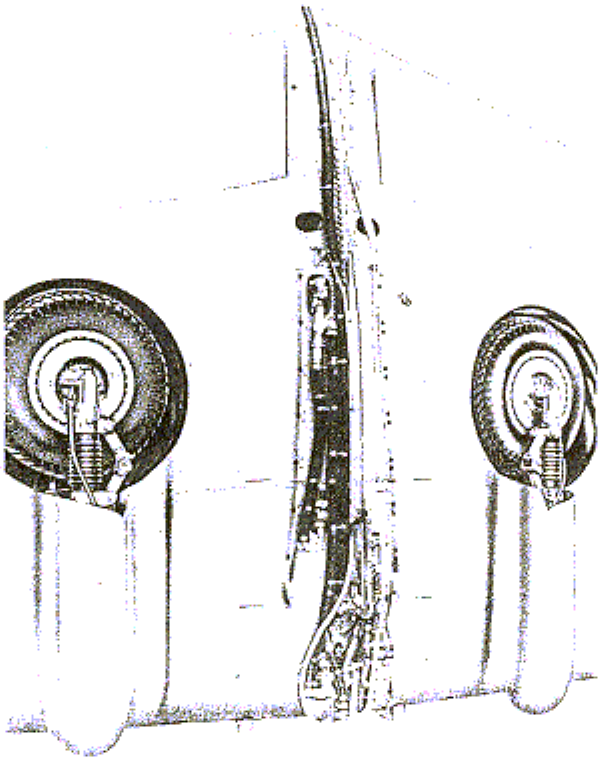
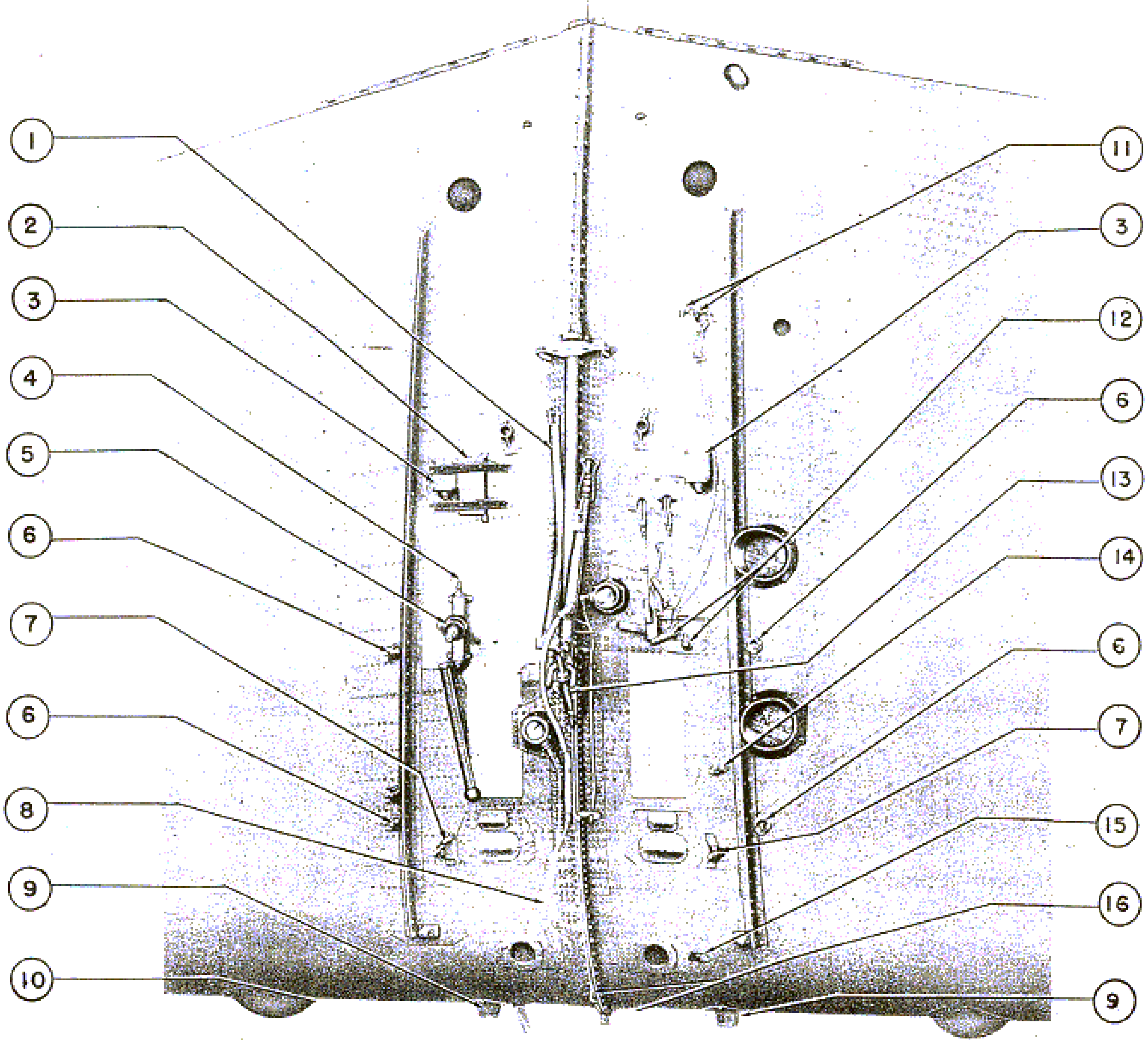


Figure 61—Center View of Panel—Lower Surface



1. ELEVATOR PUSH-PULL TUBE
2. SIGNAL PISTOL CARTRIDGE CONTAINER SUPPORT
3. PANEL JUNCTION BOX
4. HYDRAUIC PUMP OUTLET CONNECTION
5. HYDRAULIC PUMP INLET PORT
6. FUEL TANK VENT LINE CONNECTIONS
7. BRAKE HYDRAULIC LINE CONNECTIONS
8. CONTROL STICK CONDUIT ASSEMBLY
9. GUN HEATER DUCT ADAPTERS
10. OIL "Y" DRAIN VALVE SUPPORT
11. WING FLAP HYDRAULIC LINE CONNECTIONS
12. LANDING GEAR HYDRAULIC LINE CONNECTIONS
13. CONTROL STICK STOP
14. AIRSPEED LINE CONNECTIONS
15. FUEL SELECTOR VALVE SHAFT UNIVERSAL JOINT
16. COWL FLAP TORQUE SHAFT SUPPORT LUGS

Figure 62—Center View of Panel—Upper Surface

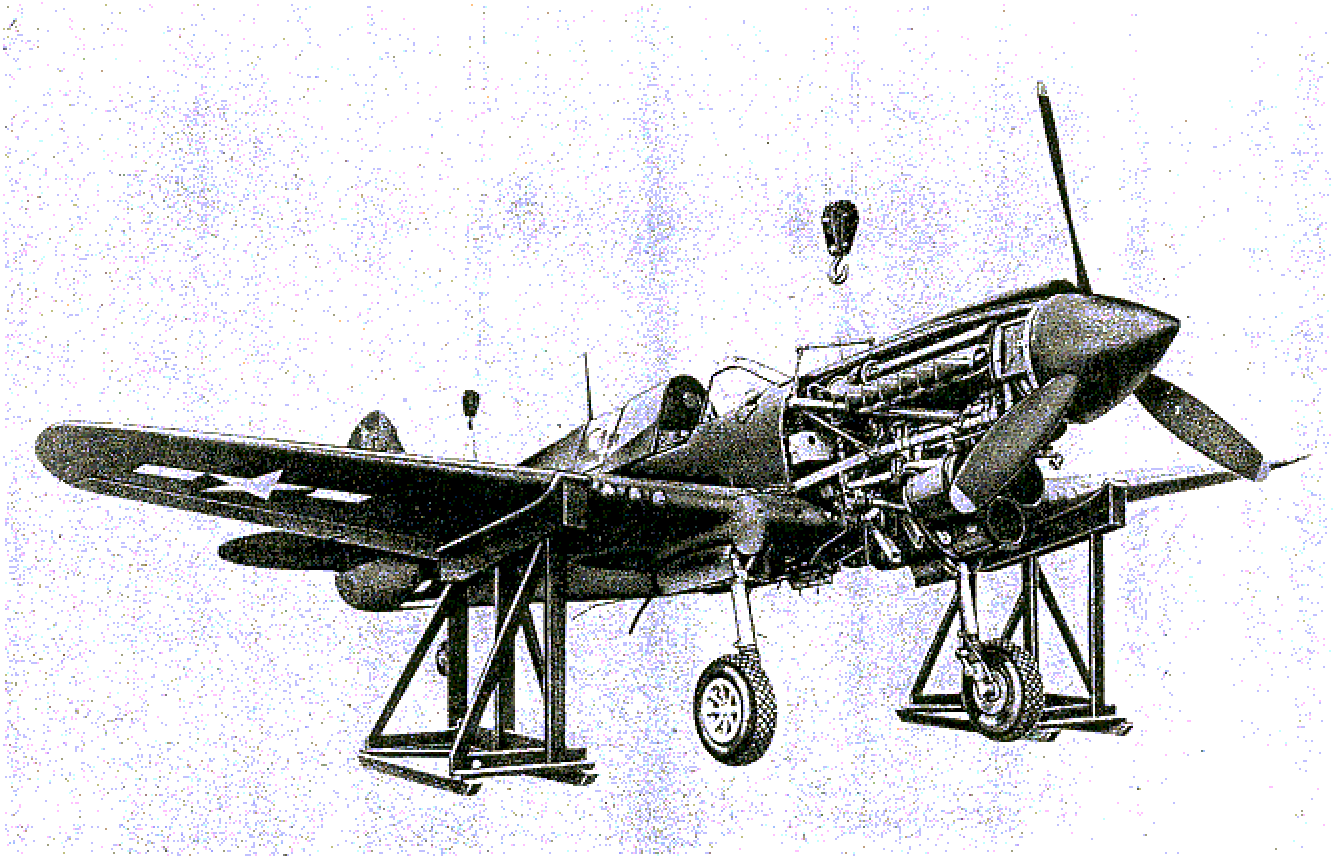


Figure 63—Airplane on Wing Supports—1/4 Front View

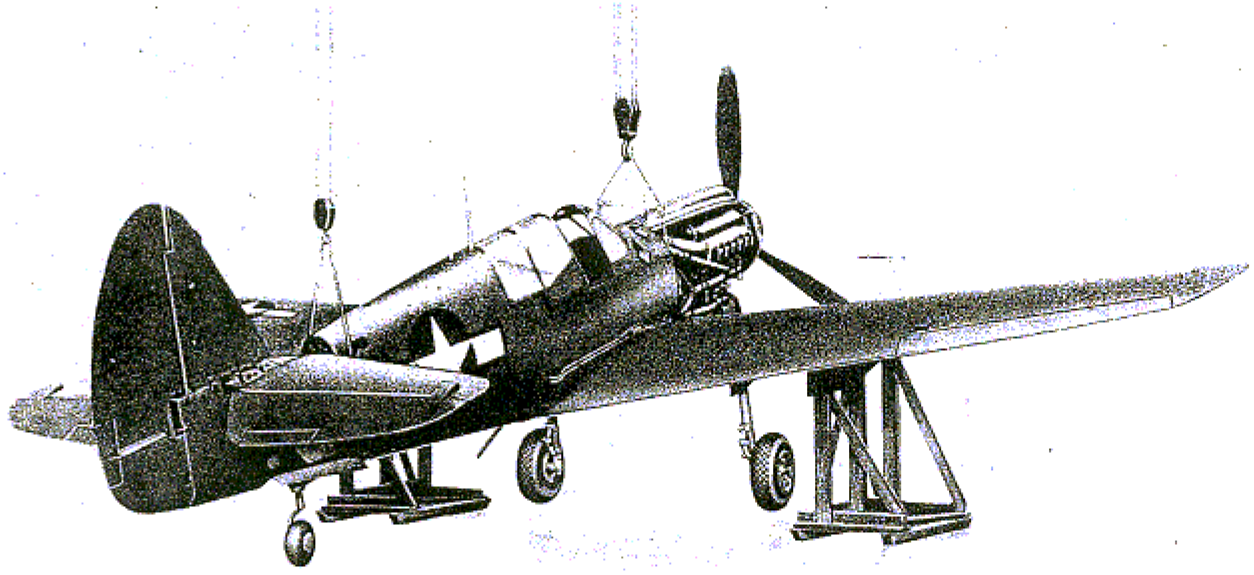


Figure 64—Airplane on Wing Supports—3/4 Rear View

15. Free the fuel supply line and 1/4-inch primer line which are secured by Adel clamps to the lug on the center line bulkhead at the wing leading edge by removing the one attaching screw.

16. Remove the cowl flap torque shaft support (figure 62) which is held by two bolts to lugs on the center line bulkhead at the wing leading edge.

17. Disconnect the electrical connector plug from the electric fuel pump motor.

18. Disconnect the fuel selector valve shaft by removing the pin above the universal joint at the top of the wing forward of the firewall on the left side.

19. Remove the pilot's seat from the cockpit.

20. Remove the armor plate immediately aft of the pilot's seat.

21. Disconnect the elevator push-pull tube from the bellcrank on the jack shaft. Also, remove the bolt attaching the control stick stop to the lug on the center line bulkhead forward of the control stick to provide more working space in the cockpit.

22. Disconnect the wing fuel tank vent lines at the hose connections on each side of the fuselage. Plug or seal the vents to the tanks.

23. Before the following steps are accomplished, hoist the airplane onto wing supports as shown in figures 63 and 64. Attach the front hoisting sling clevis ends to the lugs on the engine mount (figure 11). *Be sure* to install the nuts on the clevis bolts to avoid danger of the bolts slipping out from the clevis ends when the airplane is suspended. Attach the tail hositing sling to a bar passed through the lift tube in the rear of the fuselage (figure 11). Hoist the airplane and place the wing supports under the wing just outboard of the gun installations. Do not let the full weight of the airplane rest on the wing supports. The wheels must be off the ground so that the landing gear can be operated.

24. Raise the landing gear by placing the landing gear selector valve handle in the "UP" position and operating the electric hydraulic pump or the hand hydraulic pump. When the gear is locked in the retracted position, place the control handle in the "DOWN" position to relieve the hydraulic pressure in the system. With the selector valve handle in the "DOWN" position, the tail wheel should fall by its own weight into the extended position. If the tail wheel will not extend readily, a few strokes of the hydraulic hand pump will start it. Stop operation of the hand pump as soon as the tail wheel doors *start* to open and pull the tail wheel down by hand, if necessary. Return selector valve handle to "NEUTRAL". With the pressure relieved in the system, the nuisance of hydraulic fluid spurting out when the lines are disconnected is avoided.

IMPORTANT

If the wing is to be separated into its two individual panels after the wing is separated from the fuselage, it is necessary to remove the landing gear inner side fairing and the landing gear inner door from both panels before the wheels are retracted. This is done so that the fuel tank doors can be removed later.

It is, also, necessary to disconnect the two wing bomb control cables which are accessible through the right wheel well when the landing gear is extended. Remove the top wheel pocket cover and disconnect the wing bomb control cables at the quick detachable clevises. Remove the fairlead from the bracket above the wheel, draw cables through and replace the fairlead. (See figure 65.) The wheels can now be retracted and the wing bomb control cables will not cause any difficulty when the panels are separated.

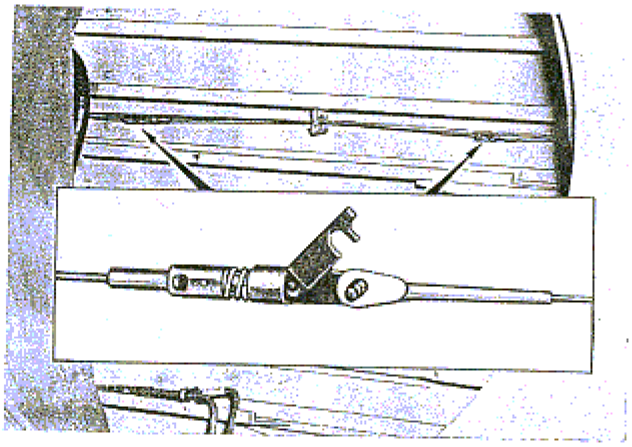


Figure 65—Wing Bomb Control Cables in Wheel Well

25. Disconnect the hydraulic line from the end of the hand hydraulic pump (figure 62) and attach a rubber hose to the pump at this point. Pump the hydraulic fluid from the system into a one gallon container by means of the hand hydraulic pump until the pump handle moves freely indicating that all fluid in the system has been withdrawn. Approximately one gallon of hydraulic fluid will be withdrawn from the system.

26. Disconnect the hydraulic line from the port at the center of the hand hydraulic pump. (See figure 62.)

27. On those airplanes that are provided with the signal pistol, the two hydraulic lines that are connected to the hand hydraulic pump lie under the cartridge container support assembly. Remove the two screws from the inboard side of the container support that attach the support to the cockpit floor, and remove the hydraulic lines from under the support assembly.

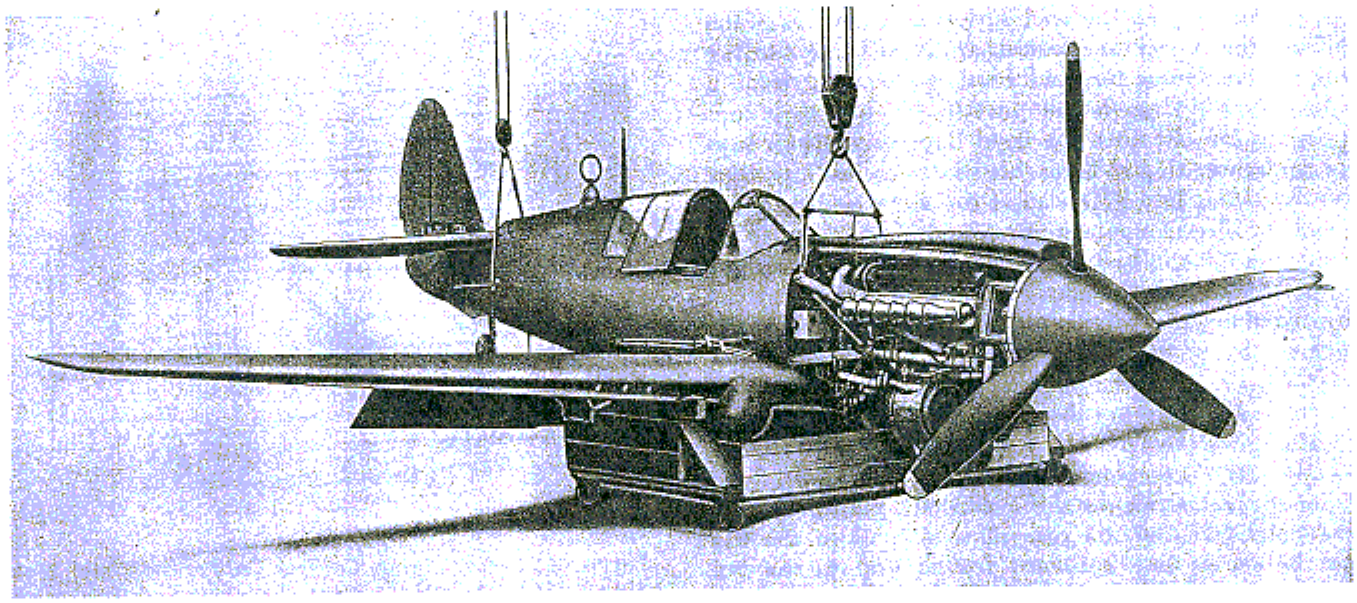


Figure 66—Airplane on Wing Cradle

28. At this stage of disassembly, hoist the airplane off the wing supports and remove to the cradle as shown in figure 66. Support the aft end of the airplane by the hoist until the wing is separated from the fuselage and the fuselage is transferred to a dolly as shown in figure 67.

IMPORTANT

Seal all ports and openings in the hydraulic system immediately upon disconnecting the lines.

29. Disconnect the two hydraulic lines to the landing gear at the connections on the cockpit floor. (See figure 62.)

30. Disconnect the two hydraulic lines to the wing flap actuating cylinder at the floor line aft of fuselage bulkhead 5 on the left side of the airplane. (See figure 62.)

31. Disconnect the two brake system hydraulic lines at the floor line, one on each side of the cockpit and forward of the rudder pedals. (See figure 62.)

32. Disconnect the two airspeed lines at the floor line on the left side of the cockpit. (See figure 62.)

33. Disconnect the electrical connector plugs from the two junction boxes on the cockpit floor, one on each side of the pilot's seat. Also, disconnect the electrical wires (those which are a part of the conduit assembly from the flight control stick and those from the fuel tank gages) from the six-stud terminal strip that is located under the main switch box. (See figure 62.)

34. Free the oxygen line which is secured by an Adel clamp to the cockpit floor at the point just inboard of the electrical junction box at the left of the pilot's seat by removing the one attaching screw.

35. Remove the nuts from the fuselage-to-wing bolts using 1/2-, 9/16-, and 5/8-inch open end and socket wrenches. Use the open end wrenches to hold the nuts inside the cockpit. Use the socket wrenches to unscrew the bolt from the nut from outside the cockpit.

36. Raise the airplane slightly to relieve the load on the wing-to-fuselage bolts.

37. Remove the wing-to-fuselage bolts, using a bolt puller if one is available.

38. Raise the aft end of the fuselage until it clears the trailing edge of the wing by approximately six inches. Then raise the front end of the fuselage approximately three inches. Be sure that all lines and connections are free, then raise the complete fuselage, front and rear, and move it forward at the same time to clear the lines at the leading edge of the wing. Transfer the fuselage assembly to a dolly as shown in figure 67.

(*b*) DISASSEMBLY OF WING.

1. To separate the wing into its two panel assemblies, the work is most easily accomplished by supporting the wing vertically on its leading edge in a buck placed just outboard of the guns in each panel. (See figure 58.)

2. Remove the fuel supply lines between the fuel tanks and the fuel selector valve on the under surface of the wing near the wing match angles. For those airplanes with the battery installed in the engine compartment, remove the battery vent line that is attached to the under surface of the wing near the match angles.

3. Disconnect the fuel line between the fuel selector valve and the fuel strainer at the selector valve.

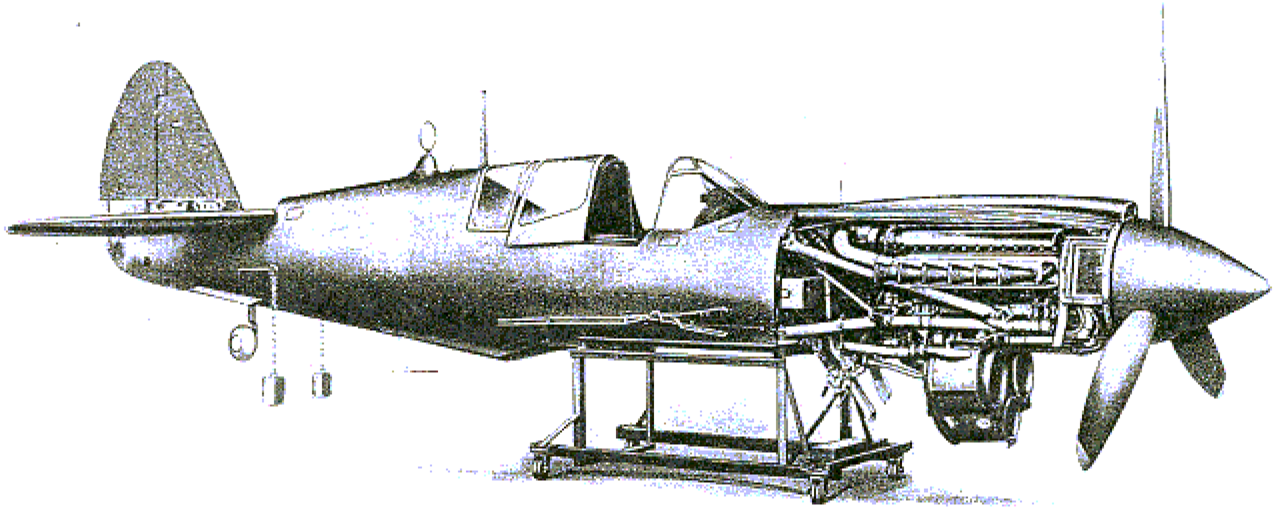


Figure 67—Fuselage on Dolly

Remove the two bolts attaching the fuel strainer to the panel, and remove the four bolts attaching the fuel pump and motor assembly bracket to the panel. Remove the fuel strainer, fuel pump and motor assembly, and the connecting fuel lines as a unit. Seal all open lines and ports to prevent dust and foreign material from entering the units.

4. Remove the bolt attaching the fuel selector valve brace to the bracket on the panel. Remove the three bolts attaching the selector valve support to the match angles. Remove the selector valve, brace, and support from the panel. The selector valve control rod that extends through the panel may be withdrawn without detaching from the selector valve.

5. Disconnect the belly-bomb-tank control cables from the bomb shackle and remove the bomb shackle. The bomb shackle is held by two bolts, one at the front and one at the rear, to the bomb rack mounting fittings which are bolted to the wing match angles.

6. Remove the belly-bomb control-cable fairleads from the tee section on the bottom of the wing.

7. The landing gear inner side fairing and the inner door must be removed in order to remove the fuel tank doors. If the inner side fairing and inner door were not removed when the wing was separated from the fuselage, it will be necessary to attach a portable hydraulic system to the two hydraulic lines to the landing gear and pump the landing gear to the extended position, in order to gain access to the attaching screws inside the fairing installation.

8. While the wheels are extended as in the previous step, remove the top wheel pocket cover from the right panel, and disconnect the wing bomb control cables at the quick detachable clevises. Remove the fairlead from the bracket above the wheel, draw cables through and replace the fairlead. The wheels can now be retracted and the wing bomb control cables will not cause any difficulty when the panels are separated.

9. Remove the six bolts which hold the bomb shackle mounting front fittings and the bomb sway brace and front keel cowl supports to the match angles and remove the two bolts attaching the tee section fittings (at the rear) to the wing match angles. Remove the front bomb shackle mounting fittings from the tee section by removing the one attaching bolt.

10. Remove the two bolts which hold the rear sway brace supports to the match angles at web 3 and remove the supports.

11. Loosen several of the bolts through the fuel tank door match angles approximately one turn to relieve the strain on the many screws which attach the tank doors to the wing.

12. Remove all screws attaching the fuel tank doors to the wing.

13. Remove the bolt through the match angles at web 3 and remove the eight bolts attaching the doors to web 3 at this point.

14. When all attaching screws are removed, lift the tank doors as a single unit, off the wing.

15. Remove the wing fuel tank gages, and the fuel tank filler caps. Remove the spring holding the scuppers to the filler cap adapter and remove the bonding at the scupper attaching screw. Be sure all fuel tank vent lines are removed from the tank fittings and seal all openings into the tanks.

16. Loosen the tank strap turnbuckles and remove the straps.

17. Remove the fuel tanks.

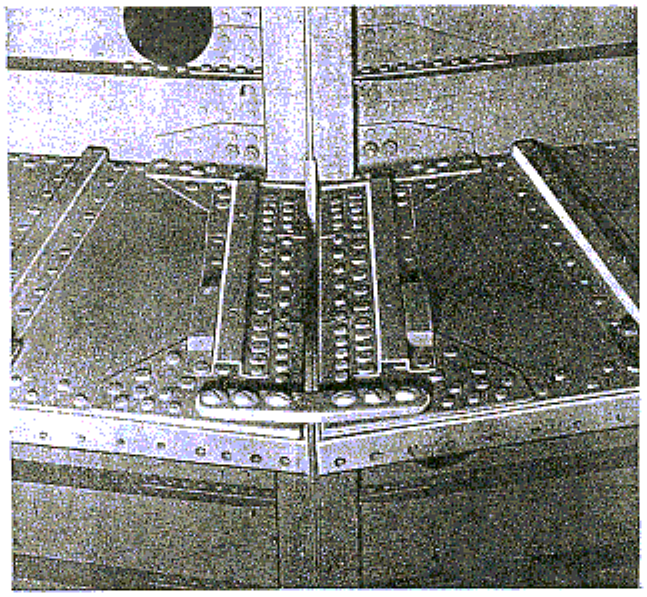


Figure 68—Splice Plate at Web 3

18. Remove the three bolts from one side of the splice plate which connects web 3 of each panel. (See figure 68.)

19. Disconnect the two 3/8-inch hydraulic lines to the right landing gear at the tee fittings located in the left wing panel between web 3 and web 4. Remove the chafing block from the center line bulkhead so that the hydraulic lines may be pulled through the opening in the bulkhead when the panels are separated. (See figure 69.)

20. Disconnect the links from the wing flap actuating cylinder to the bellcrank in the left wing

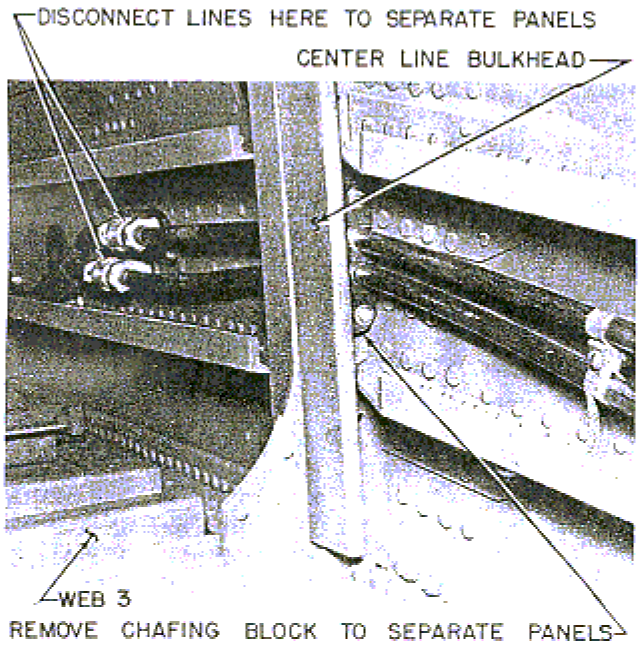


Figure 69—Landing Gear Hydraulic Lines in Wing

panel and disconnect the hydraulic lines to the actuating cylinder. The cylinder is attached to the center line bulkhead. (See figure 59.)

21. Remove the two bolts which attach the control stick torque tube rear fitting to the match angles.

22. Disconnect the links at the aileron control arm on the torque tube. (See figure 70.)

23. Remove the bonding from the control stick to the wing panel.

24. Remove the bolt which attaches the lower end of the elevator stop to the lug on the center line bulkhead. (This step may have been accomplished when the wing was separated from the fuselage.)

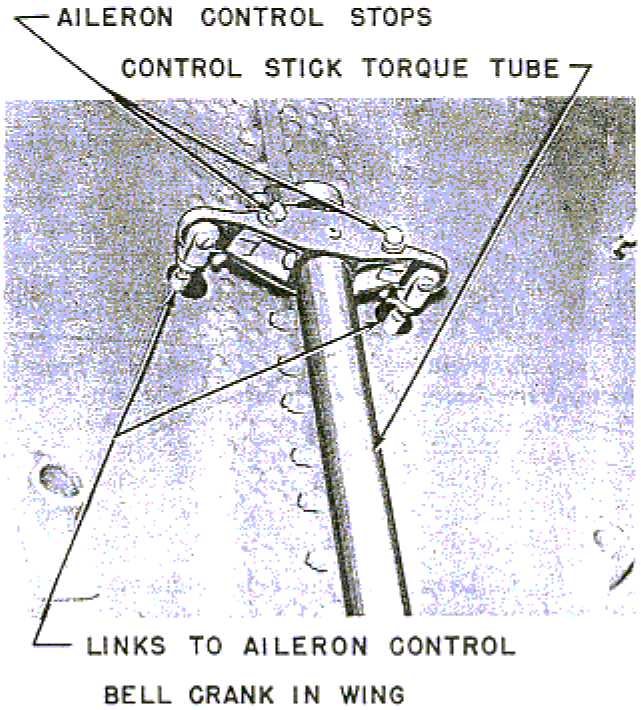


Figure 70—Control Stick Torque Tube

25. Remove the two bolts which attach the control stick torque tube forward fittings to the match angles and remove the control stick assembly.

26. Before removing all bolts through the wing match angles, block up the wing near the match angles to facilitate removal of the bolts.

27. Remove all bolts through the match angles and separate the wings. The center line bulkhead is attached to and will remain with the right panel. (See figure 59.)

(3) ASSEMBLY AND INSTALLATION.

(*a*) ASSEMBLY OF WING.

1. Support the left and right panels in dollies. Block up the panels near the match angles, as required, and install bolts at several points through the wing match angles to connect the panels.

2. Install the remainder of the bolts through the wing match angles omitting the bolts which attach the control stick torque tube forward and rear fittings to the match angles.

3. Attach the control stick torque tube assembly to the wing match angles.

4. Connect the links between the aileron bellcranks in the wing and the torque tube arm at the arm on the torque tube. (See figure 70.)

5. Connect the links from the wing flap actuating cylinder to the bell crank in the left wing panel and connect the hydraulic lines to the actuating cylinder.

6. Install the landing gear hydraulic lines in the wing and connect them to the tee fittings located in the left wing panel between web 3 and 4. Refer to the "Tube Chart for Hydraulic System" in section VIII for application of anti-seize thread lubricant and the torque requirements of the tube fittings. Install the chafing block over the hydraulic lines where they pass through the center line bulkhead. (See figure 69.)

7. Install the splice plate which connects web 3 of each panel. (See figure 68.)

8. Install the wing bomb pulley and bracket assembly on the top of the left panel and string the cables through the fairlead into the wheel well.

Note

If a portable hydraulic system is not available to lower the landing gear, attach a piece of wire to the wing bomb control cables before they are strung into the wheel well. When the wing is attached to the fuselage and the airplane hydraulic system can be used to lower the landing gear, the wing bomb control cables can be connected and the top wheel pocket cover installed. (See figure 65.)

9. Inspect the fuel tank strap brackets for security of attachment. Replace the brackets if defective and tighten the attaching bolts.

10. Make sure the filler neck scupper drain lines are attached at the scupper.

11. Make complete inspection of the fuel tank compartments. Be sure the nut plates installed on the under side of the cockpit floor and the nut plates for attaching fuel tank doors are not mutilated or missing.

12. Before installing the fuel tanks inspect the tanks for cuts, punctures and other damage. Check the tightness of the hand hole covers. Attach the filler neck adapter to the neck of the tank.

13. Install the fuel tanks. Installation is facilitated by using two "shoe horns", one placed over each web, to avoid tearing the tank covering when the tank is put in place.

Note

The "shoe horn" is made from a piece of .051 dural sheet, 12 inches wide and 18 inches long. Double back four inches of the length of the sheet, thus reducing the overall length to 14 inches. Bend the four inch doubled end over to form a right angle with a single thickness leg of 10 inches and a doubled thickness leg of four inches. The end is doubled so that danger of cutting the fingers on a sharp edge is avoided when the "horn" is removed from between the web and the tank.

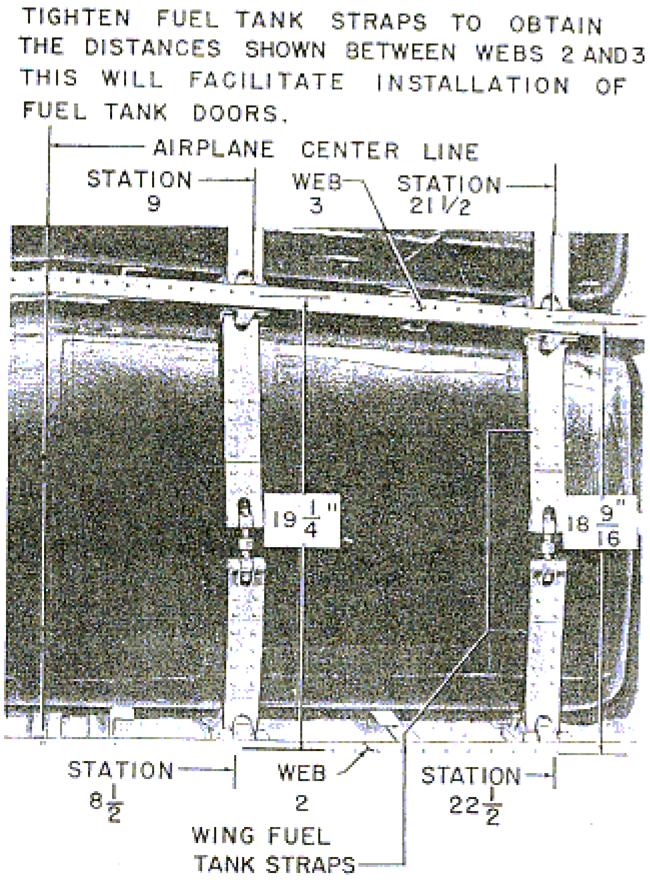


Figure 71—Tightening Fuel Tank Straps

14. Install the fuel tank straps and safety wire the turnbuckles.

Note

Care must be observed in tightening the wing fuel tank straps to prevent misalignment of web 3. Adjust the straps to obtain the distances between web 2 and 3 that are shown in figure 71. Proper alignment of web 3 will facilitate installation of the fuel tank doors.

15. Install the fuel tank strainers and drain cocks in the wing tank sumps.

16. Inspect for completeness of the fuel tank installation before installing the doors.

17. Check the depth of fuel tank against the length of the fuel gage float chamber to insure that the float chamber does not contact the bottom of the tank. If the float chamber contacts the bottom of the tank, the tank is shallow and must be re-

placed. If the shallow tank is not replaced, the tank may be punctured by the gage float chamber because of constant rubbing of the chamber against the tank bottom.

18. Install the wing fuel tank gages and the fuel tank filler caps. Install the spring holding the scuppers to the filler cap adapter and install the bonding braid at the scupper attaching screws. Be sure all openings into the tanks are sealed. Be sure to install the fuel gages so that the dials can be easily read by the pilot.

19. Install the fuel tank doors. If doors are installed as a single unit, be sure that the bolts through the fuel tank door match angles are loosened approximately one turn so that the door attaching screws may be installed.

20. Install all screws attaching the fuel tank doors in the wing. Install the eight bolts near the wing match angles attaching the doors to web 3 and safety wire.

21. Install the rear sway brace supports to the match angles at web 3.

22. Install the bomb shackle mounting front fittings and the bomb sway brace and front keel cowl supports on the match angles at web 2.

23. Attach the tee section fittings to the wing match angles at web 4.

24. Install the two pulley and bracket assemblies, one on the top and one on the lower surface of the left panel, just aft of web 4.

25. Install the belly bomb control cable fairleads on the tee section on the bottom of the wing.

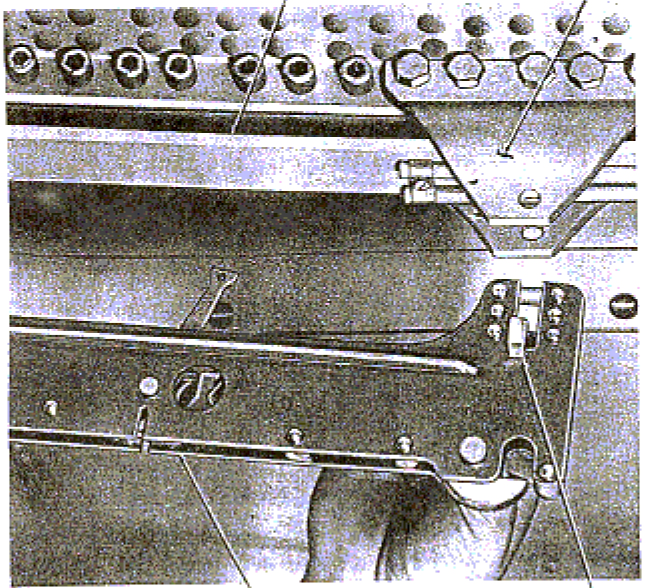


Figure 72—Inserting Block in Shackle Prior to Installation

26. Install the bomb shackle. Be sure to install the block, part No. 87-70-913, as shown in figure 72.

27. String the belly bomb cables from the bomb shackle through the fairleads and the pulleys installed in steps *24* and *25*, preceding. Cut the cables to required length and install end fittings and solder.

28. Install the two cockpit heat adapter seals in the top of the wing leading edge.

29. Install the fuel selector valve.

30. Install the fuel strainer, fuel pump and motor assembly and the connecting fuel lines, as a unit on the panel.

31. Connect the fuel supply lines between the fuel tanks and the fuel selector valve.

32. For those airplanes with the battery installed in the engine compartment, install the battery vent line on the under surface of the wing near the match angles.

33. Install the landing gear fairing.

34. Be sure that all attaching screws and bolts are installed and tightened to the proper torque.

(*b*) FINAL TEST AFTER ASSEMBLY.

1. Before the wing is attached to the fuselage, the landing gear should be tested by an auxiliary hydraulic system for proper operation. Any malfunction must be investigated and corrected.

2. Before attaching the wing to the fuselage, about 30 men should be made available to lift the complete wing and turn it about its leading edge to ascertain if any loose parts or tools have been left inside the wing. Any sound or rattle inside the wing must be investigated and corrected before the wing is attached to the fuselage.

(*c*) INSTALLATION OF WING.

1. Before attaching the wing to the fuselage, apply a generous coating of grease, Specification AN-G-3, to the mating surfaces of the fuselage lower longerons and the wing attachment tees.

2. In lowering the fuselage onto the wing, care must be taken not to damage the lower edge of the firewall, hydraulic lines, and other installations either on the wing or in the fuselage.

3. Lower the forward end of the fuselage slightly in advance of the rear of the fuselage so that front fittings at the firewall, may be engaged first, and align and insert the bolts. Then lower the fuselage until the remainder of the holes are aligned. Install the proper size bolts with the heads outboard, working progressively from front to rear. Install the three bolts attaching the wing trailing edge match angle to the fuselage (center) match angle.

4. At this stage of assembly, hoist the airplane off the wing cradle and remove to the wing supports as shown in figures 63 and 64.

5. Install and connect the landing gear and wing flap hydraulic lines. (See figure 62.) Refer to the "Tube Chart for Hydraulic System" in section VIII for application of anti-seize thread lubricant and the torque requirements of the tube fittings. Fill and bleed the airplane hydraulic system according to the instructions given in section IV, paragraph 7, *c*, (10).

6. Connect the brake hydraulic lines. (See figure 62.) Fill and bleed the brake hydraulic system according to the instructions given in section IV, paragraph 4, *a*, (8).

7. Connect the two airspeed lines at the floor line on the left side of the cockpit. (See figure 62.)

8. Connect the electrical connector plugs to the two junction boxes on the cockpit floor, one on each side of the pilot's seat. (See figure 62.) Also, connect the electrical wires (those which are a part of the conduit assembly from the flight control stick and those from the fuel tank gages) to the six-stud terminal strip located under the main switch box. Be sure that each wire is connected to the proper terminal stud. Each wire is marked by a number and must be connected to the terminal stud that is marked by the same number.

9. Connect the elevator push-pull tube to the bellcrank on the jackshaft at station 5. Attach the control stick stop to the lug on the center line bulkhead. (See figure 62.)

10. Install the station 5 armor plate.

11. Install the pilot's seat.

12. Connect the wing fuel tank vent lines at the hose connections on each side of the fuselage.

13. Connect the fuel selector valve control rod and install the pin at the universal joint located forward of the firewall at the top of the left panel leading edge. Be sure that the rod linkage is properly connected so that when the control handle in the cockpit is turned to any tank the corresponding port in the selector valve is opened. Each rod link is marked with a scribed line or a red painted line running lengthwise of the rod. The marks on the linkage must line up before the links are fastened together.

14. Connect the electrical connector plug to the fuel pump motor.

15. Install the cowl flap torque shaft support on the center line bulkhead at the wing leading edge.

16. Secure the fuel supply line and 1/4-inch primer line by Adel clamps to the lug on the center line bulkhead at the wing leading edge. The clamps are attached by one attaching screw.

17. Connect the 1/4-inch primer line at the hose connection to the fuel selector valve.

18. Connect the oil "Y" drain valve to the support on the leading edge of the wing by installing the two attaching screws.

19. Connect the fuel supply line between the engine driven pump and the electrical fuel pump.

20. On airplanes with the battery installed in the engine compartment insert the battery vent line in the top of the battery vent jar.

21. Secure the Adel clamp, holding the 3/8-inch oil tank scupper drain line, to the attaching screw in the left gun heat adapter in the wing leading edge.

22. Connect the two gun heater ducts to the adapters in the leading edge of the wing. (See figure 62.)

23. Connect the fuel supply line between the fuel selector valve and the fuselage tank at the pipe connection aft of the wing trailing edge.

24. Install the air exit duct and connect the rear crankcase breather line and the 1/4-inch vent line at the hose connections forward of the wing leading edge on the left side of the engine compartment. Be sure the air seals between the radiators and the exit duct are installed, the turnbuckles tightened and safety pinned.

25. Install the rear side cowl and cowl flap assembly.

26. Install the bottom engine cowl. Be sure to install the canvas air seals in the air intake ducts of the bottom engine cowl and secure them in place by tightening the turnbuckles and installing the safety pins. Be sure the grommets for the fuel pump, spark plug, and battery and firewall junction box cooling air pipes are installed in the ducts of the bottom engine cowl.

27. Install the wing fillets.

Note

Before attaching the left front fillet to the airplane, connect the front crankcase breather line to the overboard fitting on the fillet.

28. Install the keel fairings.

29. Install the belly tank.

b. WING TIPS.

(1) DESCRIPTION.—The wing tips are detachable for replacement in the event of damage. These tips are attached to the wing by a series of flush-type screws on the surface.

(2) REMOVAL OF WING TIPS.—Remove the lower wing tip running light and disconnect the electric wire from the panel electrical installation at the lamp terminal. Remove the attaching screws about the inboard edge of the wing tip and remove the wing tip from the panel.

Note

The electrical wire to the wing tip running light also may be disconnected at the terminal block inside the wing panel. The terminal block is accessible through the inspection door that is located on the under surface of each panel near the outboard leading edge.

(3) INSTALLATION OF WING TIPS.—A tip will fit best on the wing for which it is marked. Owing to a slight variation in manufacturing tolerances, a new tip or one from another wing may have to be reworked slightly to correctly fit any given wing. It is most important, however, when installing any wing tip, to observe the following steps in the order in which they are listed:

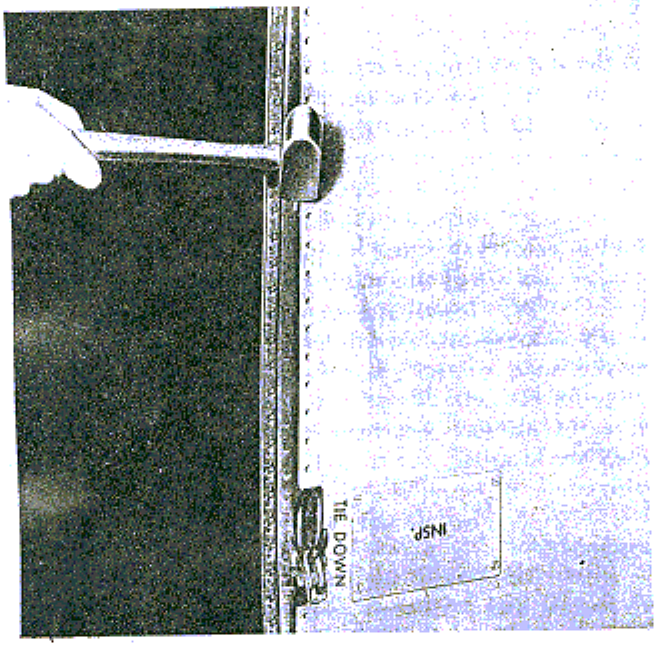


Figure 73—Installing Wing Tip—Step 1

(*a*) Make sure that the flange of the wing and bulkhead, to which the nutplate strips are attached, follows the contour of the wing. Tap with a wooden mallet to align, if necessary. (See figure 73.)

(*b*) Check all floating nuts on the wing end bulkhead flange for free movement and security of attachment. (See figure 74.)

(*c*) Tap with a wooden mallet around the inner contour of the tip attaching flange to flare out the flange slightly. Do not use force as spotwelds may be broken. (See figure 75.)

(*d*) Thread the electrical conduit to the wing tip running lights into the tip and slide the tip on the wing from the trailing edge. Align the last two holes in the lower side of the tip at the trailing edge with the nutplates in the wing and install one screw. (See figure 76.)

(*e*) Tap the wing tip into position so that the holes in the tip are aligned with the nutplates in the lower surface of the wing panel about one-quarter of the distance forward from the trailing edge. Install one screw as shown in figure 77.

Note

If, at this point, interference by the tip skin with the wing skin is noted, remove the tip and file the tip skin to allow 1/32-inch clearance when reinstalled.

(*f*) Following the procedure given in step (*e*), align the holes in the tip with the nutplates in the panel about three-quarters of the distance forward from the trailing edge and install one screw. (See figure 78.)

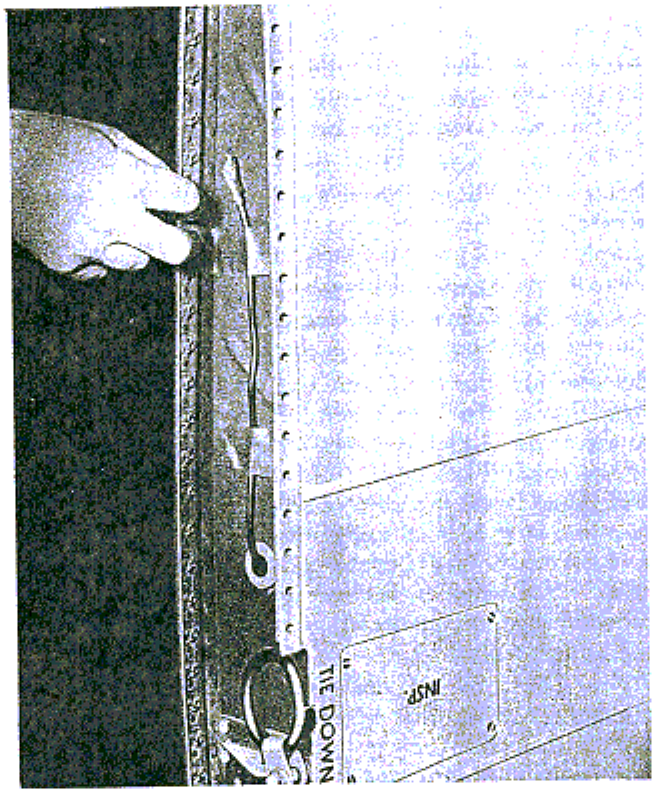


Figure 74—Installing Wing Tip—Step 2

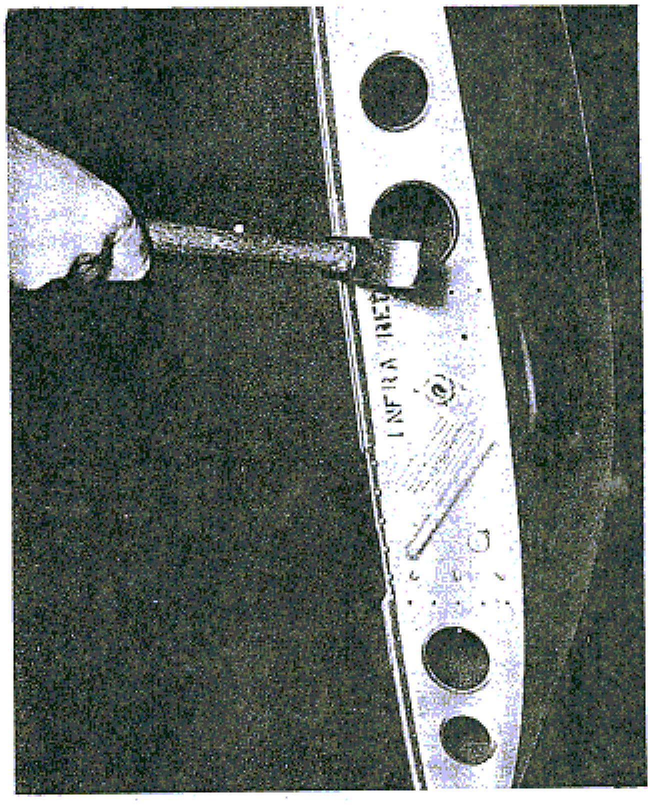


Figure 75—Installing Wing Tip—Step 3

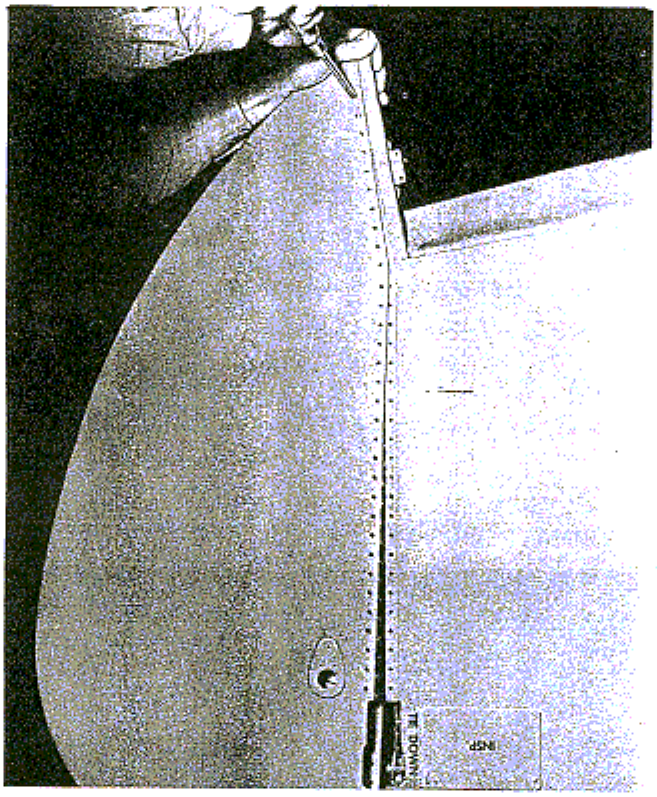


Figure 76—Installing Wing Tip—Step 4

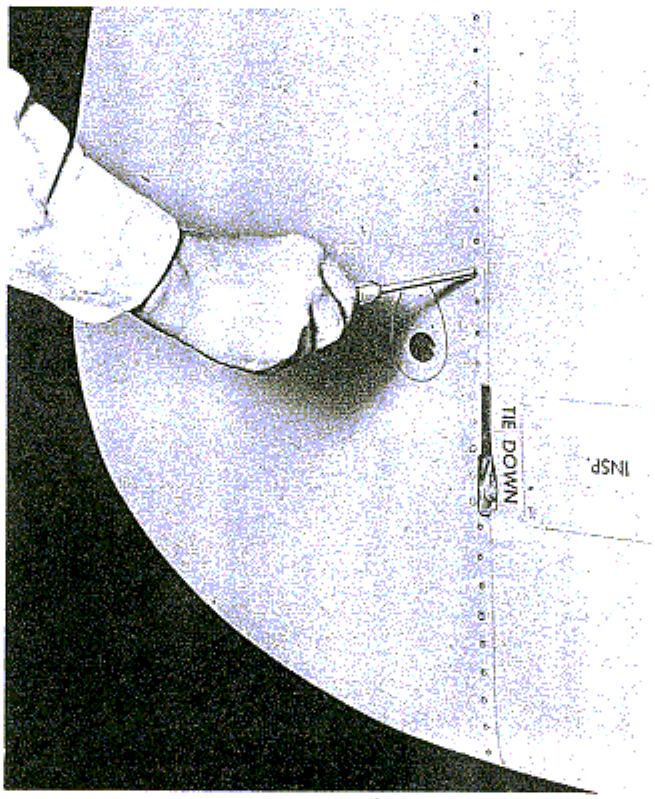


Figure 78—Installing Wing Tip—Step 6

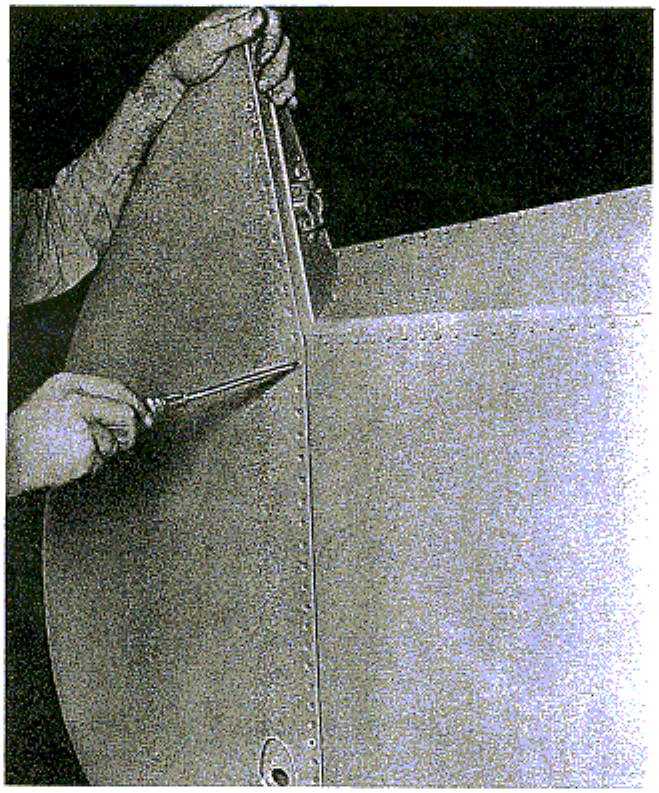


Figure 77—Installing Wing Tip—Step 5

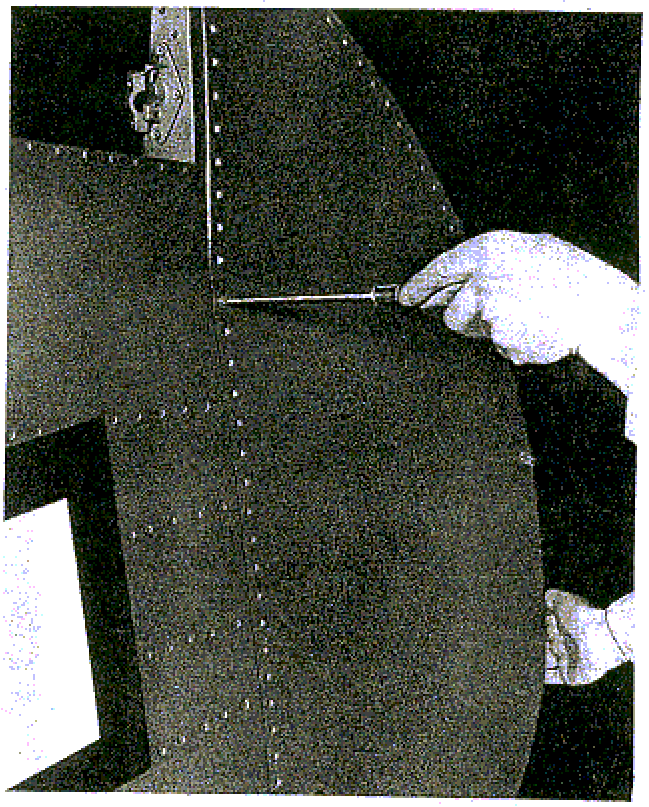


Figure 79—Installing Wing Tip—Step 7

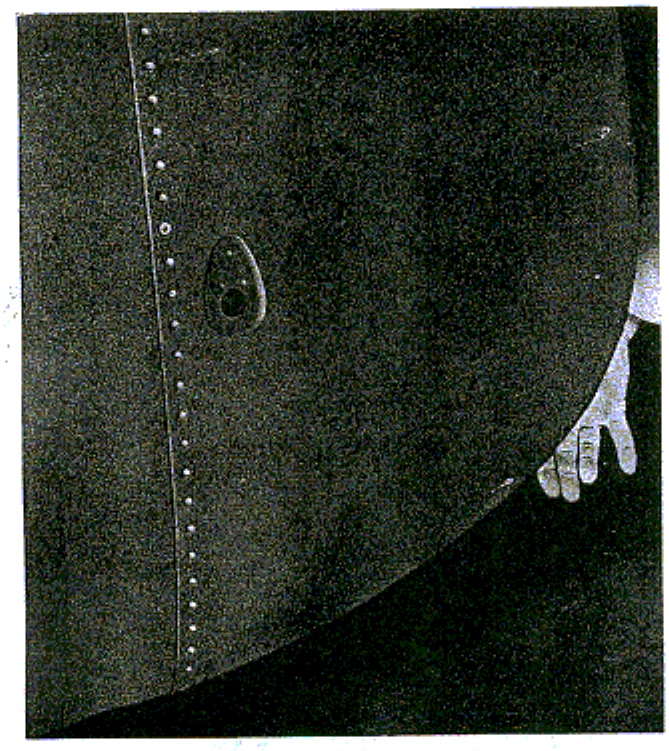


Figure 80—Installing Wing Tip—Step 8

(*g*) Working on the top side of the tip, pull the tip so that the holes align with the nutplates in the upper surface of the wing panel. Install three screws, one opposite each screw that was installed in the lower surface in steps (*d*), (*e*), and (*f*). (See figure 79.)

(*h*) If necessary, at this point strike the leading edge of the tip with cupped hands to bring the holes on the forward end of the tip in alignment and install one screw on each side near the tip nose. (See figure 80.) Do not strike the tip with a mallet as this will dent the tip bow.

(*i*) Install the remaining screws.

(*j*) General directions:

1. To align a floating nut plate with attaching holes, a smooth tapered drift may be used. However, do not force the tip itself in alignment with the drift because the dimpled tip hole may be cracked or the floating nut may be sprung out of position which will necessitate removing the entire tip.

2. When interchanging wing tips or installing a new spare tip, not previously fitted, follow the note under step (*e*). It may be necessary, where a few attaching holes do not line up, to file the tip dimpled holes. A No. 10 tap may be used if required but care must be taken not to destroy the threads of the nut plate. If the nut plate has a fibre locking collar, the tap must not enter this portion.

c. AILERONS.

(1) DESCRIPTION.—The ailerons are built with Frise-type aerodynamic balance and are also dynamically balanced. The right and left aileron trim tabs are of the fixed type, and must be adjusted on the ground. In addition to the fixed type trim tab, an electrically controlled trim tab, which is adjustable in flight, is incorporated in the left aileron for AF43-24252 and subsequent airplanes. The ailerons are constructed of metal, including a stressed skin leading edge, and are fabric covered. Three mounting bearings are provided on each aileron.

(2) REMOVAL OF AILERON.

(*a*) Remove the bonding.

(*b*) Remove the one bolt at the center hinge and the cap from each end bearing. The control arm slips out of the socket on the control drum in the panel.

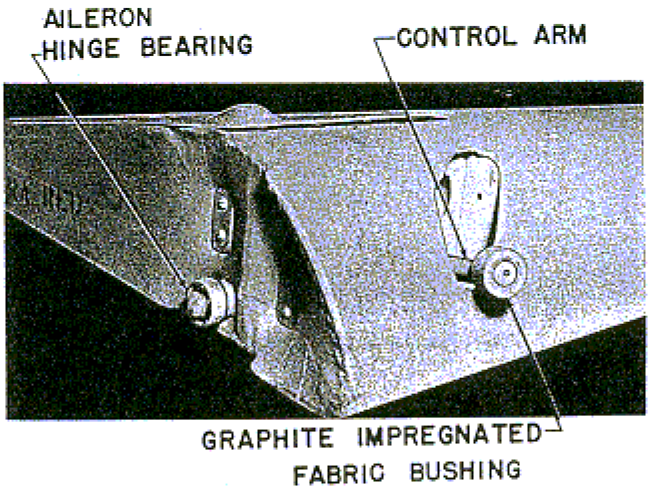


Figure 81—Inboard End of Aileron

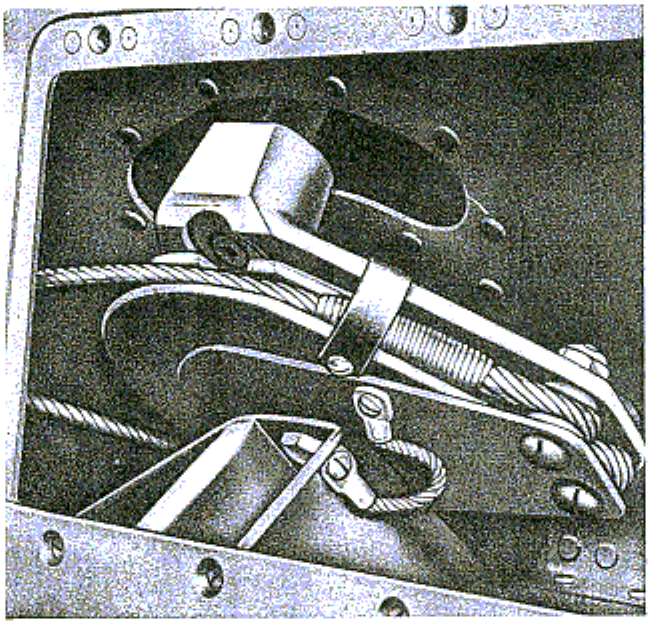


Figure 82—Aileron Control Drum in Panel

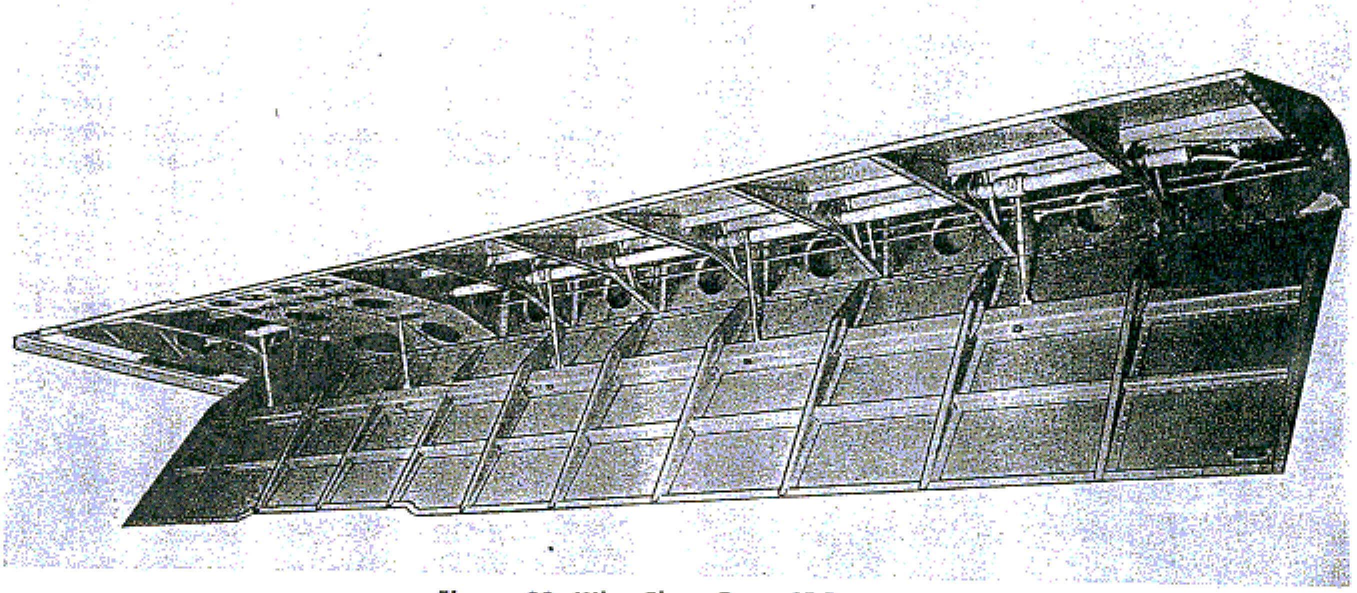


Figure 83—Wing Flap—Open 45 Degrees

(3) INSTALLATION OF AILERON.—Raise the aileron until the ball bearings on the ends of the aileron are seated in the upper half of the split clamp fittings on the panel, and the center hinge on the panel drops into place through a slot in the aileron leading edge. At the same time, it is necessary to guide the ball end of the control arm, with the composition waxed bushing installed (figure 81) into the socket of the drum in the panel. (See figure 82.) Clamp and bolt the end hinges and bolt the center hinge through an access door in the lower aileron surface. Connect the bonding tabs.

Note

Because of the design of the bearing retainers, the inboard and outboard caps are not interchangeable.

d. WING FLAPS.

(1) DESCRIPTION. — Hydraulically-operated, split trailing edge flaps extend from within a few inches of the airplane center line to the inboard ends of the ailerons on the under surface of the wings. They are attached to the wing by continuous hinges running the full length of each flap. (See figure 83.) A wing flap position indicator is installed inside the left wing panel trailing edge and is linked to the flap. When the flap is lowered, a peg, which can be seen from the cockpit, extends above the top surface of the wing and indicates the angular deflection of the flaps. When the wing flaps are closed the peg is retracted flush with the top surface of the wing. The position indicator linkage is provided with a turnbuckle for adjustment. (See figure 84.)

(2) REMOVAL OF WING FLAPS.—Disconnect the flap position indicator linkage from the left flap. Remove all clevis bolts which connect the flap control turnbuckles to the flap. Withdraw the two continuous hinge pins by pulling steadily on the hinge pin loops located near the center of the flap hinge.

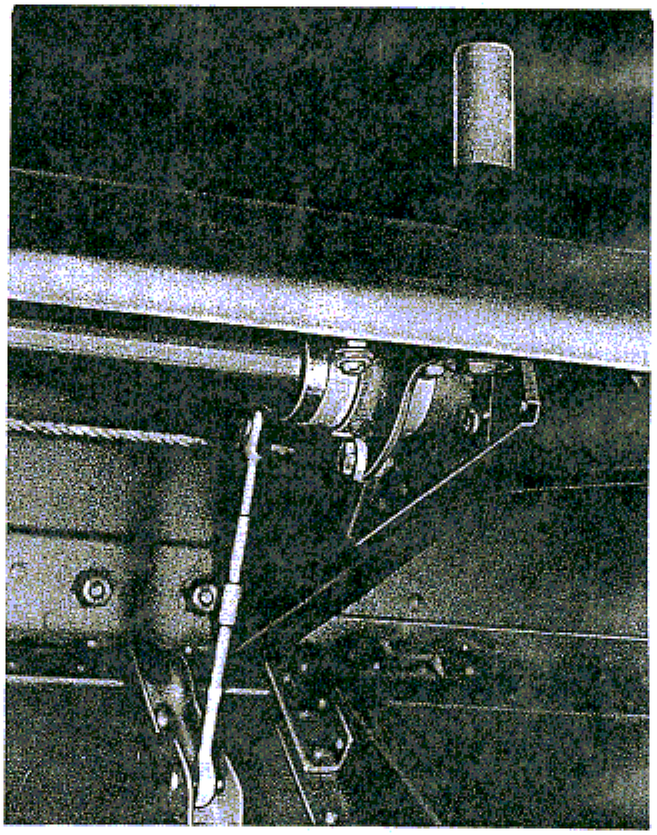


Figure 84—Wing Flap Position Indicator

(3) INSTALLATION OF WING FLAPS.—Interlock the flap hinge and hold the flap in position while inserting the hinge pins. The loop ends of the hinge pin may be clamped in the chuck of a low speed portable electric drill. Lubricate the hinge pin with

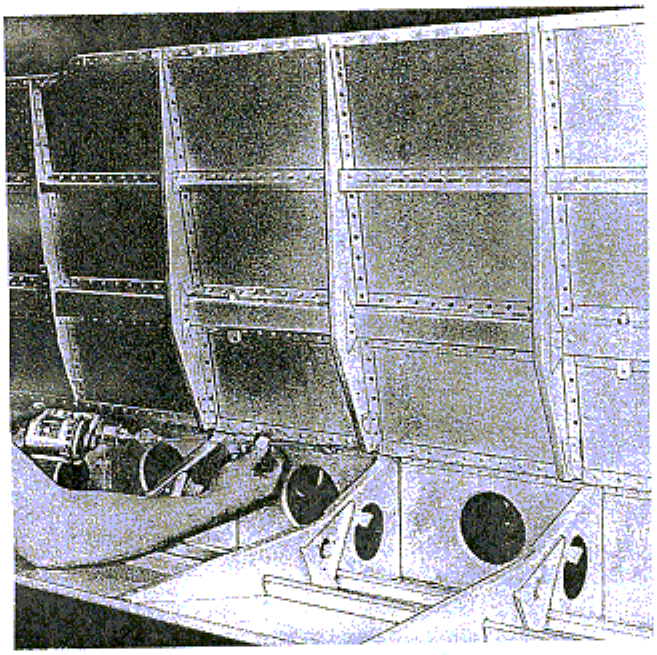


Figure 85—Installing Wing Flap Hinge Pin

engine lubricating oil, Specification AN-VV-O-446, grade 1080, and use the rotating motion of the drill to aid in feeding the hinge pin through the hinges. (See figure 85.) Attach all clevis ends of the turnbuckles to the flap and adjust the turnbuckle barrels to seat the flap at the trailing edge evenly. Lockwire all turnbuckle barrels.

(4) ADJUSTMENT OF FLAP POSITION INDICATOR. (See figure 84.)—With the flaps fully extended, adjust the turnbuckle to make the position indicator read "45 degrees." Raise the flaps and check the position of the indicator. It should be flush with the wing surface. Readjust the turnbuckle if necessary to bring the top of the indicator flush with the wing skin.

e. WING FILLETS.

(1) DESCRIPTION.—The wing fillet installation consists of the front, intermediate and rear wing fillet assemblies. The wing fillets are made of formed alclad sheet and are attached by slotted head screws which are screwed into nut plates installed in the fuselage and the wing panel. The wing fillets are lap jointed: the front fillet overlaps the intermediate fillet, and the intermediate fillet overlaps the rear fillet.

(2) REMOVAL OF WING FILLETS.—Any wing fillet may be removed from the airplane without removing the other fillet assemblies. The rear keel fairing must be removed before the rear wing fillet can be removed. Remove the attaching screws from the fillet and remove the fillet from the airplane.

(3) INSTALLATION OF WING FILLETS.—The wing fillets are installed by replacing the fillets on the airplane and installing the attaching screws. Installation of the wing fillets is facilitated by following the procedure that is given for installing new wing fillets. New or spare wing fillets must be installed in the following order: rear wing fillet, intermediate wing fillet, and front wing fillet. The following procedure is given for installing new or spare wing fillets on the airplane.

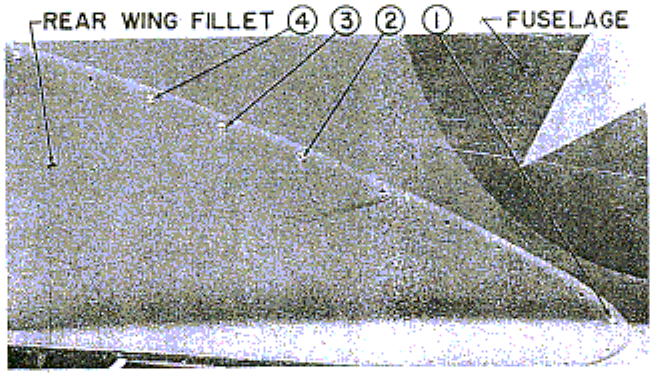


Figure 86—Installing Rear Wing Fillet—Step 1

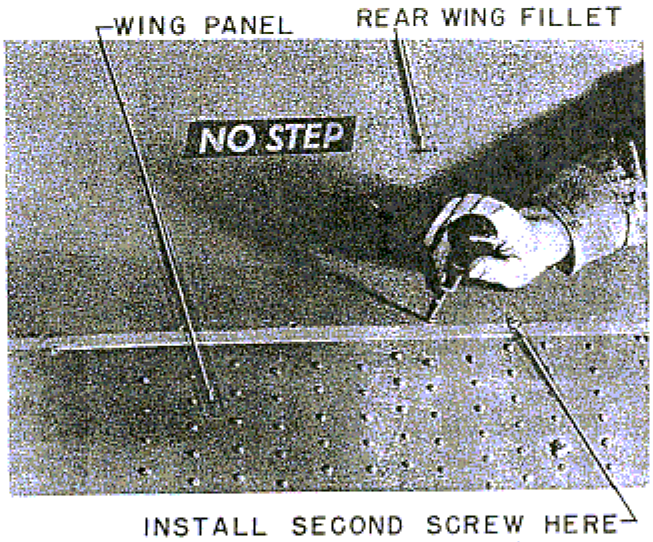


Figure 87—Installing Rear Wing Fillet—Step 2

(*a*) REAR WING FILLET.

1. Peen the edge of the rear wing fillet so as to obtain a tight fit against the fuselage.

2. Install screws at the points shown in figures 86 and 87. An ice pick may be used to force the fillet into position so that the screws can be installed more easily.

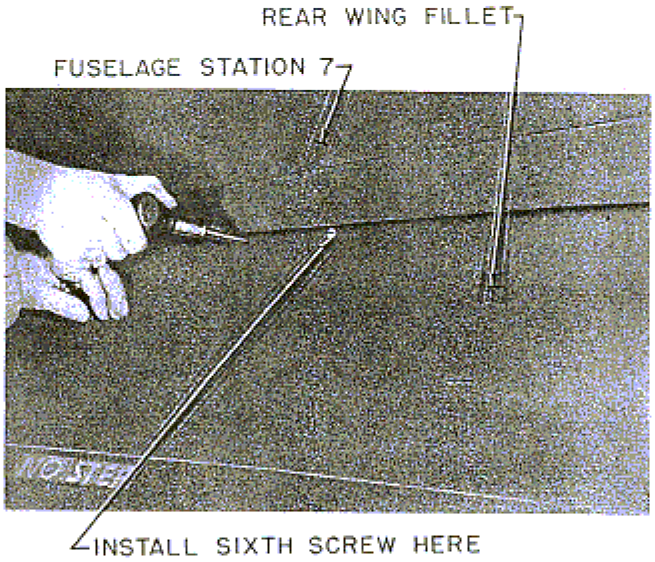


Figure 88—Installing Rear Wing Fillet—Step 3

3. Install screws along panel, working from the trailing edge forward as shown in figure 88. In some cases it will be necessary to enlarge the holes in the fillet.

4. Enlarge the remaining holes in the fillet to line up with nutplates in the fuselage and install the remaining screws.

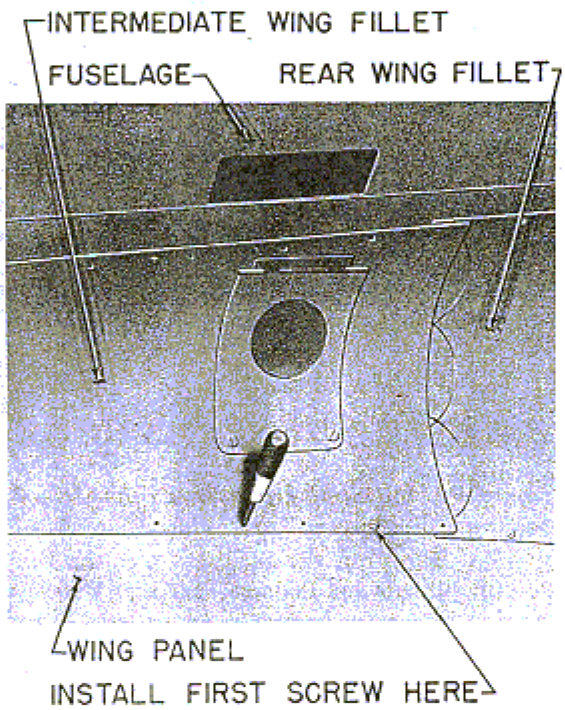


Figure 89—Installing Intermediate Wing Fillet—Step 1

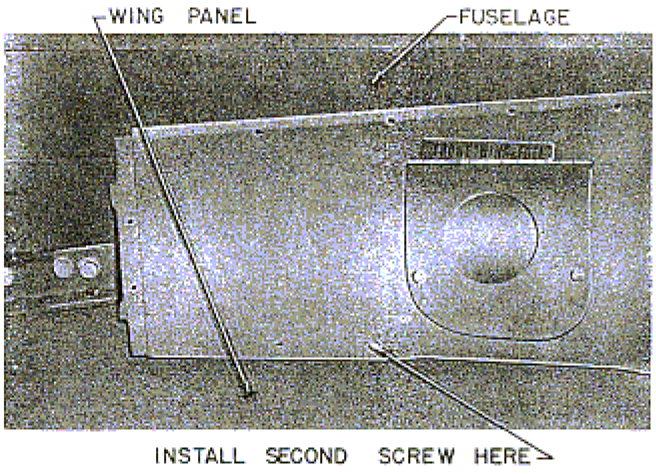


Figure 90—Installing Intermediate Wing Fillet—Step 2

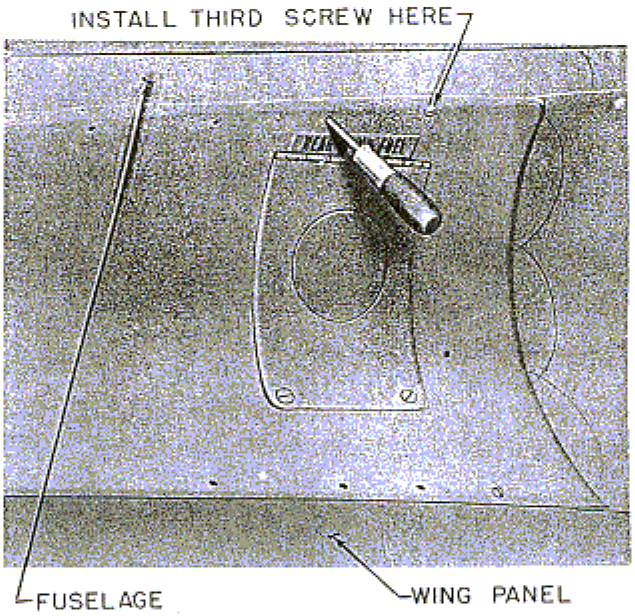


Figure 91—Installing Intermediate Wing Fillet—Step 3

(*b*) INTERMEDIATE WING FILLET.

1. Peen the edge of the fillet so as to obtain a tight fit against the fuselage.

2. Install screws through all fillet holes that line up with the nutplates in the fuselage. (See figure 89.)

3. Using ice picks, force the wing fillet into position so that the holes in the fillet line up with the nutplates in the wing panel and install the screw. (See figures 90, 91, and 92.)

4. Enlarge the remaining holes in the fillet that do not line up with the nutplates and install the screws.

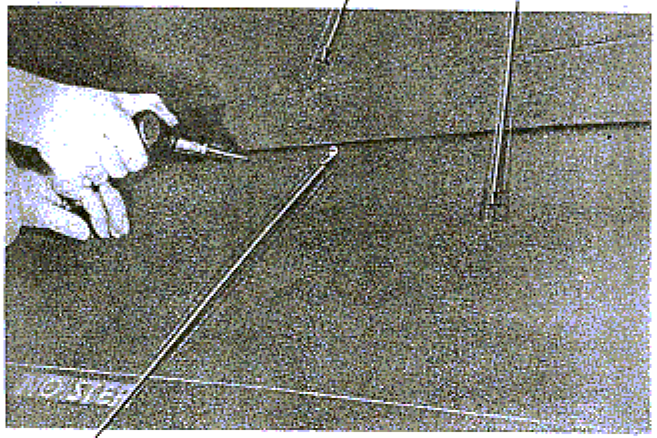


Figure 88—Installing Rear Wing Fillet—Step 3

3. Install screws along panel, working from the trailing edge forward as shown in figure 88. In some cases it will be necessary to enlarge the holes in the fillet.

4. Enlarge the remaining holes in the fillet to line up with nutplates in the fuselage and install the remaining screws.

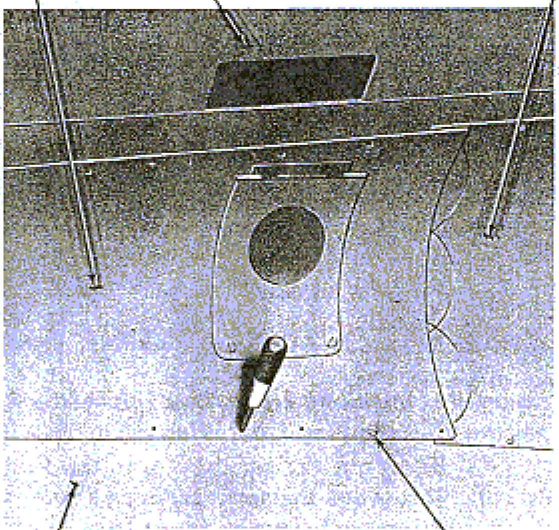


Figure 89—Installing Intermediate Wing Fillet—Step 1

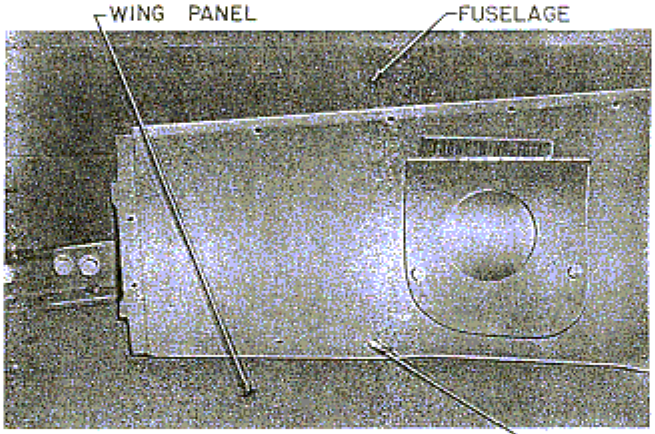


Figure 90—Installing Intermediate Wing Fillet—Step 2

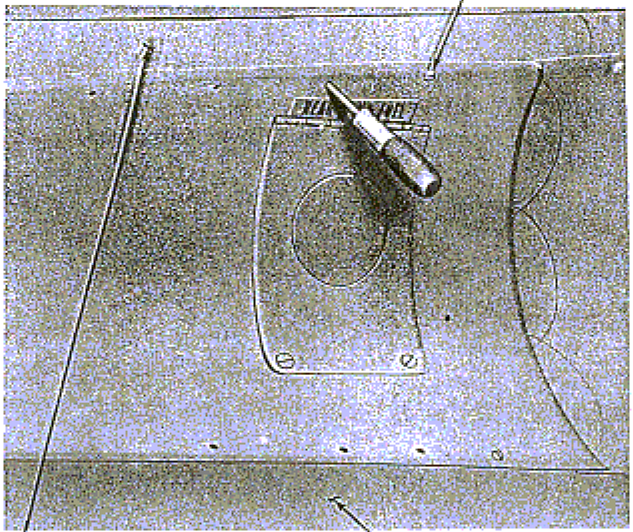


Figure 91—Installing Intermediate Wing Fillet—Step 3

(*b*) INTERMEDIATE WING FILLET.

1. Peen the edge of the fillet so as to obtain a tight fit against the fuselage.

2. Install screws through all fillet holes that line up with the nutplates in the fuselage. (See figure 89.)

3. Using ice picks, force the wing fillet into position so that the holes in the fillet line up with the nutplates in the wing panel and install the screw. (See figures 90, 91, and 92.)

4. Enlarge the remaining holes in the fillet that do not line up with the nutplates and install the screws.

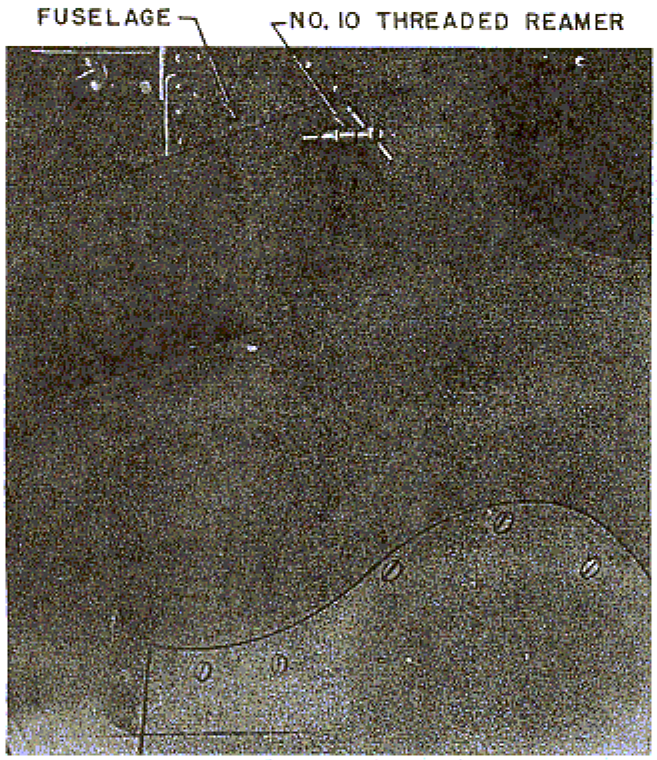


Figure 96—Installing Front Wing Fillet—Step 4

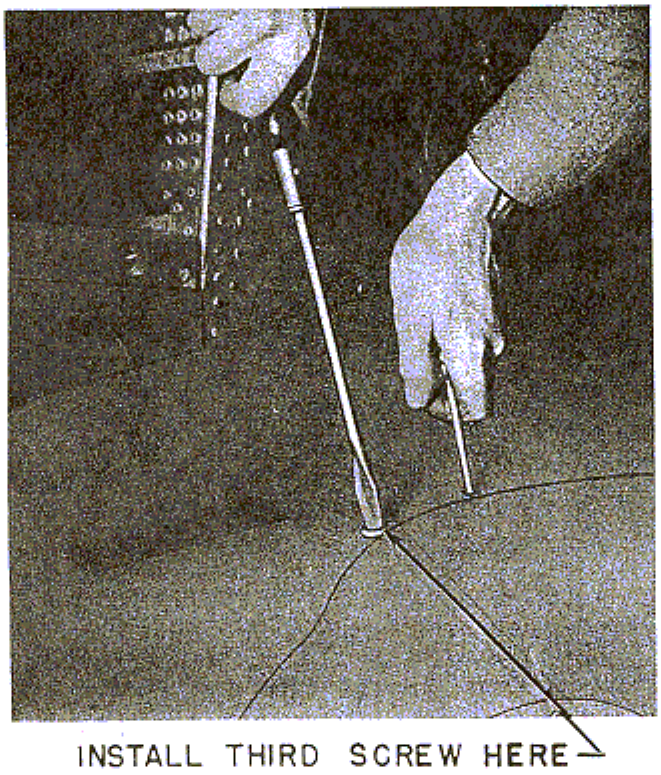


Figure 97—Installing Front Wing Fillet—Step 5

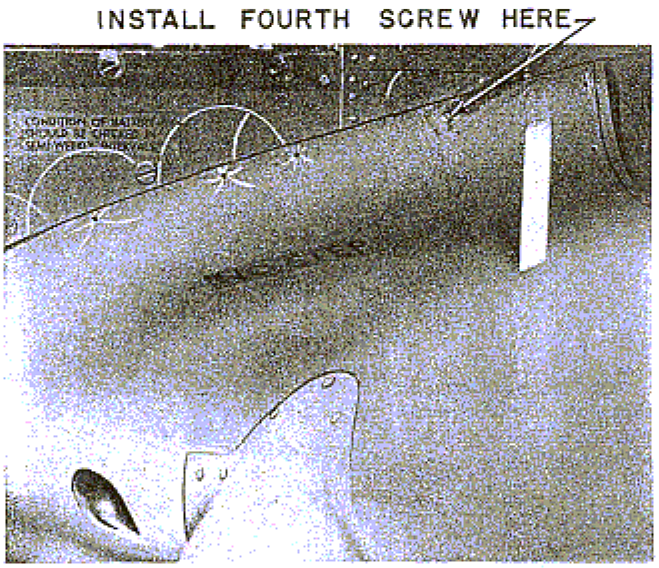


Figure 98—Installing Front Wing Fillet—Step 6

2. TAIL GROUP.

a. STABILIZER.

(1) DESCRIPTION.—The stabilizer is of aluminum alloy, multi-cellular construction and is metal covered. The stabilizer is made in one piece and is internally braced. Sixteen stud fittings are installed in the stabilizer, eight in the top and eight in the bottom surfaces. The eight stud fittings in the bottom surface are used to attach the stabilizer to the fuselage. Only the four rear-most of the eight stud fittings in the upper surface of the stabilizer are used; these are used for attaching the fitting assembly which is provided for erecting the fin on the airplane.

(2) REMOVAL OF STABILIZER.—The stabilizer, elevators, and fin may be removed from the airplane as one assembly.

(a) Remove the empennage fillets.

(b) Disconnect the electric wire leading from the base of the fin at the terminal block which is attached to the forward side of the bulkhead at fuselage station 13. The terminal block is accessible through the inspection door on the right side of the fuselage forward of the stabilizer.

(c) Remove the rudder.

(d) Disconnect the two elevator trim tab control flexible shafts at the disconnect fittings near the inboard ends of the elevators.

(e) Disconnect the elevator push-pull link from the elevator horn.

(f) Remove the nuts from the eight studs which hold the stabilizer to the fuselage fittings. If the fin is removed with the stabilizer and elevator assembly, remove the four bolts holding the fin to the fittings on the fuselage extension. Lift the stabilizer, elevators and fin from the airplane as one assembly.

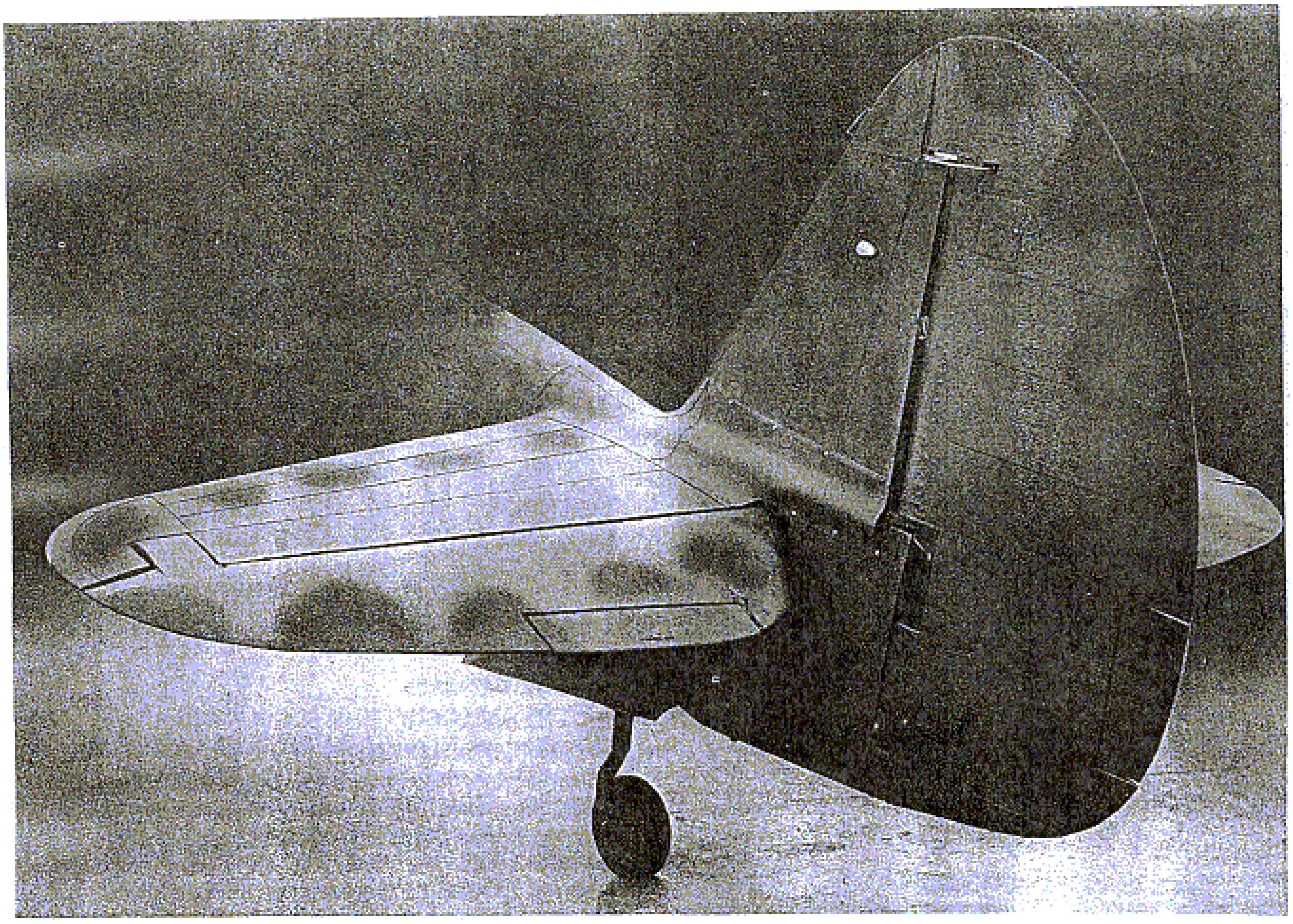


Figure 99—Empennage Assembly

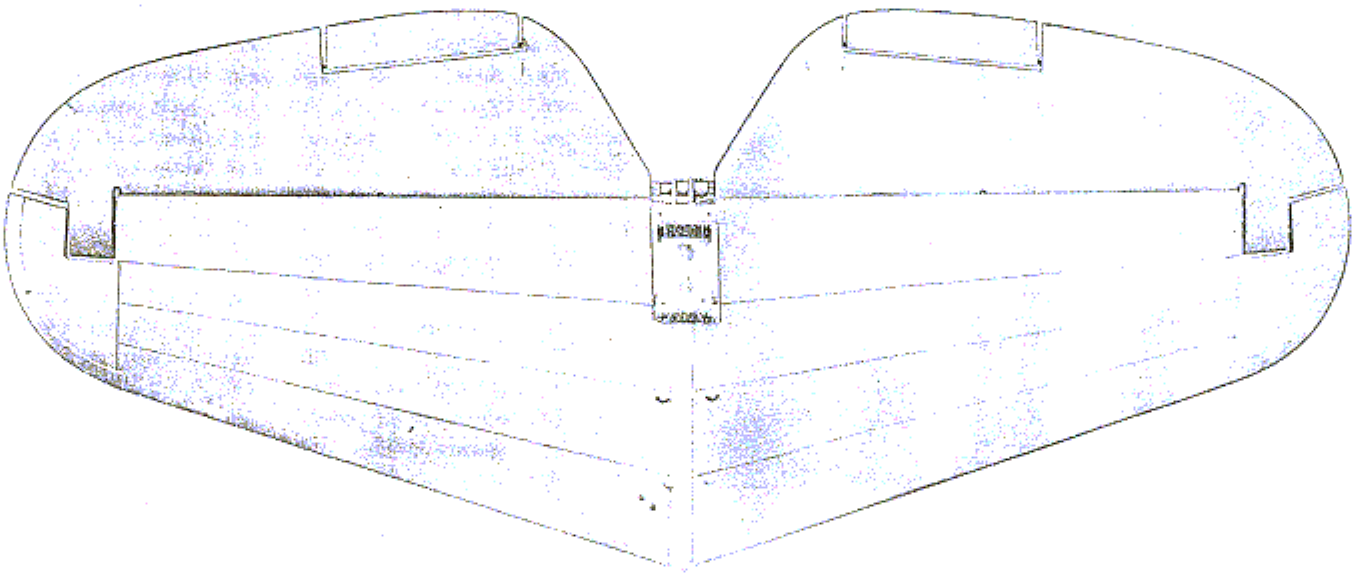


Figure 100—Stabilizer and Elevator Assembly

(3) INSTALLATION OF STABILIZER.—The stabilizer, elevators, and fin may be installed on the airplane as one assembly. If the fin was removed from the stabilizer assembly, erect the fin after the stabilizer is installed on the fuselage.

(a) Lift the stabilizer, elevators and fin (if attached) as one assembly and set it in place on the fuselage. Install the four bolts through the fin and fuselage attachment fittings. Tighten the stabilizer and fin attaching studs and bolts evenly so that the rudder hinge fittings on the fin and fuselage will be in proper alignment.

(b) Connect the electric wire from the tail running lights at the terminal block on the forward side of the bulkhead at fuselage station 13. The terminal block is accessible through the inspection door on the right side of the fuselage forward of the stabilizer.

(c) Connect the elevator push-pull link to the elevator horn.

(d) Connect the two elevator trim tab control flexible shafts at the disconnect fittings near the inboard ends of the elevators.

(e) Install the rudder.

(f) Install the empennage fillets.

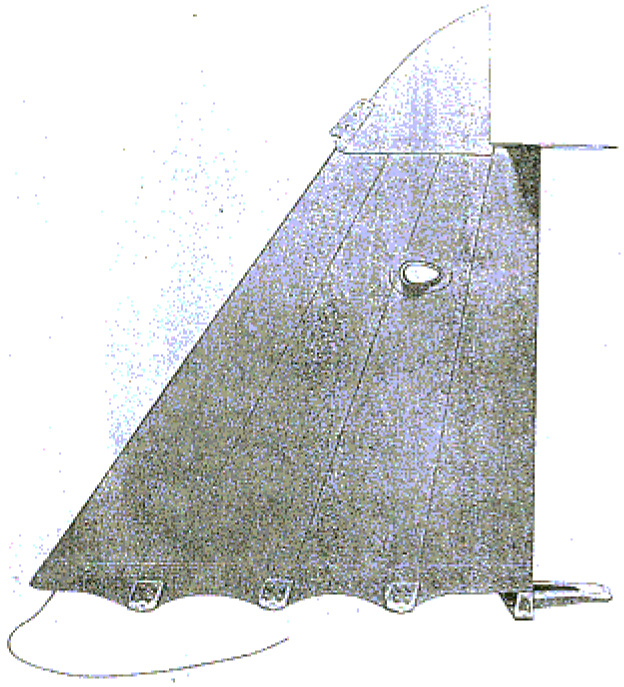
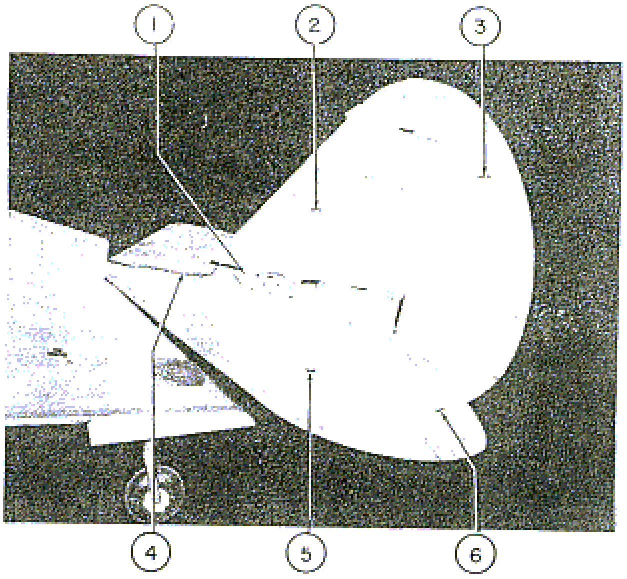


Figure 101—Fin Assembly

b. FIN.

(1) DESCRIPTION.—The fin is of aluminum alloy, multi-cellular construction and is metal covered. The fin, which is internally braced, is attached to the fitting assembly on the top of the stabilizer and to the fuselage extension by eight bolts through the attachment fittings. The attachment fittings are designed so that when the fin is erected on the airplane, it is in line (0 degree offset) with the airplane center line.



1. 87-15-914 FITTING ASSEMBLY
2. 87-12-501 FIN ASSEMBLY
3. 87-14-606 RUDDER ASSEMBLY
4. ELECTRIC CABLE TO TAIL RUNNING LIGHTS
5. 87-11-501 STABILIZER ASSEMBLY
6. 87-13-901 L/R ELEVATOR ASSEMBLY

Figure 102—Empennage Assembly Fairing Removed

(2) REMOVAL OF FIN.

(a) Remove the empennage fillets.

(b) Disconnect the electric wire leading from the base of the fin at the terminal block which is attached to the forward side of the bulkhead at fuselage station 13. The terminal block is accessible through the inspection door on the right side of the fuselage forward of the stabilizer. Free the wire from the studs in the stabilizer which are located forward of the fin.

(c) Remove the rudder.

(d) Remove the eight bolts which hold the fin to the fittings on the fuselage and to the fitting assembly that is attached to the stabilizer, and remove the fin.

(3) INSTALLATION OF FIN.

(a) Install the eight bolts attaching the fin to the fuselage and stabilizer attachment fittings. Tighten the fin attaching bolts evenly so that the rudder hinge fittings on the fin and fuselage will be in proper alignment.

(b) Install the rudder.

(c) Connect the electric wire from the tail running lights at the terminal block on the forward side of the bulkhead at fuselage station 13. The terminal block is accessible through the inspection door on the right side of the fuselage forward of the stabilizer. Attach the wire to the studs in the stabilizer which are located forward of the fin.

(d) Install the empennage fillets.

c. ELEVATORS.

(1) DESCRIPTION.—The elevator frame is of aluminum alloy construction and is covered with fabric. Each elevator is statically and dynamically balanced and is equipped with a trim tab which is manually controlled from the cockpit.

(2) REMOVAL OF ELEVATOR.

(a) Disconnect the one bonding strip at the outboard hinge bearing.

(b) Disconnect the trim tab control flexible shaft at the disconnect fitting near the inboard end of the elevator.

(c) Remove the two bolts, one from the outboard and one from the center hinge bearings.

(d) Remove the two bolts from the elevator end fitting and remove the elevator. (See figure 103.)

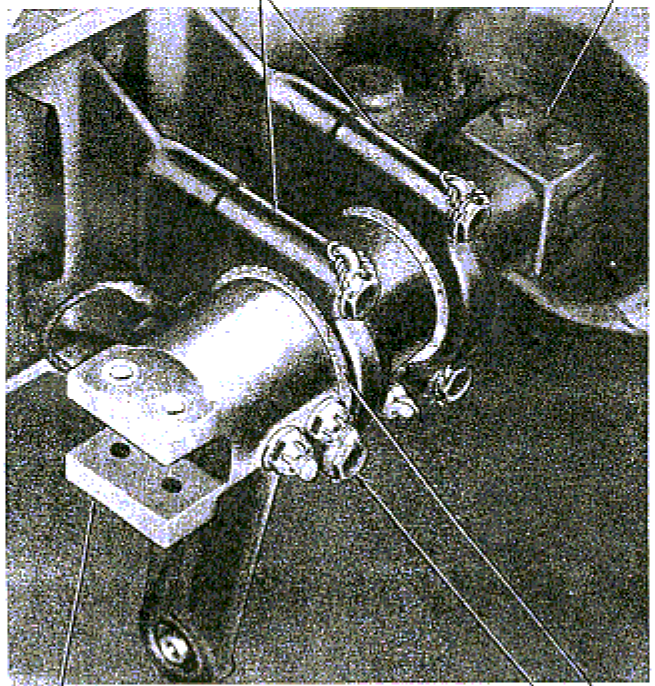


Figure 103—Elevator Connecting Assembly

(3) INSTALLATION OF ELEVATOR.

(a) Place the elevator in position on the stabilizer and install the two bolts, one in the outboard and one in the center hinge bearings.

(b) Install the two bolts through the elevator end fitting.

(c) Connect the trim tab control flexible shaft at the disconnect fitting near the inboard end of the elevator.

(d) Connect the one bonding strip at the outboard hinge bearing.

d. ELEVATOR TRIM TAB.

(1) REMOVAL.—Disconnect the control wires from the tab horn, rotate the tab as far as possible from the neutral position, and remove the two cap screws from the block on the outboard end of the front face of the tab spar. Pull the tab outward and downward until the hinge shaft on the inboard end of the tab is free.

(2) INSTALLATION.—Put the inboard end of the tab hinge shaft in place and install the two cap screws attaching the block to the outboard end. Rotate the tab to neutral position and connect the control wires to the tab horn.

e. RUDDER.

(1) DESCRIPTION.—The rudder frame is of aluminum alloy construction and is covered with fabric. The rudder is statically and dynamically balanced and is equipped with a trim tab which is manually controlled from the cockpit.

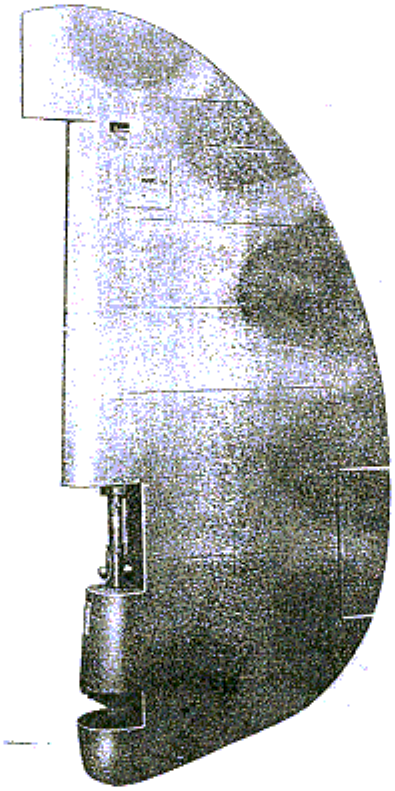


Figure 104—Rudder Assembly

(2) REMOVAL OF RUDDER.

(a) Relieve the tension in the rudder control cables by loosening one of the turnbuckles at the rudder pedal, or at the reducing pulley that is located aft of fuselage station 8.

(b) Disconnect the rudder control cables at the rudder horn.

(c) Disconnect the rudder trim tab control flexible shaft at the disconnect fitting near the rudder center hinge bearing.

(*d*) Disconnect the two bonding strips, one at the top and one at the center rudder hinges.

(*e*) Remove the top hinge bolt.

(*f*) Remove the center and lower hinge bearing caps and remove the rudder.

(3) INSTALLATION OF RUDDER.

(*a*) Before installing the rudder, inspect the three hinge bearings for free rolling.

(*b*) Hang the rudder on the top hinge fitting and install the hinge bolt.

(*c*) Seat the center and lower hinge bearings in the hinge fittings making sure that the thrust washer above the rudder lower hinge bearing (figure 105) is properly seated in the groove provided for it in the rudder lower hinge fitting block and cap. (See figure 106.)

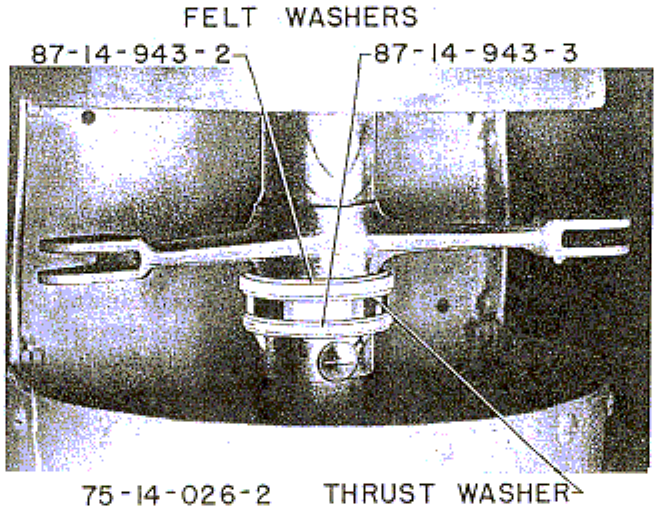


Figure 105—Rudder Lower Hinge Bearing

(*d*) If, after installing the rudder, the rudder is found to bind when it is swung through its full range of travel, it is indicative that the rudder hinge fittings were not in correct alignment when the rudder was installed. If the stabilizer and fin attaching studs and bolts were tightened down securely, the lateral alignment of the hinge fittings should be correct. Check-tighten the stabilizer and fin attachments studs and bolts and if the rudder hinges still bind, investigate for vertical misalignment. Remove the lower hinge fitting cap and swing the rudder through its complete range of travel. If the rudder swings freely it is evident that shims, part No. 75-21-303 must be *added* under the block of the lower hinge fitting. If the rudder does not swing freely, it is evident that shims must be removed from under the hinge fitting block.

(*e*) Connect the two bonding strips, one at the top and one at the center rudder hinges.

(*f*) Connect the rudder trim tab control flexible shaft at the disconnect fitting near the rudder center hinge bearing.

(*g*) Connect the rudder control cables at the rudder horn.

(*h*) Restore the tension in the cables to 110 pounds by tightening the turnbuckle which was loosened when the rudder cables were disconnected.

f. RUDDER TRIM TAB.

(1) REMOVAL.—Disconnect the control rod from the horn, rotate the tab as far as possible from the neutral position, and remove the two cap screws from the blocks on each end of the front face of the tab spar.

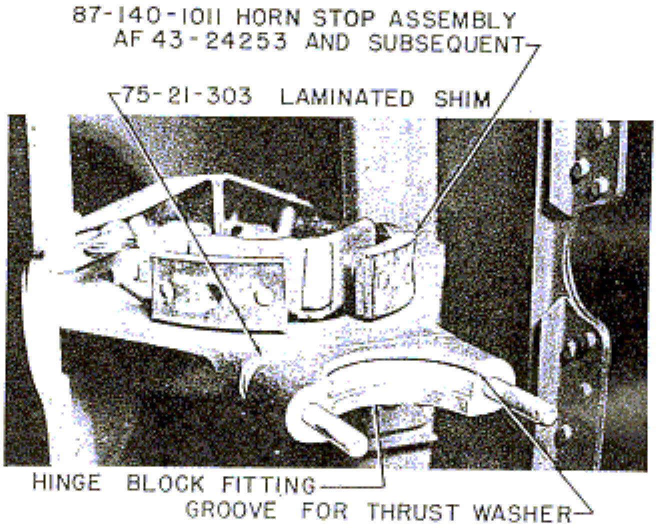


Figure 106—Rudder Lower Hinge Fitting

(2) INSTALLATION.—Install the two cap screws attaching the blocks to each end of the tab spar. Rotate the tab to neutral position and connect the control rod to the tab horn.

g. EMPENNAGE FILLETS.

(1) DESCRIPTION.—The empennage fillet installation consists of the following: the fuselage and stabilizer fillet which fits over the top of the stabilizer, a left and right fillet which is installed under the stabilizer, and a left and right fillet shoe which is installed over the stabilizer leading edge near the fuselage. The empennage fillets are made of formed alclad sheet and are attached by slotted head screws which are screwed into nut plates installed in the fuselage, stabilizer and fin.

(2) REMOVAL OF EMPENNAGE FILLETS.—Any fillet may be removed independently from the rest, by first removing the shoe on the leading edge of the stabilizer. Remove the fillet attaching screws and remove the fillet.

(3) INSTALLATION OF EMPENNAGE FILLETS.—The empennage fillets are installed by replacing the fillets on the airplane and installing the attaching screws. Installation of the empennage fillets is facilitated by following the procedure that is given below for installing new or spare empennage fillets.

(a) Install the fuselage and stabilizer fillet, part No. 87-15-905, by first, placing screws in the forward center holes. (See figure 107.)

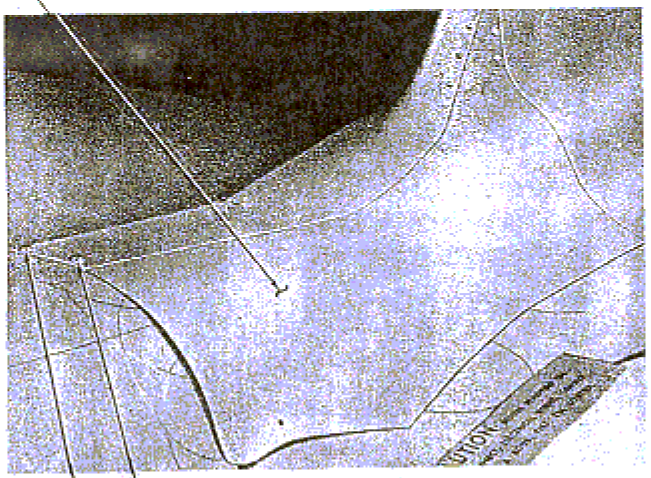


Figure 107—Installing Fuselage and Stabilizer Fillet—Step 1

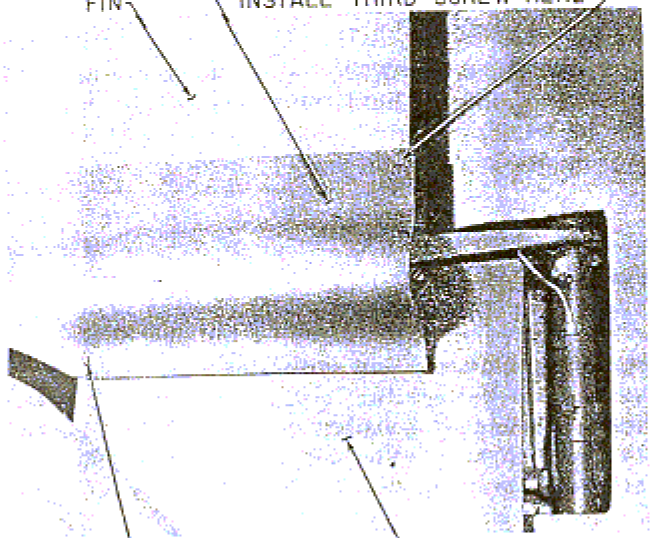


Figure 108—Installing Fuselage and Stabilizer Fillet—Step 2

(b) Next, install the screws in the rear holes. (See figure 108.)

(c) Drill out the remaining holes in the fillet and install the screws.

(d) Install all screws in top and bottom holes on both sides of the fillet, part No. 87-15-905-6. (See figure 109.)

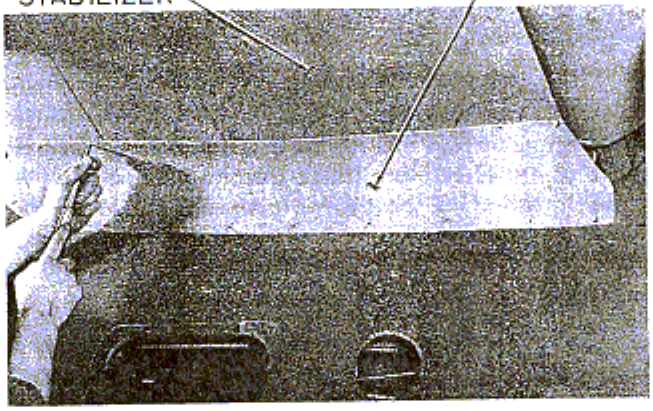


Figure 109—Installing Fuselage and Stabilizer Fillet—Step 3

(e) Install the shoe, part No. 87-15-905-5, over the leading edge of the stabilizer where the fuselage and stabilizer fillet, part No. 87-15-905, and the lower stabilizer fillet, part No. 87-15-905-6, meet. Install the rearmost screw to anchor the shoe in position (figure 110), then install the remaining screws, working from the rear of the shoe to the front.

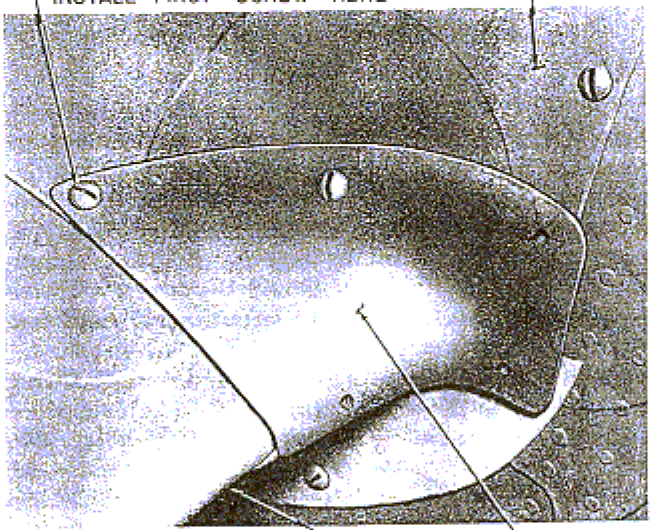


Figure 110—Installing Fuselage and Stabilizer Fillet—Step 4

3. BODY GROUP.

a. FUSELAGE.—The fuselage structure is of monocoque construction employing bulb stringers, channel-section bulkheads and alclad aluminum alloy sheet covering (24ST). The fuselage skin is attached by flush head A17ST aluminum alloy rivets. The fuselage bulkhead at station 5, for airplanes AF42-104429 through AF42-104828, is designed to protect the pilot if the airplane should nose over completely. A jack point for lifting the aft end of the airplane is installed aft of the tail wheel doors.

b. COCKPIT ENCLOSURE.

(1) WINDSHIELD.

(a) DESCRIPTION.—The windshield is made of 1/4-inch laminated plate glass, with the exception of a central panel. This central panel consists of 1-1/2-inch thick bullet-resisting glass. The frame is assembled to the fuselage by flush-head screws in fiber nuts and may be attached or removed as one unit. A clear view panel is installed in the left side of the windshield assembly on airplanes AF42-104429 through AF43-23251. This consists of a small section of the windshield side panel which may be opened inward so that the pilot can obtain as nearly as possible an unobstructed forward view. A small latch secures the clear view panel in the closed position while a small clip holds the panel in the open position. (See figure 111.)

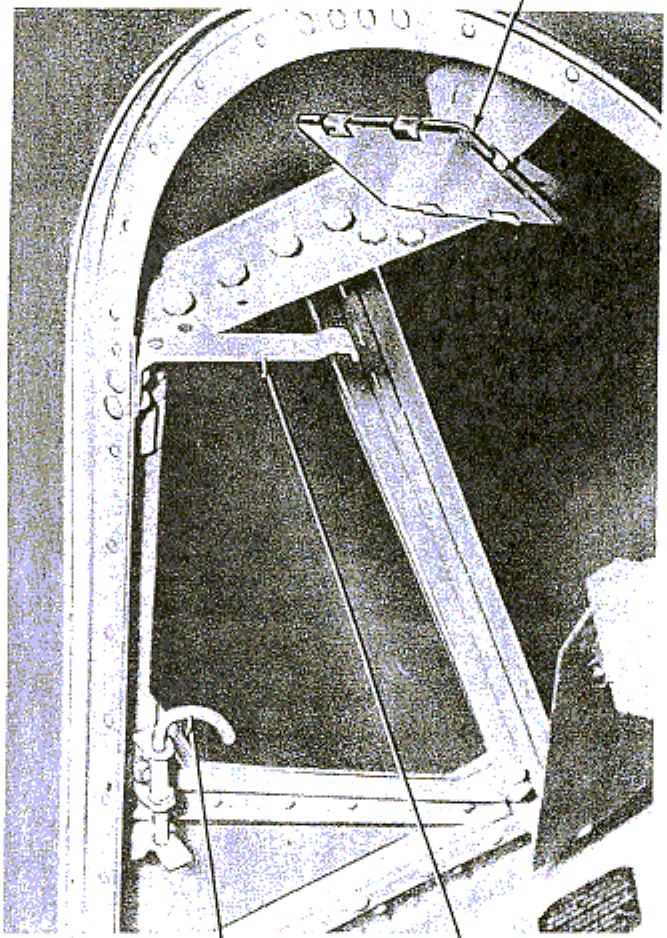


Figure 111—Clear View Panel (AF42-104429 through AF43-23251)

(b) REMOVAL OF WINDSHIELD.—Roll the canopy back. Remove the flush-head screws from around the base of the windshield and lift the assembly off the fuselage.

(c) INSTALLATION OF WINDSHIELD.—Replace the windshield assembly on the fuselage and install the flush-head screws.

(2) CANOPY.

(a) DESCRIPTION.

1. The canopy for airplanes AF-42-104429 through AF42-104828 consists of eight pieces of Plexiglas held in an aluminum alloy frame. An emergency escape panel is installed in the left side of the canopy which may be opened from either inside or outside the cockpit in the event of a turn-over on the ground. To open the escape panel from inside the cockpit pull the handle (F) (detail D, figure 112) inboard and aft to disengage the panel release assembly (G) from the studs (H) in the frame. The escape panel is opened similarly from outside the cockpit. Each corner of the canopy is mounted on a truck assembly which rolls on a track attached to the upper longeron. The canopy is moved to the forward or aft positions by a hand crank on the forward right side of the cockpit. The canopy is locked in position by engaging the pin on the control crank in a hole in the locking plate. (See detail A, figure 112.) The lever (A) on the control crank must be lifted to the horizontal position as shown in detail A, if the canopy is to be moved forward or aft by hand. The complete canopy may be released from the truck assemblies by pulling down on the emergency release handle (B). (See detail B, figure 112.) A force of at least 40 pounds is required to break the lockwire (E) which secures the canopy latch (C) on the rear pin (D) of the link rod assembly. (See detail C, figure 112.)

WARNING

Be sure lockwire (E) is properly installed in both emergency release mechanisms before the airplane is flown. The lockwire used should be .032 brass or the equivalent. The wire must preload each latch in the locked position past the dead-center position.

2. The canopy for airplanes AF42-104829 and subsequent, consists of two pieces of Plexiglas held in an aluminum alloy frame and does not have an emergency escape panel. The operation of the canopy is the same as for previous model airplanes. (See figure 113.)

(b) REMOVAL OF CANOPY.—The canopy may be removed by pulling the emergency release handle (B) (detail B, figure 113), and lifting the canopy off the airplane. The support and truck assemblies will remain on the track.

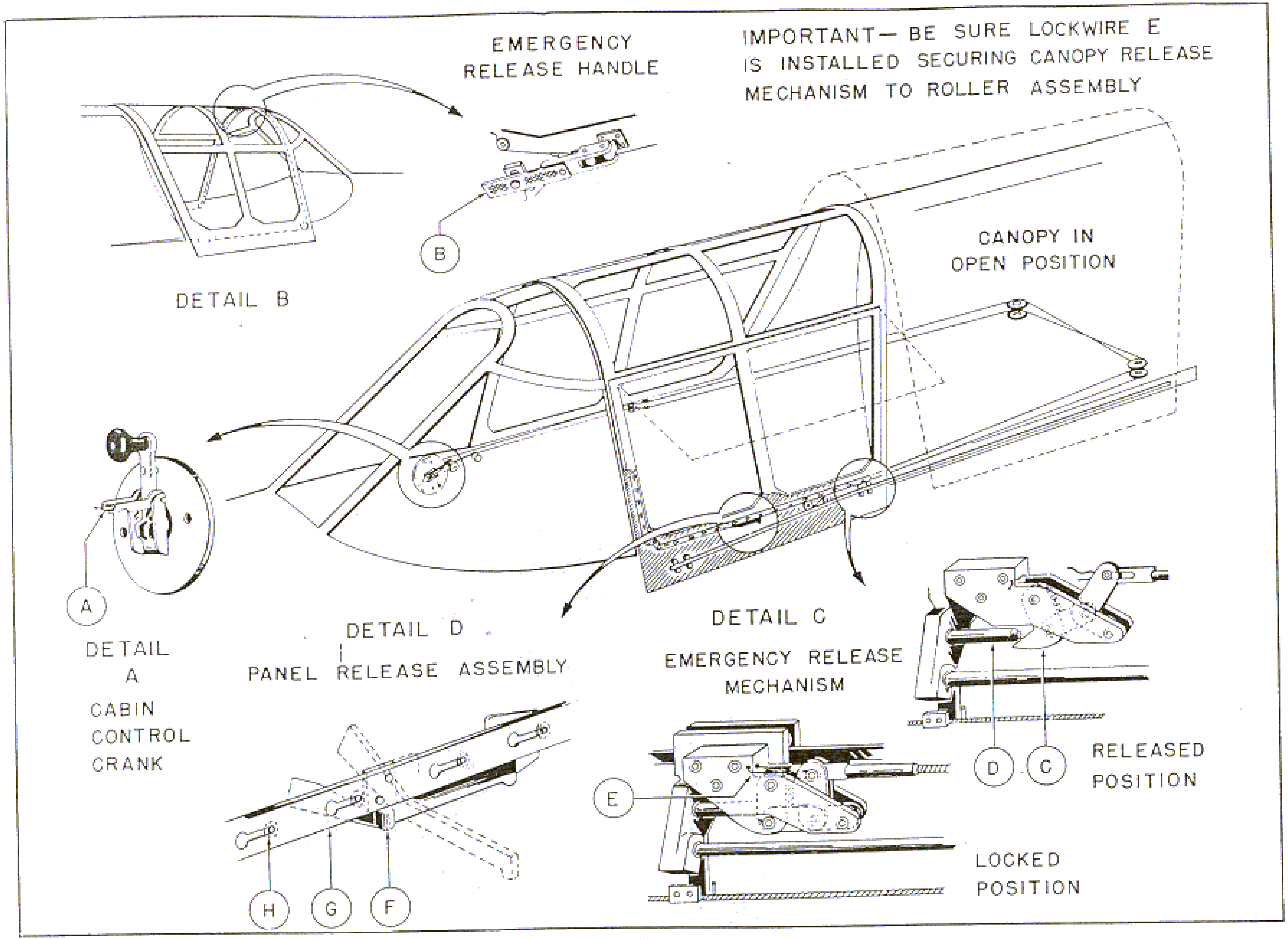


Figure 112—Canopy Controls (AF42-104429 through AF42-104828)

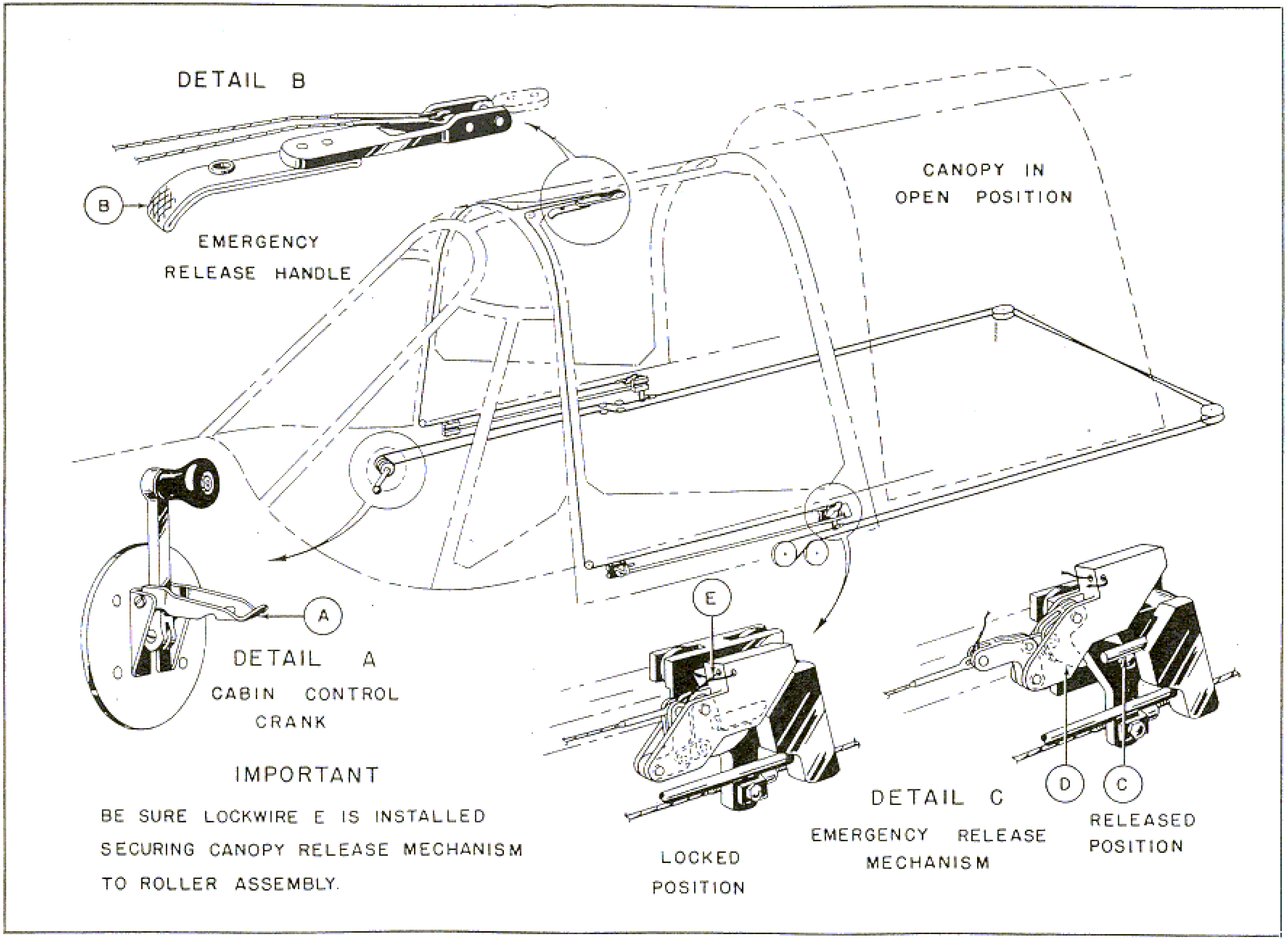


Figure 113—Canopy Controls (AF42-104829 and Subsequent)

To remove the support and truck assembly, disconnect the rear truck from the canopy control cable by removing the screw attaching the cable block to the gooseneck fitting. The screw is accessible through an opening in the upper longeron at fuselage station 5. Roll the trucks off the ends of the track.

(c) INSTALLATION OF CANOPY.—There are two major items which determine the security and smooth operation of the canopy: position and method of safety-wiring the release latches, and fit and maintenance of the several component parts which make up the entire canopy installation. Prior to installing a canopy, follow the instructions below:

1. Clean and dry the tracks upon which the canopy roller trucks move. Oil and dirt will make for excessive track wear and tend to cause a loose fit of the trucks.

2. Check the four truck assemblies for tight fit on the track. Check the gap between the top and bottom rollers for the following tolerances:

Maximum .121
Minimum .114

The outboard face of the truck fitting should have a flat surface. However, owing to track wear, it may be necessary to bend the truck fitting SLIGHTLY to close the gap between the rollers so that the truck assembly will fit tight on the track.

3. Inspect the link rod assemblies for security of pinnings. Discard any rods that are distorted. Make sure the front and rear locking pins in the gooseneck fittings are not bent or loose.

4. Inspect the canopy visually for warpage, cracked glass, looseness of the frame. Check the left and right front locking fittings for wear. These fittings are taper reamed. Check the left and right rear locking mechanisms for free movement, and security of attachment. Check the release cables for freedom of travel in the guide tubes.

5. Inspect the canopy control cables, pulleys and the control handle unit for freedom of movement, frayed wire strands and full travel. Inspect, particularly, the soldered thread fittings on the canopy control cable for secure joints and undamaged threads. The thread fittings are screwed into the control cable fastener fitting, that is, attached to the rear gooseneck of the link rod assembly.

Note

Later canopy control cables are provided with a swaged cable terminal instead of the soldered thread fitting.

6. Check the bolt attachment of the gooseneck fittings to the front truck assemblies. Make sure that the bushings are approximately .002 longer than the fitting to permit slight rotation of the fitting on the truck. The bolts must be tight and properly safety-wired.

7. Open the canopy latches and install the canopy on the front tapered locking pins and lock the rear pins in the right and left hand latches.

8. Roll the canopy forward and lock it shut. Check for canopy fit and tightness. If appreciable play is noted, determine the cause by checking the following:

a. Snug mating of front and rear locking pins.
b. Springing or bending of the link rods.
c. Slack in the release latch mechanisms.
d. Slack in the roller fit on the tracks.
e. Looseness of attachment to control cable.

Note

Do not allow more than .030 fore and aft play of the canopy.
Do not allow appreciable side motion of the canopy.

If inspection shows the canopy installation to be satisfactory, perform the next step with great care.

9. Install the safety-wire (.032 brass or equivalent) at the release latches as shown in figure 113. The wire must preload each latch in the locked position past the dead-center position.

CAUTION

Do not fracture the wire by twisting too tight.

It may be found that it is easier to install safety-wire with the canopy free from its attachment. If so, remove the canopy after performing the inspection in step *8* and thread a fairly long length of safety-wire through the release mechanism. Then reinstall the canopy on the airplane and complete the safety-wiring operation.

(d) FINAL TEST AFTER ASSEMBLY.

The first movement of the latches toward the release position should be against the preloaded safety-wire and its breakage should occur prior to the upright toggle of the latch moving past the dead-center position to the open position.

Safety-wire that is too light or poorly installed will allow vibration and high air loads will unlock the latches and cause self-jettisoning of the canopy.

When in doubt as to the proper safety wire to use, experiment with varying heavier gauges of wire until one is found that will require a strong pull of the release handle to cause the wire to break.

(3) REAR VISION GLASS.

(a) DESCRIPTION.

1. For airplanes AF42-104429 through AF42-104828, a rear vision glass is installed on each side of the fuselage aft of the cockpit. The glass is held in the frame assembly by two support straps on the side of the glass and a metal retaining strip at its forward edge.

2. For airplanes AF42-104829 and subsequent, the rear vision installation consists of two pieces of Plexiglas, one for left and one for the right side, held in an aluminum alloy frame which follows the contour of the fuselage. The complete assembly is attached to the fuselage by 24 screws around the bottom and aft frames of the rear vision assembly.

(*b*) REMOVAL OF REAR VISION GLASS.

1. For airplanes AF42-104429 through AF42-104828, the rear vision glass may be taken out by removing the support straps and metal retaining strip at its forward edge. Slide the Plexiglas sheet forward and out of the frame. Use care in removing the Plexiglas sheet to avoid marring its soft surface.

2. For airplanes AF42-104829 and subsequent, the complete rear vision assembly may be removed from the airplane by removing the 24 screws around the bottom and aft frames of the assembly and lifting the assembly off the fuselage.

(*c*) INSTALLATION OF REAR VISION GLASS.

1. For airplanes AF42-104429 through AF42-104828, slide the Plexiglas sheet in the frame and replace the metal retaining strip at the forward edge and the two support straps on the side of the glass.

2. For airplanes AF42-104829 and subsequent, replace the rear vision assembly on the fuselage and install the 24 screws around the bottom and aft frames of the assembly.

(4) CARE OF TRANSPARENT SHEETS.

(*a*) REMOVING SCRATCHES.—Slight surface scratches are easily removed by scrubbing the transparent sheet by hand with a soft cloth moistened with a turpentine-chalk mixture.

(*b*) CLEANING.—The surface may be cleaned with varnoline. This in turn may be removed by applying warm water and wiping lightly with a soft, wet cloth. Grease and oil may be removed with carbon tetrachloride, alcohols (simple or polyhydric), or ethers. Note that the transparent sheet is soluble in ketones, lower esters, aromatic hydrocarbons, phenols, arylhalides, aliphatic acids, chlorhydrins, acetals, chloroform, ethylene dichloride, propylene dichloride, and tetrachlorethylene.

4. ALIGHTING GEAR.

a. MAIN LANDING GEAR.

(1) GENERAL DESCRIPTION.—The main landing gear of this airplane is of the hydraulically retractable type, consisting of independent right and left assemblies. Each assembly consists of three essential components: the oleo strut, retracting mechanism, and the wheel and brake.

(*a*) OLEO STRUTS. (See figures 114 and 115.) —Each landing gear leg has an air-oil absorber strut which rotates aft about trunnions at the top of the strut. Each leg has an inboard side brace link attached to the panel. During retraction, bevel gears rotate the strut approximately 96 degrees so that the wheel is brought flush into the wheel well in the wing. The bevel gears also serve as structural members. Torque loads on the absorber piston are transmitted through the scissor links to the cylinder, and the bevel gears in turn transmit this torque from the cylinder to the landing gear fittings on the wing.

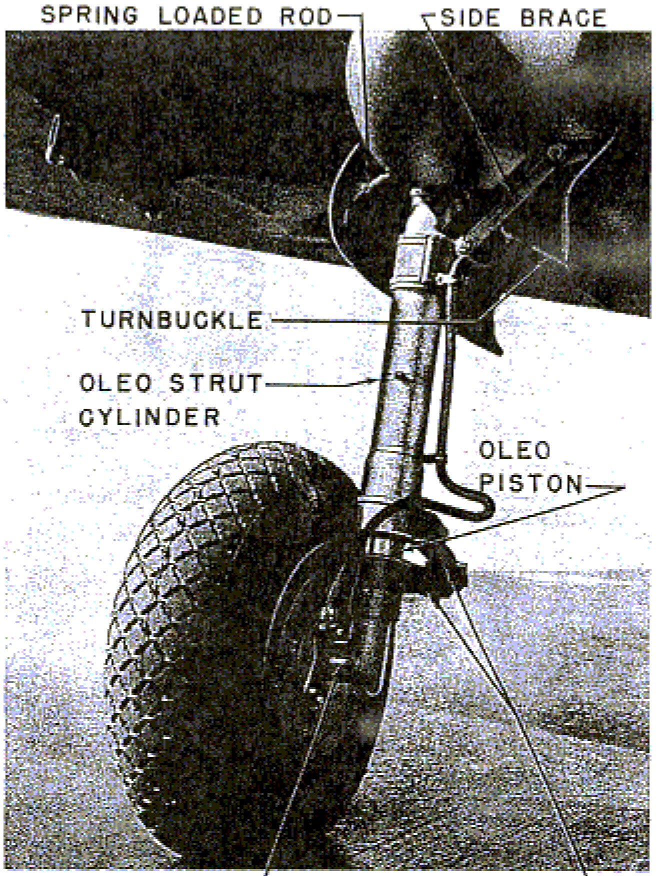


Figure 114—Main Landing Gear—Front View

(*b*) RETRACTING MECHANISM. (See figures 116 and 117.)—The retracting mechanism consists of a pair of hydraulically operated retracting struts, one in each wing panel directly forward of the wheel well. A pair of identical retracting arms connect sets of lower and upper retracting links in each mechanism. Each pair of retracting arms is anchored to a through bolt fitting to the bottom of the wing. The lower links are attached to the lower swivel trunnion, and the upper set to the tee end of the retracting piston. Extension of the retracting strut causes the landing gear to retract into the lower surface of the wing. An auxiliary hand pump installed on the right side of the cockpit, can be operated in lieu of the electric motor-driven pump in providing pressure for the hydraulic system. An electric warning system is operated by action initiated within the retracting strut in conjunction with the throttle switch as indicated in section IV, paragraph 4, *a,* (4), which results in illuminating an electric bulb located on the anti-glare shield in the cockpit, whenever the main landing gear is in an unlocked position and the engine is throttled down to 1000 rpm or less.

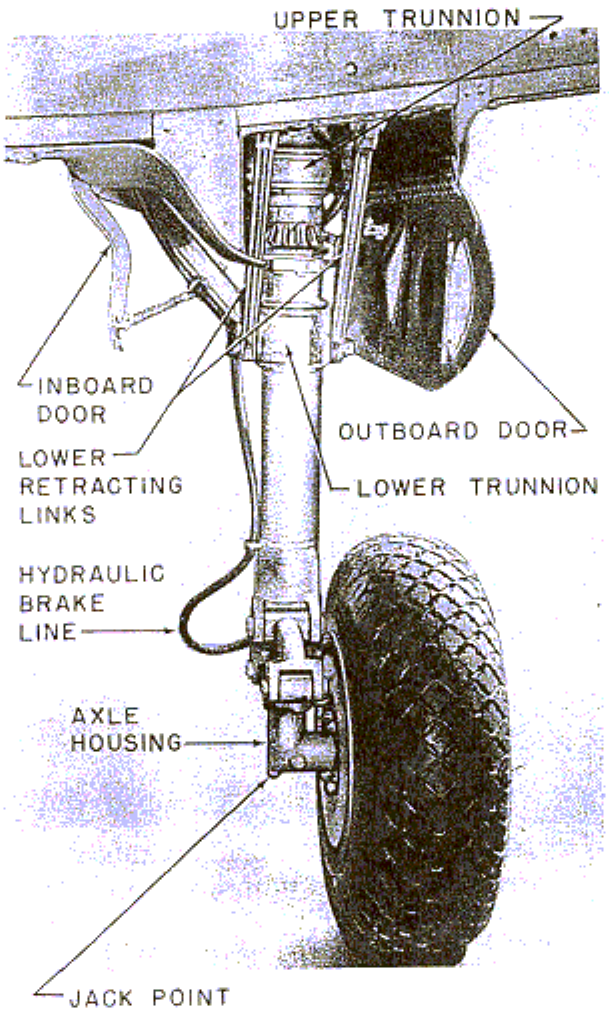


Figure 115—Main Landing Gear—Rear View

(c) WHEELS AND BRAKES.—The main landing gear wheels on all P-40N airplanes are magnesium alloy castings with the drop-center type of rim, manufactured by the Hayes Industries Corporation, Jackson, Michigan. The essential structural members are the wheel casting and the brake drum. Wheels on P-40N airplanes AF42-104429 through AF42-104828 are mounted with 30-inch smooth contour, eight ply nylon casings and 30-inch smooth contour type 1 tubes, and work in conjunction with 12x3-1/4 inch Hayes reversible hydraulic brakes. Wheels on subsequent airplanes take 27-inch smooth contour, eight ply nylon casings and 27-inch smooth contour type 1 tubes, and operate with 11x3 inch Hayes reversible hydraulic brakes. Two Warner master brake cylinders, working independently of each other and the main hydraulic system, actuate the two brakes on each airplane.

(2) THE OLEO STRUT ASSEMBLY.

(a) TO REMOVE THE OLEO STRUT ASSEMBLY.

1. Disconnect the clevis end of the turnbuckle rod which connects the inboard landing gear fairing door to the side brace link and controls the opening and closing of the inboard door. Detach either end of the cable which connects the outboard door to the support on the pinion gear wing. Unfasten the inboard end of the spring-loaded rod which connects the outboard door to the landing gear fairing bulkhead. This rod closes the outboard door by spring tension.

2. Remove the screws attaching the landing gear leading edge fairing and outboard fairing door to the wing and remove the fairing. The leading edge section of the wing fillet must be removed to gain access to the inboard screws on the landing gear fairing at the leading edge.

3. Insert the jack point studs in the panels and jack the front *and rear* of the airplane until the landing gear wheels are off the ground.

4. Remove the bleeder screw at the brake cylinder on the inner wheel fairing and drain the brake system. Disconnect the hydraulic brake hose at the fitting below the bleeder screw on the torque plate. Remove the two hose clamp fittings from their supports, one at the lower end of the oleo cylinder and the other at the lower trunnion.

5. On wheels having an outer fairing, remove by unbuttoning the four Dzus fasteners.

6. Remove the axle cap and the cotter pin and turn off the axle nut, freeing the wheel. Pull the wheel and the wheel bearings from the axle.

7. Free the upper forward circumference of the canvas in the wheel pocket and turn the canvas out, exposing the structural detail in the wheel pocket.

8. Partially retract the landing gear so that the upper retracting links and retracting-strut-piston-end through bolt are accessible through the wheel pocket.

9. Remove the cotter pin, nut, and through bolt connecting the retracting-strut piston end to the upper landing-gear retracting links.

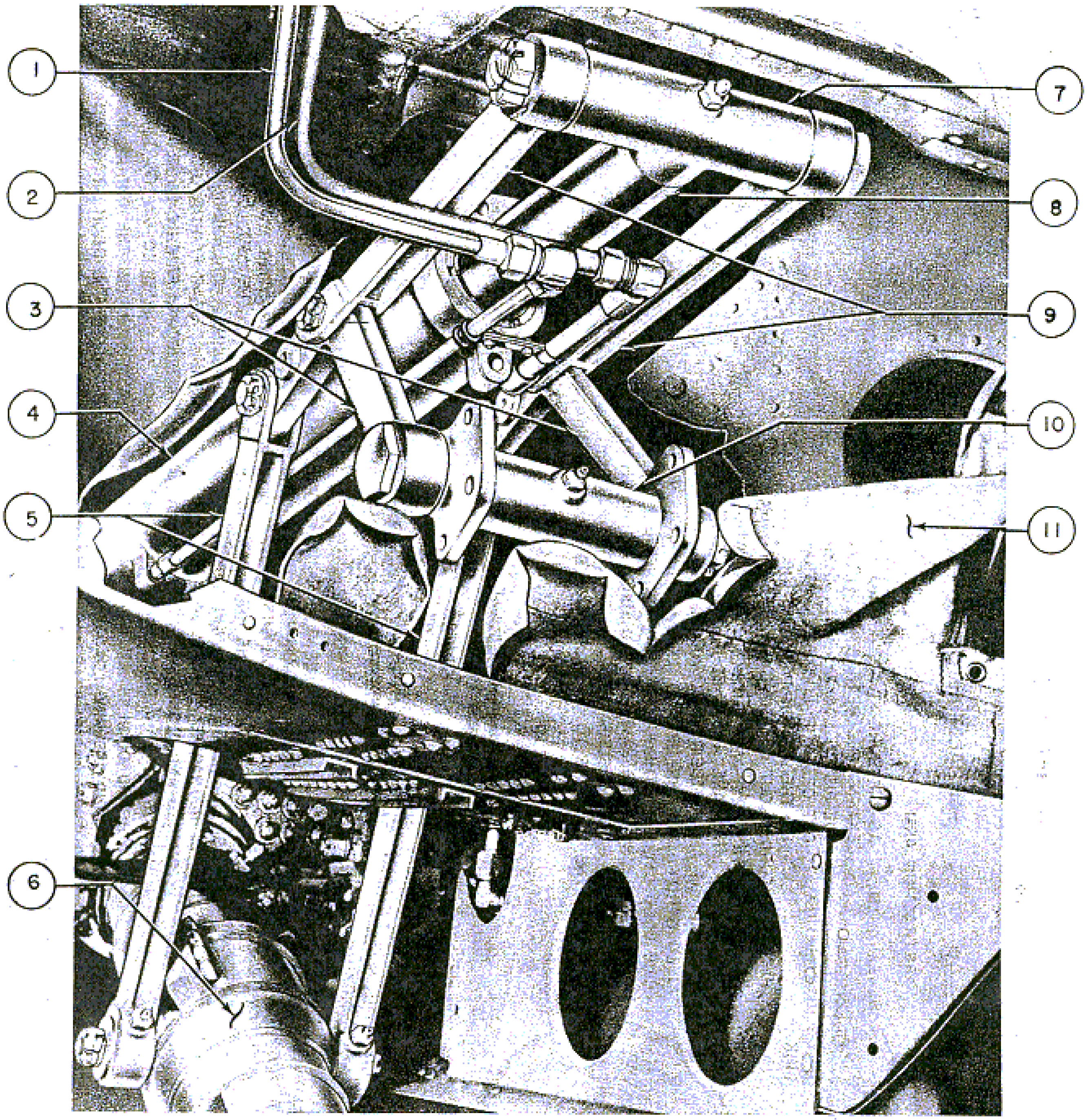
10. Return the piston completely into the retracting strut by placing the landing gear handle on the control valve in the "DOWN" position and actuating the motor-driven hydraulic pump switch on the control stick.

11. Working through the two lightening holes in the web of the wheel pocket at either side of the retracting strut cutout, remove the through bolt which attaches the retracting arms to the wing. (See figure 118.)

12. Pull the cotters, and turn off the nuts attaching the lower retracting links to the lower oleo trunnion. With the retracting arms free in the wing, there will be enough side play to remove the lower retracting links from the trunnion fittings.

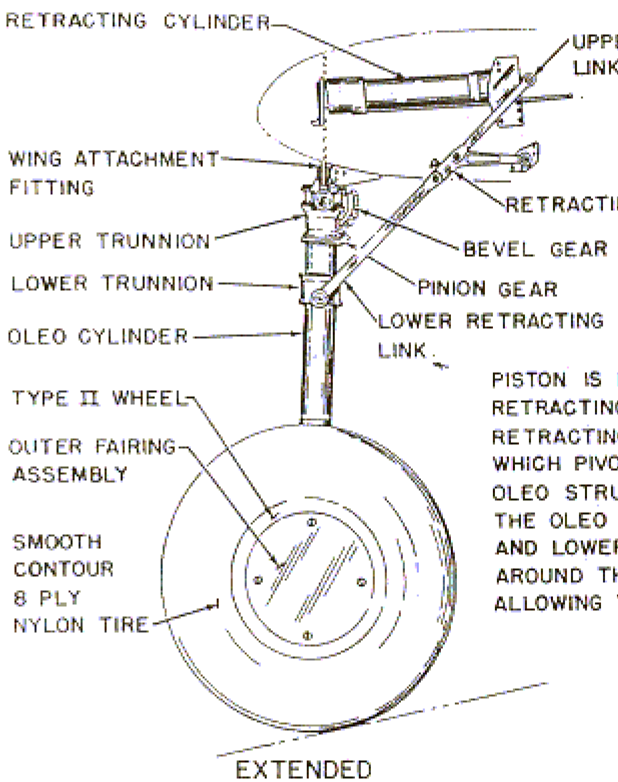
13. Disconnect the side brace link at the wing, or at the oleo strut's lower trunnion if desired.

14. Remove the cotter pins, nuts, and bolts from the wing attachment fittings and lower the oleo

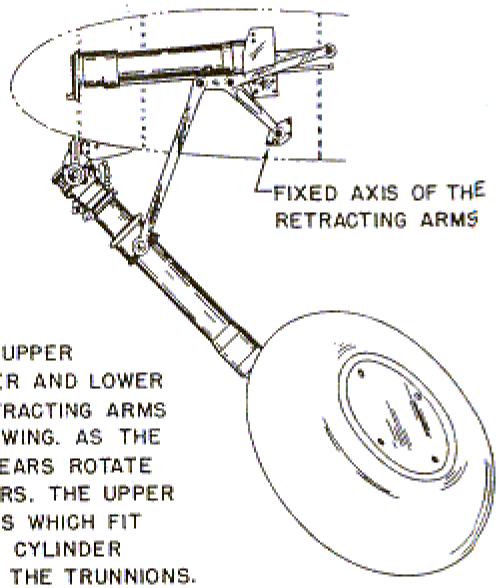


1 HYDRAULIC PRESSURE LINE
2 HYDRAULIC RETURN LINE
3 RETRACTING ARMS
4 RETRACTING CYLINDER
5 LOWER RETRACTING LINKS
6 OLEO STRUT
7 PISTON TEE END
8 PISTON
9 UPPER RETRACTING LINKS
10 RETRACTING ARMS THRU BOLT
11 WHEEL POCKET COVER

Figure 116—Main Landing Gear Retracting Mechanism



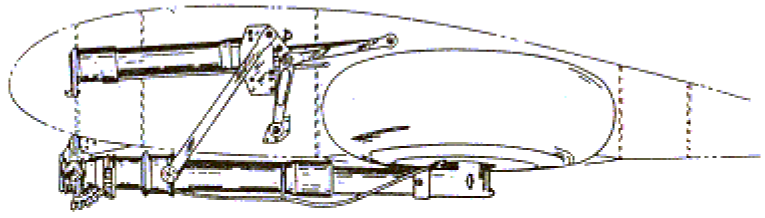
PARTIALLY RETRACTED



AS PRESSURE IS APPLIED TO EXTEND THE RETRACTING STRUT THE PISTON LOCKS ARE CAMMED OUT OF THEIR LOCKED POSITION BY THE PISTON PAWL. AS THE PISTON IS FORCED OUT OF THE CYLINDER THE UPPER RETRACTING LINKS ARE PULLED AFT. THE UPPER AND LOWER RETRACTING LINKS ARE ATTACHED TO THE RETRACTING ARMS WHICH PIVOT ABOUT THEIR FIXED AXIS IN THE WING. AS THE OLEO STRUT IS DRAWN UPWARD THE BEVEL GEARS ROTATE THE OLEO CYLINDER THROUGH THE PINION GEARS. THE UPPER AND LOWER TRUNNIONS HAVE BEARING SURFACES WHICH FIT AROUND THE BEARING SURFACES OF THE OLEO CYLINDER ALLOWING THE CYLINDER TO TURN FREELY ON THE TRUNNIONS.

EXTENDED

THE LANDING GEAR IS EXTENDED WHEN THE RETRACTING STRUT IS RETRACTED. WHEN THE LANDING GEAR IS FULLY EXTENDED THE MECHANICAL LOCKS IN THE PISTON ARE POSITIVELY CAMMED INTO THEIR LOCKED POSITION BY THE OVER-RUN OF THE PISTON PAWL. TORQUE LOADS ARE TRANSMITTED FROM THE WHEEL THROUGH THE SCISSORS LINKS TO THE OLEO CYLINDER. THE PINION AND BEVEL GEARS THEN TRANSMIT THE TORQUE TO THE ATTACHMENT FITTING ON THE WING.



RETRACTED

WHEN THE LANDING GEAR IS FULLY RETRACTED THE OLEO STRUT AND WHEEL HAVE ROTATED APPROXIMATELY 90 DEGREES SO THAT THE WHEEL LIES IN THE WHEEL POCKET FLUSH WITH THE WING. WHEN THE RETRACTING STRUT PISTON IS FULLY EXTENDED THE PISTON LOCKS ARE CAMMED INTO THE AFT LOCKED POSITION BY THE OVER-RUN OF THE PISTON PAWL LOCKING THE LANDING GEAR IN THE RETRACTED POSITION AS ILLUSTRATED. THE LANDING GEAR FAIRING DOORS ARE OPENED AND CLOSED WITH THE LANDING GEAR. THE INBOARD FAIRING DOOR IS ATTACHED BY A TURNBUCKLE TO THE SIDE BRACE OF THE OLEO STRUT. THE OUTBOARD DOOR IS ATTACHED BY LINKAGE TO A SUPPORT ON THE PINION GEAR RING AND A SPRING LOADED ROD AT THE FORWARD END OF THE DOOR ATTACHED TO THE LANDING GEAR FAIRING BULKHEAD.

Figure 117—Landing Gear Retraction

strut assembly from the wing. (See figure 119.)

15. The retracting arms may now be pulled far enough through the wing opening to remove the nuts and pull the bolts connecting the retracting arms and lower retracting links.

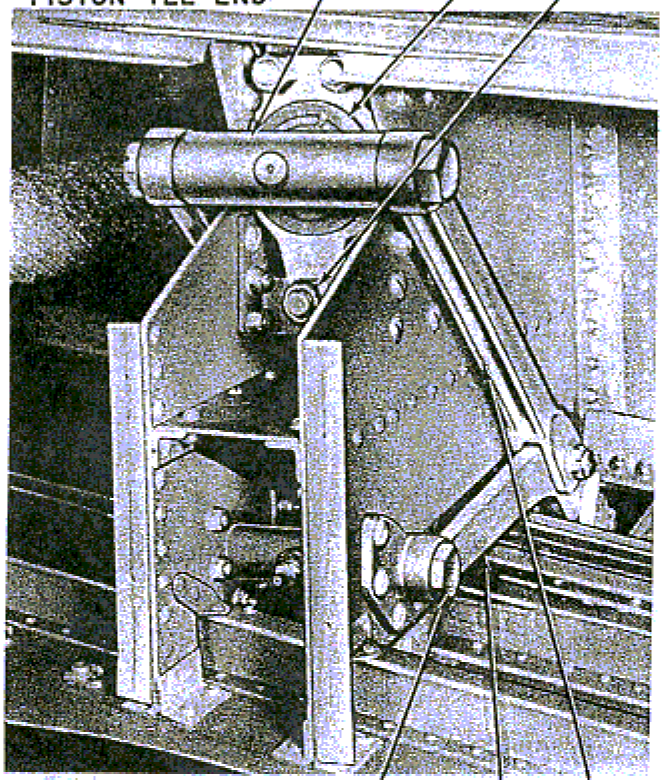


Figure 118—Retracting Arms and Upper Retracting Links

16. Remove the upper retracting links and retracting arms from the wing as illustrated in figure 120.

(b) TO DISASSEMBLE THE OLEO STRUT. *(See figure 121.)*

1. After the oleo strut assembly has been removed from the wing, vent the air pressure carefully and drain the hydraulic fluid by removing the Schrader plug. Place the oleo strut in a wooden block clamp to secure it from turning. Remove the six attaching bolts and lift the brake shoe and torque plate assembly from the axle.

2. Reverse the position of the oleo strut in the wooden block clamp and pull the cotter pin from the plunger nut. Turn the plunger nut off with a socket wrench and remove the upper trunnion cap.

3. After the upper trunnion cap is removed, pull the upper trunnion assembly, including the bevel gear and wing attachment fittings, off the oleo strut.

4. If the side brace has been removed with the oleo strut assembly, pull the cotter pin, loosen the nut, and remove the bolt that attaches the side brace to the lower trunnion. Remove the side brace from the trunnion.

5. Unscrew the eight cap screws holding the two lower trunnion halves together and pull the trunnion halves from the oleo strut.

6. Remove the two lower trunnion facer plates and the four segments.

7. Pull the cotter pins and remove the nuts and washers from the four pinion-gear attaching bolts, pull the bolts, and remove the two segments and the support. The shims will come out with the pinion gear.

8. Reverse the oleo strut cylinder in the wooden block clamp, pull the cotters, remove the nuts, and pull out the two bolts which attach the oleo piston to the axle housing. When the axle housing and oleo strut are assembled in the factory, these two parts are fitted together with .003 inch maximum clearance and jig-reamed to set the axle housing for 0 degrees 30 minutes ± 15 minutes toe-in. Therefore, it is essential that the same axle housing and oleo strut be reassembled together. If it is necessary to install a new axle housing, the two assemblies should be lined up and jig-reamed to coincide with the original assembly.

9. Pull the cotter pins and remove the nuts and washers on the two bolts, one attaching the scissor links to the lugs on the piston and the other attaching the links to the lugs on the cylinder. Turn out screws securing washers (87-31-561) to the lugs, and remove washers. Remove the bolts and pull the links free of the piston and cylinder lugs.

10. With the oleo cylinder secure in a wooden block clamp, loosen the set screw on the cylinder and turn the packing gland nut completely out of the cylinder with a spanner wrench.

11. Pull the piston assembly from the end of the cylinder. The piston assembly is composed of the gland nut, packing and packing rings, piston sleeve, piston bearing, and metering pin. (See figure 122.)

12. If it is desired to remove the metering pin, place the piston assembly in a wooden block clamp and lock the clamp in a vise. Insert the metering pin wrench (part No. 87-88-031) into the piston at the bearing end and unscrew the metering pin. Remove the metering pin and wrench, and pull the metering pin from wrench as illustrated in figure 123.

Note

Whenever a metering pin has been removed, it will be necessary to install a new copper washer when the pin is reinstalled. Never install a used washer.

13. While the piston is in the wooden clamp and secured in a vise, remove the solder from the

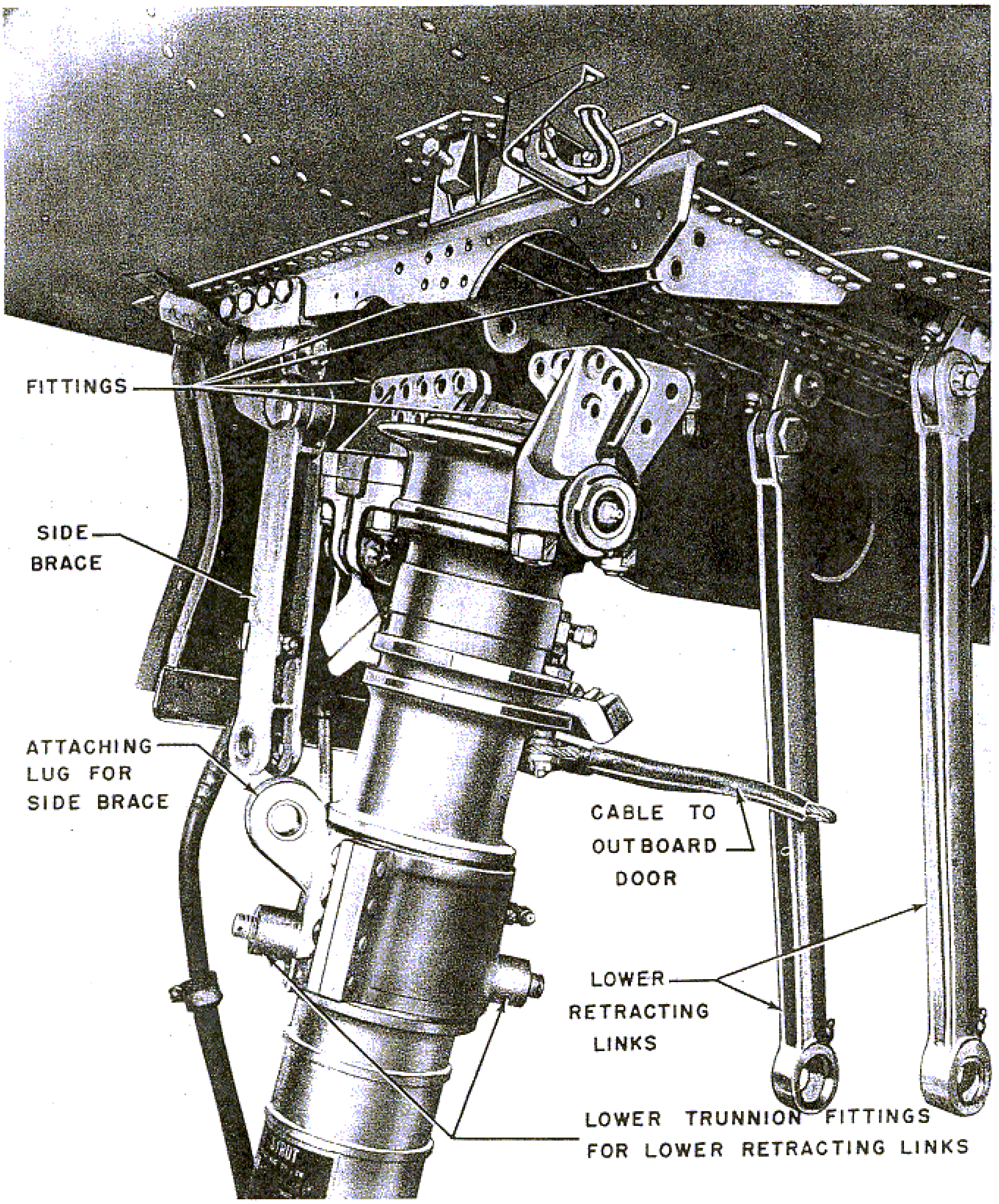


Figure 119—Removing Oleo Strut Assembly from Wing

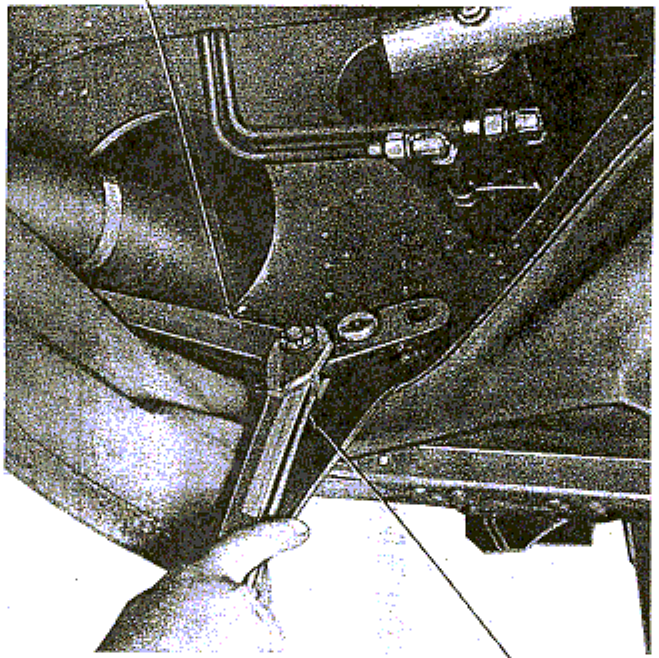


Figure 120—Removing Upper Retracting Links and Retracting Arms

three lock screws on the piston bearing, either by digging the solder out or by applying just enough heat by torch to melt it away. Remove the screws.

14. Use a spanner wrench and turn the piston bearing off the piston. The sleeve, packing ring, packing and gland nut can now be slid off the piston. The piston is now completely disassembled as illustrated in figure 122.

15. If it is desired to remove the plunger from the oleo strut, place the oleo strut in a vertical position in a vise. Mix some asbestos with water until a thick mixture is obtained, and mold a generous ring of asbestos around the oleo as shown in figure 124. This will prevent the heat from the torch, when applied to melt the solder joint, from going down into the oleo cylinder.

16. Apply heat from a torch and melt the solder.

17. Free the oleo cylinder from the vise and turn the cylinder upside down so that the melted solder will run out into a container. Now the plunger can be turned out of the cylinder with a spanner wrench without any flow of solder into the cylinder when the plunger is removed.

18. The oleo strut is now completely disassembled for inspection and servicing.

(c) TO INSPECT THE OLEO STRUT FOR REPLACEMENTS.

1. Before assembling the oleo strut, thoroughly inspect and clean all parts. Any parts found defective in any way should be replaced. Use only alcohol to clean the oleo strut parts.

2. Inspect packings carefully and clean with alcohol. Replace any packing showing the slightest damage.

3. If the plunger has been removed from the cylinder, clean the cylinder top with carbon tetrachloride or equivalent.

(d) TO ASSEMBLE THE OLEO STRUT.

1. Place the cylinder in a vertical position and secure it in a vise.

2. Mold a generous ring of asbestos and water mixture around the cylinder as illustrated in figure 124 to restrict heating to the top of the cylinder.

3. Apply heat from a torch to both the inside and outside of the top of the cylinder. Move the torch around the circumference of the cylinder rapidly so that the metal will not be overheated and consequently lose temper.

4. Have several pieces of tube solder in ring form that will just fit inside the cylinder. Brush the inside of the cylinder around the flange with a soldering solution of 15 percent zinc chloride, 35 percent glycerine, and 50 percent water. Drop a solder ring into the cylinder upon the flange.

5. Place the plunger assembly on a cradle so that it may be rotated, and heat the end of the plunger around the groove above the threads.

6. Brush on soldering solution and apply a generous coating of solder in the groove and on the nut face. Do not solder up the two spanner wrench holes on the nut face.

7. Brush the solder with a clean wire brush and insert the plunger into the cylinder.

8. Tighten the plunger into the cylinder with a spanner wrench.

9. Place a steel rule on the top of the cylinder as in figure 124 to see if the plunger has the proper protrusion above the cylinder. The bottom of the cotter hole in the plunger should be flush with the top of the steel rule. If the protrusion is not sufficient, the plunger must be removed and more solder applied to build up the cylinder flange or another plunger installed. It is imperative that the cotter hole in the plunger comply with the above specified position or it will be impossible to safety the plunger nut when the upper trunnion cap and nut are installed.

10. After the plunger is properly assembled in the cylinder, drop three more rings of solder into the cylinder while applying heat. Drop these rings in one at a time. This should thoroughly seal the joint and build up a solid cap around the plunger face.

A	87-31-906-5	FITTING
B	87-31-547	CAP
C		SOLDER JOINT
D	87-31-512	PLUNGER
E	87-31-551	BEARING
F	75-31-044	PISTON BEARING
G	75-31-045	SLEEVE
H	AN310-16	NUT
I	87-31-106-6	FITTING

J	87-31-041	UPPER TRUNNION ASSEMBLY
K		FILLING VALVE
L	87-31-525	LOWER TRUNNION ASSEMBLY
M	87-31-916	CYLINDER
N	75-31-050	METERING PIN
O	75-31-048	PACKING RING
P	75-31-049	PACKING
Q	75-31-046	CYLINDER BEARING NUT
R	87-31-912	PISTON

OLEO STRUT ASSEMBLY TO BE TESTED TO A PRESSURE OF 2800 POUNDS PER SQUARE INCH USING HYDRAULIC FLUID AAF SPECIFICATION 3586 UNAMENDED GRADE B (BLUE). CHECK SPECIFICALLY SOLDER JOINT, PACKING AND METERING PIN ON CYLINDER ASSEMBLY.

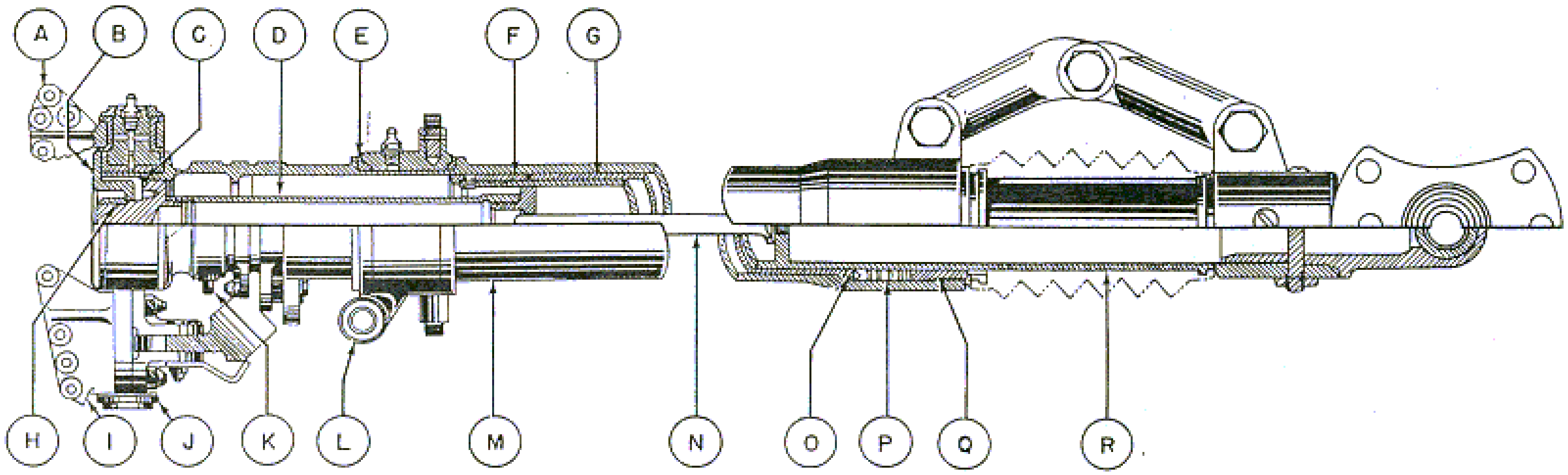


Figure 121—Landing Gear Oleo Strut

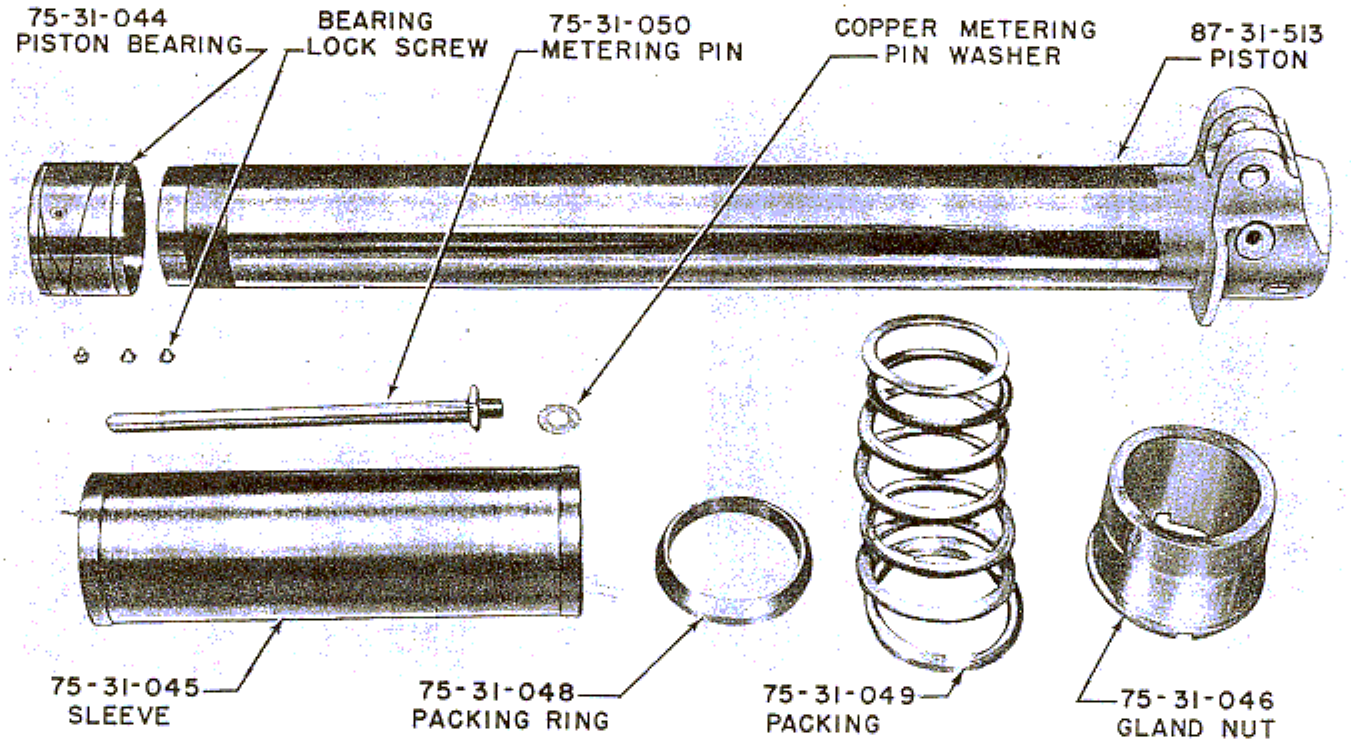


Figure 122—Oleo Strut Piston Disassembled

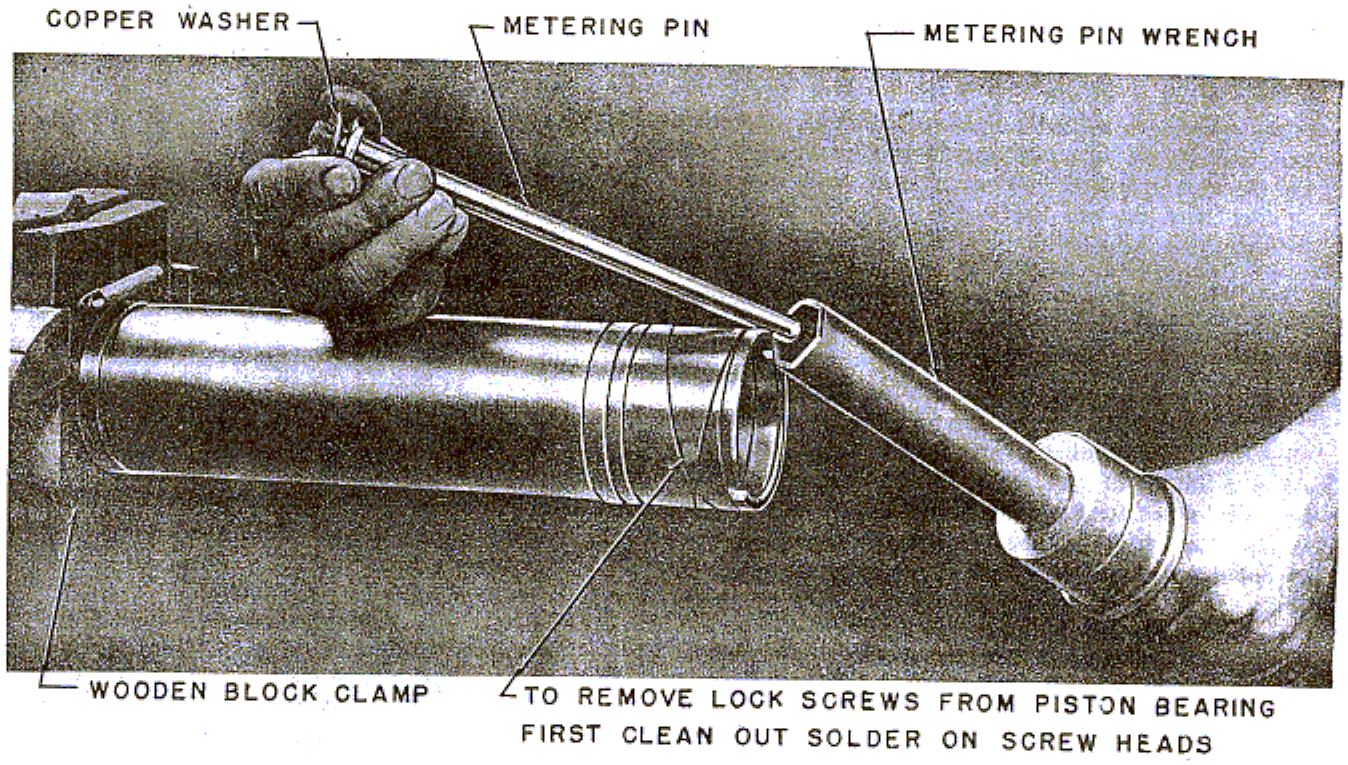


Figure 123—Removing Metering Pin from Piston

Figure 124—Checking Cotter Pin Hole Location

11. Clean the outside of the top of the cylinder where the heat was applied with a solution of 5 percent soda ash, 1 percent potassium bichromate, and 94 percent water. Polish with a cloth and set the cylinder aside to cool.

12. When the cylinder has cooled sufficiently, remove the asbestos mold. The cylinder is now ready for the assembly of the remainder of the unit.

13. First step is to assemble the piston by placing it in a wooden block clamp and insert the clamp in a vise to secure it from turning.

14. Insert the metering pin in the metering pin wrench, be sure to place a new copper washer on the threaded end below the nut, and insert the wrench with the pin in the piston. Screw in the metering pin tightly.

15. Slide the gland nut onto the piston, threaded end first, and then slide on the lower packing ring, the five packings, and the upper packing ring.

16. Slide the sleeve over the piston and screw on the piston bearing until it is tight.

17. Install the three lock screws and fill the screw heads with solder to safety them in place. Buff off the solder so that there are no burrs or sharp edges to score the cylinder wall. The piston is now completely assembled and ready for installation in the cylinder.

18. Wet the packings thoroughly with hydraulic fluid, AAF Specification 3586.

19. Slide the piston into the cylinder, secured in a wooden-block clamp, and tighten the gland nut with a spanner wrench. Tighten the nut firmly but not excessively and tighten the set screw in the cylinder. The strut is now ready for the preliminary test.

(e) TO TEST THE OLEO STRUT FOR LEAKAGE.

1. Lay the strut down on a bench horizontally with the Schrader plug up. Remove the plug and fill the cylinder with hydraulic fluid, AAF Specification 3586, while extending the piston, until oil flows over the plug hole. Screw a pressure gage into the plug hole and insert the strut in a vertical press. Apply a pressure of 2800 pounds per square inch and allow the strut to remain under this pressure for 10 minutes. Inspect the oleo strut for leaks, especially around the solder joint, packing gland nut, and metering pin. (See figure 125.)

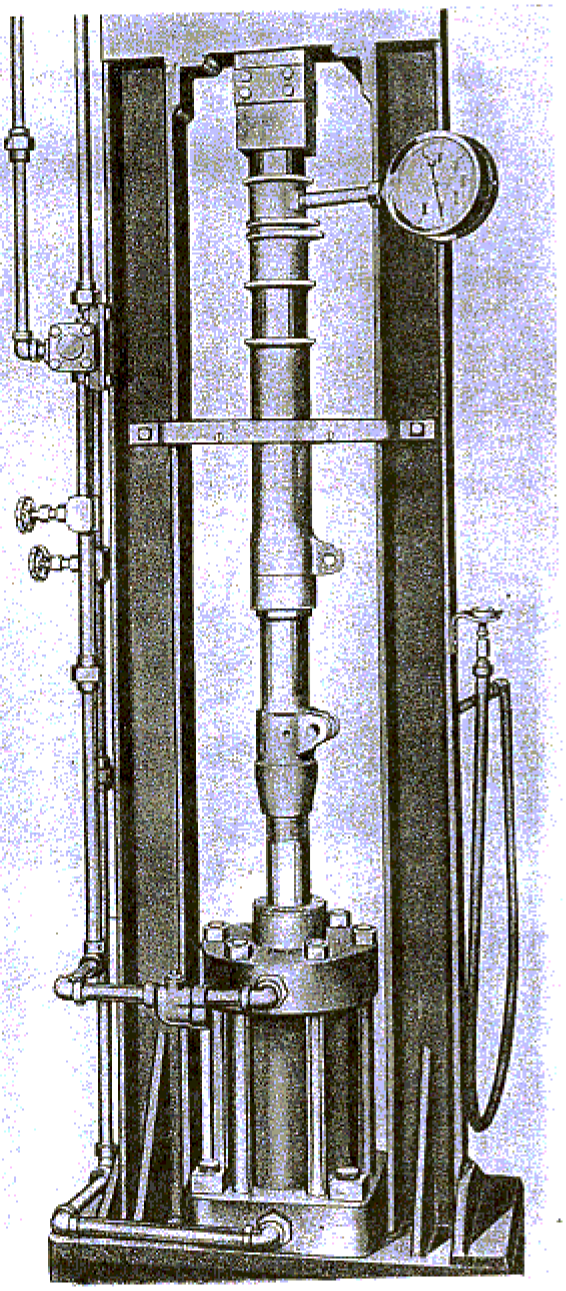


Figure 125—Pressure Test of Oleo Strut

2. If the pressure test shows no leaks, drain the hydraulic fluid. If the packing has been replaced, the oleo assembly should be run in on a machine that will move the piston in and out through at least half its total travel, a minimum of 500 cycles. The strut must be fully serviced with fluid and air before running in. This servicing may be accomplished as follows:

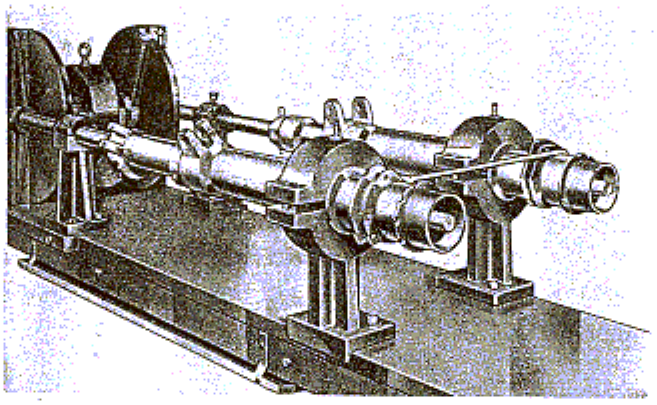


Figure 126—Running-in the Oleo Strut

a. Push the piston into the cylinder as far as possible and stand the strut in a vertical position. Fill the strut with hydraulic fluid, AAF Specification 3586, until it overflows, and replace the Schrader plug loosely. Place the oleo strut in the machine (figure 126) and cause the strut to be extended and retracted several times to eliminate air trapped in the strut. Remove the strut from the machine and check the fluid level. If additional fluid is added, repeat the procedure outlined above each time fluid is added, until the proper fluid level is obtained. Inflate the strut to 208 pounds per square inch pressure with a high pressure hand pump. Do not use compressed air. Replace the strut in the machine and run in a minimum of 500 cycles.

3. After the strut has been run in, assemble the scissor links. Be sure that the links are thoroughly clean and that the bushings are not worn or scored. Replace badly worn or scored bushings. When bushings are replaced, it will be necessary to drill a new grease passage in the bushing to align with the grease passage on the scissor link which is equipped with a Zerk fitting. Coat the surfaces of the bushings and bolts with grease, Specification AN-G-3, or equivalent, and install the scissor links on the piston and cylinder lugs. Insert the bolts, snug up the nuts, back them off one castellation, and install the cotter pins. It is very important that the bolts do not bind the bushings. Periodic inspection and greasing of the scissor links are required to assure satisfactory operation of the parts at all times.

4. Install the axle housing and axle assembly and insert the two through bolts. Turn up the nuts tightly and install cotter pins.

5. Install the pinion gear with shims as on the original installation. These shims are sweat-soldered in place. Slip the segments into place and install the four bolts and the support, making sure that the support is installed on the same side of the cylinder as the scissor link lugs.

6. Install the four segments, two facer plates, and the lower trunnion halves. Install the eight cap screws and the attachment fitting. Draw the cap screws up tightly.

7. Install the side brace on the lower trunnion and safety the nut with a cotter pin.

8. Slide the upper trunnion, with the bevel gear and wing fittings attached, onto the cylinder.

9. Slide the trunnion cap onto the plunger bolt and install the plunger nut. Take up the nut with a socket wrench and safety the nut with a cotter pin.

10. Reverse the oleo strut in the wooden block clamp and place the axle in a vertical position. Install the brake shoe and torque plate assembly on the axle, and secure the six attaching bolts. The oleo strut is now ready for lubrication before installing on the wing. Force grease, Specification AN-G-3 or equivalent, through all the Zerk fittings with a grease gun until grease oozes out of the joints. Test the trunnions to see whether they revolve freely.

(f) TO INSTALL THE OLEO STRUT ASSEMBLY.

1. Raise the oleo strut to the wing, place the landing gear visual indicator in position through the leading edge of the wing, and guide the fittings on the upper trunnion into the fittings on the wing. Insert the attaching bolts, tighten the nuts, and safety with cotter pins.

2. Attach the side brace fitting to the wing, or to the lower trunnion lug on the oleo strut if it was originally disconnected at this point. Shim side strut to .006 inch maximum clearance.

3. Attach the upper retracting links to the retracting arms and insert the assemblies into the wing through the two web lightening holes in the wheel pocket. (See figure 120.)

4. Tip the retracting arms so that the lower retracting links attachment ends protrude through the openings on the under surface of the wing far enough to provide clearance to attach the lower retracting links to the retracting arms. Attach the links to the arms with the attaching bolts and tighten the nuts. Do not tighten the nuts excessively. Safety the nuts with cotter pins.

5. Slide the lower retracting links onto the lower trunnion fittings, install and take up the nuts, and safety the nuts with cotter pins.

6. Attach the retracting arms at the pivot point in the wing with the through bolt. Do not tighten the nut on the through bolt excessively. Safety the nut on the bolt with a cotter pin.

Note

Be sure that the spacer with the Zerk fitting is installed between the pivot point bushings. (See figure 118.)

7. Attach the upper retracting links to the piston tee end on the retracting cylinder with a through bolt and tighten the nut. Do not tighten the nut excessively. Safety the nut with a cotter pin.

8. Connect the brake hose to the wheel at the torque plate fitting. Attach the two clamp fittings supporting the brake hose to the oleo cylinder.

9. Coat the wheel bearings with AAF Specification 3560 grease, and slide the wheel assembly onto the axle. Turn on the axle nut and take it up snugly. Back the nut off until the wheel turns freely, safety the nut with a cotter pin and slide on the cap. Where there is an outer wheel fairing, button it on with the four Dzus fasteners.

10. For lubrication of the landing gear assembly, see figure 39 in section III.

(g) TO TEST OPERATION OF THE OLEO STRUT ASSEMBLY.

1. Test the landing gear for proper operation with both the electric hydraulic motor-driven pump and the auxiliary pump.

2. Test the bevel and pinion gears for backlash adjustments. Allowable backlash is from .000 to .002 inch. If there is excessive backlash remove the shim from the top of the pinion gear ring and place it on the bottom. If the gears bind remove the shim from below the pinion gear ring and place it above the gear.

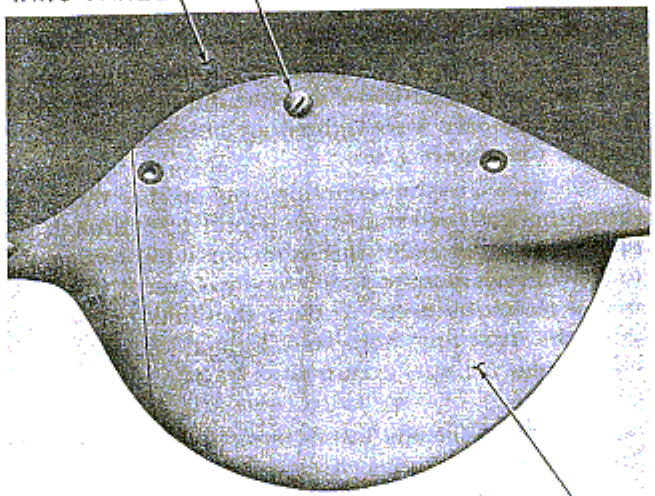


Figure 127—Installation of Landing Gear Fairing—Step 1

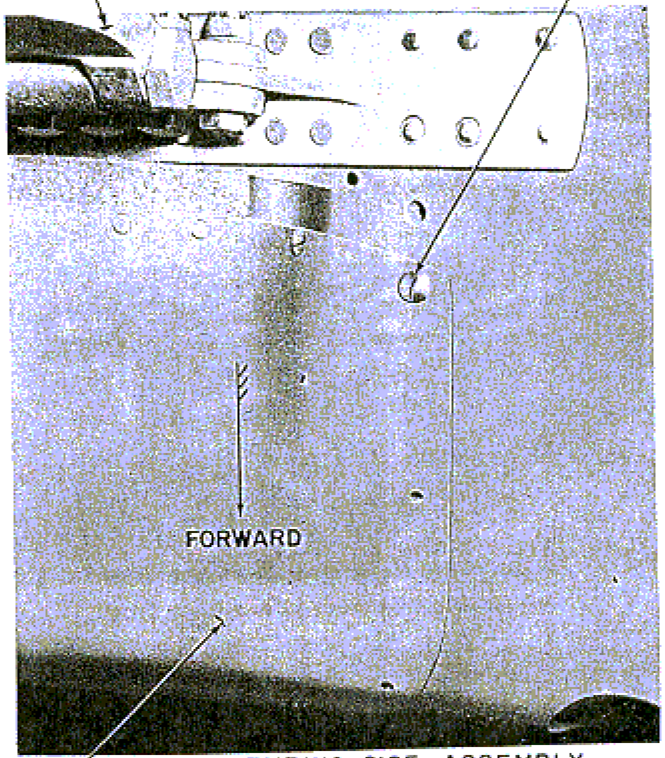


Figure 128—Installation of Landing Gear Fairing—Step 2

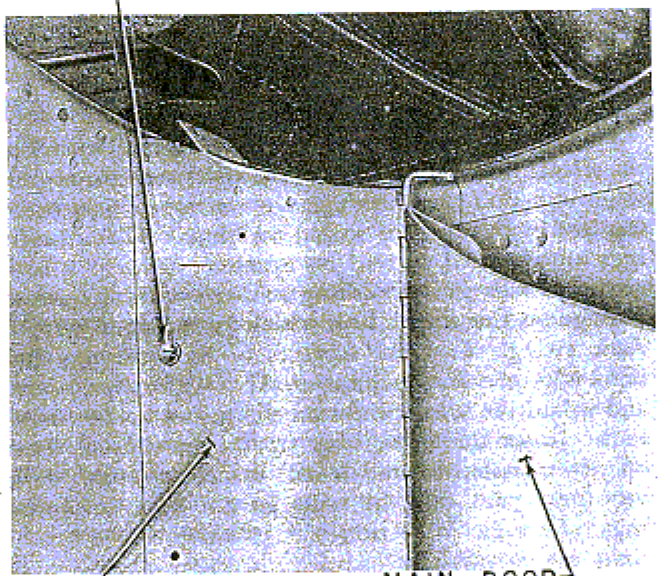


Figure 129—Installation of Landing Gear Fairing—Step 3

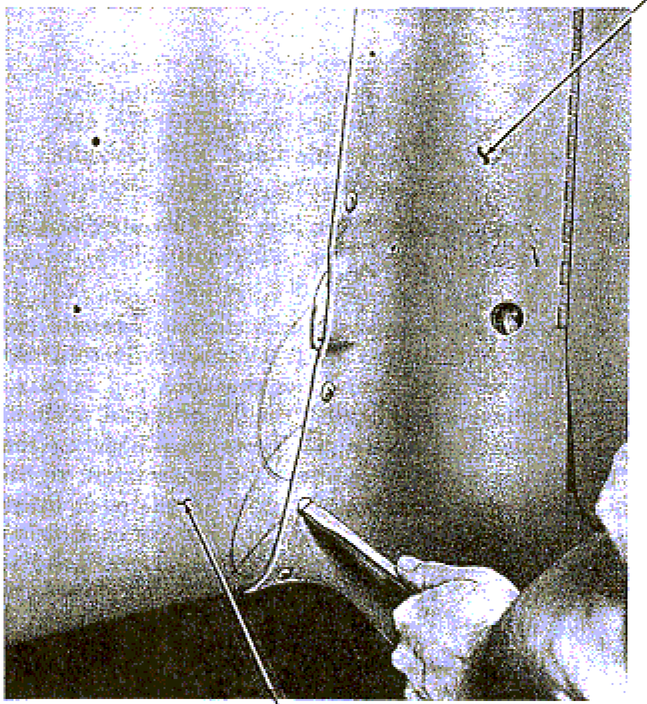


Figure 130—Installation of Landing Gear Fairing—Step 4

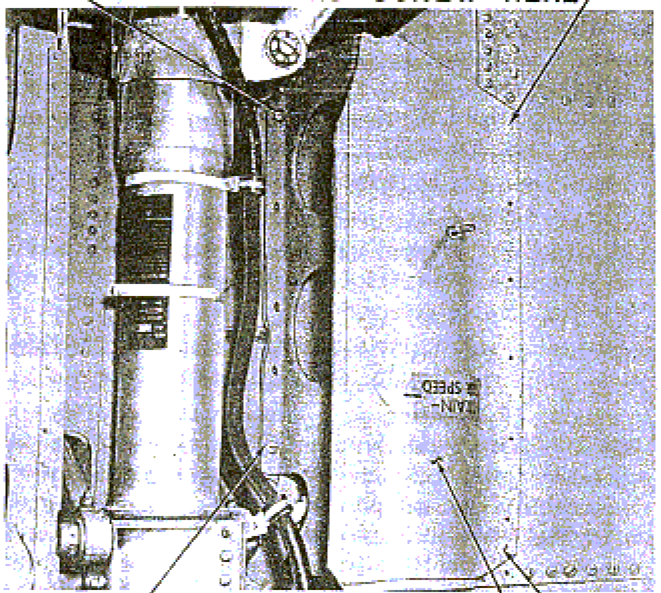


Figure 131—Installation of Landing Gear Fairing—Step 5

(*b*) TO COMPLETE INSTALLATION OF THE OLEO STRUT ASSEMBLY.

1. Replace the landing gear fairing as follows:

a. Lift the outboard fairing side assembly in place and install the first screw as shown in figure 127. Install the second and third screws as shown on figures 128 and 129. Enlarge remaining holes in the fairing, if necessary, to line-up with nutplates in the panel, and secure as indicated in figure 130.

b. Secure the inner side fairing as indicated in figure 131.

c. Figure 132 indicates how to install the inboard door fairing to which is attached the door as shown in figure 133.

2. Connect the inboard fairing door turnbuckle rod to the side brace and the spring-loaded rod to the outboard fairing door. Fasten the loose end of the cable which links the outboard door to the support on the pinion gear. Adjust the rods so that the doors close tightly when the landing gear is fully retracted.

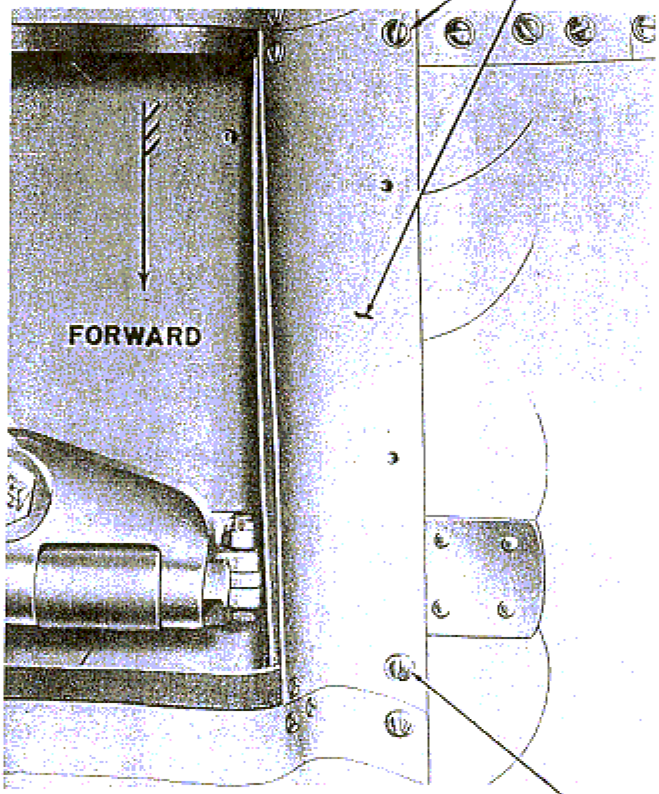


Figure 132—Installation of Landing Gear Fairing—Step 6

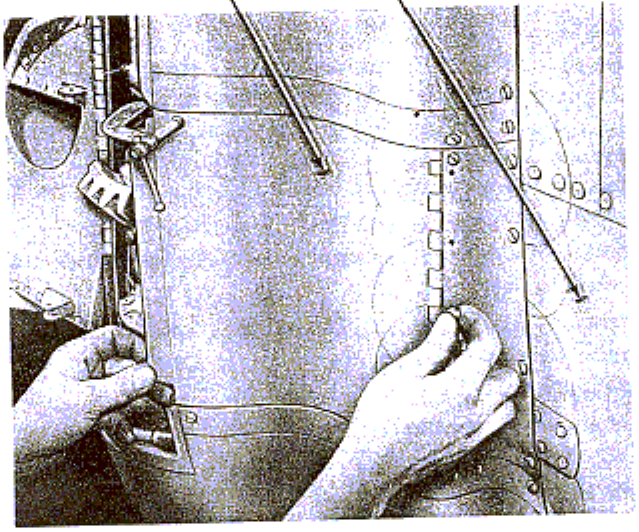


Figure 133—Installation of Landing Gear Fairing—Step 7

(i) TO SERVICE AND TEST THE OLEO STRUT.

1. With the airplane in the taxiing position, deflate the strut by backing off the filler plug slightly to allow the air to escape slowly past the copper gasket at the plug seat. Too sudden release of the air will damage the valve core. Do not attempt to remove the filler plug without first completely deflating the strut.

2. Back off the filler plug until all fizzing of air and fluid ceases.

3. Remove the filler plug and fill the strut with hydraulic fluid, AAF Specification 3586, until it is level with the plug hole.

4. Insert the plug loosely and cause the strut to be completely extended and retracted several times, preferably by raising and lowering the airplane with a hoist or jack. This method will eliminate air trapped in the strut.

5. Remove the plug and check the fluid level. If additional fluid is added, repeat the procedure outlined in step 4, preceding, each time fluid is added until the proper fluid level is obtained.

6. Replace and tighten the filler plug carefully so as not to damage the threads or valve stem. The copper gasket should be replaced whenever a filler plug is reinstalled to guard against leakage at the filler plug.

7. With the fluid at the proper level, inflate the strut through the air valve with a high pressure hand pump. Do not use compressed air. Rock the airplane while inflating the strut so that the strut will alternately extend and retract to overcome packing friction. When fully inflated, both struts must have under full load at least the minimum extension of 2 inches between the cylinder and piston collar, or 4-27/32 inches between bolt centers in the torque linkage.

Note

Any checking or adjusting of the strut inflation should be done on a reasonably level surface, sheltered from the wind, with the airplane in a taxiing position and fully loaded.

8. After inflation, test the valve, valve core and filler plug carefully for leaks by brushing a mixture of soap and water around the unit.

9. Small amounts of air can be removed from the strut by depressing the valve core. Exercise extreme care to allow the air to escape slowly to avoid damaging the valve seat. Support the tool used to depress the valve core against the lip of the valve stem. Care should be exercised to prevent damage to the filler plug and air valve assembly by excessive tightening of the air hose connection with pliers or other tools. If leakage occurs at the hose connection to the air valve and cannot be stopped by hand tightening, replace the fitting gasket in the pump hose.

(3) THE RETRACTING STRUT. (See section IV, paragraph 7, *c*, Hydraulic System.)

(4) THE LANDING GEAR WARNING LIGHT SYSTEM.

(a) GENERAL.

1. Three electrical switches, all functioning in the same circuit, are involved in the operation of the single landing gear warning light located on the anti-glare shield in the cockpit.

2. There are two main landing gear switches, one attached to the under panel in each "knee" just above the oleo strut. These switches are normally closed and are actuated independently by separate rocker and bellcrank mechanisms controlled by action within the retracting struts. (See figure 134.)

3. The throttle switch normally open, is located on the forward left side of the firewall and is actuated by a bellcrank connected to the throttle control rod. (See figure 135.)

(b) TO ADJUST THE MAIN LANDING GEAR WARNING LIGHT SWITCHES.

1. Either switch is made easily accessible by removing the landing gear "knee" fairing. The adjustable bolt at the bottom of the bellcrank is set by turning the lock nut fore or aft until the switch is in the open or off position when the landing gear is in the down-lock position. Either switch causes the warning light to illuminate whenever its companion landing gear leg is out of the down-lock (fully extended) position, and the throttle switch is closed to complete the circuit. (See paragraph *(c)* *1.* following.) Two men are required to make this adjustment, one on the ground to set the adjustable bolt, the other in the cockpit to observe the warning light and operate the landing gear control handle.

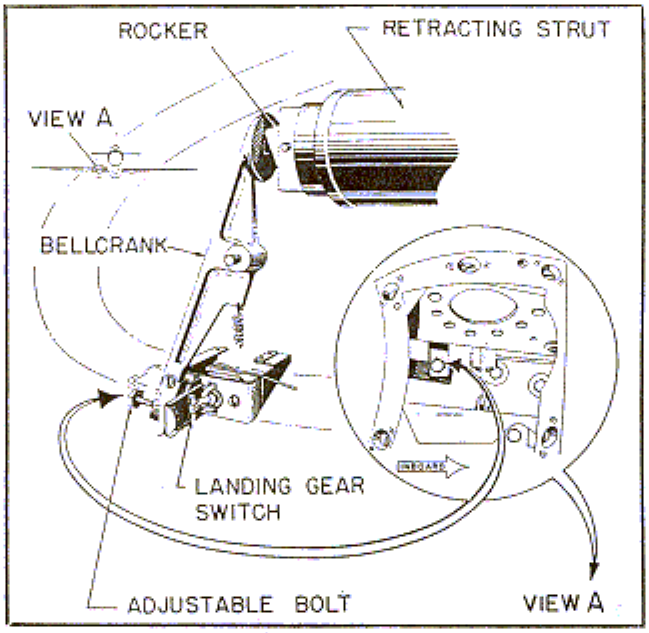


Figure 134—Landing Gear Warning Light Switch

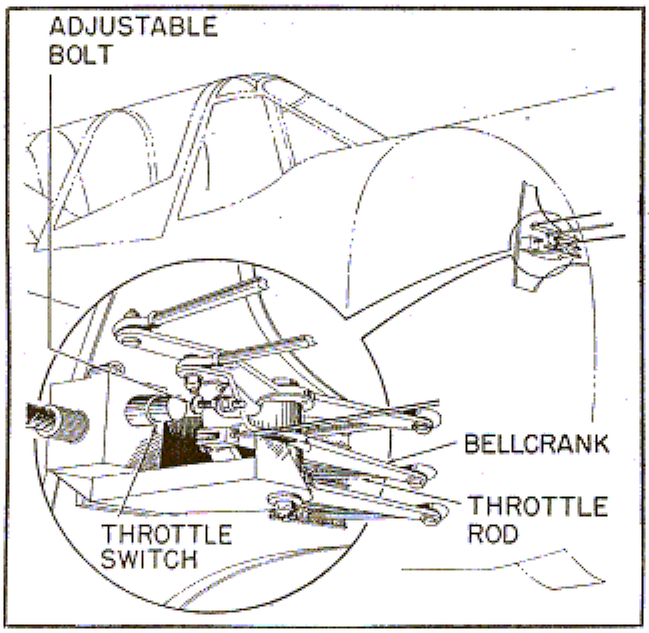


Figure 135—Throttle Warning Light Switch

(c) TO ADJUST THE THROTTLE SWITCH.

1. The adjustable bolt attached to the bracket on the bellcrank is made easily accessible by removing the engine cowling. By turning the two lock nuts, the contact bolt is adjusted to close the switch when the engine is throttled down to 1000 rpm or lower, thereby causing the warning light to illuminate and remain lighted until both legs of the main landing gear are in the down-lock position.

(d) VISUAL LANDING GEAR POSITION INDICATORS. (See figure 136.)

1. The visual position indicators (supplementing the warning light system) are two yellow painted pegs located atop each wing panel directly above the oleo struts. Linked to the lip on the oleo upper trunnion as shown in figure 136, these pegs, acting independently, rise and fall as the struts are extended and retracted, visually indicating to the pilot the position of the main landing gear units. When the landing gear legs are in the fully retracted position, the pegs disappear flush with the panel surface.

2. Normally this simple mechanism will require no adjustment, but if necessary the travel of the peg may be regulated by turning the two adjustable nuts on the linkage shown in figure 136.

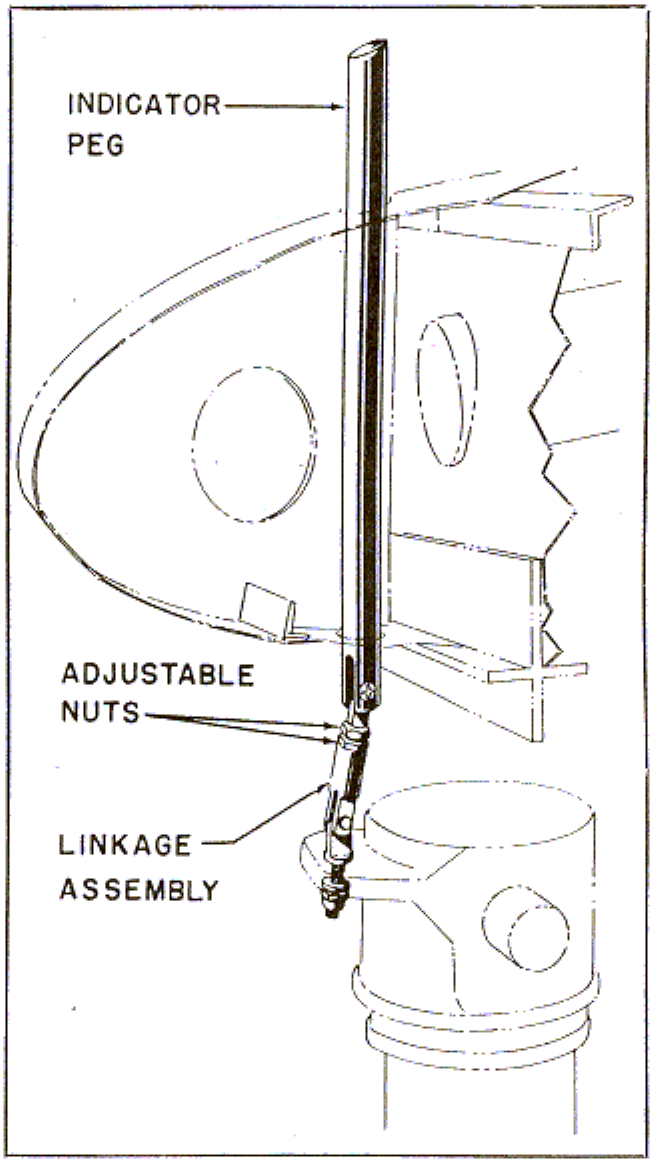


Figure 136—Landing Gear Visual Position Indicator

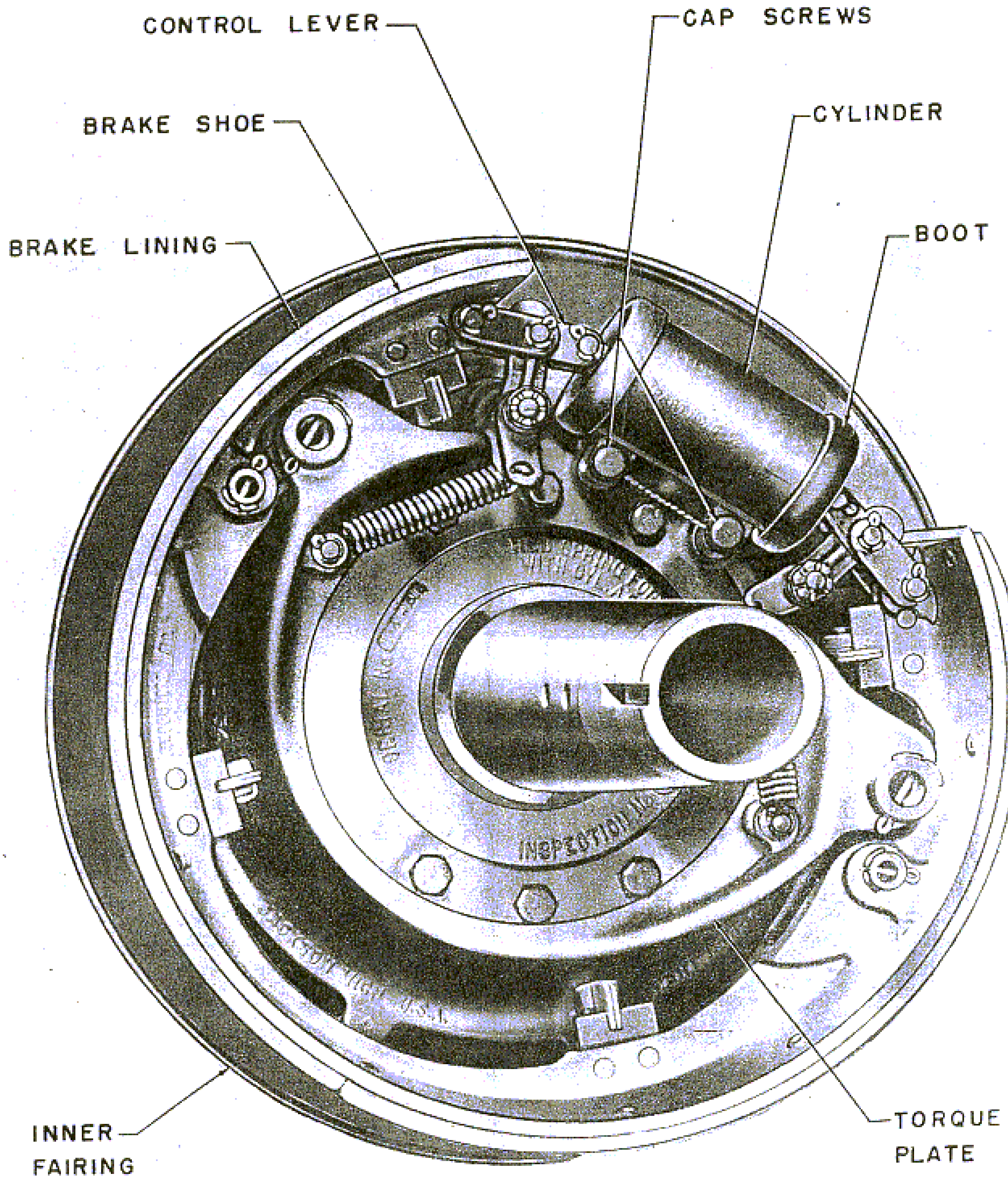


Figure 137—Hydraulic Brake

(5) THE MAIN LANDING WHEELS.

(a) TO REMOVE THE WHEELS.

1. Insert the jack point studs in the panel and jack the front and rear of the airplane until the landing gear wheels are off the ground.

2. Deflate tires.

3. On wheels having an outer fairing, remove by unbuttoning the four Dzus fasteners.

CAUTION

Before pulling wheels, exercise necessary precaution to protect parts from dirt, and damage in handling.

4. Remove the axle cap and the cotter pin and turn off the axle nut, freeing the wheel. Pull the wheel and tire assembly from the axle, exposing the brake shoe and torque plate. Hold a clean cloth over the center of the wheel as it is being removed, to prevent the bearing from falling out and collecting dirt.

(b) GENERAL MAINTENANCE ON WHEELS.

1. Except on friction and bearing surfaces, the entire wheel shall have a protective coating. Parts that have this protective coating chipped off, worn through, or removed in any manner, shall be refinished immediately, as prescribed in section VII, to prevent corrosion. Wheels corroded on the inside shall not be used at any time.

2. Wheels which do not run true, and wobble when rolled on a level surface shall be condemned. Usually such wheels have been strained and their strength impaired by hard landing. Wheels which have badly distorted reinforcing ribs or rims shall be condemned.

3. Wheels in which cracks have developed shall be reported to depots for disposition.

4. When the steel brake drums have the chromium plated surface worn through or the drum is scored or cracked, the drum shall be replaced.

5. If out-of-round drums vary .015 inch or more they shall be replaced with a new drum. The drum run-out can be checked either by an inside-diameter gage, or by setting an indicator on the axle after the brake is removed.

(c) TO REMOVE THE BRAKE DRUM FROM THE WHEEL.

1. When it is necessary to remove the brake drum, first remove tire and tube in conventional manner. Reach through the tee ribs from the outer side of the wheel with a socket wrench and turn off the 16 elastic stop nuts on the cap screws which hold the drum in the wheel.

2. Remove the 16 cap screws from the inside of the wheel.

3. Remove the drum from the wheel by one of the following four methods:

a. Place the wheel in a lathe and turn the drum out until it is thin enough to be easily bent inward and removed. (Great care shall be taken not to cut into the wheel casting.)

b. Use a sharp cold chisel and cut the drum on the flange and on the breaking surface so that it may be pounded inward, reducing the diameter to a point where the drum will fall out. (Great care shall be taken not to cut into the casting.)

c. Drill two holes midway between the brake drum bolt holes through the brake casting, but not through the brake drum at points opposite each other. Then heat the wheel as described in the following paragraph, turn the brake drum side down, and with two long punches drive the drum out.

d. Place the wheel in boiling water until it has reached the water temperature, then turn the wheel with the brake drum side down and gently drop against a hardwood block around the edge of the wheel. This will sometimes jar the drum loose enough to get bars under the inner edge, and the drum can be pried out the rest of the way.

(d) TO INSTALL THE BRAKE DRUM.

1. Submerge the wheel in a tank of boiling water until it attains the water temperature.

2. Remove the wheel quickly and press in the cold drum as fast as possible. Use an arbor press preferably to keep drum in alignment.

3. Turn wheel with outside up and, using bolt holes as guides, drill holes through drum.

4. Insert the 16 cap screws and secure with elastic lock nuts.

(e) TO INSTALL THE WHEEL.

1. Clean all greased parts of the wheel and axle assembly thoroughly with carbon tetrachloride, kerosene, gasoline, or some equivalent.

WARNING

The use of gasoline is highly dangerous, and great care must be exercised to avoid explosion and fire. Chance sparks which may result from the wearing of hob-nail shoes, faulty extension light connections, sharp metallic contact such as hammer against chisel, discharge of body static, can be the cause of fatal accidents.

2. Glazed areas on the brake lining surface, caused by grease or hydraulic fluid are best removed by a solution of carbon tetrachloride. Kerosene, gasoline or some equivalent may be substituted if necessary.

3. Lubricate axle and wheel bearings with AAF Specification 3560 grease.

4. Slide the wheel and wheel bearings onto the axle. With wheel spinning, turn on the axle nut until a bearing drag is noticed. Back off the nut to the next castellation and lock in position with a cotter pin. Do not confuse brake drag with bearing tightness while rotating the wheel during bearing adjustment.

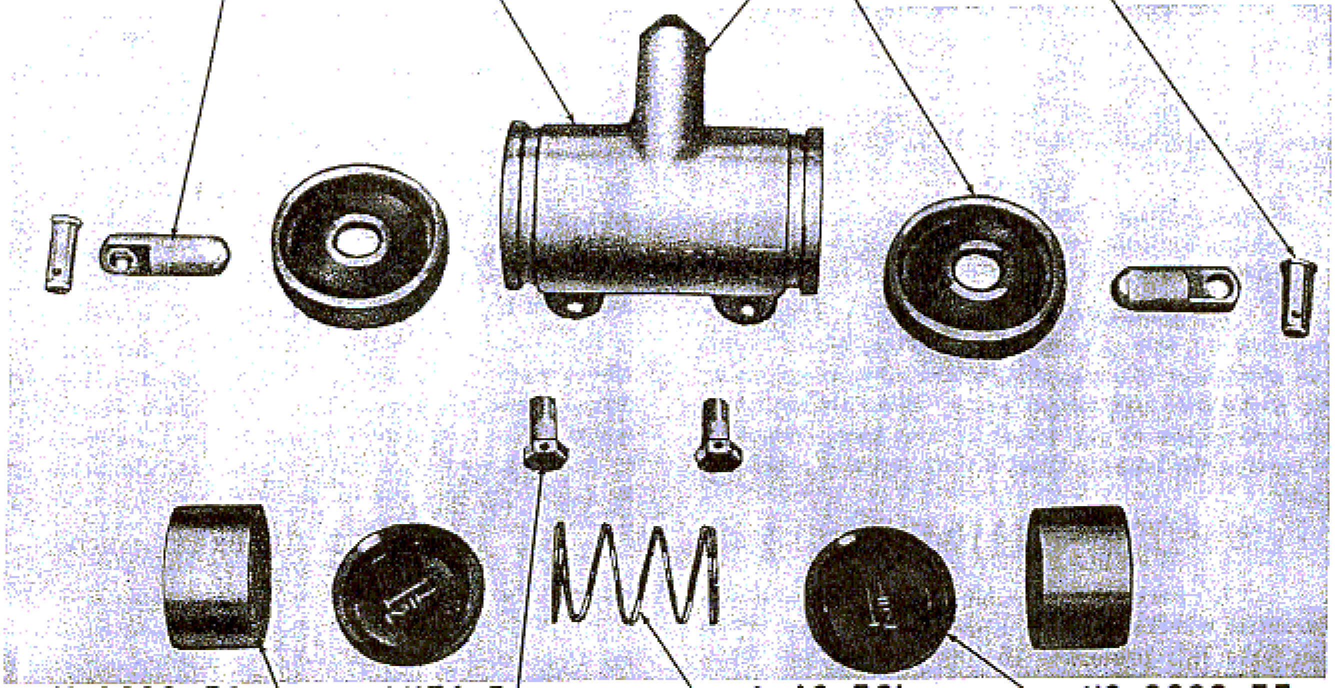


Figure 138—Hydraulic Brake Cylinder Disassembled

(6) THE HYDRAULIC BRAKE.—This airplane is equipped with the reversible type of hydraulic brake manufactured by the Hayes Industries Corporation, Jackson, Michigan. Two Warner master brake cylinders, one for each main landing wheel brake, provide the hydraulic pressure for braking. These two units operate independently of each other and have no connection with the main hydraulic system.

(a) TO REMOVE AND DISASSEMBLE THE HYDRAULIC BRAKE CYLINDER.

1. Pull wheel as outlined in section IV, paragraph 4. *a.* (5) *(a)*, then remove the bleeder screw on the rear of the cylinder and drain the fluid from the hydraulic line and cylinder.

2. Disconnect the brake hose at the fitting on the inner fairing.

3. Pull the cotter pins and remove the bolts attaching the two levers, one at each end of the cylinder, to the two cylinder piston rods. (See figure 137.)

4. Cut the lock wire on the cap screws through the lugs in the cylinder and remove the cap screws. This will free the brake cylinder from the torque plate and the cylinder can now be disassembled.

5. Remove the rubber boots at either end of the cylinder. This will allow the piston rod, piston, and piston cup to be removed from each end of the cylinder. The piston cup spring may now be removed and the cylinder is completely disassembled. (See figure 138.)

(b) INSPECTION FOR REPAIR AND REPLACEMENT.

1. Repair on brakes requires trained personnel and suitable equipment. Therefore, if the brake cylinder sleeve is scored and leakage results, the entire brake, or the cylinder assembly, shall be returned to the depot for repairs.

2. If the piston or piston cup is damaged, they shall be replaced with new parts.

3. Before assembling, wash the cylinder with alcohol and lubricate the piston and cups with hydraulic brake fluid, AAF Specification 3586. DO NOT USE MINERAL OIL OR GASOLINE.

(c) TO ASSEMBLE AND INSTALL THE BRAKE CYLINDER.

1. Insert the spring in the cylinder and then the piston cups, one in each end, to fit over the spring.

2. Next, install the two pistons, one on either end.

3. Install the rubber boots which will hold the pistons and cups in the cylinder.

4. Attach the brake cylinder to the torque plate with the two cap screws and safety-wire the screws.

5. Insert the piston rods into the holes in the boots and attach them to the brake shoe levers with the proper bolts. Safety the bolts in place with cotter pins.

6. Connect the hydraulic hose to the cylinder fitting on the back of the torque plate. The brake system now must be serviced with fluid. The correct filling and bleeding procedure is outlined in section IV, paragraph 4. *a.* (8), and should be followed to assure the efficient operation of the brake system.

7. After the brake system has been properly filled and bled, it may be found necessary to adjust the brake treadle to gain the maximum braking efficiency of the system. See section IV, paragraph 4. *a.* (8).

(d) TO SET BRAKE TREADLE ANGLE. *(See figure 139.)*

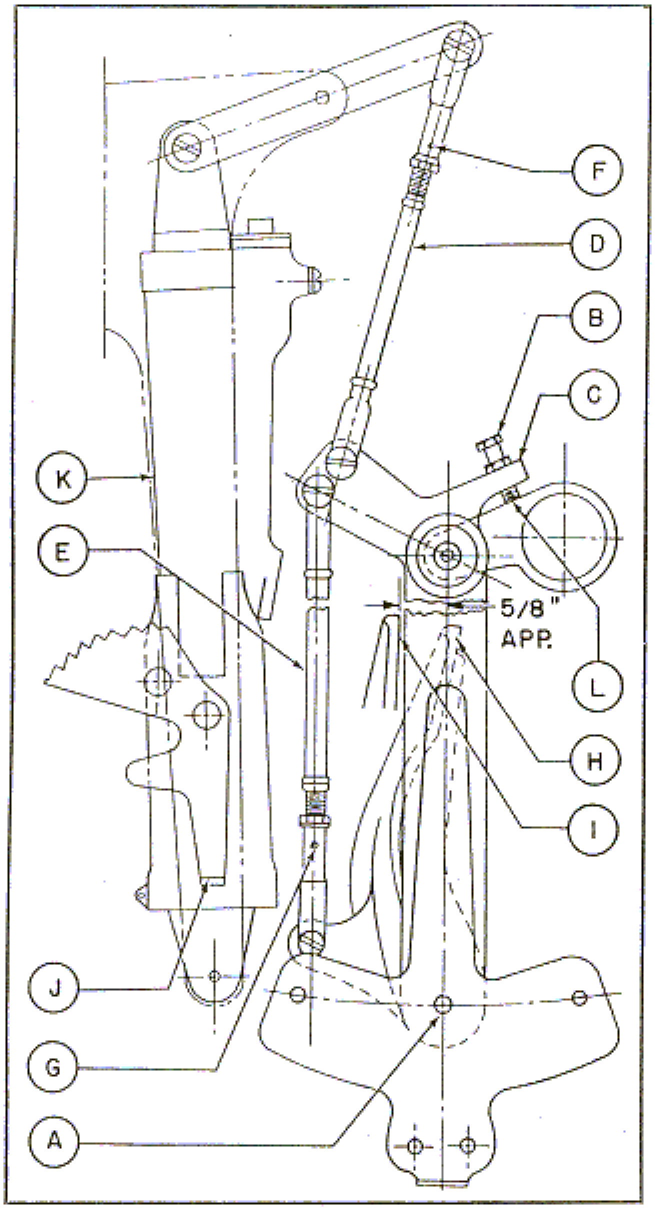


Figure 139—Setting Brake Treadle Angle

1. Put the rudder pedals in neutral position, set the pedal length adjustment in neutral by placing the pedal adjustment locking pin in center hole (A), and move the brakes to the off position.

2. Loosen lock nut (B) and turn out until it is flush with the bottom surface of lever (C).

3. Disconnect and adjust the clevis ends on rods (D) and (E) until they either cover their inspection holes (F) and (G) by one complete turn, or until the top of the brake treadle (or pedal) (H) has moved forward to point (I), where the rods are temporarily reconnected.

4. Be sure that the parking brake ratchet is seated fully at point (J) and that the brake cylinder (K) is fully compressed (off position) before connecting the rods.

5. Connect rods and safety.

6. Rotate stop bolt (B) clockwise until it touches point (M) and tighten the lock nut.

7. Check adjustment by operating the parking brake several times. The parking brake ratchet should return to point (J) when the parking brake is off. If it does not return to its proper position, check the parking brake control and cable length.

(e) TO ADJUST THE BRAKE SHOE.

1. Jack the airplane until the wheels are clear of the ground, and make sure that the parking brake lever and the brake pedal are in the neutral or off position. There must be no pressure on the brake system.

2. Swing the four feeler gage covers to one side, exposing the inspection slots. These covers with the four adjacent shoe adjusting screws are located 90 degrees apart on the outside of the wheel inner fairing.

3. Loosen the adjusting screw nearest the toe of the brake shoe by turning counterclockwise to obtain a clearance of .015 inch measured through the feeler gage slot.

4. Tighten the three remaining adjustment screws adjacent to the slots until there is .008 inch clearance between the shoe and brake drum at each of these points.

5. Return to the first adjusting screw nearest the toe of the brake shoe and tighten to reduce clearance from .015 inch to .008 inch. After this point is adjusted, it may be necessary to go over the adjustments again in the same order and slightly change each one to give the required clearance. Then close the four feeler gage covers.

CAUTION

If the wheel is removed at the time of the brake adjustment, extreme care should be taken to see that the brake is not applied with the wheel removed. Application of the brake at this time causes distortion of the one-piece shoe, rendering it unfit for further service.

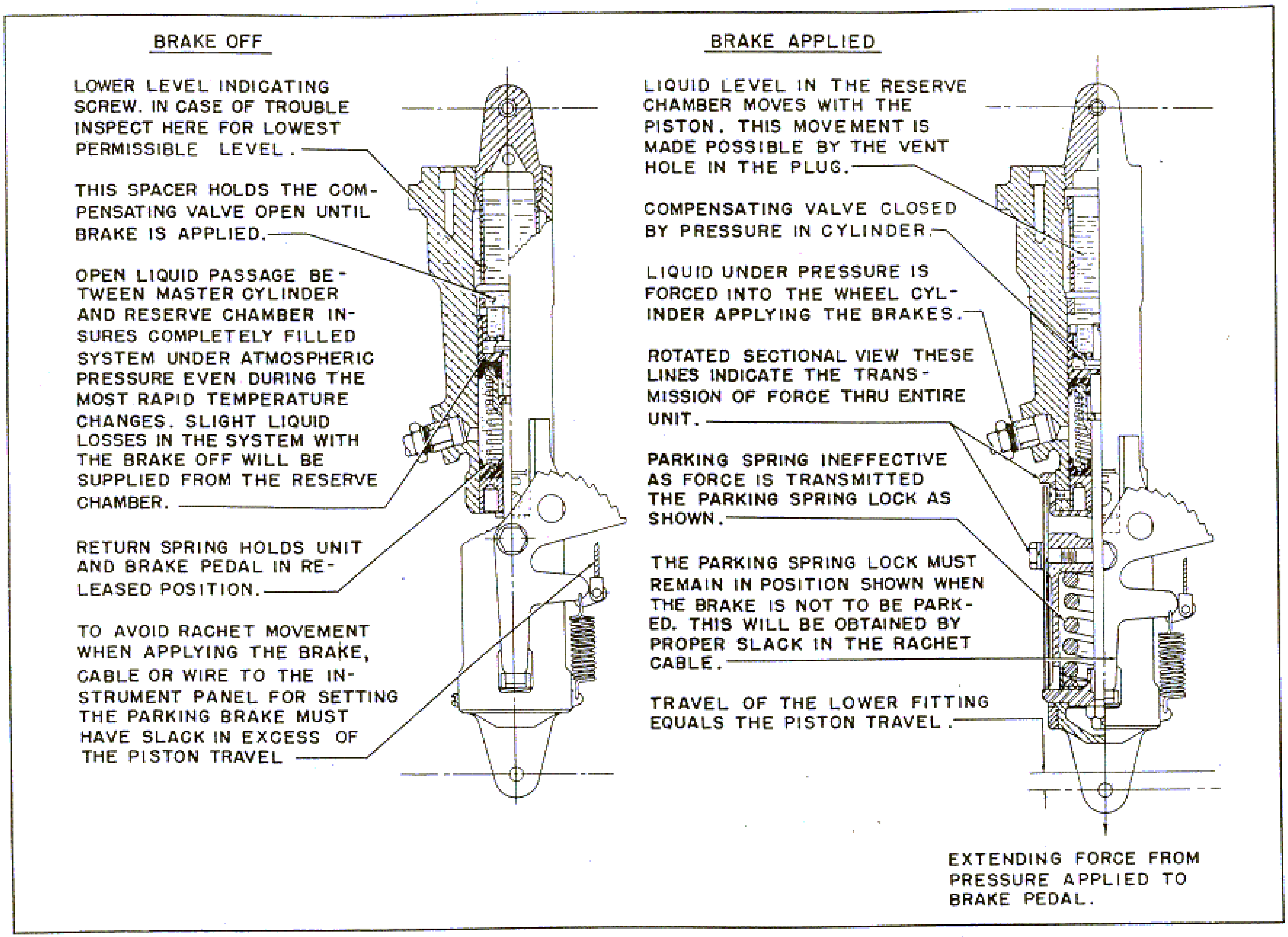


Figure 140 (Sheet 1 of 2 Sheets)—Master Brake Cylinder—Detail Operation

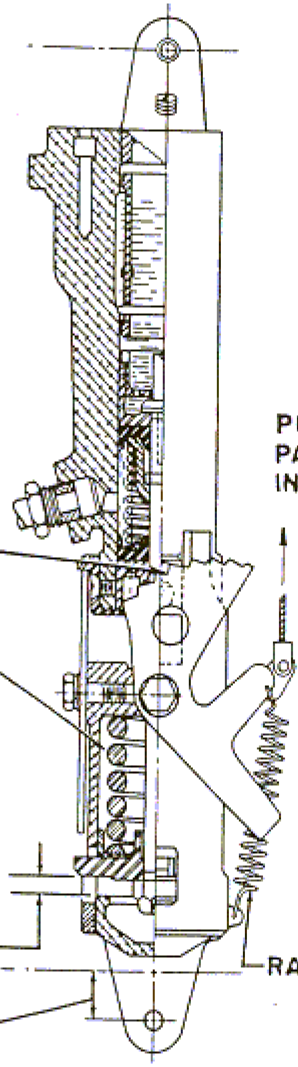


Figure 140 (Sheet 2 of 2 Sheets)—Master Brake Cylinder—Detail Operation

(7) THE MASTER BRAKE CYLINDER.

(a) GENERAL.—The two Warner master brake cylinders (or control units) installed on this airplane to provide hydraulic pressure for the application of the two main landing gear brakes, are of the extension type with parking feature, but without transfer valve. They are located on the top aft side of the firewall. (See figure 140.)

The units have been assembled very carefully and tested at the factory before shipping and, therefore, it is recommended that the units be not disassembled unless it has been determined that they are the cause of malfunctioning. The only items which may require servicing are:

1. The hydraulic cups which may have become damaged or worn in service, or which may have swelled due to improper fluid being used in the unit, causing the unit to stick.

2. A leak in the compensating valve due to some dirt or chip becoming lodged on the metallic compensating valve formed by the shoulder on the piston rod and the piston.

3. Deep narrow scratches in the cylinder wall permitting liquid to leak past the outer lip of the upper cup.

(b) TO DISASSEMBLE THE MASTER BRAKE CYLINDER UNITS.

1. Remove the vented filler plug on the top of the cylinder and turn the cylinder upside down to drain the hydraulic fluid.

2. Remove the lock screws, one in the upper and one in the lower end fitting. In the manufacture of the unit, the end fittings are lined up and machined with the housing or cylinder to which they belong. Therefore, if disassembling more than one unit at a time, it is very important to keep the parts of the different units separate.

3. Remove the upper and the lower end fittings from the control unit by holding the lug of the fitting in a vise and turning the complete unit by hand to unscrew the fittings from the cylinder and housing assemblies. A spacer which is pinned to the upper fitting assembly will be removed with the upper fitting.

4. Hold the cylinder, with the lower end up, in a vise with aluminum-covered jaws. With the control unit in this position it will be easy to remove the cotter pin and nut from the end of the piston rod which extends through the yoke in the housing assembly.

5. Remove the cotter pin from the nut and mark the slot of the nut which lines up with the cotter pin hole and measure and keep a record of how much the end of the piston rod protrudes over the end of the nut. This will save an adjusting operation when assembling. If the piston rod turns with the nut, clamp a clean wooden hammer handle or fibre drift in a vise with the handle or drift placed vertically. Slip the open end of the cylinder over the handle or drift and press down. This will force up the piston rod with the nut so that the rod below the nut can be held with a pair of pliers. After the nut has been removed, the two halves of the unit can be pulled apart.

6. The lower half is the housing assembly containing the parking spring and ratchet. The upper half is the cylinder assembly containing all parts necessary for the hydraulic operation of the unit.

7. Push gently on the piston rod protruding from the cylinder assembly until it is free of the cylinder. The lower rubber cup will either come out with the piston rod or stay in the cylinder.

8. Remove the two screws securing the "U" retainer on the bottom of the cylinder and remove the retainer.

9. Remove the lower cylinder nut with a spanner wrench and the lower spring washer and cup from the cylinder.

(c) TO REMOVE SPRING FROM THE HOUSING ASSEMBLY.

1. Normally it will not be found necessary to remove the parking spring from the housing assembly, but if it is desired to remove the spring, proceed as follows: (See figure 141.)

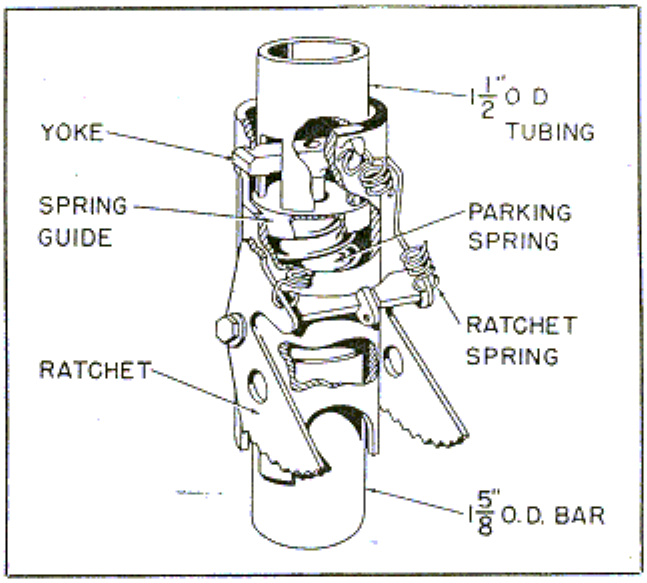
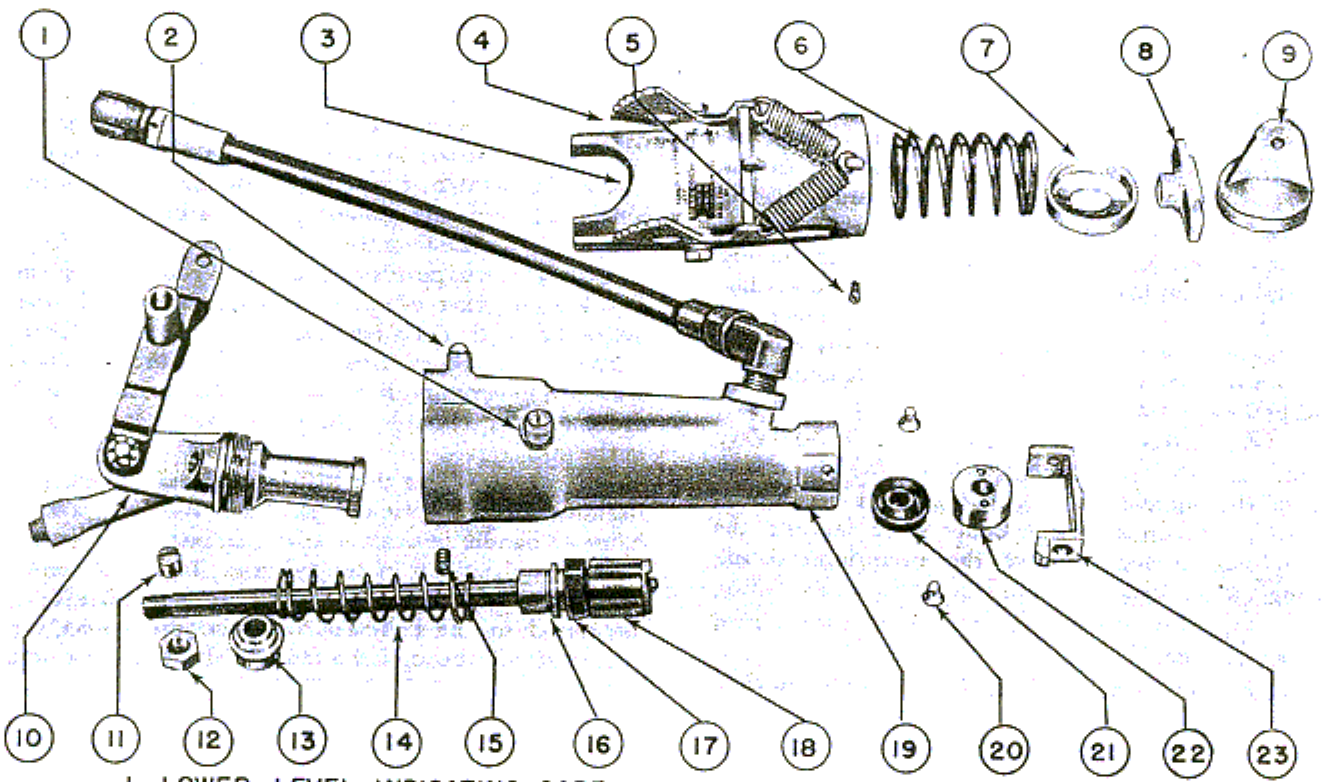


Figure 141—Removing Spring from Housing Assembly

a. Place a 1-5/8 inch diameter bar approximately 3 inches long on end on the table of an arbor press and set the housing assembly, with the slotted guides pointing downward, over the bar. The bar will take the load, when applied, instead of the slender guides on the housing assembly.

b. Cut a piece of tubing 1-1/2 inch diameter and approximately 6 inches long. Cut two 3/4-inch slots about 1 inch deep opposite each other on one end of the tubing.



1 LOWER LEVEL INDICATING SCREW
2 UPPER LEVEL INDICATING SCREW
3 HOUSING
4 RATCHET
5 LOCK SCREW
6 PARKING SCREW
7 SPRING GUIDE
8 YOKE
9 HOUSING END
10 CYLINDER END
11 PLUG
12 NUT
13 LOWER SPRING WASHER
14 SPRING
15 LOCK SCREW
16 UPPER SPRING
17 CUP
18 PISTON
19 CYLINDER
20 "U" RETAINER SCREWS
21 CUP PACKING
22 LOWER CYLINDER NUT
23 "U" RETAINER

Figure 142—Master Brake Cylinder Disassembled

c. Place the slotted tubing on the spring guide with the slots straddling the yoke. Pull the ratchet out to allow the yoke to move down when pressure is applied with the arbor press. Apply enough pressure to deflect the spring until the top face of the spring guide is flush with the bottom of the "window" or "gap" in the housing through which the yoke extends.

d. Hold the spring in this position and lift the yoke to clear the spring guide and pull it out of the housing through the window. The spring and guide can now be removed by releasing the pressure on the arbor press.

e. If an arbor press is not available, a vise that will open far enough can be used to apply pressure horizontally. The master brake cylinder is now completely disassembled. (See figure 142.)

(d) INSPECTION, REPLACEMENT, AND REPAIR.

1. Wash all parts except the natural rubber packings, with gasoline or spirits.

2. Check compensating valve by holding piston tightly against the shoulder of the rod, holding the compensating valve in the closed position. Fill with gasoline or solvent and observe for leakage. If no leakage in one minute, the valve is seating properly.

3. Slightly damaged compensating valve seats may be relapped by using grade 2A Clover Grinding Compound or equivalent. All traces of lapping compound must be washed off the seat and out of the passages through the piston rod.

4. If seats are badly damaged, a new piston rod and piston must be installed.

5. Inspect hydraulic cups for swelling, tears, or other signs of damage or deterioration. Diameter of upper cup in contact with the piston head must not be larger than the diameter of the piston. If the diameter is larger, it is an indication that cup is swollen and must be replaced. The upper end-fitting packings as well as the cups are made from a natural rubber composition. Swelling will occur when the packings come in contact with gasoline or any mineral oil. In this installation, use only AAF Specification 3586 hydraulic fluid.

6. Inspect the inside of the cylinder. Very minute and shallow scratches do not affect the operation of the control unit. A deep scratch necessitates replacement with a new cylinder since lapping the old cylinder would remove the corrosion-resisting coating on the cylinder wall.

7. Any part found worn shall be replaced with a new one.

(e). TO ASSEMBLE THE MASTER BRAKE CYLINDER.

1. Before reassembling the housing, grease the entire inner surface of the housing with a heavy grease of high melting point, preferably a rocker arm lubricant for corrosion protection.

2. Place on end on the table of an arbor press the 1-5/8 inch diameter bar used in disassembling the housing, and set the housing over the bar with the slotted guides pointed downward.

3. Next, place the parking spring and the spring guide in the housing.

4. Place the 1-1/2 inch diameter tube with slots cut out for the yoke on top of the spring guide. Be sure the slots in the tube are aligned with the "windows" in the housing so that the yoke can be installed when the spring is deflected. Apply pressure with the arbor press to deflect the parking spring until the top face of the spring guide is flush with the bottom of the "windows" in the housing through which the yoke extends.

5. While the spring is deflected, insert the yoke through a "window" of the housing assembly and place in position over the spring guide.

6. Carefully relieve the pressure from the parking spring being extremely careful not to let the spring snap up against the light bridge on the yoke as it may cause serious damage to the yoke. Do not install the housing end until the housing and cylinder are assembled together.

7. Lubricate the bore of the cylinder with hydraulic fluid, AAF Specification 3586, and lay aside.

8. Insert the piston rod into the piston, then install and tighten the piston nut.

9. Next, wet the upper cup with hydraulic fluid, AAF Specification 3586 and slip the cup over the rod against the piston.

10. Next, install the "horseshoe" washer retainer and then the upper spring washer.

11. Slip the return spring over the piston rod and then place the lower washer on the spring.

12. If the lower cup came out of the cylinder, wet it with hydraulic fluid and slip in onto the piston rod against the lower spring washer.

13. Holding the piston and rod assembly in an upside down position, slide the cylinder over the rod. Be sure that all parts are well lubricated with hydraulic fluid, AAF Specification 3586, to facilitate assembly. As the cylinder is slipped over the piston assembly look through the hole in the cylinder nut in order to properly align the piston rod with the hole in the nut.

14. When the piston and rod assembly is installed in the cylinder, slip the assembly over a hammer handle or a fibre drift clamped in a vise and force the piston up in the cylinder. This will extend the piston rod so that when the housing assembly is assembled to the cylinder assembly, the piston rod will protrude through the yoke in the housing so the nut and cotter can be installed at the end of the rod.

Note

It is very important that the nut is installed correctly on the end of the piston rod so that when the control unit is fully collapsed (brake off) the compensating valve will be held forcibly open by the spacer on the upper end fitting. If the nut is adjusted so that the piston is not depressed by the spacer (and thus not opening the compensating valve) when the control unit is collapsed there will be residual pressure on the fluid in the control unit which will cause the brake to drag. A .0015 (minmum) to .010 inch gap should exist between the lower edge of the cylinder yoke and the bottom of the guide slot in the control unit housing when the nut is installed.

15. If during disassembly, the relation between the piston rod and the top face of the nut has been noted, no adjusting operation will be required if the parts are assembled in exactly the same position provided no new parts have been installed which may change the adjustment. See section IV, paragraph 4, *a*, (7), *(b)*. If on the other hand, the adjustment operation is required, proceed as follows:

a. Install the nut so that the end of the piston rod is slightly below the face of the nut with the cotter pin hole in the rod in line with a slot in the nut. Do not install the cotter pin.

b. Grease the threads on the lower end fitting and the thread face of the housing assembly with a heavy grease and screw the end fitting into the housing assembly. The last few turns will produce considerable drag as the heavy parking spring is being depressed. Line up the locating screw hole on the housing end fitting but do not insert the locating screw.

c. Grease the threads on the upper end fitting to protect the threads against corrosion and to seal against slight seepage during the filling and bleeding operation. If it is desired, a non-hardening sealing compound such as key paste may be used. Apply the sealing compound sparingly so that it will not mix with the brake fluid which is in contact with the upper end fitting. Screw on the upper end fitting and insert the locating screw.

d. With the nut installed at the end of the piston rod as instructed in step a., preceding, it will be found that there is some end play between the two halves of the unit after both end fittings are installed. Using a feeler gage, measure the gap between the lower edge of the cylinder yoke and the bottom of the guide slot in the control unit housing. If narrow feelers are not available, the ratchet must be removed for this operation. Do not FORCE the feeler into the gap as it would open up, since it is limited by the return spring. The gap should be .0015 (minimum) to .010 inch. Remember the gap found with the feeler gages, then remove the lower end fitting and if adjustment is required, mark with a pencil the position of the nut on the rod. Using the following table, determine the number of slots in the nut through which the nut must be turned in order to obtain correct adjustment. For example: If the gap is found to be .023 to .029 inch the nut must be turned clockwise three slots (1/2 turn) to obtain the required clearance.

Gap	Turn Nut *Clockwise* the *Following Number of Slots*
.002 to .008	0
.009 to .015	1
.016 to .022	2
.023 to .029	3 (1/2 turn)
.030 to .036	4
.037 to .043	5
.044 to .050	6 (1 full turn)
.051 to .057	7
.058 to .064	8

After this adjustment, install the cotter pin. It is important that the pin be spread side-ways and *not* over the end of the rod due to the small clearance available. Screw in lower end fitting and install the locating screw. To insure safe operation, recheck the "gap" which should be large enough to admit a .0015-inch feeler.

16. If the nipple on the elbow installed in the 1/4-inch pipe tapped hole in the cylinder has been removed, or a new replacement fitting is being installed, use thread lubricant to seal the connection.

(f) TO TEST THE MASTER BRAKE CYLINDER.

[See section IV, paragraph 4, *a*, (8) *(c)*.]

(8) FILLING AND BLEEDING THE HYDRAULIC BRAKE SYSTEM.

(a) BEFORE FILLING AND BLEEDING.

1. Before starting the filling and bleeding, depress both brake treadles completely without forcing them. With the control unit in the fully extended position, the ratchets on the units must not be turned out of their normal position when the parking brake lever is not being pulled. If one or both ratchets are being turned out of position, the parking mechanism must be rigged to give additional clearance.

2. After checking the parking rigging, return the brake treadles to the normal or off position. Check brake treadle adjustment to make sure it permits the control unit to return to its normal or full off position.

IMPORTANT

If the control unit is not in the completely off position, the compensating valve within the cylinder assembly is closed, thereby arresting the flow of fluid and making it impossible to fill and bleed the system.

3. Make certain that the brake fluid is clean and that it has not been standing uncovered long enough to allow evaporation of the diacetone alcohol, and thereby increase the castor oil concentration.

4. Make certain that the liquid in the filler tank has not been under high air pressure too long, since this would cause the liquid to absorb air, which would bubble out of the liquid after the filling and bleeding, causing an air-locked system. When not in use, no air pressure should be maintained in the filler tank.

(b) FILLING AND BLEEDING BY THE PRESSURE METHOD.

(See figure 143.)

1. Remove the vented filler plug from the control unit (Warner master brake cylinder) and attach a clean, empty can (1) with a hose connection and shut-off valve (2).

2. Open the bleeder screw to the brake cylinder (12) one-half to one turn and check for leakage. Correct a small amount of leaking by applying a thin coating of Threadlube (or equivalent grease) to the external threads of the screw. Reinstall the screw, back it up one-half to one turn and connect the hose from the filler tank (9).

3. Fill tank (9) with at least 1-1/2 quarts of hydraulic fluid, AAF Specification 3586, leaving one-quarter to one-third of the tank capacity for air pressure. Close shut-off valve (6) and pump up until ten pounds per square inch is registered on gage (7).

4. Open shut-off valves (2) and (6). Under pressure from the filler tank, the fluid now will flow upward in the system, through the brake cylinder, the brake line, the control unit and into the receiving can. Due to the smallness of the passage in the compensating valve within the control unit, the arrival of fluid in the can may be expected to take approximately three minutes.

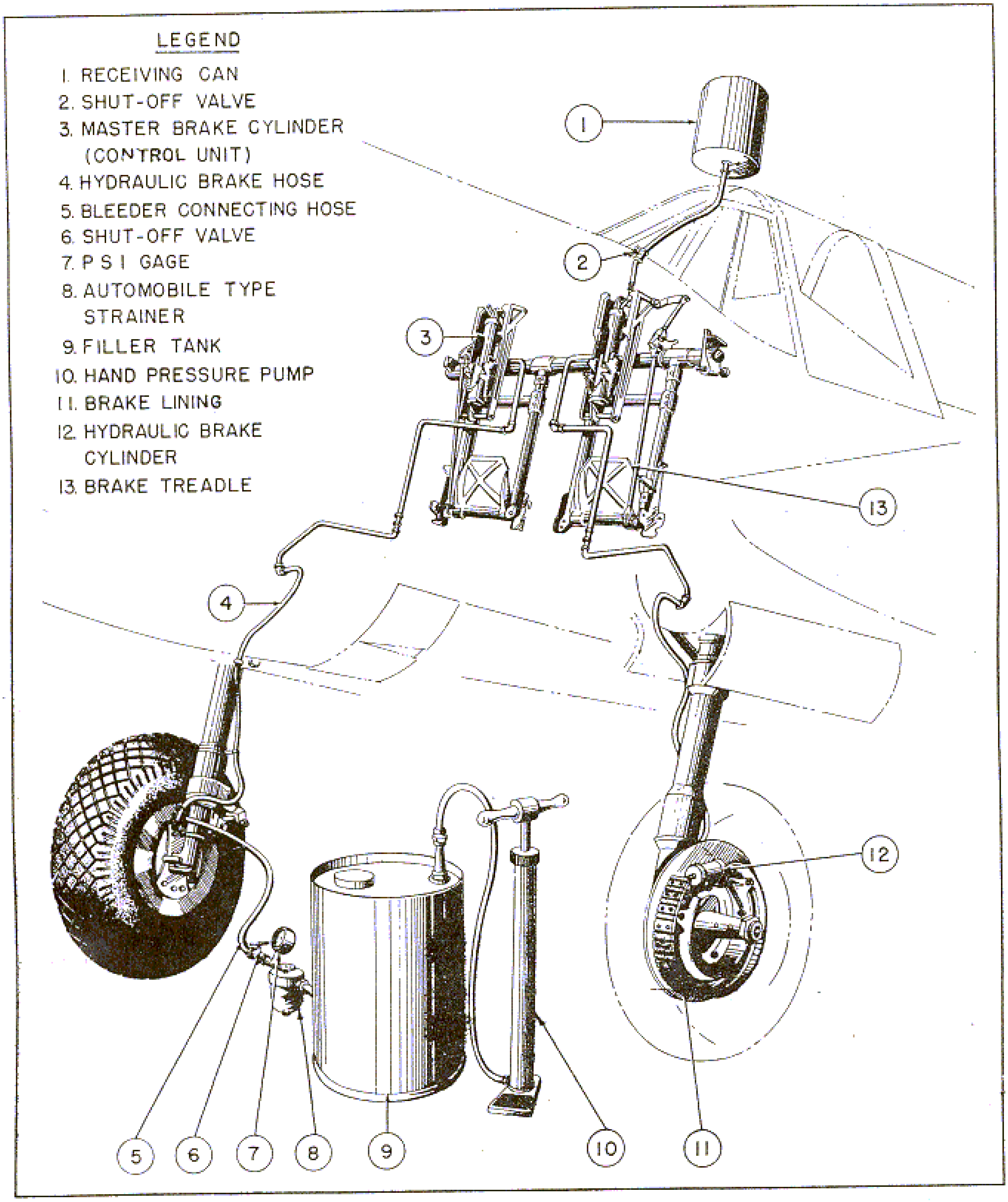


Figure 143—Method for Bleeding and Filling Brake System

WARNING

The brake treadle must not be pumped while the system is under pressure from the filler tank.

5. After approximately one pint of fluid has been forced into the can, or when air no longer bubbles out with the fluid, relieve pressure from the tank through valve at (6).

6. The fluid now under atmospheric pressure will flow by gravity slowly back into the filler tank. This reversal of flow will eliminate any air that may have been trapped between the bleeder opening and the hose line connection to the brake.

7. Let the fluid run back for two to three minutes, or until signs of entrapped air have disappeared.

8. Close the bleeder screw and remove the pressure line from the bleeder opening.

9. Apply the brake approximately ten times, exerting pressure during each application. Any small amount of residual air that may be trapped in the system will be expelled, and any excess of fluid will be forced into the receiving can.

10. Remove the receiving can and replace the vented-filler-opening plug.

(c) TO TEST THE HYDRAULIC BRAKE SYSTEM.

1. The system is now closed and is checked by applying the brake and observing the treadle travel.

2. Excessive brake travel may indicate over-clearance of the brake lining which can be checked as indicated in section IV, paragraph 4. *a.* (6) *(e)*.

3. If abnormal treadle travel persists after application of the brake as indicated in section IV, paragraph 4. *a.* (8) *(b)* *9*, preceding, the trouble may be due to any of the following conditions:

a. Additional air still trapped in the system.

b. Over-expansion of the line to the brake. This necessitates replacing with a new line.

c. An external leak in the line to the brake or in the brake itself.

d. Dirt lodged on the compensating valve, holding it open, causing an internal leak.

e. Swelled cups in the control unit or the brake cylinder due to the use of unspecified hydraulic fluid, causing internal leaking.

4. Condition a. (trapped air) is indicated by a soft or "spongy" feeling of the brake treadle, making it necessary to repeat the bleeding procedure outlined in section IV, paragraph 4. *a.* (8) *(b)*, steps *1.* through *10.* until all trapped air is expelled.

5. Conditions c., d., and e. in paragraph 3. preceding (system leaks), are revealed by a downward movement of the parking spring yoke in the lower

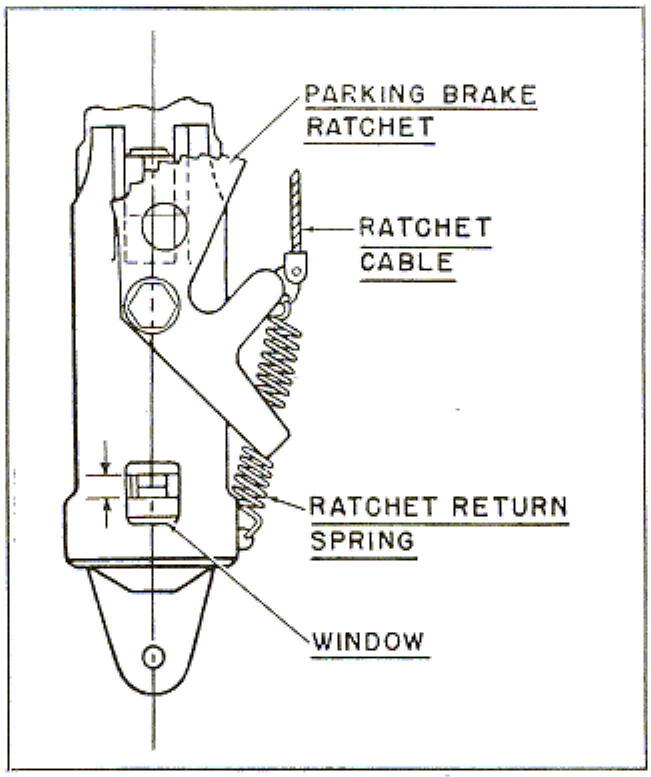


Figure 144—Master Brake Cylinder Housing Assembly

control until while the brake is being parked. This movement may be observed through the window or gap shown in figure 144. Do not confuse with downward movements, which are normal while parking the brake under the following conditions:

a. A downward movement of approximately 1/16-inch may be noticed immediately after filling and bleeding.

b. If the system is parked for 12 hours or more, a movement of 1/16-inch or 1/8-inch is to be expected if there is no expansion or contraction due to temperature changes.

6. An external leak can be detected by visual inspection, and corrected by tightening fittings or by replacing defective parts, after which the system will have to be bled again as outlined in section IV, paragraph 4. *a.* (8) *(b)*, steps *1.* through *10.*

7. An internal leak at the compensating valve is indicated by the squirting of fluid out of the filler vent hole when the unit is allowed to snap back rapidly from the parked position.

8. If unspecified hydraulic fluid has been used inadvertently, the system must be flushed out with mineral spirits and the natural rubber cups in the control unit and brake cylinder replaced.

9. For disassembly of control unit, see section IV, paragraph 4. *a.* (7) *(b)*. The disassembly of the brake cylinder is shown in section IV, paragraph 4. *a.* (6) *(a)*.

(d) FILLING AND BLEEDING BY THE GRAVITY METHOD.

1. When the pressure method is not possible, the hydraulic brake system can be filled and bled from the top with fluid under gravity.

2. Prepare for gravity filling and bleeding the same as for the pressure method explained in section IV, paragraph 4. *a.* (8) *(b)*.

3. Remove the vented filler plug from the control unit (Warner master brake cylinder) and attach a clean can (1) as shown on figure 143.

4. Fill can slowly with a quart and a half of hydraulic fluid AAF Specification 3586, keeping the connecting hose straight to avoid air pockets.

5. Open the brake bleeder after applying, if necessary, a sealant compound to its thread as explained in section IV, paragraph 4. *a.* (8) *(b) 2.* Connect a hose to the bleeder and put the other end into a clean jar or pan placed below the level of the bleeder.

6. With the control unit in the brake off position, fluid will run downward through the system, but this flow may be too slow to properly scavenge the air which tends to rise against the downward flow of the fluid and, therefore, pumping of the brake treadle is required in most instances.

7. To accelerate the downward flow by pumping, two men are required, one in the cockpit and one at the brake bleeder. Proceed as follows: With the bleeder open, depress the brake treadle rapidly. Close the brake bleeder before letting the brake pedal return. The treadle must be allowed to return very slowly at an even speed, in order to prevent the creation of a negative pressure in the system during the return stroke, which would suck air into the unit more readily than fluid from the can. After the treadle has returned to the complete off position, open the bleeder and repeat the operation until no more air is being expelled. Then close the bleeder permanently and continue procedure outlined in section IV, paragraphs 4. *a.* (8) *(b) 8.* through 4. *a.* (8) (c) *9.*

b. TAIL GEAR.

(1) GENERAL DESCRIPTION.—The tail wheel landing gear is of the hydraulically retractable type, comprising a pneumatic oleo shock absorbing strut, a standard steerable knuckle unit equipped with a Firestone CO-200 magnesium alloy wheel mounting a 12.50 inch six-ply rayon smooth contour tire statically grounded, and a 12.50 smooth contour tube. The wheel disengages its steering splines at 30 degrees ± 2 degrees, and then castors through 360 degrees. The cables connecting the steering horn to the pedals are equipped with springs to reduce taxiing shocks in the pedals and the control system. When retracted, the tail wheel is enclosed by right and left hand doors, which form the under surface of the fuselage about the wheel. (See figure 145.)

Hydraulic retraction is accomplished simultaneously with the main landing gear by the single control handle in the cockpit. The retracting mechanism consists of a hydraulic retracting strut mounted on the fuselage frames 13 and 14. The piston rod extends forward from the cylinder and carries a lug to which the upper end of the oleo strut is attached by a bolt. A long piston rod guide rod extends forward of station 11 and is supported by braces from stations 11 and 12. During retraction, the piston and rod are forced forward, carrying the upper oleo support with it.

(2) TAIL WHEEL ASSEMBLY.

(a) REMOVAL OF TAIL WHEEL ASSEMBLY.

1. Jack up or hoist the aft end of the airplane and put the tail gear in the fully extended position.

2. Disconnect the tail wheel door turnbuckles at the doors.

3. Remove the screws around the edges of the boot.

4. Disconnect the tail wheel steering cables.

5. Disconnect the oleo strut at the lower end.

6. Disconnect the drag link from the fuselage by removing the two hinge bolts at the forward end.

7. Remove the tail wheel and drag link through the tail wheel door opening.

8. Remove the bolt at the upper end of the oleo strut and remove the strut through the door opening.

9. Disconnect the hydraulic lines to the retracting strut.

10. Remove the two bolts at the front and the two bolts at the center of the strut with the piston held in the full aft position, and lower the rear end of the strut, at the same time moving it aft until the piston rod is free from the guide and can be removed through the tail wheel door opening.

(b) INSTALLATION OF TAIL WHEEL ASSEMBLY.

1. Working through the tail wheel door opening, insert the piston guide rod in the guide bearing and move the retracting strut up and forward into airplane, and secure with the two bolts at the front and the two bolts at the rear.

2. Connect the hydraulic lines to the retracting strut.

3. Bolt the upper end of the oleo strut to the lug on the piston end.

4. Raise tail wheel and drag-truss through the open door and attach the forward end by the two drag-truss-fitting attaching bolts.

5. Bolt the lower oleo strut end to the drag-truss rear fitting.

6. Attach the steering cables to the horn.

7. Replace screws around the edge of the boot.

8. Connect the tail wheel door turnbuckles to the doors.

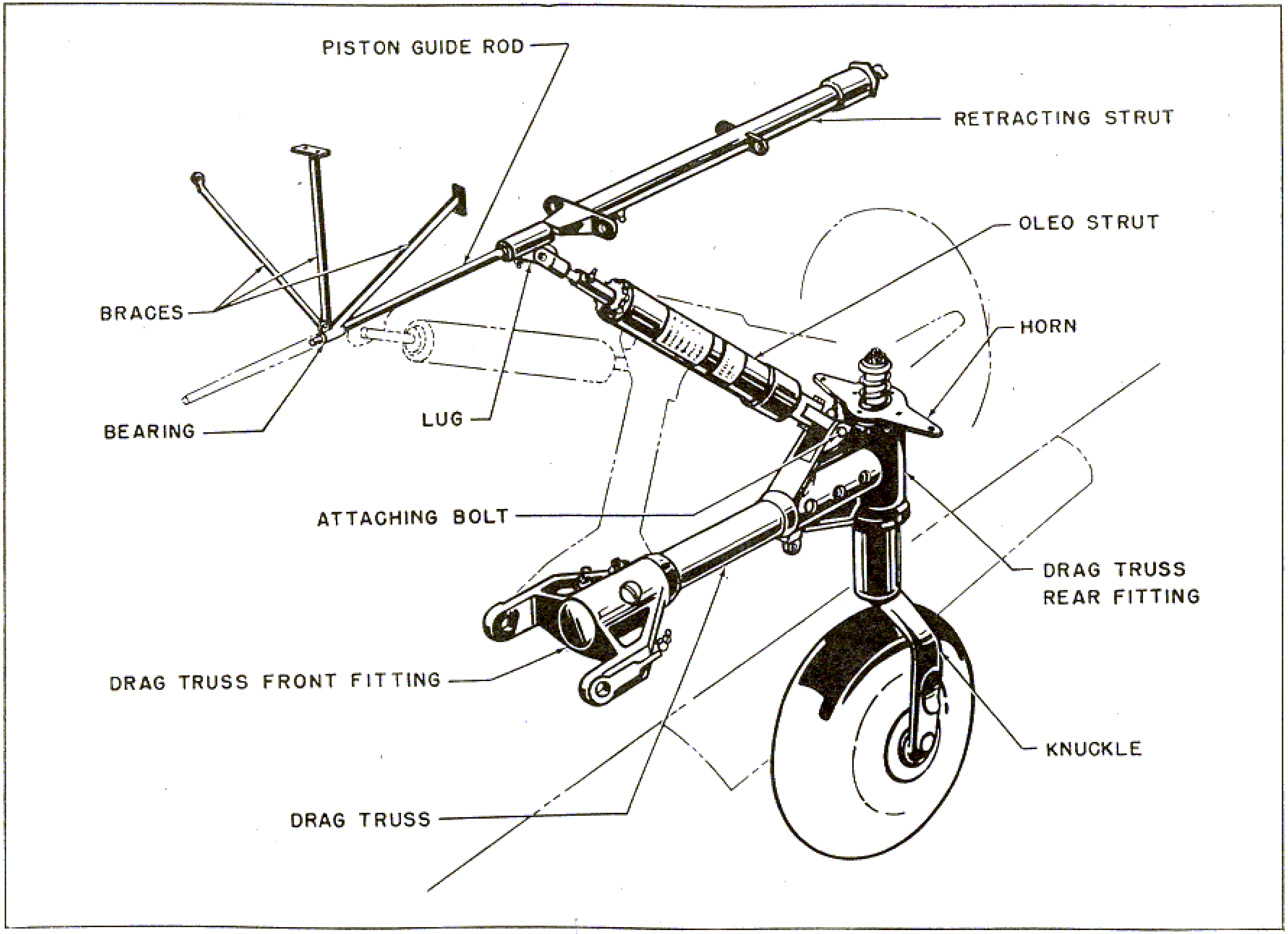


Figure 145—Tail Wheel Assembly

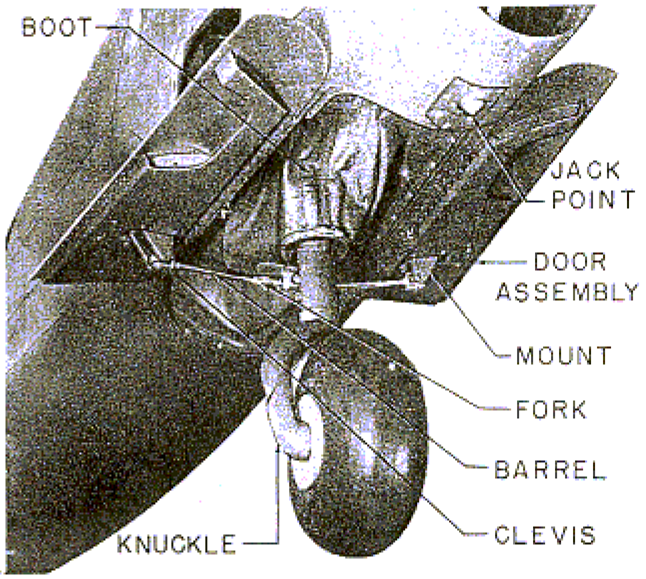


Figure 146—Tail Wheel Door Assembly

(*c*) ADJUSTMENT OF TAIL WHEEL DOORS.
(*See figure 146.*)

1. Jack up aft end of airplane and with the tail wheel extended, detach clevis end of turnbuckle on one door, leaving linkage to other door intact. Remove safety wire from both links.

2. Retract tail wheel and by working through the unclosed door opening, loosen lock nuts on turnbuckle attached to the other door, and adjust linkage to hold door flush with fuselage skin.

3. Lower tail wheel, secure adjusted turnbuckle with safety wire, detach its clevis end and follow preceding procedure to adjust the other door.

(3) OLEO STRUT.

(*a*) REMOVAL OF OLEO STRUT.

1. To remove the oleo strut only from the fuselage, first unbutton the access door below the horizontal stabilizer and the inspection hole above and forward of the access door. Place a jack under the rear jack point to support the aft end of the airplane.

2. Be sure the tail wheel is down. Work through the access door and remove the bolt attaching the lower end of the strut to the tail wheel drag link.

3. Working through the hand hole, remove the bolt attaching the oleo piston to the lug on the retracting strut.

4. Remove the oleo strut through the access door.

(*b*) DISASSEMBLY OF OLEO STRUT.
(*See figures 147 and 148.*)

1. Vent the air pressure and remove the filler plug to drain the fluid.

2. Place the oleo strut in a wooden block clamp and insert the clamp in a vise to keep the oleo cylinder from turning.

3. Force a screwdriver or similar tool under the retaining ring on the cylinder and disengage the end of the ring from the hole in the cylinder. Expand the retainer ring and slide it off the cylinder.

4. Engage a spanner wrench on the gland nut and turn the nut out of the cylinder.

5. Pull the piston assembly from the cylinder and slide the washers and packing off the piston.

6. Remove the metering pin, if desired, by using the metering pin wrench (part No. 87-88-031) carried in the tool kit. When the metering pin is removed, discard the copper gasket so that it will not be reinstalled. Never install a used gasket on a metering pin.

7. Place the piston in a wooden block clamp and tighten the clamp in a vise.

8. Remove the lock pin from the piston and piston bearing and unscrew the bearing from the piston.

(*c*) ASSEMBLY OF OLEO STRUT.

1. Before assembling the oleo strut, be sure that all parts are thoroughly clean and free of chips. Clean with alcohol and flush with hydraulic fluid under pressure. Inspect all packings and washers before installing them in the cylinder. Replace any worn part.

2. Place the piston in the wooden block clamp, screw on the piston bearing as far as it will go, and line up the bearing lock pin hole with the hole in the piston. Screw the lock pin into the piston until it is tight.

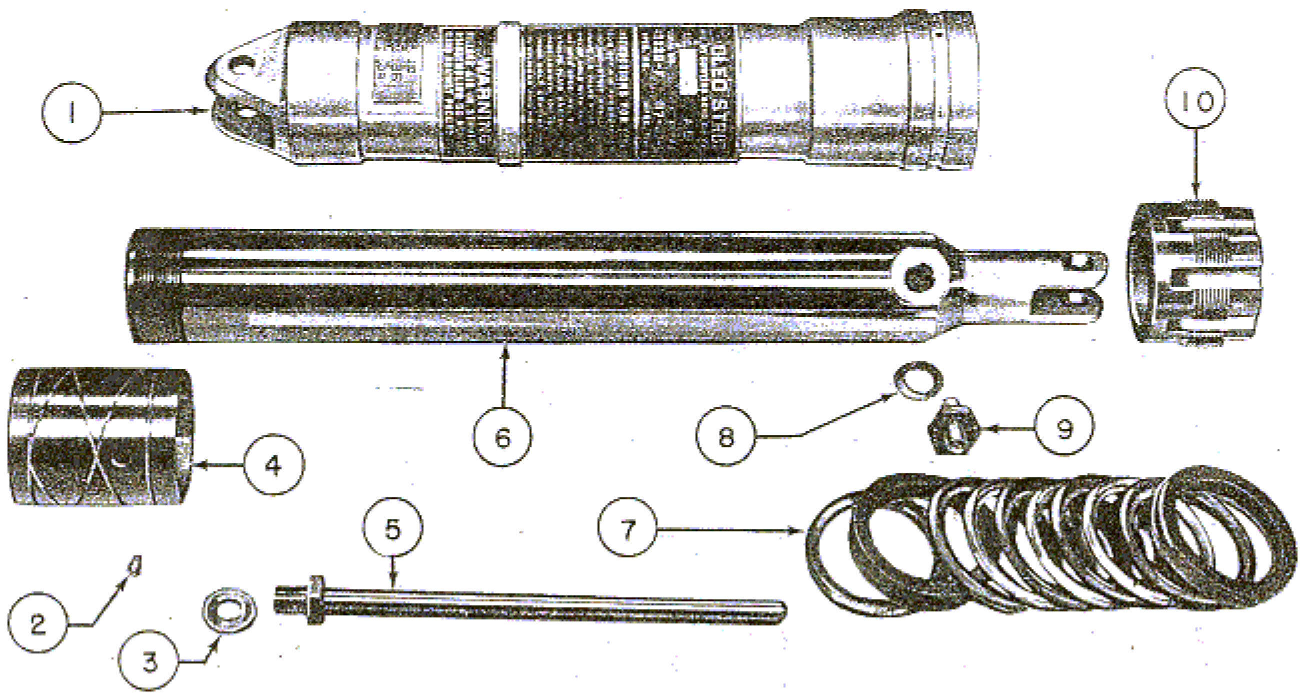
3. Release the piston from the wooden block clamp. Install the cylinder in a wooden block clamp and secure the clamp in a vise with the cylinder in a horizontal positon.

4. Install the metering pin in the cylinder and tighten with the metering pin wrench.

Be sure that a new copper gasket is installed with the metering pin. Never install a used gasket.

5. Guide the piston bearing and piston into the cylinder, wet the packings and washers thoroughly with hydraulic fluid, AAF Specification 3586, and slide the first washer over the piston and into the cylinder. If possible line threads in cylinder with shim stock to prevent damage to packings on installation. Coat shim stock with hydraulic fluid AAF Specification 3586. Install the packings one at a time as on the original installation. When the last washer and packing ring is installed, slide the gland nut over the piston and tighten it into the cylinder. Never tighten this gland nut excessively.

6. Insert the hooked end of the retainer ring into one of the two holes that line up with a slot in the gland nut. Expand the retainer and slide it onto the cylinder until it engages in the groove on the cylinder. The hooked end on this retainer should extend far enough through the cylinder to engage the gland nut and lock it in position.



1. CYLINDER
2. LOCK SCREW
3. COPPER METERING PIN WASHER
4. PISTON BEARING
5. METERING PIN
6. PISTON
7. PACKING
8. GASKET
9. FILLER PLUG
10. GLAND NUT

Figure 147—Tail Wheel Oleo Strut Disassembled

(*d*) TEST OF OLEO STRUT.

1. With the filler plug removed, extend the piston as far is it will go. Stand the cylinder in a vertical position with the piston up and fill the piston at the plug hole with hydraulic fluid, AAF Specification 3586 until it overflows. Screw a pressure gage into the plug hole in the piston and subject the strut to a pressure of 2500 pounds per square inch for ten minutes.

2. Inspect the cylinder to determine if there is any evidence of leaks around the gland nut.

3. If there is no evidence of leaks in the strut, release the pressure on the strut, and remove the gage. Drain the fluid from the strut and retract the strut into the cylinder as far as it will go. Stand the strut on end with the plug hole up and fill with hydraulic fluid, AAF Specification 3586, until the fluid overflows, and work the piston up and down several times to dispell any trapped air in the cylinder. Add additional fluid to bring the level up to the plug hole. Install the gasket and filler plug and inflate the strut with a high pressure hand pump per nameplate instructions. Never use compressed air. The oleo strut is now completely assembled, tested and serviced with fluid and air for installation in the airplane.

(*e*) INSTALLATION OF OLEO STRUT.

1. With the tail wheel down, work through the hand hole and secure bolt attaching the oleo piston to the lug on the retracting strut.

2. Working through the access door, install the bolt attaching the lower end of the strut to the drag link.

3. Jack up airplane at the panel jack studs, retract the landing gear, and observe action of tail wheel assembly.

4. Button inspection hole and access door.

(4) RETRACTING STRUT.—Refer to section IV, paragraph 7. *c.* Hydraulic System.

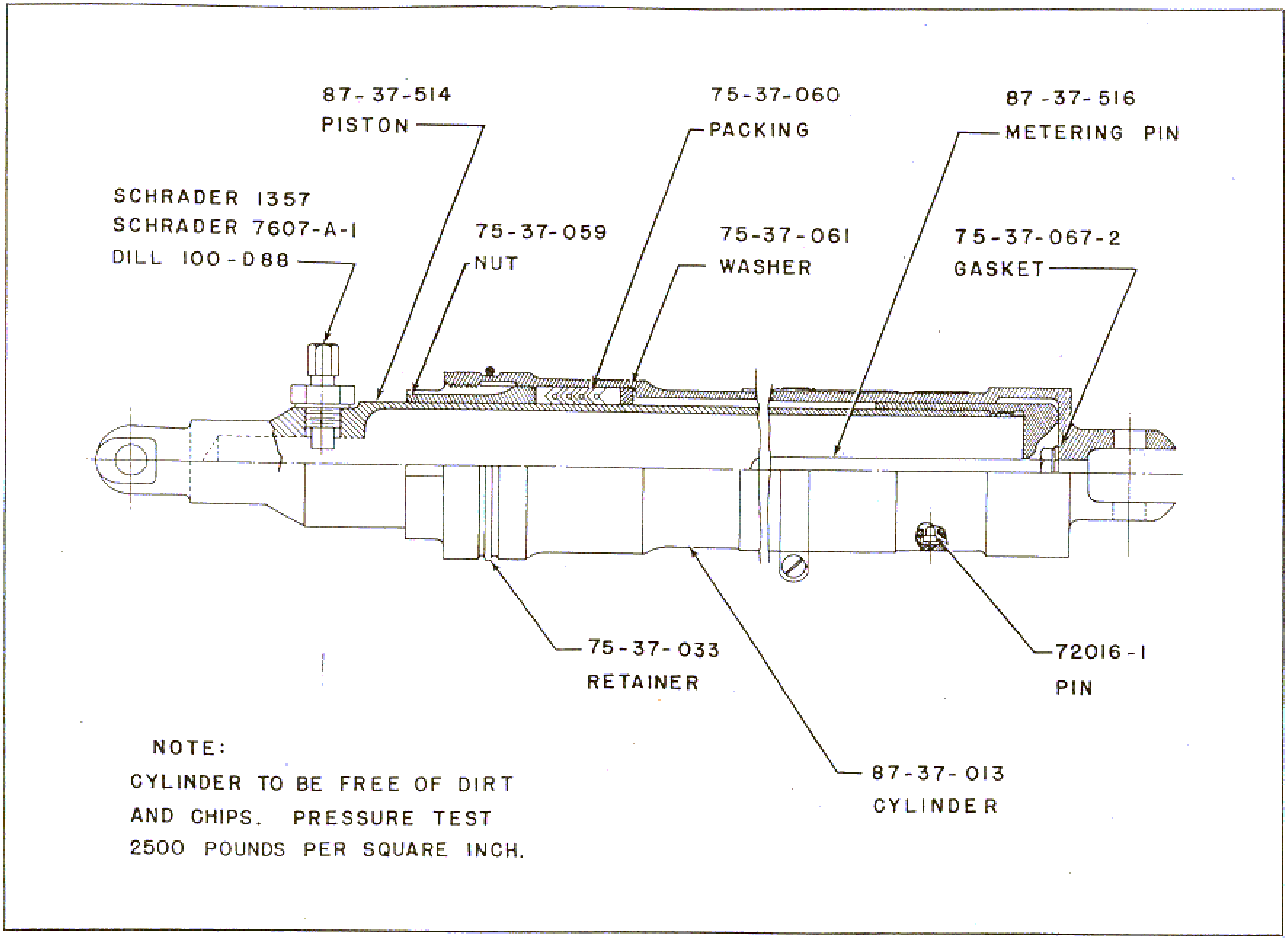
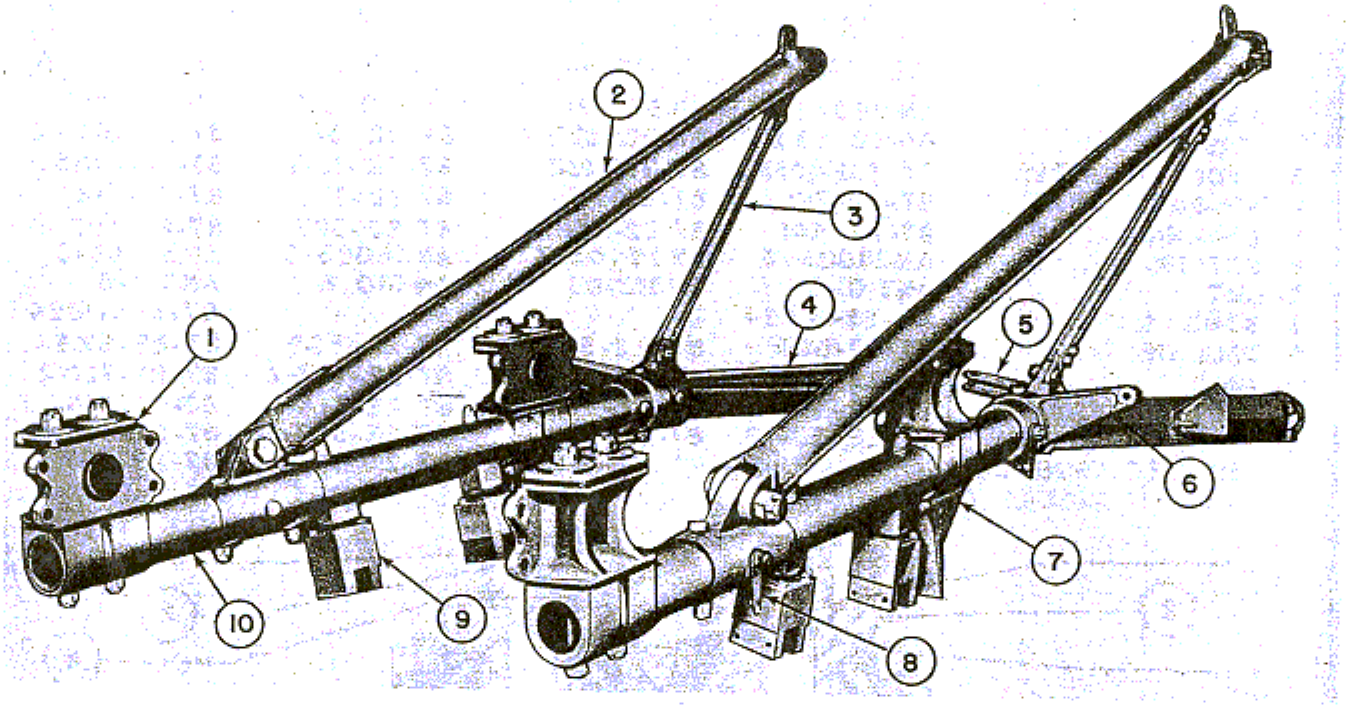


Figure 148—Tail Wheel Oleo Strut



1 ENGINE MOUNT VIBRATION ABSORBER
2 BEARER TUBE UPPER
3 DIAGONAL TUBE
4 TRUSS
5 LINK
6 LOWER COWL BRACKET (EACH SIDE)
7 AIR EXIT DUCT BRACKET (EACH SIDE)
8 BONDING TAB
9 RADIATOR MOUNTING BRACKET
10 BEARING TUBE LOWER

Figure 149—Engine Mount Assembly

5. ENGINE SECTION.

a. ENGINE MOUNT.

(1) DESCRIPTION.—The engine mount is constructed of X4130 steel alloy tubing and steel alloy forgings, normalized and heat-treated to a tensile strength of 150,000 pounds per square inch. (See figure 149.)

(*a*) Four vibration-absorbing engine supports are attached to the lower bearer tubes of the engine mount assembly for engine support, and to dampen out engine vibrations from the airplane.

(*b*) The lower bearer tubes also carry the four radiator mounting brackets, the two air exit duct brackets, the two bottom cowl supporting brackets and four bonding braid tabs.

(*c*) The engine mount assembly of P-40N airplanes AF42-104429 through AF42-104828 is equipped with the Lord type vibration-absorbing engine supports. They were subsequently modified to relieve engine vibration by the elimination of metal-to-metal contact and the installation of upper Fabreeka snubber rings. (See figure 150.)

(*d*) The Fabreeka type vibration-absorbing engine support used on airplane AF42-104829 and subsequent, is equipped with upper and lower Fabreeka pads, or snubbers, and two Fabreeka bushings, which cushion the vertical engine studs from the engine support fitting. (See figure 151.)

(2) REMOVAL OF ENGINE MOUNT.—To remove one side of the engine mount, it is not necessary to remove the engine from the airplane. The following instructions are for removing the left engine mount on airplanes with the battery installation in the engine compartment (AF42-106029 and subsequent). Removal of this engine mount was selected because its removal is more involved (only because of additional equipment which is mounted on it) than the removal of the right engine mount or engine mounts of previous models of the P-40N series airplanes.

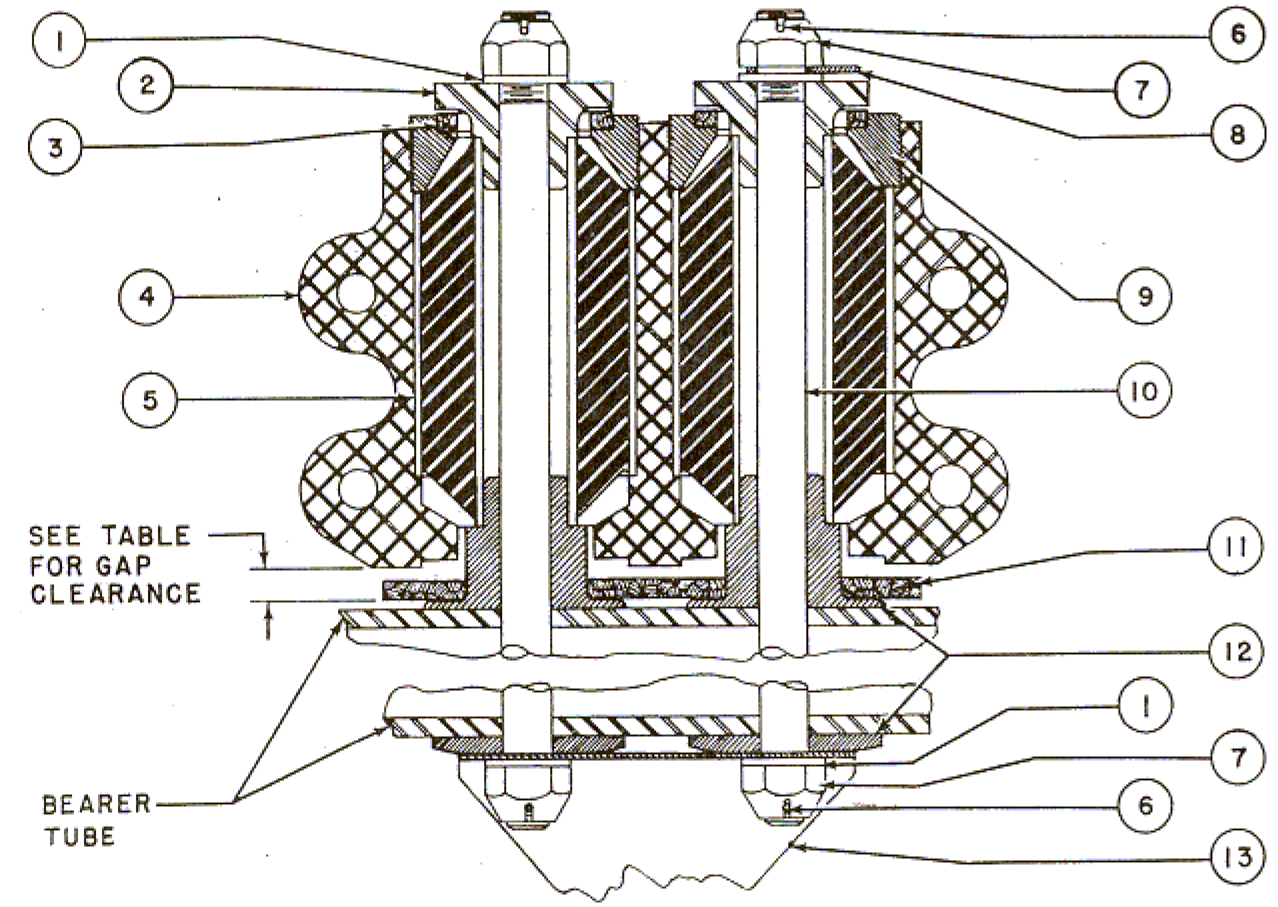
(*a*) Remove the side, top, and bottom engine cowling. Remove the front wing fillets and the rear side cowl and cowl flap assembly.

(*b*) Attach a four-legged engine harness to the engine in the manner shown in figure 12. Hook the lifting ring of the harness to a hoist and raise the hoist just enough to relieve the engine mount of the engine weight.

Note

The two shorter legs or cables of the engine harness will be attached to the front of the engine causing it to tip up at the front for greater clearance.

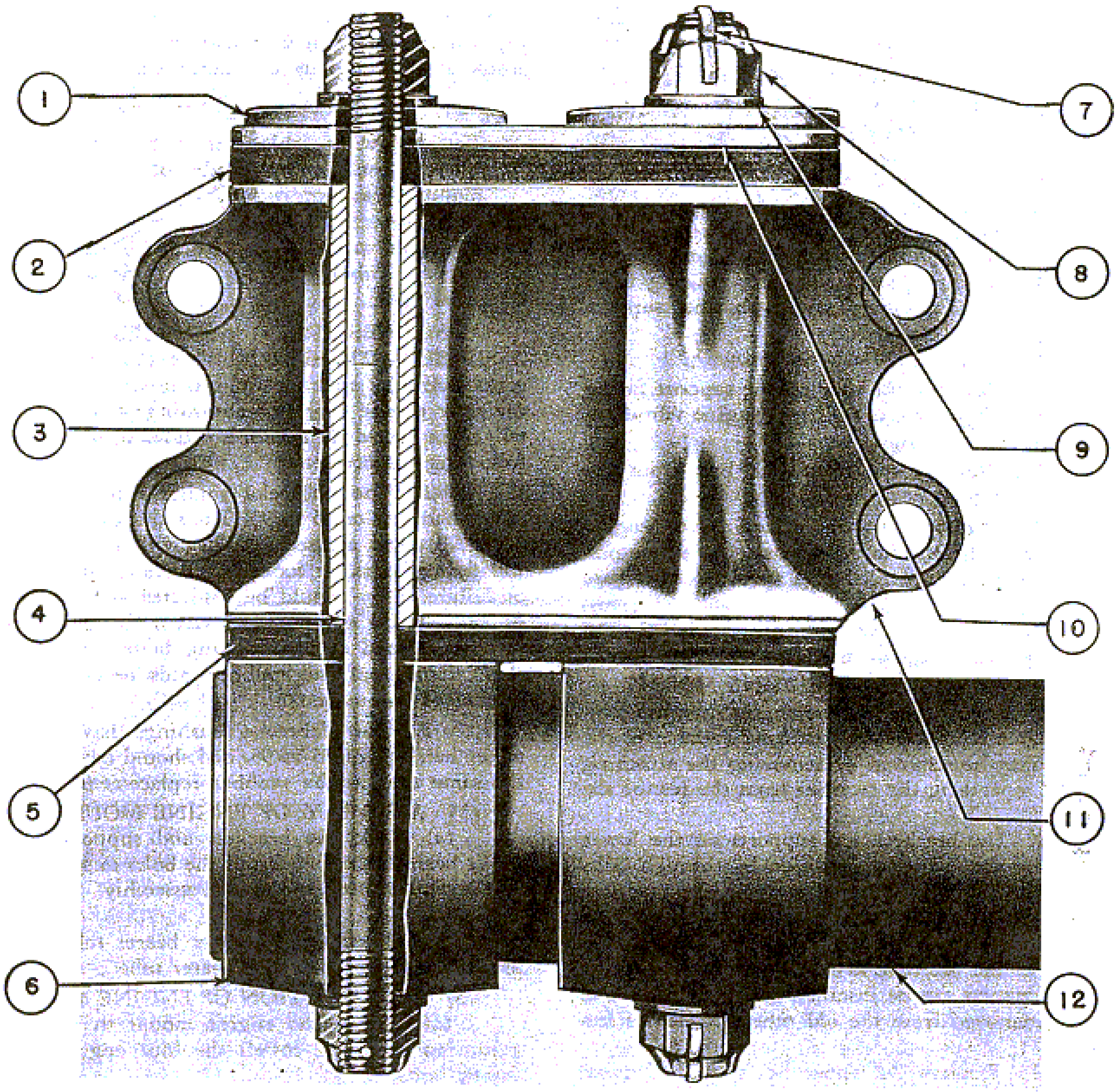
	FRONT ABSORBER		REAR ABSORBER	
	LEFT HAND	RIGHT HAND	LEFT HAND	RIGHT HAND
1 WASHER	AN 960-816	AN 960-816	AN 960-816	AN 960-816
2 STOP	87-22-533-1	87-22-533-2	87-22-533-1	87-22-533-2
3 SNUBBER (UPPER)	87-710-1015	87-710-1015	87-710-1015	87-710-1015
4 HOUSING	87-22-712	87-22-712	87-22-712	87-22-712
5 BUSHING UNIT	87-22-541	87-22-541	87-22-523	87-22-523
6 COTTER PIN	AN380C3-3	AN380C3-3	AN380C3-3	AN380C3-3
7 NUT	AN310-8	AN310-8	AN 310-8	AN310-8
8 BONDING TAB	87-554-1024			87-554-1024
9 COLLAR	87-22-529	87-22-529	87-22-529	87-22-529
10 BOLT	87-22-717-1	87-22-717-2	87-22-717-2	87-22-717-2
11 SNUBBER (LOWER)	87-22-714	87-22-714	87-22-714	87-22-714
12 SUPPORT	87-22-527-3	87-22-527-4	87-22-527-1	87-22-527-2
13 BRACKET ASSEMBLY			87-29-777	87-29-777



GAP CLEARANCE BETWEEN HOUSING AND VIBRATION ABSORBER SUPPORT

UNLOADED CONDITION		FULLY LOADED CONDITION	
LEFT SIDE	.493 ± .025 INCH	LEFT SIDE	.389 ± .040 INCH
RIGHT SIDE	.340 ± .025 INCH	RIGHT SIDE	.290 ± .040 INCH

Figure 150—Lord Type Vibration Absorber Support Assembly



1. 1075-DT-.188-.515-2.125 WASHER (2 REQUIRED)
2. 87-710-1013 FABREEKA SNUBBER
3. 87-710-1018 FABREEKA BUSHING (2 REQUIRED)
4. 87-22-717-3 ENGINE SUPPORT STUD (2 REQUIRED)
5. 87-710-1013 FABREEKA SNUBBER
6. 87-710-1011 ENGINE MOUNTING SUPPORT (2 REQUIRED)
7. AN 380 C3-3 COTTER (4 REQUIRED)
8. AN 310-8 NUT (4 REQUIRED)
9. AN 960-816 WASHER (4 REQUIRED)
10. 87-710-1014 ENGINE SUPPORT PLATE
11. 87-710-1012 ENGINE SUPPORT FITTING
12. BEARER TUBE

NOTE: ALL FOUR VIBRATION ABSORBER ASSEMBLIES ARE IDENTICAL

Figure 151—Fabreeka Type Vibration Absorber Support Assembly

(*c*) To remove the left engine mount, the following items must be removed from the airplane:

1. Radiators and oil cooler assembly.

2. Exit air duct.

3. Battery and shelf.

4. External electric power receptacle.

5. Battery junction box.

6. Propeller relay box.

7. Battery cooling air blast tube.

8. Electric cables, wires and clamps.

9. Bonding braids and safety wiring from the front and rear engine vibration-absorber support fittings.

10. Remove the exhaust shroud.

11. Remove the four engine support fitting bolts from each, the front and rear, engine vibration-absorber support fittings.

12. Remove the front link bolt from the engine mount truss.

13. Remove the upper and lower engine mount fuselage bolts from the firewall. Use the engine mount bolt puller provided as a special tool (figure 44).

14. Lift the front of the engine slightly and remove the engine mount assembly.

(3) DISASSEMBLY OF ENGINE MOUNT.

(*a*) The members of the engine mount assembly are bolted together. Any particular member of the assembly may be removed by removing the attaching bolts and separating the member from the rest of the assembly.

(*b*) The brackets and supports on the lower bearer tube are secured in position by through bolts through the fitting and the bearer tube. To facilitate the rapid and proper replacement of a lower bearer tube, the new tube should be obtained before disassembly of the old tube is begun, so that the brackets and supports can be installed on the new tube as they are removed from the old tube. Proceed as follows:

1. Remove the upper bearer and diagonal tubes.

2. Remove the top castellated nuts from the two long studs that attach each, the front and rear, engine vibration absorber support assembly to the lower bearer tube.

3. Drive the studs down and out of the support assembly and bearer tube. Note the order of assembly of the engine vibration absorber support assembly. (See figures 150 and 151.)

4. Remove the bolts from the remaining supports and brackets on the bearer tube. Tap the parts off the bearer tube and install them on the new tube. Check for correct assembly. (See figure 149.)

(4) MAINTENANCE REPAIRS AND REPLACEMENT.

(*a*) ENGINE MOUNT.—If any of the tubing of the engine mount assembly becomes dented more than 1/16 inch or bent in excess of the following allowable dimensions, it will be replaced, as any attempted repairs requiring heating or welding would necessitate normalizing and reheat-treating.

Note

The following table shows the allowable over-all bend in each tube of the engine mount assembly.

Part Name	*Allowable Bend*
Lower bearer tube	5/32 inch (.156)
Upper bearer tube	13/64 inch (.203)
Diagonal tube	1/16 inch (.0625)

(*b*) VIBRATION ABSORBER SUPPORT ASSEMBLY.—The eight Fabreeka snubbers, and the eight Fabreeka stud bushings that are assembled in the four engine vibration-absorbing support fittings will be inspected for fractures and conformance to the following requirements:

1. The Fabreeka snubbers have a Durometer hardness of 85 to 95. Their thickness is .281 ± .015. All edges are sealed. They will be replaced at 150 flying hours, or sooner, if there is any evidence of failure. They should be inspected and the torque of the vertical engine bolts tested five hours after installation and every 25 flying hours thereafter as the flattening of the snubber pads necessitates correction of the torque.

2. The Fabreeka bushings have a durometer hardness of 85 to 95, and should be replaced at the same time as the snubber replacement.

(5) ASSEMBLY OF ENGINE MOUNT.

(*a*) Slide the brackets and supports on the lower bearer tube and install the bolts to secure them in position. Check for correct assembly. (See figure 149.)

(*b*) Assemble the upper bearer tube and the diagonal tube to the lower bearer tube.

(6) INSTALLATION OF ENGINE MOUNT.

(a) Attach the engine mount to the engine mounting pads and install the four engine support fitting bolts.

(*b*) Lower the front of the engine slightly until the engine mount assembly enters the fittings on the firewall.

(*c*) Align the holes in the engine mount and the firewall fittings and install the two, upper and lower, engine mount bolts.

(*d*) Attach the link from the firewall to the engine mount truss and install the bolt.

(*e*) Connect the bonding braids and safety wire to the front and rear engine vibration absorber support assemblies.

Note

The studs attaching the engine vibration absorber support assemblies to the lower bearer tube must be tightened to the following torques:

Front Vibration Absorber
Support Studs .... 240 inch-pounds

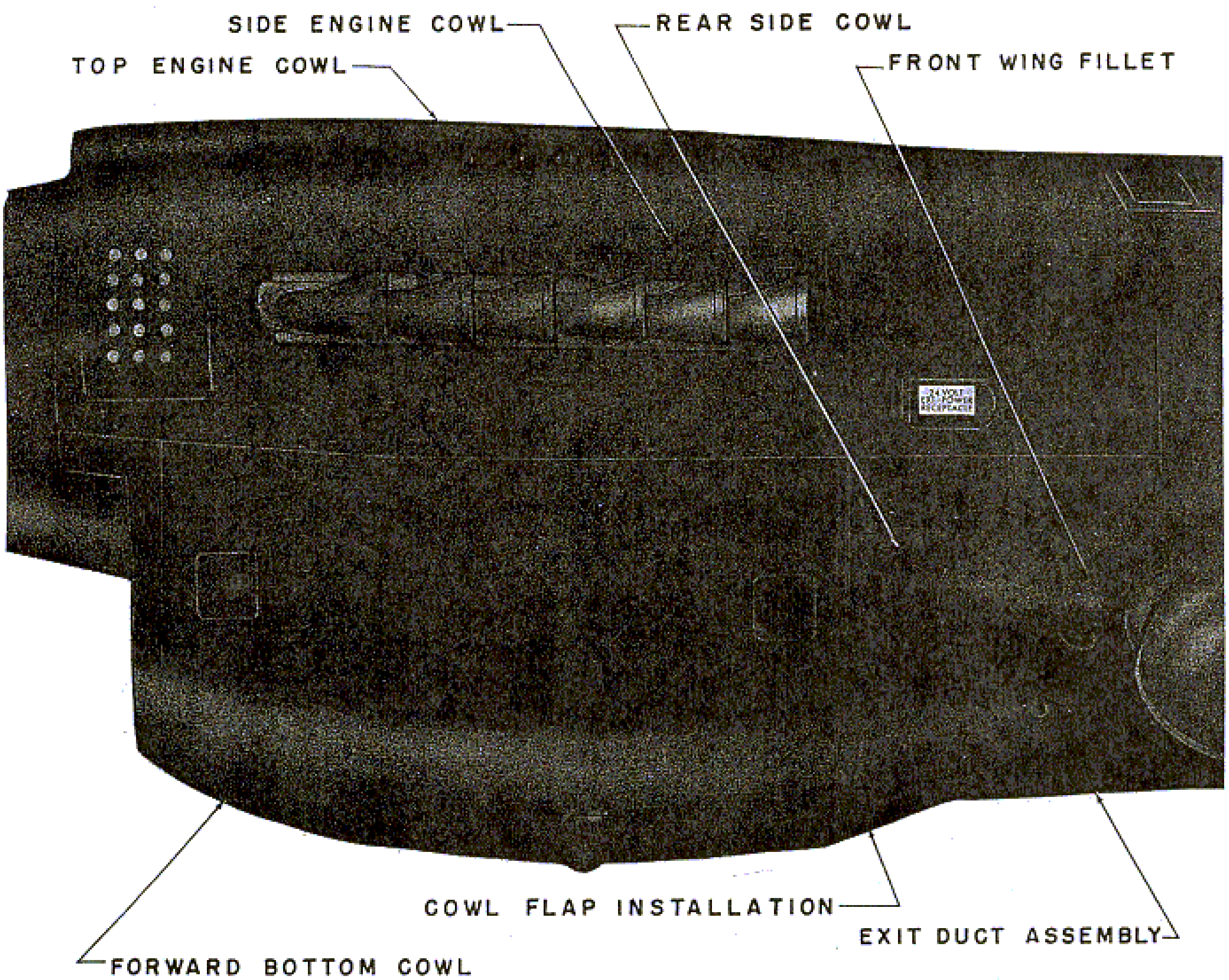


Figure 153—Engine Cowling—Left Side

(2) SIDE COWL.

(*a*) REMOVAL OF SIDE COWL.

1. Unbutton the Dzus fasteners attaching the side cowling, to the top and bottom cowling, and to the firewall and engine bulkhead.

2. Unbutton the four Dzus fasteners at the air filter door and the five Dzus fasteners within the air filter and remove the cowling.

(*b*) INSTALLATION OF SIDE COWL.

1. Place the side cowl in position over the flame-dampening exhaust stacks and button the Dzus fasteners attaching the side cowl to the top, bottom and rear side cowl, the firewall and engine front bulkhead.

2. Button the five Dzus fasteners in the air filter door frame, which attach the carburetor air filter box to the side cowl. Close the door and button the four Dzus fasteners which lock it closed.

(3) FORWARD BOTTOM COWL.

(*a*) REMOVAL OF FORWARD BOTTOM COWL.

1. Remove the side engine cowl.

2. Remove the turnbuckle safety pins, and loosen the turnbuckles from the coolant radiators and oil cooler canvas air seal, sufficiently, to release the seals from the bottom cowling. The pins and turnbuckles are accessible within the bottom cowling air intake ducts.

3. Unbutton the four Dzus fasteners holding the cowl to the engine bulkhead.

4. Remove the four Reed and Prince screws holding the cowl to the engine bulkhead.

5. Remove the nut from the right and left hand studs, fastening the cowl to the two support fittings on the cowl flap former.

6. Unbutton the four Dzus fasteners attaching the bottom cowl to the cowl flap former.

7. Disconnect the cold air tubes from the air intake ducts and remove the bottom cowl.

Rear Vibration Absorber
Support Studs ....120 inch-pounds

(*f*) Remove the engine lifting harness.

(*g*) Connect the electric cables, wires and clamps.

(*h*) Install the battery cooling air blast tube.

(*i*) Install the battery junction and the propeller relay boxes.

(*j*) Install the external electric power receptacle.

(*k*) Install the battery and shelf.

(*l*) Install the radiators and oil cooler assembly.

(*m*) Install the air exit duct.

(*n*) Install the exhaust shroud.

Note

Be sure that all installations are safety wired.

(*o*) Install the cowl flap assembly, and rear side, bottom, top, side cowling and the front wing fillets.

b. ENGINE COWLING.

(1) GENERAL DESCRIPTION. (See figures 152 and 153.)—The engine cowling consists of the top cowl, side cowl, forward bottom cowl, rear side cowl, and the cowl flap assembly. An air exit duct is installed sealing the engine compartment from the oil cooler and coolant radiators. The air passing through the radiators from the intake ducts in the forward bottom cowl, is directed out through the cowl flaps by the air exit duct.

All sections of the engine cowling are of reinforced aluminum-alloy construction with the exception of the side engine cowl. A panel of stainless steel construction is installed in the side engine cowl where the cowl fits around the flame-dampening exhaust stacks.

All sections of the engine cowling are lap jointed. The top cowl, forward bottom cowl, and the rear side cowl are overlapped by the side engine cowl. The rear side cowl is overlapped by the forward bottom cowl, the side cowl, and the front wing fillet.

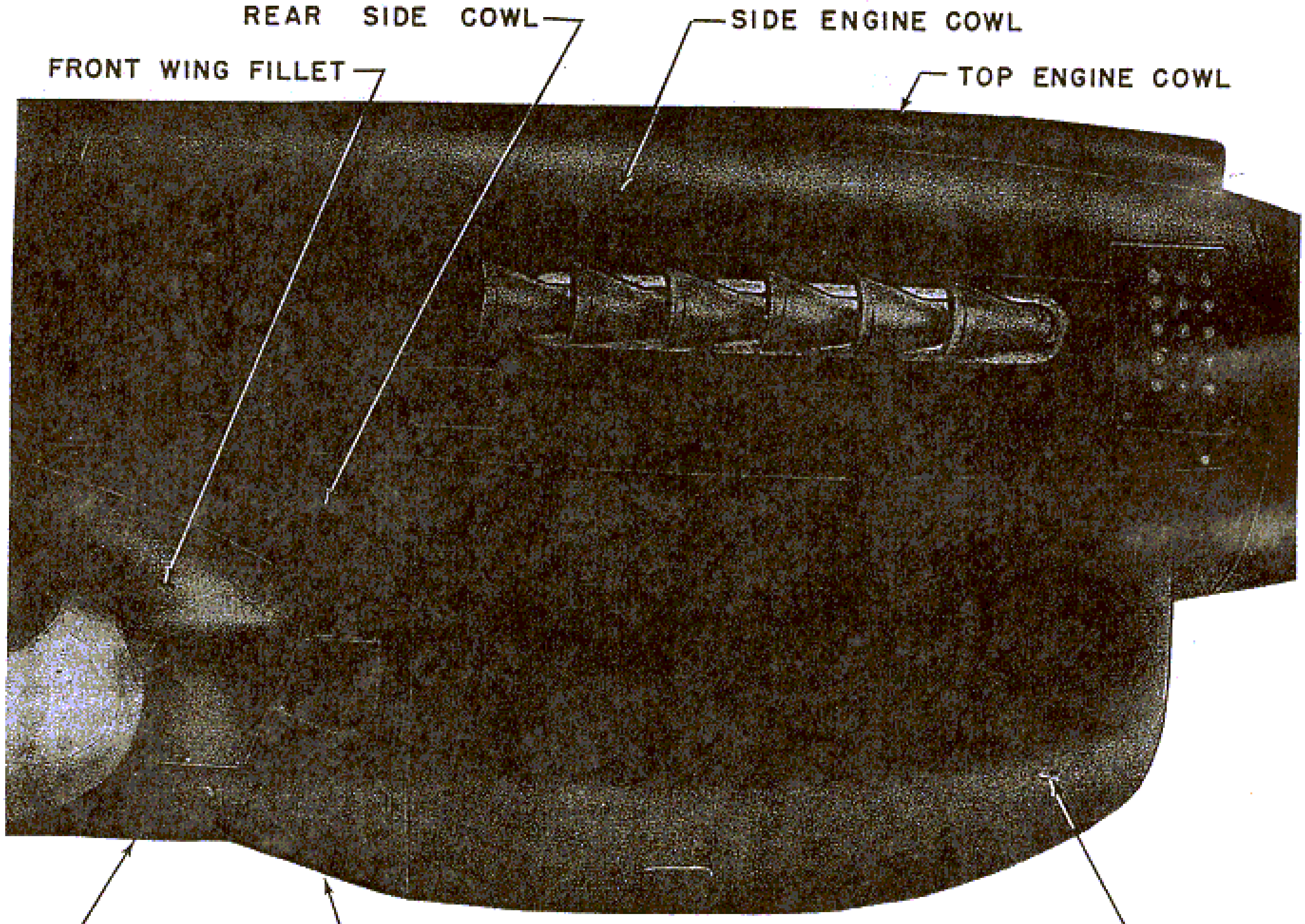


Figure 152—Engine Cowling—Right Side

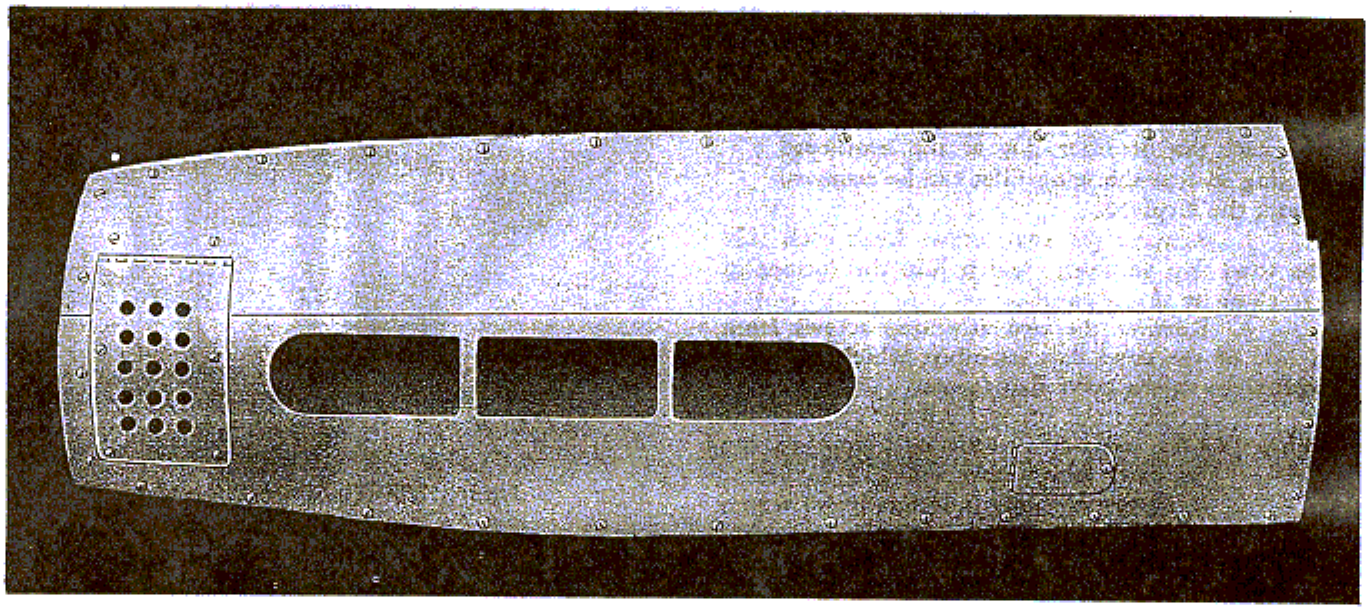


Figure 154—Side Cowl

(*b*) INSTALLATION OF FORWARD BOTTOM COWL.

1. Lift the bottom cowl in place over the oil cooler and coolant radiators. Install the spark plug, fuel pump and battery cold air tubes in the grommets in the air intake ducts of the bottom cowl.

2. Insert the two studs, one installed on each side of the bottom cowl at the top rear, through the holes provided in the cowl support fittings on the cowl flap former and install the nuts.

3. Attach the front of the bottom cowl to the engine front bulkhead by buttoning the four Dzus fasteners and installing the four recessed-head screws.

4. Button the four Dzus fasteners attaching the bottom cowl to the cowl flap former.

5. Reach through the air intake ducts of the bottom cowl and pull the oil cooler and coolant radiator canvas air seals in position. Secure by tightening the turnbuckles and installing the safety pins.

6. Install the side engine cowl.

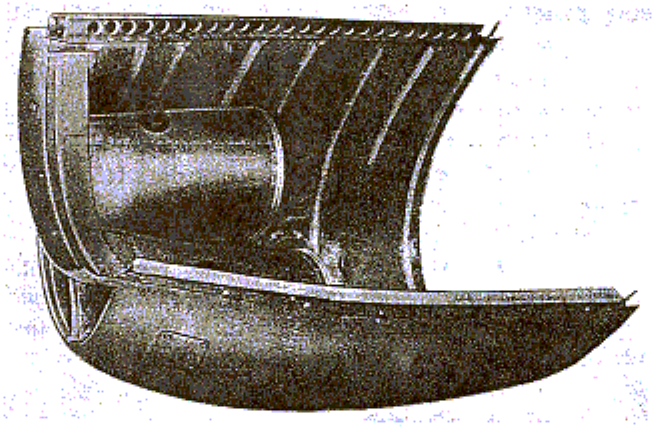


Figure 155—Forward Bottom Cowl

(4) REAR SIDE COWL AND COWL FLAP ASSEMBLY.

(*a*) DESCRIPTION.—The cowl flaps are installed aft of the forward bottom cowl and are supported on the cowl flap former. The cowl flaps control the flow of air through the oil cooler and coolant radiators. The cowl flap installation comprises four hinged flaps operated in unison by two control rods actuated by the hand lever located in the cockpit.

(*b*) REMOVAL OF REAR SIDE COWL AND COWL FLAP ASSEMBLY.

1. Remove both side engine cowls and the forward bottom cowl.

2. Remove the screws from the left and right front wing fillets and remove the wing fillets from the airplane.

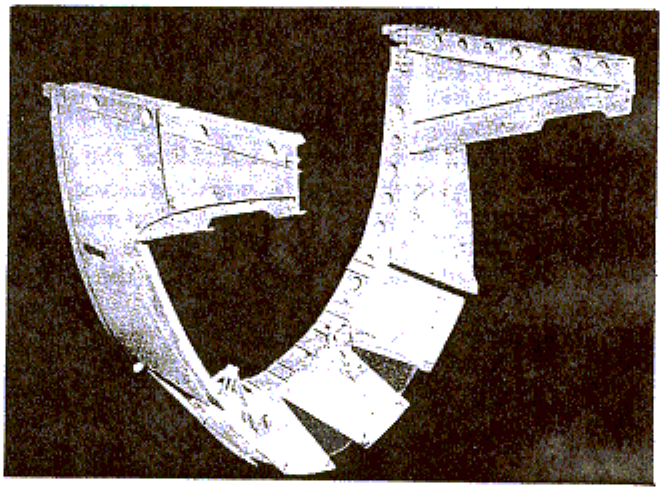


Figure 156—Rear Side Cowl and Cowl Flap Assembly

Note

The front crankcase breather line is connected through a hose connection to the overboard fitting in the left wing fillet. Disconnect the breather line at the overboard fitting so that the wing fillet can be removed from the airplane.

3. Remove the two screws from each side of the cowl flap assembly, which join the former to the fuselage at the firewall.

4. Remove the two attaching screws from each side of the cowl flap assembly, which hold the air exit duct to the cowl flap former.

5. Remove one screw from each side of the assembly, which attaches the air exit duct to the bracket on the cowl flap former.

6. Remove two bolts (left side only) which attach the upper aft side of the cowl flap assembly to the bracket provided on the engine mount.

Note

This bracket is provided for installation of the battery access door in the left rear side cowl on airplanes having the battery installation in the engine compartment.

7. Operate the cowl flaps to full open position to obtain working space and disconnect the two cowl flap control rods from the flap assembly.

8. Remove the two bolts, one on each side of the airplane, which attach the cowl flap former to the main cowl flap assembly support bracket on the engine mount.

9. Remove the rear side cowl and cowl flap assembly from the airplane.

(*c*) INSTALLATION OF REAR SIDE COWL AND COWL FLAP ASSEMBLY.

1. Place the rear side cowl and cowl flap assembly in position and install the two bolts, one on each side, which attach the cowl flap former to the support bracket on the engine mount.

2. Install two screws on each side of the assembly attaching the former to the fuselage at the firewall.

3. Install the two bolts (left side only) which attach the upper aft side of the rear side cowl assembly to the bracket on the engine mount.

4. Connect the two cowl flap control rods to the flap assembly.

5. Install one screw in each side of the rear side cowl and cowl flap assembly, which attaches the air exit duct to the bracket on the cowl flap former.

6. Install two screws in each side of the assembly which attach the air exit duct to the cowl flap former.

7. Install the forward bottom cowl, side cowls and the front wing fillets.

Note

Connect the front crankcase breather line at the hose connection on the overboard fitting in the left front wing fillet, before attaching the fillet to the airplane.

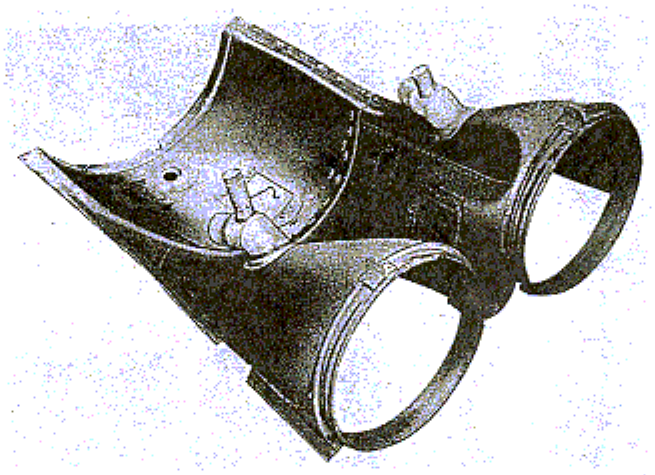


Figure 157—Exit Duct Assembly

(5) AIR EXIT DUCT.

(*a*) REMOVAL OF AIR EXIT DUCT.

1. Remove the side engine cowl.

2. Remove the forward bottom cowl.

3. Remove the rear side cowl and cowl flap assembly.

4. Remove three screws from the under surface of the air exit duct at the front, which attach the canvas air seal to the air exit duct.

5. Remove the safety pins and loosen the turnbuckles from the air seals between the aft side of the coolant radiators and the air exit duct. Push the air seals free from the exit duct.

6. Loosen the hose clamps and disconnect the two vent lines which vent overboard at the trailing edge of the exit duct on the left side at their hose connections immediately forward of the wing leading edge at the left side of the engine compartment.

7. Loosen the clamps and pry off the two gun heater ducts from their adapters at the leading edge of the wing immediately forward of the firewall.

8. Remove two screws, one from each side of the air exit duct, which attach the exit duct to the wing panel.

9. Remove the two bolts, one from each side at the top forward end of the air exit duct, which attach the air exit duct to the bracket on each side of the engine mount.

10. Now, remove the air exit duct from the airplane.

(*b*) INSTALLATION OF AIR EXIT DUCT.

1. Lift the air exit duct into position and install the two bolts, one through the bracket on the top side of each exit duct ring, which attach the air exit duct to the brackets on the engine mount.

2. Install two screws, one in each side of the air exit duct, which attach the exit duct to the wing panel.

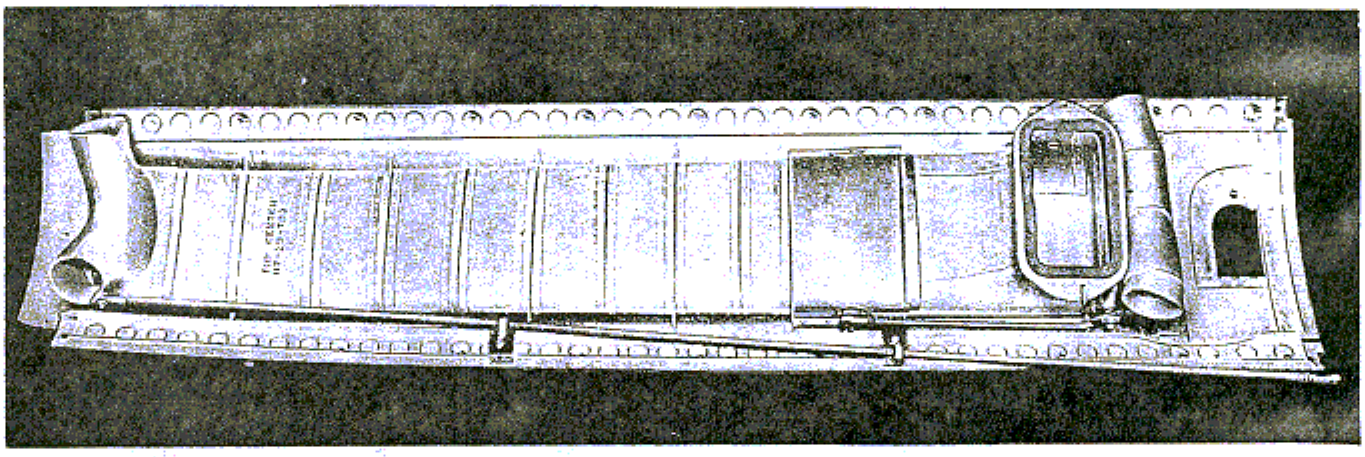


Figure 158—Top Cowl Assembly

3. Connect the two vent lines, which were removed with the exit duct, at the hose connections forward of the wing leading edge on the left side of the engine compartment.

4. Install the two gun heater ducts on the adapters at the leading edge of the wing.

5. Install the canvas air seals over the exit duct rings. Tighten the turnbuckles and install the safety pins.

6. Install the three screws attaching the canvas air seal to the air exit duct.

7. Install the rear side cowl and cowl flap assembly.

8. Install the forward bottom cowl.

9. Install the side engine cowl.

(6) TOP COWL.

(*a*) DESCRIPTION.—The carburetor air intake duct is built into the top engine cowl. Three door assemblies, two of which are installed within the duct assembly and one installed on the aft side of the carburetor air intake elbow, are controlled by push-pull tubes actuated throught a three-way linkage by one control lever in the cockpit.

(*b*) REMOVAL OF TOP COWL.

1. Remove the side engine cowl.

2. Disconnect the left and right hot air duct hose from the hot air intake at the carburetor air intake box.

3. Remove the wing nuts on each side of the carburetor and disconnect the carburetor air intake box from the carburetor.

4. Disconnect the air filter control arm at the outside bellcrank located at the top right of the firewall.

5. Disconnect the carburetor air heat control arm at the bell crank located on the right side of the carburetor air intake box.

6. Remove the five Reed and Prince screws holding the cowl to the engine bulkhead, and the two Reed and Prince screws holding the cowl to the firewall.

7. Disconnect the left and right filtered air duct hose from the filtered air intake at the front of the air intake duct in the top cowl.

8. Remove the top cowl.

(*c*). INSTALLATION OF THE TOP COWL.

1. Lift the top cowl in position and connect the filtered air ducts and the hot air ducts at their hose connections on the top cowl.

2. Install the five Reed and Prince screws attaching the cowl to the engine front bulkhead and the two Reed and Prince screws attaching the cowl to the firewall.

3. Connect the carburetor air heat control arm at the bellcrank on the right side of the carburetor air intake box.

4. Connect the air filter control arm at the outside bellcrank located at the top right of the firewall.

5. Tighten the wing nuts attaching the carburetor air intake box to the carburetor.

6. Be sure that all carburetor air control linkage is connected and the air hose is secured. Install the side engine cowl.

6. POWER PLANT.

a. ENGINE.

(1) DESCRIPTION.—The P-40N airplanes AF42-104429 through AF42-106405 are powered with the V-1710-81 Allison engine; airplanes AF42-106406 and subsequent, are powered with the V-1710-99 Allison engine. Both engines are identical except for the incorporation of the automatic engine control unit on the V-1710-99 engine.

The engine is a liquid-cooled 12-cylinder engine of the "V" type. The cylinder blocks and cylinder heads are detachable from each other and from the upper crank case. Two inlet valves and two exhaust valves for each cylinder are contained in the cylinder head assembly and are actuated by an overhead camshaft supported on the top of each cylinder head assembly. Seven main bearings are formed by the upper and lower crankcase to carry the crankshaft. The center main bearing carries the bronze thrust surfaces.

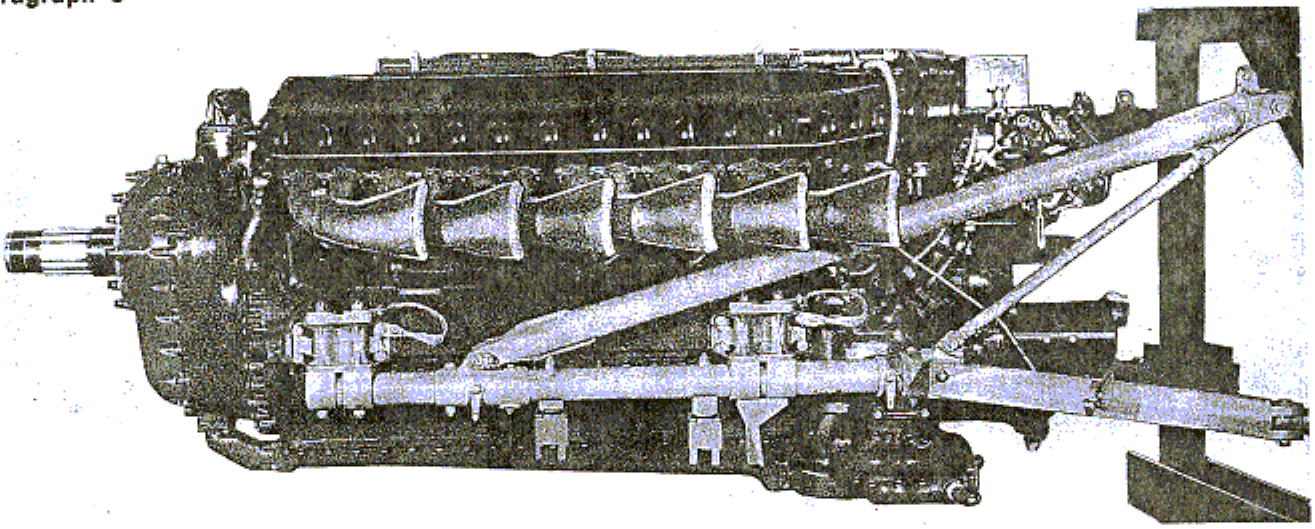


Figure 159—Engine—Left Side View

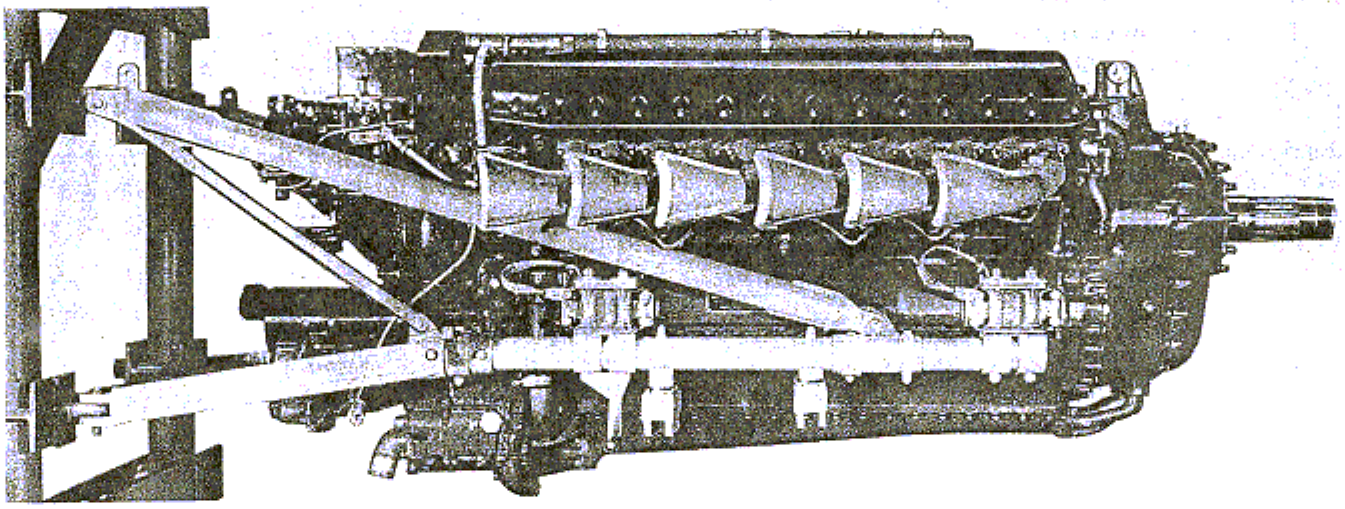


Figure 160—Engine—Right Side View

The engine is lubricated by a force feed engine lubrication system receiving its pressure from a single pressure pump of spur gear construction, in combination with a pressure relief valve. All oil to the engine passes through the disc type oil strainer which incorporates a safety by-pass valve.

The propeller reduction gear assembly on the front of the engine has a reduction ratio of 2:1 of the crankshaft. The propeller shaft carries a No. 50 spline and is supported at the front by a ball thrust bearing and at the rear by a large roller bearing.

A single speed supercharger is contained in the accessory housing. The impeller is gear-driven at a ratio of 9.60:1 of crankshaft speed. The fuel-air mixture is forced through a single supercharger outlet manifold in the vee of the cylinder blocks and a branched manifold system to the intake valves of all 12 cylinders.

The terms "RIGHT" and "LEFT" of the engine are established, as viewing the engine from the cockpit. The direction of rotation of the crankshaft, camshafts, and propeller is established in the same manner. The designation of the location of the engine cylinders is also from the rear of the engine. The rear cylinder of the right bank is designated as No. 1 R and the rear cylinder of the left bank as No. 1 L

(*a*) IGNITION.—Ignition is supplied by a double Scintilla DF magneto, two high-tension ignition-distributor heads, radio-shielded ignition cables and 24 spark plugs.

(*b*) CARBURETION. — Carburetion of the fuel is obtained by use of a single Bendix-Stromberg down-draft injection carburetor.

(*c*) MANIFOLD PRESSURE REGULATOR. —The manifold pressure is controlled by an automatic manifold pressure regulator actuated by the engine oil pressure and connected into the engine throttle control mechanism.

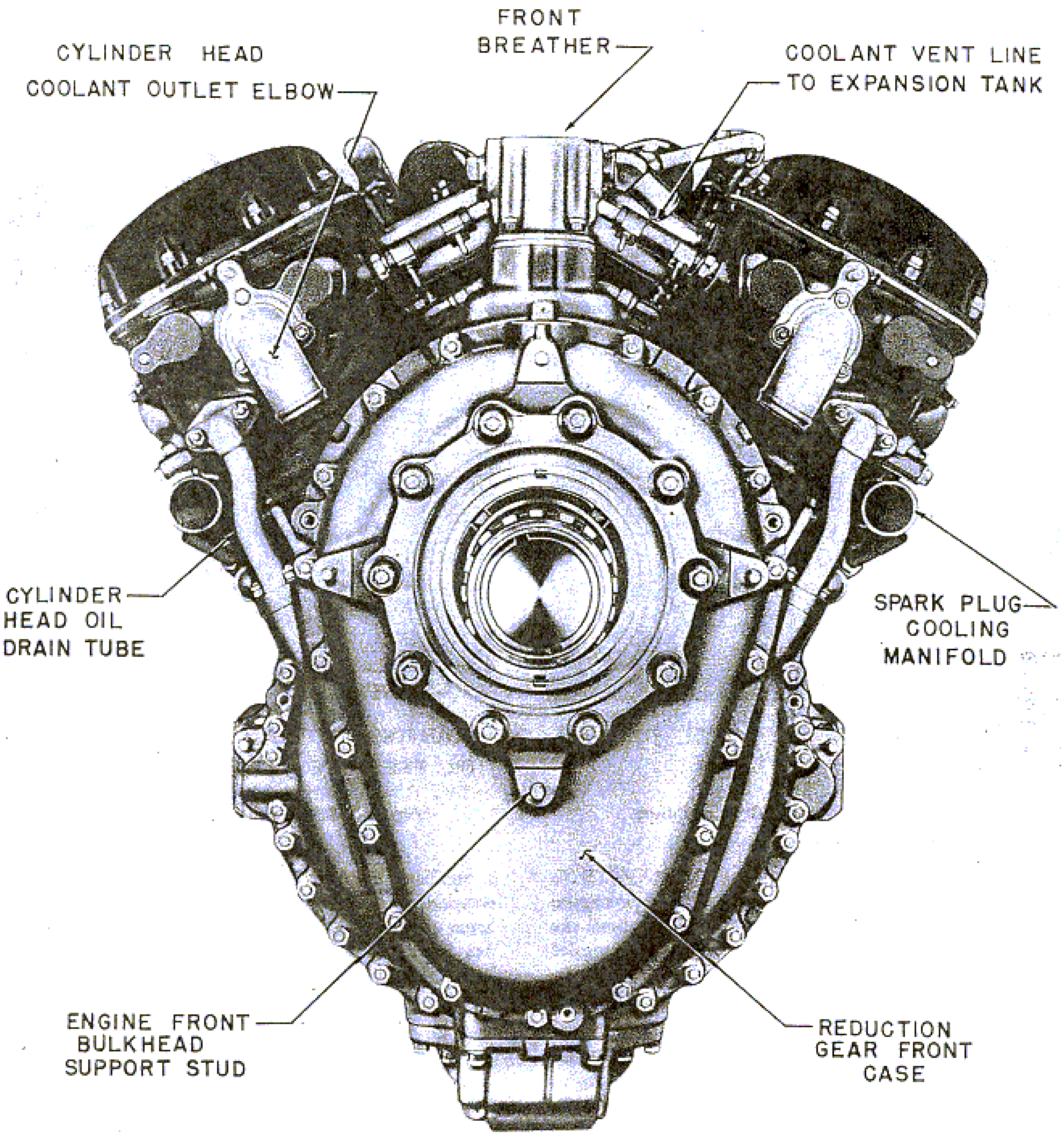


Figure 161—Engine—Front View

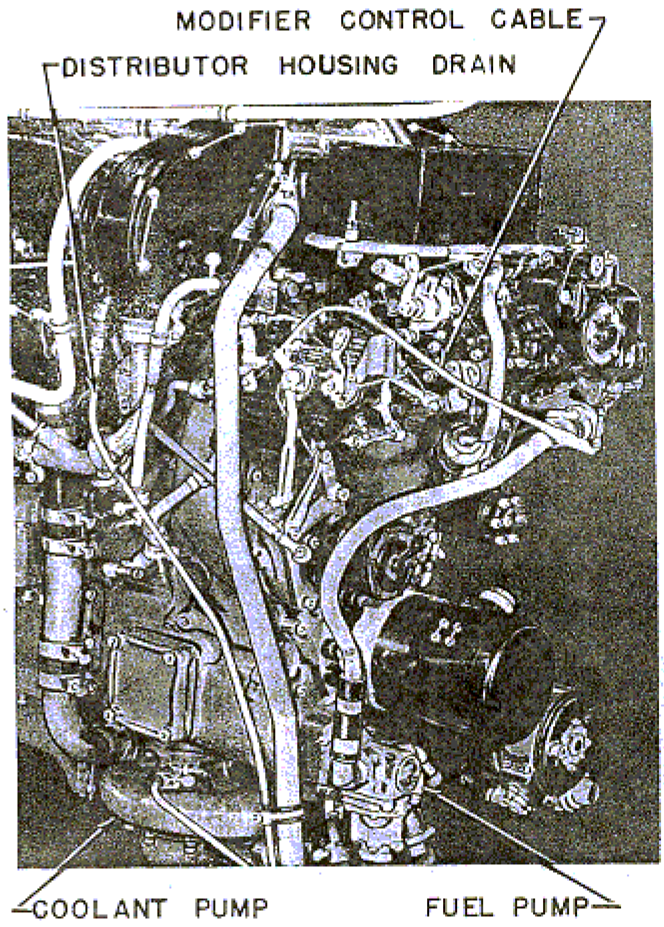


Figure 162—Engine—Left Rear View

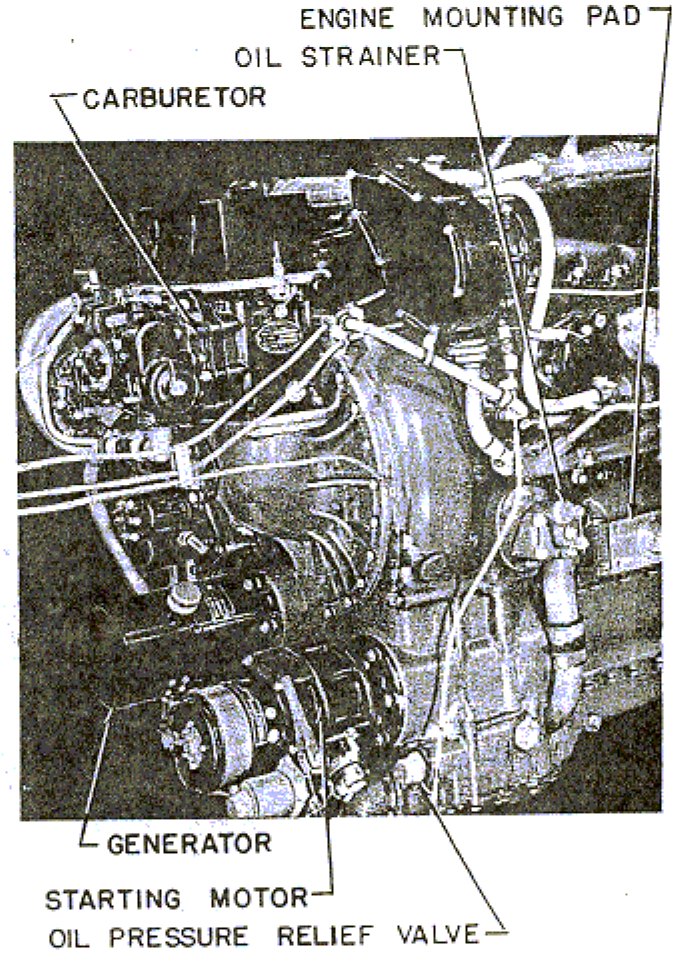


Figure 163—Engine—Right Rear View

(*d*) AUTOMATIC ENGINE CONTROL UNIT (On V-1710-99 Engine).—The automatic engine control unit linkage is so designed that when the pilot opens the throttle manually, the proper engine rpm is coordinated with the selected manifold pressure.

1. The installation of the automatic engine control unit deletes the mechanical control of engine rpm from the propeller control lever on the engine control quadrant, however, the electrical control remains.

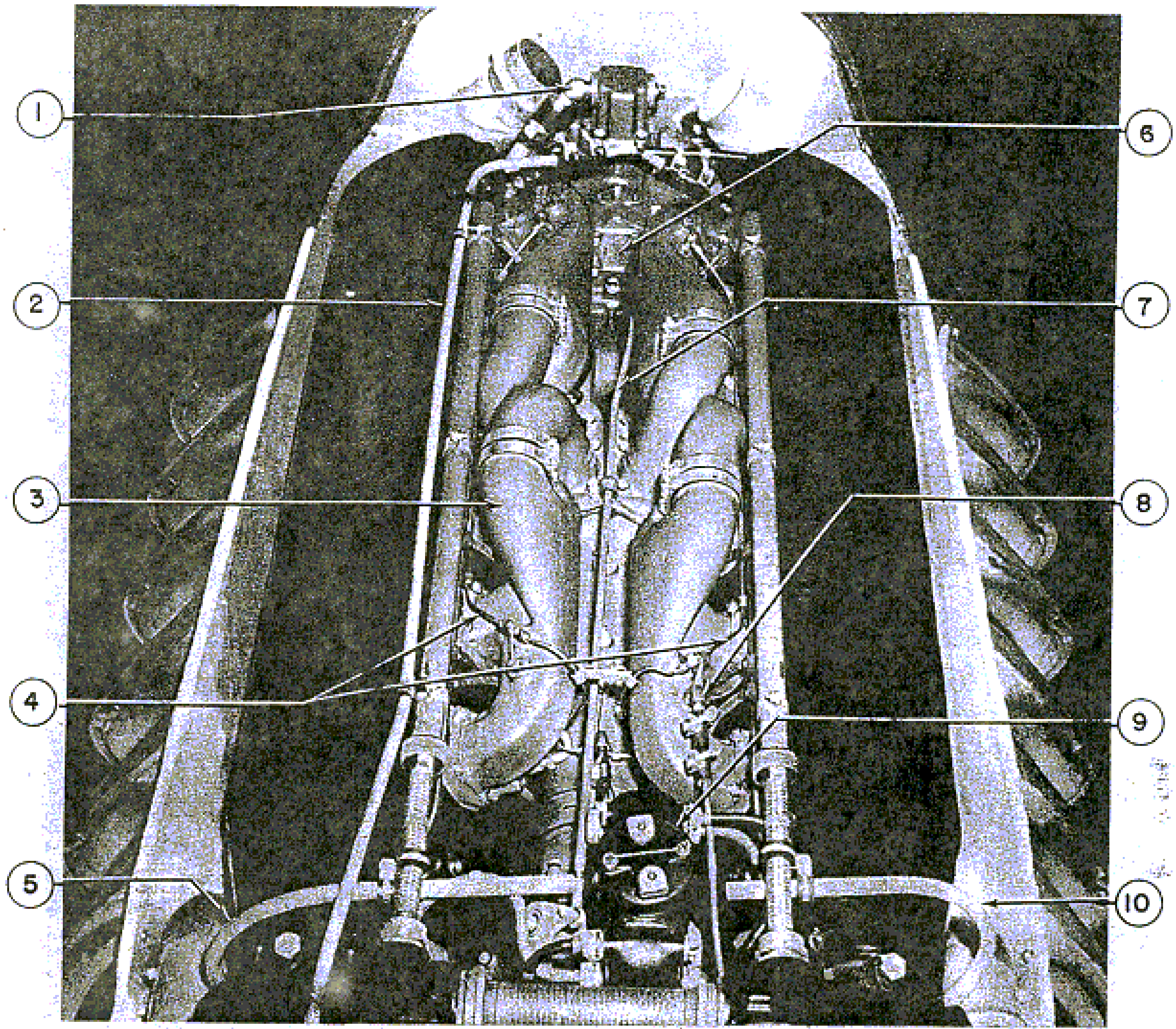
2. On airplanes AF42-106406 through AF43-24001 the economy manifold pressure modifier control lever is safety wired in the "OFF" position. The propeller governor control lever in the cockpit is also locked in the rear position on the control quadrant. A warning plate is attached to the inboard face of the control quadrant which reads, "NOTICE: THIS AIRPLANE HAS AUTOMATIC PROPELLER GOVERNOR CONTROL."

3. On airplanes AF43-24002 and subsequent, a modifier control is incorporated through a cable attached to the former propeller governor control lever on the cockpit throttle quadrant, and the modifier lever on the engine.

Note

This modifier control installation is an addition to the automatic manifold pressure regulator and should not be confused with the automatic propeller control used on the V-1710-99 engine in airplanes previous to AF43-24002.

The employment of this modifier control provides a means of obtaining a selective increased manifold pressure without advancing the throttle or increasing the engine rpm so that a more economical fuel consumption is obtained under non-combat conditions such as ferrying or cruising. A plate above the modifier control lever on the inboard face of the engine control quadrant is marked "MANIFOLD PRESSURE MODIFIER—USE FOR ECONOMICAL CRUISING POWER ONLY."



1. FRONT ENGINE BREATHER
2. COOLANT VENT LINE
3. INDUCTION BRANCHED MANIFOLD
4. MANIFOLD PRIMING LINES
5. MAGNETO COOLING TUBE
6. PROPELLER GOVERNOR MOUNTING PAD
7. PROPELLER GOVERNOR CONTROL ROD
8. MANIFOLD PRESSURE GAGE LINE
9. MAGNETO
10. MAGNETO COOLING TUBE

Figure 164—Engine—Top View

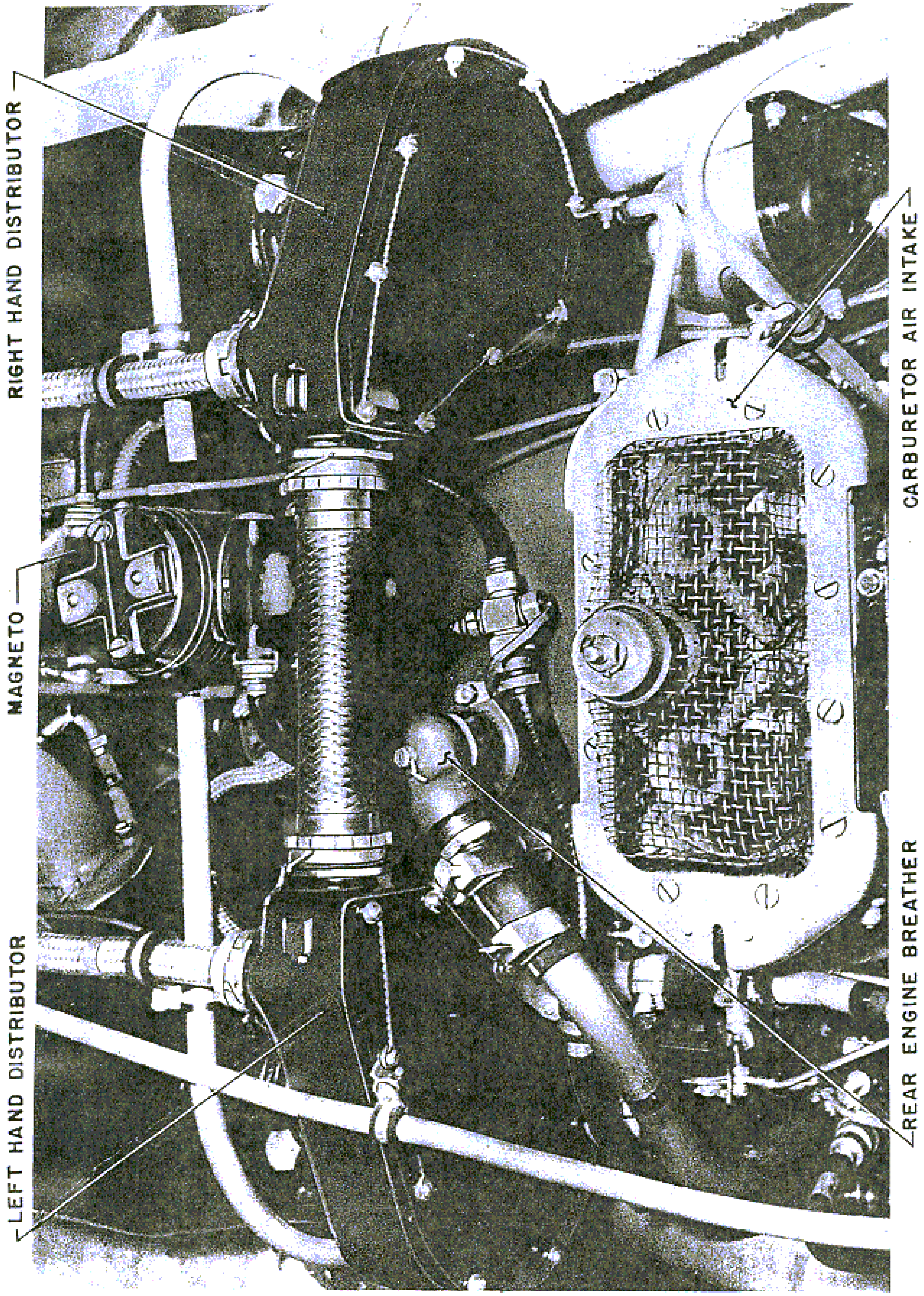
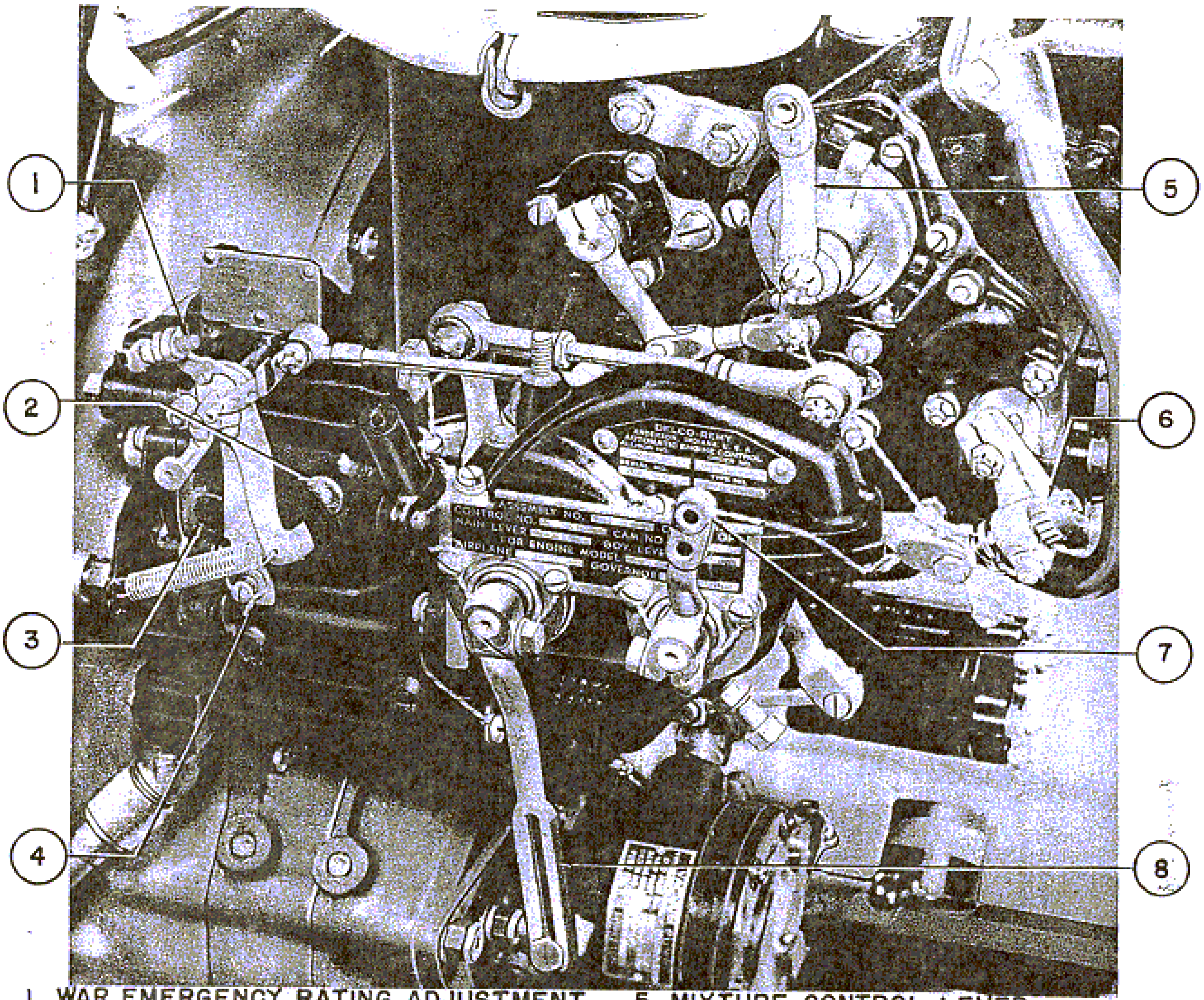


Figure 165—Engine—Top View—Rear



1. WAR EMERGENCY RATING ADJUSTMENT
2. MODIFIER "OFF" STOP
3. MODIFIER "ON" STOP
4 MODIFIER CONTROL LEVER
5. MIXTURE CONTROL LEVER
6. CARBURETOR IDLE ADJUSTMENT
7. MAIN LEVER
8. PROPELLER GOVERNOR CONTROL LEVER

Figure 166—Automatic Engine Control Unit Installed V1710-99 Engine

(2) REMOVAL OF ENGINE.—Removal of the engine is most easily accomplished by removing the entire power plant, including the engine mount and the accessories attached to it. (See figures 167 and 168.)

(*a*) Remove all engine cowling, including the cowl flap assembly and the air exit duct. See section IV, paragraph 5. *b*.

(*b*) Drain the following systems:

1. Cooling system.

2. Engine lubricating system.

3. Fuel system (excluding tanks).

(*c*) Remove the propeller and spinner assembly. See section IV, paragraph 6. *d*.

(*d*) Disconnect the propeller control electrical conduit from the brush cap, removing the two clamps from the forward engine bulkhead.

(*e*) Remove the carburetor air filter boxes and the engine front bulkhead.

(*f*) Disconnect the following from the connector panel on the right side of the firewall: two fuel primer lines, one fuel pressure line, one oil pressure line, and one manifold pressure line.

(*g*) Disconnect the oil dilution line to the oil dilution valve on the forward side of the firewall at the hose connection.

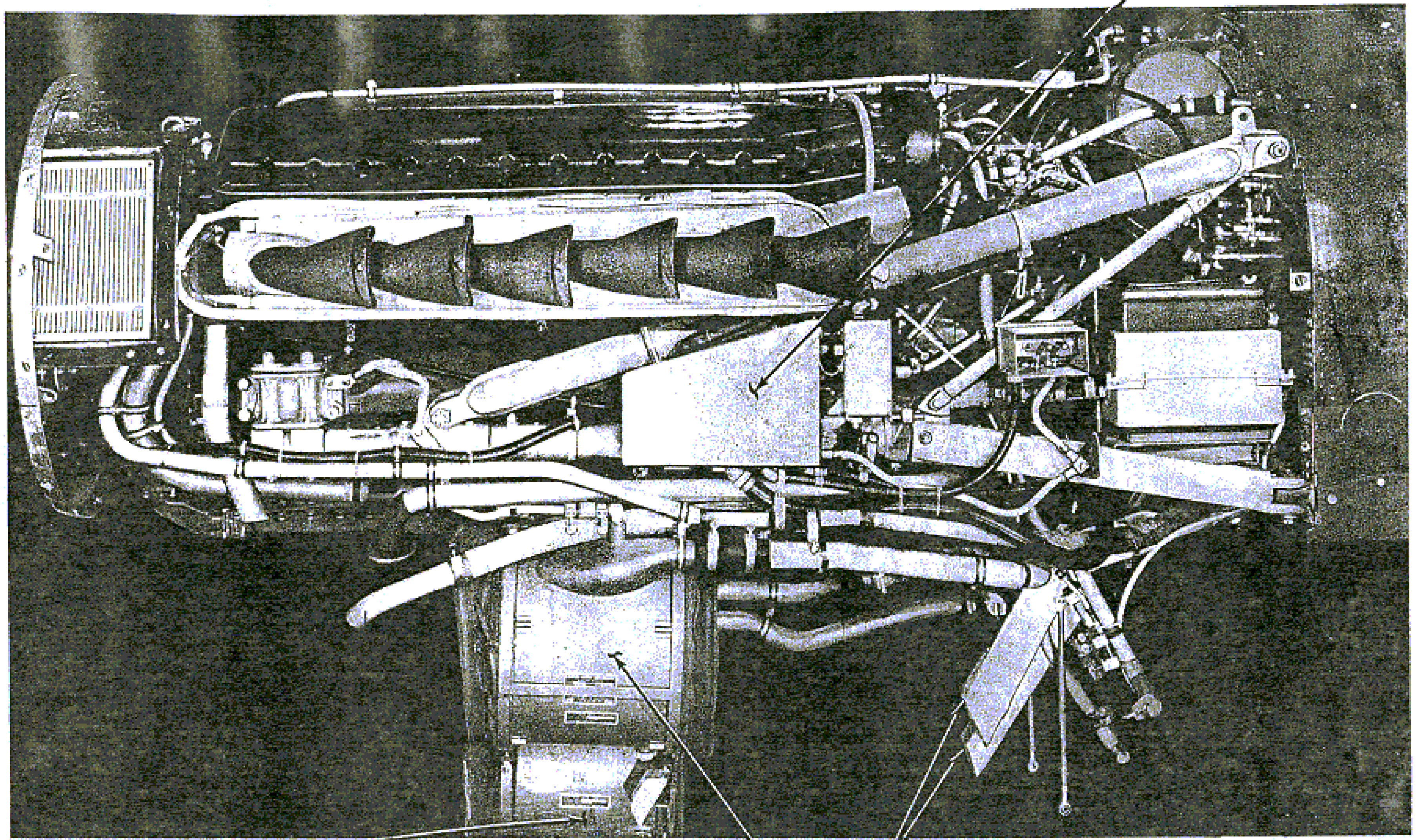


Figure 167—Engine Installed—Left Side View

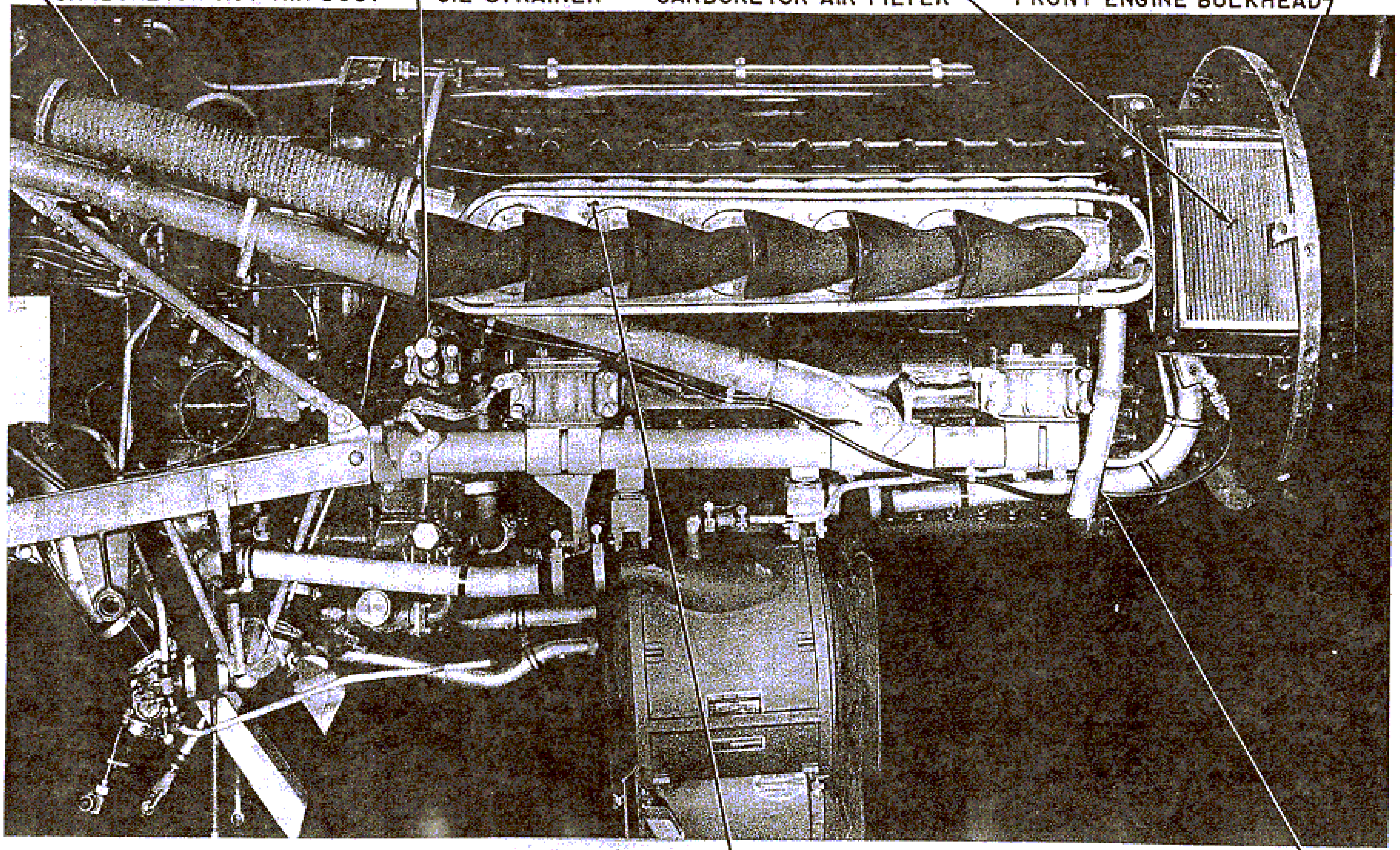


Figure 168—Engine Installed—Right Side View

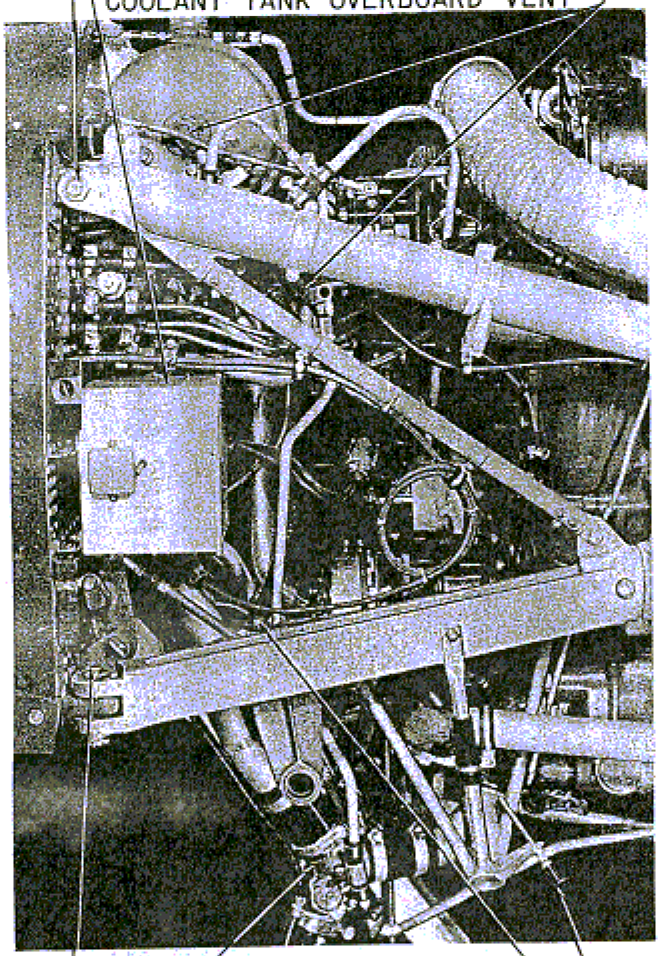


Figure 169—Engine Section—Right Rear Side View

(*h*) Disconnect the engine oil return line (between the oil cooler and oil tank) at the hose connection below the right end of the coolant expansion tank on the firewall.

(*i*) Disconnect the oil supply line to the engine at the forward hose connection at the oil "Y" drain cock.

(*j*) Disconnect the tachometer shaft from the rear of the right engine bank and remove the attaching clamps on the engine mount.

(*k*) Remove the Adel clamps supporting the right and left distributor drains to the engine mount assembly.

(*l*) Disconnect the starter pull cable by removing the starter pull button.

(*m*) Disconnect the coolant supply line from the bottom of the coolant expansion tank on the firewall.

(*n*) Disconnect the coolant vent line at the top of the coolant expansion tank.

(*o*) Disconnect the coolant temperature indicator electrical conduit at the top of the junction box on the right side of the firewall.

(*p*) Disconnect the fuel line from the electric fuel pump to the engine-driven fuel pump at the engine-driven fuel pump.

(*q*) Disconnect the generator electrical conduit at the generator and tie back out of the way.

(*r*) Disconnect all electrical connections at the starting motor and tie back out of the way.

(*s*) Disconnect the propeller control electrical conduit at the left side of the firewall (upper inboard conduit).

(*t*) Disconnect the magneto electrical conduit at the left side of the firewall (lower outboard conduit).

(*u*) Disconnect the oil tank vent line at the hose connection on the forward side of the firewall and left of the coolant expansion tank.

(*v*) Disconnect the engine controls. (See figure 175.)

1. Disconnect the mixture control rod from the lever on the carburetor.

2. Disconnect the throttle control rod from the lever on the manifold pressure regulator.

Note

On airplanes powered by the V-1710-99 engine, the throttle control rod is connected to the lever on the automatic engine control unit.

3. Disconnect the propeller governor control rod from the lower bellcrank on the firewall. (For V-1710-81 engine installation only.)

Note

On airplanes powered by the V-1710-99 engine, the propeller governor is controlled by the automatic engine control unit.

4. On airplanes AF43-24002 and subsequent, disconnect the control wire from the manifold pressure modifier lever on the automatic engine control unit at the lower bellcrank on the firewall. The lower bellcrank was used for manual control of the propeller governor on airplanes powered by the V-1710-81 engine. (See step *3.* preceding.)

(*w*) Disconnect the carburetor vent line at the firewall hose connection directly below the left top engine mount attachment fitting.

(*x*) Disconnect the coolant temperature indicator electrical conduit at the thermometer bulb in the coolant outlet pipe at the front of the right cylinder block.

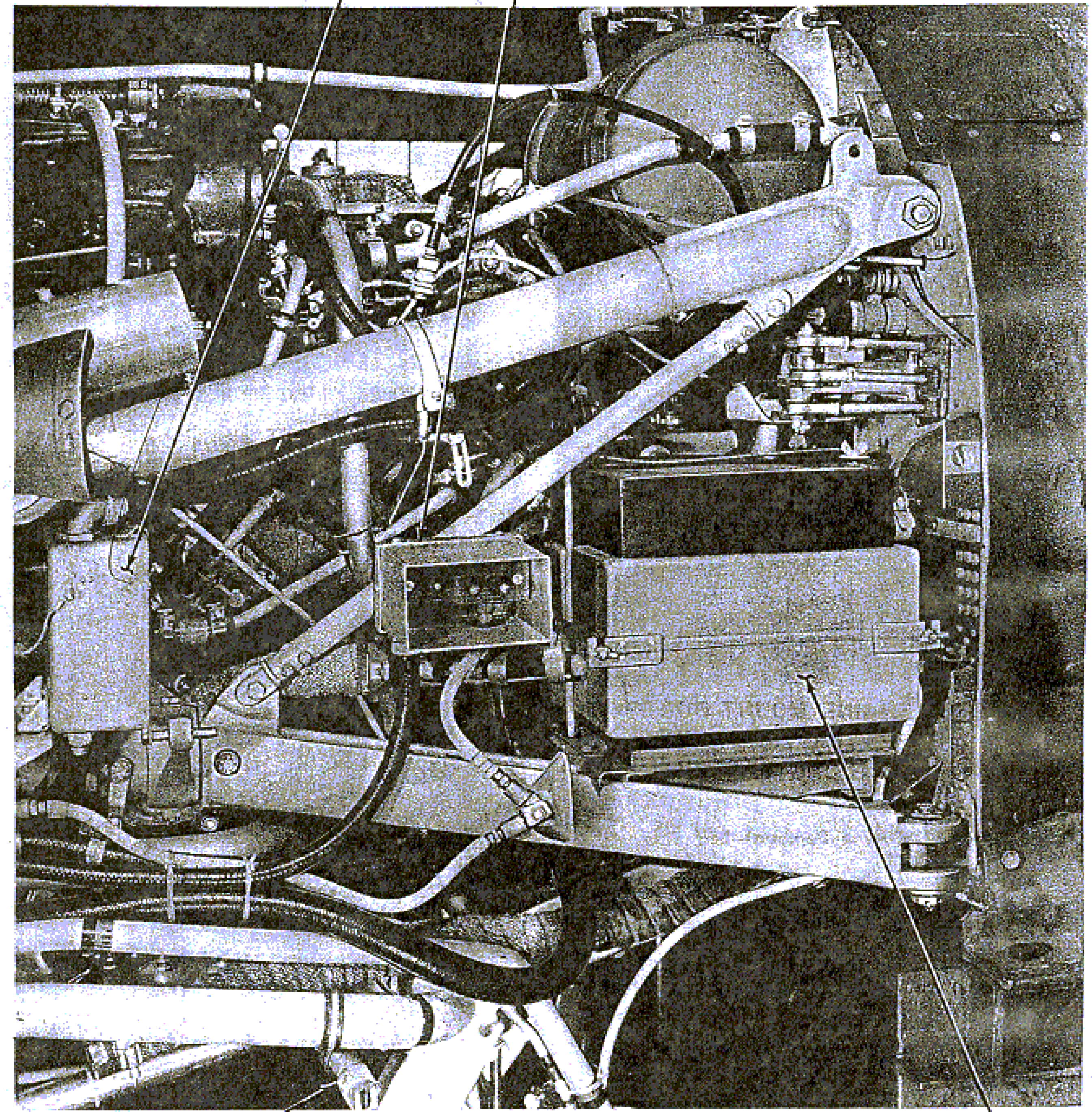
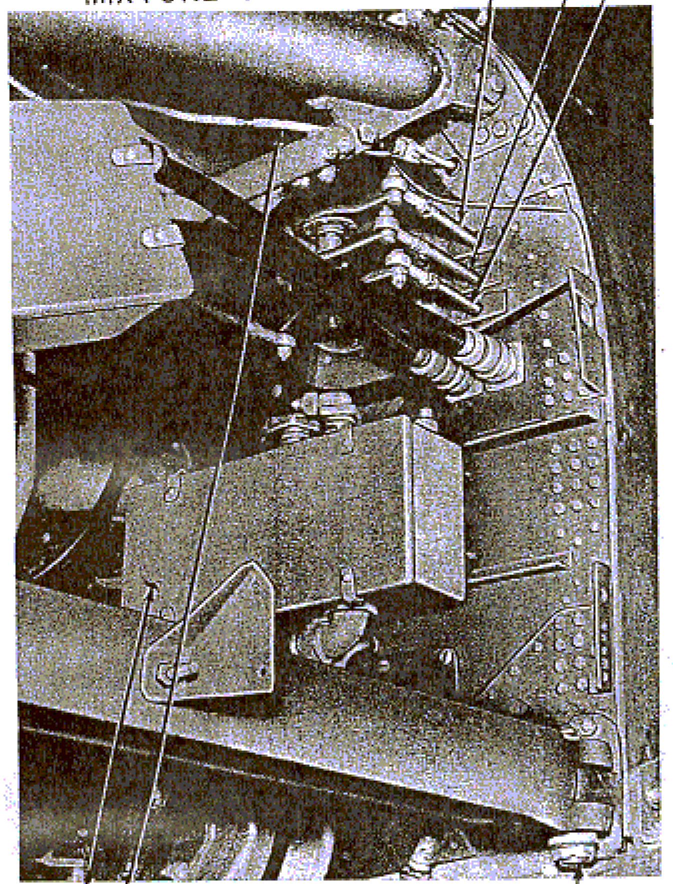
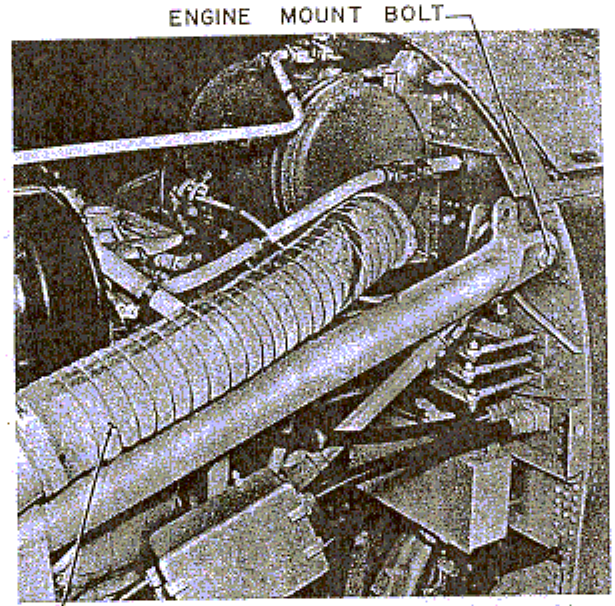


Figure 170—Engine Section—Left Rear Side View





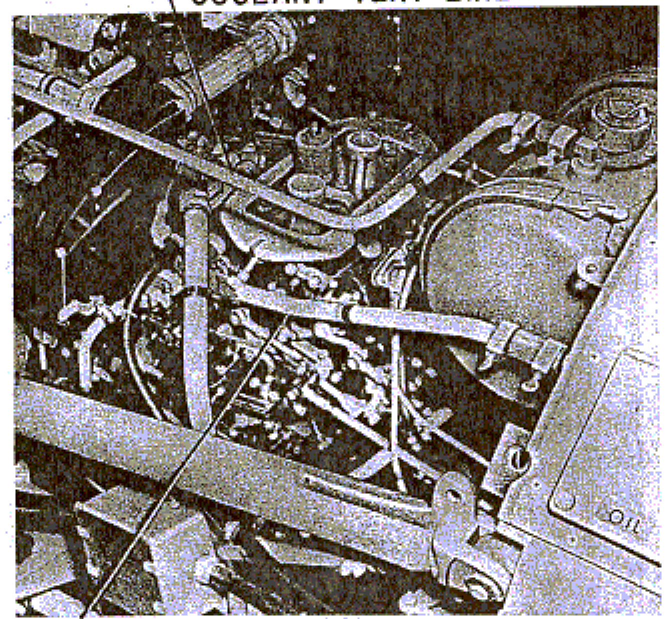


Figure 171—Engine Removal—Left Side

CAUTION

To prevent damage to the electrical wires within the conduit, unscrew the lower serrated nut while holding the center serrated nut. Then remove the electrical connection, cut the safety wire and remove hexagon thermometer bulb.

(*y*) Remove the two bolts holding the cowl flap torque shaft support to the center line bulkhead.

(*z*) Remove the battery from the left engine mount shelf on airplanes with the battery installed in the engine compartment.

(*aa*) Attach an engine hoisting harness to the engine in the manner described in section II, paragraph 4. *c*. (See figure 12.)

Note

The lifting hoist must have a safe capacity of not less than 1-1/2 tons.

(*ab*) Hoist the engine just enough to relieve the engine mount of the engine weight.

(*ac*) Remove the two front bolts from the right and left links, (figure 169) extending from the rear of the engine mount trusses to the center of the firewall.

(*ad*) Remove the four engine mount fuselage bolts from the firewall. Use the engine mount bolt puller provided as a special tool (figure 44).

(*ae*) With the hoist, carefully move the engine and mount forward until all connections are clear.

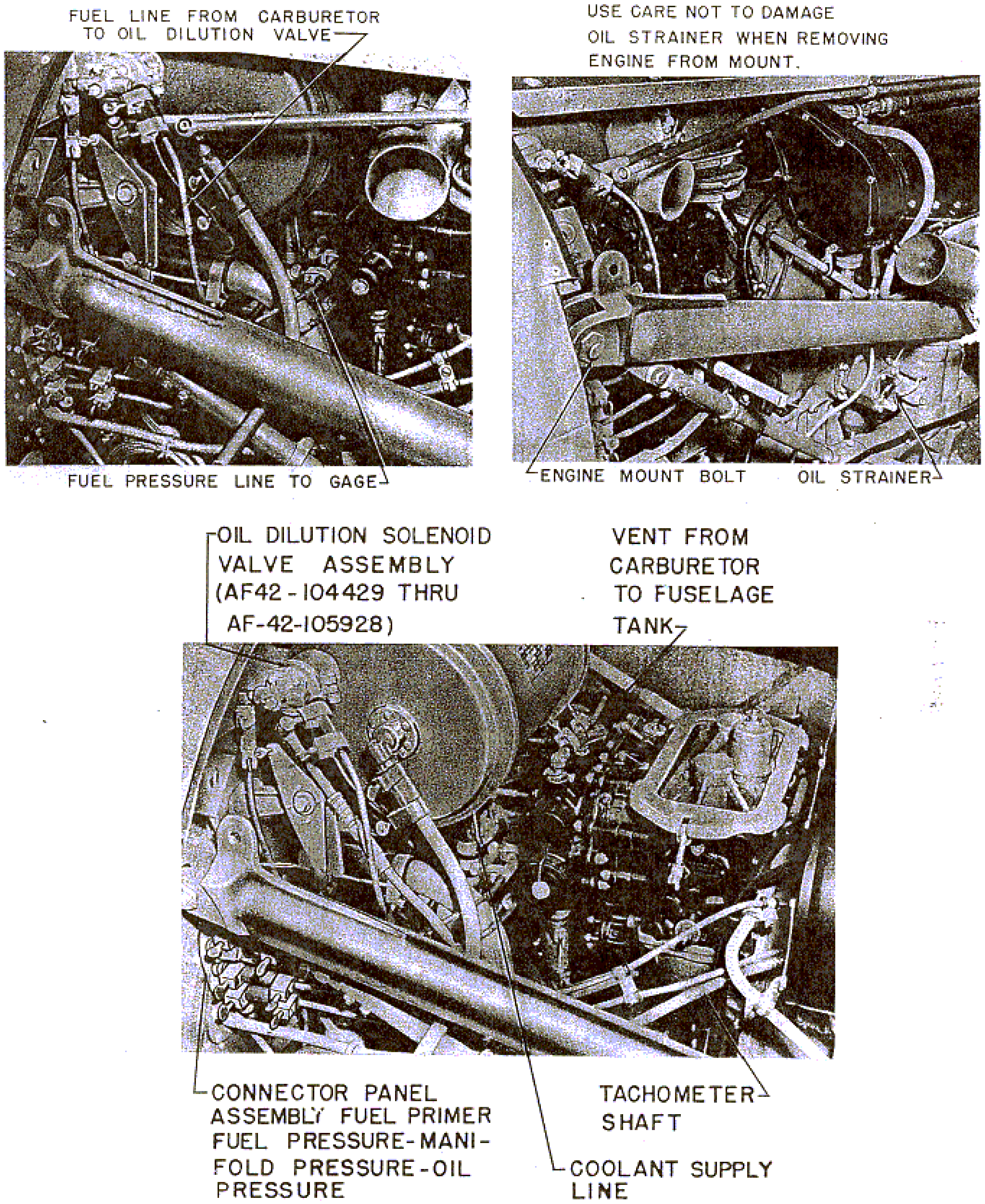


Figure 172—Engine Removal—Right Side

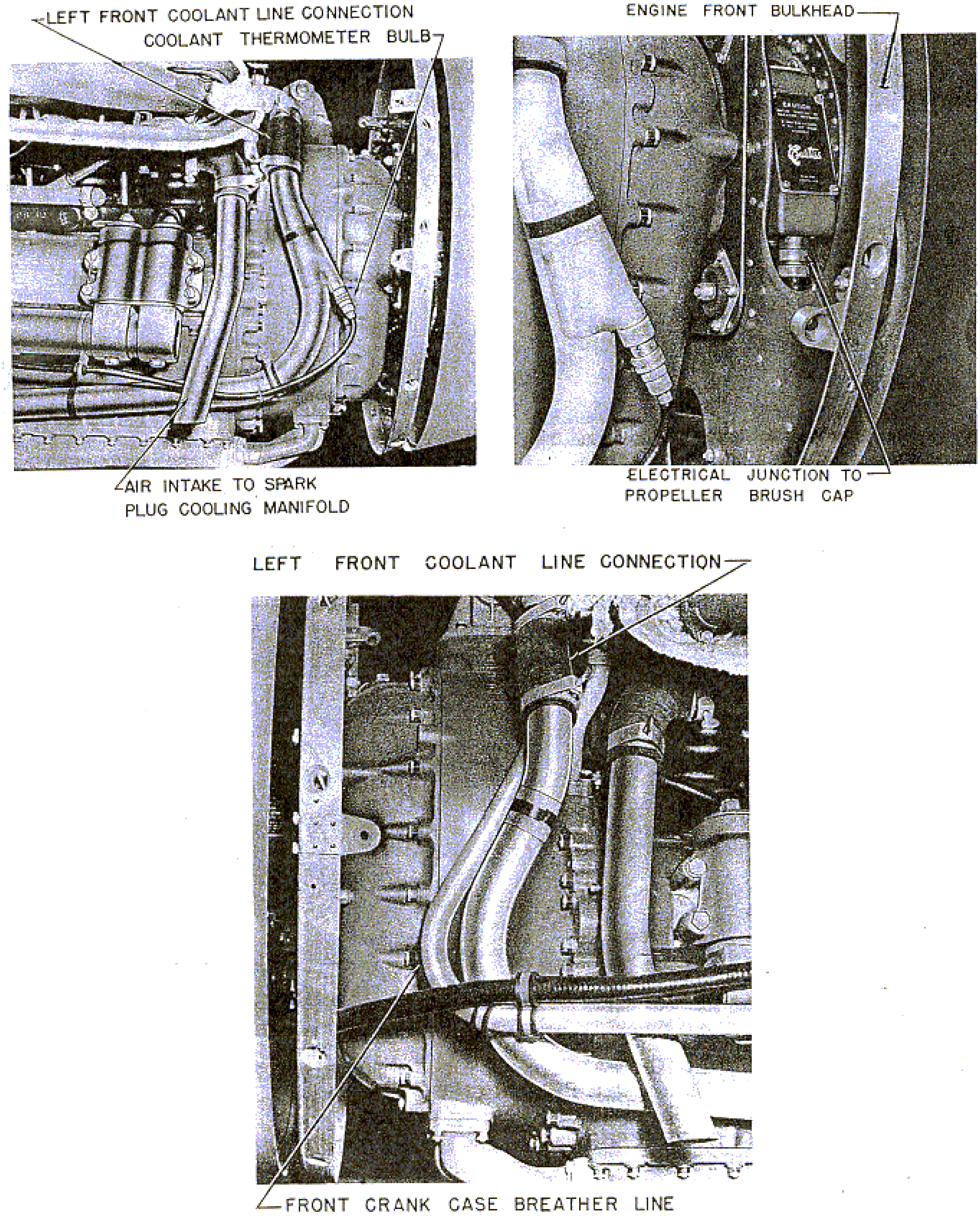
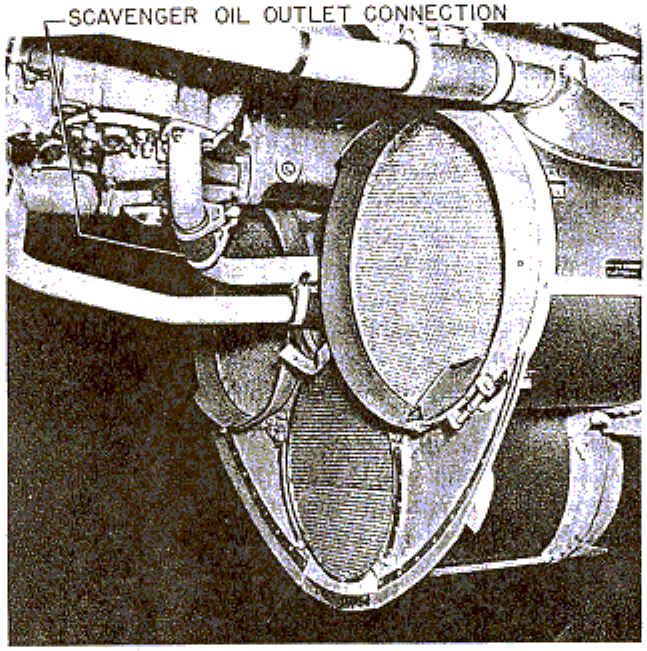


Figure 173—Engine Removal—Front



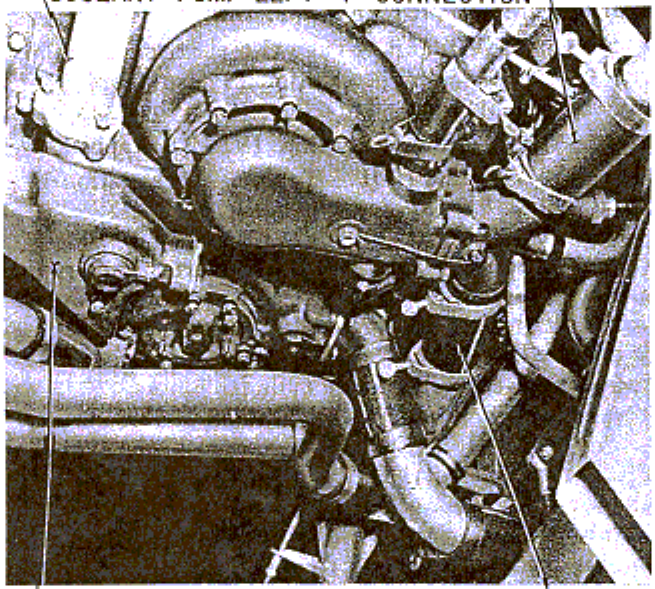


Figure 174—Engine Removal—Bottom

(*af*) Attach the engine to a shop engine stand.

(*ag*) Remove the engine accessories from the accessory-housing on the rear of the engine.

(*ah*) Disconnect all engine mount accessories, wires and tubing from the engine assembly.

(*ai*) Disconnect all oil and coolant lines from the engine and radiators.

(*aj*) Use extreme care in lowering the oil and coolant radiators from the engine mount to prevent possible damage.

(*ak*) Remove the safety wire and the 16 bolts that secure the engine mount vibration absorbers to the engine mounting pads.

(*al*) After the bolts have been removed, guide the engine carefully from the mount, lower it and fasten it to the engine shipping box mounting rails or engine overhaul stand.

(3) INSTALLATION OF ENGINE.

(*a*) If a new or depot-overhauled engine is to be installed, it will be unpacked in accordance with instructions given in section II, paragraph 4, and the first steps of preparation for service will be performed in accordance with section II, paragraph 5.

(*b*) Install the engine accessories on the accessory housing.

(c) Install the exhaust stacks and shrouds.

(*d*) With the engine supported by the engine lifting harness, attach the engine, mount to the mounting pads on the engine. Install and safety wire the 16 bolts securing the four engine vibration absorber support assemblies to the mounting pads.

(*e*) Install the engine on the fuselage. With the front of the engine raised slightly higher than the rear, first, engage the engine mount in the top fittings on the fuselage and hold by inserting drifts or screwdrivers through the bolt holes in the fuselage and engine mount fittings. Next, lower the engine and engage the engine mount in the lower fittings on the fuselage. Remove the drifts from the upper fittings, insert them in lower fittings and raise the engine to align the holes in the upper fittings. Install the two engine mount bolts, one on each side of the airplane, in the upper engine mount and fuselage fittings. Next, align the holes in the lower engine mount and fuselage fittings and install the two engine mount bolts, one on each side of the airplane. Install the two links between the engine mount trusses and the fitting at the center of the firewall.

(*f*) Attach the oil cooler and coolant radiator assembly to the brackets on the engine mount.

(*g*) Connect the oil and coolant lines between the oil cooler and coolant radiators and the engine.

(*h*) Install the cowl flap torque shaft and support on the engine mount and the lugs on the wing center line bulkhead.

(*i*) Connect the coolant temperature indicator electrical conduit at the thermometer bulb in the coolant outlet pipe at the front of the right cylinder block.

(*j*) Connect the carburetor vent line at the hose connection on the left side of the firewall.

(*k*) Connect the engine controls. (See figure 175.)

1. Connect the mixture control rod to the lever on the carburetor.

2. Connect the throttle control rod to the lever on the manifold pressure regulator.

Note

On airplanes powered by the V-1710-99 engine, the throttle control rod is connected to the lever on the automatic engine control unit.

3. Connect the propeller governor control rod to the lower bellcrank on the firewall. (For V-1710-81 engine installation only.)

Note

On airplanes powered by the V-1710-99 engine, the propeller governor control is controlled by the automatic engine control unit.

4. On airplanes AF43-24002 and subsequent, connect the control wire from the manifold pressure modifier lever on the automatic engine control unit to the lower bellcrank on the firewall. The lower bellcrank was used for manual control of the propeller governor on airplanes powered by the V-1710-81 engine. (See step *3*, preceding.)

(*l*) Connect the oil tank vent line to the engine crankcase and accessory housing at the hose connection located at the left of the coolant expansion tank on the forward side of the firewall.

(*m*) Connect the magneto electrical conduit at the receptacle on the left side of the firewall.

(*n*) Connect the propeller control electrical conduit at the receptacle on the left side of the firewall.

(*o*) Connect the electrical conduit at the receptacle on the starting motor.

(*p*) Connect the generator electrical conduit at the receptacle on the generator.

(*q*) Install the fuel line between the electric fuel pump and the engine-driven fuel pump.

(*r*) Connect the coolant thermometer electrical conduit at the receptacle in the junction box on the firewall.

(*s*) Connect the coolant system vent line at the hose connection at the top of the coolant expansion tank.

(*t*) Connect the coolant supply line at the hose connection at the bottom of the coolant expansion tank.

(*u*) Install the starter pull cable.

(*v*) Attach the Adel clamps supporting the left and right distributor drains to the engine mount assembly.

(*w*) Connect the tachometer shaft at the drive located on the right rear of the engine below the distributor housing.

(*x*) Install the oil supply line between the oil "Y" drain valve and the inlet to the engine.

(*y*) Connect the engine oil return line (between the oil cooler and oil tank) at the hose connection on the right side of the coolant expansion tank on the firewall.

(*z*) Connect the 1/4-inch oil dilution lines at the hose connections to the oil dilution valve.

(*aa*) Connect the following lines at the connector panel on the right side of the firewall: two fuel primer lines, one fuel pressure line, one oil pressure line, and one manifold pressure line.

(*ab*) Install the engine front bulkhead on the reduction gear front case.

(*ac*) Attach the propeller control electrical conduit by two clamps to the engine front bulkhead.

(*ad*) Install the propeller and spinner assembly. See section IV, paragraph 6. *d*.

(*ae*) Install the battery in airplanes having the battery installation in the engine compartment.

(*af*) Inspect engine installation for completion before installing the air exit duct and the engine cowling. Be sure that all fuel, oil, coolant, and vent lines are connected and that all electrical connections are made up to this point of installation.

(*ag*) Install the air exit duct. See section IV, paragraph 5. *b*.

(*ah*) Install all engine cowling and the cowl flap assembly. See section IV, paragraph 5. *b*.

b. ENGINE ACCESSORIES.

(1) DESCRIPTION.—All power plant accessories may be removed without removing the engine or any part of the airplane structure. The following accessories are installed on the engine:

(*a*) STARTER.—Type G-6 electric inertia, direct cranking starter. See section IV, paragraph 7. *d*.

(*b*) GENERATOR.—Type M-2, 28.5-volt, 50-ampere generator. See section IV, paragraph 7. *d*.

(*c*) FUEL PUMP.—Type G-9. See section IV, paragraph 6. *b*.

(*d*) PROPELLER GOVERNOR.—100,008-1G (Curtiss Propeller Division). The starter, generator, and fuel pump are mounted on the rear of the engine accessory drive housing and the propeller governor is mounted on the aft side of the reduction gear housing in the vee between the cylinder blocks.

c. POWER PLANT CONTROLS.

(1) ENGINE CONTROLS. *(See figure 175.)*

(*a*) DESCRIPTION.—The engine controls are contained in a conventional engine control quadrant that is attached to the left cockpit wall. The following engine control levers are contained in the quadrant:

For V-1710-81 engine installation (AF42-104429 through AF42-106405): throttle, carburetor mixture, and propeller governor.

For V-1710-99 engine installation (AF42-106406 and subsequent): throttle, carburetor mixture, and economy manifold pressure modifier.

Note

The linkage between the economy manifold pressure modifier control lever (formerly the propeller governor control lever) on the quadrant and the modifier lever on the automatic engine control unit was not installed at the factory in airplanes AF42-106406 through AF43-24001.

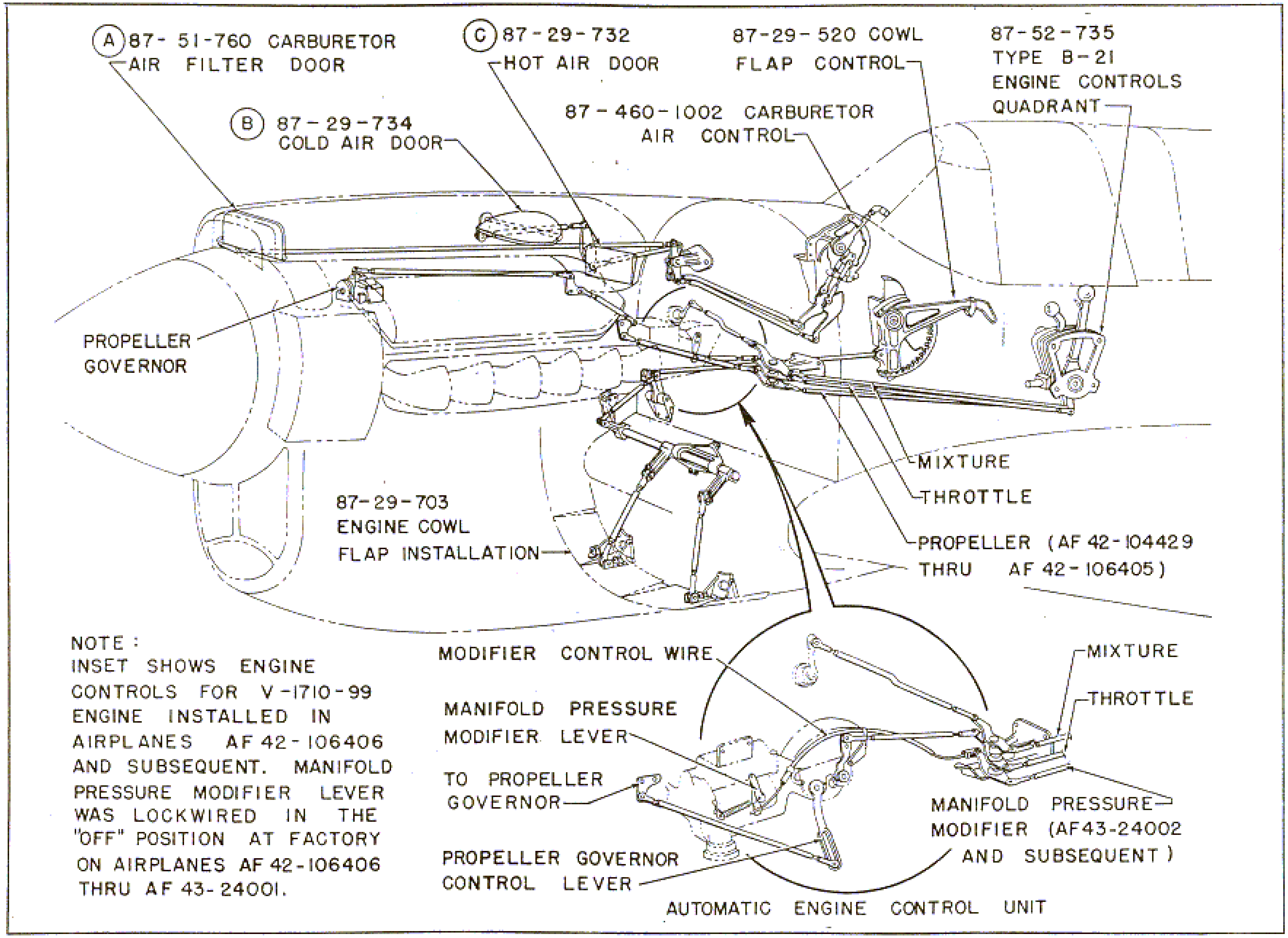


Figure 175—Power Plant Controls

The throttle lever for the V-1710-81 engine installation, is connected to a main lever on the automatic manifold pressure regulator which in turn is connected to a differential lever that is linked to the carburetor throttle. The throttle lever selects the desired manifold pressure and the regulator maintains this pressure within desirable limits from sea level up to the critical altitude of the supercharger. The control of the propeller governor for obtaining the desired engine rpm for the selected manifold pressure is attained through manual setting of the propeller governor control lever on the engine control quadrant.

The throttle lever for the V-1710-99 engine installation, is connected to a main lever on the automatic engine control unit which in turn is connected to a differential lever that is linked to the carburetor throttle. In addition, the main lever is connected through cams to the propeller governor control lever on the engine control unit. The automatic engine control unit coordinates engine rpm with the desired manifold pressure by the operation of the single lever (throttle lever) on the engine control quadrant in the cockpit. Manual control of the propeller governor is eliminated by the automatic engine control unit. The automatic engine control unit performs the function of the automatic manifold pressure regulator, in maintaining a selected manifold pressure, independent of altitude, up to the ceiling of the supercharger, and coordinates the selected manifold pressure with the proper engine rpm.

A stop is provided in the engine control quadrant which limits the throttle setting to 52 in. Hg. at 3000 rpm. When the seal is broken and the throttle is pushed by the stop to the full forward position, war emergency power of 57 in. Hg. at 3000 rpm is obtained.

The economy manifold pressure modifier lever for the V-1710-99 engine installation provides for increasing the manifold pressure above the selected manifold pressure by approximately 10 in. Hg. without changing the throttle setting (or consequently, the engine rpm). The modifier lever on the engine control quadrant (formerly the propeller governor control lever) is connected to the modifier lever on the automatic engine control unit.

(b) ADJUSTMENT OF ENGINE CONTROLS.

1. GENERAL.—All control rods and bellcranks must be accurately adjusted to give full and free movement of the control levers of each respective unit. The linkage must not be bent or rubbing any part of the airplane through the full movement of the controls from the cockpit control quadrant to the carburetor and propeller governor.

2. ADJUSTMENT OF AUTOMATIC ENGINE CONTROL.

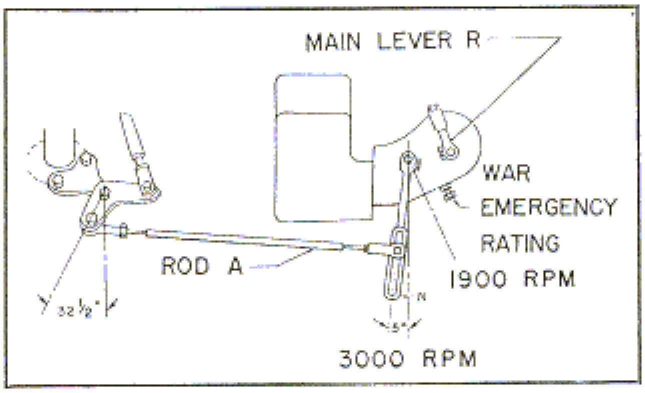


Figure 176—Automatic Control

IMPORTANT

Adjustment of the engine control unit must be accurately made to the dimensions and angles shown in figures 176 and 177.

a. Disconnect rod (A) (figure 176).

b. Move the propeller governor lever clockwise to the 3000 rpm stop.

c. With a protractor measure, make sure that the angles are as shown in figure 176.

d. Place main lever (R) in the extreme counter-clockwise position and check propeller governor control lever (N). As shown in figures 176 and 177, it must be positioned five degrees forward of the vertical center line.

e. If lever (N) is not so positioned change it to the correct position by removing the lever from the splined shaft and replacing it in the next fore or aft splines as found necessary.

Note

The clamp screw at the top of lever (N) must be entirely removed before the lever can be removed from the splined shaft for repositioning.

f. With levers (R) and (N) and the propeller governor lever against its stop they are all in the 3000 rpm position.

g. With the three levers firmly held in these positions reconnect rod (A) as shown in figures 176 and 177.

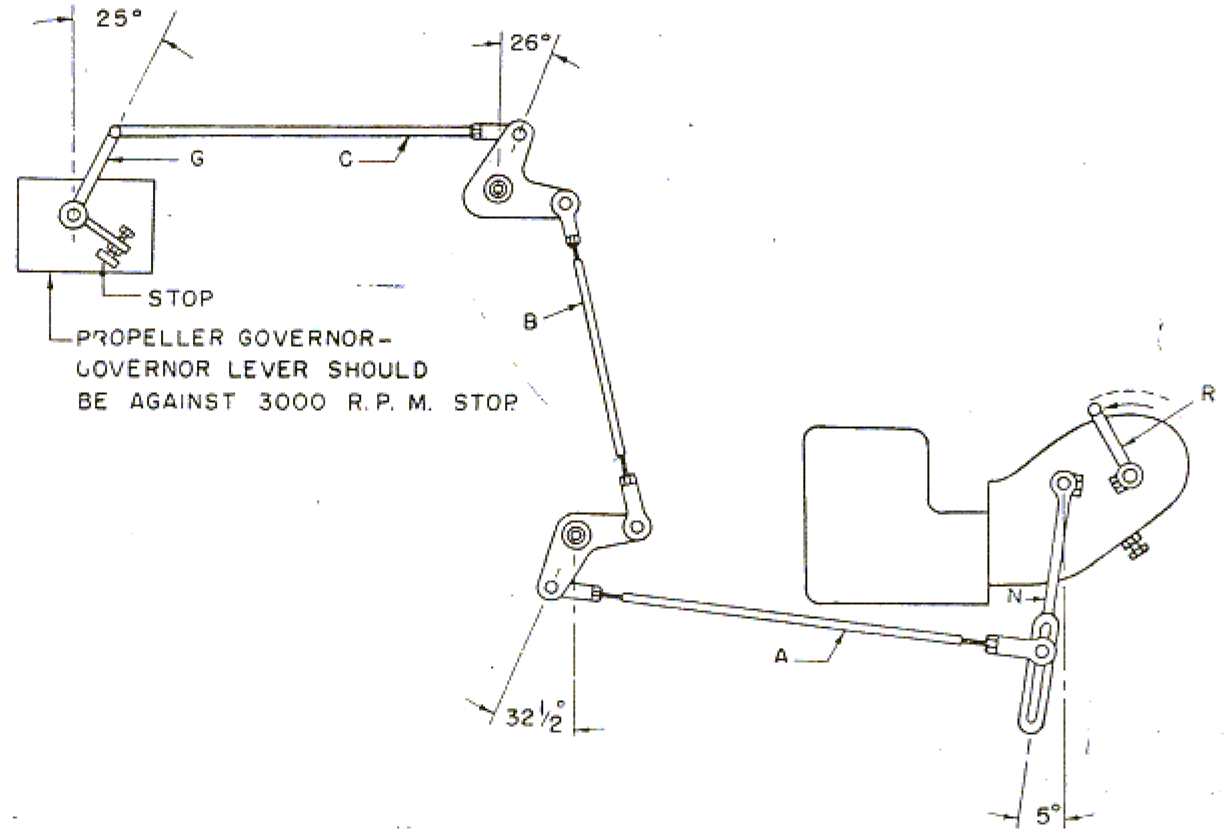
h. In attaching rod (A) to lever (N), position it as shown in figure 178. The mark on the side of the serrated washer must align with the arrow on the side of the lever (N) as in figure 178.

CAUTION

Each serration of error up or down the slot in lever (N) will result in an increase or decrease of nine rpm in engine operation.

i. If the propeller governor lever does not touch its stop when the main lever (R) is rotated fully counter-clockwise lengthen the rod (A) slightly to obtain the contact with the stop.

j. Check the linkage from the main lever (R) to the quadrant in the cockpit. The movement of



IMPORTANT: IT IS RECOMMENDED THAT ADJUSTABLE ENDS OF RODS "B" AND "C" BE PERMANENTLY FIXED BY SOLDERING OR BRAZING TO PREVENT CHANGE OF ADJUSTMENT WHEN SERVICING LINKAGE. DESIRED LEVER "G" CURTISS NO. 88533 HAS 24 SERRATIONS AT HUB PERMITTING ITS SETTING AT 25° ± 7½°. ABOVE ANGLE MAY BE CHECKED BEFORE GOVERNOR IS INSTALLED ON ENGINE.

Figure 177—Automatic Control Linkage

the cockpit throttle lever should provide full movement of the main lever (R) with sufficient cushion at both extremes of the cockpit throttle lever movement. When the cockpit throttle is in the closed position, the carburetor butterfly should be fully closed unless it has been set for idling.

3. ADJUSTMENT OF ECONOMY MANIFOLD PRESSURE MODIFIER.

a. The manifold pressure modifier control is to be adjusted by setting the modifier lever on the automatic engine control unit in the "OFF" position against the "OFF" stop (figure 166), and the manifold pressure modifier lever on the cockpit throttle quadrant in the rear position, allowing 3/16 inch cushion.

b. Tighten the set screw on the engine end of the flexible wire and lockwire.

c. Tighten the set screw in the connecting clevis on bellcrank end of the flexible wire control and lockwire.

d. The movement of the cockpit modifier lever from its aft to forward position in the control quadrant should provide full movement of the automatic engine unit modifier lever from its "OFF" stop to the full "ON" stop.

(2) COWL FLAP CONTROL.

(See figure 175.)

(a) DESCRIPTION.—The cowl flaps are manually controlled by the cowl flap control assembly which is mounted on a bracket attached to the right cockpit wall at station 3. The control lever is con-

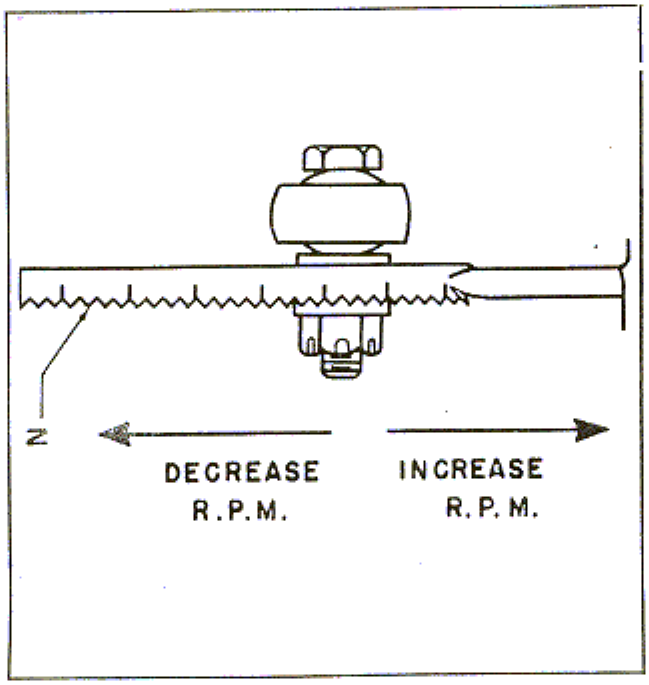


Figure 178—Automatic Control Ratchet

nected by adjustable push-pull rods and bellcranks to a torque which is held by support brackets just forward of the wing leading edge. The cowl flaps, located immediately aft of the forward bottom cowl, are connected by two adjustable links to bellcranks on the torque tube.

The cowl flap control lever may be locked in any selected position by means of a ratchet rack and a finger latch. The finger latch is located near the grip of the control lever. An indicator plate is provided on the control assembly which shows the position at which the control lever should be set for the different operating conditions. The indicator plate is marked: "CLOSED", "HIGH-SPEED", "COMBAT-CLIMB", and "GROUND COOLING". (See figure 29.)

(b) ADJUSTMENT OF COWL FLAP CONTROL.—The control rods, the auxiliary lever assembly and the torque shaft assembly must give full and free movement through the entire arc of its travel.

1. Position the cowl flap control lever so that the finger latch will engage the sixth notch from the aft end of the ratchet rack.

2. Adjust the control rods sufficiently to move the flaps to a contour position with the bottom cowl.

3. Lock and safety all control linkage.

(3) CARBURETOR AIR CONTROL.

(a) DESCRIPTION.—The carburetor air control lever is attached to a bracket on the right upper longeron just aft of fuselage station 3. The single control lever controls the position of three doors in the carburetor air intake duct for admitting either filtered, hot, or cold air to the carburetor. Control of these doors is obtained by a three-way system of push-pull rods and bellcranks connected to the control lever.

The control lever rack has three notches in which the spring-loaded latch of the control lever is engaged to lock the control in either the "FILTERED", "HOT" or "COLD" position. (See figure 28.)

(b) ADJUSTMENT OF CARBURETOR AIR CONTROL.

(See figure 175.)

1. With the air control lever in the filtered or top position in the rack, door (A) must seal in the vertical position and bear tightly against the adjustable stop.

2. Door (A) must seal firmly in the horizontal position when the control lever in the cockpit is in the bottom or cold air position.

3. When the cockpit air control lever is in the center or hot air position, door (A) need not seal tightly.

4. Door (B) must lie flat against stop when the control lever in the cockpit is in either the cold air or filtered air position.

5. Door (B) need not seal when the control lever is in the hot air position.

6. Door (C) must seal firmly when control lever is in either the cold air or the filtered air position.

7. When the adjustments are completed all controls will be locked and safety wired.

d. PROPELLER.

(1) DESCRIPTION.—A Curtiss electric constant speed 11 foot diameter, three-bladed propeller is installed on this airplane.

(2) REMOVAL.—To remove the propeller from the airplane:

(a) Operate the propeller to maximum low pitch.

(b) Remove the right-hand section of the engine cowl and work through the hand holes in the forward engine cowl bulkhead.

Note

The carburetor air filter box installed on the right side of the engine compartment aft of the engine front bulkhead must be removed in order to reach through the handholes in the engine front bulkhead and the spinner aft bulkhead when removing the nose cone. Remove the filter box as follows: Remove the three screws which hold the filter box to the engine front bulkhead. Loosen the clamps at the hose connection between the filter box and the air intake duct on the top cowl. Lift out filter box complete with hose and clamps.

(c) Disconnect the flexible conduit from the brush holder cap assembly.

(d) Remove the safety pin from the top and bottom brush holder latch assembly.

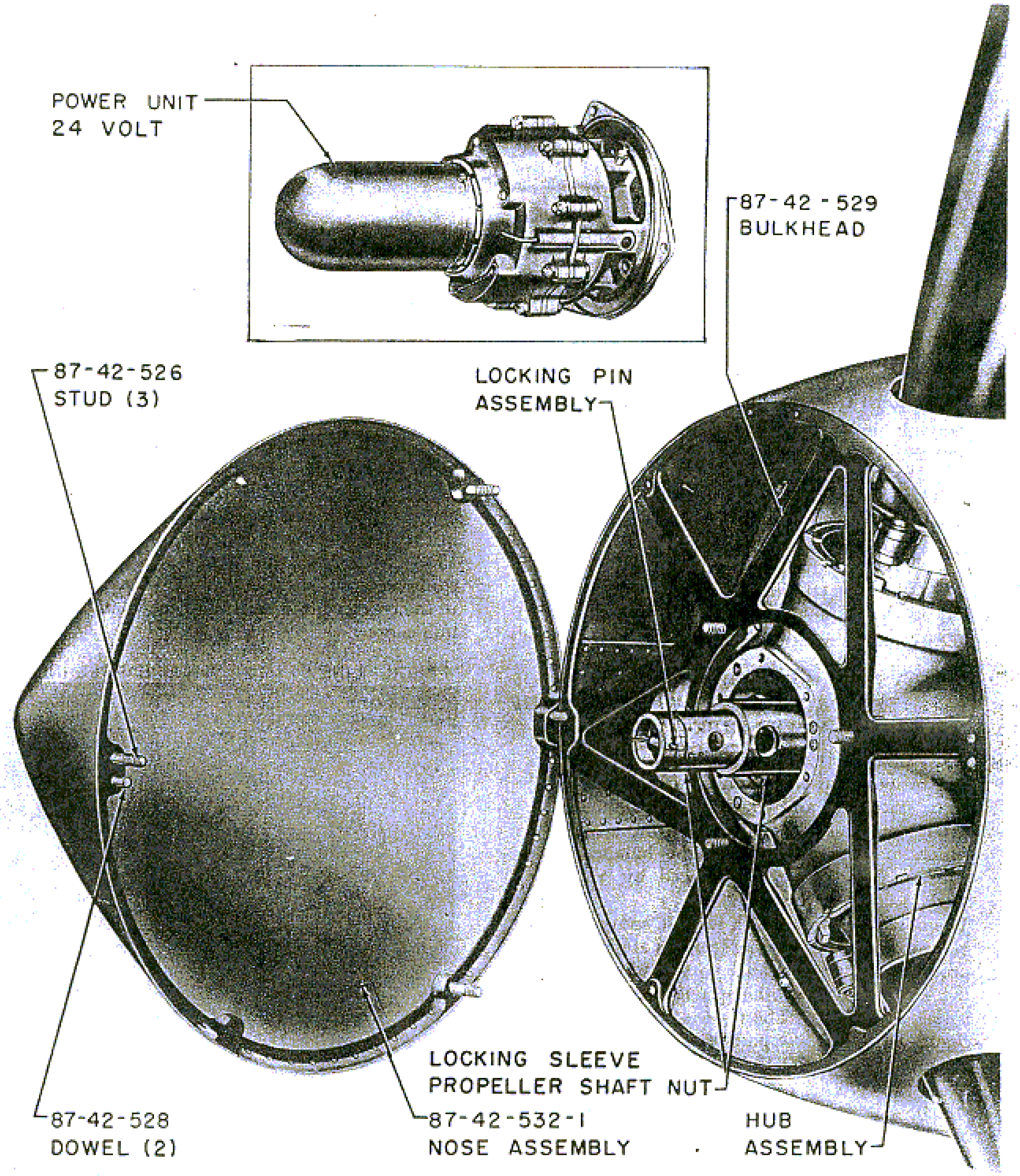


Figure 179—Propeller Assembly—Front View

(e) Raise the brush holder latches and remove the brush holder cap carefully to avoid damage to the brushes.

(f) Remove the three elastic stop nuts attaching the spinner nose cone to the aft section and remove the nose cone.

(g) Remove the cap screws and the three nuts from the flange of the propeller power unit assembly. Remove the power unit assembly, the synthetic rubber seal, and the grease seal from the propeller shaft.

(h) Remove the locking pin assembly and the locking sleeve, install the extension nut with pin, insert a bar completely through the two holes in the nut, and turn the nut off.

(i) The propeller may now be removed from the propeller shaft. Exercise extreme care when removing the propeller to avoid damage to the propeller shaft threads. The propeller weighs approximately 375 pounds. Therefore, it is advisable to use at least three men to remove this assembly. Place the propeller in a suitable buck. NEVER allow the end of the blades to support the weight of the propeller.

(3) TO REMOVE THE AFT SECTION OF THE PROPELLER SPINNER FROM THE PROPELLER HUB.

(a) Remove the ten flush-head screws from the three cover assemblies on the outer surface of the spinner aft section and remove the covers.

(b) Remove the outer circle of screws from the rear of the aft bulkhead. DO NOT DISTURB THE INNER CIRCLE OF BALANCE SCREWS.

(c) Remove the aft section of the spinner from the propeller hub.

(4) TO REMOVE THE AFT BULKHEAD FROM THE PROPELLER HUB.—Remove the nine nuts and bolts from the inner flange of the propeller hub and lift the bulkhead from the hub.

(5) TO ASSEMBLE THE AFT BULKHEAD TO THE PROPELLER HUB.—Place the aft bulkhead in position on the aft side of the propeller hub and install the nine bolts attaching the bulkhead to the hub flange.

(6) TO ASSEMBLE THE AFT SECTION OF THE PROPELLER SPINNER TO THE PROPELLER HUB.

CAUTION

The propeller assembly on each airplane has been statically and dynamically balanced. After any damage whatever to a spinner which may have destroyed the balance, it must be rebalanced or replaced by a correctly balanced spinner.

The nose cone, spinner aft section, spinner aft bulkhead, and the three spinner aft section propeller blade covers are each marked with the serial number of the spinner assembly of which it is a part. These parts are not interchangeable with like parts of any other spinner assembly. Each part of the spinner assembly is marked to facilitate correct assembly which will maintain the static and dynamic balance of the complete assembly: A metal marker on the inside of the spinner aft section must align with a similar metal marker on the front of the spinner aft bulkhead upon assembly; the blade covers and the blade openings in the spinner aft section are marked "A", "B", and "C" and the covers must be installed in the blade opening having the same letter as the cover; the nose cone is dowelled and can be installed only one way.

(a) Install the spinner aft section over the hub and propeller blades. Be sure the marker on the spinner aft section is opposite the marker on the spinner aft bulkhead.

(b) Install the outer circle of screws in the rear of the spinner aft bulkhead attaching the spinner aft section to the bulkhead.

(c) Install the three propeller blade covers in the blade openings in the spinner aft section. Be sure each cover is installed in the opening for which it is marked.

(7) TO ASSEMBLE PROPELLER BLADES TO PROPELLER HUB.

(a) When this assembly takes place, make sure that the threads of the hub and blade are clean and free from any metal chips or other foreign matter. (See figure 182.) Coat the thread with a mixture of 70 percent white lead and 30 percent lubricating oil. Remove the locking plates which have been temporarily installed on the nuts of the loose blades. The No. 1 blade is numbered on the retaining nut and this blade must be assembled in the No. 1 hub barrel. The No. 1 blade is opposite the master spline of the hub, and the No. 2 and No. 3 blades are placed clockwise in the hub as facing the front of the unit. (See figure 182.) Each blade has a gear backlash shim. These shims are not interchangeable. Place the blade shim in the correct hub barrel with the chamfer towards the hub center.

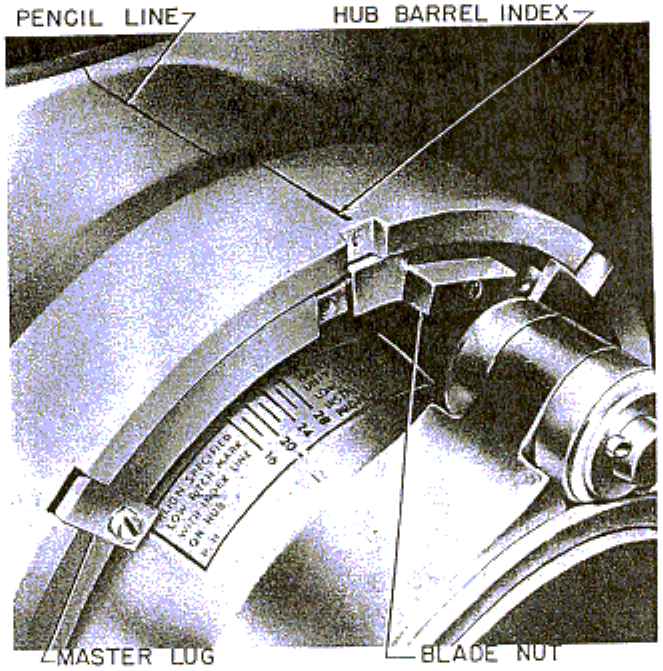


Figure 180—Propeller Hub Indices and Master Lug Slot

(b) MASTER LUG AND BLADE NUT SLOT.—Insert the propeller blade into the hub barrel. Screw each blade nut into the hub until one-half of the threads are engaged. With someone exerting an outward pull on the blade, tighten the blade nut with the spanner wrench provided and approximately

a ten pound brass hammer, until the paint marks on the slots of the blade nut and hub line up. (See figure 180.) If there are no paint marks, tighten the blade nut until it is barely possible to turn the blade by hand. A check should be made with a wooden blade wrench to make sure the blade will rotate after bringing the two slots in line with each other. Insert the lock lug in lined up slots, screw lug into slots securely and lock with lockwire.

Note

The lug which goes into these painted slots is known as the master lug.

(c) HUB BARREL INDICES.—The propeller hub barrels are indexed on the face or front side of hub in order to correctly position the blade sector gear for receiving the power unit. Since the indices on the blade sleeve have proven more or less inaccurate by field personnel, the following method which is now being used, has proven itself simple and sufficiently accurate. Proceed as follows: with the hub and blade assembly on a flat surface, with hub face up, place a straight edge across the face of hub from the hub barrel index to the center of the power unit contact directly opposite on the other side of hub. Draw a straight pencil line along the straight edge from the hub barrel index to the engine shaft opening of the hub. This can be repeated for the second index or hub barrel. When drawing a line for the third index, the line must run between the two power unit contacts which are directly opposite the third barrel. (See figure 180.) After these pencil lines have been drawn, a vertical line is dropped into the engine shaft opening in order to bring the pencil lines close to the teeth of the blade sector gear.

Note

The positioning of the blades is done when the hub and blade assembly is mounted on the engine shaft, otherwise, the setting of the blade sector gears would be disturbed in handling and assembly to engine shaft.

(8) TO ASSEMBLE PROPELLER TO ENGINE SHAFT.

(a) There are two points to make sure of when placing the propeller and hub assembly on engine propeller shaft, namely: make sure that the brushes have been removed from brush housing (remove the two safety pins, unsnap and lift out brush unit) (figure 181) and that the engine propeller shaft has been turned so that the master spline is at the bottom. Have the master spline of the hub at the bottom so that the matching or alignment of these two master splines will be easier to align. (See figure 182.) Clean engine propeller shaft with varnoline and then coat the splines with castor oil. The shaft threads are painted or coated with anti-seize threadlube.

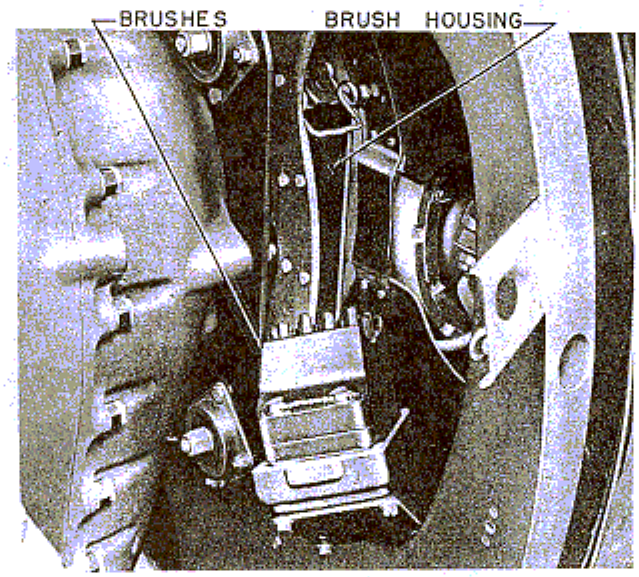


Figure 181—Brushes and Housing

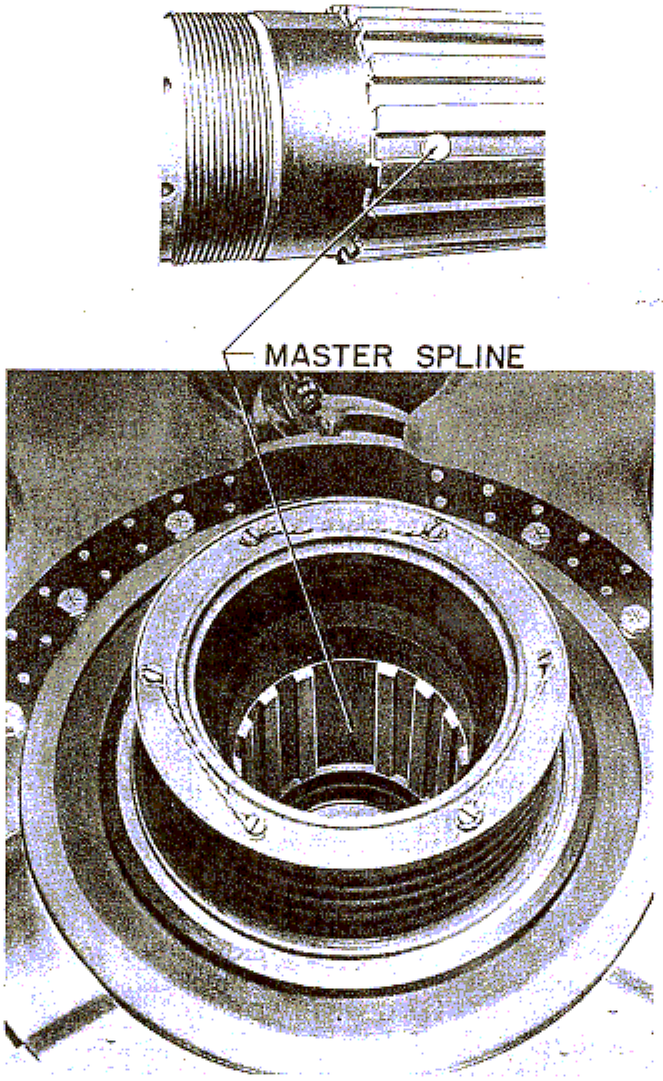


Figure 182—Master Spline

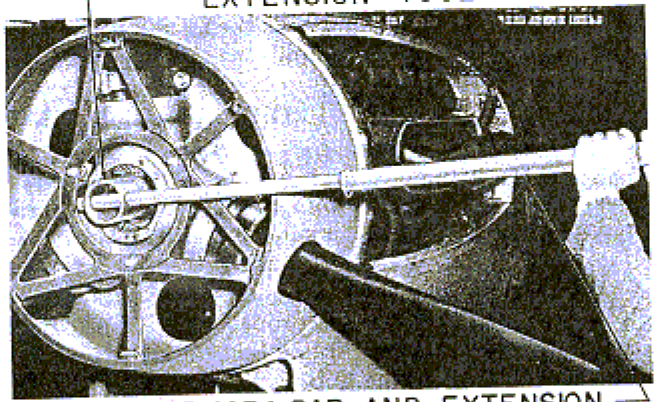


Figure 183—Installing Propeller Shaft Nut

(b) PROPELLER SHAFT NUT.—Just before assembling propeller to engine shaft, install grease seal, split cone, and propeller shaft nut in hub.

Note

The halves of the split cone must be placed over the propeller shaft nut, and the cone and nut are installed as a unit. Place propeller assembly on to propeller shaft and tighten the propeller shaft nut securely with the propeller shaft extension nut provided. Use a round steel bar (approximately four feet long) inserted completely through the two holes of extension nut for this tightening. (See figure 183.) Install propeller shaft locking sleeve and locking pin assembly.

(c) BRUSHES ON HUB SLIP RINGS.—At this point, apply prussian blue to the four top brushes of the brush unit and place brushes back into the brush housing. Snap into place with the top and bottom snaps. Swing the propeller blades backwards and forwards just a trifle, this will show clearly how the brushes are riding on the hub slip rings.

CAUTION

The brushes must not ride the ridges or insulations between the slip rings. If the brushes are not riding the slip rings, shims are provided for installation behind rear cone or brush housing as required. With the brushes correctly positioned, install safety pins into brush housing snaps.

Note

If brushes protrude 3/8 inch or less from brush holder, they should be replaced.

(d) SETTING OF BLADE SECTOR GEAR.—As the propeller blade is rotated into high pitch angle, the leading edge of the third tooth of each blade sector gear is brought up to vertical center line as explained in paragraph (7), *(c)*, preceding. (See figure 184.)

Note

A wooden blade wrench should be used if blades are stiff or difficult to turn.

WARNING

If the blades are not properly set or positioned, the power unit will not mesh into blade sector gears. The above blade positioning is for P-40N series starting with AF42-104429.

(9) TO INSTALL POWER UNIT SEALS AND CONTACT POINTS.

(a) Before assembling power unit to hub, make sure that the felt or grease seal has been dipped in castor oil. This will prevent moisture seeping through the breather holes of power unit housing and severe corrosion inside of power gear. Place felt or grease seal into power gear opening. Place neoprene seal in seal groove of adapter plate just to rear of power gear.

Note

To prevent deterioration, remove and clean this seal each time power unit is removed from hub. Clean the contact points on hub and power unit.

CAUTION

The contact points on the hub must coincide with the contact points in power unit. Place power unit over engine propeller shaft and against the hub. Secure the power unit to the hub with the six attaching bolts and lockwire them together.

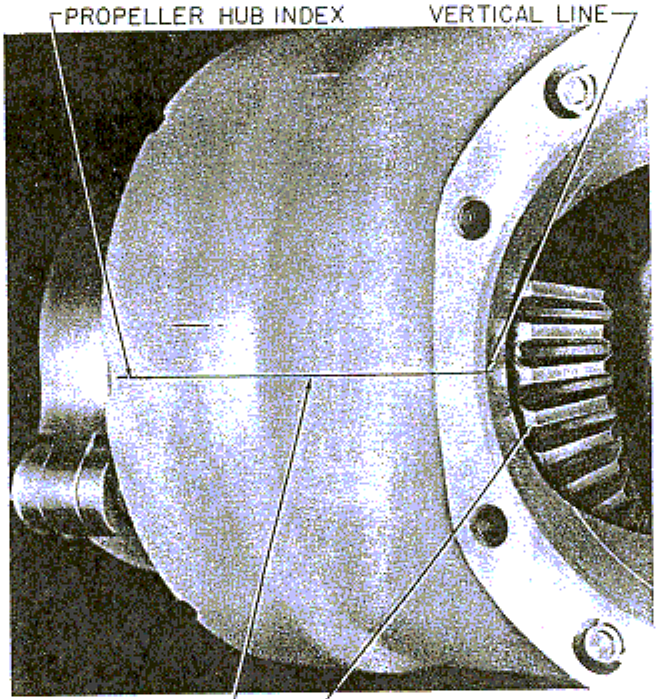


Figure 184—Sector Gears Setting

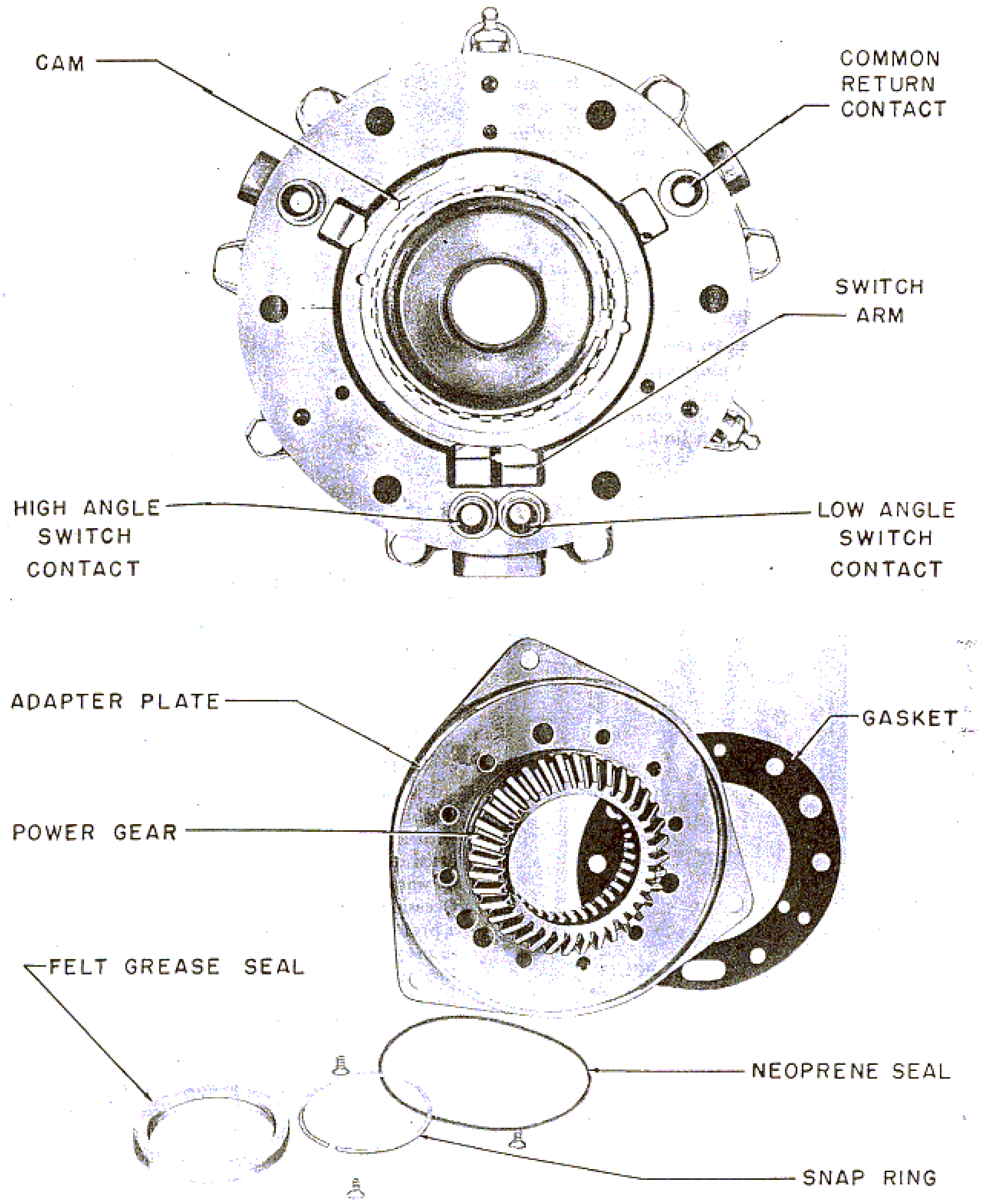


Figure 185—Power Unit Low Pitch Position

(10) TO ASSEMBLE POWER UNIT—LOW PITCH POSITION.

(a) When placing a power unit in the hub, the power unit must be in low pitch position. If there is any question of this low pitch position, proceed as follows: as facing the power gear of the power unit, remove the three countersunk flat head screws and snap ring with a screwdriver. Remove the adapter plate and its gasket. At this point, the cam and contacts are clearly visible. (See figure 185.)

(b) If the low angle cam is not touching the low angle switch contact, the power unit is not in low pitch position.

CAUTION

Unlock and remove the two mechanical low stop plug bolts and stop plug unit. (See figure 186.) This is done to prevent damage to the speed reducer, should the current carry the cam beyond the stop pin limit.

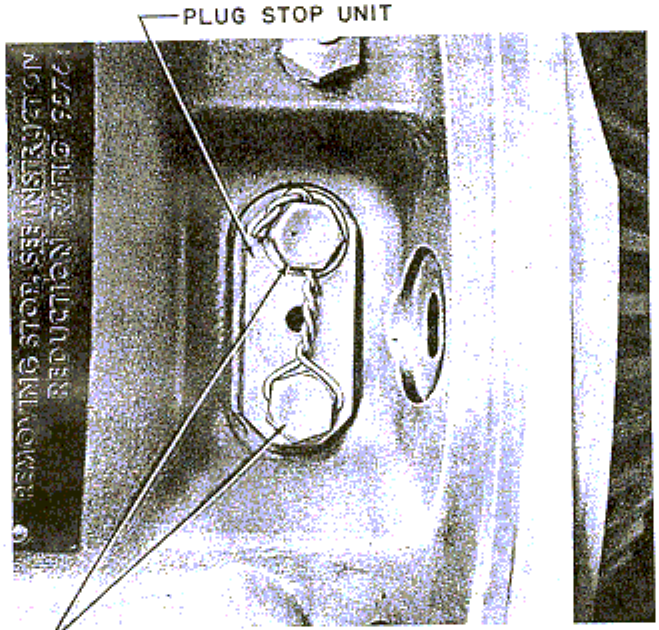


Figure 186—Mechanical Low Stop Plug

(c) Using a 24-volt battery, touch one end of the battery lead to the low angle switch contact. With the other battery lead, make and break contact with the common return contact until the cam just touches the low angle switch contact as illustrated in figure 185. The power unit is now in low pitch position. Replace gasket and adapter plate and fasten with the three countersunk flat head screws. (See figure 185.)

CAUTION

Replace the mechanical low stop plug with the mark "0" (or dot) on stop plug adjacent to mark "0" on housing. Replace stop plug bolts and lockwire together.

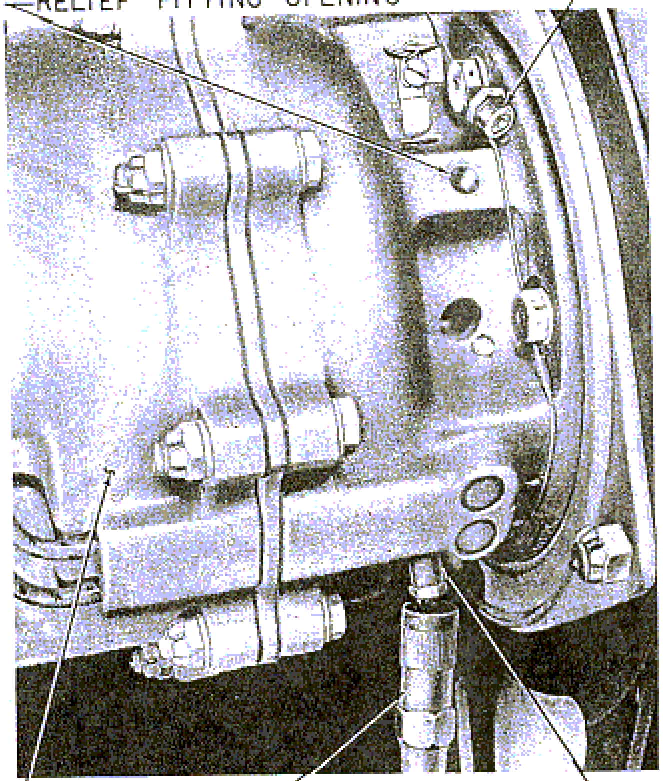


Figure 187—Hub Lubrication

(11) PROPELLER HUB LUBRICATION.

(a) Using the two Zerk fittings alternately, fill the hub with Specification AN-G-4, Grade AA, grease with a pressure gun. These two Zerk fittings are located on the speed reducer (Power Unit) housing just forward of the front hub face. (See figure 187.) Occasionally the grease relief fitting will stick, and as a precautionary measure, the relief fitting is removed to prevent an excessive pressure occurring in the housing resulting in burst seals. (See figure 185.) Fill the hub uniformly, otherwise an air pocket may occur causing the grease to flow out of the relief fitting opening before the hub is completely filled. For airplanes operating in warm climates, it is advisable to use No. 2 grease. Replace relief fitting after hub is completely filled.

(b) POWER UNIT LUBRICATION.—Curtiss speed reducer oil conforming to Specification AN-O-4 is used to lubricate the power unit assembly. This oil level must be checked every 50 hours. Check the oil level as follows: remove the filler plug located near the front of the housing. Rotate the propeller until the plug opening is approximately 20 degrees below the horizontal center line of power unit assembly with the airplane at a ground angle of approximately 12 degrees—or eight degrees below the horizontal center line when the airplane is levelled (tail up). In either

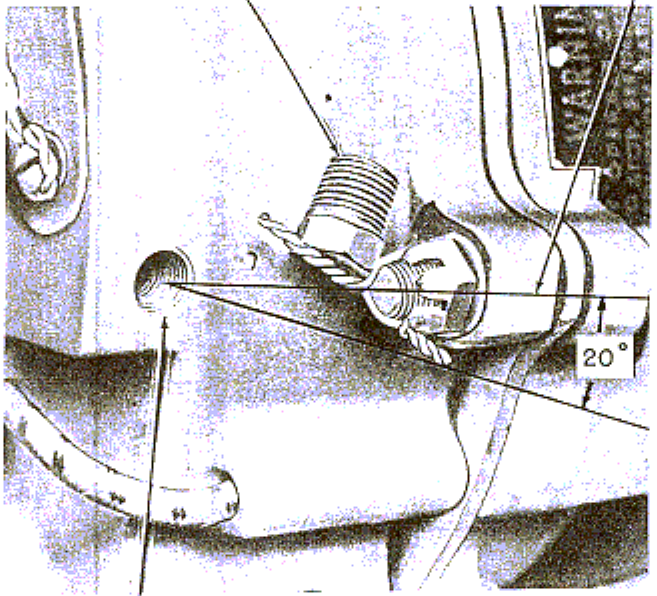


Figure 188—Power Unit Lubrication

of these positions, the oil in the speed reducer should be visible at the plug opening, if not, fill at this plug opening until proper oil level is reached. Replace filler plug and lockwire.

e. STARTING SYSTEM.

(1) Engines in airplanes AF42-104429 through AF42-105639 are equipped with a type B-9 hand inertia starter. When the starter has been energized, the hand crank must be removed before actuating the starter engaging mechanism. Applicable instructions for starting engines equipped with the B-9 starter are given in section III, paragraph 3, *a,* (2).

(2) Engines in airplanes AF42-105640 and subsequent, are equipped with a type G-6, 24-volt combination electric inertia, direct cranking starter. See section IV, paragraph 7, *d,* (8).

f. COOLING SYSTEM.

(1) GENERAL DESCRIPTION. *(See figure 189.)*—The engine is liquid cooled, using ethylene glycol, Specification AN-E-2, as the coolant liquid. A centrifugal coolant pump located on the bottom of the accessories housing supplies coolant to each cylinder block at two inlets, one located at the coolant jacket and the other at the rear of the cylinder head. The outlet scroll of the pump terminates in a tee with two flanged ends, and is connected by pipe to the dual inlets of each cylinder block. The coolant is admitted to the bottom of the cylinder block through an inlet manifold which is cast the full length of each jacket. These manifolds have an orifice at each cylinder barrel which meters the coolant flow. The inlet at the rear of the cylinder head provides a direct rapid flow over the combustion chambers. The coolant leaves the engine through the outlet in front of the cylinder head and is conveyed through pipes to the coolant radiators where the heat is dissipated before it is returned to the coolant pump and recirculated through the engine. A coolant expansion tank mounted at the highest position on the firewall provides a head and insures a constant supply of coolant liquid to the pump.

(2) COOLANT EXPANSION TANK.

(a) DESCRIPTION. *(See figure 190.)*

1. The coolant expansion tank is attached by a strap and bracket assembly to the forward top center part of the firewall. It has a total capacity of 3.5 US (2.9 Imperial) gallons. The filler cap is on top of the expansion tank and is accessible through an access door in the top engine cowl. The top forward part of each cylinder block is vented directly to the expansion tank. The overboard vent line extends from the filler assembly on the top of the tank through the tank to the right side and out through the right side engine cowl.

2. In airplanes AF42-104429 through AF42-104828, a spring-loaded pressure relief valve is incorporated in the filler cap. This valve opens when the pressure in the cooling system exceeds the atmospheric pressure by 15 pounds per square inch. Excess pressure is vented through the overboard vent line. A small vacuum relief valve is provided in the filler assembly and opens when the atmospheric pressure exceeds the pressure in the system. (See detail A, figure 190.)

3. In airplanes AF42-104829 and subsequent, an altitude compensated pressure relief valve is incorporated in the filler cap. Altitude compensation is accomplished by means of a sealed bellows which is highly evacuated. Atmospheric air pressure tends to collapse the bellows which in turn decreases the effective spring force that seats the valve.

In the normal spring-loaded valve described in paragraph *2,* preceding, a decrease in atmospheric pressure allows the cooling system relief valve to open at a lower absolute pressure. However, in the case of this altitude compensating relief valve, the decreasing atmospheric pressure relieves the collapsing pressure on the sealed bellows, hence the internal spring is able to provide more force to seat the valve. The increasing force being directly proportional to the decreasing atmospheric pressure will maintain a constant absolute cooling system pressure, fulfilling the function of this valve. This valve opens at 23 pounds per square inch absolute pressure. Absolute pressure is equal to gage pressure (pressure in cooling system) plus atmospheric pressure. Example: At sea level, with standard atmospheric pressure of 14.7 pounds per square inch, this valve should open when the pressure in the cooling system reaches 8.3 pounds per square inch gage. Excess pressure is vented through the overboard vent line. A small vacuum valve also in the filler cap connects the vent passage directly to the tank and opens when the

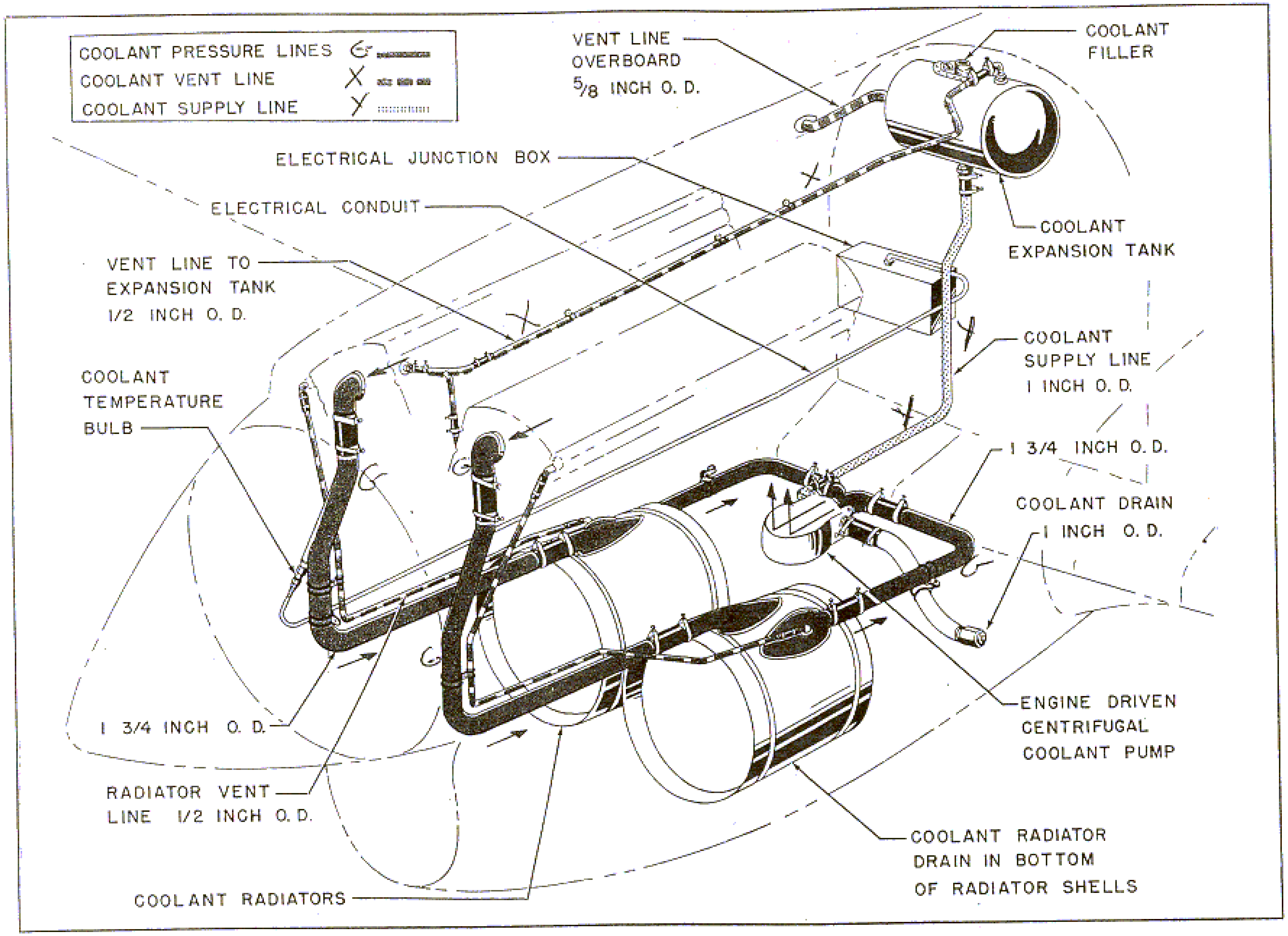


Figure 189—Cooling System

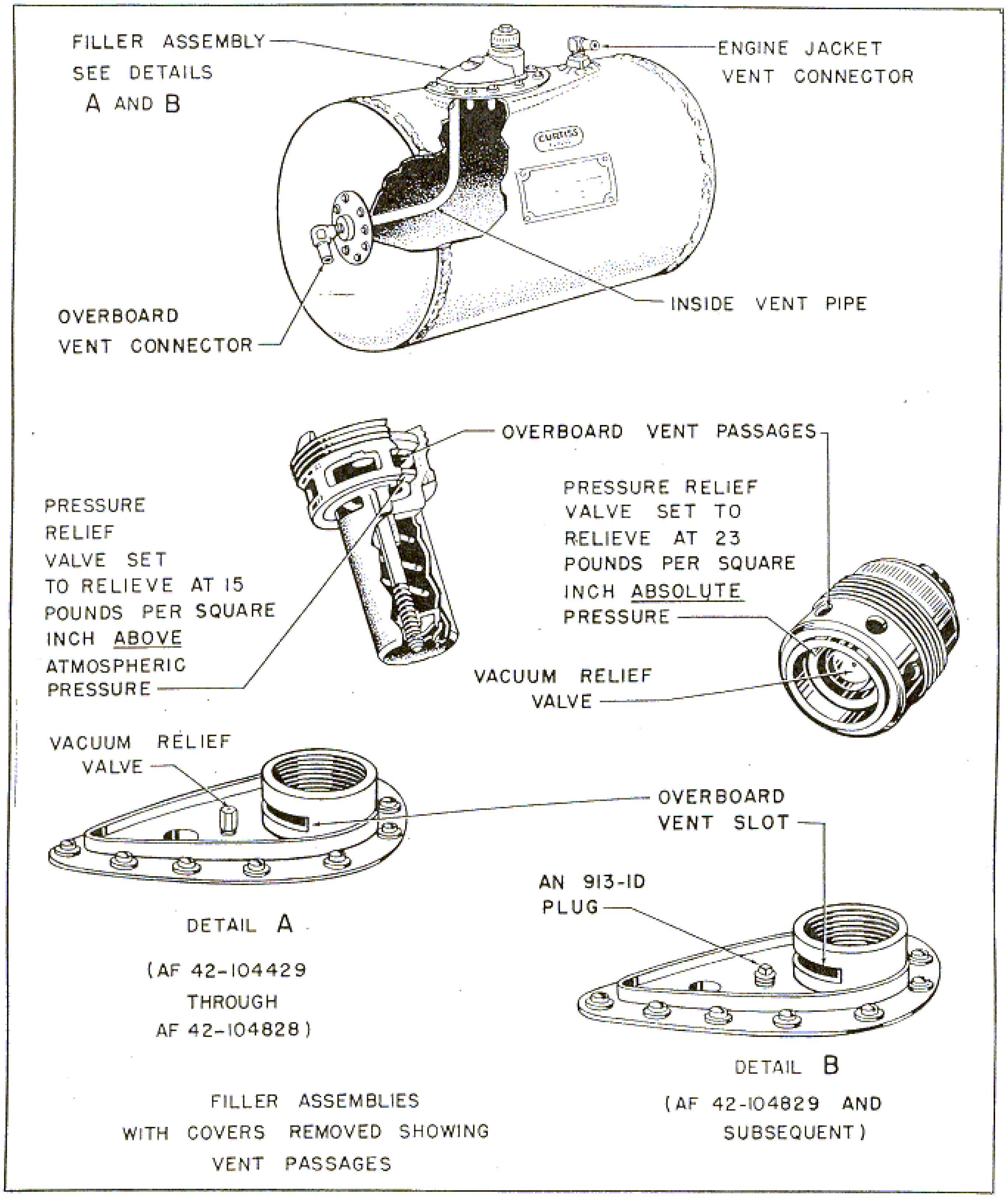


Figure 190—Coolant Expansion Tank Details

atmospheric pressure exceeds the tank pressure by one pound per square inch gage or less. (See detail B, figure 190.)

(b) REMOVAL OF COOLANT EXPANSION TANK.

1. Remove the top and side engine cowls. Remove the skin from the left rear side cowl in order to gain access to the coolant pump drain line.

2. Drain the coolant system at the plug on the end of the coolant pump drain line. (See figure 170.) The filler cap on top of the coolant expansion tank should be removed to speed drainage, and the airplane in its normal three-point ground position.

3. Disconnect the coolant vent line at the top of the expansion tank.

4. Disconnect the overboard vent line at the right end of the expansion tank.

5. Disconnect the coolant supply line from the tank fitting under the expansion tank.

6. Disconnect the two top connections of the strap assembly holding the expansion tank to the firewall, and remove the tank.

(c) REPAIR OF COOLANT EXPANSION TANK.—The coolant expansion tank may be repaired by employing the same precautions in cleaning and using the same methods for repair as outlined for the oil tank in section IV, paragraph 6, *g*. After the tank is repaired, test the tank under water with 20 pounds per square inch air pressure.

(d) INSTALLATION OF COOLANT EXPANSION TANK.

1. Reinstall the coolant expansion tank by replacing it in the strap assembly that supports the tank on the firewall.

2. Connect the coolant supply line at the hose connection under the expansion tank.

3. Connect the overboard vent line at the hose connection on the right side of the tank.

4. Connect the coolant vent line at the hose connection at the top of the tank.

5. Replace the drain plug in the end of the coolant pump drain. Tighten the plug and safety wire.

6. Replace the top and side engine cowl. Replace the skin of the left rear side cowl.

(3) COOLANT PUMP.—The coolant pump is a centrifugal type mounted on the bottom of the engine accessory housing and driven by the accessory gear train. The coolant pump drain pipe and plug are attached to the left side of the coolant pump body. The drain plug is safety wired to the drain pipe. (See figure 170.)

(4) COOLANT RADIATORS.

(a) DESCRIPTION.—Two coolant radiators, contained in a support and strap assembly, are hung on four shock absorbing mounting brackets which are installed on the engine mount. The coolant radiators are equipped with either aluminum alloy or copper tube cores. The radiators are vented to the front of each cylinder block to avoid air locks in the radiators.

(b) REMOVAL OF COOLANT RADIATORS.—The oil cooler and coolant radiators may be removed from the airplane as one complete assembly, or each unit may be removed separately.

1. TO REMOVE ONE RADIATOR.

a. Remove the side and forward bottom engine cowls. See section IV, paragraph 5, *b*.

b. Drain the coolant system through the two drain plugs, one in the bottom of each coolant radiator.

c. Remove the safety pin and loosen the turnbuckle which holds the air seal on the ring of the air exit duct. Separate the seal from the exit duct.

d. Disconnect the radiator vent line at the hose connection on the radiator.

e. Disconnect the two coolant lines at the hose connections on the radiator.

f. Remove the one bolt attaching the cooler duct bulkhead assembly to the bracket on the coolant radiator.

g. Remove the nuts from the four bolts which hold the radiator strap assembly to the radiator support. Remove the strap assembly and remove the coolant radiator from the airplane.

2. TO REMOVE THE OIL COOLER AND COOLANT RADIATORS AS AN ASSEMBLY.

a. Remove the side and forward bottom engine cowls. See section IV, paragraph 5, *b*. Drain the coolant system through the two drain plugs, one in the bottom of each coolant radiator.

b. Drain the oil system at the oil "Y" drain valve and the oil cooler drain plug.

c. Remove the three screws from the canvas air seal at forward end of the air exit duct.

d. Remove the safety pins and loosen the turnbuckles which hold the air seals on the air exit duct rings. Separate the air seal from the exit duct.

e. Disconnect the two oil lines from the oil cooler at their hose connections. Reach the hose clamps through the access door in the left side of the air exit duct.

f. Disconnect the vent line from each coolant radiator at the hose connection on the radiator.

g. Disconnect the two coolant lines from each coolant radiator.

h. Remove the two bolts from each of the four radiator mounting brackets and remove the complete oil cooler and coolant radiator assembly from the airplane.

(c) REPAIR OF COOLANT RADIATOR.

1. On airplanes equipped with 87-50-015 brass coolant radiators, the following repair information is applicable:

a. Clean the radiator core with steam for 1/2 hour just before making any repairs. The steam should pass downward into the internal passages with the radiator so placed that the condensation will drain freely from the bottom.

b. During the cleaning operation, the core air passages must be cleaned of all foreign matter with a long core brush and steam or compressed air.

c. Visually inspect the coolant radiators for the following conditions:

(1) Tube leaks.

(2) Core surface leaks.

(3) Surface leaks between the core and shell assembly.

(4) Dents in core or shell.

(5) Bullet holes in core or shell.

d. Test for invisible leaks. Submerge the radiator in warm water with all openings closed and apply air pressure, not to exceed 50 pounds per square inch. Bubbles will emerge from the points where leaks are located.

e. Surface leaks on the face of the core or between the core and shell assembly should be repaired with a soldering iron instead of a radiator torch as excessive heat may loosen other soldered joints or burn the core metal.

f. When emergency repairs are necessary, individual tubes up to 20 may be plugged temporarily.

2. On airplanes equipped with 87-440-1015 aluminum alloy coolant radiators, the only repair possible is to plug leaky tubes up to a maximum of 60.

(d) INSTALLATION OF COOLANT RADIATORS.

1. TO INSTALL ONE RADIATOR.

a. Place the coolant radiator in the support, install the radiator support strap pad under the straps, where necessary, and install the straps which hold the radiator in the support.

Note

The strap pad consists of a piece of 1/4 inch thick sponge neoprene or equivalent material cut to the width of the strap and about 11 inches long.

b. Install the bolt attaching the cooler duct bulkhead assembly to the bracket on the coolant radiator.

c. Connect the two coolant lines at the hose connections on the radiator.

d. Connect the radiator vent line at the hose connection on the radiator.

e. Pull the air seal over the ring of the air exit duct, tighten the turnbuckle and safety wire.

f. Be sure the drain plugs or drain cocks in the coolant radiators are safety wired.

g. Fill the coolant system. See section IV, paragraph 6, *f*, (5), following.

h. Install the side and forward bottom engine cowls. See section IV, paragraph 5, *b*.

2. TO INSTALL THE OIL COOLER AND COOLANT RADIATORS AS AN ASSEMBLY.

a. Assemble the oil cooler and coolant radiators and install as one assembly.

b. Lift the complete radiator assembly in position and install the eight bolts attaching the assembly to the four radiator mounting brackets on the engine mount.

c. Connect the two coolant lines at the hose connections on each coolant radiator.

d. Connect the coolant radiator vent line at hose connection on each radiator.

e. Connect the two oil lines to the oil cooler at their hose connections near the cooler.

f. Install the air seals over the air exit duct rings. Tighten and install the safety pins in the turnbuckles.

g. Install the three screws attaching the canvas air seal to the forward end of the air exit duct.

h. Be sure the oil "Y" drain valve is closed and the drain plugs or drain cocks in the oil cooler and coolant radiators are safety wired.

i. Fill the coolant system. See section IV, paragraph 6, *f*, (5), following.

j. Fill the oil system. See section IV, paragraph 6, *g*.

k. Install the side and bottom engine cowls. See section IV, paragraph 5, *b*.

(5) FILLING THE COOLING SYSTEM.

(a) A certain amount of air will be left in the forward cylinder jackets when filling the cooling system in the three-point position. Consequently the expansion tank must be filled to the top. The system will hold approximately 15.5 US (12.9 Imperial) gallons.

(b) Inspect entire coolant system for possible leaks.

(c) Replace the filler cap on top of the coolant expansion tank and secure it with safety wire.

g. LUBRICATION SYSTEM.

(1) GENERAL DESCRIPTION.

(a) OIL FLOW THROUGH ENGINE.

1. The oil flows from the bottom of the oil tank through a supply line in which is incorporated the "Y" drain cock to the oil inlet connection on the engine. It is circulated by one pressure pump and returned to the oil tank by two scavenging pumps of the conventional spur-gear type.

2. The oil supplied to the pressure pump from the oil tank is delivered to the exterior of the disc-type oil strainer through a spring-loaded check valve, which prevents oil flow from the tank to the system when the engine is not running. A pressure of only one pound per square inch from oil pump side of the valve is necessary to provide check valve response in opening.

3. The oil strainer is equipped with a safety by-pass valve set to open at a pressure of 100 pounds per square inch.

4. Oil pressure at the outlet of the oil strainer is transmitted to the piston of the adjustable relief valve, which by-passes excess oil directly from

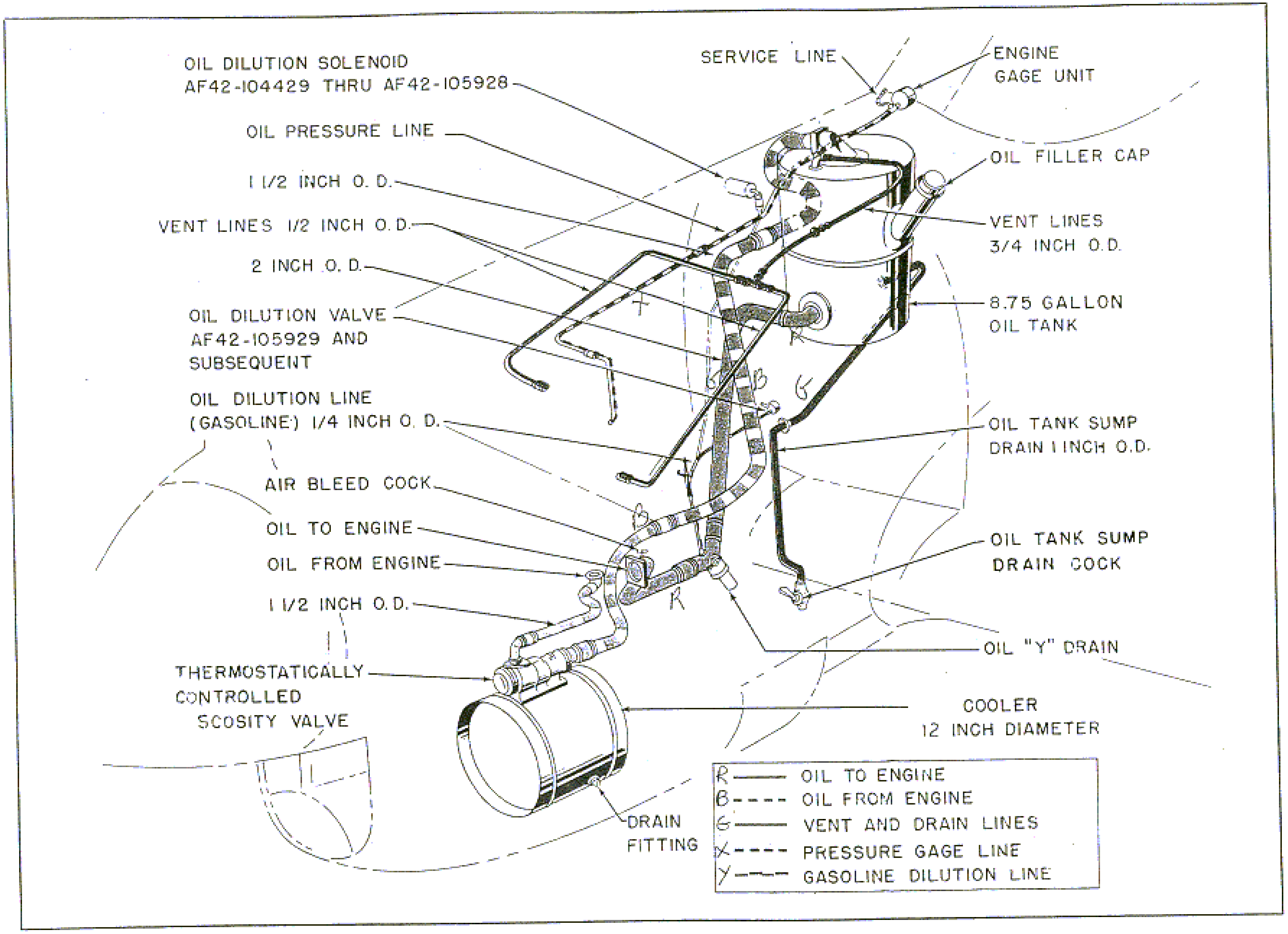


Figure 191—Engine Lubricating System

the outlet to the inlet of the pressure pump. This arrangement maintains a constant oil pressure in the engine. The relief valve is accessible, for cleaning or oil pressure adjustment, without removal of the oil pump.

5. Oil is distributed from the strainer outlet to the moving parts of the engine. A large tube in the crankcase upper half is connected to a drilled passage in each main bearing web, conveying oil to the main bearings. The main bearings and crankpin journals are fitted with aluminum alloy plugs and are all interconnected to carry oil to the connecting rod bearings from which it is thrown to lubricate the cylinder walls and the piston pins. A continuation of this tube provides oil for the bearings of the reduction gear pinion, the spray on the reduction gear, the propeller governor, and the governor drive bearings.

6. A branch from the lead to the crankcase tube carries oil to the inclined shafts of the camshaft drive and to the magneto drive shaft bearing. Oil is carried through the inclined shafts to the camshaft locating bearing where it enters the hollow camshaft for lubrication of the camshaft bearings and the valve mechanism from a hole in each journal and in the heel of each cam.

7. Three oil passages distribute oil from the oil strainer outlet to the supercharger and all accessory drives contained in the accessories housing.

8. Oil drains through passages at both ends of the camshaft compartment to the crankcase. In level or propeller-end-up positions, all oil drains to the oil pan and is scavenged by the main scavenge pump from the accessories and of the oil pan. The second scavenge pump is located in the reduction gear housing and is driven by the oil plug of the reduction gear pinion. Its inlet is located low in the forward portion of the reduction gear housing so that oil will be scavenged in near vertical positions. The discharge from the forward scavenge pump is carried to the outlet of the main scavenge pump so there is but one oil outlet to the engine.

9. The scavenge pumps circulate the oil from the engine oil outlet through the oil temperature-regulator, the oil cooler and back to the oil tank.

(2) OIL COOLER.—The oil cooler (sometimes referred to as the oil temperature regulator) is contained in a support and strap assembly under the two coolant radiators. A thermostatically controlled rotary type oil temperature control valve mounted on top of the oil cooler controls the flow of oil from the engine through the oil cooler. In operation, the helix bimetal thermostat rotates the rotary valve, allowing the tempered oil to flow through the warm-up passages or to the core section of the oil cooler depending upon the operating conditions. The oil cooler is equipped with either an aluminum alloy or a copper tube core.

(3) OIL COOLER BLANKET. *(See figure 192.)* —A one inch oil cooler blanket ring, part No. 87-46-721, is provided as loose equipment. The blanket ring

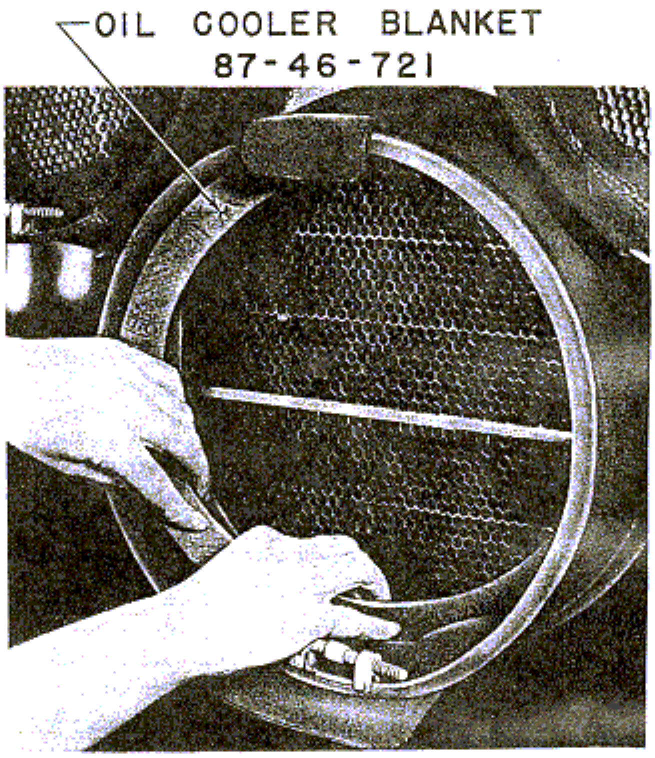


Figure 192—Installing Oil Cooler Blanket

is installed simply by placing it inside the oil cooler housing against the front face of the core. The air pressure will hold it in place. The blanket ring prevents the flow of cold air through the outer portion of the oil cooler core and thus keeps the oil warm and permits it to circulate more freely. The oil cooler blanket ring should be installed when the ground air temperature is −9°C (+15.8°F) or below. If for any reason the engine oil temperature is in excess of 90°C (194°F) the oil cooler blanket should be removed.

(4) OIL TANK.

(a) DESCRIPTION.—The oil tank is located aft of the firewall and forward of the armor plate installation at station 2 and is accessible by removing the fuselage cover between the firewall and windshield. The oil tank contains a hopper which keeps the oil in circulation and returns the same oil to the engine without mixing it with all the oil in the tank, but withdrawing additional fresh oil from the tank as needed. This is an aid in warming up the engine and also helps in oil dilution. Two vent tubes, one from the right and the other from the left side of the engine, connect to the tank at a single union. The oil tank is equipped with a pendulum assembly at the oil outlet which has a travel vertically of 75 degrees and horizontally of 15 degrees either side of the pendulum

center line. The pendulum assembly is designed so that the mouth of the pendulum is always below the oil level in the tank regardless of the flight attitude of the airplane, thus insuring a constant supply of oil to the engine oil pump.

The tank capacity is 8.75 US (7.3 Imperial) gallons. The tank should be filled to the top of the filler neck before each flight. The filler cap is reached by means of an access door on the left top of the fuselage forward of the windshield. (See figure 25.)

(b) REMOVAL OF OIL TANK.

1. Drain the oil tank through the oil "Y" drain valve and the oil tank sump drain.

Note

The oil "Y" drain and the oil tank sump drain are accessible through the two access doors, marked "OIL DRAIN" that are located in the air exit duct just aft of the cowl flaps.

2. Drain the oil cooler.

Note

The oil cooler drain plug is accessible through the access door marked "OIL DRAIN—COOLANT DRAIN" on the bottom of the "bath tub" cowl.

3. Remove the fuselage forward plate cover between stations 1 and 2.

4. Disconnect the vent and the oil return line at the top of the oil tank. Disconnect these same two lines at a point forward of the firewall and below the coolant tank and remove these lines from the firewall.

5. In the cockpit, remove the gun sight and the gun sight support by removing the four bolts which hold the gun sight support to the armor plate.

6. Disconnect the engine oil supply line at the elbow on the bottom of the tank.

7. Disconnect the elbow fitting at the tank.

8. Disconnect the oil tank sump drain on the lower rear of the tank.

9. Detach the upper cradle assembly by removing the four nuts holding it to the firewall and armor plate.

10. Remove the filler cap and pull the scupper off the filler neck.

11. Remove the tank from the padded mountings in the lower cradle by raising it up straight.

(c) REMOVAL AND DISASSEMBLY OF OIL TANK PENDULUM.

1. Remove the ten screws that fasten the bottom inspection cover to the tank plate and remove the cover.

2. Hold the pendulum assembly with one hand through the bottom inspection hole while removing the six screws which attach the pendulum assembly to the oil outlet plate.

3. Carefully remove the pendulum assembly through the inspection hole. If disassembling more than one pendulum at a time, it is very important to keep the parts of each assembly together because of the close tolerance of the parts, insuring a snug fit of the base of the pendulum and a complete freedom of movement of the pendulum without binding in its operation.

4. The pendulum may now be disassembled by removing the three nuts that fasten the base to the pendulum.

(d) REPAIR OF OIL TANK.

1. Minor damage to the tank skin can be successfully repaired wherever soldering or welding equipment is available. Whenever structural damage has occurred to a tank, send it to a repair depot where the necessary equipment is available for such repairs.

2. To eliminate danger from possible ignition of explosive gases when repairing aircraft oil tanks, the following precautions must be taken:

a. No repairs requiring the application of heat will be attempted on oil tanks installed in an airplane.

b. After removal the oil tank will be flushed for 15 minutes with hot water entering at the bottom of the tank and overflowing at the top.

c. After flushing with hot water, clean the oil tank with live steam, passing the steam through the tank for a minimum period of one hour. The tank will be mounted so that there is an opening at the top and one at the bottom, at the lowest point of the tank. The live steam will be fed in at the top opening and allowed to escape through the bottom opening. All other openings will be closed.

WARNING

Never use a hot soldering iron to solder oil tanks without using the previously described steam-cleaning method or the following warm water method. A hot iron could ignite explosive gases.

d. Flush hot water through the bottom of the tank and out the top for a minimum period of one hour. Plug all openings except the one nearest the damaged portion of the tank and fill nearly full with warm water.

Position the tank so that the unplugged opening and the damaged surface will be at the top.

With the tank in this position add water nearly up to the hole or crack to be repaired so that no space will be left for the formation of explosive gases. The tank may then be safely soldered or welded.

e. When the exterior of the oil tank is to be cleaned with paint remover or any combustible solvents, this cleaning will be done prior to flushing or steaming of the interior of the tank.

f. The repair work should be done as soon as possible after the tank has been cleaned. Under no circumstances will a tank that has been flushed or steam-cleaned be allowed to stand more than 30 minutes before being repaired. Tanks that are allowed to stand in excess of this period will be recleaned before applying any heat.

g. Welding of oil tanks that have contained oil will not be attempted near any combustible materials or in any building containing such materials.

3. Failure in an oil tank can usually be repaired by simply welding the crack. The paint coatings should first be removed for a distance of at least three inches all around the crack. This can be done by the application of paint remover.

4. Drill a small hole (3/64 to 1/16 inch in diameter) at each end of the crack to prevent its progression under the welding heat or after the tank is again in service. The welding can then be accomplished, using an oxygen-hydrogen flame. The flame should be adjusted to a neutral condition with the hydrogen gage set about five pounds per square inch above the oxygen gage. A filler rod of the same material as the tank shell can be used, although five percent silicon rod, if available, is generally easier to handle and gives better results in complicated welds. United States Aluminum Company Flux 22, or equivalent, should be used. It is mixed to a paste condition with water, the surface to be welded is coated with it, and the rod dipped in it. Enough heat should be applied to form a bead on the inside of the joint being welded, but care should be exercised to prevent melting holes in the material. A good practice to follow is to weld from each end of a crack toward the center to prevent the crack's progressing ahead of the flame.

5. Before installing the oil tank in the airplane, test the tank under warm water with five pounds per square inch air pressure in the tank.

(e) ASSEMBLY AND INSTALLATION OF OIL TANK PENDULUM.

1. Replace the three nuts that fasten the base to the pendulum.

2. Carefully replace the pendulum assembly through the inspection hole.

3. Hold the pendulum assembly with one hand while replacing the six screws which attach the pendulum assembly to the outer plate.

4. Replace the cover and ten screws that fasten the bottom inspection cover to the tank plate.

(f) INSTALLATION OF OIL TANK.

1. Dry and clean the inside of the tank with compressed air.

2. Lower this tank on the padded and asbestos covered mountings in the fuselage.

3. Replace the scupper on the filler neck and the filler cap.

4. Attach the cradle assembly to the fuselage by replacing the four nuts holding it in place.

5. Connect the oil tank sump drain on the lower rear of the tank.

6. Connect the elbow fitting at the bottom of the tank.

7. Connect the engine oil supply line to the elbow on the bottom of the tank.

8. Connect the vent and oil return lines at the top of the oil tank and at a point forward of the firewall and below the coolant tank.

9. Replace the gun sight and gun sight support with the four bolts holding the gun sight support to the armor plate.

10. Tighten and safety wire all connections.

11. Replace the fuselage forward plate cover between stations 1 and 2.

12. Close the "Y" and sump drain cocks and safety wire.

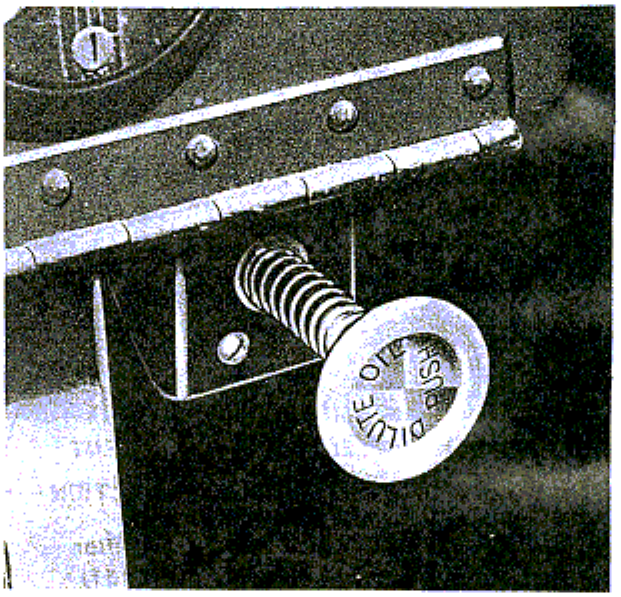


Figure 193—Oil Dilution Control

(5) OIL DILUTION SYSTEM.

(a) An electrically operated oil dilution valve is installed on the upper right side of the firewall on airplanes AF42-104429 through AF42-105928. (See figure 172.) The valve is operated by a solenoid which is controlled by a switch on the main switch panel.

(b) A manually operated oil dilution valve is installed on the lower center of the firewall on airplanes AF42-105929 and subsequent. The valve is controlled from the cockpit by a push-pull control under the main switch panel. (See figure 193.)

(c) The oil dilution valve introduces fuel obtained from the carburetor into the oil inlet line at the oil "Y" drain valve. The oil dilution system is operated when a cold weather start is anticipated. Proper oil dilution procedure for the P-40N series airplanes is given in Technical Order 01-25CN-30, Cold Weather Operations and Maintenance Instructions for the P-40N Series Airplanes.

(6) OIL PRESSURE TRANSMITTER.

(a) DESCRIPTION.—For airplanes AF42--105929 through AF43-23151 the type A-1 diaphragm type oil pressure transmitter is installed and is attached to the right engine mount. (See figure 194.) The purpose of the transmitter is to transmit the engine oil pressure to the gage unit on the instrument through a liquid medium having low viscosity. The line between the oil pressure gage and the transmitter

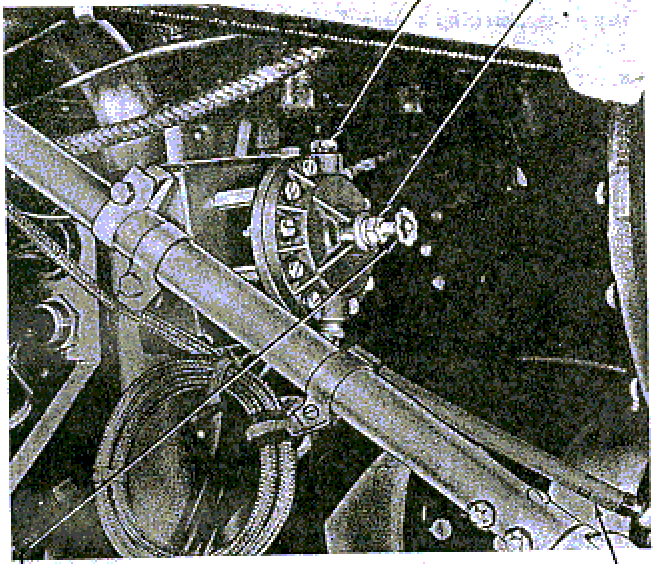


Figure 194—Oil Pressure Transmitter (AF42-105929 through AF43-23151)

is serviced with compass liquid, Specification AN-VV-C-551; the line between the transmitter and the pressure connection on the engine is serviced with hydraulic fluid, Specification AN-VV-O-366 (red color). For AF43-23152 and subsequent airplanes, the transmitter is not installed. Instead, the oil pressure line is serviced with hydraulic fluid, Specification AN-VV-O-366. This line is filled by means of a hand gun through the oil gage service fitting on the right side of the instrument panel.

(*b*) SERVICING THE OIL PRESSURE TRANSMITTER.

1. To fill the transmitter chamber with compass liquid, unscrew the lock nut (5) from the threaded portion of the shaft. Then push the shaft in to the full limit towards the center of the transmitter assembly. Turn the thumbwheel (6) clockwise until the backing plate at the end of the shaft is set firmly against the diaphragm as shown in figure 195.

2. To gain access to the bleeder cap (C) of the oil pressure gage line, remove the two retaining screws in the top of the instrument panel and tip the panel assembly aft to obtain sufficient hand space.

3. Remove the bleeder cap (1) and install a threaded bleeder tube (2) in place of the cap just removed. Allow the other end of the bleeder tube to terminate in small bleeding liquid receptable (3).

4. Fill the small hand gun (7) with compass liquid, Specification AN-VV-C-551 and attach at (8) on the transmitter. Slowly operate the hand gun to force the liquid up through the transmitter and the oil pressure gage line and out through the bleeder tube into the receptacle. With the bleeder tube below the surface of the liquid in the receptacle, operate the hand gun until all air is expelled from the line and the compass liquid flows evenly out the bleeder tube. Disconnect the bleeder tube (2) and reinstall the cap (1). Disconnect the hand gun from the filler connection (8) of the transmitter and replace the cap.

5. Return the diaphragm backing plate to its normal position by turning the thumbwheel (6) counterclockwise until the shaft can be pulled out. Tighten the lock nut (5).

6. Return the instrument panel to its original position and install the retaining screws.

7. To fill the transmitter chamber on the opposite side of the diaphragm and the engine oil pressure inlet line with hydraulic fluid proceed as follows:

a. Disconnect the engine oil pressure inlet line (H) at the connection on the engine.

b. Remove the plug (4) at the top of the transmitter front chamber, and using a hand oil squirt can containing hydraulic fluid, Specification AN-VV-0-366 (red color), inject the fluid into the transmitter chamber allowing it to flow through the chamber and out the oil pressure line.

c. When the fluid flow is established and clean, reconnect the engine oil pressure line (9), and continue to inject the fluid until the chamber and the line are filled. Replace the plug (4) and safety wire. The transmitter is now ready for operation.

8. The transmitter must be serviced every 50 hours flying time with a new diaphragm and fluid in both chambers.

CAUTION

To prevent possible danger to the diaphragm, the pressure used to inject the compass liquid must not exceed 20 pounds per square inch. The use of compressed air filling tanks is not advised, as air entering the system with liquid will cause malfunctioning in service.

(7) FILLING THE OIL SYSTEM.—When the oil system is completely drained, the following procedure is recommended. Fill the tank to the top of the filler neck. Start the engine, run until the oil temperature is approximately 70°C (158°F), wait five minutes, and then check the oil level. If necessary, make additions to bring the level up to the neck.

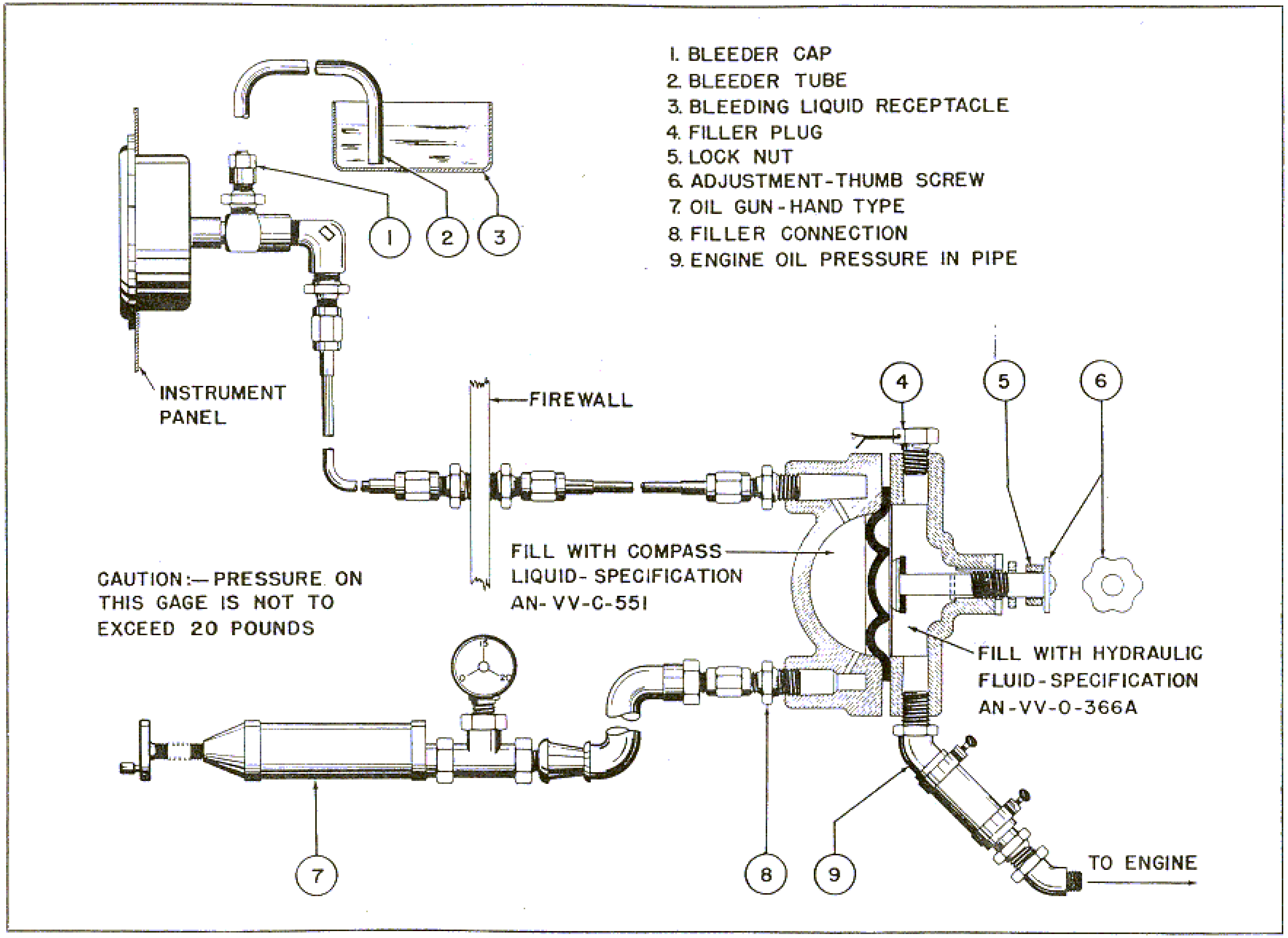
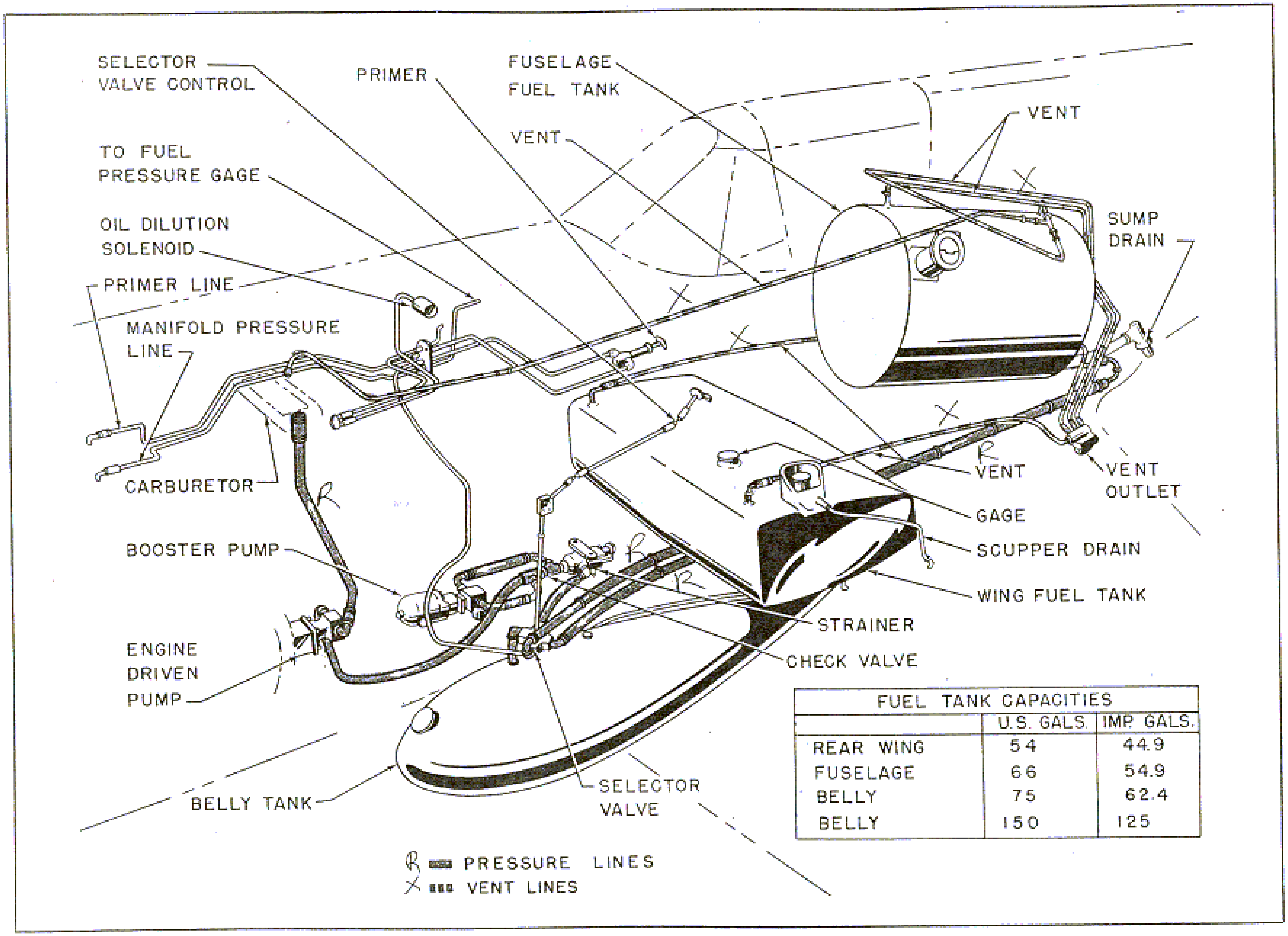
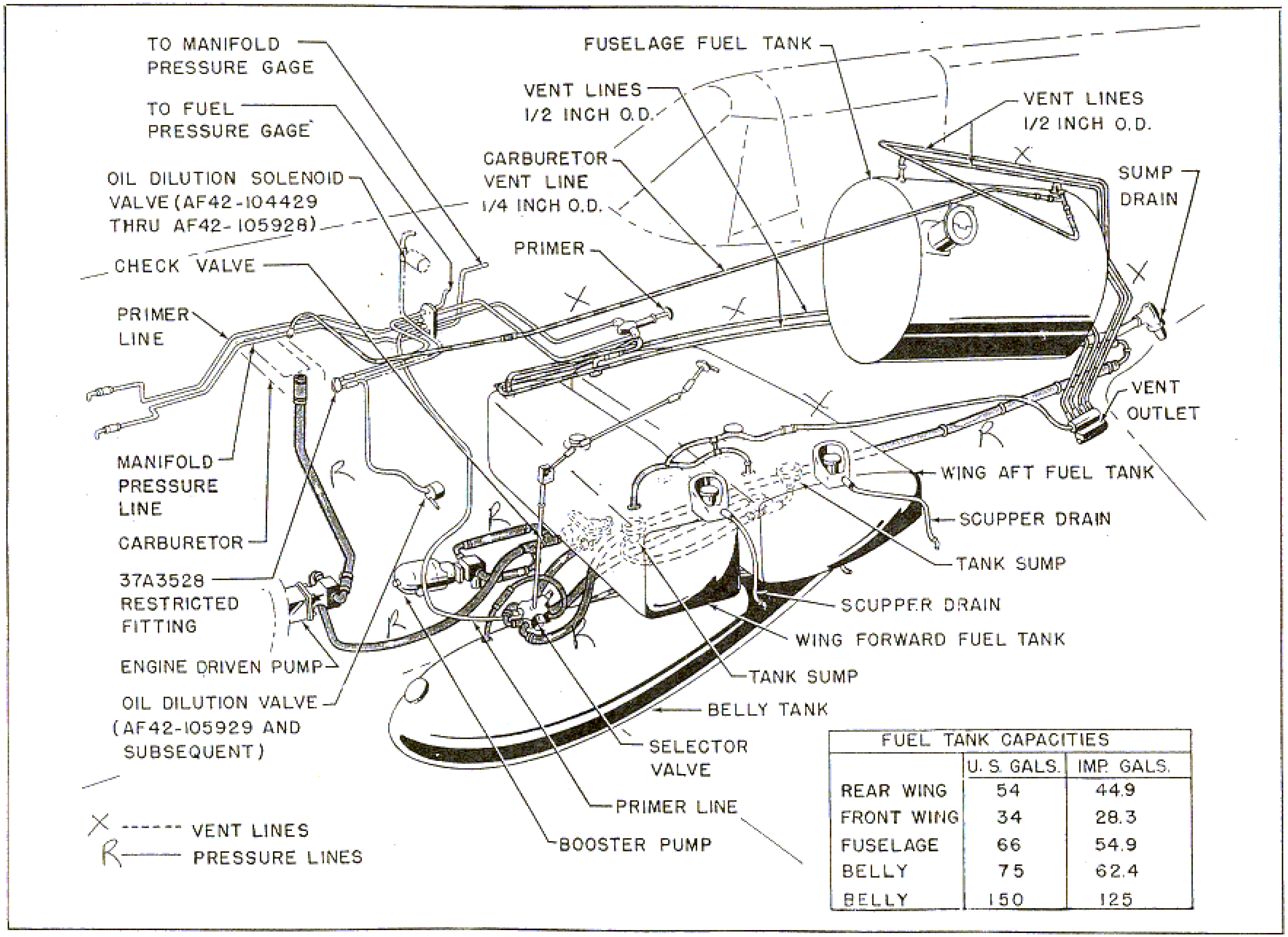


Figure 195—Servicing Oil Pressure Transmitter



FUEL TANK CAPACITIES		
	U.S. GALS.	IMP. GALS.
REAR WING	54	44.9
FUSELAGE	66	54.9
BELLY	75	62.4
BELLY	150	125

Figure 196—Fuel System (AF42-104429 through AF42-105128)



FUEL TANK CAPACITIES		
	U. S. GALS.	IMP. GALS.
REAR WING	54	44.9
FRONT WING	34	28.3
FUSELAGE	66	54.9
BELLY	75	62.4
BELLY	150	125

Figure 197—Fuel System (AF42-105129 and Subsequent)

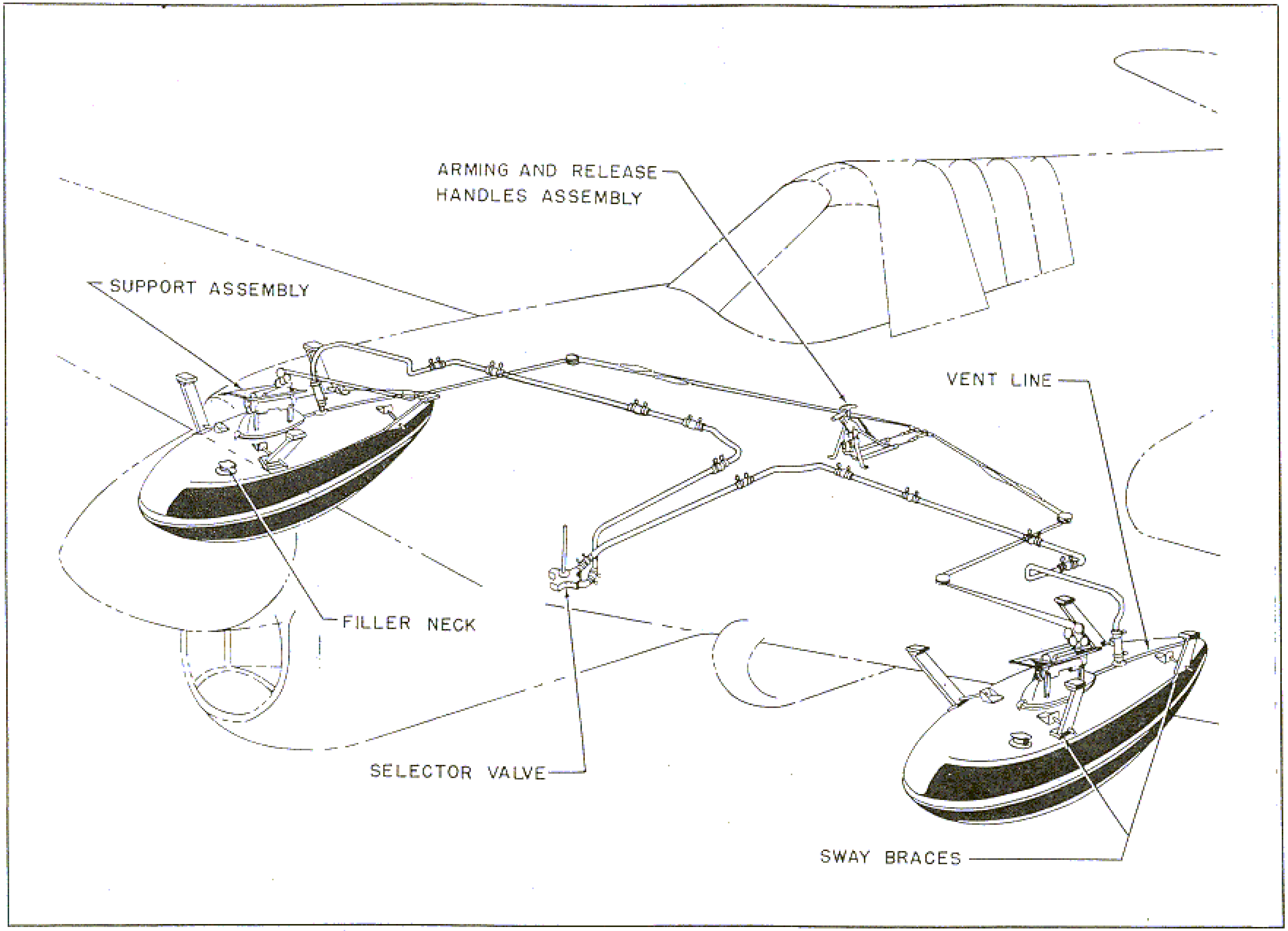


Figure 198—Long Range Fuel System

b. FUEL SYSTEM. *(See figures 196 and 197.)*

(1) GENERAL DESCRIPTION. — Three self-sealing cells, one located in the fuselage and two in the wing, afford the normal fuel tankage of the P-40N airplane. Provision is made for the installation of a belly tank and two auxiliary wing tanks for long range flying. An engine-driven pump and an electric booster pump, both of the G-9 type, provide pressure for the system. A Lunkenheimer C-4 strainer, a five port selector valve, complete ventilation, and self-sealing tubes are the chief additional features of this fuel system.

(2) TANKS.

(a) DESCRIPTION.—Each of the two auxiliary wing tanks holds 225 US (187.5 Imperial) gallons. The capacity of the other tanks is given in figure 197. The wing tanks are located beneath the cockpit floor; the fuselage tank is to the rear of the pilot immediately aft of station 5 bulkhead. The belly tank is fastened to the bomb shackle beneath the wing on the center line of the airplane, the auxiliary wing tanks to the outboard wing bomb carriers. (See figure 198.)

All tanks are vented to the atmosphere. The wing and fuselage tanks vent lines drain at a "gang" drain in the trailing edge of the wing fillet on the left side of the airplane. A vent line connects the carburetor fuel chamber to the top of the fuselage tank. This vent allows air to be expelled from the top of the carburetor fuel chamber when it is being filled and prevents vapor lock. The passage is closed by a check valve when the chamber is full. All fuel tanks contain an internal division system to trap fuel in a bank or side slip, assuring ample available fuel in such maneuvers.

(b) TO REMOVE THE BELLY TANK.

1. Drain the tank through the drain cock on the bottom of the tank and be sure that all safety precautions are taken to prevent fire or explosion. Have at least two hand fire extinguishers within reach.

2. Unbutton the oil drain access door on the right side of the exit duct and loosen the two clamp fittings on the synthetic rubber hose connection on the fuel supply line to the selector valve. Take the synthetic rubber cap from the tool kit and install it on the end of the fuel selector valve line.

3. Remove the two nuts and washers from one side of the sway brace assembly and remove the assembly.

4. Unbutton the fuel tank drain-access door and, with a man supporting the tank at the forward and aft ends, insert a hand in the access door opening and pull back on the release lever at the front of the shackle. This procedure will release the carrying hooks and allow the tank to drop free of the shackle. Use extreme caution when removing the belly tank not to damage the short feed line connection on top of the tank. Remove the tank from under the airplane, and if the tank is not completely empty, be sure to keep the tank upright until it is thoroughly drained. Spilling fuel creates a dangerous fire hazard, and extreme care should be exercised to guard against it. If fuel is accidentally spilled, clean it up immediately.

(c) TO INSTALL THE BELLY TANK.

1. If the sway brace channels are not installed in the wing panel, install them. The front channels are installed on web 2 at 16.375 inches from the airplane center-line. The rear channels are installed on web 3 at 16.78 inches from the airplane center line.

2. Unbutton the front tank fuel drain access door on the keel fairing and insert a hand to pull the release lever back until the carrying hooks are open.

3. With a man at each end of the belly tank, raise the tank and guide the fuel supply line on top of the tank into the synthetic rubber fitting on the botton of the exit duct forward of the bomb shackle.

4. Raise the tank until the lugs on the top of the tank are inserted in the slots on the bomb shackle.

5. Insert a hand through the fuel drain access door, push the two carrying hooks up to the lock position and pull back on the release lever on the bomb shackle approximately one inch to engage the carrying hook locks.

6. Unbutton the oil drain access door on the right side of the exit duct. Working through this access door remove the synthetic rubber cap on the fuel line to the fuel cock and complete the connection between the tank line and fuel cock line with a short length of synthetic rubber hose. Tighten the clamps at either end of the hose connection. Stow the synthetic rubber cap in the tool kit on the duffle bag.

7. Install the sway brace boards in the channels on the wing and tighten the front and rear strap assemblies so that the belly tank is in line with the airplane center line.

(d). TO REMOVE EITHER WING TANK.

1. Remove the inboard fixed-landing-gear fairing.

2. Disconnect and remove the belly tank sway braces.

3. Remove the keel fairing.

4. Remove the wing fillets.

5. Drain the fuel cells.

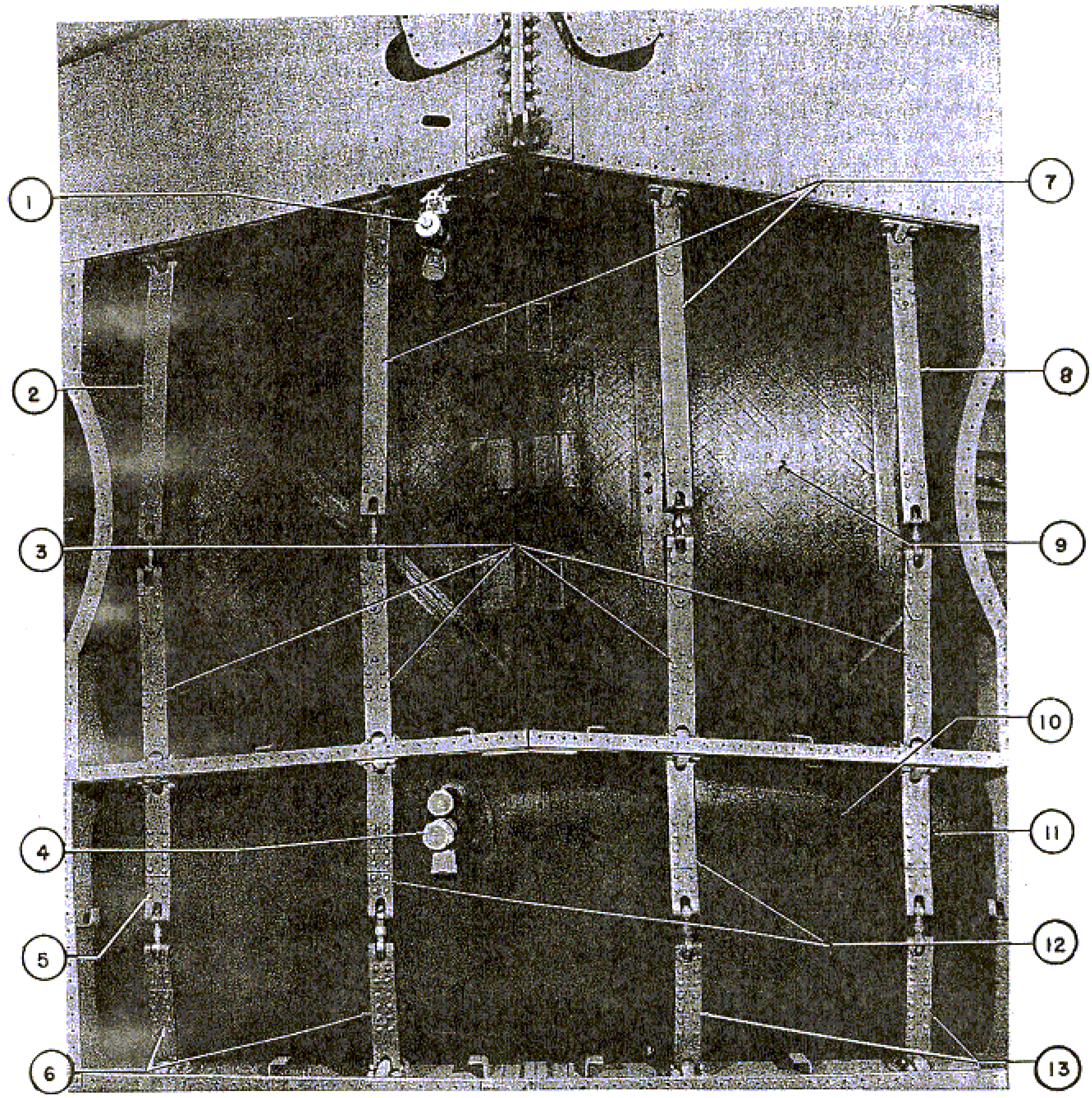
6. Disconnect the vent lines at the top of the fuel cells above the upper wing skin.

7. Remove the control cables and the belly bomb shackle.

8. Remove fuel lines, fuel gages, and filler caps. All connections to the self-sealing fuel cells must be broken, otherwise they will be torn at the fittings.

9. Remove the filler cap on the filler neck and then unscrew the filler neck, using tool 87-88-596, by inserting the tool into the slots on the circumference of the filler neck.

10. Remove the fuel tank doors in the bottom of the wing as a single unit as follows:



1. 87-45-071 SUMP
2. 87- 44-568 L STRAP
3. 87-44-567 L/R STRAPS
4. 87-45-071 SUMP
5. 87-44-059 L STRAP
6. 87-44-057 L STRAP
7. 87-44-569 L/R STRAPS
8. 87-44-568 R STRAP
9. 87-423-1001 REAR WING FUEL TANK
10. 87-423-1000 FRONT WING FUEL TANK
11. 87-44-059R STRAP
12. 87-44-058 L/R STRAPS
13. 87-44-057R STRAPS

Figure 199—Installation of Wing Tanks

a. Withdraw the bolts at each end of the skid, which attach the skid to the match angles.

b. Remove all screws and bolts which attach the doors to the wing, including the screws and bolts through web 3.

11. Loosen the tank strap turnbuckles and remove the straps. (See figure 199.)

12. Remove the fuel tank, from the tank compartment taking care not to damage the filler neck, gage, and vent line fittings on the tank. (See figures 200, 201, 202, and 203.)

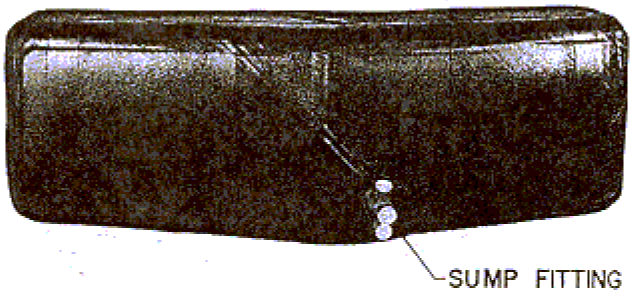


Figure 200—Front Wing Fuel Tank—Bottom View

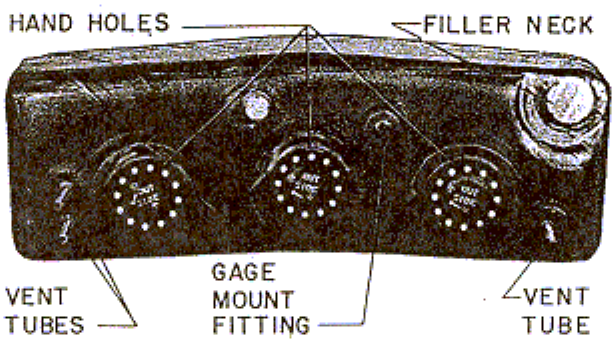


Figure 201—Front Wing Fuel Tank—Top View

Note

Additional information for removing the wing fuel tanks is given in section IV, paragraph 1, *a,* (2), (b).

(e) TO INSTALL EITHER WING TANK.—Complete instructions for installing the wing fuel tanks are contained in section IV, paragraph 1, *a,* (3), (a).

(f) TO REMOVE THE FUSELAGE TANK.

1. Remove the aft keel fairing and drain the fuel from the tank.

CAUTION

Exercise every precaution to reduce fire hazards.

2. Working through the fuselage access door, remove the duffle bag, the radio transmitters

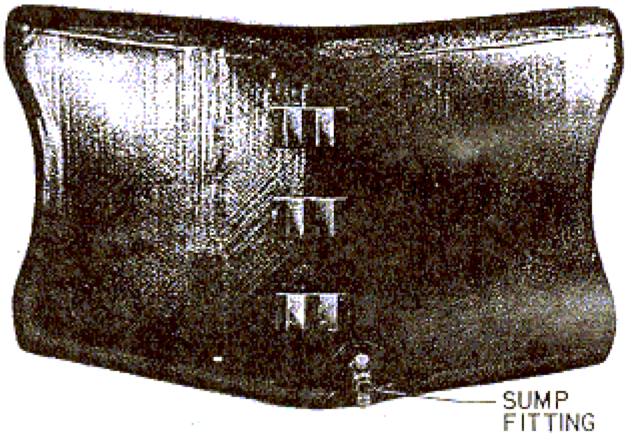


Figure 202—Rear Wing Fuel Tank—Bottom View

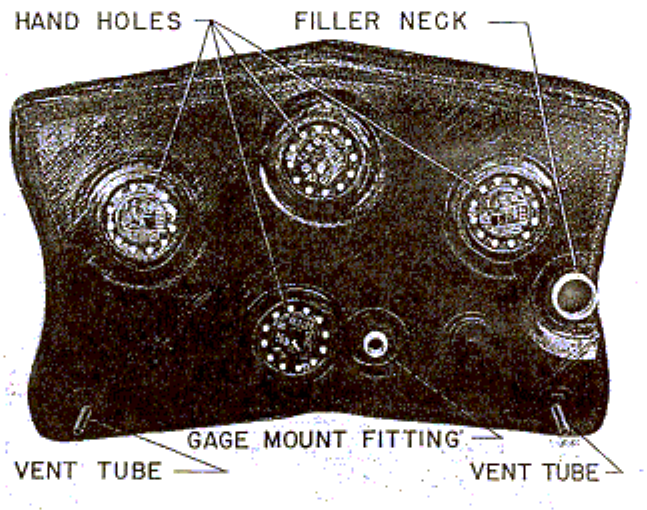


Figure 203—Rear Wing Fuel Tank—Top View

and receivers on the shelves forward of the door, and the top radio shelf attached to bulkheads 8 and 9. Remove the radio receiver and transmitter unit from the shelf aft of the access door if one is installed.

3. Climb through the access door into the fuselage and disconnect the fuel supply line at the bottom of the tank. Disconnect the rear vent line at the top of the tank. Cut the lock wire and disconnect the turnbuckle at the aft end of the tank and the rear tie-down strap at the top of the tank. Disconnect the bonding tab at the nut plate on the tank to the right of the sump assembly.

4. Remove the oxygen cylinder above the fuel tank at station 6 bulkhead.

5. Working from within the cockpit, remove the pilot's seat.

6. Remove the pilot's headrest.

7. Remove the armor plate at station 5 bulkhead.

8. Remove the bonding tabs, one on the right side of the tank and the other on the filler neck.

9. Disconnect the electric conduit at the gage transmitter.

10. Remove the short pipe elbow from the forward vent line on the top of the tank.

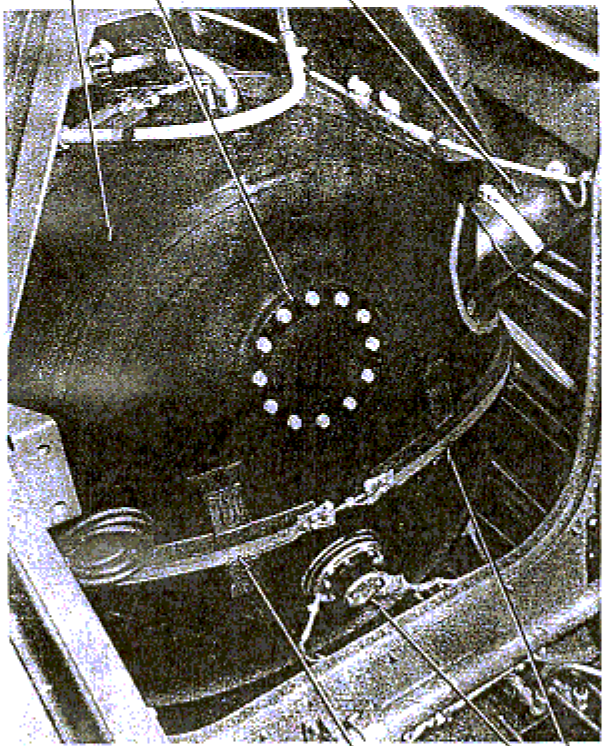


Figure 204—Fuselage Fuel Tank Installation

11. Cut the lock wires and disconnect the turnbuckles on the forward tie-down and retaining straps. (See figure 204.)

12. Loosen the two clamps on the filler neck and remove the filler neck cap and adapter. Remove the seven screws around the circumference of the filler neck on the outside of the fuselage skin and remove the nut plate and filler neck.

13. Remove the hydraulic hand pump handle and stow it under the right rudder pedal.

14. Remove the control stick and push-pull rod and lay the assembly on the cockpit floor to act as a skid.

15. Remove the canopy control crank on the right side of the fuselage.

16. Remove the gun sight.

17. Place the landing gear control handle in the "DOWN" position.

18. Place the cowl flap control in the open position and all other controls in their forward positions.

19. Place a pad on the floor of the cockpit.

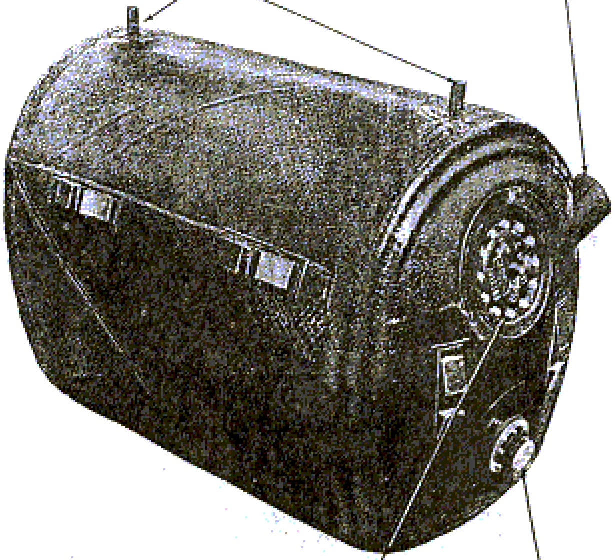


Figure 205—Fuselage Tank—Right Front View

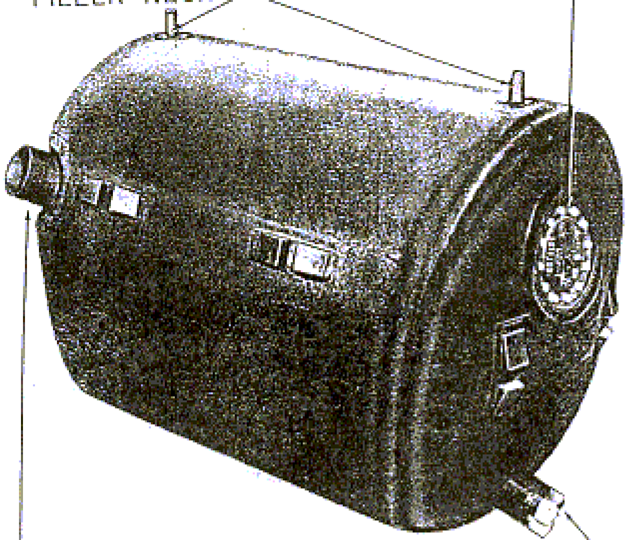


Figure 206—Fuselage Tank—Left Rear View

20. With one man in the fuselage to apply a forward force and one man in the cockpit to grasp the tank at the transmitter and lift it over the bulkhead at station 5, move the tank carefully into the cockpit.

21. Move the tank as far forward as it will go and start to tip the rear of the tank upward. Work the tank back and up until it is in a vertical position. Lift the tank straight up out of the cockpit. (See figures 205 and 206.)

Note

On airplanes AF42-104829 and subsequent, it will be necessary to remove the cockpit canopy, the rear vision installation, and the plate on the rear deck in order to remove the fuselage tank.

(g) TO INSTALL THE FUSELAGE TANK.

Note

Extreme care should be exercised when installing the fuselage tank so that damage to the tank assembly, cockpit controls and pipes and fittings, will be avoided. Two men are required to install the tank.

1. Before the installation of the fuselage tank, check over the cockpit for the following items:

a. Removal of flight control stick and push-pull tube.

b. Removal of hand hydraulic pump handle.

c. Removal of canopy control crank.

d. Removal of gun sight.

e. Removal of bomb-tank release and arming controls from the cockpit floor.

Note

In airplanes AF43-24252 and subsequent, the bomb-tank release and arming controls are located on the left cockpit wall. On airplanes prior to AF43-24252, the location of the controls will be changed to the left cockpit wall at the discretion of the Army Air Forces.

f. Landing gear control handle in "DOWN" position.

g. Cowl flap control in "GROUND COOLING" position.

2. Before installation of the fuselage tank, check over the fuselage for the following items:

a. Removal of radio equipment from top and center shelves forward of fuselage access door, and removal of top shelf.

b. Condition of all control cables, pulleys, electric conduit, and other installations in fuselage forward of fuselage access door.

c. Condition of synthetic rubber pads on fuselage bulkheads at stations 6 and 7. If these pads are worn, replace them. Make sure the pads are in place on the bulkheads.

d. Condition of all tank straps, synthetic rubber pads, strap fittings and turnbuckles. Replace worn rubber pads, strap fittings and turnbuckles. Replace worn strap bolts or bolts or turnbuckles having stripped threads. If new straps are to be installed, insert a strap bolt in each tie-down fitting to test the fit of the bolt. If the bolt does not fit freely, using a punch and hammer, spread the fittings so that the bolts will fit freely but not loosely before attempting to install the straps on their fuselage fittings.

3. Install the fuselage tank filler neck.

a. Before installation inspect the synthetic rubber filler neck for breaks and deterioration and install a new one if necessary.

b. Place the nut plate against the filler neck flange and attach the filler neck to the fuselage by installing the seven screws through the fuselage skin, filler neck flange, and the nut plate.

Note

Use an awl or a punch to align the holes in the fuselage skin with the holes in the filler neck flange and the nut plate. Install the top screw first and work around the opening until all screws are installed.

c. Insert the cap and adapter assembly into the filler neck. Push the cap in until it is flush with the fuselage skin and turn the cap handle so that it parallels the line of thrust.

d. Install the clamp on the filler neck, close to the fuselage skin, to hold the filler cap adapter in the neck.

4. Place a pad on the floor of the cockpit.

5. Raise the tank to the walkway on the wing and move it up even with the cockpit opening.

6. With two men on the wing, tip the tank so that the forward end is down and raise the tank up until it rests on the cockpit sill. One man can now balance the tank while the other takes his place on the opposite side of the cockpit.

7. Lift the tank off the sill and allow it to lower into the cockpit with the tank still in a vertical position until it rests on the pad on the cockpit floor.

8. Grasp the forward end of the tank resting on the cockpit floor with one hand and lift up slightly on the tank while turning the aft end downward. Keep on working the tank to a horizontal position being extremely careful not to foul any of the controls or instruments in the cockpit.

9. After the tank is about half way down, one man should straddle the tank and grasp the tank both fore and aft and work the tank down to a horizontal position.

CAUTION

Be sure that all oil, grease and water is wiped from the soles of the shoes and cockpit sills so that injuries from slipping will be avoided.

10. The man straddling the tank can now start the tank backward into the fuselage through station 5 bulkhead.

11. The man straddling the tank should now move down onto the wing and with the other man on the opposite side of the cockpit, work the tank back into the fuselage until there is room in the cockpit for one man. One man should now station himself in the cockpit facing the tank while the other man crawls through the fuselage access door and, by working over the center radio shelf, raises the tank to clear the pad on station 7 bulkhead while the man in the cockpit pushes the tank into the fuselage until it rests in its cradle. The man in the fuselage should guide the aft strap between the retaining lugs on the aft end of the tank.

12. While the man is in the fuselage he should fasten the rear tie-down strap at its turnbuckle, take the turnbuckle up and lockwire it. Connect the rear vent line to the fitting on top of the tank and tighten the clamp. Connect the two vent lines at the hose fittings aft of the tank and connect the fuel outlet line to the sump fitting at the bottom rear of the tank.

13. The man in the cockpit should connect the front strap and take up the turnbuckle. Then connect the front tie-down strap and take up on the turnbuckle. Lockwire all turnbuckle bolts.

Note

The fuselage tank should be centered in the cradle so that the turnbuckles on the front and the rear tank straps can be taken up equally.

14. Insert the short pipe elbow in the front vent line connection and connect the other end to the tank vent fitting. Tighten the two clamps.

15. Connect the electric conduit at the gage transmitter.

16. Place a clamp over the filler neck and install the filler neck on the adapter on the tank. Slip the clamp down over the adapter and tighten to secure the filler neck on the tank adapter.

Note

A new filler neck will have to be trimmed on a bevel so that it will fit the filler neck adapter on the tank properly.

17. Connect the two bonding braids, one at the filler neck and one at the fuel gage transmitter.

18. Return the landing gear control handle to "OFF" position.

19. Install the gun sight.

20. Install the canopy control crank on the right side of the cockpit.

21. Replace the handle on the hand hydraulic pump.

22. Install the flight control stick and push-pull tube assembly.

23. Install the station 5 armor plate.

24. Install the pilot's seat.

25. Install the pilot's head rest.

26. Install the oxygen cylinders above the fuselage tank at station 6.

27. Be sure the fuselage tank sump drain cock is closed and safety wired and that the supply line is properly connected.

28. Install the rear keel fairing.

29. On airplanes AF42-104829 and subsequent, re-install the plate on the rear deck. Re-install the rear vision installation and the cockpit canopy.

(3) FUEL LINES.—See section VIII for Fuel System Tubing Diagram and Tubing Chart. All fuel lines are gun-fire protected, self-sealing tubes. These self-sealing fuel lines are made up of a seamless compound inner tube, layers of self-sealing material, plies of reinforcement, and a compound cover. The fuel lines will seal completely within two minutes after firing at a temperature of —4°C to +38°C (25° to 100°F), and will seal within four minutes after firing at a temperature of —29°C (—20°F). Clamps for aromatic resistant self-sealing hose will be tightened by adjusting the clamp to finger tightness, then applying 2 to 2-1/2 turns. After installation, hose clamps will be inspected daily for proper tightness until the hose ceases to "cold-flow" and the hose clamp remains tight. (See figures 196 and 197.)

WARNING

Be sure that all layers of material in the self-sealing hose are firmly sealed together. After installation, be sure that the proper number of layers of material are showing beyond the clamp. Any discrepancy here will require immediate investigation, as a layer of material may have been pushed into the hose when it was installed on the tube connection, thus closing the fuel passage.

(4) FUEL SYSTEM PUMPS.—Fuel is pumped from the tanks to the injection type Stromberg Bendix carburetor by a type G-9 engine-driven fuel pump. An electric fuel pump is incorporated in the suction line between the engine-driven fuel pump and the fuel cock. The electric pump (figure 207) consists of an integral explosion-proof electric motor and a small centrifugal type pump. This electric pump does not replace the engine-driven pump, but it is used in conjunction with it. The electric fuel pump switch should be "ON" for all engine operations. The electric fuel pump is controlled by a switch on the left hand side of the main switch panel and has two positions, "ON" and "OFF".

Note

When the Stromberg Bendix carburetor is first used after installation, or has been drained, this procedure should be followed: Open the fuel cock and set the mixture control at "AUTOMATIC RICH" and the throttle half open. Switch on the electric fuel pump and allow the electric pump to operate until a small amount of fuel runs from the supercharger drain. A special condition exists when the carburetor is partly filled with air.

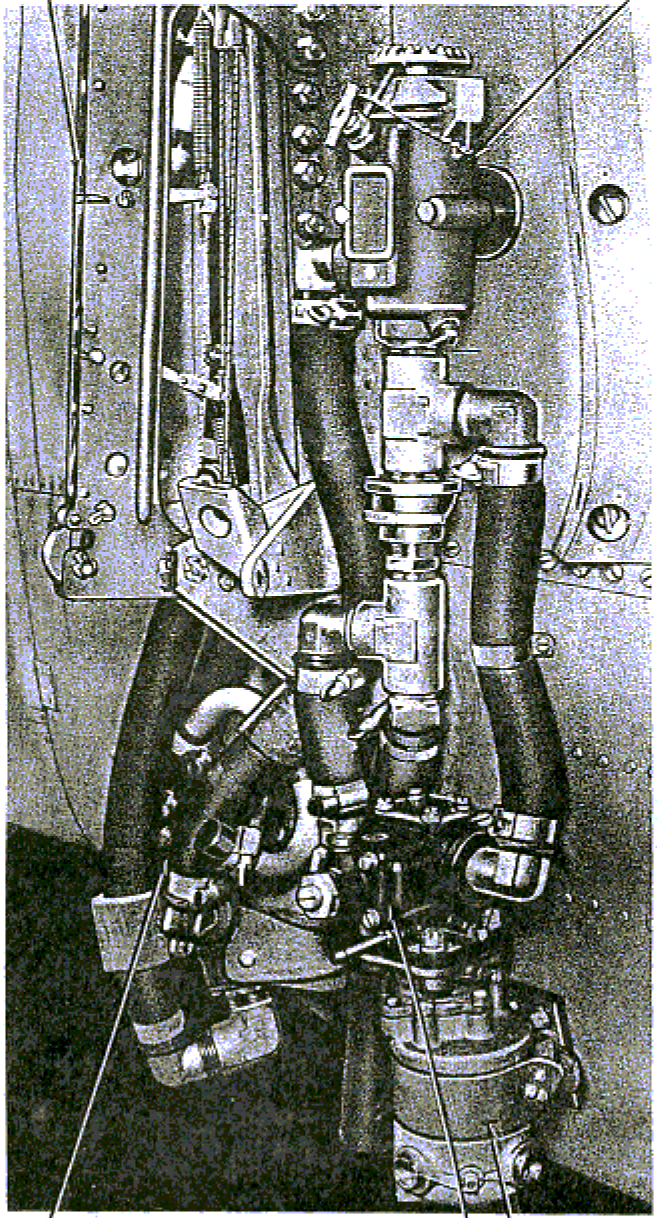
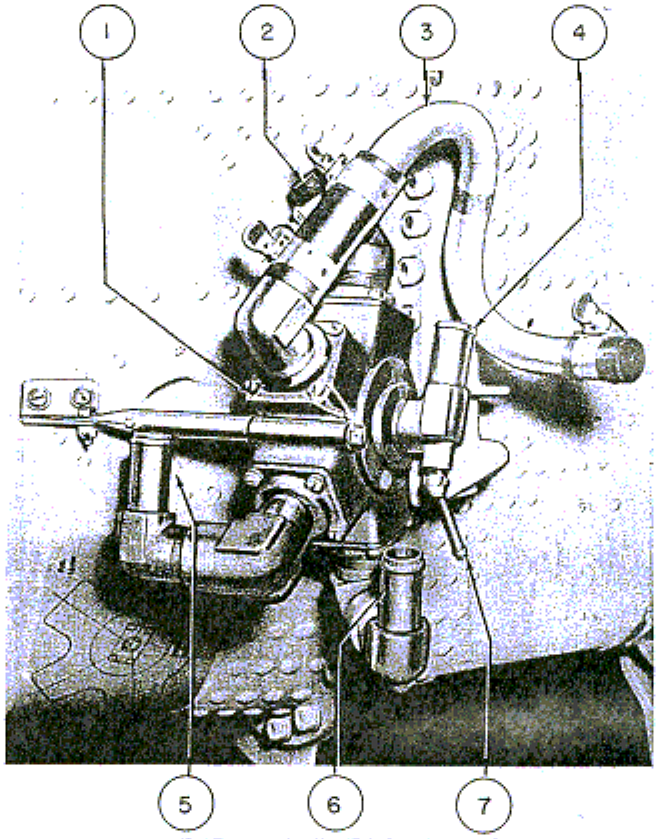


Figure 207—Electric Pump, Strainer, and Selector Valve Installation

The rate at which the fuel may enter the second "regulator chamber" and the "fuel control body" is held to idling rate, causing the carburetor to fill slowly. Since there are no vents in the system beyond the "second regulator chamber", all imprisoned air must escape through the nozzles causing the engine to stop after being started. To eliminate this condition, remove the vent plug from the "second regulator chamber" and operate the electric fuel pump until the fuel is level with the plug opening. Replace the plug. One minute is the usual elapsed time for filling of the carburetor.

(5) FUEL SELECTOR VALVE. *(See figure 208.)* —The fuel selector valve is mounted on a support on the wing match angle.



1. FUEL SELECTOR VALVE
2. FROM AUXILIARY TANKS
3. FROM BELLY TANK
4. TO FUEL STRAINER
5. FROM FUSELAGE TANK
6. FROM WING TANKS
7. PRIMER LINE

Figure 208—Fuel Selector Valve

(6) PRIMER.—The engine primer system consists of a supply line from the fuel selector valve to the primer, and a line from the primer to the engine intake manifolds. The priming system on the engine is independent of the carburetor and pumping the carburetor throttle will not discharge fuel into the engine.

(7) FUEL LEVEL GAGES.

(a) FUSELAGE TANK EQUIPMENT.—The fuselage tank is equipped with General Electric DC Selsyn fuel level equipment consisting of an 8DJ11LAT model indicator (weight 0.355 pound) and an 8TJ13LAH model transmitter (weight 1.2 pound). This 24-volt equipment is adapted to the basic operating system, known as the three-wire system, which requires the use of three leads to connect the transmitter to the indicator. (See figures 209 and 260.)

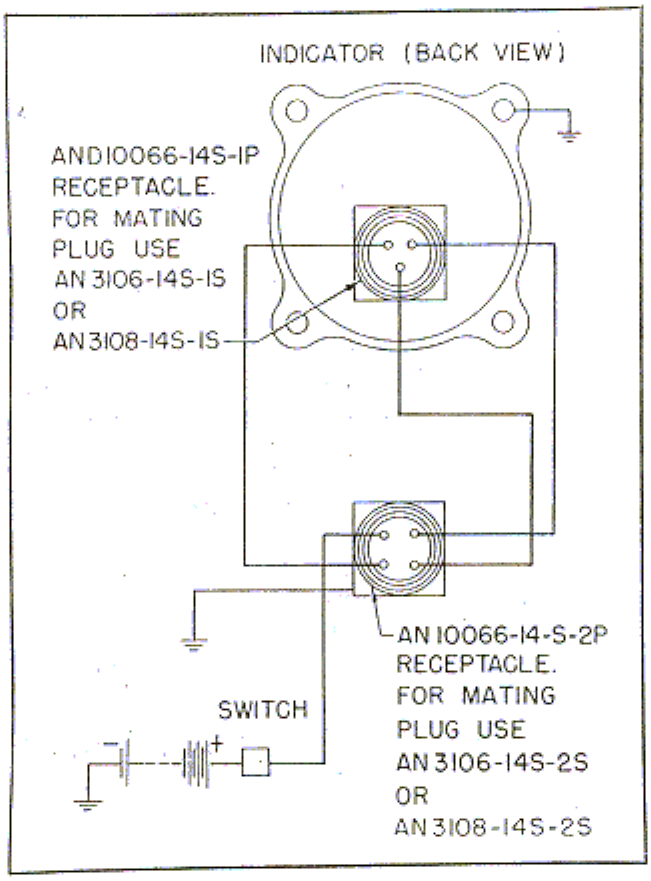


Figure 209—Fuel Level Gage Wiring Diagram

1. TO INSTALL THE INDICATOR.

a. Place the indicator in the instrument panel from the back in the position drilled for it on the left side.

b. Line up the four indicator mounting lugs with the holes drilled in the panel and secure with No. 6-32 screws. Self-locking nuts are provided on the instrument.

c. Attach wires as shown on the wiring diagram (figure 209).

2. TO INSTALL THE TRANSMITTER. *(See figure 210.)*

a. Before inserting the transmitter into the opening provided in the forward end of the fuselage tank, be sure that the tank is empty and that the float or float arm does not strike any baffle in the tank.

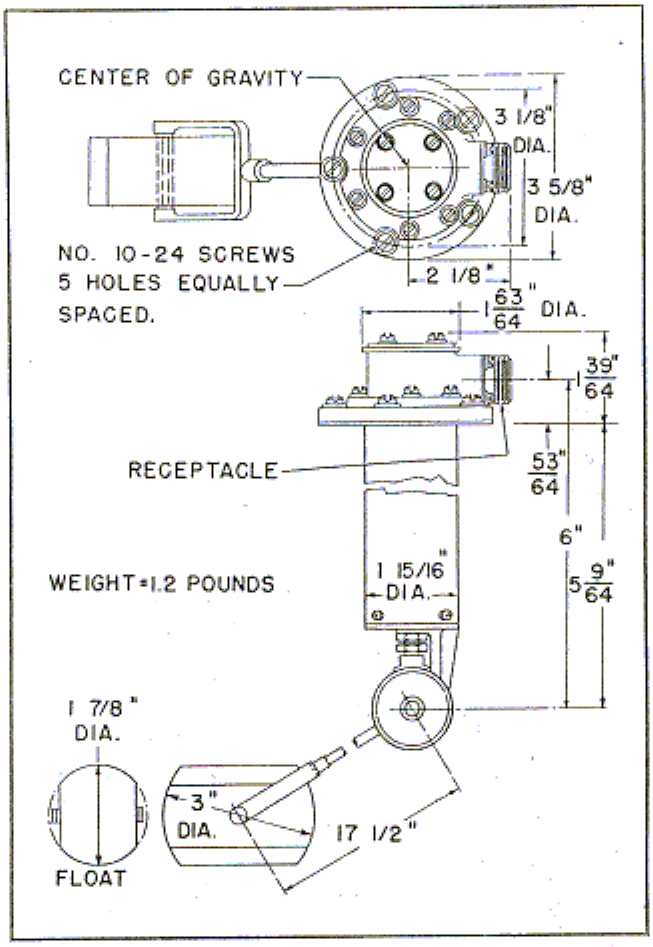


Figure 210—Fuel Level Gage Transmitter

b. Insert the transmitter in the tank opening with the receptacle located 135 degrees clockwise from the bearing bracket, and secure with No. 10-24 screws through the five equally spaced holes in the transmitter flange. It is now necessary to make the adjustment for empty tank condition.

3. ADJUSTMENT WITH THE FUEL TANK EMPTY.

a. Be sure the tank is empty so that the float will rest on the bottom of the fuel tank.

b. Connect the transmitter and the indicator in accordance with the external connection diagram, figure 209.

c. Loosen the four screws on top of the transmitting element assembly and rotate the adjusting disc until the pointer reads zero. Tighten the four screws. Attach external wires as shown on figure 209.

(b) WING TANK GAGES.—The wing tanks are equipped with float-type sight-gages mounted in the top of the tanks with the dial heads protruding from the floor of the cockpit.

(8) SCUPPER DRAINS.—The wing tank scuppers in the left wing fillet are provided with drain lines passing downward through the lower wing skin just to the left of the tank door.

(9) STRAINERS AND TANK DRAINS.

(a) In the bottom of each tank is a sump fitting in which is installed the tank finger strainer, fuel line outlet, and drain plug. All drain plugs incorporate a drain cock for the removal of water. The drain plug in installed directly in the sump fitting in the wing and belly tanks and a remote drain is provided for the fuselage tank. The tank sumps are designed to permit the settling of water to the sump and the removal of this water from the sump without draining the entire tank. Access to the wing tank sumps and drains is through doors in the keel fairing. The drain assembly for the fuselage tanks is under the fuselage to the right of the keel fairing and aft of the trailing edge of the wing, and is accessible through a door in the keel fairing. The belly tank drain and sump are located in the bottom of the tank.

(b) Besides the finger strainers in each tank, there is a strainer in the main fuel line between the fuel selector valve and the electric fuel pump. Access to this strainer is gained through a door on the bottom of the exit duct aft of the cowl flaps. There is also a strainer in the carburetor near the leading edge and is controlled by a rod through the leading edge to a gear box on the forward left side of the firewall. Another control rod runs from the gear box through the firewall into the cockpit to the indicator plate handle. When the engine is not running, a decided "click" can be heard when the indicating plate is engaged. When the engine is running, this engagement can be felt through the control handle. It is mandatory that the fuel selector valve settings be determined by this "click" or "feel" method and not solely by the position of the control handle pointer in the cockpit. If this precaution is not taken, fuel may flow between tanks, creating a very dangerous condition. Inability to hear the "click" or "feel" the engagement is usually caused by excessive drag in the fuel valve or by interference of the rods with other parts. Whenever this condition occurs, the control linkage will be disconnected at the fuel selector valve yoke and both the control linkage and fuel selector valve assembly will be checked for freedom of movement. Drag in the fuel selector valve assembly can be determined by turning the selector valve stem yoke with the fingers.

CAUTION

Whenever fuel selector valve controls are disconnected or fuel selector valve assemblies are removed or replaced, the reassembly of parts must be carefully checked to insure that the valve ports open to the tank positions indicated by the control handle pointer.

7. FIXED EQUIPMENT GROUP.

a. INSTRUMENTS.—The instrument board is mounted on two supports at the bottom and braced by two rods at the top which are attached to the front armor plate. The supports and braces are mounted on bushings. The support bushings are 150P20 (monel) and are installed with the load-rated sides toward each other. Replacement of these bushings and washers should coincide exactly with the original installation.

LIST OF INSTRUMENTS

Instrument	*Type*	*Specification*
Air speed indicator	F-2	94-27335
Altimeter	AN5760-3	AN-GG-A-461
Carburetor air temperature	AN5790-6	AN-GG-I-522
Clock	A-11	94-27970
Compass	B-16	94-27807
Coolant temperature thermometer	AN5790-6	AN-GG-I-522
Engine gage unit	B-7	94-27943
Fuel quantity gage	8DJ11LAT	General Electric
Manifold pressure gage	AN5770-1	AN-G-9
Rate of climb indicator	AN5825-2	AN-GG-I-518
Tachometer	C-11	94-27353
Turn and bank indicator	C-1	94-27337

b. SURFACE CONTROLS.

(1) AILERON CONTROLS. *(See figure 211.)*

(a) DESCRIPTION.

1. The control stick and aileron control torque tube are supported as a unit by two bearings bolted to the wing match angle. Each aileron system has an adjustable link connected to an arm on the control stick torque shaft extending down through the wing to a bellcrank. Cables equipped with turnbuckles for adjustment, run aft from the bellcrank to pulleys and then outboard to a drum which operates the aileron through an eccentric arm.

2. The movement of the stick, for full aileron travel in either direction from its neutral position, is 20-1/2 degrees on either side from the center line of the airplane.

3. The specified tension of the aileron cable is 110 pounds when the ambient temperature is 21°C (70°F).

4. The stops for the aileron control system are bolts through the arms on the aft end of the torque shaft.

(b) ADJUSTMENTS AND RIGGING.

1. Ailerons will be rigged with 1 2 inch maximum droop, measured at the inboard trailing edge of the aileron, with the controls in neutral position.

2. Turnbuckles on the cables are accessible through the inboard trailing edge of the wing when the flaps are lowered.

3. Adjustments on the links are located above the upper wing skin at the aft end of the control torque shaft.

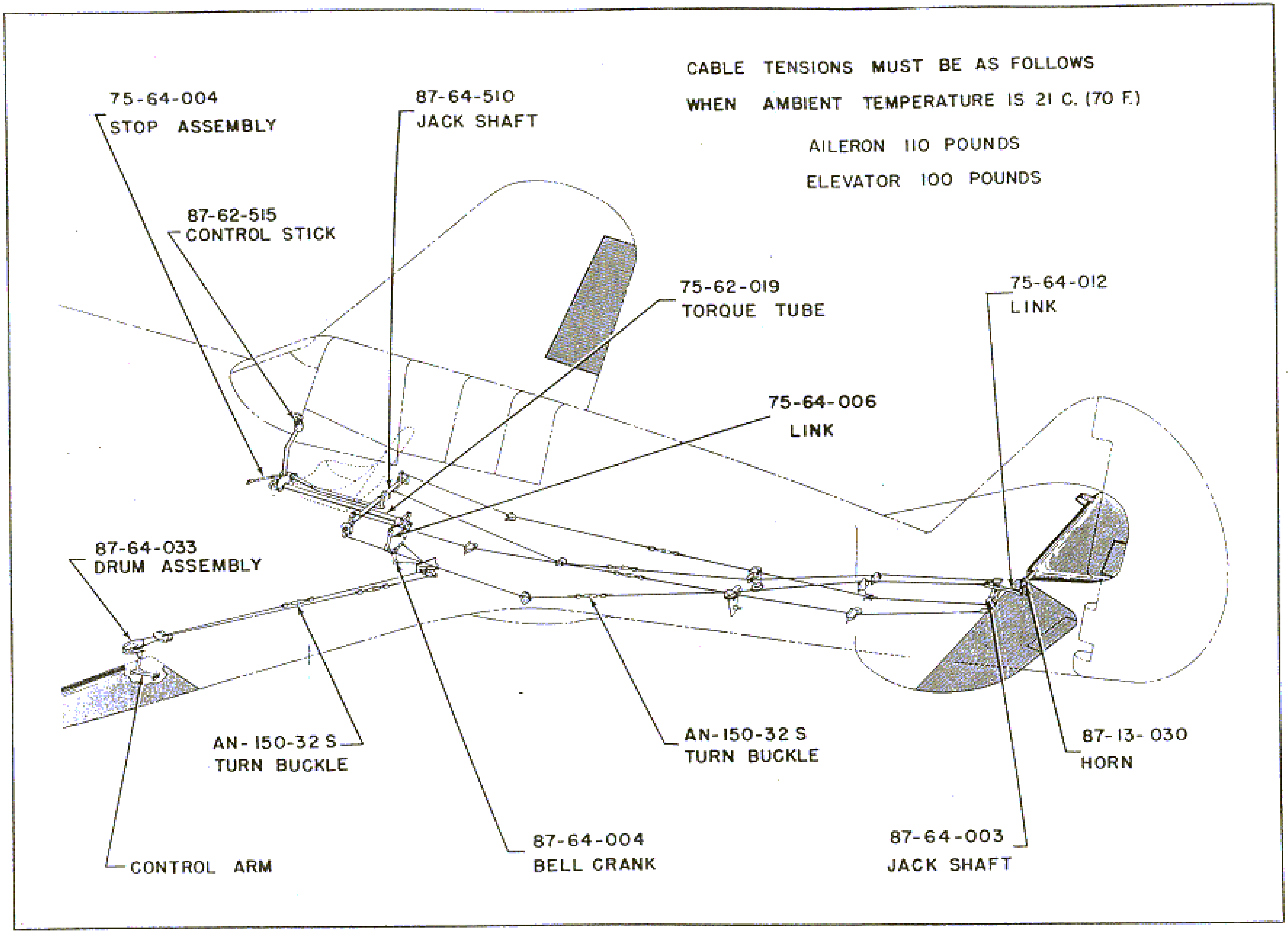


Figure 211—Aileron and Elevator Controls

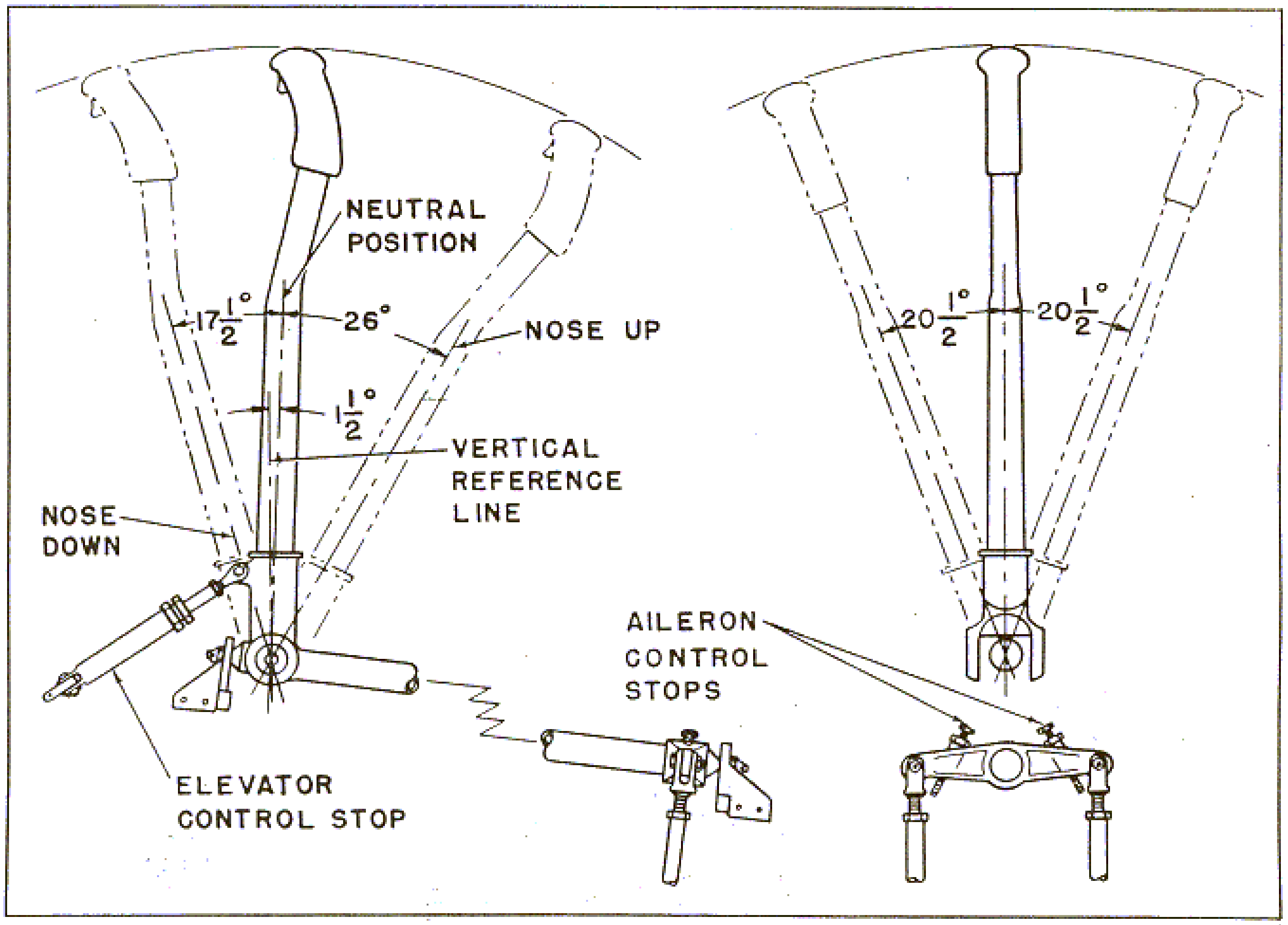


Figure 212—Control Stick Setting

(2) ELEVATOR CONTROLS. *(See figure 211.)*

(a) DESCRIPTION.

1. The stick is connected to the elevator controls by a push-pull tube to a lever on the front jackshaft at station 5. Bellcranks on the jackshaft are connected by two pairs of cables, equipped with turnbuckles for adjustment, to bellcranks on a rear jackshaft at station 16. The cables are crossed between front and rear jackshafts. From the bellcranks on the rear jack-shaft, a single short push-pull link connects to the elevator horn.

2. The stop for the elevator control system is an adjustable cylinder and piston unit attached to the front of the control stick, and leading forward and down to attach to the wing match angle.

3. The specified tension of the elevator cables is 100 pounds when the ambient temperature is 21°C (70°F).

(b) TO REMOVE FRONT JACKSHAFT.—To remove the forward jackshaft, disconnect the push-pull tube from its arm and the four cables from the horns. Remove the eight bolts attaching the three bearing supports to the bulkhead and remove the shaft and bearing supports. The bearing supports may then be detached if desired by removing the nuts at the end of the shaft.

(c) TO REMOVE REAR JACKSHAFT.—The rear jackshaft may be removed by disconnecting the cables and link, and then removing the four bolts which attach the bearings to their supports.

(d) TO INSTALL FRONT JACKSHAFT.—Assemble the bearing supports on the torque shaft and install the retaining nuts on the shaft ends. Attach the jackshaft assembly to the bulkhead at station 5 by the eight bolts through the three bearing supports. Connect the flight control stick push-pull tube to the jackshaft arm and connect the four control cables to the horns.

(e) TO INSTALL THE REAR JACKSHAFT.—Install the four bolts which attach the bearings to their supports and connect the cables and the elevator link to the jackshaft horns.

(f) ADJUSTMENT.—The turnbuckles for adjusting the tension in the elevator control cables are accessible through the fuselage access door. To adjust the elevator throws and cable tension proceed as follows: Set the front jackshaft in neutral position (cen-

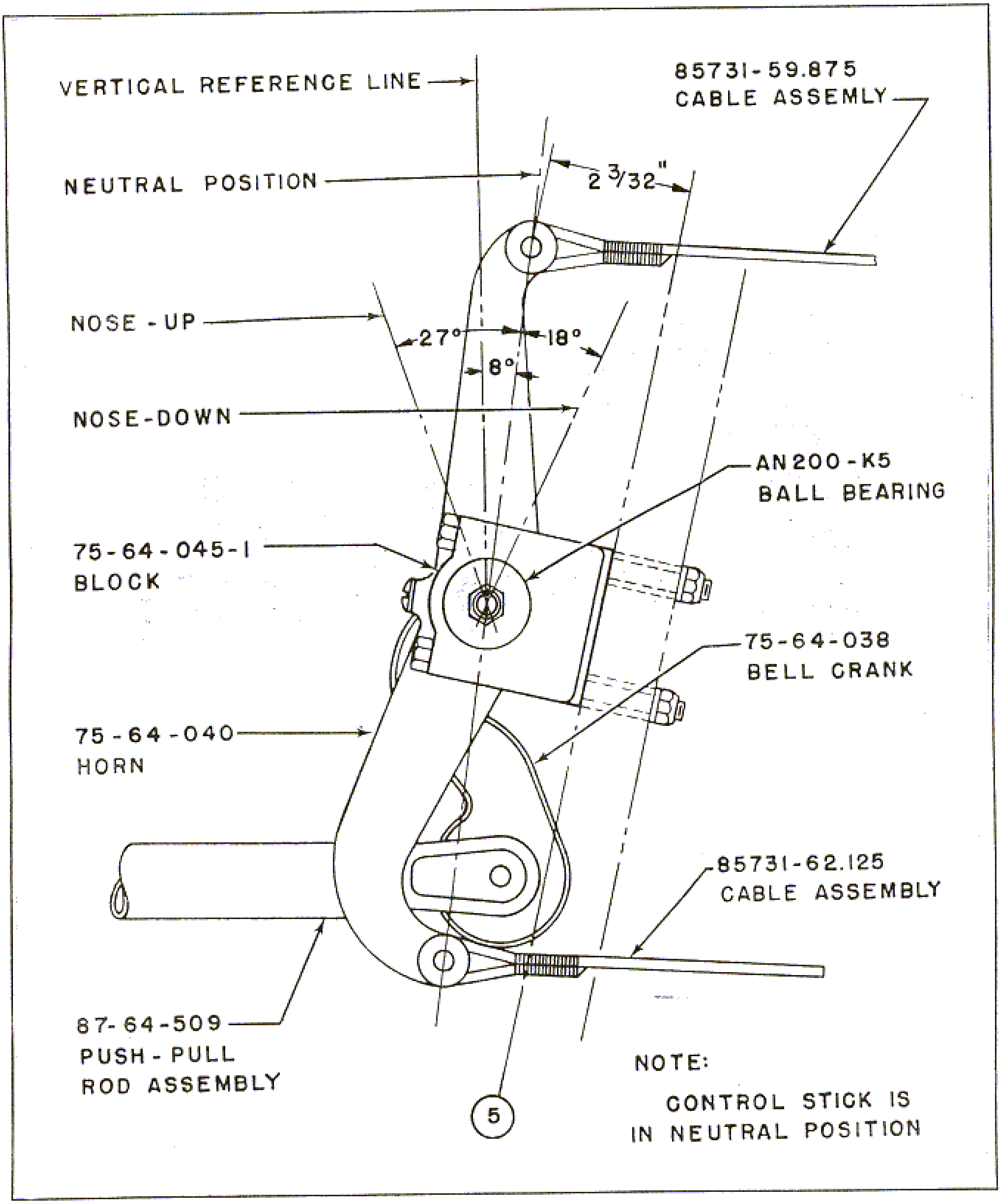


Figure 213—Jackshaft Setting

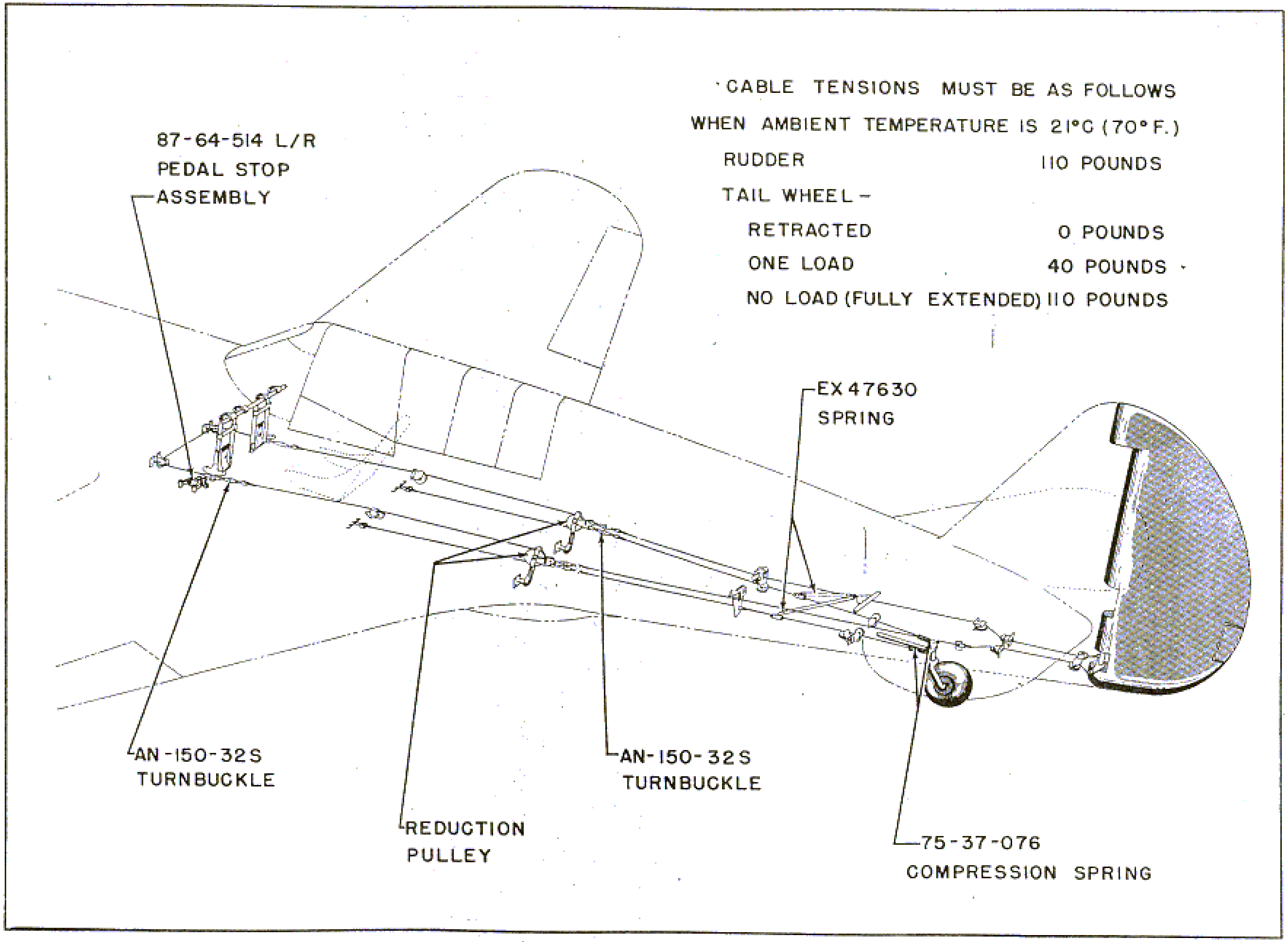


Figure 214—Rudder and Tail Wheel Controls

ter line of top hole in jackshaft horn at 2-3/32 inches from the bulkhead). (See figure 213.) Adjust the cable turnbuckles until the elevator surfaces are in neutral and then using a tensiometer (figure 215) adjust turnbuckles to obtain 100 pounds tension in the cables when the surrounding temperature is 21°C (70°F). Adjust the elevator movement by adjusting the stop on the forward side of the flight control stick. (See figure 212.) The range of movement of the elevators should be 30 degrees up and 20 degrees down from the streamline with the stabilizer. The permissible tolerance is ± 2 degrees.

(3) RUDDER AND TAIL WHEEL CONTROLS. *(See figure 214.)*

(a) DESCRIPTION.

1. The rudder control system is operated by two cables running aft from the rudder pedals. Each cable passes around a reduction pulley mounted on an arm at station 8. Two cables attached to each reduction pulley by turnbuckles, lead aft, one connecting to the rudder horn, the other to the tail wheel horn. These move in unison for steering the airplane on the ground. A run-around cable runs from one pedal forward around two pulleys to the opposite pedal.

2. Each tail wheel control cable passes through a pair of guide pulleys at station 13. Slack in the cable is avoided by the use of two coil tension springs attached to the lift tube at the center line of the fuselage and to the cable at station 12. The cable also incorporates a compression spring to avoid transmitting taxiing shock to the rudder pedals.

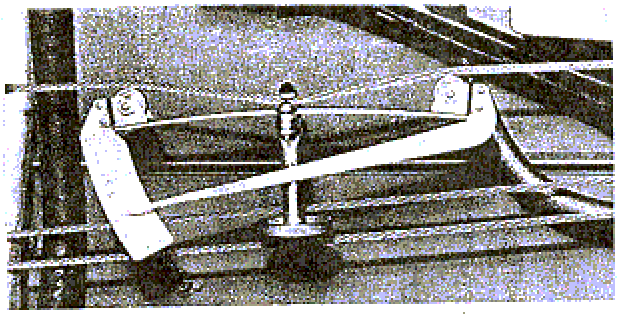
3. The rudder pedal stops are small castings mounted on the fuselage-wing attachment angle, one on each side of the cockpit near the floor. The rudder pedal in the full forward position strikes the adjustable stop screw head. There is also a horn stop assembly installed on the lower rudder hinge block in AF43-24253 and subsequent airplanes. (See figure 106.) The horn stop assembly prevents the rudder from exceeding its normal range of travel when loads are imposed that stretch the rudder cables.

4. The specified tension of the rudder and tail wheel cables is as follows when the ambient temperature is 21°C (70°F):

Rudder Cables	110 pounds
Tail Wheel Cables (retracted)	0 pounds
Tail Wheel Cables (one load)	40 pounds
Tail Wheel Cables (no load)	110 pounds

All cables requiring specified tension are tested for correct loading by a tensiometer. (See figure 215.)

(b) ADJUSTMENT.—The turnbuckles for adjusting the tension in the rudder and tail wheel control cables are located just aft of station 8 and are accessible through the fuselage access door. Other adjustment is obtained at the turnbuckles which are installed in the cables at the rudder pedals. To adjust the rudder throws and cable tensions, proceed as follows:



CABLES MUST BE RIGGED TO FOLLOWING TENSIONS, WHEN THE AMBIENT TEMPRATURE IS 21°C (70°F)

AILERON	110 POUNDS
ELEVATOR	100 POUNDS
RUDDER	110 POUNDS
TAIL WHEEL	
RETRACTED	0 POUNDS
ONE LOAD	40 POUNDS
NO LOAD (FULLY EXTENDED)	110 POUNDS

Figure 215—Use of Cable Tensiometer

1. Hold the rudder pedals in neutral position by clamping the two pedals to a straight metal bar.

2. Adjust the two turnbuckles in the rudder control cables at station 8 so that the rudder is in neutral position (in streamline with fin.)

3. Adjust the turnbuckles at the rudder pedals and at the reduction pulleys to obtain a tension of 110 pounds in both, rudder and tail wheel cables, when the surrounding temperature is 21°C (70°F).

Note

Jack the aft end of the airplane so that the tail wheel will be fully extended when adjusting the rudder cable tension to 110 pounds.

4. Unclamp the rudder pedals from the metal bar and adjust the rudder throws by adjusting the pedal stops which are located forward of each pedal. The range of movement of the rudder is 30 degrees either side from the streamline with the fin. The permissible tolerance is ± 2 degrees.

Note

On those airplanes having the rudder horn stop installed, back off the bumpers so that the adjustment of the stops forward of the rudder pedals can be made accurately; then, adjust the bumpers of the horn stop assembly to permit full rudder movement.

5. Push each rudder pedal to the extreme forward position and check the clearance between the reduction pulley and the bulkhead at station 8. The reduction pulley should clear the bulkhead by at least 1/2 inch. If this clearance is not obtained, readjust the turnbuckles to obtain it.

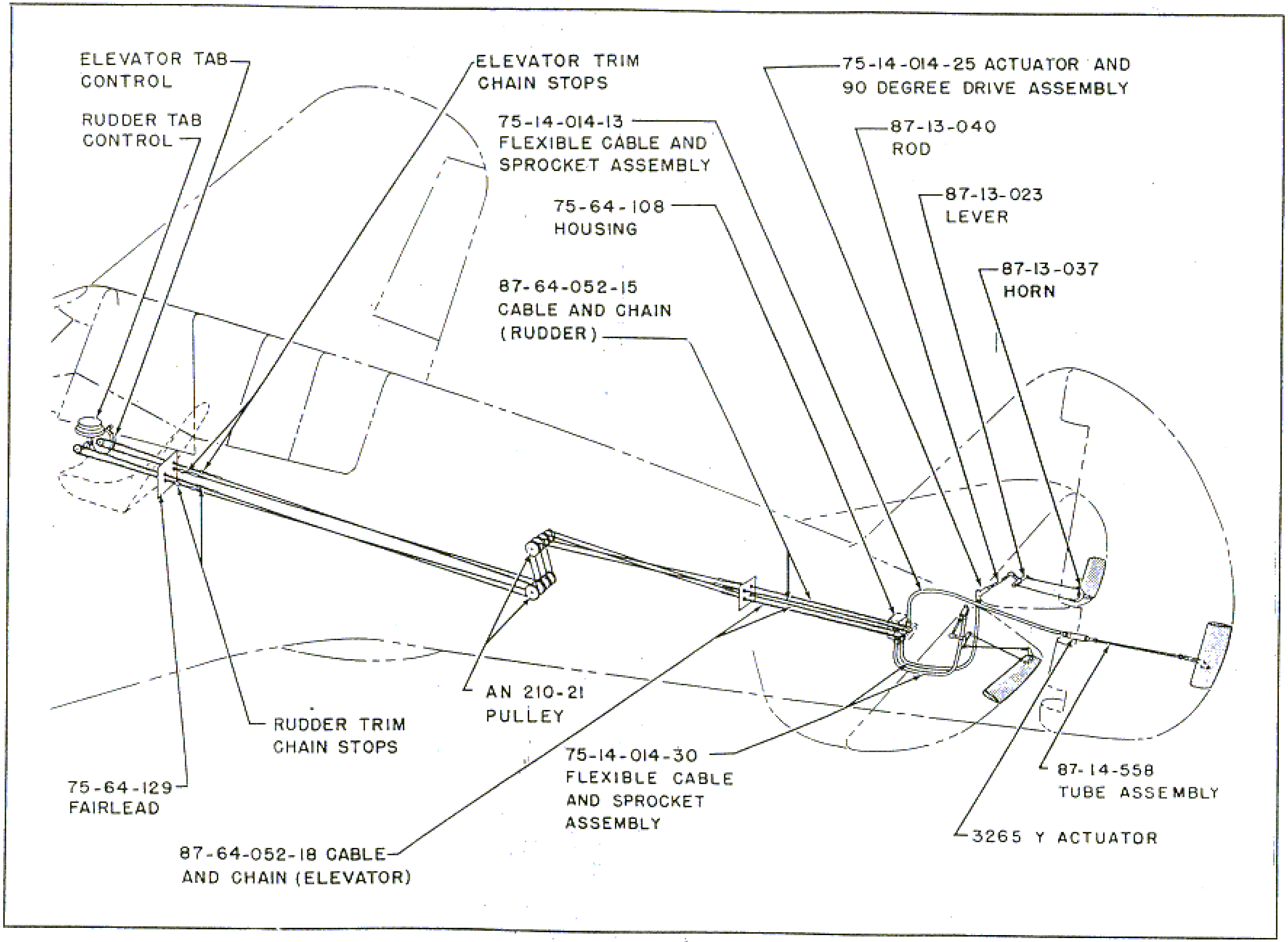


Figure 216—Trim Tab Controls

(4) TRIM TAB CONTROLS.

(a) AILERON TRIM TABS.—Airplanes AF42-104429 through AF43-24251 are equipped with fixed aileron trim tabs of metal which must be adjusted while the airplane is on the ground. Merely bend them up or down as desired. They are attached to the inboard trailing edge of each aileron.

Note

Airplane AF43-24252 and subsequent, are equipped with an electrically operated trim tab in addition to the fixed trim tabs. The electric aileron trim tab, located on the left hand aileron, inboard of the fixed trim tab, is controlled by means of an electric motor mounted in the leading edge of the aileron. The momentary contact operating switch for the motor is located aft of the engine control quadrant and just forward of the rudder trim tab control.

(b) ELEVATOR AND RUDDER TRIM TABS.

1. DESCRIPTION.—The elevator and rudder trim tab controls are mounted on the left side of the cockpit. Motion is transmitted by a chain and sprocket drive to the gear-box mounted just forward of the rear elevator jackshaft. The control chain is equipped with turnbuckles for adjustment. From the gear-box, three flexible shafts, two for the elevator and one for the rudder, transmit motion, one to each tab control actuator unit. Short tie rods connect these actuators to the elevator tabs; a longer rod, enclosed in a fairing on the right side of the rudder, connects with the rudder tab.

2. ADJUSTMENT.

a. Control chain tension is adjustable by turnbuckles accessible through the baggage compartment door.

b. In the assembly of the rudder trim tab actuating arm, 7/8 ±1/32 inch is allowed between the end of the actuator screw jack and the end of the tube. The lock nut is tightened against the actuator, and the actuator and tube are jointly drilled and cottered. The actuator is extended 3-5/8 ± 1/32 inches (measured from the center of the hinge pin-holes to the end of the actuator screw jack), to assure proper throw of the trim tab. The clevis end can be adjusted so that the distance between the hinge pin center on the actuator and the clevis-and-bolt-hole center is approximately 23/32 to 25/32 inch.

c. The rudder tab actuating arm fairing located on the right side of the rudder is removed and the actuating arm assembly is installed. The rudder tab control, located at the left of the pilot's seat is set at 0 degrees before the flexible shaft is attached to the rudder tab actuator.

d. Final adjustment of the trim tab is attained by turning the clevis end of the actuating arm assembly as required to align the trim tab center line with the rudder center line. The lock nut is tightened against the clevis end, and the clevis end and tube are jointly drilled and cotter pinned.

c. HYDRAULIC SYSTEM. *(See figure 217.)*

(1) GENERAL DESCRIPTION.—The main hydraulic system of this airplane operates the retractable alighting gear and the wing flaps. An Eclipse, type 809, model 3, motor-driven hydraulic pump, accessible through the fuselage access door, is the chief source of pressure for the system which must be serviced exclusively with hydraulic fluid, AAF Specification 3586. An auxiliary hand pump located on the right side floor of the cockpit may be used to produce pressure in place of the Eclipse motor. Two main landing gear retracting struts, one tail wheel retracting strut, one flap actuating cylinder, a control or selector valve, three relief valves, a check valve, reserve tank, line tubes and fittings comprise the remaining essential components of the system. Consult Tubing chart of Hydraulic system in section VIII for torque requirements in assembling tubes and fittings.

(2) MOTOR DRIVEN HYDRAULIC PUMP.

(a) GENERAL.

1. The Eclipse pump, type 809, model 3, which builds pressure in the hydraulic system is of spur gear construction, mounted on a 24-volt electric driving motor. The upper spur gear shaft of the pump unit is keyed to the motor armature shaft by a flexible coupling which provides the driving force for the pump. The lower spur gear is meshed with the upper gear and its shaft is retained in the two pump housing sections. The pump housing is of the split type held together by eight bolts and two cap screws. The two pump housings are held in alignment by two dowel pins through the pump flanges. The pump head incorporates an inlet and an outlet port for external tubing connections. A pressure relief valve is also installed in the pump head and provides the means to limit the outlet pressure to 1150 pounds per square inch. An oil seal, installed on the drive end of the upper spur gear shaft, prevents leakage of oil into the electric motor housing from the pump housing.

2. The unit is mounted, by means of a bracket provided on the motor housing. A type B-6B switch, located on the control stick below the grip, controls the operation of the pump. The inlet port is connected to the hydraulic fluid reserve tank. The outlet port is connected to the system supply line.

(b) EXTERNAL INSPECTION FOR MOTOR TROUBLE.

1. If the electric motor (to which the hydraulic motor-driven pump is attached) fails to operate, or operates at too low a speed, the possible cause may be low voltage, due to a discharged battery. Check the battery and recharge if necessary.

2. It may also be due to loose or corroded battery terminals. Clean, tighten, and coat with vaseline.

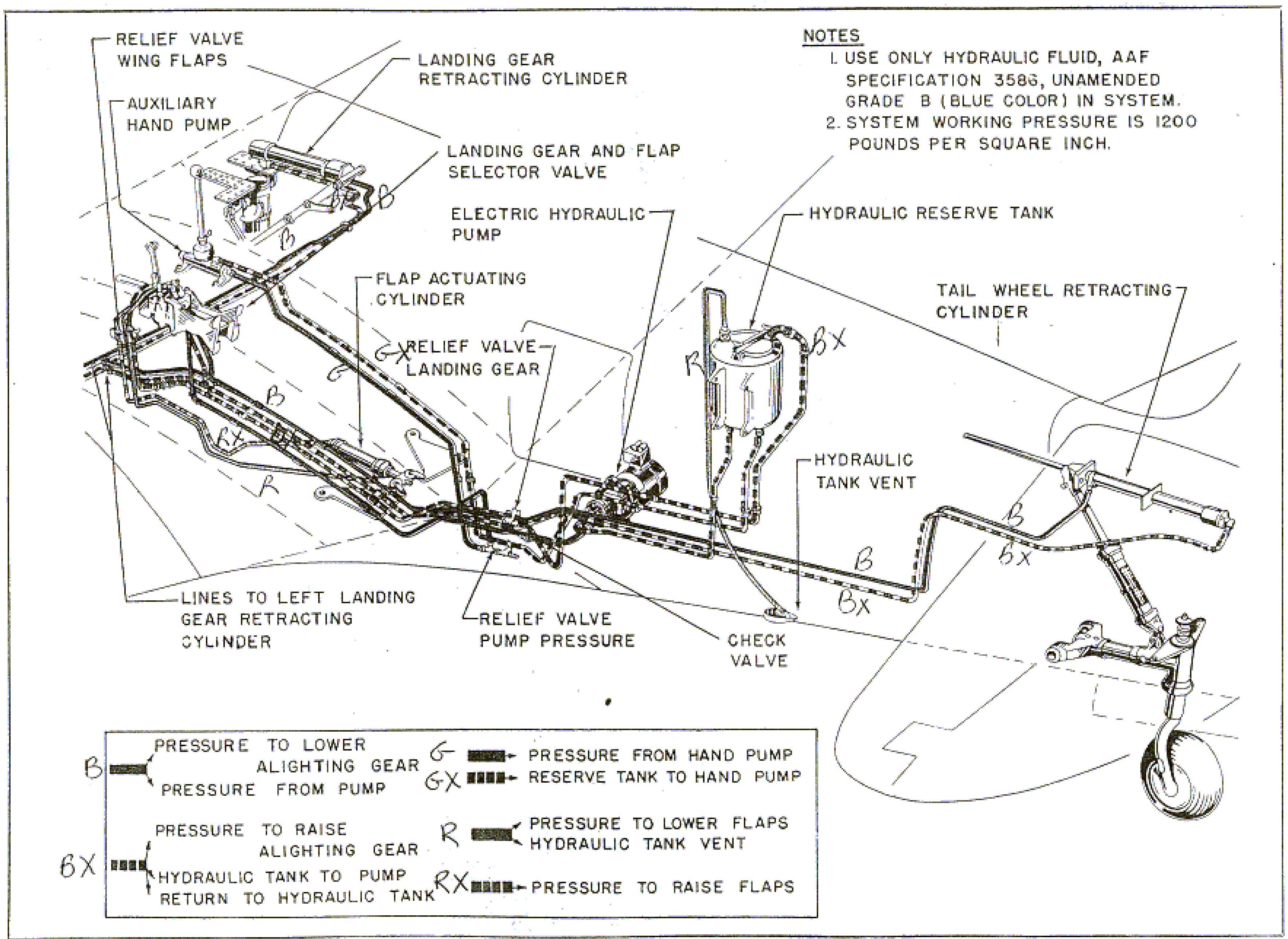


Figure 217—Hydraulic System

3. If these are not the cause, check the wiring connections for loose or high resistance connections.

4. If the motor shows low output pressure or capacity, check the system for insufficient fluid supply, low setting of the relief valve (installed in the pump head), leak in the line or valves, low operating speed, loose fittings, or improper fluid.

(c) TO DISASSEMBLE THE MOTOR DRIVEN PUMP.

1. Remove the motor and pump assembly from the fuselage by first disconnecting the electric cables from the battery, and the inlet and outlet hydraulic lines from the ports on the pump face. Remove the bolts attaching the base of the motor housing to the fuselage mounting shelf.

2. Place the motor and pump assembly in a vise with aluminum covered jaws as shown in figure 218.

3. Cut the safety wire on the two cap screws on the pump body and remove the screws. Engage the heads of the eight through bolts with a wrench and turn the lock nuts off the inboard side of the pump flange with another wrench. (See figure 218.)

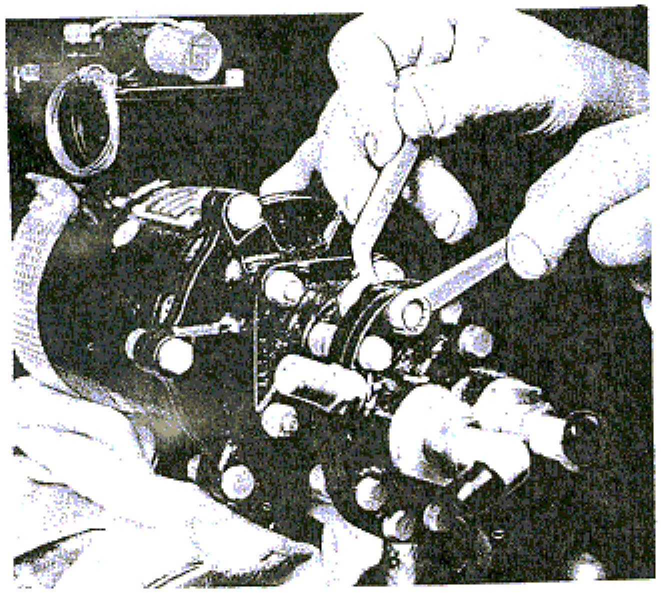


Figure 218—Removing Bolts to Separate Hydraulic Pump Unit

4. Release the pump motor from the vise, turn it to a vertical position, secure again, and tap the two dowel pins from the pump flanges with a punch and light hammer. (See figure 219.)

5. Tap lightly around the port plate with a wooden hammer to separate the pump face from the pump body and pull the spur gears from the pump housing. (See figure 220.)

CAUTION

The spur gears must be handled with extreme care to prevent nicking or scratching. When overhauling more than one pump at a time, keeps the gears in sets for reinstallation in the same pump bodies.

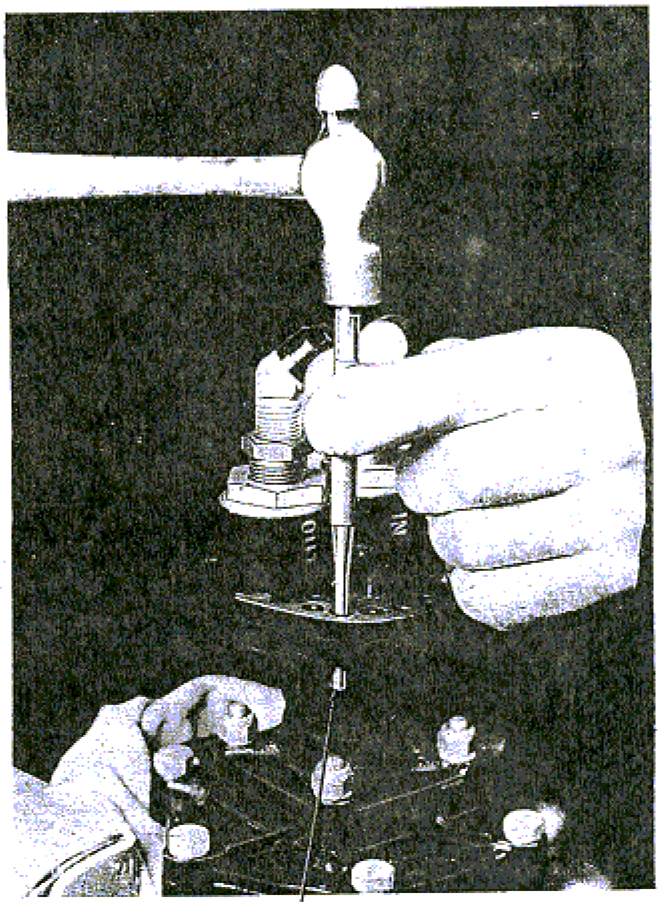


Figure 219—Removing Pins from Pump Housing Flange

6. The pump body can now be separated from the motor housing by removing the four lock nuts around the body flange.

7. Removal of oil seal at the drive end of the pump body is effected by unscrewing the slotted nut in the pump body.

8. Disassembly of the relief valve on the port face of the pump simply requires the removal of the cap and the unscrewing of the relief spring retainer.

(d) INSPECTION FOR REPLACEMENTS.

1. When the pump is disassembled, thoroughly clean all parts with alcohol and examine them carefully for signs of wear and damage, and the presence of foreign matter such as metal chips, grit and dirt. If the spur gears or pump housing are damaged, even slightly, replace with a new pump unit. When foreign matter is found, the complete hydraulic system must be drained and flushed.

(e) TO ASSEMBLE THE MOTOR DRIVEN PUMP.

1. Assemble the relief valve by screwing in the relief spring retainer and installing the cap.

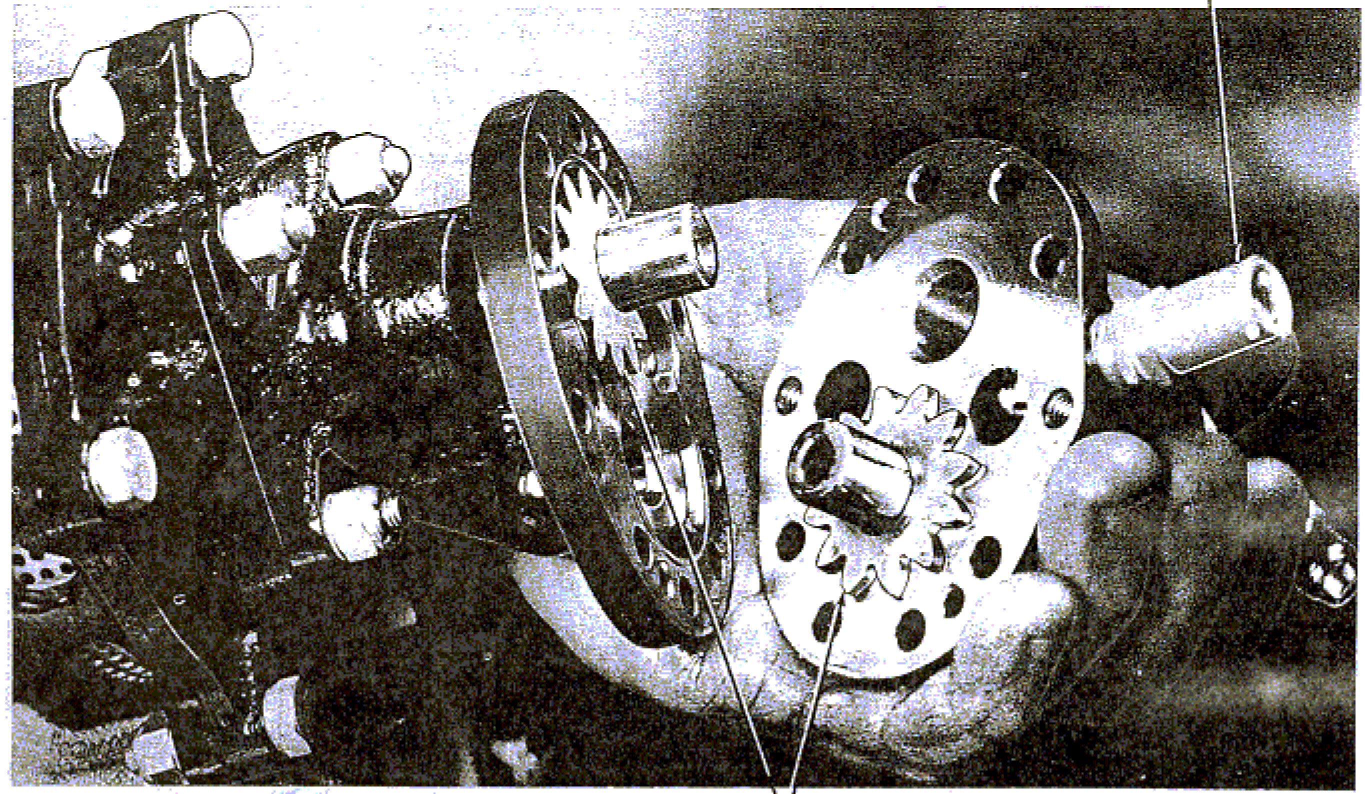


Figure 220—Separating Hydraulic Pump Housing

2. Install the oil seal at the drive end of the pump body by screwing in the slotted nut in the pump body.

3. Secure the motor housing in a vertical position in a vise with aluminum jaws, then after making certain that the machined surfaces are thoroughly clean, attach the pump body to the motor housing by installing the four locking nuts.

4. Reinstall the spur gears, handling carefully to avoid nicking or scratching, making sure where more than one pump is disassembled, that the gears are kept in sets as originally installed, and are returned to the same pump bodies.

5. Attach the pump face to the pump body by first tapping in the dowel pins with a punch and light hammer. Change the assembly in the vise to a horizontal position, then secure the eight through bolts by the use of two wrenches as shown in figure 218, and install the two cap screws and safety with wire.

6. Remove the complete assembly from the vise and bolt the base of the motor housing to the fuselage mounting shelf. Fit the inlet and outlet hydraulic lines to the ports in the pump face, and connect the battery cables.

(3) AUXILIARY HYDRAULIC HAND PUMP.

(a) GENERAL.—The auxiliary hydraulic hand pump, located on the right side of the cockpit is a single cylinder, reciprocating, double action pump, equipped with an intake check and a discharge check valve. This pump provides pressure for the hydraulic system in lieu of the motor-driven pump.

(b) TO DISASSEMBLE THE AUXILIARY HYDRAULIC PUMP.

1. Remove the hand pump from the floor of the cockpit by disconnecting the two hydraulic lines and removing the four hold-down bolts.

2. To facilitate handling of the pump and to protect the cylinder, it is recommended that the cylinder be mounted to a metal table with a perpendicular tee piece for clamping in a vise.

3. With the pump body mounted to a table in a vise, turn the boot inside out and pry off as shown in figure 221.

4. Cut the safety wire on the pump nut and turn the nut from the pump body by the special hand pump wrench (part No. 87-88-032) carried in the airplane tool kit. (See figure 222.) Remove the shim under the nut flange.

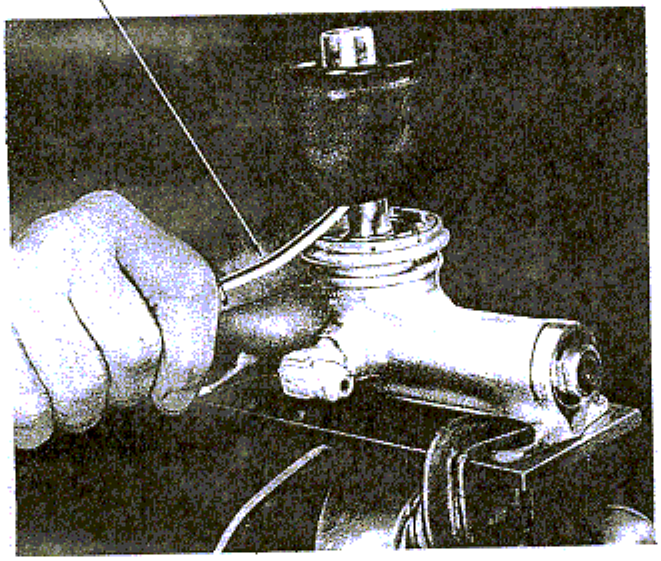


Figure 221—Removing Boot from Hand Pump

5. Pull the ball-piston end out of the pump housing. (See figure 223.) Remove the pump nut packing.

6. Pull the snap rings with a snap-ring wrench and remove the valve assemblies at both ends of the pump cylinder.

7. A screwdriver may be used in either end to push the piston assembly from the pump cylinder. Place the screwdriver in the slot on the retainer when applying force to remove the piston so that the face of the retainer will not be disfigured.

8. The piston and valves may now be disassembled to check the ball and ball seats as well as the springs.

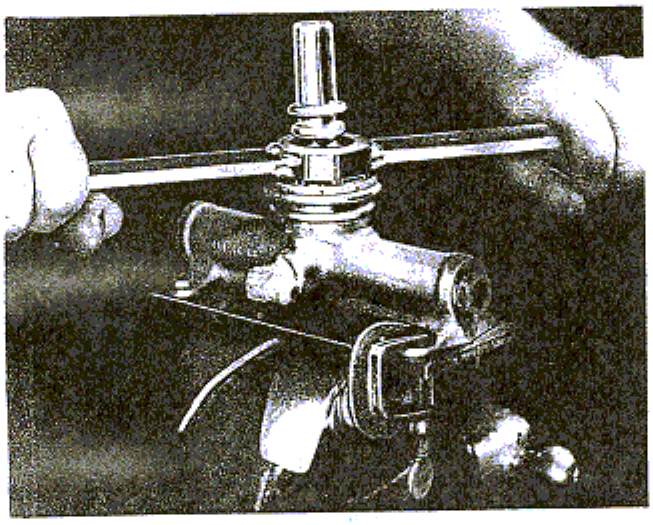


Figure 222—Removing Nut from Hand Pump Body

9. Insert the correct size Allen wrench in a vise in a horizontal position with just enough of the wrench protruding to engage the Allen setscrew in the retainers at either end of the piston.

10. Engage the Allen wrench in the Allen setscrew and apply an adjustable wrench to the piston at its flat sides. Turn the piston with the wrench to loosen the Allen setscrew. Extreme care must be exercised in this operation to avoid breaking the wrench.

11. When the Allen setscrew has been loosened, pull the piston from the Allen wrench and unscrew the retainer with a screwdriver. This will free the packing ring and packings as well as the spring and hardened steel ball.

12. Reverse the piston and remove the other retainer in the same manner as described in steps *10* and *11*, preceding.

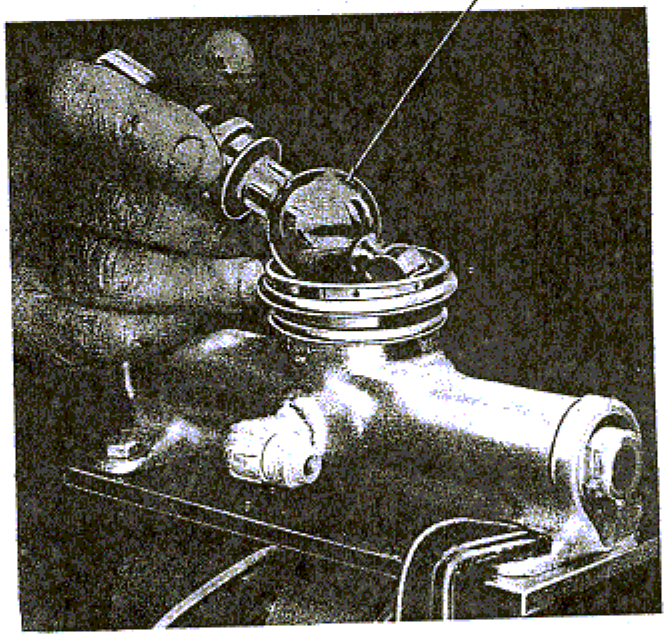
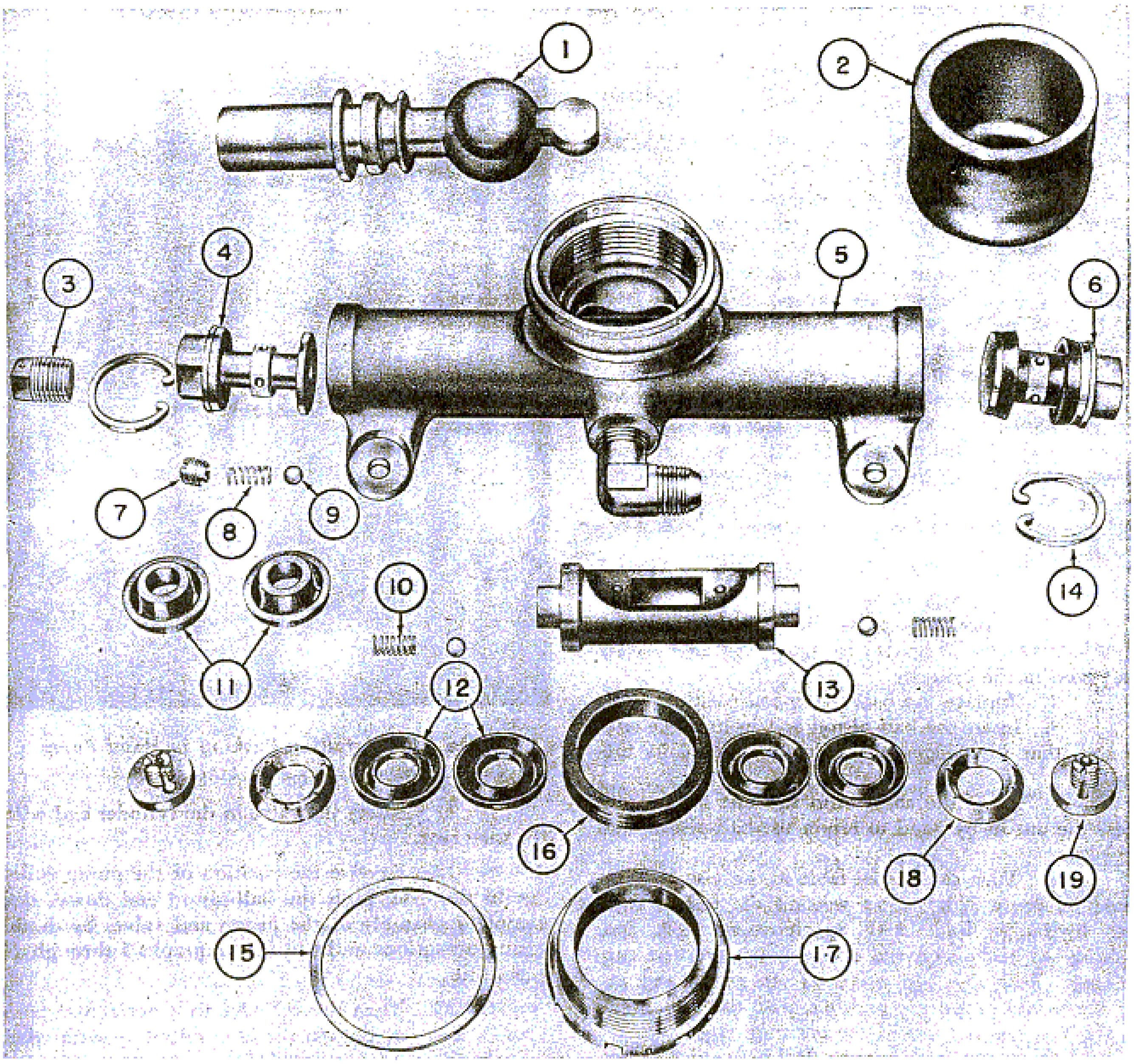


Figure 223—Removing Ball-Piston End from Hand Pump Body

13. In removing the ball and spring in either of the two valves, extreme care must be exercised to avoid damaging the retainer end by twisting off the ears. If a small screwdriver is used for this operation, the retainer is quite often damaged beyond repair; therefore, it is suggested that a special tool be made for this delicate operation. A tool can be made by taking a small size concrete drill and grinding the point down flat so that the four fins on the drill engage the four slots in the retainer. Insert this special tool in a vise in vertical position and slip the valve over the tool until the retainer is engaged properly. Place the adjustable wrench on the flat sides of the valve end and turn the piston until the retainer is loosened. Remove



1. BALL-PISTON END
2. BOOT
3. PLUG
4. VALVE
5. PUMP BODY
6. VALVE ASSEMBLY
7. RETAINER
8. SPRING
9. HARDENED STEEL BALL
10. SPRING
11. CUP PACKING
12. PACKING
13. PISTON
14. SNAP RING
15. SHIM
16. PACKING
17. NUT
18. PACKING RING
19. RETAINER

Figure 224—Hydraulic Hand Pump Disassembled

the valve from the special tool and remove the retainer with a small screwdriver. The spring and hardened steel ball will now drop out of the valve.

14. The valve cup packings can now be slipped off the valve. The pump is completely disassembled. (See figure 224.)

(c) INSPECTION FOR MINOR REPAIRS AND REPLACEMENTS.

1. Most pump failures are due to foreign matter lodging in between the steel balls and seats which must lap perfectly in the piston assembly; therefore, inspect those units carefully and be sure they are thoroughly clean before reassembly. When the ball seat is scratched or pitted, try hand lapping to secure a perfect lap fit with the ball. If a perfect fit cannot be effected, replace the entire piston unit.

2. In assembling the rubber packings, for the complete pump assembly, care must be taken not to damage the feather edges, for a slight cut will cause unsatisfactory pump performance and necessitate replacing the packings. Before installing, immerse the packings and coat the parts with hydraulic fluid, AAF Specification 3586.

(d) TO ASSEMBLE THE HYDRAULIC HAND PUMP.

1. Attach the pump body to the special table in a vise as illustrated in figure 225 and install the piston in the cylinder.

2. Replace the ball-piston-end-packing ring.

3. Insert the ball-piston end in its place and be sure that it engages the rectangular slot in the piston.

4. Drop the shim onto the nut flange and screw the nut in by hand to retain the ball-piston end in place.

5. Turn the special table in the vise as illustrated in figure 225. After wetting the piston cups with hydraulic fluid, AAF Specification 3586, and pushing the ball-piston end down, insert the first cup packing. Push this cup down on the piston and insert the second piston cup packing, push this cup down on the first cup and install the packing ring.

6. Insert the hardened steel ball and a spring in the piston end.

7. Place an Allen wrench on the Allen setscrew in the retainer and guide the retainer down into place on the piston. Engage a screwdriver in the slot in the face of the retainer and screw the retainer into place. Tighten the Allen setscrew with the Allen wrench.

8. In assembling either of the two valves at the pump cylinder ends, first slide on the cup packings coated with hydraulic fluid, AAF Specification 3586.

9. Insert the hardened steel ball and spring in the valve.

10. Place the special tool described in paragraph (3), *(b)*, *13*, preceding, in a vise in a vertical position and engage the retainer. Install the retainer by applying an adjustable wrench to the flat sides of the valve end.

PUSH BALL-PISTON END DOWN AS FAR AS POSSIBLE

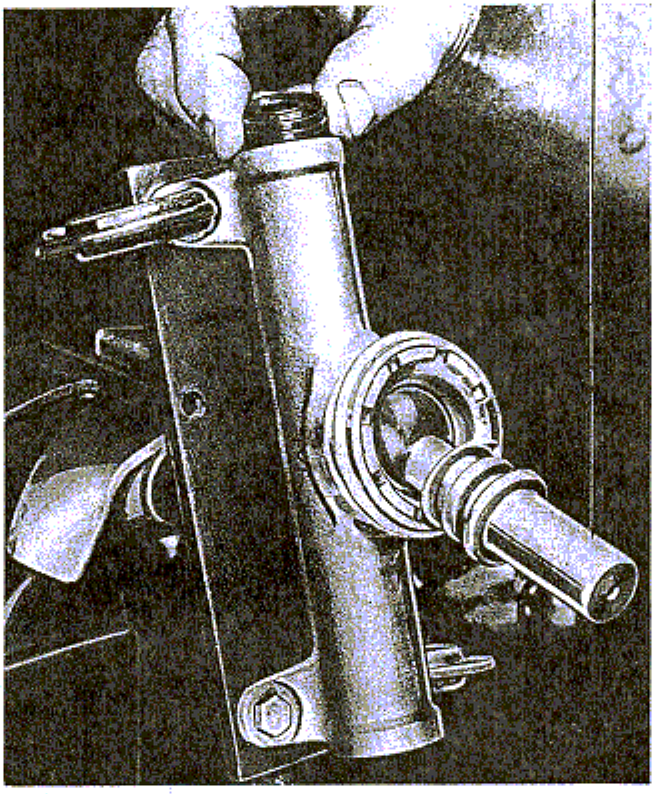


Figure 225—Installing Packing in Hand Pump

11. Safety the valve in the cylinder end with the snap ring.

12. Reverse the position of the pump cylinder in the vise, push the ball-piston end down, and complete assembly of the piston and valves by duplicating operations outlined in paragraphs 5 through *11* preceding.

13. Turn the cylinder to a horizontal position in the vise, tighten the nut and safety with wire.

14. Turn the rubber boot inside out, force the top of the boot over the flange on the ball-piston end, then turn the boot down and stretch its bottom over the flange on the pump body.

(e) TEST.

1. Before installing the auxiliary hand pump, test it in accordance with the procedure outlined on figure 226.

(4) HYDRAULIC CONTROL VALVE. *(See figure 227.)*

(a) GENERAL.—The hydraulic control (or selector) valve for the retracting and lowering of the alighting gear and wing flaps, is located on a mounting bracket at the left side of the cockpit just forward of station 5 bulkhead. This control valve meters the flow of pressurized hydraulic fluid through a series of

TEST PROCEDURE:

1. PUMP MUST DELIVER ONE QUART FOR 80 STROKES (40 CYCLES) MAXIMUM AT 500 POUNDS PER SQUARE INCH PRESSURE.
2. PLUG PORT "B" APPLY 2500 POUNDS PER SQUARE INCH PRESSURE AT PORT "A". PUMP MUST NOT LEAK MORE THAN 5 DROPS A MINUTE.
3. PLUG PORT "A" AND "B" APPLY 2500 POUNDS PER SQUARE INCH PRESSURE AT PORT "C". PUMP MUST NOT LEAK MORE THAN 5 DROPS A MINUTE.
4. USE ONLY HYDRAULIC FLUID, AAF SPECIFICATION 3586, UNAMENDED, GRADE B FOR TEST.

A	87-33-067	BODY
	PISTON ASSEMBLY	
B	87-33-048	PISTON
C	87-33-064	PACKING
D	87-33-065	PACKING RING
E	87-33-504-1	HARDENED STEEL BALL
F	87-33-058-2	SPRING
G	87-33-062	RETAINER
H	87-33-504-2	10-32 ALLEN SET SCREW
	VALVE ASSEMBLY	
I	87-33-049	VALVE
J	87-33-059	CUP-PACKING
K	87-33-054-1	HARDENED STEEL BALL
L	87-33-058-1	SPRING
M	87-33-055	RETAINER
N	87-33-070	SNAP RING
O	895-71	PLUG
	BALL INSTALLATION	
P	87-33-054	PACKING
Q	87-33-528	BALL-PISTON END
R	87-33-053	SHIM
S	87-33-050	NUT
T	87-33-051	BOOT
U	87-33-052	PLUG
V	87-33-057	PIN

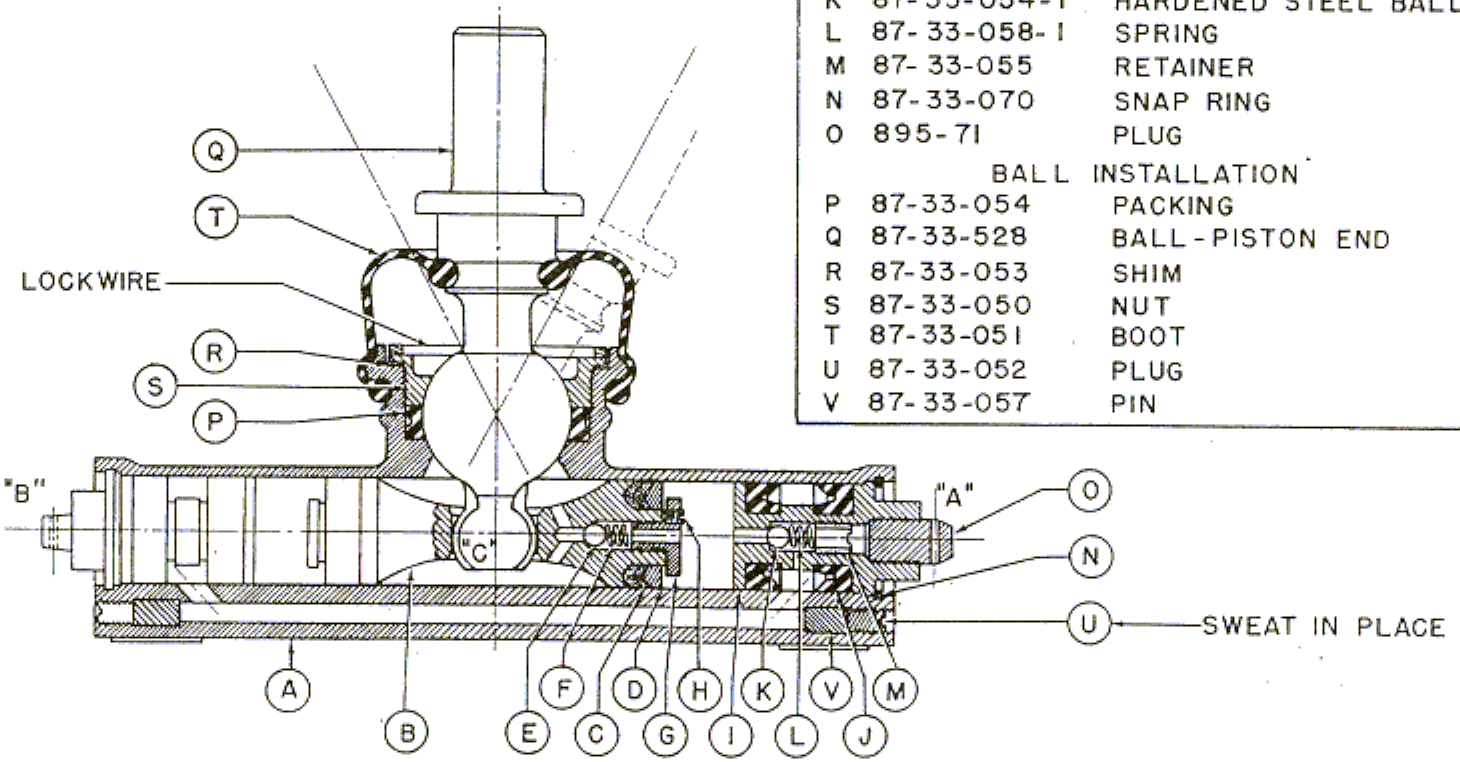


Figure 226—Test of Hydraulic Hand Pump

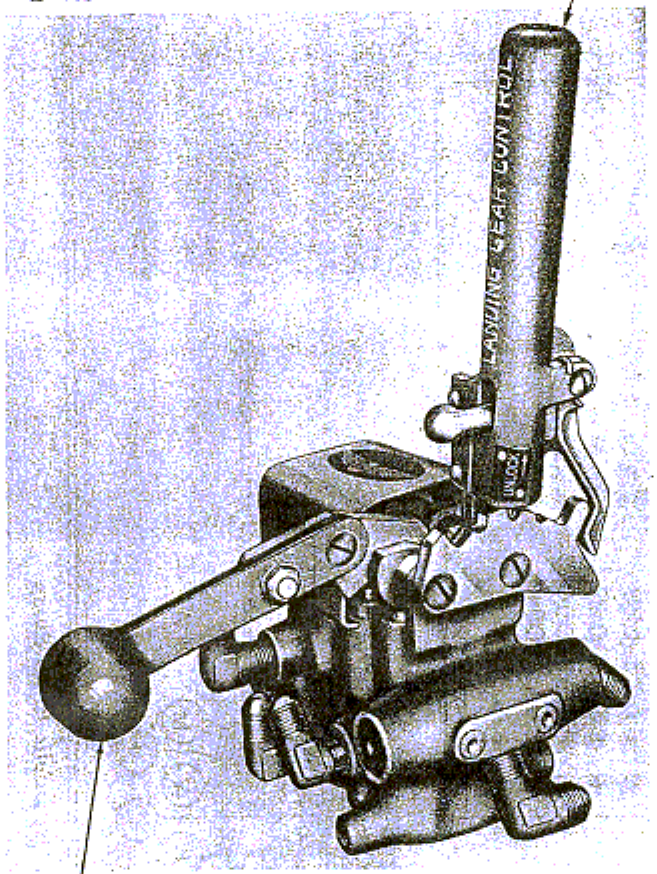


Figure 227—Hydraulic Control Valve

poppet valves operated by camshafts attached to the control handles when either the motor-driven pump or the auxiliary hand pump is employed to produce the hydraulic pressure.

(b) TO DISASSEMBLE THE HYDRAULIC CONTROL VALVE.—Disconnect all hydraulic lines to the valve and remove the valve from its mounting bracket on station 5 bulkhead, and proceed as follows:

1. Clamp the control valve in a vise with aluminum covered jaws at the four attachment bosses. Remove the cotter pins and nuts from the two camshaft bolts. (See figure 228.)

2. Push the bolts back beyond the valve cover and remove the cover from the valve body.

3. Pull the bolts and the segment completely out of the camshafts and lift the camshafts from the valve body. (See figure 229.)

4. Remove the retainer spring on top of the valve body and pull the followers out of the valve as shown in figure 230. It is very important that the followers and gaskets, including the shims, be kept together and in order so that they may be replaced in the same order in the valve body upon reinstallation. (See figure 231.)

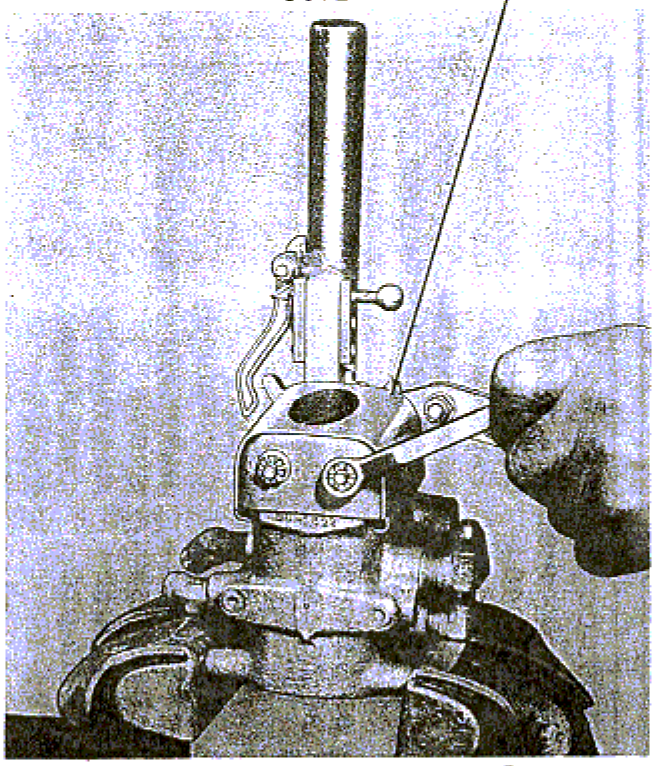


Figure 228—Removing Nut on Camshaft Bolt

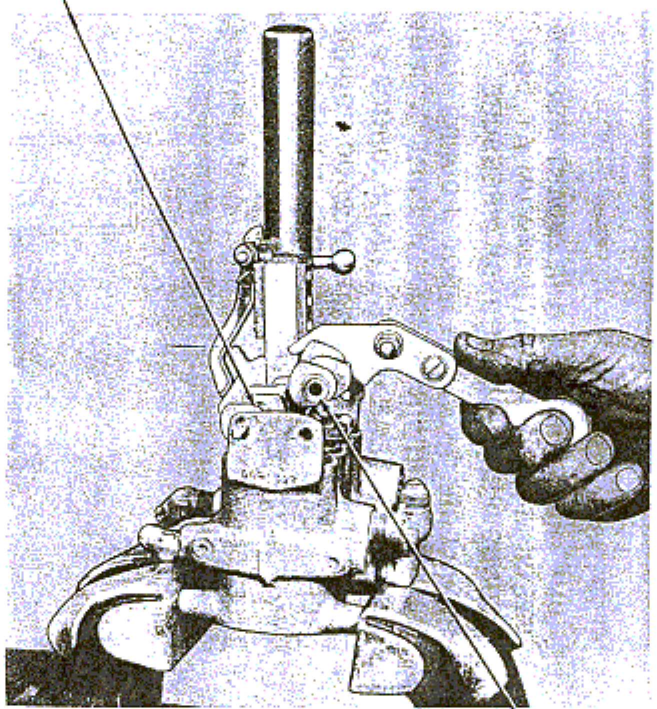


Figure 229—Removing Control Camshaft

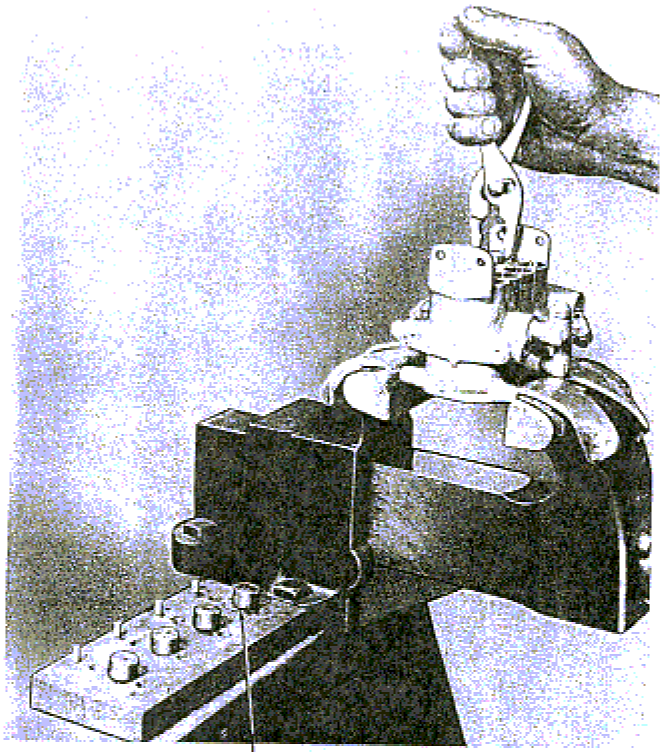


Figure 230—Removing Followers from Valve Body

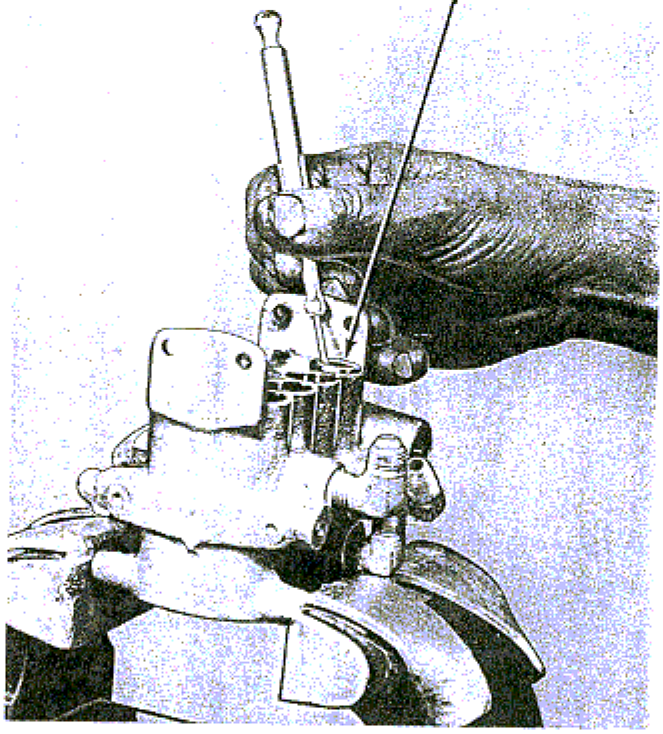


Figure 232—Removing Gaskets and Shims from Valve Body

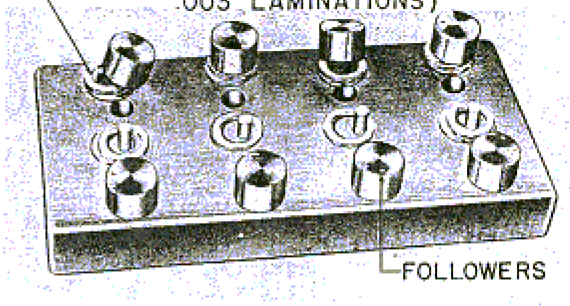


Figure 231—Method for Keeping Follower Assemblies Intact

5. Remove the gaskets and shims from the valve and place them with the correct followers. (See figure 232.)

6. Release the valve body from the vise, turn upside down, and replace it in the vise. Next, remove the eight snap rings locking the retainers in the valve body. Use either a snap ring wrench or a small pair of pliers. (See figure 233.)

7. After the rings are all removed, engage the ends of the retainers with a pair of pliers and pull the retainers free of the valve body. (See figure 234.)

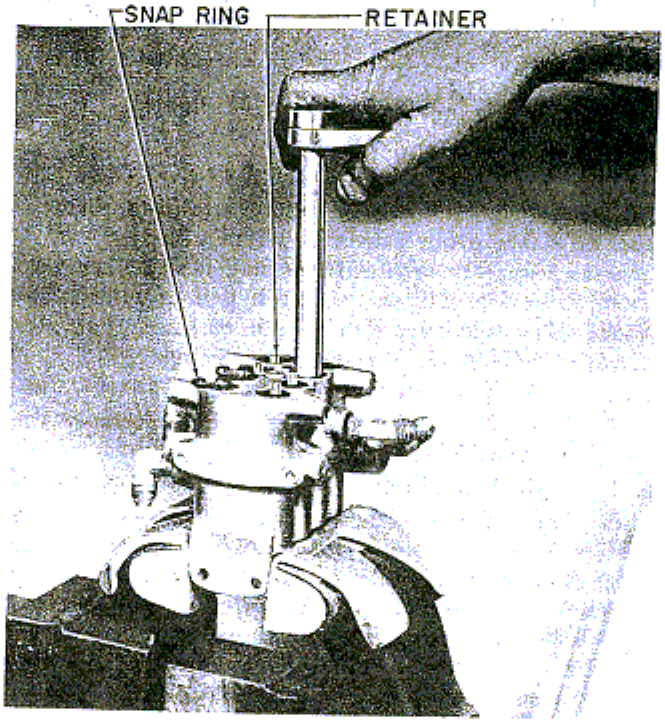


Figure 233—Removing Snap Ring from Retainer

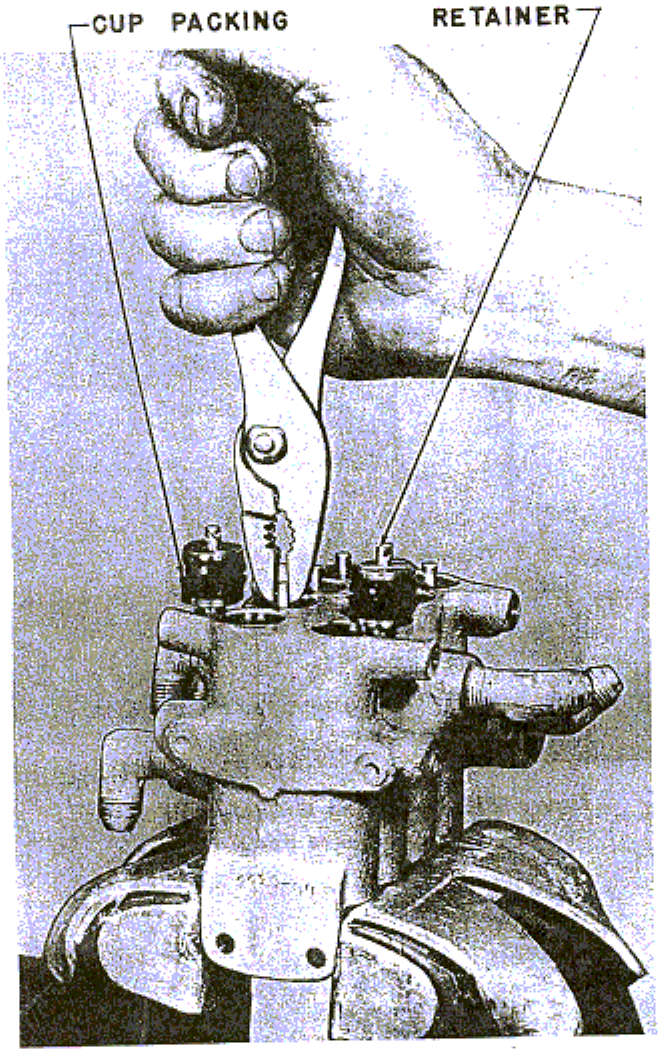


Figure 234—Removing Retainers

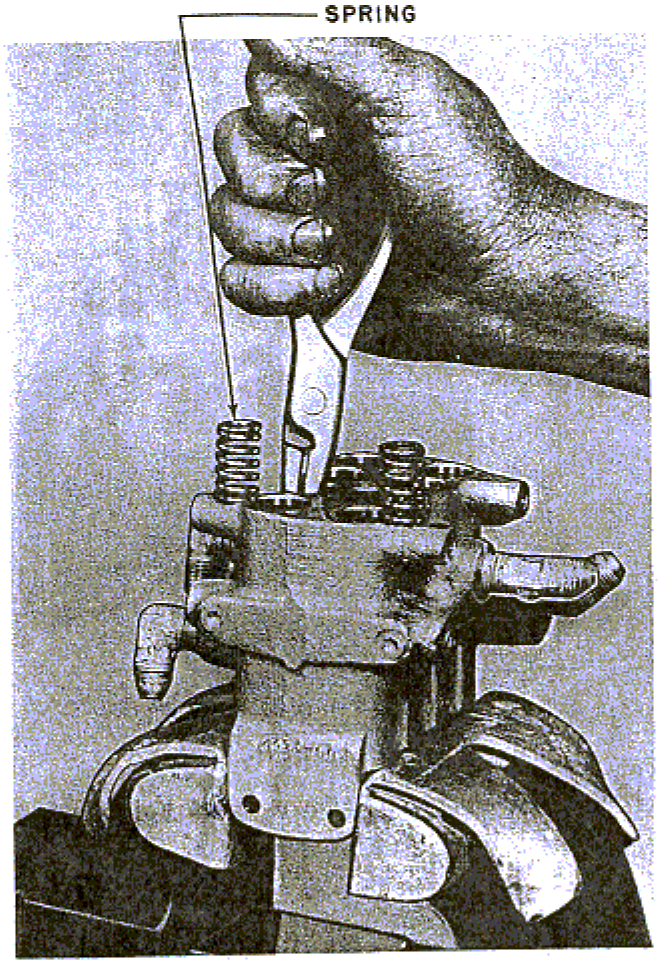


Figure 235—Removing Valve Springs

When removing the retainers, exercise extreme care not to damage the rubber cups by fouling them in the snap ring grooves inside the valve body.

8. The valve springs may now be removed from the valve body with a light pair of pliers. (See figure 235.) Be very careful not to score the valve cylinder surface with the pliers or springs.

9. Turn the valve body over in the vise. Pull the cotter pins from the valve nuts. Remove the valve body from the vise.

10. To facilitate the removal of the valve nuts, it is suggested that a tool be made up to engage the slotted ends of the valves in order to keep the valves from turning with the nuts. Such a tool can be easily fashioned from a piece of tubing that may be inserted into the valve cylinders. Saw a slot in the diameter of one end of the tube 1/4-inch deep, and cut a piece of 1/4-inch steel band the length of the diameter of the tube. Insert the steel band into the slot on the tube and anchor the steel into the slot with solder. Grind the end of the bar down to be sure that no sharp edges

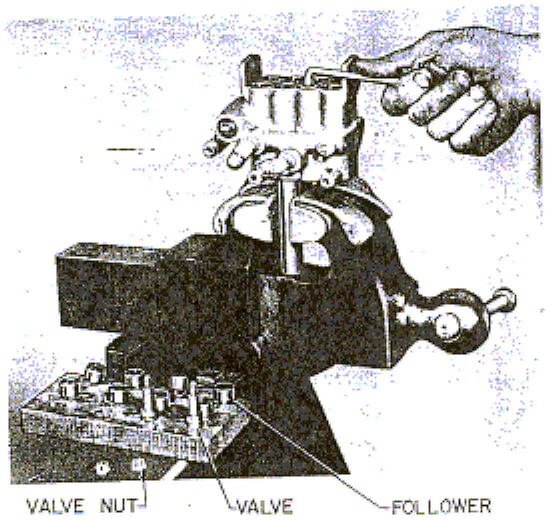


Figure 236—Removing Valves from Valve Body

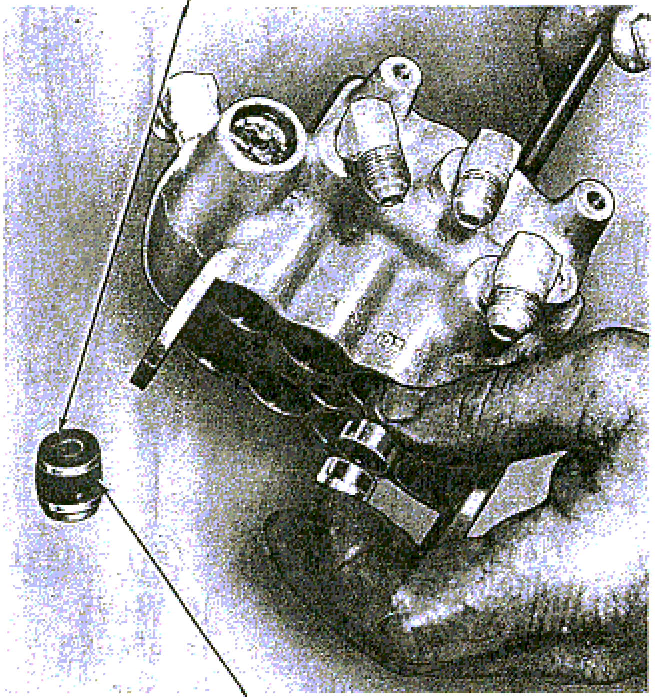


Figure 237—Removing Valve Cups and Washers from Valve Body

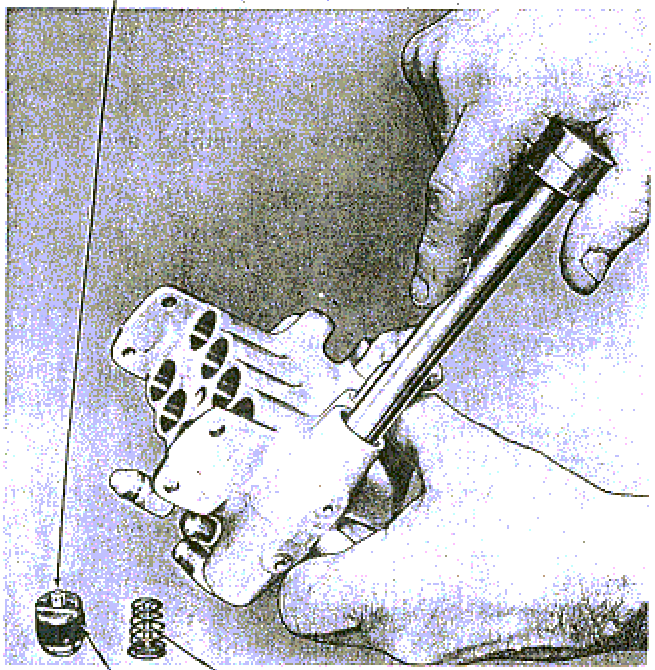


Figure 238—Removing Retainers and Valves—Inlet Port

of the steel band protrude beyond the circumference of the tube to score the valve cylinder surfaces when installed.

11. Line up all the slots in the ends of the valves to parallel each other so that the valve slots can be quickly engaged by the special tube wrench.

12. Insert the tube in the vise with the special end up to engage the valve slots and retain the valves while the nuts are turned off. (See figure 236.)

13. As the valves are removed from the valve body, be sure to mark them so that they will be installed in the same location.

14. After all valves have been removed, free the valve body from the vise and lay it on the bench so that a small diameter bar or screwdriver may be inserted from the bottom side of the valve body. Push the assemblies consisting of a top and bottom washer, two rubber cups, and a spacer out of the valve body. (See figure 237.)

15. Next, remove the snap rings from both sides of the inlet port with a snap ring wrench.

16. Remove the retainer, the spring, and the valve on each side of the inlet port. (See figure 238.) The control valve is now completely disassembled as illustrated in figure 239.

(c) INSPECTION FOR MINOR REPAIRS AND REPLACEMENTS.—The presence of foreign matter and worn parts are the two principal causes of malfunctioning of the hydraulic control valve.

1. Clean all passages and parts of the control valve with alcohol and clean out with hydraulic fluid AAF Specification 3586 under pressure. Compressed air may be used but it will then be necessary to flush out the valve immediately with hydraulic fluid to remove all moisture.

2. Replace all worn parts, and if warranted, the complete control unit.

(d) TO ASSEMBLE THE HYDRAULIC CONTROL VALVE.

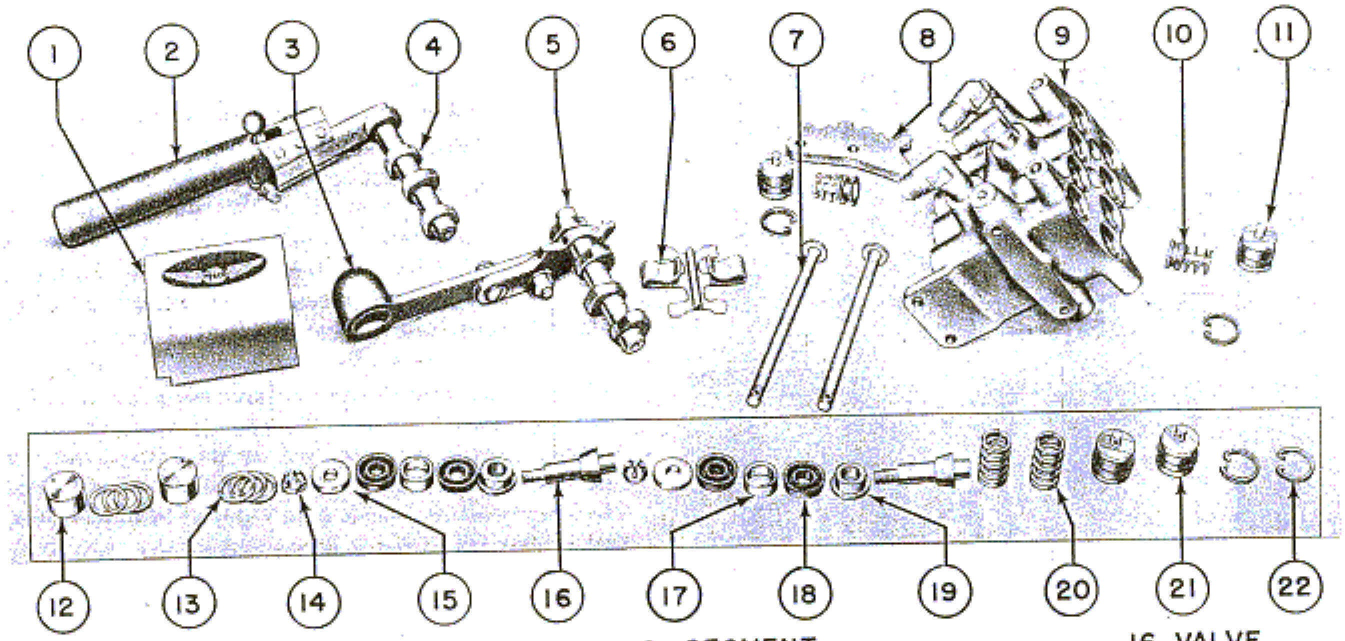
1. Before assembling, immerse packings and coat other parts and the interior of the control valve with hydraulic fluid, AAF Specification 3586. Handle packings with great care to avoid damaging their feather edges.

2. Place the valve, spring and retainer in each side of the inlet port of the valve body and install the snap ring.

3. Next, place the valves in the valve body and install the assemblies, consisting of a top and bottom washer, two rubber cups, and a spacer, over the stem of the valve. Hold the slotted end of the valve with a screwdriver and install the nut on the end of the valve. The special tool used in holding the valves during disassembly may be used in assembling the valves in the valve body. Install the cotter pins in the nuts.

Note

When assembling the valves in the valve body, it is extremely important that each



1 COVER
2 LANDING GEAR CONTROL HANDLE
3 FLAPS CONTROL HANDLE
4 CAMSHAFT
5 CAMSHAFT
6 RETAINER SPRING
7 CAMSHAFT BOLT
8 SEGMENT
9 VALVE BODY
10 PORT VALVE AND SPRING
11 RETAINER
12 FOLLOWER
13 GASKET
14 NUT
15 WASHER
16 VALVE
17 SPACER
18 CUP
19 WASHER
20 SPRING
21 RETAINER
22 SNAP RING

Figure 239—Control Valve Disassembled

valve is reinstalled in its original location as all valves are lapped into their respective seats on the original installation. If new valves are installed, they too must be lapped into their seats.

4. Holding the valve body in a vise, place the valve springs in the valve body and install the retainers and the snap rings. When installing the retainers use extreme care not to damage the rubber cups by fouling them in the snap ring grooves inside the valve body.

5. Release the valve body from the vise, turn it upside down and replace it in the vise. Install the gaskets or laminated shims and replace the followers in the valve body. Be sure the gaskets and followers are replaced in the same cylinders of the valve body from which they were removed.

6. Replace the retainer spring on top of the valve body.

7. Place the camshafts in position over the valve followers in the body and install the camshaft bolts through the segment and camshafts.

8. Replace the cover on the valve body and install the nuts and cotter pins in the camshaft bolts. The control valve is now reassembled and can be removed from the vise.

(e) CHECK AND TEST.

1. When the control valve is completely assembled, check the clearance of the camshafts and followers with feeler gages as illustrated in figure 240. The clearance between camshafts and followers must be between .005 and .015 inch.

2. Before installation in the airplane, test the control valve for leakage under pressure in accordance with instructions given on figure 241.

(5) CHECK VALVE.

(a) GENERAL.—A check valve is installed in the pressure line from the motor-driven pump in the fuselage. This valve is located on the left side of the airplane and may be reached through the stowage compartment door. Its purpose in the system is to prevent by-passing the hand pump pressure through the electric pump when the hand pump is operated.

(b) TO DISASSEMBLE THE CHECK VALVE.

1. Clamp the check valve in a vise with aluminum covered jaws at the nut face on the upper end of the valve body and turn off the stop nut.

THE CLEARANCE BETWEEN THE CAMSHAFTS AND FOLLOWERS SHOULD BE .005 " TO .015 "

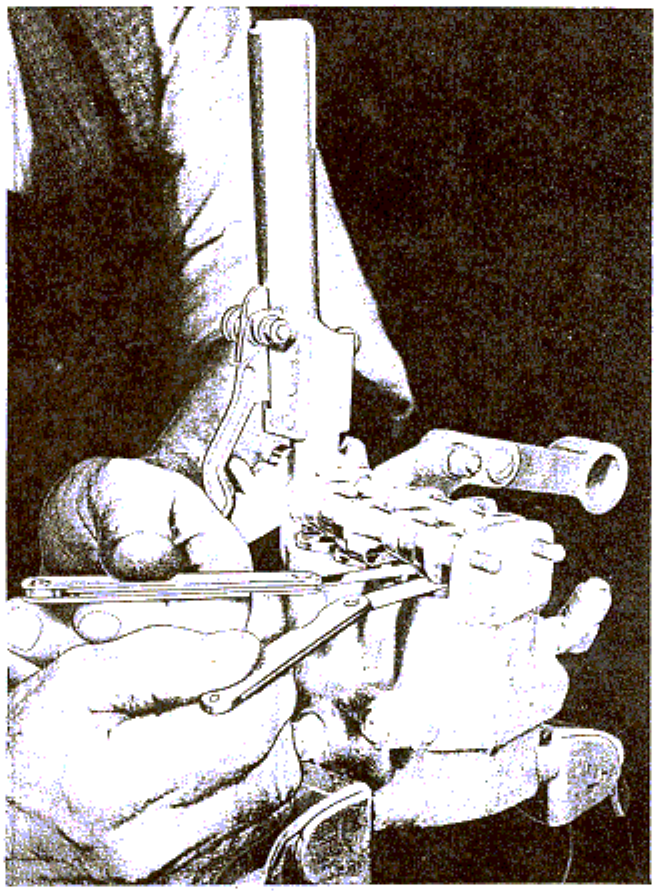


Figure 240—Testing Clearance of Camshafts and Followers

2. Pull the snap ring with a snap ring wrench or a pair of light pliers.

3. The bushing, spring, and valve will now fall out when the valve is released from the vise and turned bottom side up. (See figure 242.)

(c) INSPECT FOR REPLACEMENT.

1. Improper seating of the natural-rubber inner valve due to the presence of foreign matter, is the common cause of malfunctioning of the check valve assembly. Therefore, check the valve body carefully for the presence of dirt, grit or other foreign matter. Clean all parts thoroughly with alcohol and flush out with hydraulic fluid AAF Specification 3586 under pressure.

2. Replace the inner valve if it shows the least sign of being deformed.

3. Before assembling the check valve unit, coat the parts and inner valve with hydraulic fluid, AAF Specification 3586.

4. After cleaning, replacing the inner valve if necessary, and assembling, if the check valve does not function properly, replace the entire valve assembly.

(d) TO ASSEMBLE THE CHECK VALVE.

1. Insert the inner valve, spring, bushing, and snap ring in the valve body, in that order. (See figure 242.)

2. Screw the stop nut on the valve body and tighten.

(6) HYDRAULIC RELIEF VALVES.
(See figures 243, and 244.)

(a) GENERAL.—One single and two twin relief valves are incorporated in the lines of the main hydraulic system of this airplane, besides the pressure relief valve installed in the motor-driven pump head. Their function is to protect the system from excessive fluid pressures, which may result from over-pumping and/or thermal expansion due to atmospheric temperature. The single relief valve is located at the extremity of the auxiliary hand pump pressure line between stations 8 and 9, and is accessible through the fuselage access door. The twin relief valve which limits the pressure in the flap operating lines is located just forward of station 5 between the control valve and the cockpit floor and is accessible from the cockpit. The other twin relief valve protects the alighting-gear lines from excessive pressure, and is located between stations 8 and 9 and is accessible through the fuselage access door.

(b) TO DISASSEMBLE THE SINGLE RELIEF VALVE.

1. Working through the fuselage access door, disconnect the hydraulic lines and remove the single relief valve from the airplane.

2. Loosen the lock nut and turn out the adjusting screw. The nut and gasket will come off with the screw. The spring and plunger will now drop out of the valve body. (See figure 243.)

(c) TO DISASSEMBLE THE TWIN RELIEF VALVE.—The two twin relief valves in the main hydraulic system of this airplane are identical, so the procedure in disassembling either valve would be the same.

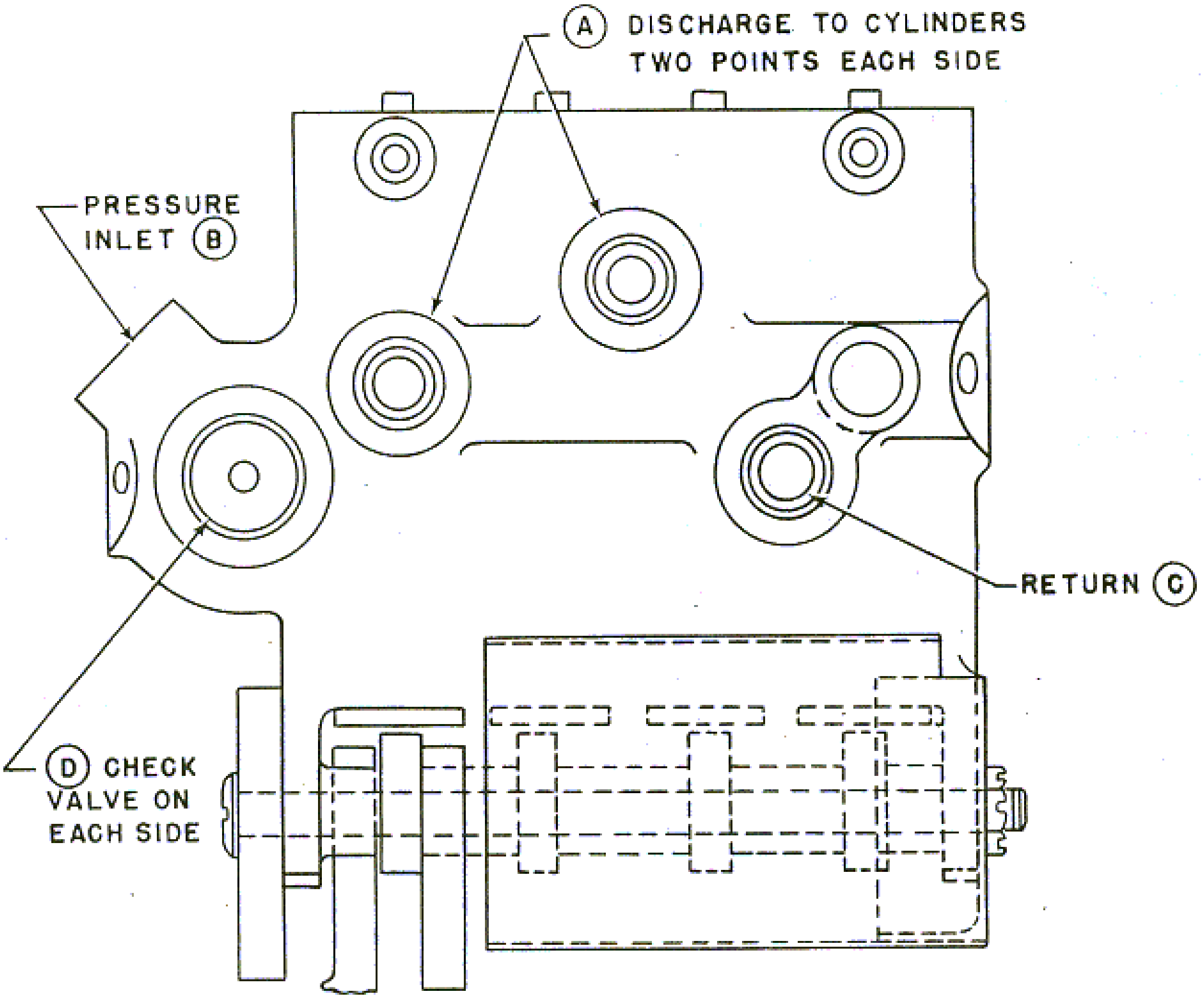
1. First disconnect the hydraulic lines and remove the twin relief valve from the airplane.

2. Loosen the two lock nuts and turn out the adjusting screws. After the setscrews are removed, the two springs and plungers will drop out. (See figure 244.)

(d) INSPECTION AND MAINTENANCE.

1. In service, replace and return to depot for disposition all improperly functioning relief valves.

2. If tested valves are not available for replacement, inspect the old valve for the presence of dirt or other foreign matter. Dirt lodged on the needle-point plunger seat can cause a leak and consequent loss of pressure, or dirt may plug the small passage from the pressure lines to the relief line and cause building up of excessive pressure. In any event, always clean the valve parts with alcohol and flush out the body with hydraulic fluid AAF Specification 3586 under pressure. If there is any appreciable amount of dirt present in the valve being examined, drain the system and flush and fill with fresh fluid.



NOTE:

1. TEST AT 2500 POUNDS PER SQUARE INCH (SEE TEST NOTED BELOW)
2. MINIMUM VALVE TRAVEL TO BE .040 INCH
3. ALL PASSAGES MUST BE CLEAN AND FREE FROM DUST, GRIT AND FOREIGN MATTER.

TEST:

BOOST WITH HAND PRESSURE AT 2500 POUNDS PER SQUARE INCH AS FOLLOWS:

1. WITH VALVES IN NEUTRAL POSITION APPLY PRESSURE THRU EACH OF FOUR POINTS (A) SEPARATELY, THERE SHOULD BE NO LEAKAGE AT (B),(C),(D).

2. WITH VALVES IN NEUTRAL POSITION APPLY PRESSURE AT (B) AND (C) SEPARATELY THERE SHOULD BE NO LEAKAGE AT ANY OF FOUR POINTS (A)

Figure 241—Test of Hydraulic Control Valve

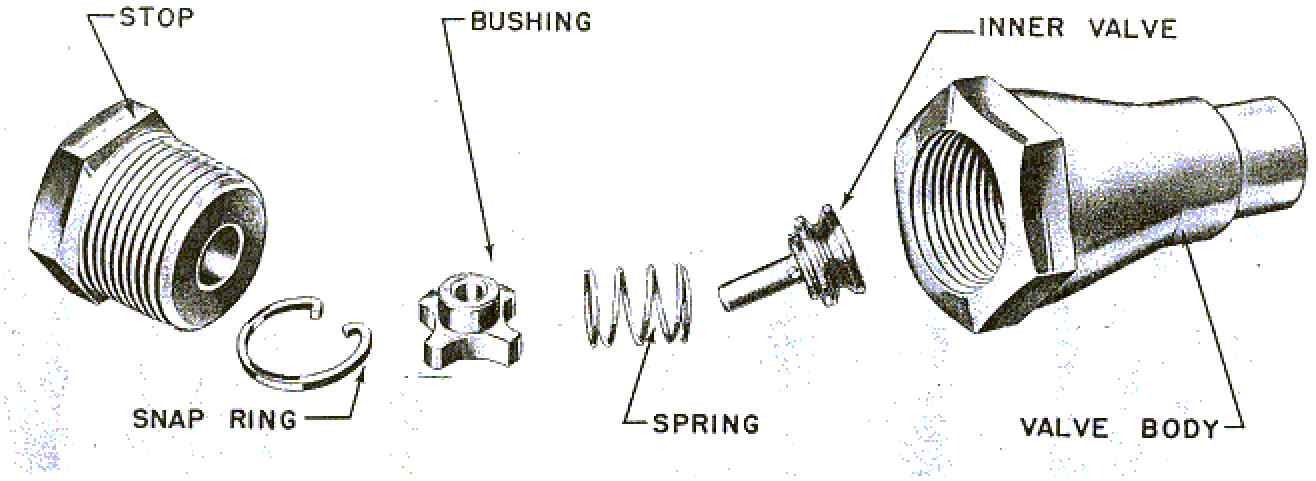
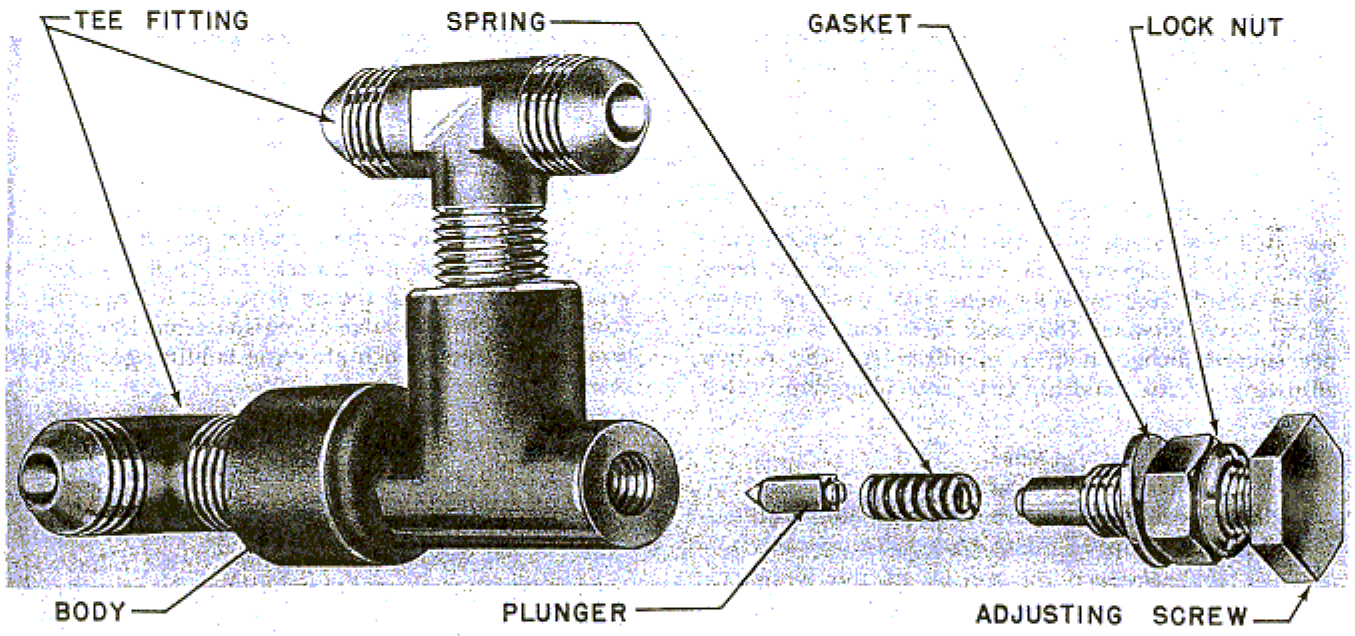


Figure 242—Hydraulic Check Valve Disassembled



NOTE: SET VALVE TO BY-PASS AT 1500 POUNDS PER SQUARE INCH

Figure 243—Single Hydraulic Relief Valve Disassembled

3. Plungers with damaged needle-points must be replaced.

4. Check each spring to make sure it does not bind or catch on the threads of the adjusting screw, causing improper seating of the plunger.

(e) TO TEST THE HYDRAULIC RELIEF VALVES.

1. Remove the plug at the forward end of the hydraulic hand pump, and install a pressure gage capable of registering a minimum of 2000 pounds pressure per square inch.

2. First, check the pressure setting of the relief valve in the head of the electric motor-driven pump body by placing the landing gear and wing-flaps control handles in the neutral position. Then start the motor-driven pump and while it is running set the valve by turning the adjusting screw until a pressure of 1150 to 1200 pounds per square inch is registered on the installed testing gage.

Turn the adjusting screws in all hydraulic relief valves clockwise to allow an increase in the line pressure and counterclockwise to decrease the pressure.

IMPORTANT

Do not run the motor-driven pump longer than three minutes at any one time while adjusting the hydraulic relief valves.

3. To check either the landing gear or wing-flaps twin relief valves, it is first necessary to

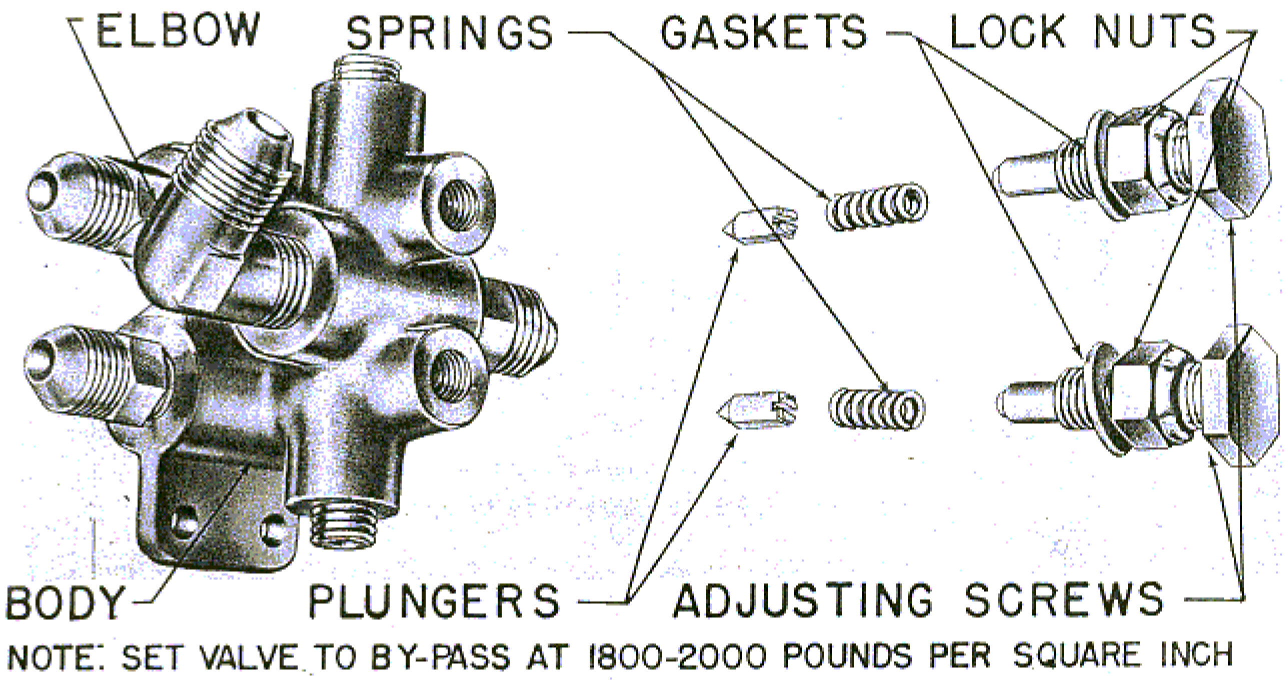


Figure 244—Twin Hydraulic Relief Valve Disassembled

adjust the single relief valve in the hand-pump pressure line to a setting of at least 2100 pounds per square inch. This is necessary to make sure that the hand pump can deliver to the system past the hand-pump relief valve between 1800 and 2000 pounds pressure per square inch, which is required for the proper adjusting of the landing gear and wing-flaps relief valves.

Note

Great physical effort is required to reach 2000 pounds per square inch pressure with the hand pump.

4. To check the setting of the wing-flaps relief valve, keep the landing gear control handle in the neutral position and place the wing-flaps control handle in the up position. Operate the hand pump until maximum pressure is attained and then turn the adjustable screw in the up line of the wing-flaps relief valve until the pressure gage registers 1800 to 2000 pounds per square inch.

Note

A hissing or squeaking sound within the valve with each stroke of the hand pump indicates that fluid is passing through the relief valve being tested.

5. The relief valve in the wing-flaps down line is set by placing the wing-flaps control handle in the down position, keeping the landing gear control handle in neutral, and continuing to pump after the flaps are lowered. Listen for the hiss or squeak indicating passage of fluid through the down line, and set adjusting screw to register between 1800 and 2000 pounds per square inch on the installed testing gage.

6. To check the landing-gear relief-valve up line, jack up or hoist the airplane, put the wing-flaps selector handle in the neutral position, the landing gear selector valve in the up position, and operate the hand pump. Set the valve to register from 1800 to 2000 pounds per square inch after the landing gear is fully retracted.

7. Check the landing gear down line the same as for the up line except that the landing gear selector valve is placed in the down position. Set the down line adjustment of the relief valve at 1800 to 2000 pounds per square inch.

8. Now the hand-pump single relief valve can be adjusted. Place the landing gear and wing-flaps selector handles in the neutral position, operate the hand pump, and turn the adjusting screw counterclockwise until the hand-pump single relief valve passes fluid at 1500 pounds per square inch.

9. Remove the testing pressure gage from the hand pump and reinstall the plug.

(7) LANDING GEAR RETRACTING STRUT.

(a) GENERAL.—The retracting struts (one for each leg) are located above the oleo struts in the leading edge of the wing forward of the wheel pockets. Extension of a strut causes its landing gear to retract until the wheel lies flush in the wing. The strut piston has a travel of 11.06 inches for full retraction, and has two sets of mechanical locks which are operated by the over-travel of an internal sliding pawl. The mechanical locks consist of two sets of six radial segments, retained in square broached holes in the piston, which are positively cammed into and out of the locked position by the sliding pawl. (See figure 245.)

1. FOR TEST AND ASSEMBLY USE HYDRAULIC FLUID AAF SPECIFICATION 3586, UNAMENDED GRADE B (BLUE). UNDER NO CONDITION SHOULD MINERAL OIL BE USED.
2. TO MANIPULATE PAWL "O" USE 5/32 INCH DIAMETER DRILL ROD, 16 INCHES OR LONGER, END THREADED 8-36. INSERT ROD THRU 1/4 INCH HOLE IN CAP "N".
3. ELIMINATE OR ADD SHIMS AS REQUIRED TO SHIMS "D" AND "J" SO THAT LOCKS "E" WILL HAVE CLEARANCE OF .003-.006 INCH IN LOCKED POSITION.
4. TEST COMPLETE ASSEMBLY TO 2500 POUNDS PER SQUARE INCH.

A	75-33-029	ROCKER
B	75-33-026-1	PIN
C	75-33-025-1	NUT
D	75-33-030-1	SHIM
E	75-33-027	LOCK
F	87-31-027	PISTON
G	87-31-034	SHAFT
H	87-33-510	CYLINDER
I	87-31-028	BEARING
J	75-33-030-2	SHIM
K	87-33-515	END
L	75-33-026-2	PIN
M	75-33-025-2	NUT
N	75-33-023	CAP
O	75-33-021	PAWL

A — CAUTION- THIS LEVER MUST BE INSTALLED AS SHOWN. DO NOT REVERSE.

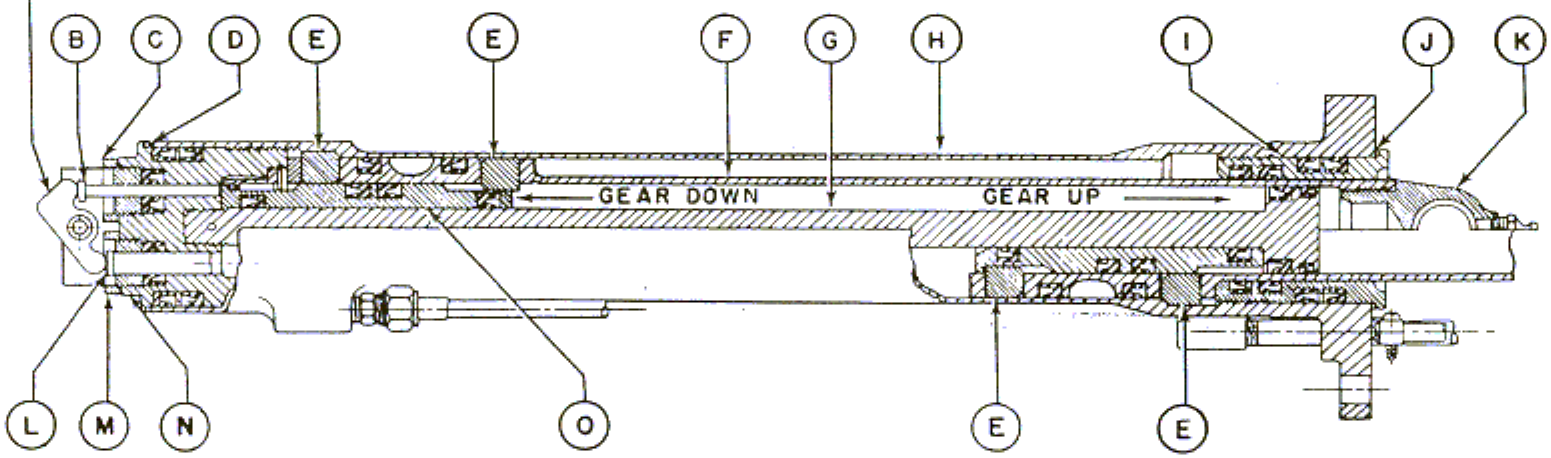


Figure 245—Landing Gear Retracting Strut

(b) TO REMOVE AND DISASSEMBLE THE LANDING GEAR RETRACTING STRUT.

1. Jack the airplane and extend the strut about half-way so that the piston end protrudes into the wheel pocket.

2. Working through the wheel pocket, remove the through bolt attaching the upper retracting links to the piston end.

3. Retract the strut and disconnect the two hydraulic lines at the aft end of the strut.

4. Remove the three securing nuts at the aft end of the cylinder and pull the strut out of the wing through the wheel pocket.

5. Remove the length of pipe extending to the forward end of the cylinder.

6. Place the cylinder in a wooden block clamp and secure the clamp in a vise.

7. Remove the cotter pin and pull the clevis pin retaining the rocker in the cap assembly.

8. Place the handle of the hand pump spanner wrench or some similar tool in the cap and turn the cap out of the cylinder.

9. Remove the cylinder from the vise and wooden block clamps. Extend the piston by standing the strut on the piston end to allow the pawl to slide down the piston rod and disengage the mechanical locks. Pull the piston out of the cylinder far enough to insert the piston in a wooden block clamp and secure the clamp in a vise.

10. Place a hard wood block on the piston end and tap the block with a hammer until the piston end is loosened. Turn off the end of the piston and remove the piston from the wooden block clamp.

11. Replace the cylinder in the wooden block clamp and secure it in a vise. Push the piston, piston rod, and cap out of the cylinder and hold a hand under the cylinder to catch the locks as they drop out of the square broached holes in the piston. Revolve the piston until all locks have fallen out. Pull the piston assembly from the cylinder and remove the cylinder from the vise.

12. Extend the piston rod beyond the piston enough to insert the piston rod in a wooden block clamp with the cap pin in a vertical position. Punch the pin from the cap with a hammer and punch, and by using a tool such as the handle of a spanner wrench, turn the cap from the piston rod. Remove the piston rod from the vise and wooden block clamp.

13. Pull the piston rod and pawl from the piston, exercising care not to injure the packing cups on the pawl and piston rod as they are pulled from the piston past the square broached holes and threads. Use a light screwdriver with a curved end to depress the packing cup edges as they are pulled past the broached holes. If this precaution is not taken, the edges of the cups will be torn or cut and will not be fit for further service.

14. Place the cylinder in a vise with aluminum-covered jaws and turn the bearing out of the cylinder with a spanner wrench.

15. The snap ring and spring may be removed from the cylinder cap, if it is desired, by depressing the end of the snap ring with a pair of pliers and removing the ring. Tip the cap down and the spring will fall out.

16. If there is evidence of leaks around the two pins in the cylinder cap, the pins and cups may be removed for inspection or replacement. To remove the pins and cups, cut the lock wires on both nuts on the cap and remove the nuts. The pins can now be pulled out and the cups removed through the nut openings. The retracting strut is now completely disassembled.

(c) INSPECTION OF PARTS.

1. Clean all parts with alcohol and inspect thoroughly. Flush out with hydraulic fluid AAF Specification 3586 under pressure to remove any dirt lodged on the parts. Examine all packings carefully and replace any showing damage, however slight. Replace all worn parts.

(d) TO ASSEMBLE THE LANDING GEAR RETRACTING STRUT.

1. Before assembling the retracting strut, wash all parts with alcohol and be sure the parts are free of chips and other foreign matter.

2. Place the cylinder in a vise with aluminum-covered jaws. Wet the packing cups on the bearing with hydraulic fluid, AAF Specification 3586, and screw the bearing into the cylinder end. If there was a shim on the original installation, be sure to replace the shim on the bearing. Tighten the bearing in place with a spanner wrench. Do not tighten excessively.

3. Wet the packing cups on the piston rod and slide the piston rod into the piston. Be careful not to foul the cups on the sharp edges of the square broached holes. Use a screwdriver with a curved end of a similar tool and depress the edges of the cups as they slide past the broached holes.

4. Wet the packing cups on the pawl and slide the pawl onto the piston rod and into the piston. Be sure that the collar on the pawl is outboard. Carefully guide the pawl cups through the square broached holes.

5. If the cylinder cap pins and cups have been removed, wet the cups with hydraulic fluid and insert them into the nut holes. Exercise extreme care in this operation that the edges of the cups are not cut or scored by the threads in the nut holes. When the cups are properly seated, replace the pins in the nuts and screw the nuts into their respective openings. Lockwire the nuts. The cylinder is ready for installation on the piston rod.

6. Push the piston rod part way into the cylinder and insert the end in a wooden block clamp. Secure the clamp in a vise. Take the cylinder cap in one hand and drop the spring into the cap with the collar up. Line up one of the slots on the spring with the pin hole in the cap and install the snap ring. Screw the cap onto the piston rod and line up the pin holes on both assemblies. Insert the pin and tap it into place with a light hammer. Stake both ends of the pin.

7. Release the piston rod from the wooden block clamp and wet the packing cups on the cap and piston with hydraulic fluid, AAF Specification 3586. Insert the piston assembly into the cylinder and turn the cylinder and piston up in a vertical position resting on the cap. This position will keep the pawl in the proper location while the locks are inserted into the square broached holes in the piston. Insert the upper row of locking segments first and allow the cylinder to move down over this row of locks to retain them in place while the bottom locks are inserted in the broached holes. Carefully guide the cylinder over the lower rows of locks. Start the cap into the cylinder and turn it up by hand as far as possible. It there was a shim on the cap in the original installation, be sure that it is replaced. Be sure that the piston protrudes through the bearing at the opposite end of the cylinder.

8. Place the cylinder in a wooden block clamp and secure the clamp in a vise. Turn the cap up tight with the handle of a spanner wrench or similar tool. Do not tighten excessively.

9. Release the cylinder from the clamp and reverse the cylinder. Place the end of the piston in a wooden block clamp and secure the clamp in a vise. Thread the piston end on to the piston and tighten with a hard wooden block and a light hammer. Secure with Hammerlock cotter pin and lockwire.

10. Install the lever on the cap with the clevis pin and safety the pin with a cotter pin. This lever must be installed as shown in figure 245. Do not reverse.

11. Release the piston from the wooden clamp and install the hydraulic line assembly on the forward end of the cylinder.

12. Insert the cylinder in a vise with aluminum-covered jaws. Replace the through bolt in the end assembly and attach an indicator. Be sure that the face on the dial is turned so that the indicator hand is at zero. Pull the piston end out as far as possible and turn the ball and collar on the indicator to contact the cylinder. The indicator should show the extent of movement of the blocks in their locked position. The locks should have backlash of .003 to .006 inch in their locked position. Shims may be added or eliminated from the cap and the bearing to produce the required lock clearance in the locked position.

(e) FINAL TEST AFTER ASSEMBLY.—Test the retracting strut for leaks before installing in the airplane. The strut must show no leaks at 2500 pounds per square inch. If the test shows no evidence of leakage, the strut is ready to install in the wing.

(f) TO INSTALL LANDING GEAR RETRACTING STRUT.

1. If the landing gear has been corrected for toe-in, be sure that the shims, part numbers 87-31-505-904 and 87-31-505-905, used in the original installation, are replaced on the studs of the retracting strut support assembly. Equal numbers of each shim must be used and not more than four of each shim is allowed for one support assembly.

2. Reinstall the same number of .010 brass aligning shims on each of the three studs of the support assembly (if any were used).

3. Place the strut in the wing through the wheel pocket, fitting it over the three studs of the support assembly.

4. Fasten the strut on the studs by using three new self-locking nuts, one 42 E.O. 98 (Elastic Stop Nut Corporation) and two 365-820.

5. Turn the strut piston by hand to test the alignment of the retracting strut in the support assembly. If binding exists, remove the retracting strut and correct the alignment by adding or removing the .010 brass aligning shims between the retracting strut flange and the support assembly. When the binding condition has been removed, the used self-locking nuts should be replaced with new ones.

6. Insert the through bolt attaching the landing gear upper links to the tee-end of the retracting strut piston.

7. Grease the through bolt using grease, Specification AN-G-3.

8. Connect the hydraulic system lines to the retracting strut and replace the wheel pocket cover.

9. Test-operate the landing gear through several cycles.

10. Replenish the hydraulic reserve tank with fluid, AAF Specification 3586, and bleed the system. See section IV, paragraph 7, *c*, (10).

11. Adjust the landing gear warning light switches. See section IV, paragraph 4, *a*, (4).

12. Operate the landing gear to the full down position and remove jacks.

(8) THE TAIL WHEEL RETRACTING STRUT.

(a) GENERAL. *(See figure 246.)*—The retracting strut is located on the center line of the airplane at the top of the fuselage between stations 13 and 15 with a piston guide extending to station 12. The retracting strut is bolted to attachment fittings on stations 13 and 14 bulkheads. The tail wheel retracting strut functions the same as the main landing gear struts except that its internal mechanism provides for down-lock only, of the tail gear. It operates simultaneously with the main landing gear struts in response to the positioning of the landing gear control in the cockpit.

(b) TO REMOVE AND DISASSEMBLE THE RETRACTING STRUT.

1. Unbutton the access door and the two round inspection holes at the aft end of the fuselage on the left side. Unbutton the inspection door near the top of the fuselage on the right side.

A	87-37-920	CYLINDER
B	75-37-020	BUSHING
C	75-37-032	CUP PACKING
D	87-37-919	PISTON
E	75-37-079	SPRING
F	75-37-030	CUP PACKING
G	75-37-080	FOLLOWER
H	75-37-031	CUP PACKING
I	75-37-024	ACTUATOR
J	75-37-028	SHIM
K	87-37-016	GUIDE
L	87-37-905-5	RIVET
M	AN-24-25	BOLT
N	AN-24-20	BOLT
O	81-37-013	LUG
P	75-37-026	WASHER
Q	75-37-025	STUD
R	75-37-023	LOCK
S	75-37-029	CUP PACKING
T	75-37-019	CAP

1. STRUT MUST BE FREE OF CHIPS.
2. STRUT MUST NOT LEAK AT 2500 POUNDS PER SQUARE INCH PRESSURE.
3. USE ONLY HYDRAULIC FLUID AAF SPECIFICATION 3586 UNAMENDED GRADE B (BLUE).
4. LEAK TEST MUST BE MADE WITH PISTON IN MID-STROKE POSITION

ADJUST END MOTION OF PISTON TO +.001, −.003

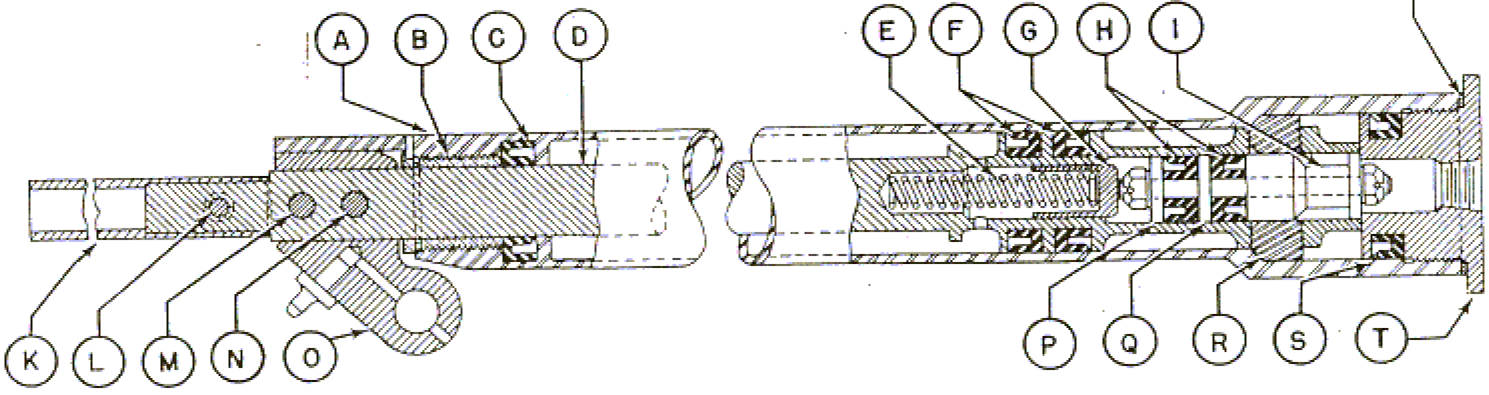


Figure 246—Tail Wheel Retracting Strut

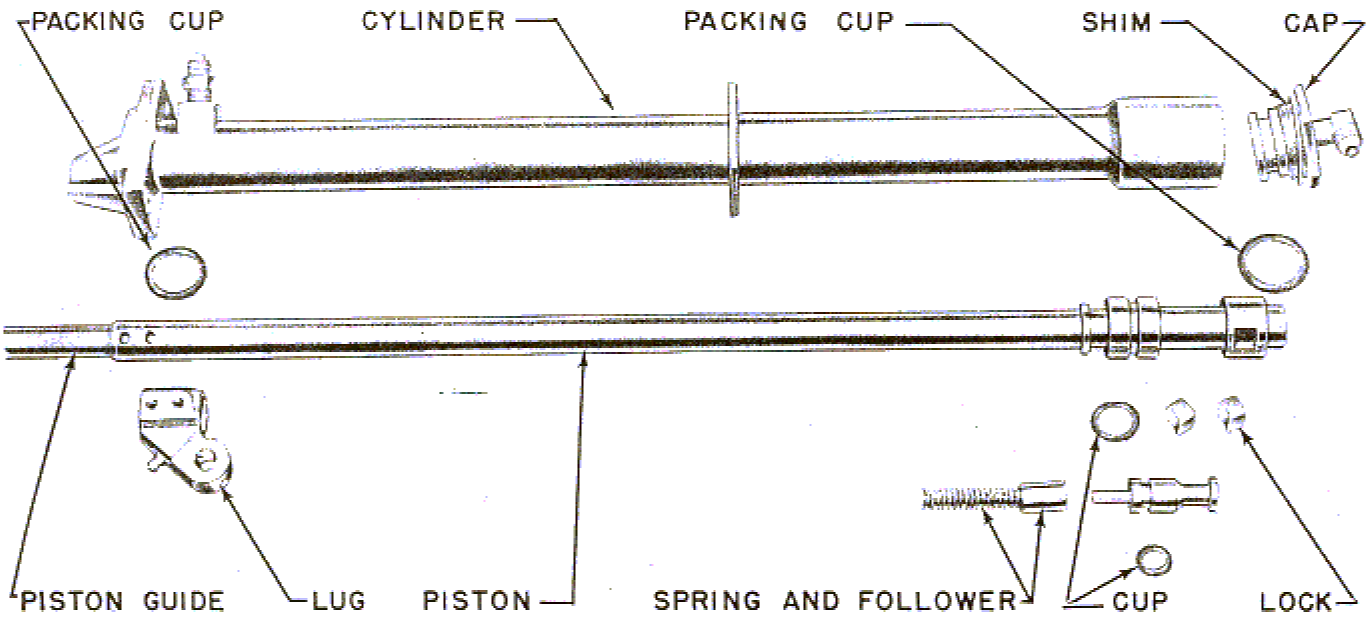
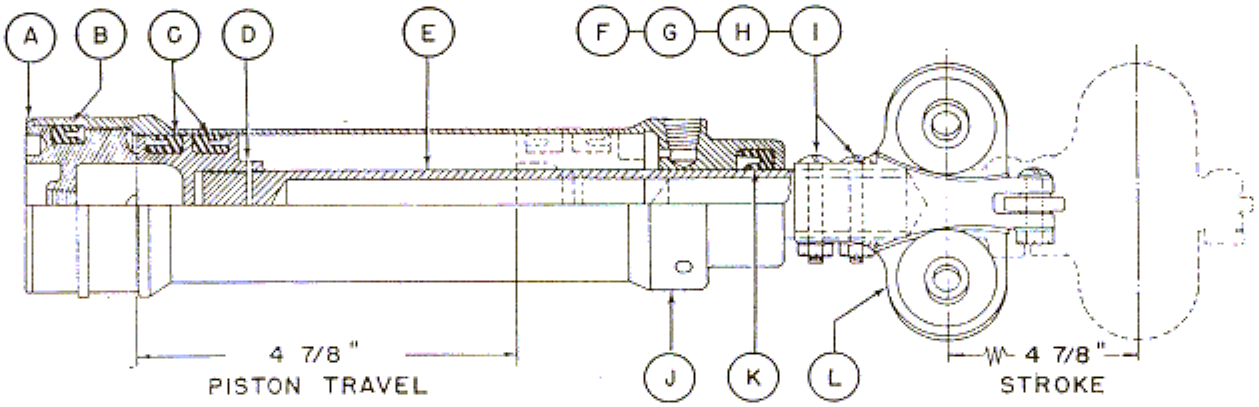


Figure 247—Tail Wheel Retracting Strut Disassembled

A	75-64-073	PLUG	G	AN960D10	WASHER
B	99178	CUP PACKING	H	AN320-3	NUT
C	99179	CUP PACKING	I	AN380-C2-2	COTTER PIN
D	106D-1-20	PIN	J	75-64-071	CYLINDER
E	75-64-072	PISTON ASSEMBLY	K	99180	CUP PACKING
F	AN23-23	BOLT	L	87-64-024	END ASSEMBLY



PRESSURE TEST ASSEMBLY TO 2500 POUNDS PER SQUARE INCH

Figure 248—Wing Flap Actuating Cylinder

2. Place a jack under the rear jack point aft of the tail wheel doors to support the airplane.

3. If the oleo strut is installed, disconnect it at the lug on the retracting strut piston.

4. Disconnect the hydraulic lines from the forward and aft ends of the cylinder.

5. Remove the two attaching bolts at station 13 bulkhead.

6. Remove the two attaching bolts at station 14 bulkhead and pull the retracting cylinder aft until the piston guide is free of the support at station 12 bulkhead.

7. Remove the retracting cylinder from the fuselage through the access door below the stabilizer.

8. Place the cylinder in a wooden block clamp and insert the clamp in a vise.

9. Remove the cotter pins, nuts, washers, and bolts attaching the lug to the piston. Slide the lug off the piston and piston guide.

10. Remove the cylinder bushing with a spanner wrench.

11. Move to the opposite end of the cylinder and remove the cap assembly and shims.

12. Grasp the piston guide and push the piston out of the cylinder far enough to free the two locks from the square broached holes. Remove the locks and pull the piston and guide completely out of the cylinder.

13. Tip the piston with the guide end up until the actuator, follower, and spring drop out of the piston end.

14. Remove the cup from the forward end of the cylinder and remove the cylinder. The cylinder and piston are now completely disassembled as illustrated in figure 247.

(c) INSPECTION OF PARTS.

1. Clean all parts thoroughly with alcohol and flush out with hydraulic fluid AAF Specification 3586 under pressure.

2. Replace all worn packing cups and other parts showing any deformity.

(d) TO ASSEMBLE THE RETRACTING STRUT.

1. Insert the spring and follower into the end of the piston.

2. Coat the cups on the actuator with hydraulic fluid, AAF Specification 3586, (never use mineral oil) and slide the actuator into the piston. Be very careful not to tear or injure the edges of the packing cups as they enter the cylinder and are pushed past the square broached holes in the lock assembly.

3. Wet the cup that fits into the forward end of the cylinder with hydraulic fluid and replace the cup in the cylinder. Be extremely careful not to damage the cup surface on the threads in the end of the cylinder. Cover the threads with shim stock to prevent damage to cup.

4. Replace the two locks in the square broached holes and insert the piston and guide into the cylinder, guide end first.

5. Screw the bushing into the cylinder until it is tight. Do not tighten the bushing excessively.

6. Wet the packing cup on the cap with hydraulic fluid, AAF Specification 3586, replace the shim, and screw the cap into the aft end of the cylinder.

7. Check the piston for backlash. The motion of the piston must be adjusted to .002 or .005 inch. Adjustment can be made by adding or removing a shim between the cap and cylinder.

8. Slide the lug over the piston guide and onto the piston, line up the piston holes with those in the lug, and insert the rear bolt.

(e) TEST FOR LEAKAGE.

1. For this test, use only hydraulic fluid, AAF Specification 3586.

2. Place the piston in the mid-stroke position and apply 2500 pounds per square inch.

3. Inspect for leakage at the end cap, end bushing, and the two hydraulic line pipe fittings.

(f) TO INSTALL RETRACTING STRUT.

1. Be sure the airplane is placed on jacks so that the landing gear may be test-operated after the retracting strut is installed.

2. Retract the strut fully.

3. Using the access door on the right of the fuselage, insert the retracting strut, piston guide foremost, far enough into the fuselage so that the cylinder may be raised to a position forward of station 14 bulkhead.

4. Move the cylinder aft through the opening at the top of station 14 bulkhead until the piston guide rod can be inserted in the braced bearing within the fuselage.

5. Bolt retracting strut at station 14 bulkhead.

6. Bolt retracting strut at station 13 bulkhead.

7. Bolt oleo strut to the lug on the piston guide rod.

8. Connect the hydraulic lines at the forward and aft ends of the cylinder.

9. Test-operate the landing gear through several cycles.

10. Replenish the hydraulic reserve tank with hydraulic fluid, AAF Specification 3586, and bleed the system. See section IV, paragraph 7, *c,* (10).

11. Replace the access door below the stabilizer.

12. Operate the landing gear to the full down position and remove jacks.

(9) WING FLAP ACTUATING CYLINDER.

(a) GENERAL.—The hydraulic actuating cylinder is mounted on the center line bulkhead near the trailing edge of the wing. The cylinder operates the bellcrank which is connected to a span-wise push-pull tube running the length of each flap. The actuating cylinder is made accessible for removal from the bulkhead by removing the two lower surface doors

near the cylinder and the two hand holes immediately forward.

(*b*) TO REMOVE AND DISASSEMBLE THE ACTUATING CYLINDER. (*See figure 248.*)

1. Disconnect the two hydraulic lines at the cylinder.

2. Remove the two bolts attaching the bell-crank arms to the piston end.

3. Remove the four bolts, two in the forward and two in the aft clamp assemblies which attach the cylinder to the center line bulkhead.

4. Remove the cylinder through one of the access doors.

5. Place the cylinder in a wooden block clamp and insert the clamp in a vise.

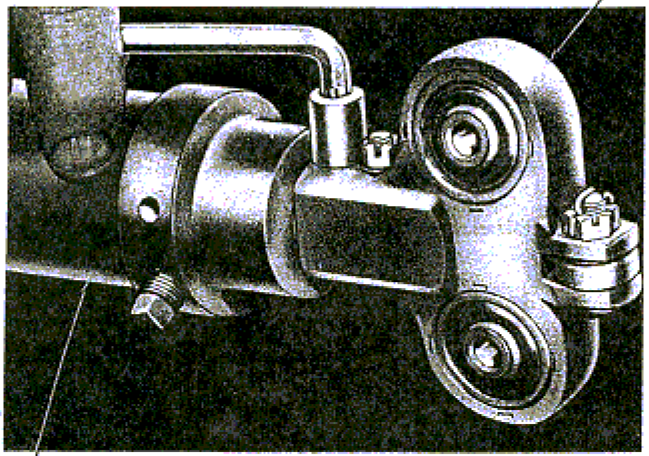


Figure 249—Removing End of Piston Shaft

6. Remove the cotters, nuts, and washers from the two bolts attaching the end of the piston shaft. (See figure 249.)

7. Unscrew the end nut with the spanner wrench (87-88-030) carried in the tool compartment on the duffle bag. (See figure 250.)

8. Remove the piston assembly from the cylinder through the uncapped end.

9. The rubber cups may now be removed from the end nut and the piston and the actuating strut is disassembled. (See figure 251.)

(*c*) INSPECTION OF PARTS.

1. Clean with alcohol and inspect all parts thoroughly. Flush with hydraulic fluid to eliminate chips, dirt, grit, or other foreign matter lodged on the parts. Replace all cups that are injured in any way. Replace all worn parts.

(*d*) TO ASSEMBLE AND INSTALL THE ACTUATING CYLINDER.

1. Insert the piston and shaft into the cylinder. Coat a film of hydraulic fluid, AAF Specification 3586 over the piston cups so that they will slide into the cylinder easily. Be very careful not to injure the edges of the cups as they enter the cylinder. Push the piston through until the shaft protrudes sufficiently from the other end to attach the end assembly.

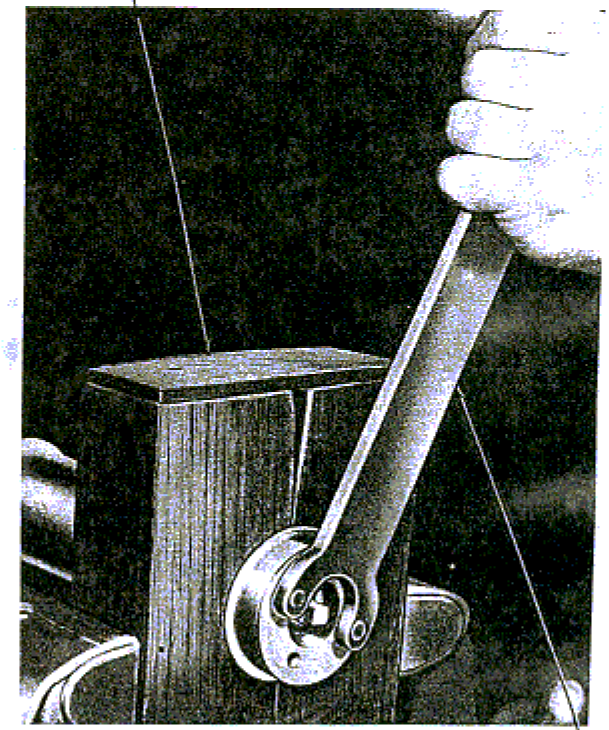


Figure 250—Removing End Nut from Cylinder

2. Coat the cup on the end nut with hydraulic fluid, AAF Specification 3586 and screw the nut into the cylinder. With the cylinder held firmly in a wooden clamp, tighten the end nut with the spanner wrench (87-88-030).

3. Slip the end assembly onto the piston shaft, line up the bolt holes on the end assembly and piston shaft and then insert the attaching bolts. Install the washers and nuts and tighten the nuts. Install cotters and the cylinder is reassembled.

4. Place the wing flap actuating cylinder through the flap cylinder access door, located at the right of the center line bulkhead and close to the trailing edge of the wing. (See 8, figure 20.)

5. Be sure to place the guide bearing, located at the end of the piston of the actuating cylinder, on the track of the center line bulkhead.

6. Place the forward and aft clamp assemblies around the cylinder and fasten the clamps to the center line bulkhead with four bolts.

Note

Do not secure the clamp assemblies until the

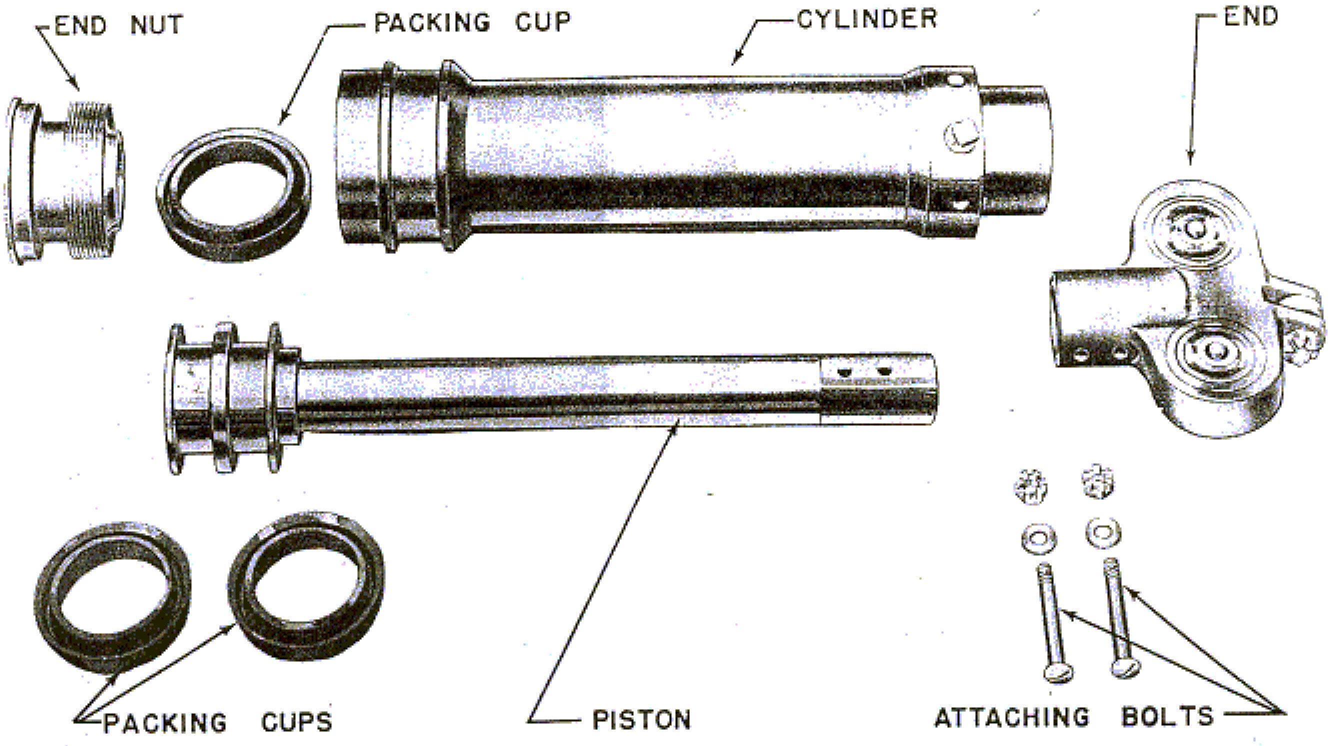


Figure 251—Flap Actuating Cylinder Disassembled

two hydraulic lines have been connected to the cylinder.

7. Connect the two hydraulic lines at the cylinder.

8. Tighten the forward and aft clamp assemblies.

9. Fasten the two bolts attaching the bell-crank arms to the piston end of the cylinder.

10. Test-operate the actuating cylinder through several cycles.

11. Replenish the hydraulic reserve tank with hydraulic fluid, AAF Specification 3586, and bleed the system. See section IV, paragraph 7, *c*, (10).

12. Replace the two flap cylinder access doors.

13. Replace the intermediate keel fairing.

(10) FILLING AND BLEEDING THE HYDRAULIC SYSTEM.

(*a*) PUMP METHOD.

1. The airplane should be supported on jacks or cradles so that the landing gear and wing flaps can be operated.

2. Fill the system through the reserve tank in the fuselage with hydraulic fluid, AAF Specification 3586 filtered through an AN-F-3 Micronic filter. Fill the tank to the base of the cap opening, with the landing gear down and the flaps up. During the filling operation, operate the landing gear twice by hand and three or four times by power and operate the flaps several times, always taking care that the reserve tank is kept full.

3. Any air in the system will be returned to the reserve tank and there vented overboard.

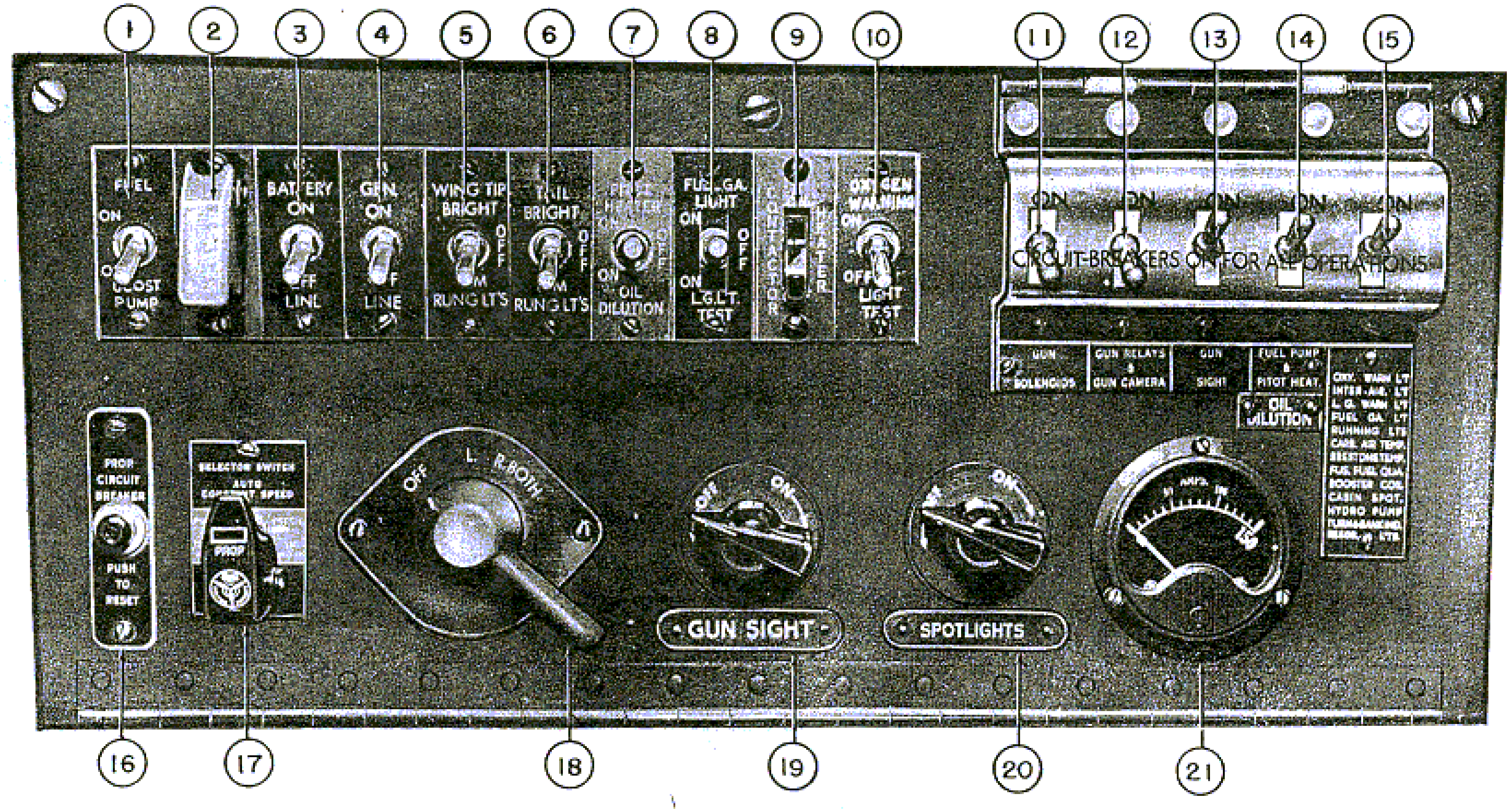
4. If the system still shows signs of air after the filling operation, it may be necessary to disconnect the hydraulic lines at the tail wheel retracting strut and bleed the system at that point.

5. Do not replace the filler cap until the filling operation is completed.

(11) HYDRAULIC BRAKES. (See section IV, paragraph 4, Alighting Gear.)

d. ELECTRICAL SYSTEM.

(1) GENERAL DESCRIPTION.—The electrical system is a single wire grounded negative installation, including the wiring and equipment for ignition, generator, starter, electrical instruments, running lights, instrument and cockpit lights, gunnery equipment, landing gear retracting warning system and the electrically controlled propeller. The majority of the electrical cables, in the fuselage are open wire bundles, while the electrical cables in the engine compartment and the wing are carried in flexible conduit assemblies. Junction boxes are provided in the engine compartment and the fuselage to house electrical equipment and to provide terminal post junctures for wiring harnesses. There are no junction boxes in the wing electrical installation; the wiring runs between open terminal blocks. Electrical plugs and receptacles are provided to facilitate the removal of the wing and the engine section from the fuselage and to facilitate the removal of the different electrical equipment from the airplane.



1 FUEL BOOST PUMP
2 GUN AND CAMERA
3 BATTERY LINE
4 GENERATOR LINE
5 WING TIP RUNNING LIGHTS
6 TAIL RUNNING LIGHTS
*7 PITOT HEATER AND OIL DILUTION (AF42-104429 THRU AF42-106028)
8 FUEL GAGE LIGHT AND LANDING GEAR LIGHT TEST
9 CONTACTOR HEATER
10 OXYGEN WARNING LIGHT TEST
11 CIRCUIT BREAKER-GUN SOLENOIDS
12 CIRCUIT BREAKER-GUN RELAYS AND GUN CAMERA
13 CIRCUIT BREAKER-GUN SIGHT
14 CIRCUIT BREAKER-FUEL PUMP AND PITOT HEATER AND MISCELLANEOUS
15 CIRCUIT BREAKER-MISCELLANEOUS
16 PROPELLER CIRCUIT BREAKER
17 PROPELLER SELECTOR SWITCH
18 IGNITION SWITCH
19 GUN SIGHT RHEOSTAT
20 SPOT LIGHT RHEOSTAT
21 AMMETER
* PITOT HEATER (AF42-106029 AND SUBSEQUENT)

Figure 252—Main Switch Panel

WARNING

Never use airplane battery power for ground operation of electrical equipment unless there is no other source of power available, and then operate only the essential equipment for as limited a time as possible.

(2) ELECTRICAL CONTROL SWITCHES.

Note

The battery line switch on the main switch panel must be "ON" before any airplane battery power can energize the circuits of the electrical system.

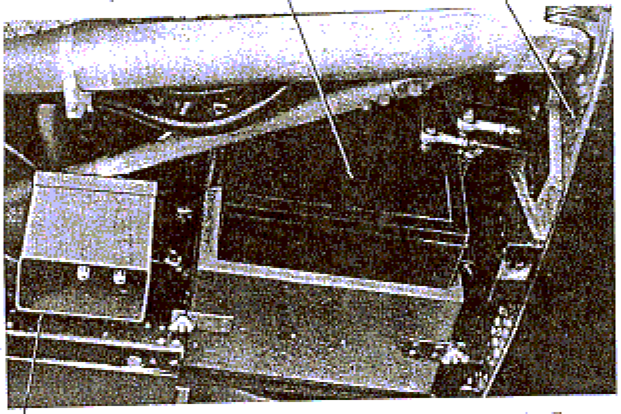


Figure 253—Battery Installation (AF42-106029 and Subsequent)

(a) MAIN SWITCH PANEL. — The main switch panel is located under the instrument panel in front of the pilot. The panel is hinged along the bottom to the box assembly. Access to the wiring inside the switch box is obtained by unbuttoning the three fasteners at the top and allowing the panel to swing open. The switches on the main switch panel are shown in figure 252.

(b) WINTERIZATION JUNCTION BOX.—The winterization junction box is located on the left cockpit wall, below the engine control quadrant. The junction box contains the following switches: starter switch, generator line circuit protector, and landing light switch (AF42-106029 and subsequent).

Note

The generator line circuit protector will not be installed in airplanes AF44-7501 and subsequent at the factory and will be removed from all airplanes in service.

The winterization junction box has space provision for control switches for any winterization equipment that may be installed on the airplane in service.

(c) AILERON TRIM TAB SWITCH (AF43-24252 and subsequent).—The aileron electric trim tab switch is located below the upper left longeron just forward of and adjacent to the elevator and rudder trim tab controls.

(d) GUN TRIGGER SWITCH.—The gun trigger switch is located on the grip of the flight control stick.

(e) HYDRAULIC PUMP SWITCH.—The motor-driven hydraulic pump switch is located just below the grip on the forward side of the flight control stick.

(3) BATTERY.

(a) DESCRIPTION.

1. A 24-volt, 11 ampere-hour storage battery, part No. DD-28250 (Electric Storage Battery Company) was installed in airplanes AF42-104429 through AF42-105803. A 24-volt, 34 ampere-hour storage battery. Specification AN-W-B-152, is installed in airplanes AF42-105804 and subsequent. The battery is installed in the fuselage between stations 9 and 10 in airplanes AF42-104429 through AF42-106028 and in the engine compartment on the left engine mount in airplanes AF42-106029 and subsequent. (See figure 253.)

4. Each installation is ventilated, and the air stream after passing over the battery is directed into a jar containing a felt pad. This pad is saturated with a solution of bicarbonate of soda which neutralizes the acid fumes from the battery before the air is passed overboard.

(b) PREPARING A BATTERY FOR SERVICE.—The battery is shipped in a dry-charged condition. The vent plugs must be left tightly in place until ready to fill the battery with electrolyte. Prepare the battery as follows:

1. Remove vent plugs from cells.

2. Fill each cell of dry charged batteries, with electrolyte prepared to a specific gravity of 1.275. The temperature of the filling electrolyte should not exceed 32°C (90°F). Fill to ⅜ inch above protector on top of separators, making sure not to cover the bottom vent hole.

Note

In preparing an electrolyte of 1.275 specific gravity, the proportions of water and acid are approximately ½ gallon of water for each galon of 1.400 acid or 2-¾ gallon of water for each gallon of 1.835 acid.

CAUTION

NEVER POUR WATER INTO ACID. A reaction of explosive violence will result if water is poured into acid and may cause serious acid burns to personnel. ALWAYS POUR ACID SLOWLY INTO WATER AND STIR THE MIXTURE CONSTANTLY UNTIL THE ACID AND WATER ARE THOROUGHLY MIXED TO DISSIPATE THE HEAT GENERATED EVENLY

THROUGHOUT THE MIXTURE. Always prepare the electrolyte in an earthenware, glass, or rubber-lined container.

3. Allow the battery to stand at least an hour after filling with electrolyte. If level has fallen, add more electrolyte to restore it to level.

4. If necessary, the battery may be immediately placed in service, but if time and equipment permit, a refreshing charge is preferable. Replace vent plugs.

(c) CLEANING CORROSION.—External corrosion of terminals and leads is caused by spilled electrolyte, excessive gassing or overflow due to poor sealing. Remove with a stiff (not wire) brush, neutralize acid with a solution of baking soda (sodium bicarbonate), one pound per gallon of water, and rinse parts thoroughly with water. If baking soda is not available, ordinary soap and water applied to the corroded parts with a bristle brush or cloth will be quite effective. Apply a light coating of vaseline or terminal grease to the terminals only.

(d) SERVICE TROUBLES AND REMEDIES—STORAGE BATTERY.

Trouble	*Possible Cause*	*Remedy*
(a) Battery will not hold its charge.	1. Battery is worn out.	1. Remove the battery and give it a capacity test on an approved AAF battery capacity tester as follows: Charge the battery fully, over-charge for two hours at normal rate, check specific gravity of all cells, adjust specific gravity if above 1.310 or below 1.260, allow to stand 24 hours, then give capacity test with five minute battery capacity tester. Recharge fully if battery passes test. This will require about five hours at normal charging rate. If an approved AAF battery capacity tester is not available, and the battery is suspected of being worn out, it can be checked as follows: Remove the battery and charge until two hydrometer readings, taken two hours apart, show no increase. Battery is worn out if, at the end of this charge: Final hydrometer reading is not above 1.250, or if final terminal voltage is not above 29 volts, when charging at approximately normal charging rate, or if electrolyte temperature rises more than 8°C or 15°F above that of the surrounding air.
	2. Charging rate not set right.	2. Refer to "Voltage Regulator" instructions in section IV, paragraph 7, *d,* (5).
	3. Discharge too great to replace.	3. Use of starter, radio, and other electrical equipment on ground, and use of electrical equipment in air, must be reduced. Use external power source wherever possible.
	4. Standing too long (hot climates).	4. Batteries will require removal and charging if left in an unused airplane for one week or more in very hot climates.
	5. Equipment left "ON" accidentally.	5. Remove and recharge battery.
	6. Short circuit (ground) in wiring.	6. Check wiring.
	7. Impurities put in electrolyte.	7. Replace battery.
	8. Broken cell partitions. This is usually indicated by two adjacent cells running down continually, particularly if left standing a few days.	8. Replace battery.

Trouble	*Possible Cause*	*Remedy*
(b) Battery life is short.	1. Overcharge.	1. Voltage regulator needs check. Refer to "Voltage Regulator" instructions, section IV, paragraph 7, *d*, (5).
	2. Level of electrolyte below tops of plates.	2. Keep electrolyte level ⅜ inch above plate baffle.
	3. Heavy discharges.	3. Use external power sources wherever possible to conserve the battery.
	4. Allowed to sulphate. This occurs only when battery is left in a discharged condition (under one-half) for a period of time.	4. Charge at normal rate until the specific gravity does not rise for two hours and then give a 60-hour overcharge at 10 percent of the normal battery charging rate. Use capacity test and if battery is still low, replace it.
	5. Impurities in electrolyte.	5. Replace battery.
	6. Battery improperly stored prior to use. Idle batteries tend to discharge themselves. Batteries should be stored in as cool a place as possible and given a recharge once each month in temperature below 27°C (80°F), and every two weeks in temperatures above 27°C (80°F).	6. Recharge battery. If plates have sulphated, see remedy 4, preceding.
(c) Cracked cell jars.	1. Hold-down loose.	1. Replace battery.
	2. Frozen battery. Newly added water on top or a low state of charge could cause this.	1. Replace with fully charged battery.
(d) Compound on top of battery melts.	1. Charging rate too high.	1. Voltage regulator needs check. Refer to "Voltage Regulator" instructions, section IV, paragraph 7, *d*, (5).
	2. Electrolyte on top of cells. This may be caused by overfilling or improper operation of the ventilating system may short circuit the battery. The resulting heat will then soften the battery compound.	2. To correct this condition, be sure the ventilating lines are clear, remove any electrolyte from the top of the battery and neutralize with sodium bicarbonate. Then wash the top of the battery thoroughly, charge and reinstall in the airplane.
(e) Electrolyte runs out vent plugs.	1. Too much water added to battery.	1. Remove excess with self-leveling syringe.
	2. Excessive charging rate.	2. Voltage regulator needs check. Refer to "Voltage Regulator" instructions, section IV, paragraph 7, *d*, (5).

Trouble	*Possible Cause*	*Remedy*
(f) Excessive corrosion inside container.	1. Overcharging.	1. Voltage regulator needs check. Refer to "Voltage Regulator" instructions, section IV, paragraph 7, *d*, (5).
	2. Spillage from overfilling, melted sealing compound or cracked jars.	2. Remove excessive electrolyte. Reseal if necessary. If jars are cracked, replace battery.
	3. Vent lines leaking or clogged.	3. Clean out line and replace any leaky hose.
(g) Battery freezes.	1. Discharged battery.	1. Replace with fully charged battery.
	2. Water added and battery not charged immediately.	2. Water should never be added in freezing weather when batteries are to be left standing for a period of four or five hours before charging. About half an hour charge will mix the water with the electrolyte and then the freezing will be in accordance with the freezing point table. See remedy 4 following.
	3. Leaking jar. Water added and froze.	3. Replace battery.
	4. Extreme cold.	4. It is almost always necessary to replace a battery, although in case of a partial freezing, thawing in a warm room may save battery. It should be thoroughly checked in this case before use in an airplane.

Freezing Points

Specific Gravity	Freezing Point
1.300	−71°C (−96°F)
1.275	−62°C (−80°F)
1.250	−52°C (−62°F)
1.225	−37°C (−35°F)
1.200	−27°C (−17°F)
1.175	−20°C (− 4°F)
1.150	−15°C (+ 5°F)
1.125	−11°C (+12°F)
1.100	− 7°C (+19°F)

Trouble	*Possible Cause*	*Remedy*
(h) Battery polarity reversed.	1. Connected backwards on charger.	1. Such battery should be slowly discharged and recharged properly and tested. See instructions for making capacity test under (a) preceding.
	2. Connected backwards on airplane.	2. Same as 1 preceding.
(i) Battery consumes excessive water.	1. Charging rate too high (if in all cells).	1. Voltage regulator needs check. Refer to "Voltage Regulator" instructions, section IV, paragraph 7, *d*, (5).
	2. If in one cell only—cracked jar.	2. Replace battery.
(j) Battery will not come up on charge.	1. Battery worn out.	1. Give capacity test as instructed preceding.
	2. Battery badly sulphated. Caused by standing idle in discharged condition.	2. Charge as for sulphated battery, preceding.

(4) GENERATOR.

(a) DESCRIPTION.—Power is supplied in the airplane electrical system by a type M-2, 28.5-volt, 50-ampere generator mounted on the left rear of the engine accessory drive housing.

(b) REMOVAL OF GENERATOR.

1. The side engine cowls and left rear side cowl must be removed from the airplane before the generator will be accessible for removal.

2. Remove battery from shelf at rear of left engine mount forward of the firewall (figure 170). Remove the vent and drain connections from the battery and the cooling tubes at the battery cooling jacket. Remove the cables from the battery posts. The battery may then be removed as a unit with the cooling jacket.

3. Remove the plug of the electrical conduit from generator, cover the plug receptacle on the generator with tape to prevent damage from dirt or careless handling.

4. Remove the lock and retaining nuts which attach the generator to the mounting pad, leaving one of the top nuts until last. While removing the top nut, support the aft end of the generator to prevent possible bending of the armature shaft. Pull generator straight aft until free from the engine, then out left side over battery shelf.

(c) MAINTENANCE REPAIRS AND REPLACEMENTS.

1. OIL SEALS.—A generator will not function in a bath of oil. If oil is observed in the generator, the drive pad oil seal is defective and will be replaced.

2. BRUSH WEAR.—Generators used above 25,000 feet will consume brushes very rapidly. If the airplane is used at these altitudes, brushes will be checked after each flight of one hour or more duration at altitudes of 25,000 feet or over, and replaced as required. When new, the brushes are 3/4 inch long. When 1/4 inch has worn off, they must be replaced.

3. REPLACING A WORN BRUSH.—When replacing a worn brush, the new brush should be properly seated against the commutator by inserting a strip of No. 000 sandpaper between the brush and the commutator with the sanded side next to the brush. Pull in the direction of armature rotation, being careful that the sandpaper is kept in the same contour as the surface of the commutator. Repeat this sanding operation until the brush is completely seated. Remove sand and brush dust or metal particles with dry compressed air. Sticking brushes must be wiped clean with a cloth moistened with unleaded gasoline.

CAUTION

Do not use emery cloth or coarse sandpaper in seating the brush against the commutator.

4. SMOOTHING GENERATOR COMMUTATOR.

a. If the commutator is rough or coated (dark colored), smooth with No. 000 sandpaper.

b. If the commutator is very rough, badly scored, pitted or eccentric, it must be resurfaced at the Repair Depot.

Note

Bad scoring or eccentricity can be detected by holding the pointed end of a pencil or the like on top of the brush while the generator is running, and if the pencil is vibrated up and down by the brush, it can be considered that the commutator needs resurfacing, especially if sandpaper does not remove the vibration condition.

5. CONDUIT.—Before inserting the cable plug, make certain that it can be placed at any point within three inches from the generator receptable. This represents the possible movement of the generator during engine operation. If necessary, remove bonds or conduit supports which interfere with this movement.

6. CONNECTORS.—Plugs will be safetied in place by drilling a .040 hole across the corner of the conduit coupling nut and tying it to a fixed member.

(d) INSTALLATION OF GENERATOR.

1. While being installed, the generator must be carefully handled, and protected from dirt or foreign matter becoming deposited on the armature shaft or the machined surfaces of the generator face plate and engine mounting pad. It is also extremely necessary that both the air intake and exhaust ports of the generator housing be temporarily covered with tape during the installation to prevent foreign matter from entering the generator fan and cooling system.

2. Pass the generator in through the left side of engine mount, turning it into position to enter the splined end of the armature shaft into the driving gear within the engine accessory housing, and on the six mounting studs carefully supporting the aft end of the generator while starting one of the top retaining nuts. Then all six nuts will be evenly tightened and lock nuts installed.

3. Remove the protective tape from the plug receptacle on the generator and install the electrical conduit plug into the receptable, making sure that both are clean and make a firm contact. Remove the tape from the air intake and exhaust ports of the generator housing.

4. The battery and terminals should at this time be cleaned and inspected. The battery then is installed on its shelf at the rear of the left engine mount forward of the firewall and firmly secured. The battery cables will be securely attached to their proper posts, the negative being grounded. Reconnect the battery cooling tubes, the vent, and drain connections.

5. The side engine cowls and left rear side cowl may now be reinstalled and secured to their position on the airplane. (See section IV, paragraph 5, *b.*)

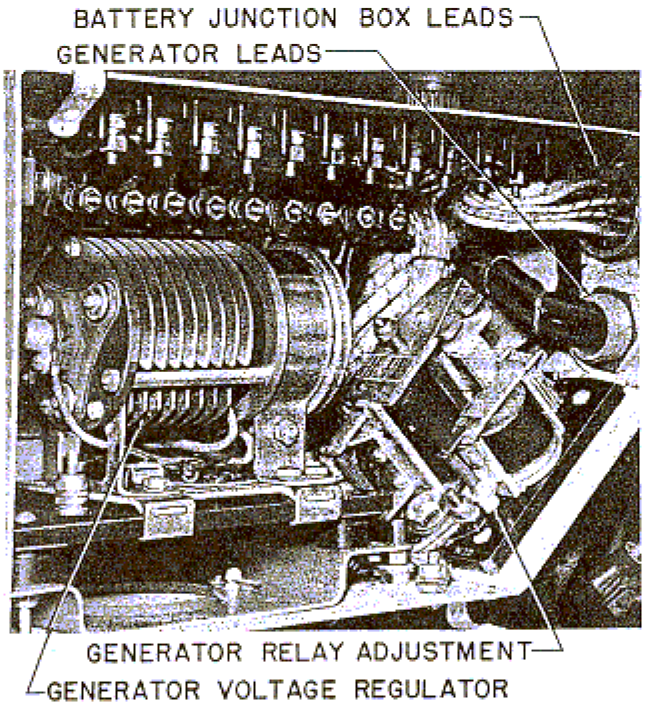


Figure 254—Firewall Junction Box (AF42-106029 and Subsequent)

(5) GENERATOR VOLTAGE REGULATOR.

(a) GENERAL.—The generator voltage regulator, U. S. Army Specification 94-32276 is located in the battery junction box opposite the fuselage access door in airplanes having the battery installed in the fuselage (AF42-104429 through AF42-106028) and in the firewall junction box on airplanes having the battery installed in the engine compartment (AF42-106029 and subsequent). (See figure 254.)

(b) FUNCTION OF REGULATOR. — The purpose of the voltage regulator is to maintain the voltage of the electrical system constant regardless of variations in the speed of the generators and conditions of varying electrical loads. Constant voltage is necessary for much of the electrically operated equipment on the airplanes, and to keep the battery charged. Voltage regulation is accomplished automatically by the voltage regulator by controlling the amount of resistance inserted into the field circuit of the generator.

Handle voltage regulators with care as close regulation of voltage is necessary for much of the electrical equipment. The voltage regulator is precision equipment and will not withstand rough treatment.

(c) ADJUSTMENT OF REGULATOR.

1. Use a precision voltmeter with a 30-volt range. Voltmeters particularly suited for adjustment of the voltage regulator will be issued to the service. These must be handled carefully as they will not maintain accuracy under conditions of mishandling, or vibration and shock. In the event a precision portable voltmeter is not available, a type B-1 voltmeter may be used. Before using this voltmeter, be sure that it has been calibrated against a precision voltmeter for accuracy. Satisfactory temporary accuracy is obtained by calibrating accurately at 28.0 volts on the voltmeter scale. If this type meter is used, it should be recalibrated each day prior to use.

2. Adjust the regulators as follows:

a. Place generator line switch on the main switch panel in the "OFF" position.

b. Start the engine and allow to warm up for a period necessary to bring engine to operating temperature.

c. Connect the negative terminal of the portable voltmeter to ground. The voltage regulator compartment or the structure around it are satisfactory grounds.

d. Connect the positive terminal of the portable voltmeter to the "B" terminal of the voltage regulator.

e. The speed of the engine should be increased to 1800 rpm.

f. The voltmeter should indicate 28.0 volts. If it does not, adjust the voltage regulator to give a reading of 28.0 on the voltmeter by turning the knurled adjusting knob. Turning the knob to the right will increase the voltage, and turning it to the left will decrease it. (See figure 255.)

g. After the regulator is adjusted, reduce the speed of the engine to idling.

Note

In case no voltage is obtained from the generator, recheck the system as outlined in section IV, paragraph 7, *d,* (7).

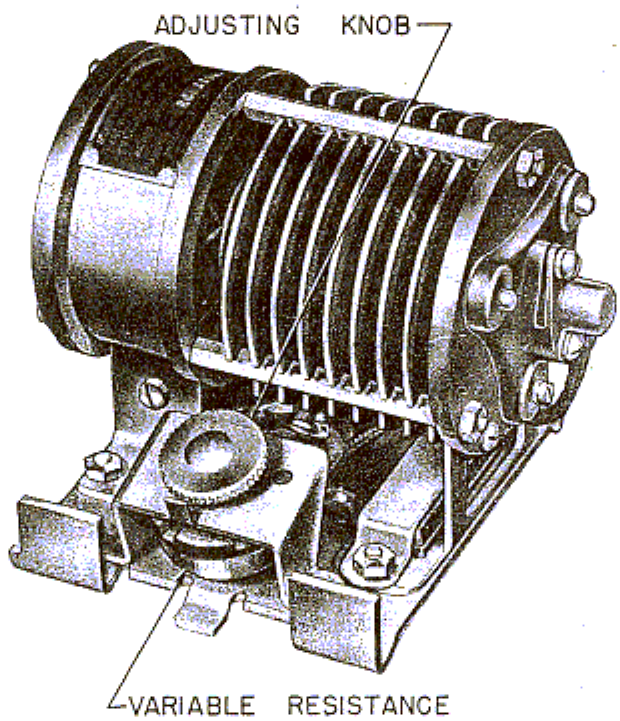


Figure 255—Voltage Regulator

(6) GENERATOR REVERSE CURRENT RELAY.

(*a*) GENERAL.—A 24-volt, reverse current relay (generator current control switch), U. S. Army Specification 94-32276, is located in the battery junction box opposite the fuselage access door in airplanes having the battery installed in the fuselage (AF42-104429 through AF42-106028), and in the firewall junction box in airplanes having the battery installed in the engine compartment (AF42-106029 and subsequent. (See figure 254.)

(*b*) FUNCTION OF REVERSE CURRENT RELAY.—The relay switch connects the generator to the airplane electrical system when the generator voltage is sufficiently high. However, the relay will close only when the generator switch on the main switch panel is closed. The relay switch also opens automatically in case the generator voltage becomes lower than the system voltage, causing a reverse current to flow, as happens when the engine speed is reduced to idling or the engine is off. Hence, the term sometimes used for the relay switch is "reverse current cut-out."

Note

Never close the reverse current relay manually by pressing the contacts together, as serious damage to the relay, the electrical system, and to the individual closing the contacts may result.

(*c*) RELAYS.—The following relays are suitable for use:

Type	*T. O. No.*
General Electric, models 3GTR72A1A and 3GTR72C1	03-5AD-6
Westinghouse, part Nos. 1240224-A and 1171000-A	03-5AF-3
Leece-Neville, part Nos. 24552 and 24565	03-5-37

Where possible, when a relay is removed, it will be replaced by a relay of the same number.

(*d*) CHECKING CLOSING VOLTAGE OF RELAY.—After all the regulators have been adjusted to a voltage of 28.0, check the closing point of the relay switch. To check the closing voltage of the relay, the voltmeter will be connected in the same manner as for adjustment of the voltage regulator. Place the generator switch on the main switch panel in the "ON" position. Slowly increase the speed of the engine until a current reading is noted on the ammeter on the switch panel. The voltmeter reading will show a slight drop, as the relay closes. This voltage just before the relay closes is the relay closing voltage. This should be between 26 and 26.5 volts. If it is different from that value, adjust the relay in accordance with "Instructions for Adjustment of Relays," paragraph (6), (*e*), following. After the relay has been adjusted, the reverse current release value of the relay will be checked as follows: With battery switch "ON," operate engine so that ammeter shows current output from generator. Slowly reduce engine rpm, watching ammeter. Ammeter reading will decrease to zero and then begin to read in the reverse direction. Note the current reading just before the ammeter pointer returns to zero. This reading should be between -8 and -20 amperes. If the pointer does not immediately return to zero, advance the throttle until the ammeter shows current output from the generator, open main line switch, and stop the engine in the prescribed manner. In such cases, the relay is probably stuck and will be checked and replaced if necessary.

(*e*) INSTRUCTIONS FOR ADJUSTMENT OF RELAY.

Note

The following adjustments should be made with the relays removed from the airplane, if suitable test equipment is available. If equipment is not available, relay will be replaced.

1. GENERAL ELECTRIC RELAY, PART NO. 3GTR72A1A.—Adjustment of the closing voltage is made by turning a small screw in a spring clip immediately above the name plate. Turning the screw clockwise raises the closing voltage, and turning it counterclockwise lowers the closing voltage. Extreme care should be taken not to damage the pilot armature while adjustments are being made.

2. LEECE-NEVILLE RELAY, PART NO. 24552.—Adjustment of the closing voltage is made by turning a small slotted nut near the generator terminal. This nut controls the tension on the small spring. Increasing the tension on the spring raises the closing voltage, and decreasing the tension lowers the closing voltage.

3. WESTINGHOUSE RELAY, PART NO. 1240224A.—Adjustment of the closing voltage is made by turning a small screw with a screwdriver to adjust the position of the armature inside the small coil. Turning the screw in lowers the closing voltage, and turning it out raises the closing voltage.

Note

A differential type of relay switch will soon be placed in service. This relay will close when the generator is producing voltage 0.5 volt higher than the remainder of the system. This relay will not require adjustment and this fact will be noted on the name plate.

(7) SERVICE TROUBLES AND REMEDIES—GENERATING SYSTEM

Before removing electrical units, try and determine a basic cause for the trouble encountered. Some indication of malfunction is always existing and apparent just prior to complete failure of any equipment and this should be checked. The airplane wiring diagram will help to establish the location points of the connections and equipment involved. To trace out the wiring for proper connections and continuity, use electric continuity test meter, part No. 37D4883; and a portable precision voltmeter (accuracy within one percent) must be used for properly checking the voltage. If trouble exists, always check voltage regulator before testing generator.

Note

Before removing connections to any electrical equipment, be sure that the battery power is "OFF" and will remain "OFF" until the equipment is again connected. This is especially important in working with radio equipment, and all other equipment that has power applied when the battery circuit switch is "ON".

Trouble	*Possible Cause*	*Remedy*
(a) Generator produces no voltage. No indication on ammeter when generator line switch is "ON," engine running at proper speed (1800-1850 rpm), and load applied.	1. Reversed wiring at the generator or the reverse current relay.	1. Check wiring diagram.
	2. Open circuits in wiring, particularly in voltage regulator.	2. Try replacing regulator or if possible, check continuity of all leads from generator to regulator. Remove generator plug, and check contacts and cable soldering.
(Note: Closing the switch to the hydraulic pump motor should cause the ammeter reading to increase. Removing the load should reduce the reading to zero again, indicating normal operation.)	3. Defective ammeter, generator line switch, or wiring.	3. Connect positive terminal of portable voltmeter at "BAT." terminal of reverse current relay and ground negative terminal. If voltage is indicated, the ammeter or wiring to ammeter is at fault. Check and replace. If voltage is not indicated, the generator line switch or the reverse current relay is at fault. Check and replace.
	4. Leads from ammeter to shunt may be reversed.	4. Check continuity and polarity.
	5. Defective reverse current relay.	5. Replace relay.
	6. Loss of field residual magnetism.	6. Generator field should be "flashed." This should be done with the regulator removed or disconnected. Locate a point in a terminal box where the battery voltage is available. This may be located with the voltmeter, the negative terminal connected to ground and the positive terminal used as a test lead. With a length of No. 18 or larger cable, connect to the source of the battery voltage. With the engine operating at 1800 rpm and the generator switch off, touch the "hot" battery lead to the "A" terminal on the voltage regulator mounting base and note if a voltage is obtained on the voltmeter. If no voltage is obtained, the generator is faulty and should be replaced. If voltage is obtained, replace the regulator and see if voltage is still obtained. If no voltage is then obtained, the voltage regulator is faulty and should be replaced. If voltage is obtained after flashing the field and replacing the voltage regulator, the difficulty was due to a loss of residual magnetism of the generator, and the system is again in operating condition. If a generator repeatedly loses its residual magnetism, it should be replaced by a new generator.

Trouble	*Possible Cause*	*Remedy*
	7. Open field wiring.	7. Remove regulator from the mounting base. If an ohmmeter is available, measure resistance of the generator field with an ohmmeter connected between "A" terminal on the mounting base and ground. This value should be approximately three ohms for the type M-2 generator. If the ohmmeter reading differs greatly from the above value, the generator wiring and generator should be checked. Remove the connector plug at the generator and check the field again between the "A" and "E" terminal on the generator. If again a value different from approximately 3 ohms is obtained, check the condition of the generator by removing the brush band or end housing, the connector plug at the generator, and the cables leading to the connector plug, replacing all defective parts.
	8. Defective voltage regulator.	8. If the field resistance is correct, connect "B" terminal to "A" terminal on the voltage regulator base. Have the generator switch in the "OFF" position. Increase the engine speed slowly, and watch the portable voltmeter. If the voltage builds up to approximately 28.5 with an engine speed less than 1800 rpm, the generator is satisfactory but the regulator is probably faulty and should be replaced. Do not increase engine speed to give a voltage of more than 30 volts. Decrease the engine speed to idling speed and remove the lead between "A" and "B".
	9. Brushes too short.	9. Replace brushes.
	10. Brushes stuck in holders.	10. Remove brushes and clean with a cloth moistened with unleaded gasoline.
	11. Undesired insulation at wiring connection owing to paint or corrosion preventive compounds.	11. Check voltage drop across terminals. Clean terminals carefully, if voltage is indicated.
(b) Voltage holds properly to a certain point and begins to drop before overload.	1. Defective ammeter.	1. Check ammeter against ammeter of known accuracy, and replace if necessary.
	2. Regulator field resistors partly burned out.	2. Replace regulator.
	3. Regulator armature stuck.	3. Replace regulator.
(c) Voltage drops uniformly as load is applied.	1. Severely damaged generator commutator.	1. Replace generator.
(Note: Be sure engine is up to speed.)	2. Regulator defective.	2. Exchange regulator.
	3. Loose cable or plug connections.	3. Check for local overheating in cable connections, especially at generator.
	4. Loose field circuit connections.	4. (a) Check for tightness; check field current with ammeter for fluctuation or low reading. (Should increase with load.) (b) Replace generator.

Trouble	*Possible Cause*	*Remedy*
(d) Voltage drops to very low value at small loads.	1. Generator cable unsoldered at plug.	1. Replace cable. (Do not attempt to resolder on airplane.)
	2. Defective generator connections.	2. Check for loose main cable bolts or brush trouble.
	3. Damaged generator.	3. Replace.
(e) Generator will not deliver *any* load at proper speed and voltage.	1. Defective reverse current relay.	1. Check relay. [See section IV, paragraph 7, *d,* (6).]
	2. Reverse current relay out of adjustment.	2. Tap regulator dashpot (General Electric model) to raise voltage. Relay will close at some voltage below 30 if not defective. Adjust relay. (See section IV, paragraph 7, *d,* (6).)
(f) Voltage rises or drops excessively under load.	1. Voltage regulator adjustment is improperly set.	1. Adjust regulator. [See section IV, paragraph 7, *d,* (5).]
(g) Generator produces approximately two volts or "residual" voltage.	1. Voltage regulator does not allow sufficient field current to "build up" voltage.	1. Adjust regulator.
	2. Field lead to regulator "A" terminal is open.	2. Replace wire.
	3. Generator field circuit open.	3. Replace generator.
(h) Generator produces low voltage.	1. Generator armature or field is partially shorted.	1. Replace generator.
	2. Voltage regulator resistor is open at a midpoint.	2. Replace regulator.
	3. Regulator setting is too low.	3. Check and adjust regulator.
	4. Insufficient brush pressure.	4. Replace brush springs in generator.
	5. Improper brush fit.	5. Sand the brushes.

(8) STARTER. (Also see section IV, paragraph 6, *e.*)

(*a*) DESCRIPTION.—A type G-6 24-volt combination electric inertia, direct cranking starter, U. S. Army Specification 95-32304 is mounted on the right rear of the engine accessory housing on AF42-105640 and subsequent airplanes. Provision is made for hand energizing, and engaging the starting motor with the engine, through an access door in the right side of engine rear bottom cowl (figure 37). Access for lifting the starter brushes before hand cranking is obtained through the access door in the lower rear section of the right side engine cowl (figure 35).

NOTE

Hand crank the engine in accordance with section III, paragraph 3.

WARNING

Never energize the starting motor *electrically* when the brush lifting knob at the end of the starter is in the "OFF" position. If the starter is energized electrically when the brush lifting knob is "OFF" considerable arcing will result and there is danger of burning out the starting motor. *The "brush lifting knob" does not lift the brushes off the commutator, but instead relieves the spring tension from the brushes.*

(*b*) STARTING CIRCUIT.

1. When energizing the starter electrically, always use an external power source, unless an emergency makes it necessary to use the airplane battery.

2. Wiring of the starter electrical circuit is shown in figure 258. The electrical energy from the power source (airplane battery or the battery cart) is conducted to the circuit breaker bus in the main switch panel and thence, through the circuit breaker (reference No. 88), to the starter switch which is located in the winterization junction box under the engine control quadrant. When the starter switch is placed in the "ENERGIZING" or "ENGAGE" position, the coil in the starter relay is energized and closes the contacts of the relay. Electrical energy from the power source, then flows directly through the closed contacts of the starter relay to the starter motor. When the starter switch is placed in the "ENGAGE" position, the ignition booster coil is set into operation at the same time the engaging solenoid of the starter clutch is energized.

Note

A type B-4 starter relay, U. S. Army Specification 94-32324, was installed in airplanes AF42-104429 through AF43-23151 at the factory. A type B-8 starter relay, U. S. Army Specification 94-32424, is installed in all subsequent model P-40N airplanes. All replacements should be of the latter type.

(*c*) REMOVAL OF STARTER .

1. The right side engine cowl and right rear side cowl must be removed from the airplane before the starting motor will be accessible for removal.

2. Disconnect the oil to tank return line at the hose connection below the right end of the coolant expansion tank on the firewall and at joint at lower end of this line and remove.

3. Disconnect the oil dilution line to the oil dilution valve on the forward side of the firewall at the hose connection.

4. Disconnect all electrical connections at the starting motor.

5. Disconnect the starter pull button cable.

6. Remove the lock and retaining nuts which attach the starter to the mounting pad of the engine. Leaving one of the top nuts until last. While removing the top nut, support the aft end of the starting motor to prevent possible damage caused by falling or bending the engaging clutch shaft.

7. Pull the starter assembly straight aft until free from the engine, then out right side of engine mount.

CAUTION

While handling the starting motor, care must be used not to damage the brush lifting knob on the aft end of the starting motor or the engaging solenoid. (See figure 35.)

(*d*) MAINTENANCE REPAIRS AND REPLACEMENTS.—Starting motors will not be repaired in the field. In the event trouble is experienced during normal operation, replace the unit and send the unserviceable starting motor to the depot for overhaul.

(*e*) INSTALLATION OF STARTER.

1. While being installed, the starting motor assembly must be protected from dirt or foreign matter becoming deposited on the machined surfaces of the starter face plate and engine mounting pad.

2. Pass starter in through right side of engine mount turning it into position to enter the engaging clutch within the engine accessory housing and on the mounting studs.

3. Carefully supporting the aft end of the starting motor assembly while starting one of the top retaining nuts. Then all six nuts will be evenly tightened and the lock nuts installed.

4. Make all electrical connections at the starting motor and solenoid. Make sure they are clean and have a firm contact.

5. Reconnect the oil dilution line to the oil dilution control valve on the firewall.

Note

Use new hose and clamps if deterioration is evident.

6. Reconnect the oil tank return line at the oil hose connection below the right side of the coolant expansion tank on the firewall and reconnect lower end of this line using new hose if necessary.

(9) IGNITION SYSTEM.

(*a*) MAGNETOS.—Ignition is furnished this engine by one double Scintilla DF magneto which is mounted in front of the carburetor at the top of the accessory housing on a two bolt flange having two elongated slots for the holding studs, thus permitting turning of the magneto through an angle of 20 degrees to obtain more accurate ignition timing of the engine.

(*b*) DISTRIBUTOR.—Two high tension ignition distributor heads are located in the distributor drive housings on the rear of the engine, and are driven by the two cam shafts. The right distributor fires the exhaust spark plugs on both banks of cylinders. The left distributor fires all intake plugs of both banks of cylinders.

(*c*) SPARK PLUGS. — Twenty-four spark plugs are used in this engine, two to each cylinder. One spark plug is fired by the exhaust distributor, and the other is fired by the intake distributor. All spark plugs are set at .012 inch with a tolerance of plus .002 inch or minus .001 inch.

(*d*) BOOSTER COIL.—To facilitate starting, a high tension booster vibrator coil, U. S. Army Specification 94-32182, type C-1 is used when the electric starter is engaged to supplement the output of the engine magneto until the engine starts. It delivers high voltage current to an individual collector ring and booster finger on the segment of the distributor head and thence to the spark plugs. The booster coil is located in the firewall terminal box in airplanes which have the battery installed in the fuselage, and is located in the battery junction box, which is attached to the left engine mount, in airplanes which have the battery installed in the engine compartment.

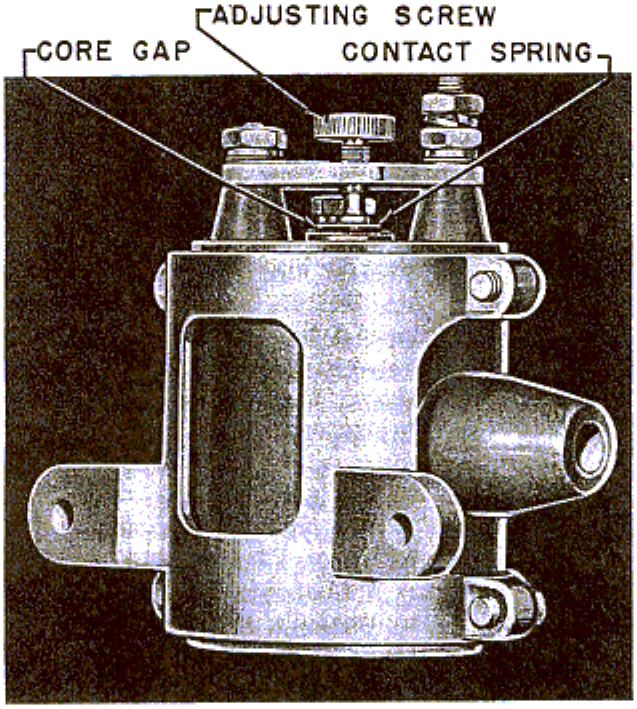


Figure 256—Booster Coil

IMPORTANT

The booster vibrator coil must be spaced at .033 inch core gap between the contact spring and the top of the core. (See figure 256.) This is a very hot contact and great care must be taken to set the points exactly. If the points are burned, they must be replaced by a new contact spring and adjustable contact screw. Extreme caution must be used not to overheat and melt the booster coil. A cooling off period of five minutes between engine starting operations should be allowed to eliminate that danger, unless it is an emergency start.

(10) HYDRAULIC PUMP MOTOR.—The hydraulic pump is driven by a 24-volt Eclipse type 809, model 3 electric motor. The motor and pump are assembled as one unit which is located between stations 9 and 10 in the fuselage.

(11) EXTERNAL POWER RECEPTACLE.

(*a*) For airplanes AF42-105640 through AF42-106028, an electric power cart plug receptacle is installed below the battery junction box opposite the fuselage access door.

(*b*) For airplanes AF42-106029 and subsequent, the external electric power cart receptacle is installed adjacent to the battery starter junction box on the left side of the engine compartment. The access door is stenciled "EXTERNAL ELECTRIC POWER CART PLUG—24V". (See figure 253.)

(*c*) The receptacle is provided so that electric power from the cart battery may be plugged into the airplane electrical system for starting the engine and test-operating the electrical equipment. Power from the airplane battery must *not* be consumed for ground operation of the airplane equipment. A British type cart plug adapter S42B6927, is carried in a clip located on the right side of the fuselage opposite the access door.

(12) ELECTRICAL BONDING.—All parts are bonded according to specification, and replacement should be made with clamps, bolts, metal strips and pig tails similar to those provided in the original installation.

(13) WIRES.—All wires are identified by a number attached to each end of the wire. The Electrical Wire Tabulation chart completely describes each wire used in the electrical system of the model P-40N airplane. The wire types are as follows:

Low-Tension Insulated Single Conductor Cable	Specification AN-J-C-48
High-Tension Ignition Cable	Specification AN-J-C-56
Shielded Cable	U. S. Army Specification 95-27273

All wires listed in the Wire Tabulation are the low-tension single conductor type, Specification AN-J-C-48, except where noted otherwise. All wire terminals are manufactured by Thomas and Betts Company, Elizabeth, New Jersey.

(14) CIRCUITS AND DIAGRAMS.

(*a*) REFERENCE DRAWINGS.—The following drawings cover the installation of the electrical equipment in this airplane:

Drawing No.	*Title*	*For Airplanes*
87-550-1005	Electrical Wiring Diagram	AF42-104429 through AF42-104828
87-550-1105	Electrical Wiring Diagram	AF42-104829 through AF42-105639
87-550-1205	Electrical Wiring Diagram	AF42-105640 through AF42-105928
87-550-1305	Electrical Wiring Diagram	AF42-105929 through AF42-106028
87-550-1405	Electrical Wiring Diagram	AF42-106029 through AF43-24251
87-550-1505	Electrical Wiring Diagram	AF43-24252 and subsequent
87-552-1000	Fuselage Electrical Installation	AF42-104429 through AF42-104828
87-552-1100	Fuselage Electrical Installation	AF42-104829 through AF42-105928
87-552-1200	Fuselage Electrical Installation	AF42-105929 through AF-42-106028

Drawing No.	Title	For Airplanes
87-552-1400	Fuselage Electrical Installation	AF42-106029 and subsequent
87-554-1000	Power Plant Electrical Installation	AF42-104429 through AF42-105639
87-554-1100	Power Plant Electrical Installation	AF42-105640 through AF42-106028
87-554-1400	Power Plant Electrical Installation	AF42-106029 and subsequent
87-558-1000	Wing Electrical Installation	AF42-104429 through AF42-106028
87-558-1400	Wing Electrical Installation	AF42-106029 through AF43-24251
87-558-1500	Wing Electrical Installation	AF43-24252 and subsequent

(*b*) INDIVIDUAL CIRCUIT DIAGRAMS.—The individual circuit diagrams provided in this Handbook show the complete wiring and operation of each electrical circuit in the Model P-40N airplane. These diagrams show the wiring of the circuits with the battery installed in the engine compartments. They are also applicable where the battery is installed in the fuselage. The "Supplement to the Individual Circuit Diagrams" (figure 266), shows the wiring for airplanes with the battery installed aft in the fuselage and should be used in conjunction with the individual circuit diagrams. The equipment and wires in the individual circuit diagrams are referred by number respectively, to the list of electrical equipment and the wire tabulation which follow the circuit diagrams in this section. The equipment numbers are underlined; the wire numbers are not.

(15) LIST OF MANUFACTURERS.—Following is a list of manufacturers of electrical equipment to whom reference is made in the equipment lists of the electrical wiring diagrams:

Abbreviation	Manufacturer
Breeze	Breeze Manufacturing Company Newark, New Jersey.
Cannon	Cannon Electric Development Co. Los Angeles, California
Eclipse	Eclipse Aviation Corp. Div. Bendix Aviation Corporation Bendix, New Jersey
Electric Battery	Electric Storage Battery Co. Philadelphia, Penna.
General Electric	General Electric Corporation Schenectady, New York
Grimes	Grimes Manufacturing Co. Urbana, Ohio
Hubbell	Harvey Hubbell, Inc. Bridgeport, Conn.
Int. Resist.	International Resistance Company Philadelphia, Penna.
Klixon-Spencer	Spencer Thermostat Company Attleboro, Massachusetts
Mallory	P. R. Mallory & Co., Inc. Indianapolis, Indiana
Micro Switch	Micro Switch Corporation Freeport, Illinois
Propeller Div.	Curtiss-Wright Corporation Propeller Division Caldwell, New Jersey
Ward	Ward Leonard Electric Co. Mount Vernon, New York.

WIRE TABULATION—ELECTRICAL SYSTEM

Wire No.	Size	Length	Terminal	Terminals Required
1	AN14	7′ 10″	B36G	1
2	AN14	7′ 10″	B36G	1
3	AN14	7′ 8″	B36G	1
4	AN14	7′ 8″	B36G	1
5	AN16	8′ 0″	B36G	1
6	AN16	8′ 0″	B36G	1
7	AN16	8′ 0″	B36G	1
8	AN14	2′ 2″	B36G	1
9	AN14	1′ 10″	B36G	1
10	AN14	1′ 10″	B36G	1
11	AN14	1′ 10″	B36G	1
12	AN16	5′ 3″		
13	AN16	4′ 6″	B77G	1
14	AN16	4′ 9″		
15	Specification AN-J-C-56	Furnished On Engine		
18	AN18	2′ 7″	A36G, A77G	1 Each
19	AN18	1′ 7″	A36G	1
20	AN18	1′ 6″	A36G	1
21	AN14	5′ 6″	B36G	1
22	AN18	8′ 8″		
23	AN18	8′ 8″		
24	AN16	2′ 4″	B36G	1
25	AN6	2′ 4″	E26	1
26	AN6	2′ 4″	E26	1
29	AN14	3′ 10″	B36G	1
30	AN14	2′ 10″	14G6-8	1
31	AN14	2′ 11″	14G6-8	1
32	AN14	3′ 1″	14G6-8	1
33	AN16	3′ 2″	16NA6	1
34	AN16	2′ 11″	16NA6	1
35	AN16	3′ 1″	16NA6	1
36	AN18	3′ 9″	A36G	1
37	AN18	3′ 8″	A36G	1
38	AN18	3′ 10″	A36G	1
40	AN18	2′ 8″	A36G	2
41	AN18	2′ 10″	A36G	2
42	AN14		B36G	2
43	AN14	3′ 5″	B36G	2
44	AN18	3′ 3″	A36G	2
45	AN18	3′ 2″	A36G	2
46	AN16	3′ 1″	B36G	2

Wire No.	Size	Length	Terminal	Terminals Required	Wire No.	Size	Length	Terminal	Terminals Required
47	AN6	2′ 7″	E26	2	105	AN18	0′ 6″	A33G	2
48	AN6	2′ 7″	E26	2	106	AN18	6′ 9″	A36G	1
49	AN18	3′ 11″	A36G	1	107	AN18	6′ 9″	A36G	1
50	AN18	3′ 10″	A36G	1	108	AN18	6′ 9″	A36G	1
51	AN12	3′ 6″	C36	1	109	AN18	6′ 9″	A36G	1
52	AN18	8′ 5″	A36G	1	110	AN20	16′ 8″	A36G	2
53	AN14	3′ 6″	B36G	1	111	AN18	16′ 7″	A36G	2
54	AN18	3′ 4″	A36G	1	112	AN6	16′ 9″	E71, E26	1 Each
55	AN18	4′ 0″	A36G	1	113	AN18	16′ 8″	A36G	2
56	AN18	4′ 0″	A36G	1	114	AN18	16′ 8″	A36G	2
57	AN12	4′ 0″	C36		115	AN16	16′ 7″	B36G	2
58	AN18	4′ 0″	A36G	1	116	AN6	16′ 7″	E73, E26	1 Each
59	AN14	4′ 0″	B36G	1	117	AN20	16′ 8″	A36G, A33G	1 Each
60	AN18	4′ 0″	A36G	1	118	AN6	16′ 5″	E71, E26	1 Each
61	AN18	5′ 8″	A36G, A77G	1 Each	119	AN18	17′ 5″	A36G, A33G	1 Each
62	AN18	5′ 8″	A36G, A77G	1 Each	120	AN16	1′ 3″	B36G	2
63	AN12	5′ 0″	C36	2	121	AN16	0′ 7″	B36G	1
64	AN18	5′ 0″	A36G	2	122	AN6	1′ 0″	E73, E71	1 Each
65	AN14	16′ 6″	B36G	2	123	AN18	1′ 9″	A36G	2
66	AN18	16′ 6″	A36G	2	124	AN16	1′ 8″	B36G	2
67	AN12	2′ 6″	C36	2	125	AN18	5′ 6″	A36G	2
68	AN18	2′ 6″	A36G	2	126	AN6	1′ 11″	E73, E71	1 Each
69	AN12	6′ 6″	C36	1	128	AN20	0 10″	A36G, A33G	1 Each
70	AN12	5′ 2″	C36	1	129	AN18	1′ 3″	A36G, A33G	1 Each
71	AN18	0′ 4″	A36G	2	131	AN6	3′ 6″	E71	2
72	AN14	3′ 0″	B36G	1	133	AN6	3′ 6″	E73, E71	1 Each
73	AN14	3′ 0″	B36G	1	134	AN16		B71G	1
74	AN18	1′ 6″	A36G	1	136	AN18		A33G	2
75	AN18	0′ 6″	A36G	1	137	AN14	3′ 10″	B36G	2
76	AN18	9′ 7″	A36G	1	138	AN14		B36G, B77G	1 Each
77	AN18	9′ 5″	A36G	1	139	AN14	6′ 1″	B36G, B77G	1 Each
78	AN12	8′ 7″	C36	1	140	AN18	3′ 11″	A36G	1
79	AN18	9′ 3″	A36G	1	141	AN18	3′ 9″	A36G	1
80	AN18	9′ 4″	A36G	1	142	AN18	3′ 7″	A36G	1
81	AN18	9′ 5″	A36G	1	144	AN18	4′ 11″	A36G, A77G	1 Each
82	AN18	9′ 5″	A36G	1	145	AN14	3′ 6″	B36G	2
83	AN18	4′ 0″	A36G	1	147	AN6	4′ 11″	E26	2
84	AN18	4′ 0″	A36G	1	148	AN20	6′ 2″	A36G, A77G	1 Each
85	AN12	4′ 0″	C36	1	149	AN20	6′ 1″	A36G, A77G	1 Each
86	AN18	4′ 0″	A36G	1	150	AN18	5′ 10″	A36G, A77G	1 Each
87	AN18	4′ 0″	A36G	1	151	AN18	5′ 4″	A36G, A77G	1 Each
88	AN18	4′ 0″	A36G	1	152	AN12	5′ 4″	C36, C77	1 Each
89	AN18	4′ 0″	A36G	1	153	AN14	5′ 5″	B36G, B77G	1 Each
90	AN18	16′ 6″	A36G	2	154	AN18	3′ 9″	A36G	2
91	AN18	5′ 0″	A36G	2	155	AN18	5′ 4″	A36G, A77G	1 Each
92	AN12	5′ 0″	C36	2	156	AN18	5′ 3″	A36G, A77G	1 Each
93	AN18	5′ 8″	A36G, A77G	1 Each	157	AN18	3′ 10″	A36G	2
94	AN18	5′ 8″	A36G, A77G	1 Each	158	AN18	3′ 12″	A36G	2
95	AN18	5′ 6″	A36G	1	159	AN18	2′ 6″	A36G	2
96	AN18	5′ 6″	A36G	1	160	AN18	4′ 6″	A36G, A77G	1 Each
97	AN18	5′ 6″	A36G	1	161	AN18	2′ 7″	A36G	2
98	AN18	5′ 6″	A36G	1	162	AN18	2′ 8″	A36G	2
99	AN12	2′ 10″	C36	2	163	Furnished On			
100	AN18	2′ 10″	A36G	2		Spotlight		A36G	1
101	AN18	0′ 5″	A36G	2	164	Furnished On			
102	AN12	5′ 2″	C36	1		Spotlight		A36G	1
103	AN12	6′ 6″	C36	1	165	AN18	2′ 2″	A36G	1
104	AN18	1′ 6″	A36G, A33G	1 Each	166	AN18	2′ 5″	A36G	1

Wire No.	*Size*	*Length*	*Terminal*	*Terminals Required*
169	AN18	2′ 9″	A36G	1
170	AN18	2′ 7″	A36G	1
171	AN18	2′ 7″	A36G	1
172	AN18	4′ 4″		
173	AN18	2′ 7″		
174	AN18	5′ 8″	A36G	1
175	AN18	4′ 8″		
176	Furnished On Spotlight		A36G	1
177	Furnished On Spotlight		A36G	1
178	AN14	1′ 11″	B77G	2
179	AN18	2′ 3″	A36G, A77G	1 Each
180	AN14	1′ 0″	B77G	2
184	AN14	0′ 8″	B36G, B77G	1 Each
185	AN18	2′ 3″	A36G, A77G	1 Each
186	AN18	4′ 4″	A36G	1
187	AN18	4′ 6″	A36G	1
188	AN18	1′ 3″	A36G	1
189	AN18	2′ 8″	A36G	1
190	AN18	2′ 8″	A36G	1
191	AN18	1′ 4″	A77G	2
192	Furnished On Guns and Bomb Control Switch			
193	AN12	7′ 2″	C36	1
194	AN12	7′ 2″	C36	1
195	AN18		A36G, A33G	1 Each
196	Furnished On Guns and Bomb Control Switch		A36G	1
197	Furnished On Guns and Bomb Control Switch		A36G	1
198	AN18	5′ 0″	A36G, A33G	1 Each
199	AN18	5 0″	A36G, A33G	1 Each
200	AN18	2′ 9″	A36G	1
201	AN18	2′ 10″	A36G	1
202	AN18	2′ 11″	A36G	1
203	AN6		E71	2
204	AN12	17′ 1″	C71, C36	1 Each
205	AN12	17′ 0″	C71, C36	1 Each
206	AN12	5′ 4″	C36	2
207	AN12	5′ 4″	C36	2
208	AN18	2′ 4″	A36G, A77G	1 Each
209	AN18	3′ 0″	A36G	2
210	AN18	5′ 0″	A36G	1
211	AN18	2′ 8″	A77G	1
212	AN18	2′ 8″	A77G	1
213	AN18	0′ 3″	A77G	2
214	AN18	5 6″	A36G, A77G	1 Each
215	AN18	2′ 9″	A77G	1
216	AN18	2′ 8″	A77G	1
217	AN18	2′ 5″	A36G, A77G	1 Each
218	AN18	3′ 8″	A36G	2
219	AN18	4′ 9″	A36G	2
220	AN18	0′ 3″	A36G, A77G	1 Each
221	AN18	2′ 7″	A36G, A77G	1 Each
222	AN14		B36G	2
224	AN18	2′ 1″	A36G, A77G	1 Each
225	AN6	18′ 4″	E26, E71	1 Each
226	AN6	2′ 6″	E26, E71	1 Each
227	AN6	1′ 6″	E73, E71	1 Each
228	AN2		2G1	2
229	AN14		B36G	1
230	AN18	1′ 8″	A36G	1
231	AN18	3′ 1″	A36G	2
232	AN18	1′ 8″	A36G	2
233	AN18	2 1″	A77G, A36G	1 Each
238	AN14		B33G, B77G	1 Each
239	AN14	0′ 3½″	B77G	2
240	AN14	0′ 3½″	B77G	2
241	AN14		B36G, B77G	1 Each
242	AN14		B36G, B77G	1 Each
243	AN14	5′ 0″	B36G, B77G	1 Each
244	AN4		F71	1
245	AN4		F73	1
246	AN18	12′ 11″	A77G	1
247	AN18	16′ 1″	A77G	1
248	AN18	15′ 5″	A77G	1
249	AN18	11′ 6″	A77G	1
250	AN18	7′ 10″	A36G, A77G	1 Each
251	AN2		2G3	2
252	AN2		2G1, 2G3	1 Each
260	AN18	1′ 0″	A36G	2
261	AN18	1′ 0″	A36G	2
262	AN18	1′ 8″	A36G	2
271	U. S. Army Specification 95-27273	2′ 8″	AC660-5	1
273	AN18	2′ 8″	A36G	1
274	AN2		3530D, 2G1	1 Each
275	AN2		3530D, 2G3	1 Each
301	AN2		AN660-6	1
302	AN2		2G3	1
303	AN14		B36G	2
304	AN14		B36G	2
305	AN14		B36G	1
306	AN2		2G3	2
307	AN14		B33G, B36G	1 Each
313	AN14	3′ 6″	B36G	1
314	AN18	3′ 6″	B36G	1
315	AN18	4′ 0″	B36G	1
316	AN14	4′ 0″	B36G	1
317	AN14	13′ 0″	B36G	2
318	AN18	13′ 0″	A36G	2
319	AN18	1′ 3″	A36G	2
320	AN14	1′ 2″	B36G	2
321	AN14	1′ 2″	B36G	2
322	AN18		A36G, A77G	1 Each
323	AN18		A36G, A77G	1 Each
324	AN18		A36G, A77G	1 Each
325	AN18		A36G	1
326	AN18		A36G	1
327	AN18		A36G	1
328	AN18		A36G	1
329	AN18		A36G	2
330	AN18		A36G	2

Wire No.	Size	Length	Terminal	Terminals Required
331	AN18		A36G	1
332	AN18		A36G	1
333	AN18			
334	AN18			
335	AN18		A33G	1
336	AN18		A33G	1
337	AN18		A33G	2
338	AN18		A33G	2
339	AN18		A36G	1
401	AN14	7′ 10″	B36G	1
402	AN14	7′ 10″	B36G	1
403	AN14	7′ 8″	B36G	1
404	AN14	7′ 8″	B36G	1
405	AN16	8′ 0″	B36G	1
406	AN16	8′ 0″	B36G	1
407	AN16	8′ 0″	B36G	1
408	AN14	4′ 2″	B36G	1
409	AN14	4′ 2″	B36G	1
410	AN14	4′ 2″	B36G	1
411	AN14	4′ 2″	B36G	1
412	AN16	5′ 3″		
414	AN16	4′ 9″		
415	Specification AN-J-C-56 Furnished On Engine			
416	AN14	1′ 6″	B36G	2
417	AN14	5′ 3″	B36G	2
418	AN2	5′ 11″	2G3-ALR	1
419	AN14	2′ 0″	B36G, B33G	1 Each
420	AN20	1′ 0″	A36G, A33G	1 Each
421	AN2	2′ 9″	2G3-UA, 2G3	1 Each
422	AN2	0′ 9″	2G3, 2G2	1 Each
423	AN2	1′ 7″	2G1, 2G2	1 Each
424	AN2	5′ 3″	3530D, 2G1-UA	1 Each
425	AN2	5′ 7″	3530D, 2G3-ALR	1 Each
426	AN2	0′ 7″	2G3-UA	2
427	AN14	5′ 8″	B36G	1
428	AN20	5′ 8″	A36G	1
429	AN14	5′ 8″	B36G	1
430	AN20	5′ 8″	A36G	1
431	AN6	5′ 8″	E73	1
432	AN8	5′ 8″	D26	1
433	AN16	5′ 8″	B36G	1
434	AN16	0′ 9″	B36G	1
435	AN8	1′ 0″	D26	1
436	AN6	1′ ½″	E26	1
437	AN20	1′ 1″	A36G	1
438	AN14	1′ ½″	B36G	1
439	AN20	1′ ½″	A36G	1
440	AN14	1′ 3″	B36G	1
441	AN16	1′ 6″	B36G	2
442	AN6	3′ 0″	E71, E72	1 Each
443	AN6	2′ 6″	E71	1
444	AN16	2′ 6″	B36G	1
445	AN6	2′ 6″	E73	1

Wire No.	Size	Length	Terminal	Terminals Required
446	AN18	8′ 0″		
447	AN18	8′ 0″		
448	AN14	5′ 6″	B36G	1
449	AN18	4′ 0″	A36G, A33G	1 Each
450	AN18	4′ 0″	A36G, A33G	1 Each
451	AN18	5′ 3″	A36G	2
452	AN18	5′ 5″	A36G	2
453	AN14	6′ 1″	B36G	2
454	AN18	6′ 0″	A36G	2
455	AN18	5′ 7″	A36G	2
456	AN18	6′ 1″	A36G	2
457	AN18	1′ 6″	A36G	2
458	AN18	4′ 2″	A36G	2
459	AN12	6′ 1″	C36, C71	1 Each
460	AN12	6′ 1″	C36, C71	1 Each
461	AN6	6′ 1″	E26, E71	1 Each
462	AN6	2′ 6″	E71, E73	1 Each
463	AN16	1′ 0″	B36G	1
464	AN18	1′ 6″	A36G	2
465	AN14	5′ 8″	B36G	2
466	AN20	5′ 7″	A36G	2
467	AN14	5′ 1″	B36G	2
468	AN20	5′ 6″	A36G	2
469	AN6	5′ 0″	E26	2
470	AN8	5′ 5″	D26	2
471	AN16	6′ 2″	B36G	2
472	AN18	1′ 7″	A36G	1
473	AN18	1′ 6″	A36G	1
474	AN14	4′ 10″	A36G	1
475	AN14	3′ 10″	B77G	1
476	AN14	3′ 11″	B77G	1
477	AN14	4′ 1″	B77G	1
478	AN16	4′ 2″	B36G	1
480	AN16	4′ 1″	B36G	1
481	AN18	15′ 10″	A36G	2
482	AN6	15′ 8″	E26, E71	1 Each
483	AN18	14′ 9″	A36G, A33G	1 Each
484	AN8	14′ 6″	D26	2
485	AN16	14′ 3″	B36G	2
486	AN14	2′ 0″	B36G, B77G	1 Each
487	AN6	2′ 5″	E26, E71	1 Each
488	AN6	2′ 5″	E26, E71	1 Each
489		2′ 3″	B33G, B77G	
490	AN14	2′ 5″	B36G, B77G	1 Each
491	AN18	2′ 5″	A36G, A77G	1 Each
492	AN14	2′ 5″	B36G, B77G	1 Each
493	AN14		B77G	2
494	AN18	5′ 6″	A36G	2
495	AN6	1′ 11″	E71, E73	1 Each
496	AN18	1′ 0″	A36G, A33G	1 Each
497	AN6	3′ 5″	E71, E73	1 Each
498	AN6	3′ 10″	E71	2
499	AN6	1′ 0″	E71	2
500	AN16		B36G	2

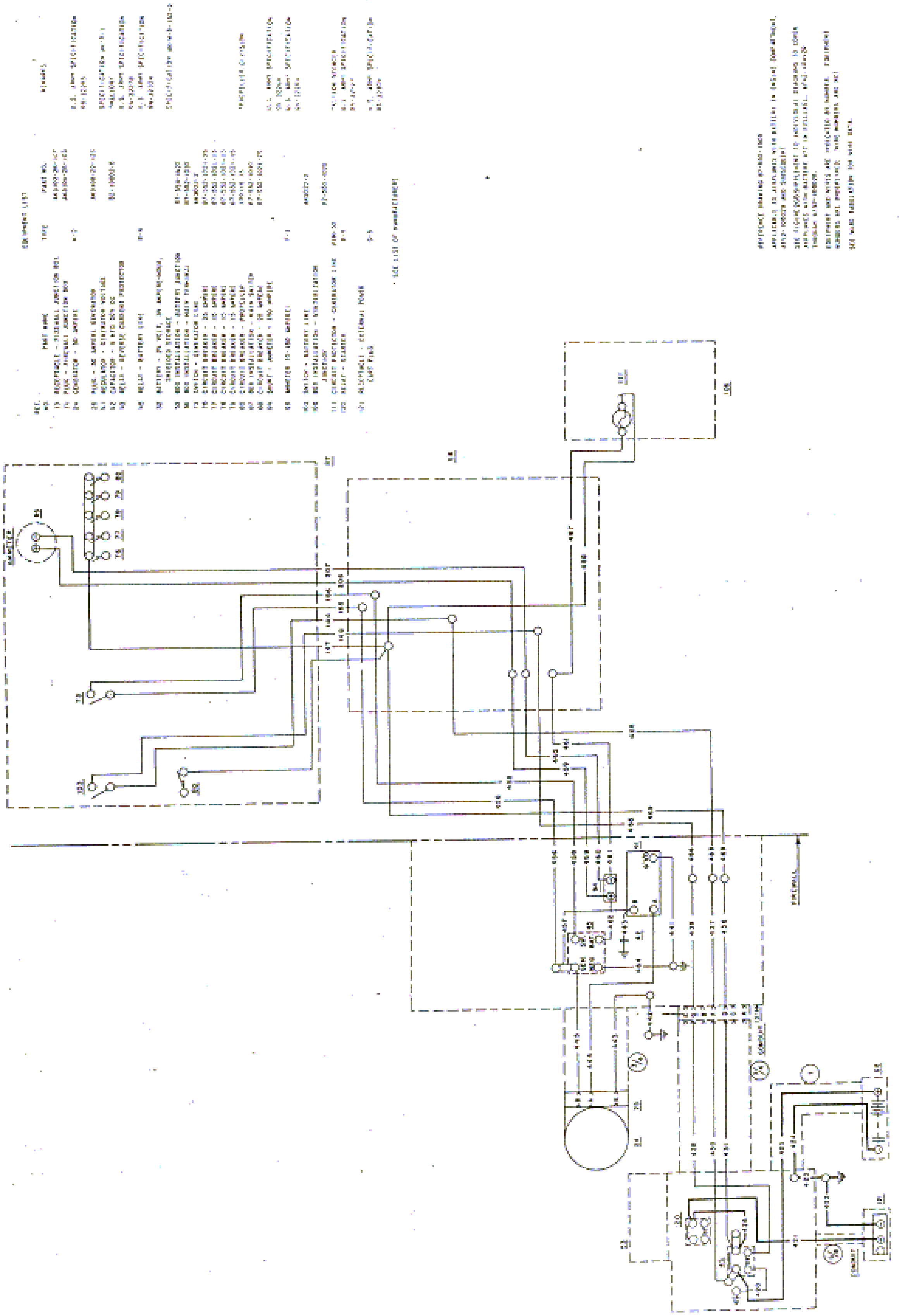


Figure 257—Generator and Battery Circuit

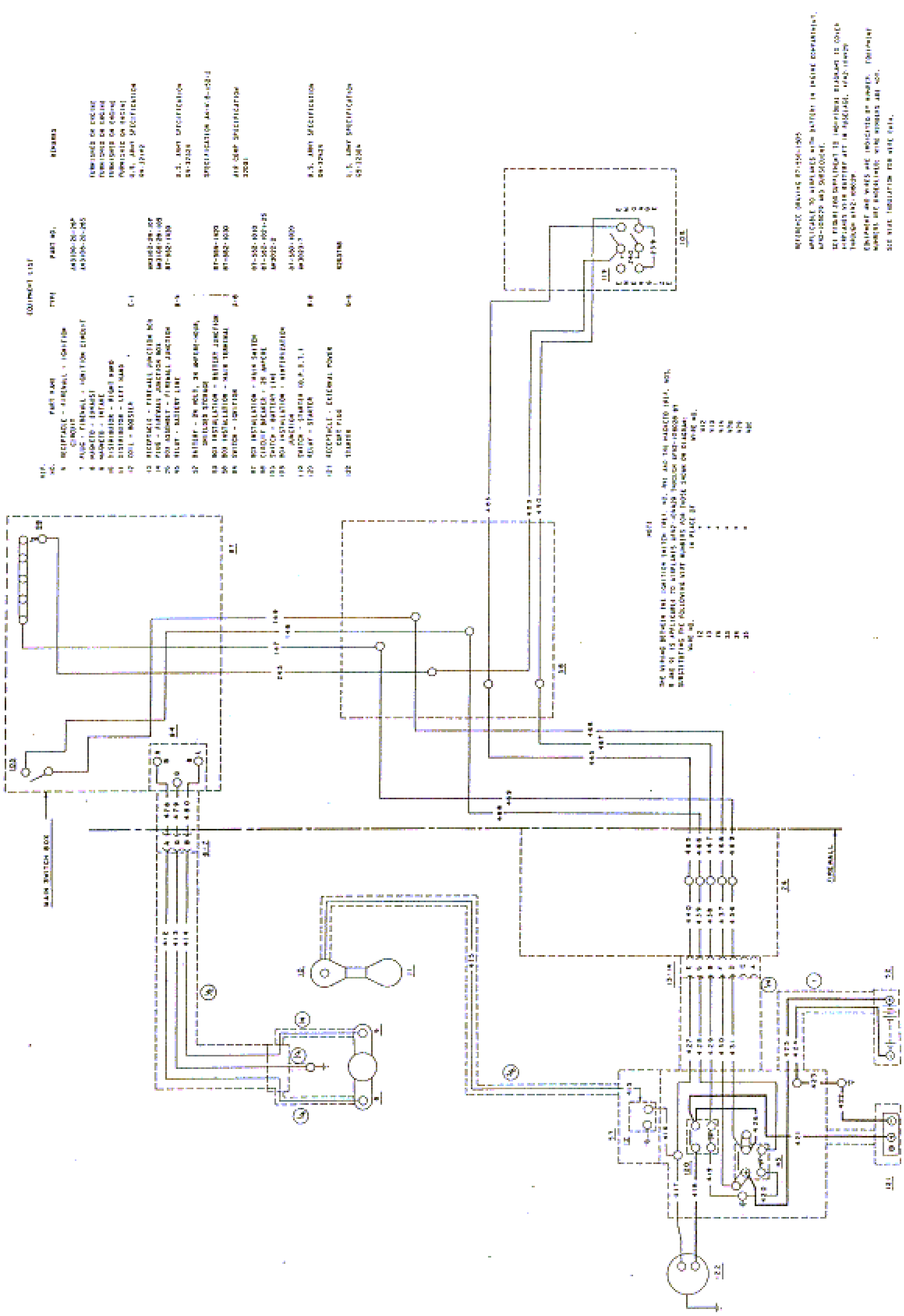


Figure 258—Starter and Ignition Circuit

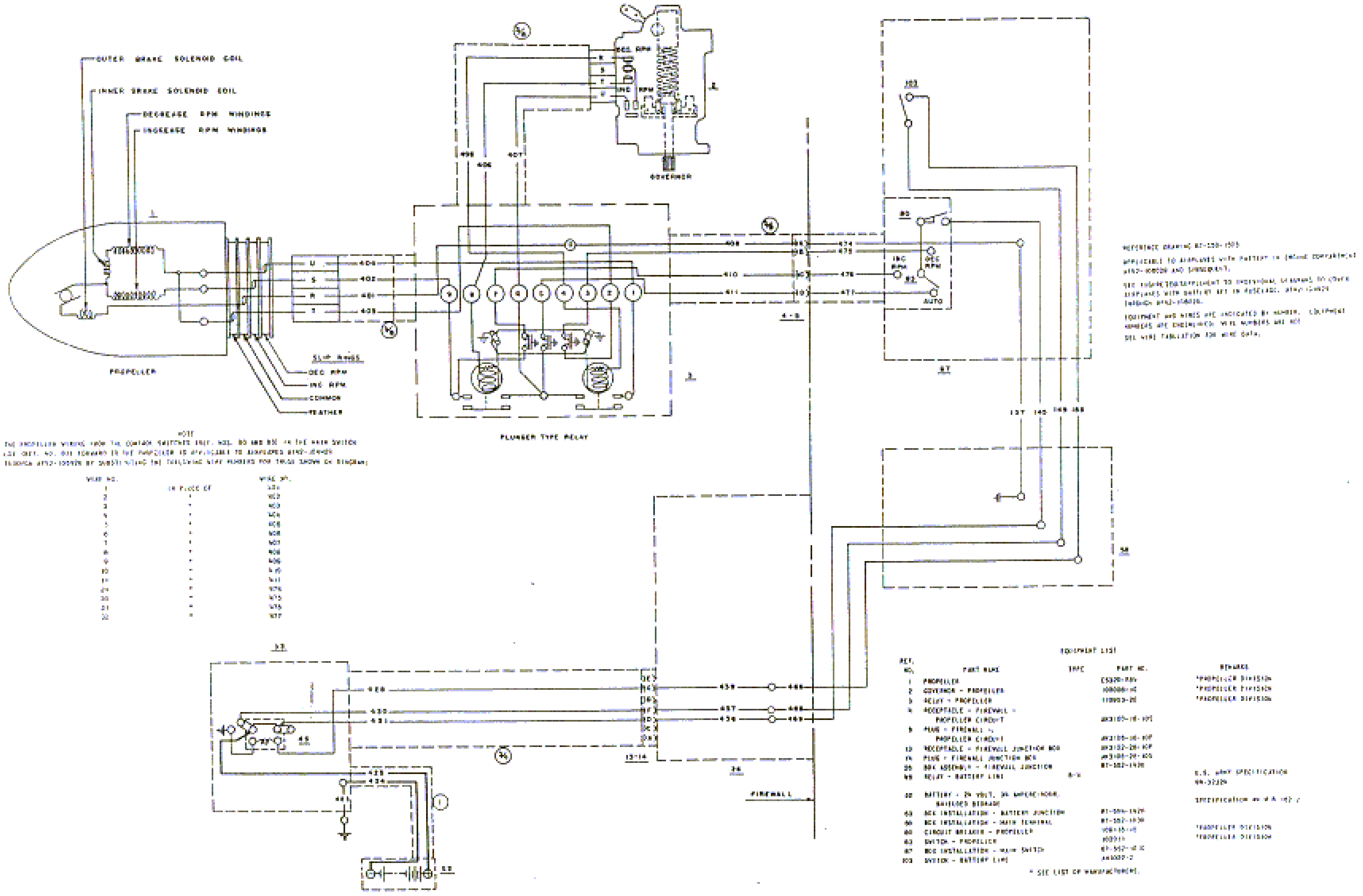
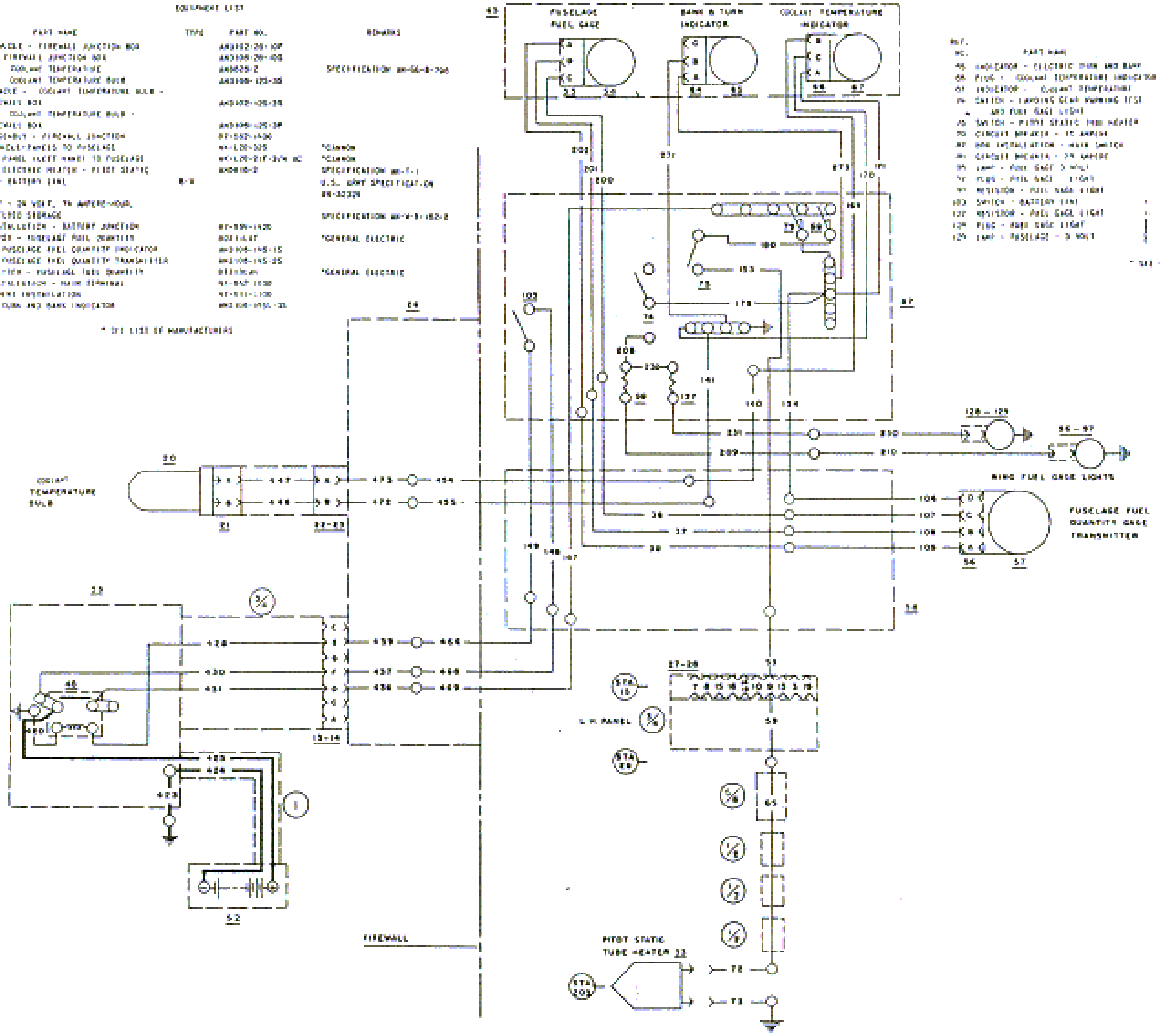


Figure 259—Propeller Circuit

EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NO.	REMARKS
13	RECEPTACLE - FIREWALL JUNCTION BOX		AN3102-28-10P	
19	PLUG - FIREWALL JUNCTION BOX		AN3106-28-10S	
20	BULB - COOLANT TEMPERATURE		AN5525-2	SPECIFICATION AN-GG-B-296
21	PLUG - COOLANT TEMPERATURE BULB		AN3108-12S-3S	
22	RECEPTACLE - COOLANT TEMPERATURE BULB - FIREWALL BOX		AN3102-12S-3S	
23	PLUG - COOLANT TEMPERATURE BULB - FIREWALL BOX		AN3106-12S-3P	
26	BOX ASSEMBLY - FIREWALL JUNCTION		87-552-1430	
27	RECEPTACLE-PANELS TO FUSELAGE		AN-L20-32S	*CANNON
28	PLUG - PANEL (LEFT HAND) TO FUSELAGE		AN-L20-21P-3/4 BC	*CANNON
33	TUBE - ELECTRIC HEATER - PITOT STATIC		AN5816-2	SPECIFICATION AN-T-1
46	RELAY - BATTERY LINE	B-6		U.S. ARMY SPECIFICATION 94-32378
52	BATTERY - 24 VOLT, 34 AMPERE-HOUR, SHIELDED STORAGE			SPECIFICATION AN-W-B-152-2
53	BOX INSTALLATION - BATTERY JUNCTION		87-554-1420	
54	INDICATOR - FUSELAGE FUEL QUANTITY		8DJ1-LAT	*GENERAL ELECTRIC
55	PLUG - FUSELAGE FUEL QUANTITY INDICATOR		AN3106-14S-1S	
56	PLUG - FUSELAGE FUEL QUANTITY TRANSMITTER		AN3106-14S-2S	
57	TRANSMITTER - FUSELAGE FUEL QUANTITY		8TJ1-ICAN	*GENERAL ELECTRIC
59	BOX INSTALLATION - MAIN TERMINAL		97-552-1030	
63	INSTRUMENT INSTALLATION		97-551-1100	
64	PLUG - TURN AND BANK INDICATOR		AN3106-14SL-3S	

* SEE LIST OF MANUFACTURERS



ILLUSTRATED PARTS

REF. NO.	PART NAME	TYPE	PART NO.	REMARKS
65	INDICATOR - ELECTRIC TURN AND BANK	A1	CLASS A	SPECIFICATION AN I-15
66	PLUG - COOLANT TEMPERATURE INDICATOR		AN3106-14S-2S	
67	INDICATOR - COOLANT TEMPERATURE		AN5795-6	SPECIFICATION AN-GG-I-522
74	SWITCH - LANDING GEAR WARNING TEST AND FUEL GAGE LIGHT		AN3022-5	
75	SWITCH - PITOT STATIC TUBE HEATER		AN3022-7	
79	CIRCUIT BREAKER - 15 AMPERE		87-552-402-15	
87	BOX INSTALLATION - MAIN SWITCH		87-552-1010	
89	CIRCUIT BREAKER - 25 AMPERE		87-552-402-25	
95	LAMP - FUEL GAGE 3 VOLT		3863249	
97	PLUG - FUEL GAGE LIGHT		A1052	
99	RESISTOR - FUEL GAGE LIGHT		3745222-10	
103	SWITCH - BATTERY LINE		AN3022-3	
122	RESISTOR - FUEL GAGE LIGHT		3745222-10	
124	PLUG - WING GAGE LIGHT		290	*CANNON
129	LAMP - FUSELAGE - 3 VOLT		3863249	

* SEE LIST OF MANUFACTURERS

REFERENCE DRAWING 87-550-1003

APPLICABLE TO AIRPLANES WITH BATTERY IN ENGINE COMPARTMENT. AF42-108028 AND SUBSEQUENT.

SEE FIGURE 260A SUPPLEMENT TO INDIVIDUAL DIAGRAMS TO COVER AIRPLANES WITH BATTERY AFT IN FUSELAGE, AF42-106429 THROUGH AF42-108028.

EQUIPMENT AND WIRES ARE INDICATED BY NUMBER. EQUIPMENT NUMBERS ARE UNDERLINED. WIRE NUMBERS ARE NOT.

SEE WIRE TABULATION FOR WIRE DATA.

Figure 260—Instrument Circuit

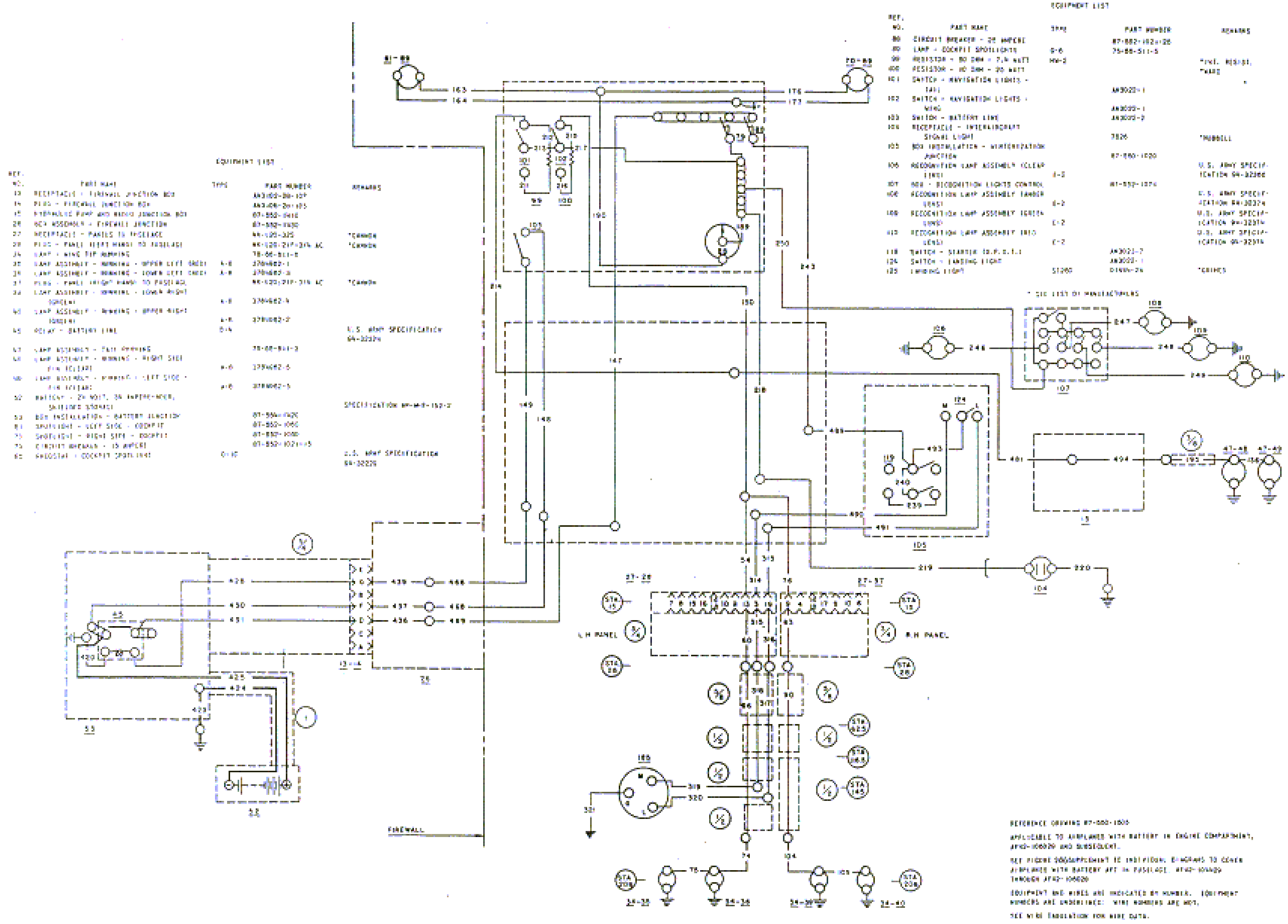
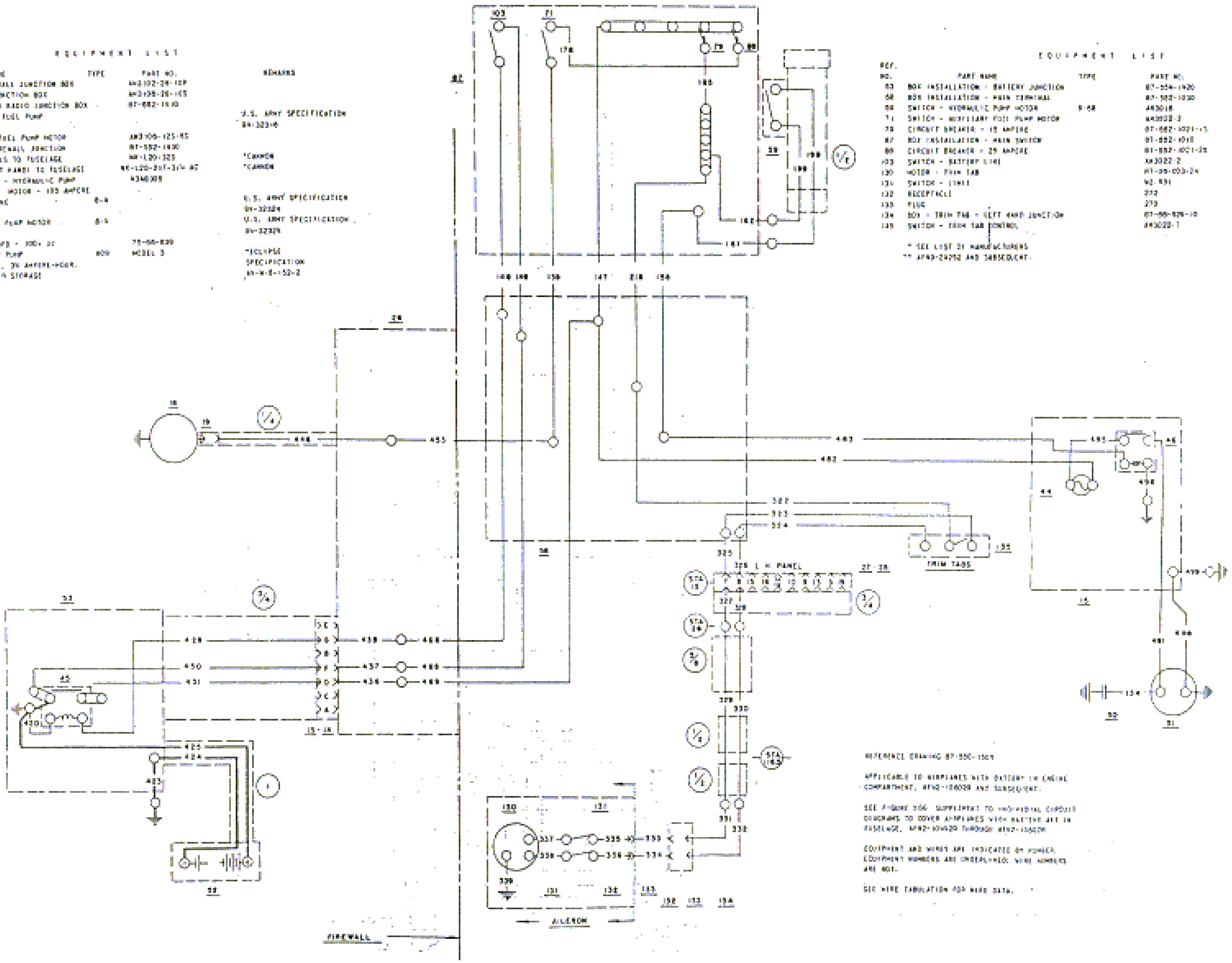


Figure 261—Lighting Circuit



EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NO.	REMARKS
13	RECEPTACLE - FIREWALL JUNCTION BOX		AN3102-28-10P	
14	PLUG - FIREWALL JUNCTION BOX		AN3106-28-16S	
15	HYDRAULIC PUMP AND RADIO JUNCTION BOX		87-882-1510	
18	MOTOR - AUXILIARY FUEL PUMP			U.S. ARMY SPECIFICATION 94-32316
19	PLUG - AUXILIARY FUEL PUMP MOTOR		AN3106-12S-8S	
26	BOX ASSEMBLY - FIREWALL JUNCTION		87-882-1530	
27	RECEPTACLE - PANELS TO FUSELAGE		WK-120-32S	*CANNON
28	PLUG - PANEL (LEFT HAND) TO FUSELAGE		WK-120-20F-31M BG	*CANNON
44	CIRCUIT PROTECTOR - HYDRAULIC PUMP MOTOR - 185 AMPERE		K346305	
45	RELAY - BATTERY LINE	B-4		U.S. ARMY SPECIFICATION 94-32324
46	RELAY - HYDRAULIC PUMP MOTOR	B-5		U.S. ARMY SPECIFICATION 94-32325
50	CAPACITOR - 0.5 MFD - 100V DC		75-66-830	
51	MOTOR - HYDRAULIC PUMP	609	MODEL 3	*ECLIPSE
52	BATTERY - 24 VOLT, 34 AMPERE-HOUR, SHIELDED STORAGE			SPECIFICATION AN-W-B-152-2

EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NO.	REMARKS
53	BOX INSTALLATION - BATTERY JUNCTION		87-554-1420	
58	BOX INSTALLATION - MAIN TERMINAL		87-582-1030	
68	SWITCH - HYDRAULIC PUMP MOTOR	B-6B	AN3018	
71	SWITCH - AUXILIARY FUEL PUMP MOTOR		AN3022-2	
78	CIRCUIT BREAKER - 15 AMPERE		87-882-1021-15	
87	BOX INSTALLATION - MAIN SWITCH		87-882-1010	
88	CIRCUIT BREAKER - 25 AMPERE		87-882-1021-25	
103	SWITCH - BATTERY LINE		AN3022-2	
130	MOTOR - TRIM TAB		87-55-003-24	
131	SWITCH - LIMIT		W2-531	*MICRO SWITCH
132	RECEPTACLE		272	*CANNON
133	PLUG		273	*CANNON
134	BOX - TRIM TAB - LEFT HAND JUNCTION		87-66-525-10	
135	SWITCH - TRIM TAB CONTROL		AN3022-1	

* SEE LIST OF MANUFACTURERS
** AF42-26752 AND SUBSEQUENT.

REFERENCE DRAWING 87-550-1509

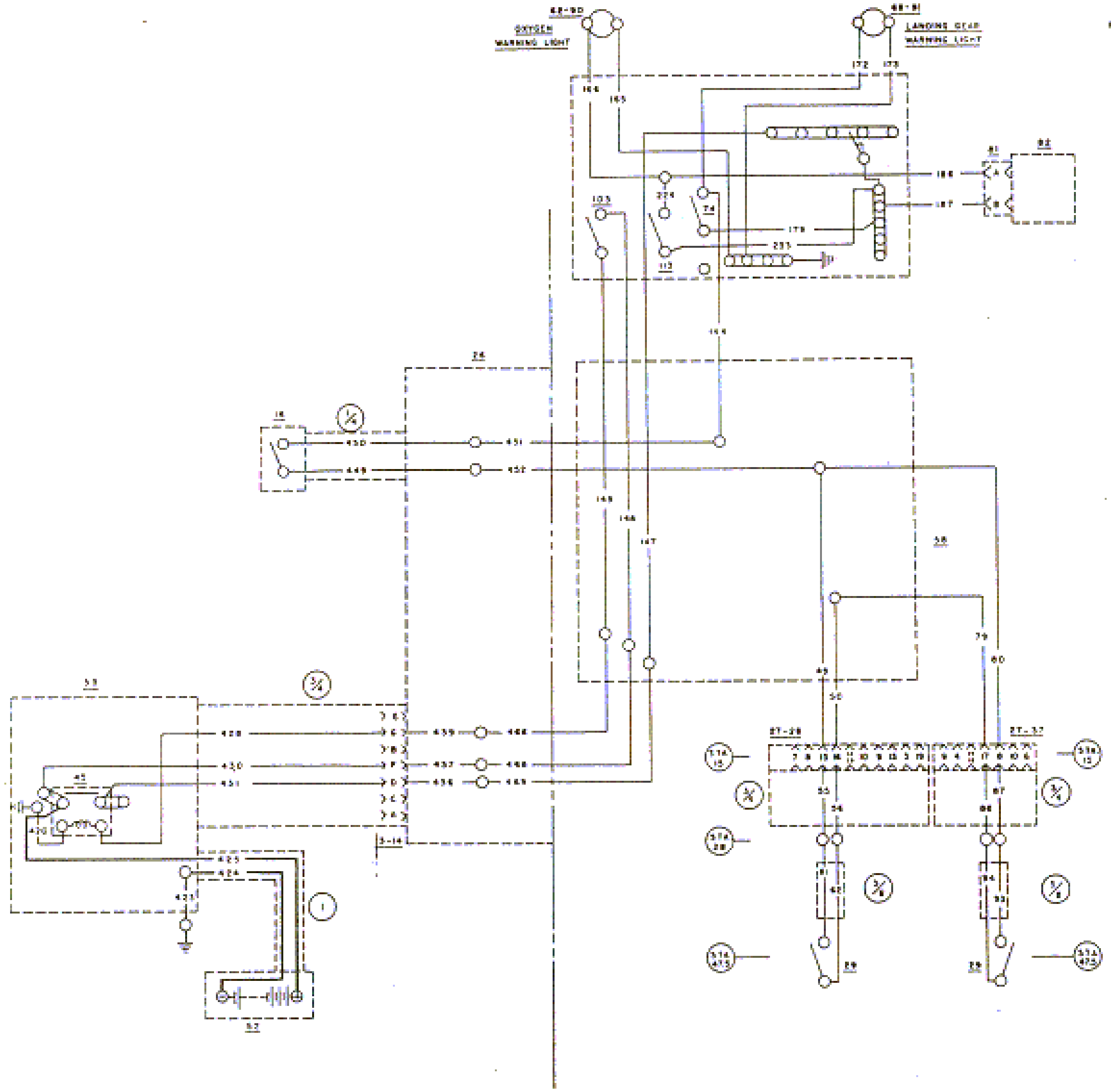
APPLICABLE TO AIRPLANES WITH BATTERY IN ENGINE COMPARTMENT, AF42-108029 AND SUBSEQUENT.

SEE FIGURE 306 SUPPLEMENT TO INDIVIDUAL CIRCUIT DIAGRAMS TO COVER AIRPLANES WITH BATTERY AFT IN FUSELAGE, AF42-109420 THROUGH AF42-108028

EQUIPMENT AND WIRES ARE INDICATED BY NUMBER. EQUIPMENT NUMBERS ARE UNDERLINED; WIRE NUMBERS ARE NOT.

SEE WIRE TABULATION FOR WIRE DATA.

Figure 262—Motor Drive Circuit



EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NO.	REMARKS
13	RECEPTACLE - FIREWALL JUNCTION BOX		AN3102-28-10P	
14	PLUG - FIREWALL JUNCTION BOX		AN3106-28-10S	
18	SWITCH - LANDING GEAR WARNING LIGHT		YZ-RDI	*MICRO SWITCH
26	BOX ASSEMBLY - FIREWALL JUNCTION		87-652-1930	
27	RECEPTACLE - PANELS TO FUSELAGE		RK-L20-32S	*CANNON
28	PLUG - PANEL (LEFT HAND) TO FUSELAGE		RK-L20-21P-3/4 AC	*CANNON
29	SWITCH - LANDING GEAR WARNING LIGHT	B-18	3845788	
37	PLUG - PANEL (RIGHT HAND) TO FUSELAGE		RK-L20-21P-3/4 AC	*CANNON
45	RELAY - BATTERY LINE	B-4		U.S. ARMY SPECIFICATION 94-32324
52	BATTERY - 24 VOLT, 34 AMPERE-HOUR, SHIELDED STORAGE			SPECIFICATION AN-W-B-152-2
53	BOX INSTALLATION - BATTERY JUNCTION		87-664-1420	
54	BOX INSTALLATION - MAIN TERMINAL		87-662-1030	
62	LAMP ASSEMBLY - OXYGEN PRESSURE WARNING		5283863-2	
68	LAMP ASSEMBLY - LANDING GEAR WARNING		399022-2	
74	SWITCH - LANDING GEAR WARNING TEST AND FUEL GAGE LIGHT		AN3022-5	
81	PLUG - OXYGEN PRESSURE WARNING SIGNAL		AN3106-10S-4S	
82	SIGNAL ASSEMBLY - OXYGEN PRESSURE	G-1		U.S. ARMY SPECIFICATION 94-32076
90	LAMP - OXYGEN PRESSURE WARNING LIGHT		24 V - 28 V., .174 S.C., T-3-1/4	
91	LAMP - LANDING GEAR WARNING LIGHT		24 V - 28 V., .174 S.C., T-3-1/4	
103	SWITCH - BATTERY LINE		AN3022-2	
113	SWITCH - OXYGEN PRESSURE WARNING		AN3022-8	

* SEE LIST OF MANUFACTURERS.

REFERENCE DRAWING 87-590-1020

APPLICABLE TO AIRPLANES WITH BATTERY IN ENGINE COMPARTMENT. AF42-10600 AND SUBSEQUENT.

SEE FIGURE 168 SUPPLEMENT TO INDIVIDUAL DIAGRAMS TO COVER AIRPLANES WITH BATTERY APT IN FUSELAGE. AF42-[illegible] THROUGH AF42-10599.

EQUIPMENT AND WIRES ARE INDICATED BY NUMBER. EQUIPMENT NUMBERS ARE UNDERLINED; WIRE NUMBERS ARE NOT.

Figure 263—Landing Gear and Oxygen Warning Circuit

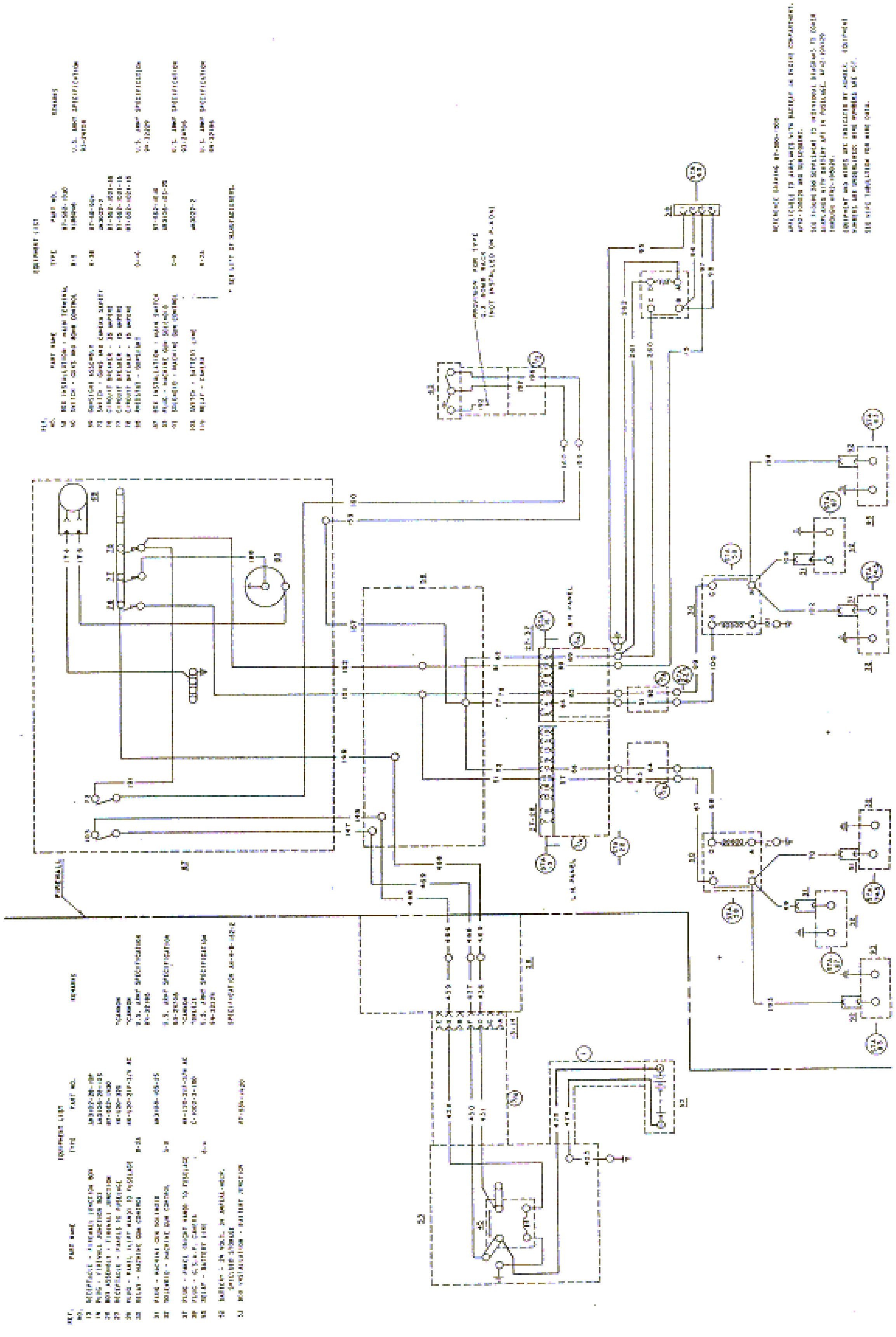
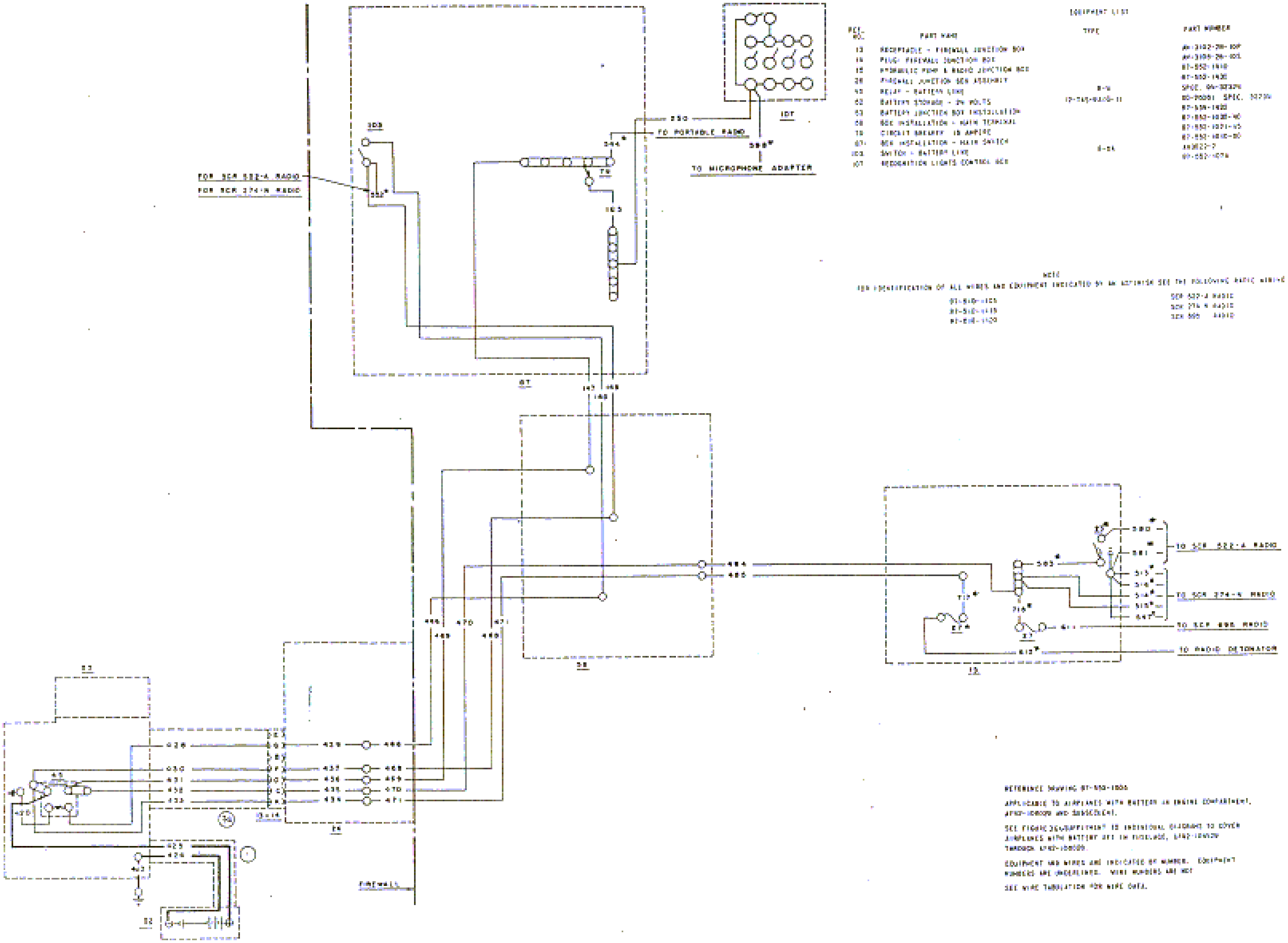


Figure 264—Gun and Camera Circuit



EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NUMBER	REMARKS
13	RECEPTACLE - FIREWALL JUNCTION BOX		[illegible]	
14	PLUG - FIREWALL JUNCTION BOX		[illegible]	
15	HYDRAULIC PUMP & RADIO JUNCTION BOX		[illegible]	
38	FIREWALL JUNCTION BOX ASSEMBLY		[illegible]	
45	RELAY - BATTERY LINE	[illegible]	[illegible]	
62	BATTERY STORAGE - 24 VOLTS	[illegible]	[illegible]	
63	BATTERY JUNCTION BOX INSTALLATION		[illegible]	
68	BOX INSTALLATION - MAIN TERMINAL		[illegible]	
78	CIRCUIT BREAKER 15 AMPERE		[illegible]	
87	BOX INSTALLATION - MAIN SWITCH		[illegible]	
103	SWITCH - BATTERY LINE	[illegible]	[illegible]	
107	RECOGNITION LIGHTS CONTROL BOX		[illegible]	

NOTE
[illegible]

REFERENCE DRAWING [illegible]

[illegible]

Figure 265—Radio Power Circuit

EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NUMBER	REMARKS
10	DISTRIBUTOR - RIGHT HAND			FURNISHED ON ENGINE
11	DISTRIBUTOR - LEFT HAND			FURNISHED ON ENGINE
12	COIL - BOOSTER	C-1		U.S. ARMY SPECIFICATION 94-32182
16	SWITCH - LANDING GEAR WARNING LIGHT		12-831	*MICRO SWITCH
17	VALVE ASSEMBLY - OIL DILUTION		87-46-622	
18	MOTOR - AUXILIARY FUEL PUMP			U.S. ARMY SPECIFICATION 94-32316
19	PLUG - AUXILIARY FUEL PUMP MOTOR		AN3106-12S-6S	
20	BULB - COOLANT TEMPERATURE		AN5525-2	SPECIFICATION AN-GG-B-786
21	PLUG - COOLANT TEMPERATURE BULB		AN3108-12S-3S	
22	RECEPTACLE - COOLANT TEMPERATURE BULB - FIREWALL BOX		AN3102-12S-3S	
23	PLUG - COOLANT TEMPERATURE BULB - FIREWALL BOX		AN3106-12S-3P	
24	GENERATOR - 50 AMPERE	M-2		U.S. ARMY SPECIFICATION 95-32285
25	PLUG - 50 AMPERE GENERATOR		AN3106-22-12S	
26	BOX ASSEMBLY - FIREWALL JUNCTION		87-662-1430	
41	REGULATOR - GENERATOR VOLTAGE			SPECIFICATION AN-R-1 *MALLORY
42	CAPACITOR - 8 MFD 50V DC		82-10002-8	
43	RELAY - REVERSE CURRENT PROTECTOR			U.S. ARMY SPECIFICATION 94-32216
44	CIRCUIT PROTECTOR - HYDRAULIC PUMP MOTOR - 100 AMPERE		93A6309	
45	RELAY - BATTERY LINE	B-4		U.S. ARMY SPECIFICATION 94-32324
46	RELAY - HYDRAULIC PUMP MOTOR	B-4		U.S. ARMY SPECIFICATION 94-32324

EQUIPMENT LIST

REF. NO.	PART NAME	TYPE	PART NUMBER	REMARKS
47	LAMP ASSEMBLY - TAIL RUNNING		73-66-611-3	
48	LAMP ASSEMBLY - RUNNING - RIGHT SIDE - FIN (CLEAR)	A-9	3784902-8	
49	LAMP ASSEMBLY - RUNNING - LEFT SIDE - FIN (CLEAR)	A-9	3784862-8	
50	CAPACITOR - 0.5 MFD - 100V DC		75-66-539	
51	MOTOR - HYDRAULIC PUMP	809	MODEL 3	*ECLIPSE
52	BATTERY - 24 VOLT, 11 AMPERE-HOUR	12HC-70	85-28283	*ELECTRIC BATTERY SEE NOTE 2
53	BOX INSTALLATION - BATTERY JUNCTION		87-664-1420	
66	PLUG - FUSELAGE FUEL QUANTITY TRANSMITTER		AN3106-14S-2S	
67	TRANSMITTER - FUSELAGE FUEL QUANTITY		8TJ13LAM	*GENERAL ELECTRIC
68	BOX INSTALLATION - MAIN TERMINAL		87-662-1030	
84	SHUNT - AMMETER - 150 AMPERE			U.S. ARMY SPECIFICATION 94-32284
104	RECEPTACLE - INTERAIRCRAFT SIGNAL LIGHT		7426	*HUBBELL
111	CIRCUIT PROTECTOR-GENERATOR LINE	PLN-80		*KLIXON-SPENCER
119	SWITCH - STARTER (D.P.S.T.)		AN3023-7	
120	RELAY - STARTER	B-8		U.S. ARMY SPECIFICATION 94-32424
121	RECEPTACLE - EXTERNAL POWER CART PLUG		42B3748	
122	STARTER	G-4		U.S. ARMY SPECIFICATION 95-32304
123	PLUG - STARTER DISCONNECT		AN3106-24-1P	
124	SWITCH - LANDING LIGHT		AN3022-1	
125	LANDING LIGHT	ST250	01444-24	*GRIMES

* SEE LIST OF MANUFACTURERS

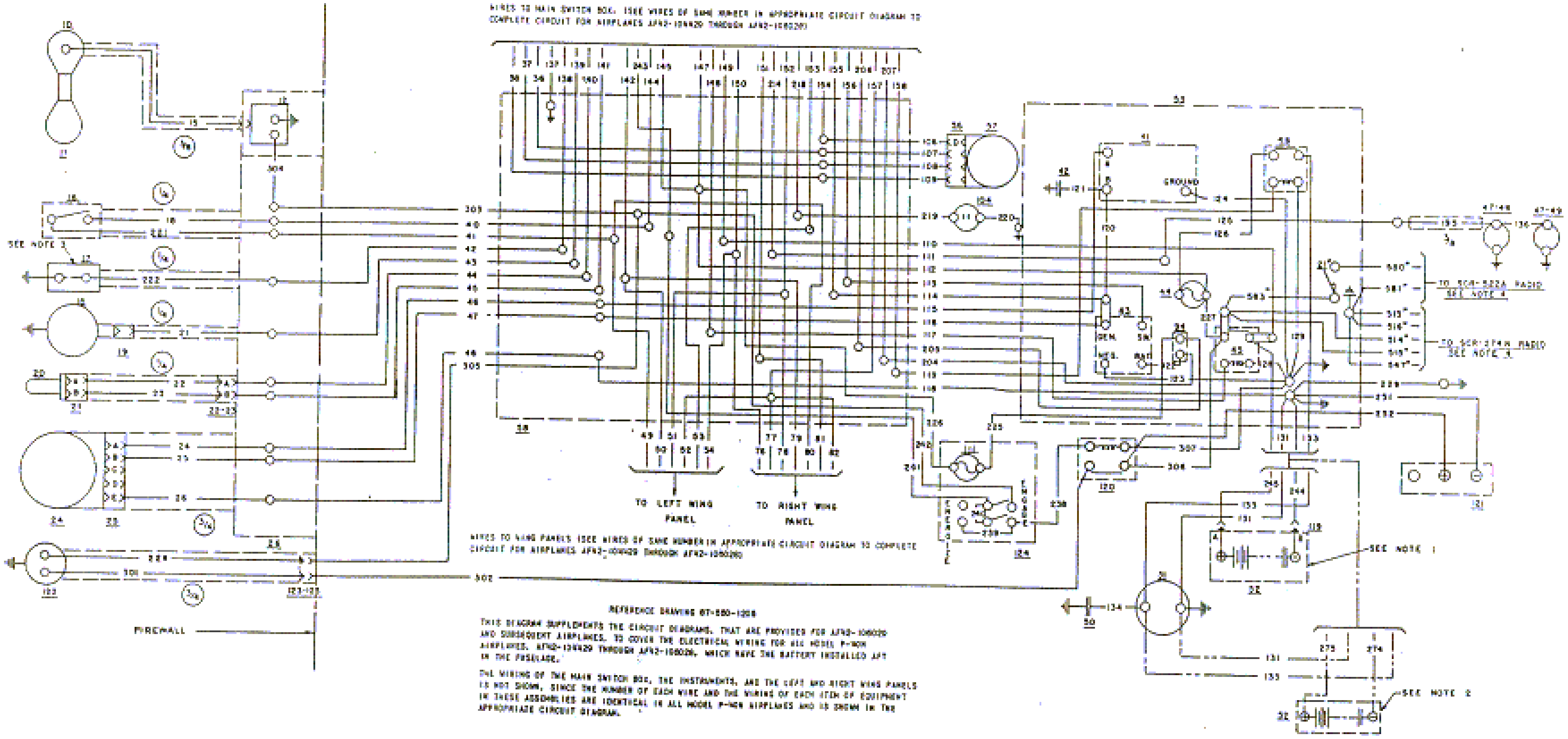
NOTES

1. AN 11 AMPERE-HOUR STORAGE BATTERY, ELECTRIC STORAGE BATTERY COMPANY, PART NO. 85-28283, USING WIRES NO. 288 AND 245 WITH AN 3106-24 RS PLUG, IS INSTALLED IN AIRPLANES AF42-104429 THROUGH AF42-105004 (SHOWN IN SOLID LINES).
2. A 11 AMPERE-HOUR STORAGE BATTERY, SPECIFICATION AN-W-B-162, USING WIRES NO. 274 AND 275 WITH TERMINALS NO. 3530 B, 261 AND 262 INSTEAD OF THE AN 3106-24-RS PLUG, IS INSTALLED IN AIRPLANES AF42-105004 THROUGH AF42-106028 (SHOWN IN BROKEN LINES).
3. OIL DILUTION SOLENOID INSTALLED IN AIRPLANES AF42-104429 THROUGH AF42-106028, AND CONTROLLED BY AN3022-6 SWITCH IN MAIN SWITCH BOX. WIRE NO. 138 CONNECTS TO "MOMENTARY ON" SIDE AND WIRE NO. 183 CONNECTS TO "ON" SIDE OF SWITCH. IN SUBSEQUENT AIRPLANES, AN3022-6 SWITCH IS REPLACED BY AN3022-2 SWITCH. (SEE REFERENCE NO. 75 OF INSTRUMENT AND PITOT STATIC TUBE HEATER CIRCUIT.)
4. FOR IDENTIFICATION OF ALL WIRES AND EQUIPMENT INDICATED BY AN ASTERISK, SEE THE FOLLOWING RADIO WIRING DIAGRAMS:

   87-510-1020 - SCR-695A RADIO
   87-510-1105 - SCR-522A RADIO
   87-510-1105 - SCR-274N RADIO

5. EQUIPMENT AND WIRES ARE INDICATED BY NUMBER. EQUIPMENT NUMBERS ARE UNDERLINED; WIRE NUMBERS ARE NOT.

SEE WIRE TABULATION FOR WIRE DATA.



REFERENCE DRAWING 87-550-1208

THIS DIAGRAM SUPPLEMENTS THE CIRCUIT DIAGRAMS, THAT ARE PROVIDED FOR AF42-106029 AND SUBSEQUENT AIRPLANES, TO COVER THE ELECTRICAL WIRING FOR ALL MODEL P-40N AIRPLANES, AF42-104429 THROUGH AF42-106028, WHICH HAVE THE BATTERY INSTALLED AFT IN THE FUSELAGE.

THE WIRING OF THE MAIN SWITCH BOX, THE INSTRUMENTS, AND THE LEFT AND RIGHT WING PANELS IS NOT SHOWN, SINCE THE NUMBER OF EACH WIRE AND THE WIRING OF EACH ITEM OF EQUIPMENT IN THESE ASSEMBLIES ARE IDENTICAL IN ALL MODEL P-40N AIRPLANES AND IS SHOWN IN THE APPROPRIATE CIRCUIT DIAGRAM.

Figure 266—Supplement to Individual Circuit Diagrams

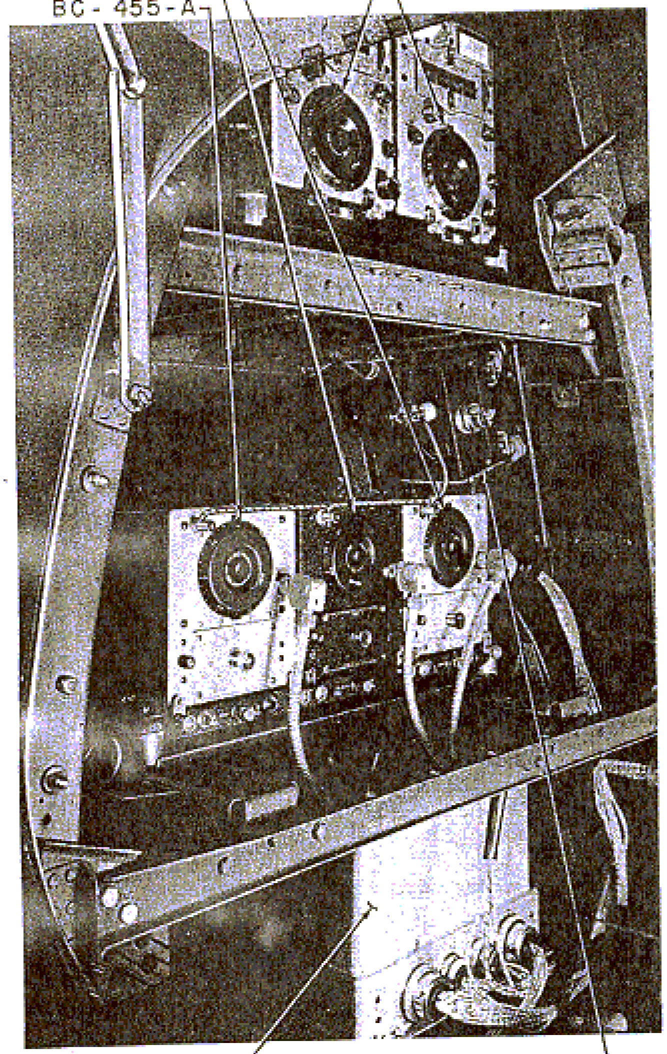


Figure 267—SCR-274 Radio (AF42-104429 Through AF43-23251)

e. COMMUNICATIONS EQUIPMENT.

(1) GENERAL.

(a) The radio installation used in this airplane depends on allocation. Airplanes AF42-104429 through AF42-104508 have either SCR-274-N or SCR-522 radio installed. Airplanes AF42-104509 through AF42-104828 have both SCR-274-N and SCR-695, or SCR-522 and SCR-695 radios installed. Airplanes AF42-104829 and subsequent, have SCR-274-N and SCR-695, or SCR-522 and SCR-695 radios with provision in both cases for the SCR-515 radio in addition. On airplanes AF42-104672 through AF42-105778, there is provision only for installing the SCR-535 radio, which is the British equivalent of the SCR-695 radio. Provision for the installation of the MN26 radio compass is included on airplanes AF43-23252 and subsequent.

CAUTION

BEFORE DOING ANY WORK ON THE RADIO, DISCONNECT THE BATTERY.

(b) The wiring diagrams show only wiring as installed by the manufacturer for the operation and control of the equipment. Wire numbers as shown on the diagrams are attached to both ends of each wire. Accompanying each diagram will be found a complete list of equipment. Wire tabulations are also included, designating wire sizes. All wire is of the low-tension, single conductor type cable conforming to Specification AN-J-C-48.

(2) SCR-274N RADIO. *(See figures 267 and 268.)*

(a) DESCRIPTION.

1. RECEIVING EQUIPMENT.

a. GENERAL.—The receiving equipment consists of three receivers, three dynamotors, a receiver control box and a range filter.

b. RECEIVERS.—The three receivers, BC-453-A, BC-454-A, and BC-455-A, are mounted on one of the two lower shelves, just forward of the fuselage access door. On airplanes AF42-104429 through AF43-23251, the receivers are mounted on the middle shelf. On airplane AF43-23252 and subsequent, the receivers are mounted on the lower shelf. The three receivers cover the following frequency ranges:

BC-453-A	190 - 550 KC
BC-454-A	3.0 - 6.0 MC
BC-455-A	6.0 - 9.1 MC

c. RECEIVER CONTROL BOX.—The radio receiver control box (BC-450-A) is located on the right cockpit wall just forward of the oxygen regulator. It is equipped to tune any one of the three receivers separately. (See figure 269.)

d. RANGE FILTER.—The range filter (FL-8), is located directly below the recognition lights switches. It provides selection of voice or range reception when both are being received simultaneously. (See figure 269.)

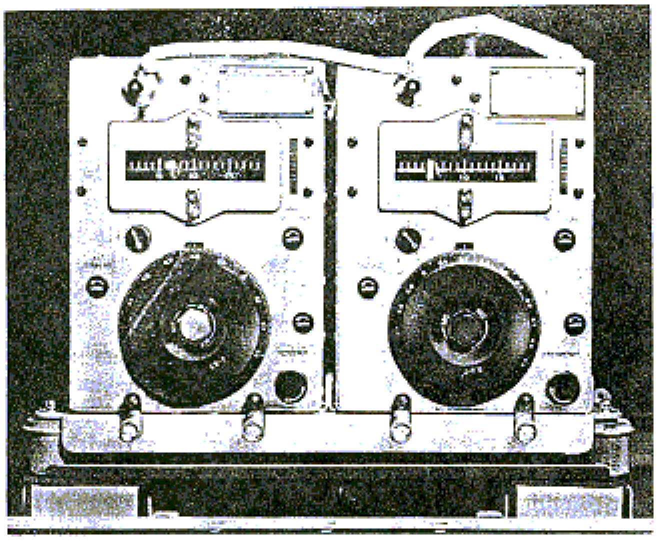
2. TRANSMITTING EQUIPMENT.

a. GENERAL.—The transmitting equipment consists of two transmitters, a transmitter control box, a modulator and dynamotor, antenna switching relay and antenna.

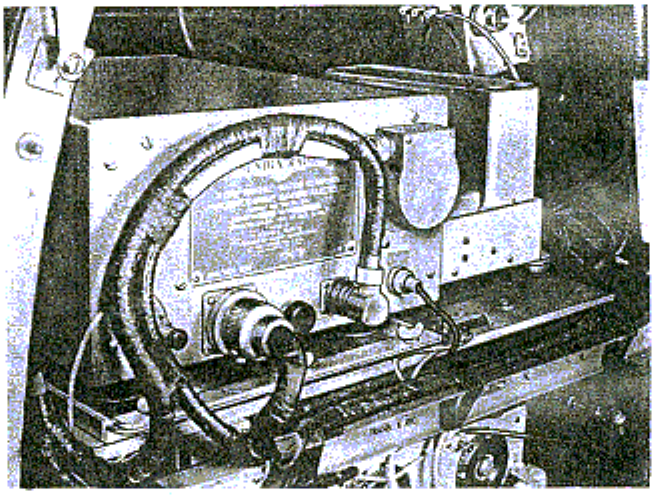
b. TRANSMITTERS.—The BC-457-A and BC-458-A transmitters are mounted on the uppermost of the three shelves directly forward of the fuselage access door. (See figure 267.) The two transmitters cover the following frequency ranges:

BC-457-A	4.0 - 5.3 MC
BC-458A	5.5 - 7.0 MC

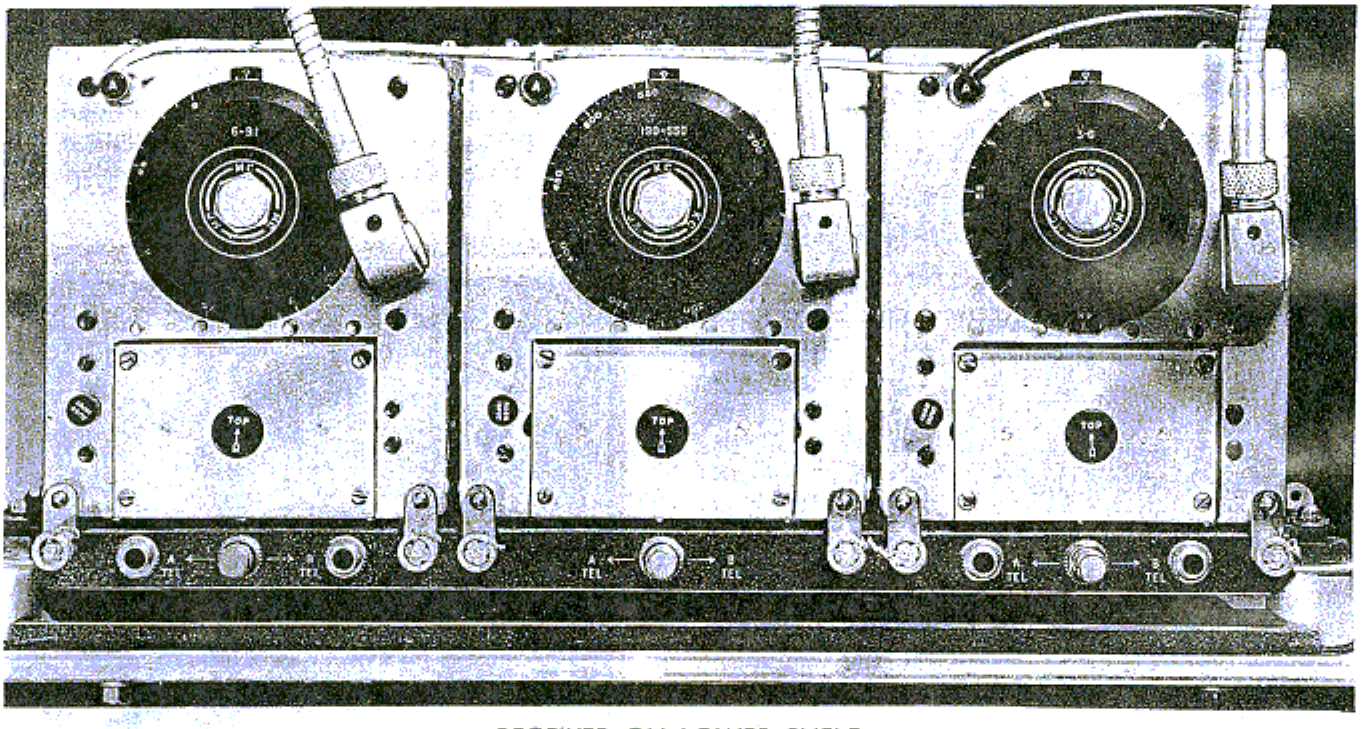
In addition to these two units, another transmitter, BC-459-A, is also part of the SCR-274-N transmission equipment and may be installed at the discretion of the Army Air Force for either one of the above. This unit covers the frequency range 7.0 - 9.1 MC.



TRANSMITTERS ON TOP SHELF



MN-26 RADIO COMPASS AND BC-456-A MODULATOR ON MIDDLE SHELF



RECEIVER ON LOWER SHELF

Figure 268—SCR-274 Radio and MN-26 Radio Compass (AF43-23252 and Subsequent)

c. MODULATOR.—The modulator (BC-456-A) is mounted on the lowest shelf on airplanes AF42-104429 through AF43-23251. On airplane AF43-23252 and subsequent, the modulator is mounted on the right hand side of the middle shelf.

d. ANTENNA SWITCHING RELAY.—The antenna switching relay (BC-442-A) is located between stations 8 and 9 on the right fuselage wall.

e. ANTENNA.—The antenna consists of a span of wire from the antenna mast to the vertical stabilizer. The antenna lead-in terminates at a feed-through insulator on the top center of the fuselage. A beaded antenna lead-in assembly is used from the antenna switching relay, thence to the transmitters and receivers.

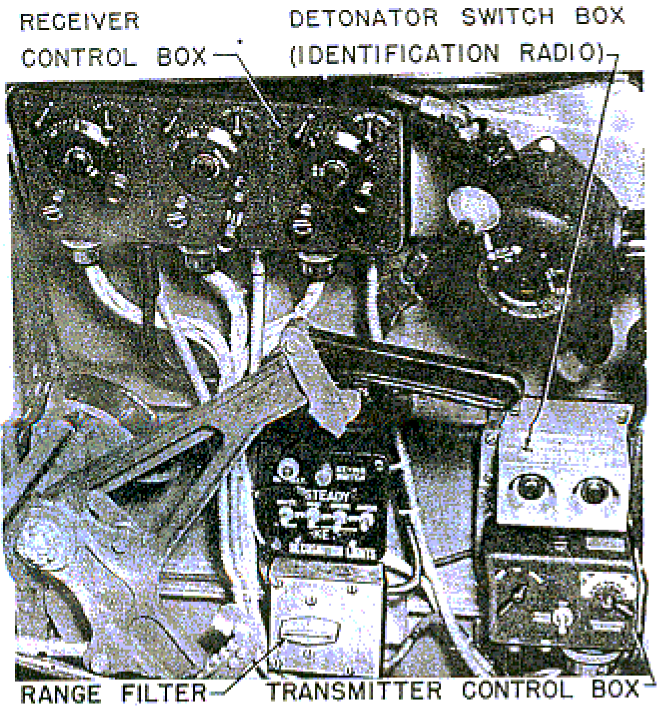


Figure 269—SCR-274 Radio Controls

3. CIRCUIT PROTECTION.—All fuses for the protection of the SCR-274-N radio equipment are integral with the units and there are no external fuses provided.

(b) REMOVAL OF SCR-274-N RADIO.—The SCR-274-N transmitters or receivers may be removed by unlocking snap fasteners located at each shock mount and, after disconnecting all plugs and antenna leads, lift the assembly from the mounting rack. The SCR-274-N dynamotor and antenna relay are similarly removed. On airplanes equipped with the MN-26 radio compass receiver, it will be necessary to first remove the compass receiver in order to gain accessibility when removing the SCR-274-N modulator and antenna relay.

(c) OVERHAUL AND REPAIRS.—In the event it is necessary to remove faulty radio equipment, it should be sent to a depot for overhaul or repairs.

(d) REPLACEMENTS.—In making replacements, refer to the equipment list accompanying the wiring diagram for the particular installation. Refer to the wire tabulation for the particular installation for wire sizes.

(e) INSTALLATION OF SCR-274-N RADIO.

1. To install the receivers and transmitters place the units in their respective mounting racks, securely lock the snap fasteners, and connect all plugs and antenna leads. The dynamotor and antenna relay are similarly installed. On airplanes equipped with the MN-26 radio compass, install the SCR-274-N modulator and antenna relay before installing the radio compass.

2. Wiring harnesses and tuning cables must be installed with enough slack to allow for swaying of radio equipment which is shock mounted.

3. Tuning shafts should be installed with a minimum of bends to avoid binding and rough tuning.

4. Plugs should be properly inserted in their respective sockets and should be carefully tightened to avoid stripping threads.

5. The beaded antenna lead assembly for the SCR-274-N radio should be kept clear of all parts of the airplane structure to avoid arcing.

(3) MN-26 RADIO COMPASS.

(a) GENERAL.—The radio compass equipment consists of a compass receiver, loop antenna, sense antenna and interconnecting cables. Controls consist of a *remote control tuning unit, azimuth control* unit and a visual left-right indicator. Both control units and indicator are located in the cockpit, easily accessible to the pilot.

(b) MN-26C RECEIVER.—The compass receiver is mounted on the middle of three shelves between stations 8 and 9 directly forward of the fuselage access door. The receiver is complete with self-contained power supply. (See figure 268.)

(c) MN-20 ROTATABLE LOOP ANTENNA.—The loop antenna is mounted at the top center of the fuselage between stations 9 and 10. It is rotated by means of a flexible shaft from the azimuth control unit located in the cockpit. (See figure 291.)

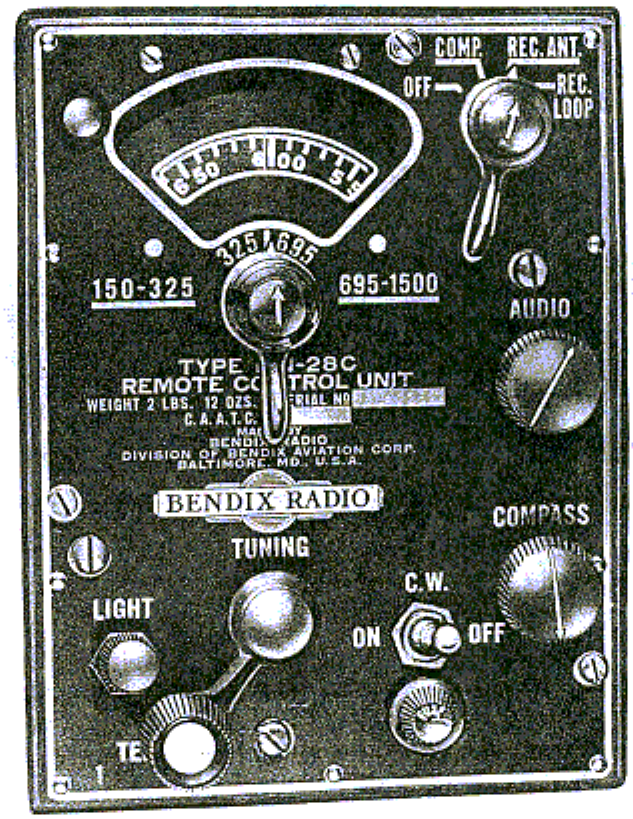


Figure 270—Radio Compass Remote Control

(*d*) SENSE ANTENNA (87-610-1082).—The sense antenna extends from a feed-through insulator on the left side of the fuselage at station 9 to the vertical stabilizer. It is used in conjunction with the loop antenna for compass operation. When used alone, the sense antenna serves for non-directional reception.

(*e*) MN-28A REMOTE CONTROL UNIT.—The remote control unit is mounted on a bracket directly below the main switch panel. It contains a dial indicating frequency to which the receiver is tuned, a crank to tune the receiver, a frequency band switch which selects any one of three available frequency bands, a four-position switch to select desired operating function and an audio knob to regulate the level of the audio signal in the headset. (See figure 270.)

(*f*) MN-22A AZIMUTH CONTROL.—The azimuth control is mounted on a bracket attached to station 3 bulkhead on the right hand side of the cockpit. This control has a dial indicating degrees of rotation of the loop antenna. (See figure 271.)

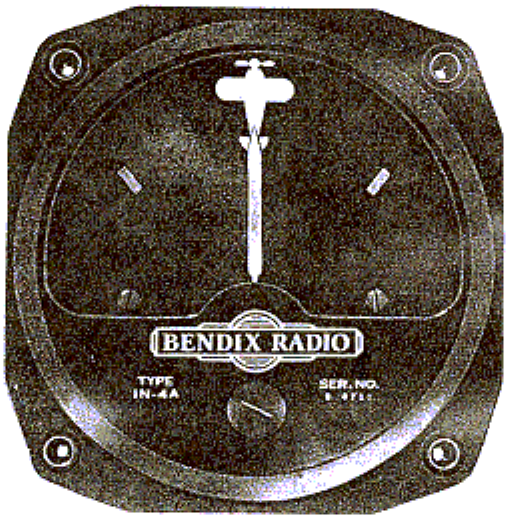


Figure 272—Radio Compass Left—Right Indicator

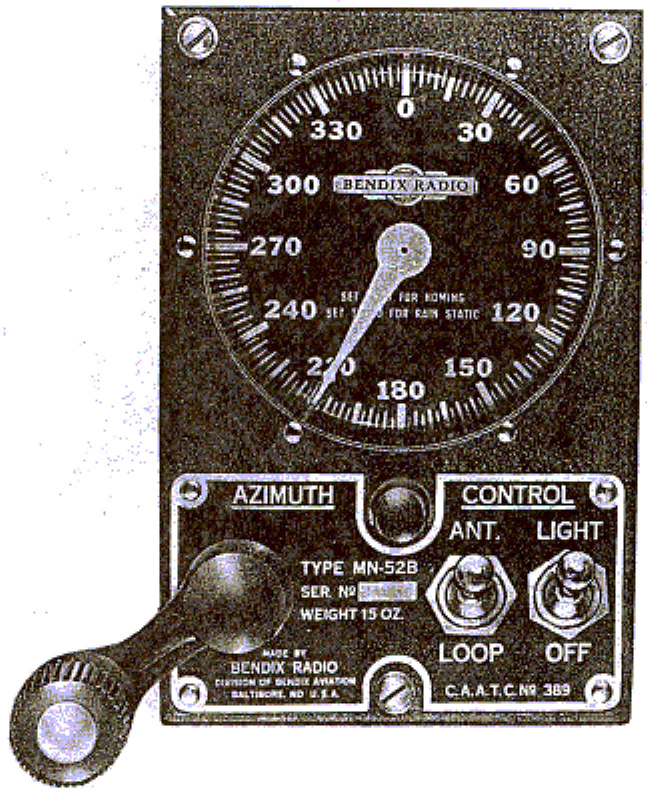


Figure 271—Radio Compass Azimuth Control

(*g*) IN-4A LEFT-RIGHT INDICATOR.—The left-right indicator is installed on the instrument panel. The indicator dial is marked with a small conventionalized figure of an airplane to indicate the "on course" flight. (See figure 272.)

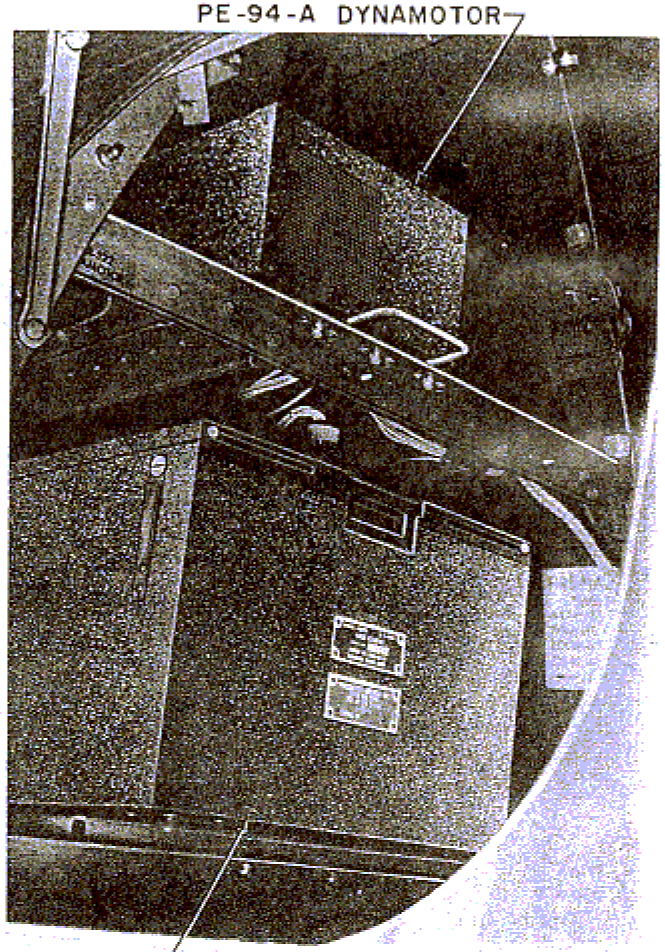


Figure 273—SCR-522 Radio

(4) SCR-522-A RADIO. (See figure 273).

(*a*) DESCRIPTION.

1. GENERAL.—The SCR-522-A radio is a high frequency command set for voice communication. It consists of a transmitter-receiver and dynamotor mounted in the fuselage just forward of the fuselage access door. Controls for this radio are provided in the cockpit. (Only voice communication facilities are available, but continuous audio-tone modulation is also provided.)

2. TRANSMITTER-RECEIVER.—The transmitter-receiver assembly is mounted on the middle shelf between stations 8 and 9 forward of the fuselage access door. The amplifier portion is so designed that interphone communication between two or more stations is possible. Both transmitter and receiver are simultaneously switched to any one of four crystal-controlled channels between 100-156 MC.

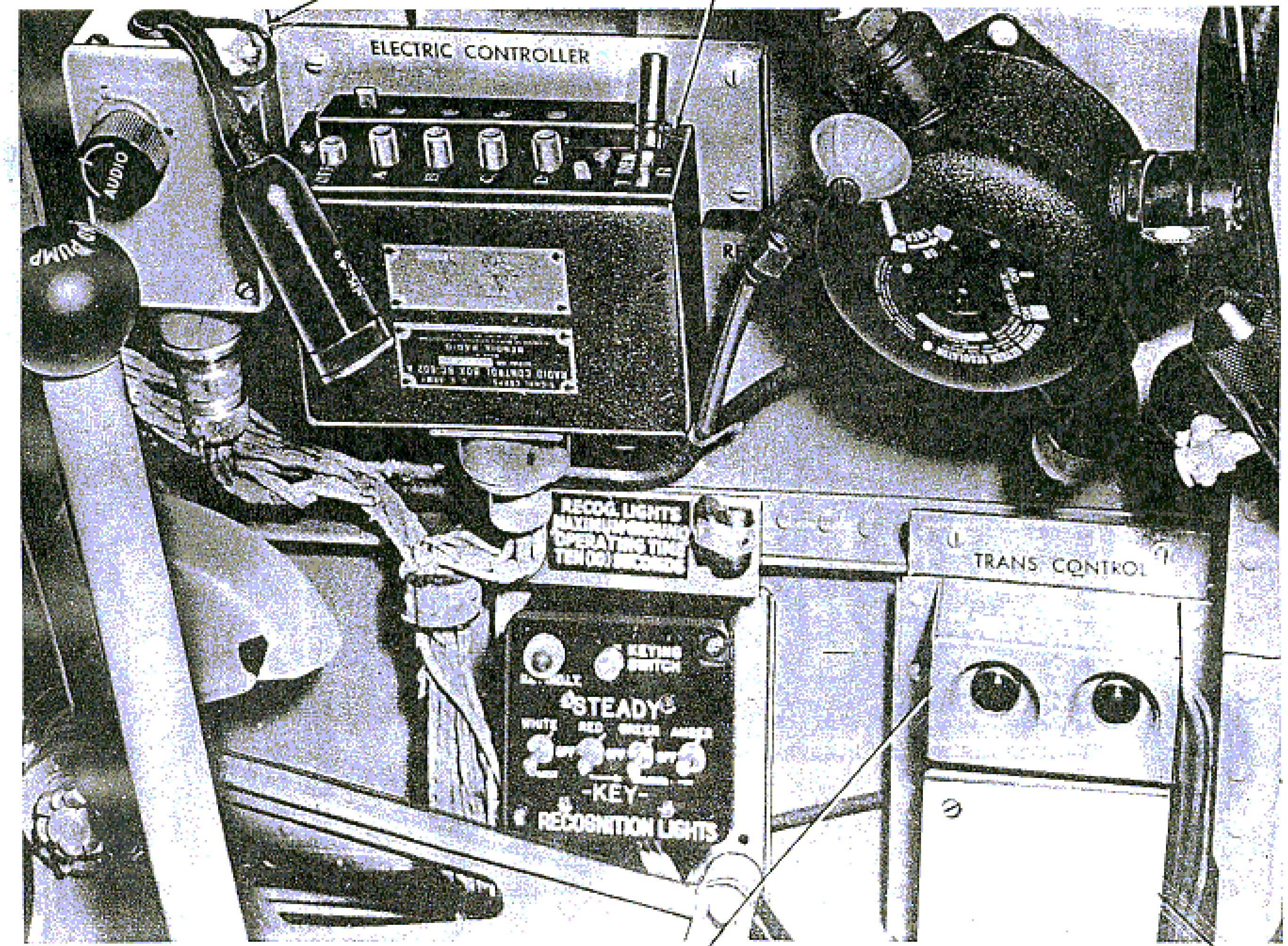
3. DYNAMOTOR.—The dynamotor, H42-D3114, is mounted on the top shelf between stations 8 and 9, and serves as the power supply.

4. RADIO CONTROL BOX.—Radio control box BC-602-A, is mounted on a bracket on the right side of the cockpit aft of station 3 bulkhead. It provides complete remote control of communications with five red push buttons by which channels are selected and the power turned on and off. (See figure 274.)

5. JACK BOX.—Jack box BC-629, is mounted on a plate aft of station 3 bulkhead just forward of the radio control box. It provides for connections between the transmitter-receiver unit and the pilot's microphone and headset. It is equipped with an audio volume control to regulate the volume level of the signal received in the headset. (See figure 274.)

BC-629 JACK BOX

BC-602-A RADIO CONTROL BOX



BC-765 DETONATOR SWITCH BOX

M-299 MICROPHONE ADAPTER

Figure 274—SCR-522 Radio Controls

6. MICROPHONE ADAPTER.—Microphone adapter M-299, is mounted forward of bulkhead station 4 on a bracket with the detonator. It is used in conjunction with microphone T-30-P. (See figure 274.)

7. CIRCUIT PROTECTION.—A 40-ampere push button reset type circuit-protector located in the radio junction box is used for the SCR-522-A radio.

(b) REMOVAL OF SCR-522-A RADIO.—To remove the SCR-522-A transmitter receiver or dynamotor, first disconnect all plugs and loosen Dzus fasteners attaching slide trays to shelves. The trays may then be removed by sliding them off the shelves with their respective units attached.

(c) OVERHAUL AND REPAIRS. — In the event it is necessary to remove faulty radio equipment, it should be sent to a depot for overhaul or repairs.

(d) REPLACEMENTS. — In making replacements, refer to the equipment list accompanying the wiring diagram for the particular installation. Refer to the wire tabulation for the particular installation for wire sizes.

(e) INSTALLATION OF SCR-522-A RADIO.

1. When installing the SCR-522-A transmitter-receiver and dynamotor, make certain that prongs on the forward ends of their respective trays enter the proper sockets provided on the shelf and that Dzus fasteners are locked.

2. Wiring harnesses and tuning cables must be installed with enough slack to allow for swaying of radio equipment which is shock mounted.

3. Tuning shafts should be installed with a minimum of bends to avoid binding and rough tuning.

4. Plugs should be properly inserted in their respective sockets and should be carefully tightened to avoid stripping threads.

5. The plug attaching to the microphone adapter should be securely lockwired to screw on the front of adapter.

6. Make certain outer sheath on the SCR-522-A antenna coaxial feed cable is bonded to the structure of the airplane. Ground straps should be installed from the airplane structure to one of the ground binding posts on each rack.

(5) PORTABLE RADIO (DETROLA MODEL 438).—The portable radio is mounted on a bracket attached to the base of the main switch panel. Fuse for this radio is located in the main switch box. It is used with the SCR-522-A radio installation when it is necessary to have a receiver for the reception of range signals. It covers the frequency range from 200 to 400 kilocycles (beacon and weather band).

(6) IDENTIFICATION RADIO SCR-695 (IFF).

(a) RECEIVER.—The receiver (BC-966-A) is shock-mounted on a shelf between stations 10 and 11 just aft of the fuselage access door. Indicator 87-67-972, mounted on the same shelf with the receiver, includes two test lamps which light when the detonator is used.

(b) POWER-CONTROL BOX. — Power-control box, BC-958-A, and selector-control box, BC-965-A, are mounted on the right wall of the fuselage above the receiver.

(c) ANTENNA.—The "Spike" antenna mast (AN-95) is screwed into a fitting in the top of the fuselage between stations 11 and 12.

(d) DETONATOR. — Detonator switch box BC-706-A, mounted on a shelf at station 11 just aft of the warning indicator, includes a crash switch which destroys the receiver in the event of a crash landing. Switch box, BC-765, mounted on the right side of the cockpit at station 4, includes two detonator switch buttons which are depressed simultaneously to destroy the receiver. (See figure 274.)

(e) COCKPIT POWER-CONTROL SWITCHES.—The cockpit power-control switches are mounted on a bracket attached to bulkhead on the right hand side of the cockpit.

(7) WIRING HARNESSES.—The wiring harnesses are held in place by a quick-opening type of clamps attached to the bulkheads, stringers, or shelves, and are similarly located for all installations, running aft from the cockpit along the right side of the fuselage. To remove the harnesses it is only necessary to squeeze the clamps, allowing them to spring open, after which the harnesses may be removed.

(8) LIST OF MANUFACTURERS.—Following is a list of manufacturers of radio equipment to whom reference is made in the equipment lists of the radio wiring diagrams:

Abbreviation	*Manufacturer*
Spencer	Spencer Thermostat Company Attleboro, Massachusetts
Detrola	Detrola Corporation Detroit, Michigan
Cutler-Hammer	Cutler-Hammer, Inc. Milwaukee, Wisconsin
Jones	Howard B. Jones Chicago, Illinois
Cannon	Cannon Electric Development Co. Los Angeles, California
Bendix	Bendix Radio Division Bendix Aviation Corporation Baltimore, Maryland

WIRE TABULATION. — SCR-274-N RADIO

Reference Wiring Diagrams:

87-610-1015 (Airplanes AF42-104429 through AF42-104828)

87-610-1115 (Airplanes AF42-104829 through AF42-106245)

87-610-1215 (Airplanes AF42-106246 and subsequent)

Wire No.	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*
501	AN-20	523	AN-20	551	AN-20	622	AN-20
502	AN-18	524	AN-20	552	AN-20	623	AN-18
503	AN-18	525	AN-20	553	AN-20	624	AN-18
504	AN-20	526	AN-20	554	AN-20	625	AN-20
505	AN-20	527	AN-18	573	AN-20	626	AN-20
506	AN-20	528	AN-20	582	AN-18	627	AN-18
507	AN-20	529	AN-20	584	AN-18	628	AN-20
508	AN-20	530	AN-20	600	87-67-902-94	629	AN-18
509	AN-20	531	AN-20	601	87-67-902-94	*630	AN-18
510	AN-18	532	AN-20	*602	87-67-902-40	630	AN-20
511	AN-18	533	AN-18	*603	87-67-902-40	631	AN-20
512	AN-18	534	AN-20	*604	87-67-902-40	632	AN-18
513	AN-18	535	AN-20	610	AN-20	633	AN-20
514	AN-18	536	AN-18	613	AN-20	634	AN-20
515	AN-12	537	AN-20	614	AN-20	635	AN-18
516	AN-12	538	AN-18	615	AN-20	636	AN-20
517	AN-18	539	AN-20	616	AN-20	637	AN-18
518	AN-20	540	AN-20	617	AN-20	638	AN-20
519	AN-20	541	AN-20	618	AN-18	639	AN-20
520	AN-18	*542	AN-16	619	AN-20	671	AN-20
521	AN-20	542	AN-18	620	AN-20	672	AN-18
522	AN-18	547	AN-20	621	AN-18		

*Effective on airplanes AF42-104429 through AF42-104828.

WIRE TABULATION. — SCR-522-A RADIO

Reference Wiring Diagrams:

87-610-1005 (Airplanes AF42-104429 through AF42-104828)

87-610-1105 (Airplanes AF42-104829 and subsequent)

Wire No.	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*
543	AN-20	562	AN-20	577	AN-18	*591	AN-20
544	AN-16	563	AN-20	578	AN-20	*592	AN-20
*550	AN-18	564	AN-20	579	AN-20	*593	AN-20
551	AN-20	565	AN-20	580	AN-10	*594	AN-20
552	AN-20	566	AN-20	581	AN-10	*595	AN-20
553	AN-20	567	AN-20	582	AN-18	596	AN-20
554	AN-20	568	AN-20	*583	AN-10	597	AN-20
555	AN-20	569	AN-20	584	AN-18	598	AN-20
*556	AN-20	570	AN-20	*585	AN-20	599	AN-20
557	AN-20	571	AN-20	586	AN-20	600	87-67-902
558	AN-20	573	AN-20	587	AN-20	601	87-67-902
539	AN-20	574	AN-20	588	AN-20	*670	AN-14
*560	AN-20	575	AN-20	589	AN-20	755	AN-16
561	AN-20	576	AN-18	590	AN-20		

*Effective on Airplanes AF42-104429 through AF42-104828.

WIRE TABULATION.—SCR-695-A RADIO

Reference Wiring Diagrams:

87-610-1020 (Airplanes AF42-104509 through AF42-104828)

87-610-1120 (Airplanes AF42-104829 and subsequent)

Wire No.	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*
605	AN-16	645	AN-12	656	AN-18	*707	AN-16
607	AN-16	646	AN-18	657	AN-18	*708	AN-16
608	AN-16	647	AN-18	658	AN-18	711	AN-12
609	AN-16	648	AN-18	659	AN-18	712	AN-12
611	AN-12	649	AN-12	*660	AN-16	713	AN-18
612	AN-16	650	AN-12	660	AN-18	714	AN-12
640	AN-18	651	AN-12	661	AN-16	715	AN-12
641	AN-18	652	AN-12	703	AN-16	716	AN-12
642	AN-18	653	AN-12	704	AN-16	717	AN-16
643	AN-18	654	AN-12	705	AN-16	718	AN-12
644	AN-18	655	AN-12	706	AN-16		

*Effective on Airplanes AF42-104829 and subsequent.

WIRE TABULATION.—RADIO COMPASS
(MODEL MN-26)

Reference Wiring Diagram:

87-610-1075 (For all airplanes equipped with Radio Compass)

Wire No.	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*	*Wire No.*	*Size*
726	AN-20	733	AN-20	740	AN-20	747	AN-20
727	AN-20	734	AN-20	741	AN-20	748	AN-20
728	AN-20	735	AN-20	742	AN-20	749	AN-20
729	AN-20	736	AN-18	743	AN-18	750	AN-20
730	AN-20	737	AN-18	744	AN-20	751	AN-16
731	AN-20	738	AN-20	745	AN-18	752	AN-16
732	AN-20	739	AN-20	746	AN-20		

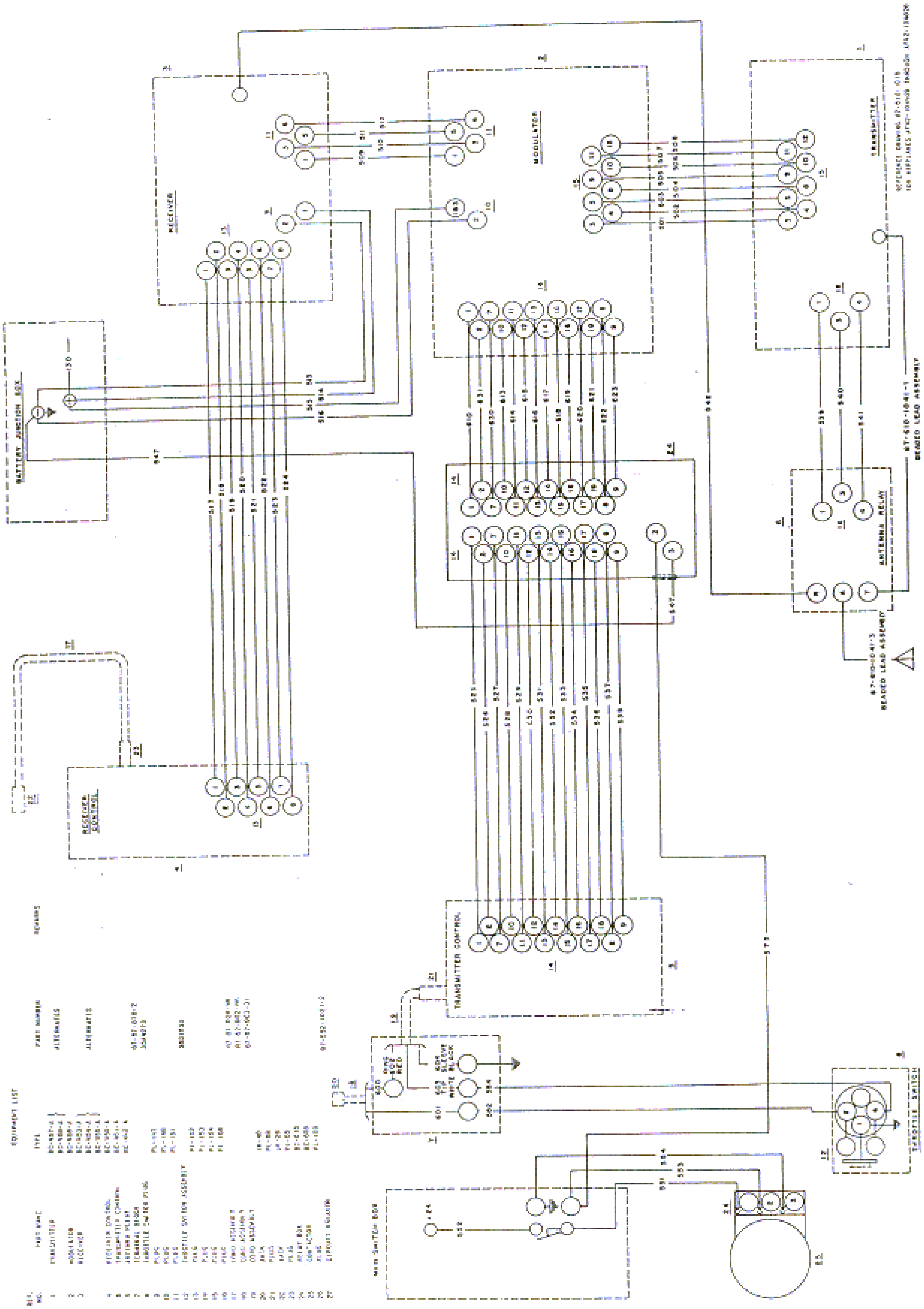


Figure 275—SCR-274 Radio Wiring Diagram (AF42-104429 Through AF42-104828)

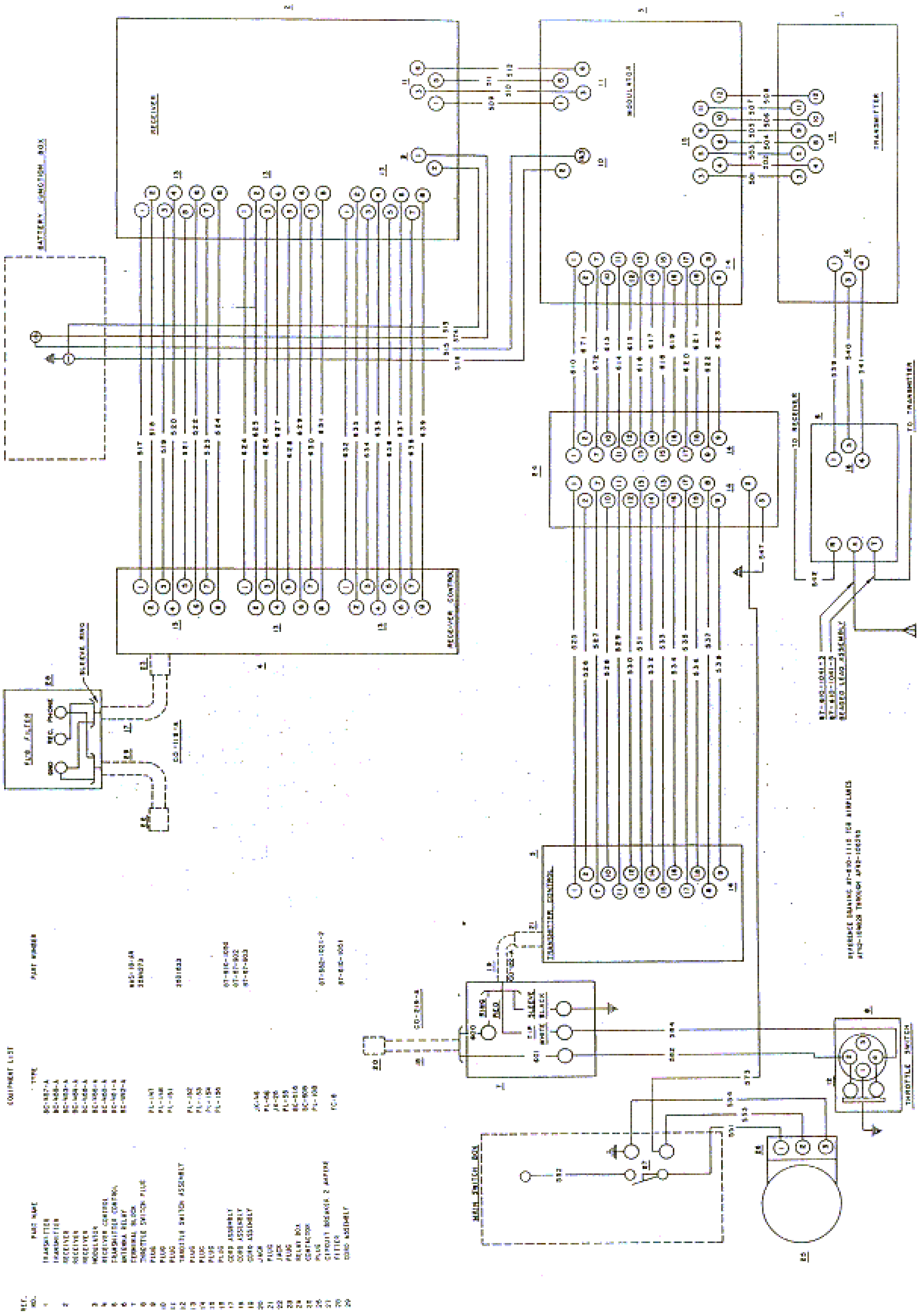


Figure 276—SCR-274 Radio Wiring Diagram (AF42-104829 Through AF42-106245)

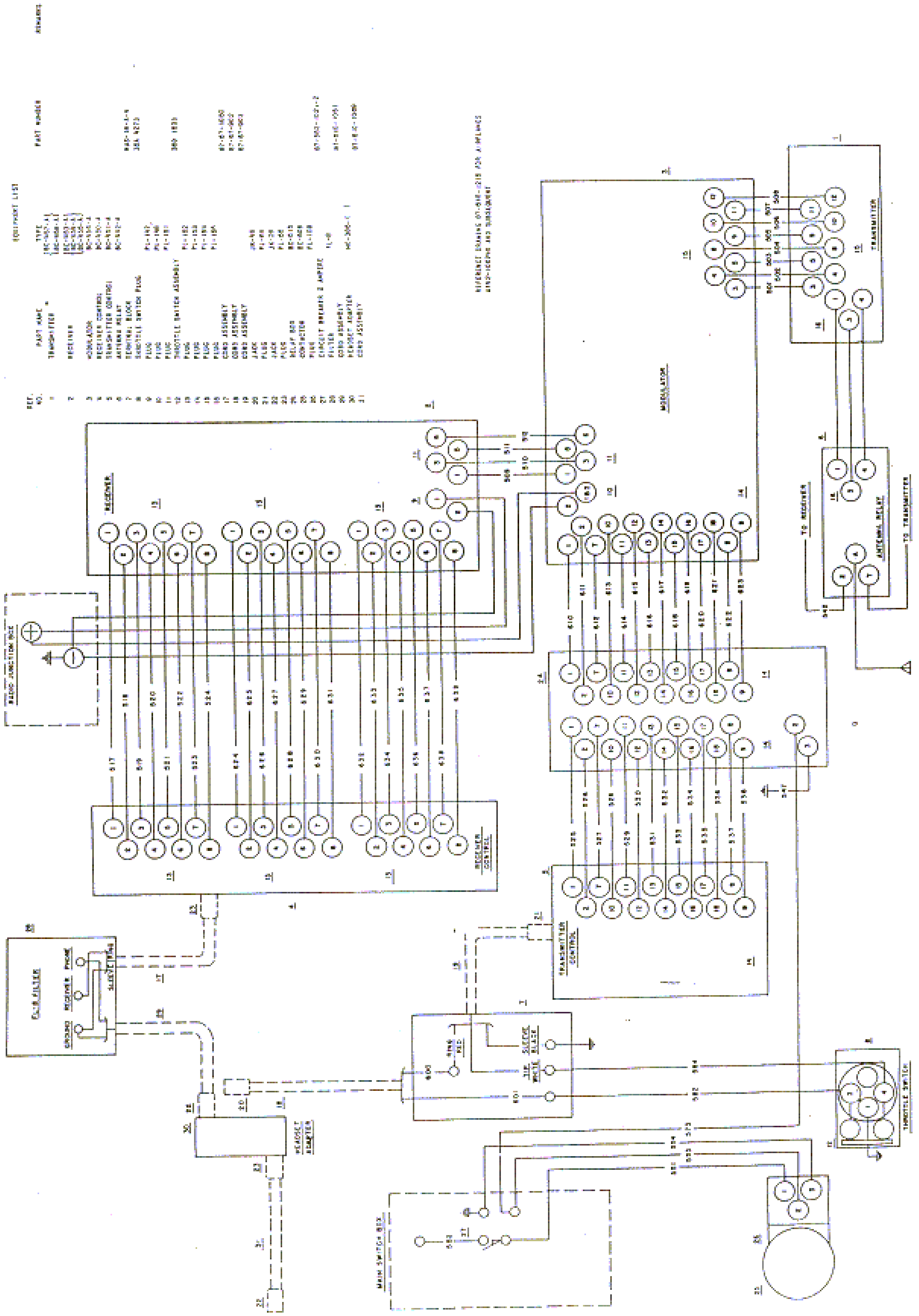


Figure 277—SCR-274 Radio Wiring Diagram (AF42-106246 and Subsequent)

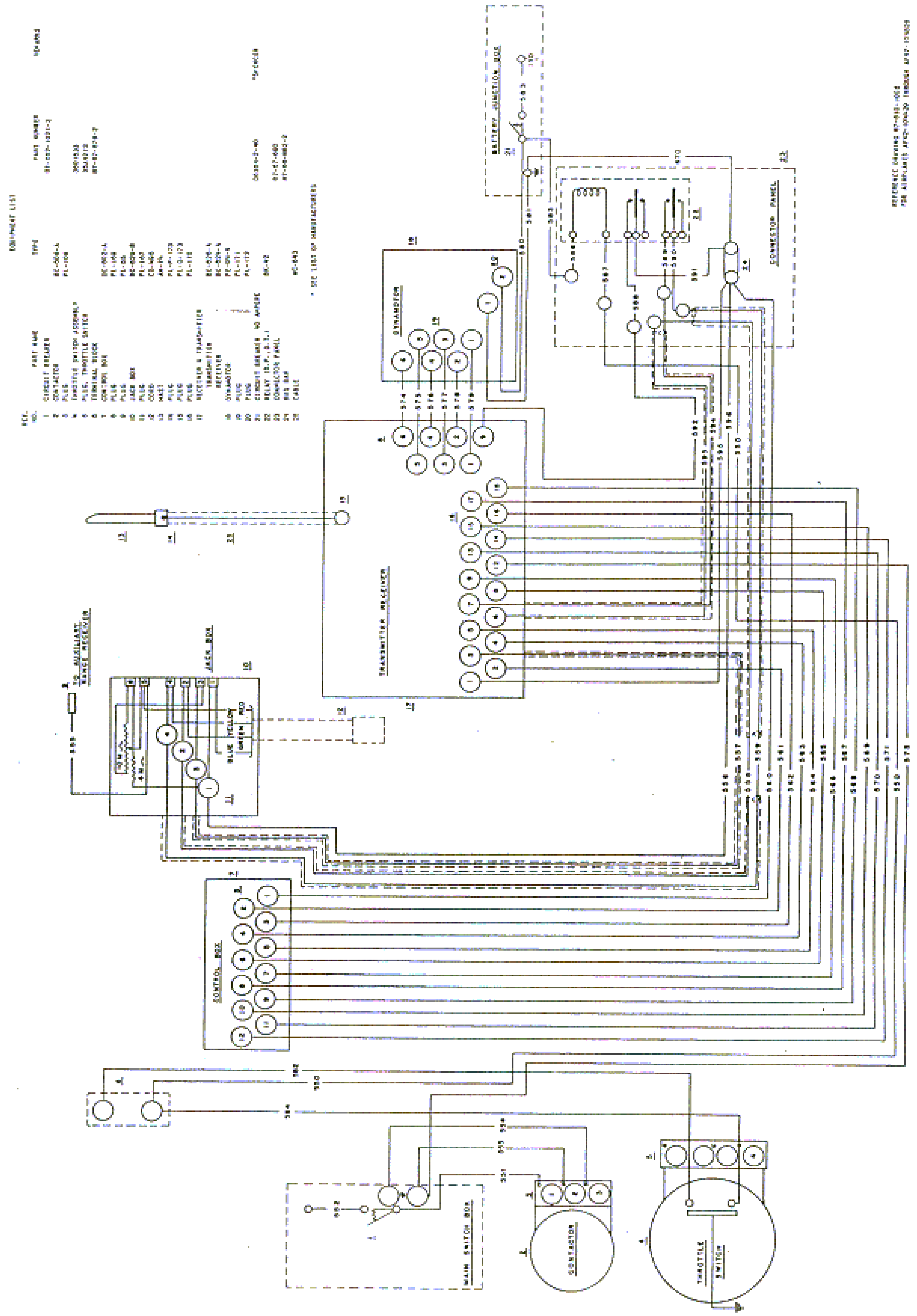


Figure 278—SCR-522 Radio Wiring Diagram (AF42-104429 Through AF42-104828)

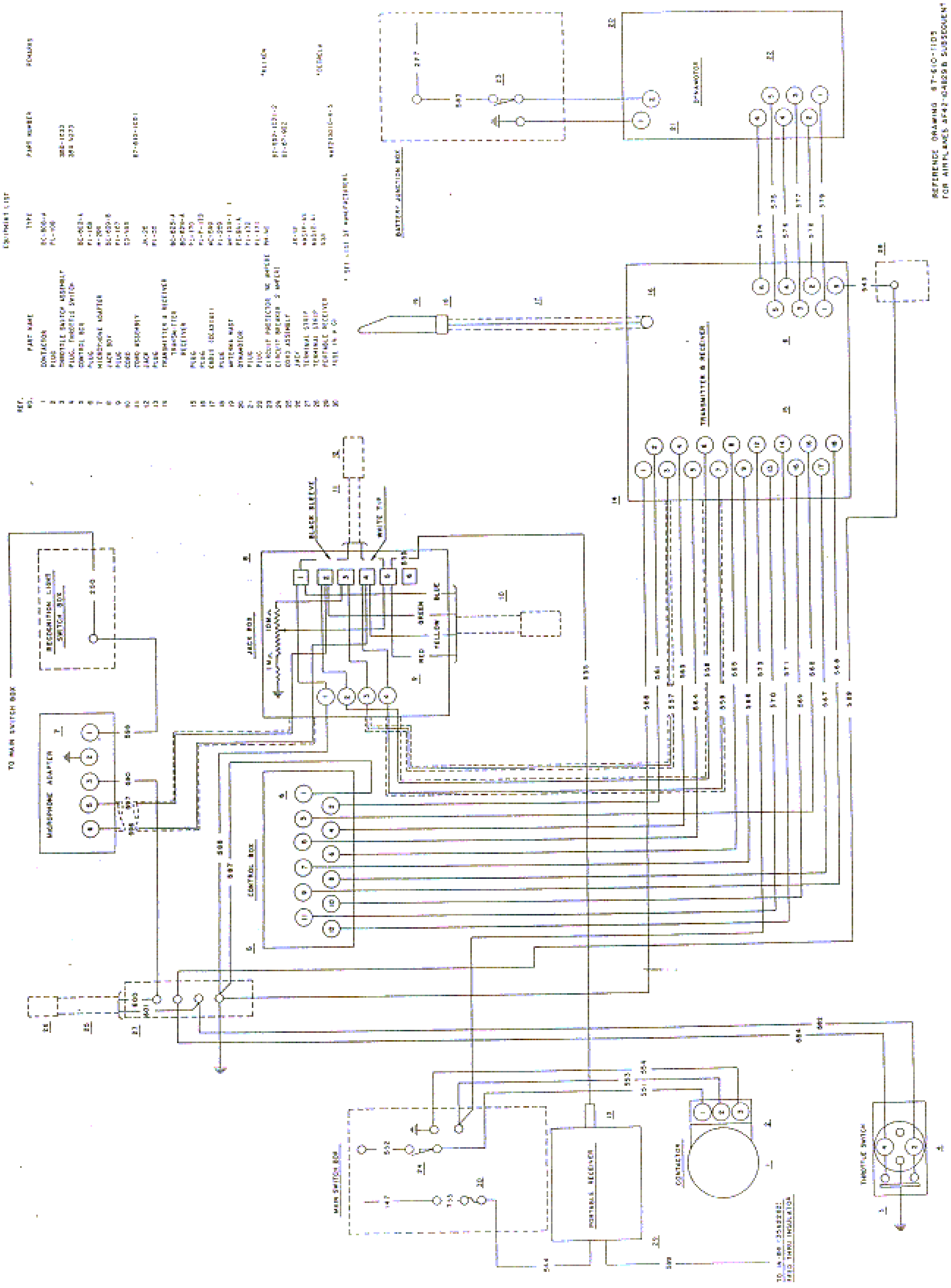


Figure 279—SCR-522 Radio Wiring Diagram (AF42-104829 and Subsequent)

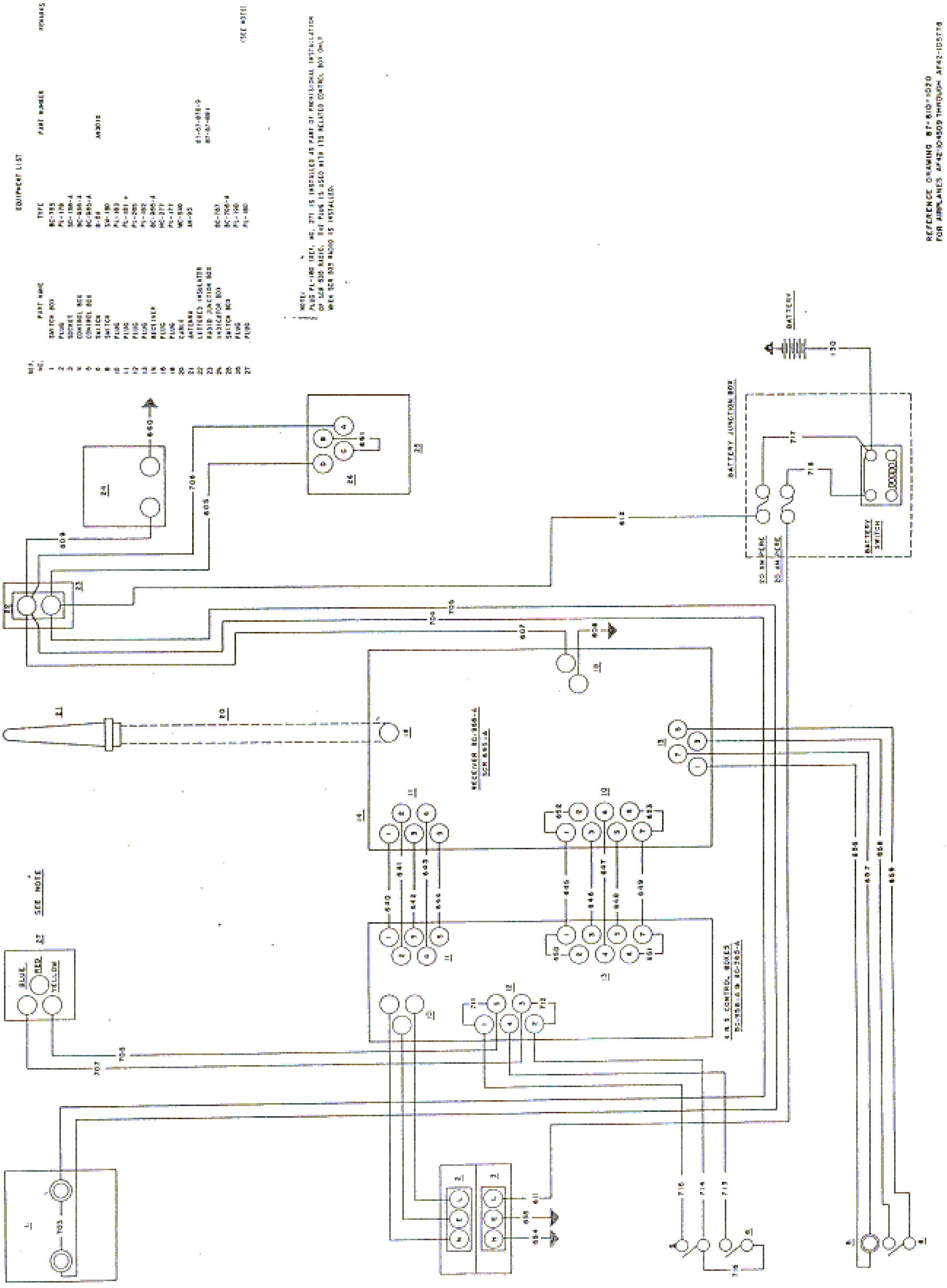


Figure 280—SCR-695 Radio Wiring Diagram (AF42-104509 Through AF42-105778)

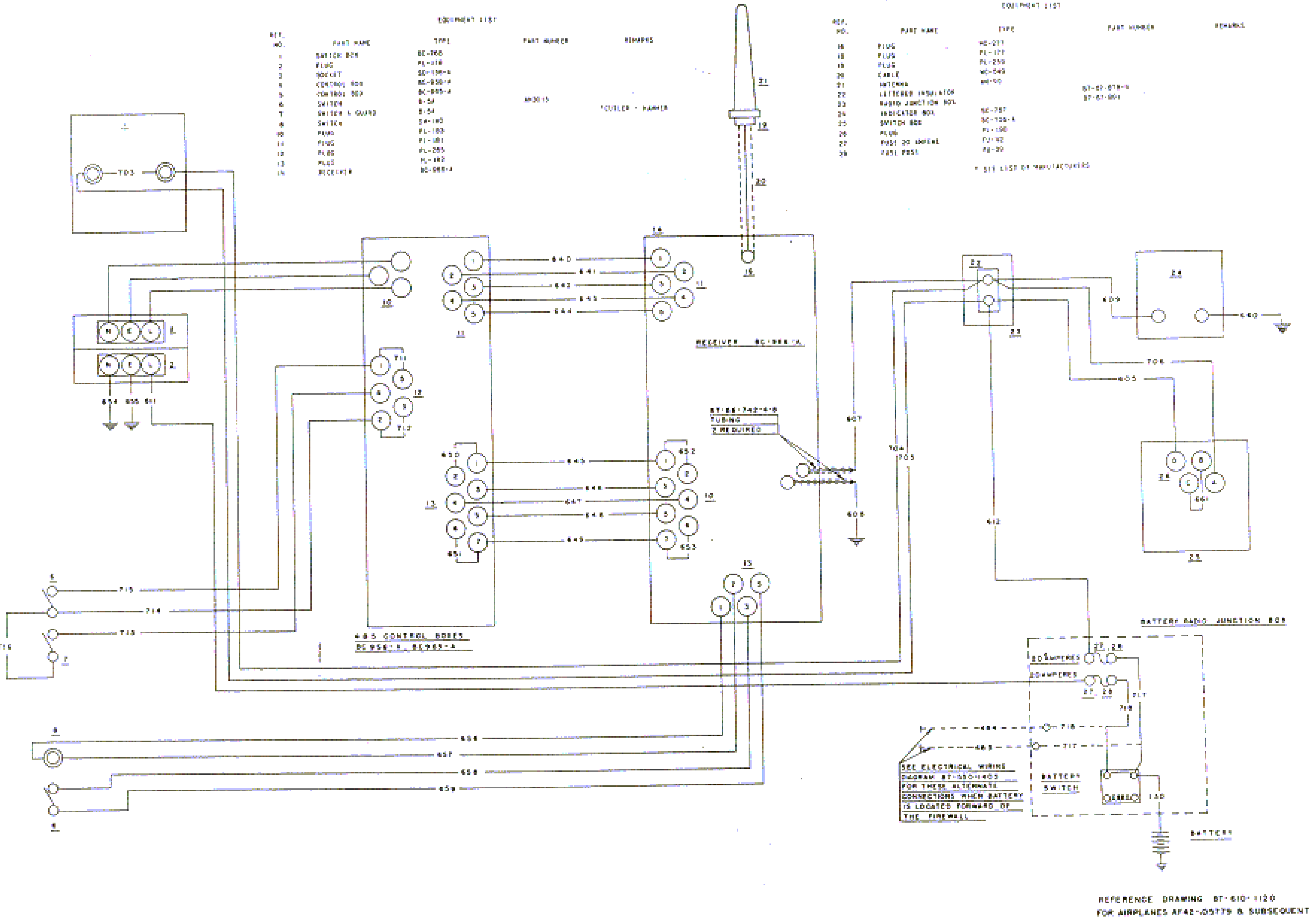


Figure 281—SCR-695 Radio Wiring Diagram (AF42-105779 and Subsequent)

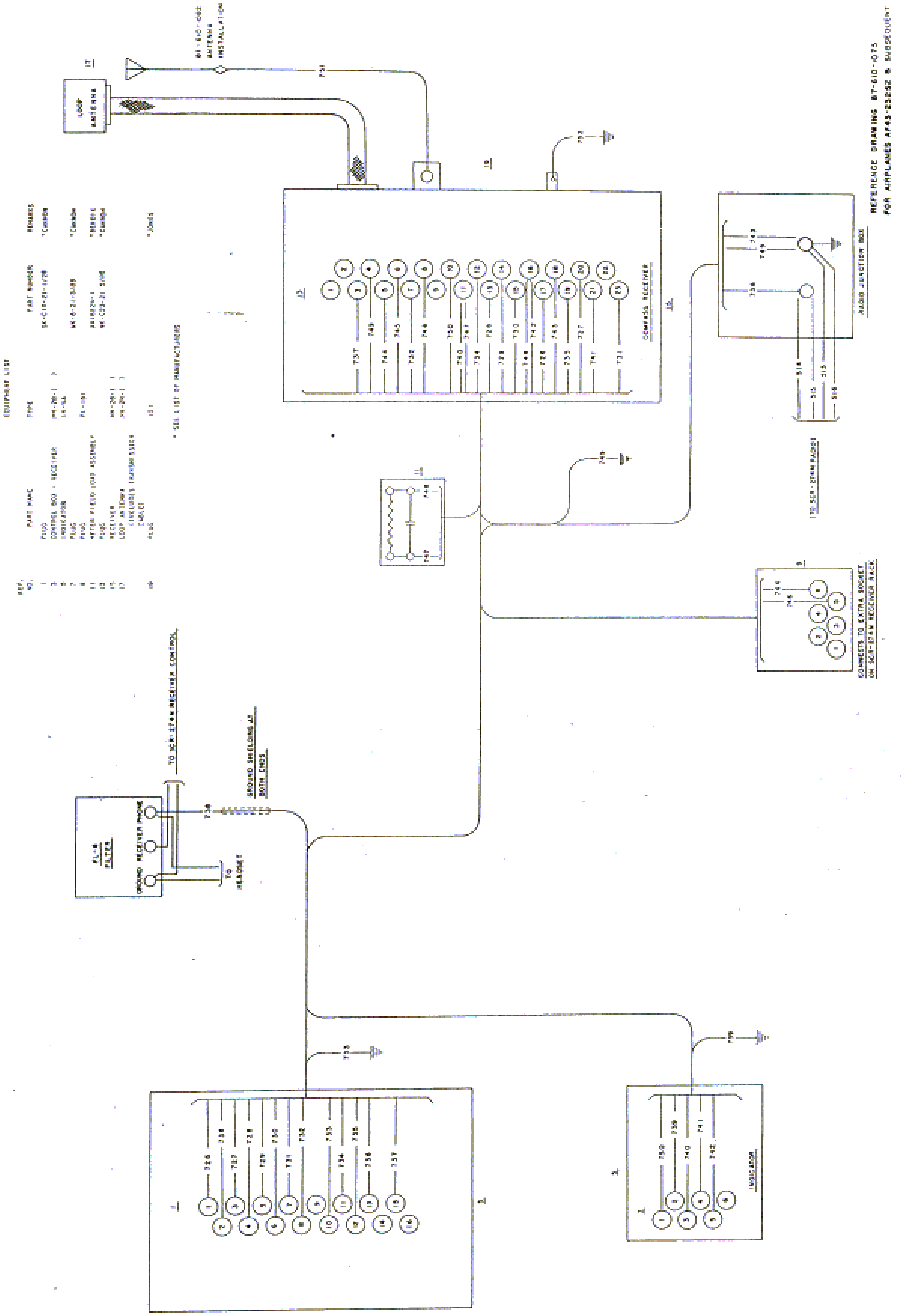
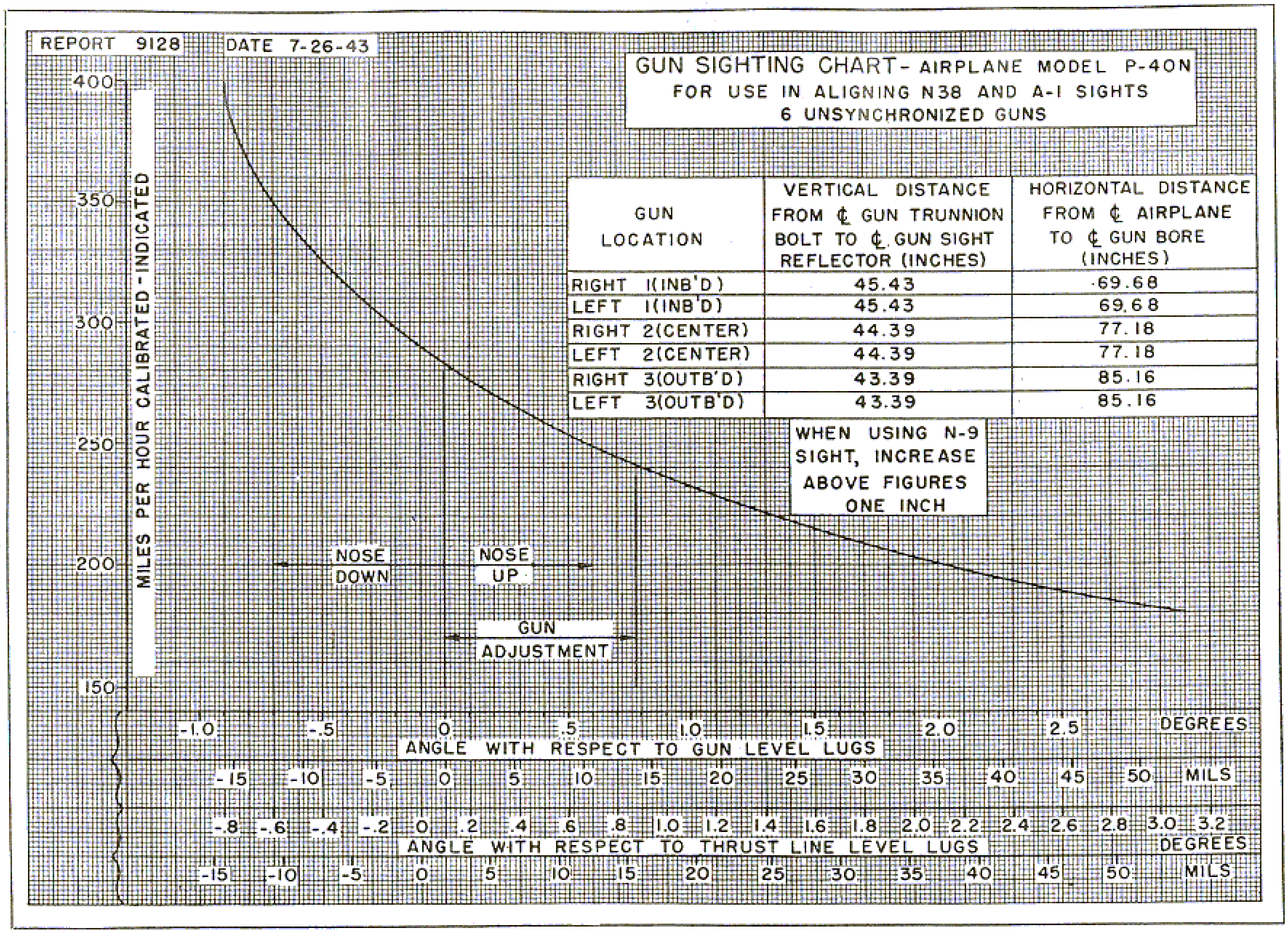
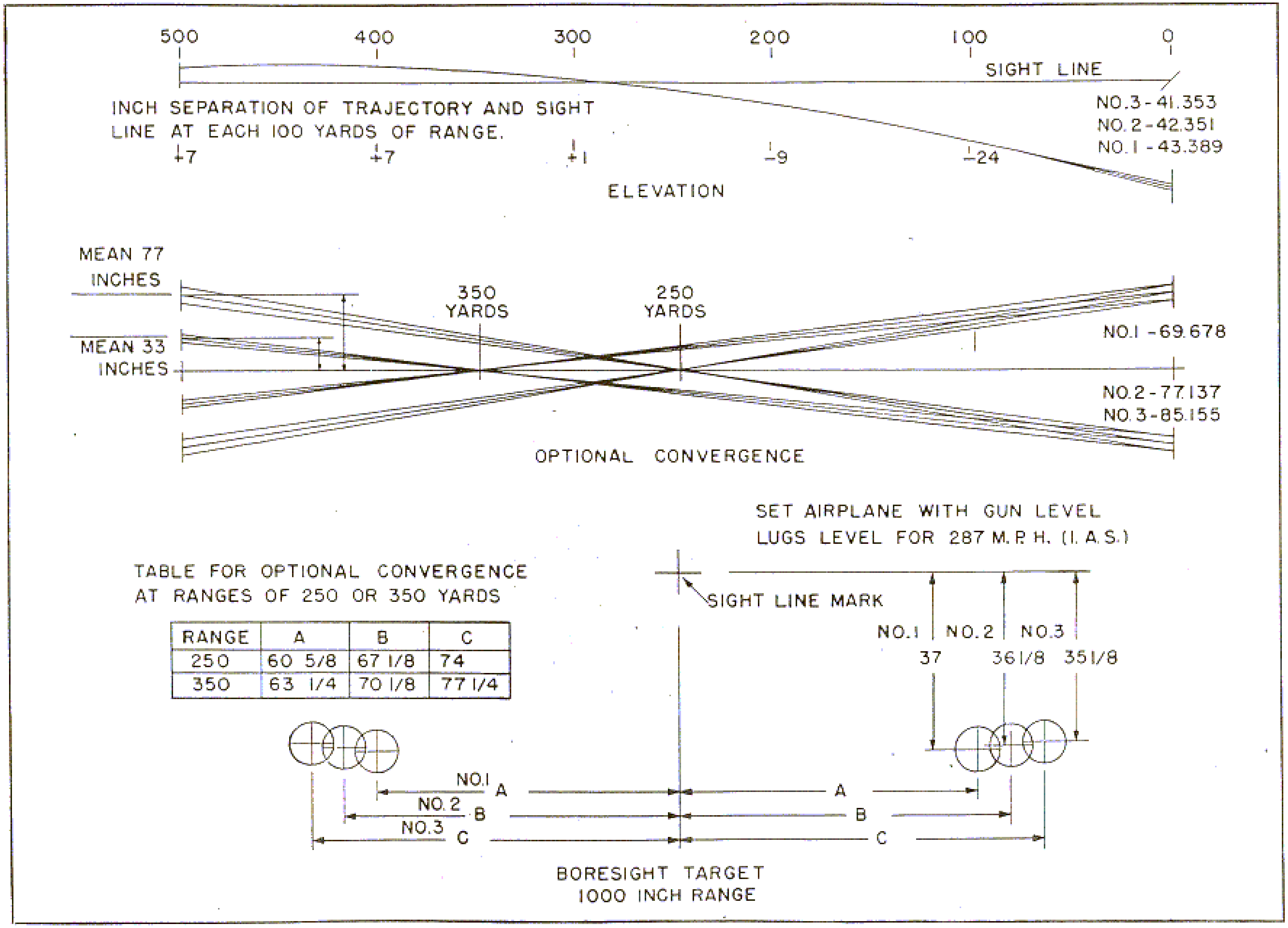


Figure 282—MN-26 Radio Compass Wiring Diagram (AF43-23252 and Subsequent)



GUN LOCATION	VERTICAL DISTANCE FROM ₵ GUN TRUNNION BOLT TO ₵ GUN SIGHT REFLECTOR (INCHES)	HORIZONTAL DISTANCE FROM ₵ AIRPLANE TO ₵ GUN BORE (INCHES)
RIGHT 1(INB'D)	45.43	69.68
LEFT 1(INB'D)	45.43	69.68
RIGHT 2(CENTER)	44.39	77.18
LEFT 2(CENTER)	44.39	77.18
RIGHT 3(OUTB'D)	43.39	85.16
LEFT 3(OUTB'D)	43.39	85.16

Figure 283—Gun Sight Chart



RANGE	A	B	C
250	60 5/8	67 1/8	74
350	63 1/4	70 1/8	77 1/4

Figure 284—Bore Sight Chart

f. ARMAMENT PROVISIONS.

(1) GUNNERY EQUIPMENT.

(a) DESCRIPTION.—The gunnery equipment of P-40N airplanes AF42-104429 through AF42-104904 consists of four model M-2 .50 caliber wing guns and 940 rounds of ammunition as normal load and 1206 rounds as overload. Airplanes AF42-104905 and subsequent are equipped with six model M-2 .50 caliber wing guns with 1410 rounds of ammunition as normal load and 1686 rounds as overload. The guns and ammunition boxes are installed outboard of the landing gear in each wing panel. The guns fire outside the propeller disc. All P-40N airplanes are equipped with type N-3B gun sights.

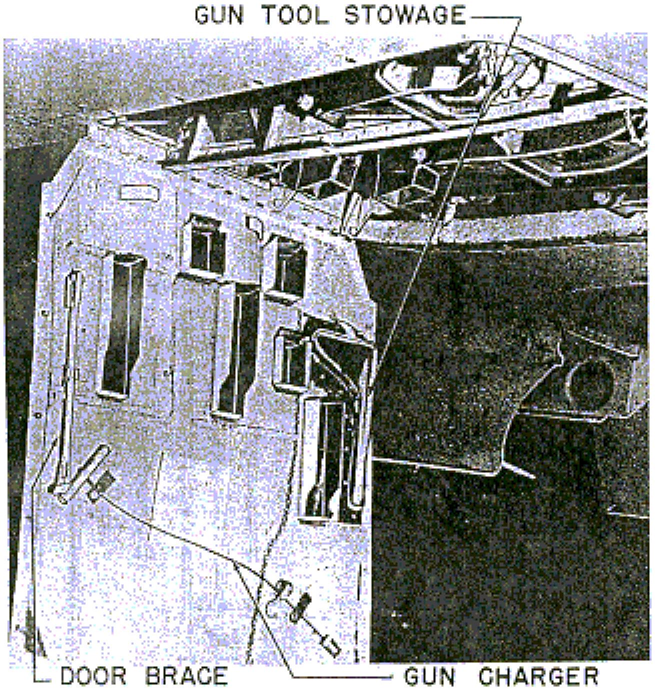


Figure 285—Gun Access Door

(b) REMOVAL OF GUNS.

1. Unbutton the gun access door and lower the door from the gun compartment. Swing the door brace up and button it to the wing with the Dzus fastener.

2. Remove the leading edge cover plate from the leading edge of the wing by unbuttoning the two Dzus fasteners. Unscrew the blast tube from the retainer and remove the tube from the muzzle of the gun.

3. Detach the feed and link ejection chutes from the gun.

4. Remove the rear mounting bolt without disturbing the adjustment.

5. Pull the toggle down on the rear mount adapter and release the saddle over the gun. Rotate the saddle to clear the gun and allow the adapter to swing downward.

6. Remove the solenoid attaching nut and allow the solenoid to swing downward, suspended from the electric cable.

7. Swing the saddle over the gun and lock with the toggle. Raise the rear end of the gun and support the mount adapter with the drift pin.

8. Release the toggle on the front adapter. Swing the eyebolt down and pull out the lock pin plates on either side of the gun. This will release the gun from the adapter without disturbing the adjustment.

9. Withdraw the drift pin from the rear mount adapter and remove the gun from the wing without disturbing the adjustment.

10. After the initial installation and adjustment of the guns by bore-sighting, it will be possible to remove the guns whenever necessary without disturbing the adjustments as long as the yoke nuts on the front adapters and the locking nuts on the serrated plates on the aft mounts are not tampered with.

(c) GUN ACTION REMOVAL.—The gun action may be removed as follows without removing the gun:

1. Remove the leading edge cover plate.

2. Unscrew the blast tube from the retainer on the gun barrel at the leading edge of the wing.

3. Unbutton the gun access door.

4. Detach the feed chutes from the inboard and center guns and the link chute from the outboard gun.

5. Loosen the front mounting bolt slightly to allow the front adapter to pivot on the yoke.

6. Remove the rear mounting bolt.

7. Through the port in the upper wing skin, loosen the nut as far as possible in order to drop the gun down to clear web 5. Release the toggle, swing the saddle over the gun, and allow the rear adapter to swing under the gun.

8. Remove the back plate from the gun and withdraw the bolt, driving pin, and gun barrel, with the barrel extension and lock frame, from the gun.

(d) PREPARING GUNS PRIOR TO INSTALLATION.

1. Identify by chalk or paint the guns to be installed in left or right wings.

2. Clean guns thoroughly. If a new gun is to be installed, clean as follows:

a. Remove the gun from the container.

b. Remove the back plate and oil buffer tube assembly from the gun and clean these assemblies with dry cleaning solvent (Federal Specification P-S-661.) Submerge back plate and oil buffer tube assembly in AXS-777 oil.

c. Remove the bolt from the gun and disassemble.

d. Place the receiver group, barrel extension, oil buffer body, and disassembled bolt in the degreaser tray at a suitable angle for drainage and lower into the degreaser.

e. Allow gun to remain in degreaser for 5 to 10 minutes and then wash with a spray of trichlorethylene.

f. When all traces of degreaser fluid have evaporated, completely submerge parts listed in step d, preceding, in an AXS-777 oil bath.

g. Reassemble bolt, oil buffer assembly.

h. Reassemble entire gun making sure that none of the components is missing.

3. Adjust head space (distance between the base of the cartridge and face of the bolt) and timing. (See section IV, paragraph 7, *f*, (1), *(f) 1.)*

CAUTION

Care must be exercised to avoid roughening the barrel surface during adjustment.

(e) INSTALLING GUNS IN GUN BAYS.

1. Install the rear adapter on the gun. The saddle over the gun for the tie-down arrangement should be installed with the largest overhang on the outboard side for each gun. Adjust the tie-down rod for proper tension with the toggle in the locked position. Do not tighten excessively, or damage may result. Adjust the lower nut on the tie-down rod so that it will be approximately 1/16 inch below the saddle. The purpose of this lower nut on the tie-down rod is to keep the tie-down mechanism intact when it is released by the toggle and swung out of position.

2. Install blast tube retainers as follows:

a. Screw the retainer in the blast tube until it shoulders.

b. Slip the assembled blast tube over the gun muzzle and onto the barrel jacket until it shoulders.

c. Rotate the assembled blast tube until the threaded holes in the retainer align with the slots or holes in the gun barrel jacket. If the gun has a slotted jacket, three threaded holes in the retainer must register with slots. If the jacket has round holes, two threaded holes in the retainer should register with holes in the jacket.

Note

On round-hole barrel jackets, if two threaded holes in the retainer will not register with those in the jacket because of discrepancies in the gun, one will suffice.

d. Assemble the studs in the retainer, small diameter heads inside for the slotted jacket and large diameter heads inside for the round-hole jacket. (See note under step 2, c, preceding).

e. Set the studs tight, and then back off approximately one-half turn, leaving the studs with slots at right angles to the gun axis. The studs must secure the retainer in all directions.

f. Lockwire through the slots in the studs and around the retainer.

g. Remove blast tubes.

Note

Retainer, studs, and blast tube will have some lost motion after being assembled as described above. This is necessary to allow movement of parts, thus breaking up powder residue which may cause seizing of parts after extensive firing.

3. Unbutton the gun-access door.

4. Install the front adapters to the gun compartment, but do not tighten the yoke nut, so that the adapter may be lined up correctly with the gun upon installation. Be sure that the locking plates are installed in all adapters, and that the toggles are all on the outboard side. The pins on the locking plates should not extend beyond the inner surfaces of the adapters or they will foul the gun upon installation.

5. Mount the gun by inserting it, muzzle end first, through the gun compartment, and guide the muzzle through the holes provided in webs 3, 2, and 1. Be sure that the front of the gun is properly engaged by the front adapter.

6. Support the rear of the gun with the drift pin stowed in the pocket on the left gun-access door. Insert the drift pin through the rear mount and adapter.

7. Raise the front of the gun enough to engage the pins on the locking plates in the holes on the gun. Swing the eyebolt up and lock it with the toggle.

8. Remove the drift pin from the rear adapter and allow the gun to drop down as far as it will go.

9. Release the toggle on the rear adapter to free the saddle, and swing the adapter downward under the gun.

10. Install the solenoid on inboard side of the gun and tighten and safety the attaching nut.

11. Swing the rear adapter up and engage the eyebolt in the saddle. Throw the toggle up to lock the saddle and adapter.

12. Install the rear mounting bolt, which has a flat side to key it to the lateral adjusting sleeve, and insert the lock pin in the bolt. Be sure the lock pin is retained by a chain.

13. Tighten the yoke nut through the port in the top surface of the wing with the special gun wrench carried in the stowage pocket on the left wing gun-access door.

14. Attach the link chute to the side of the gun.

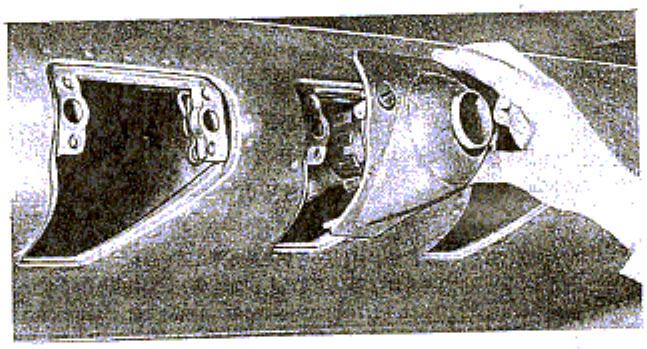


Figure 286—Installation of Leading Edge Cover Plate

15. Insert the blast tube into the leading edge of the wing over the muzzle of the gun. The correct location of each blast tube is given on the name plate attached to the tube. Screw the blast tube onto the retainer on the barrel jacket as far as it will go, then back off the tube approximately half a turn, leaving it with the two locking lugs at the front end of the tube in a vertical position. It is extremely important that the blast tube be backed off approximately half a turn, because if it is tight on the retainer, powder residue will collect in the threads and cause seizure. Slip the leading edge fairing over the blast tube, if necessary moving the shutter so that the opening is in the proper location, and button the fairing to the leading edge with the two Dzus fasteners. A lock in the fairing will engage the blast tube lugs and prevent the tubes turning off the adapter. Make certain that the ears on the blast tube keep it from turning. If the Dzus fasteners appear to be loose in their securing spring, the springs can be set up by bending them slightly inward. After these operations are completed, it will be noted that the blast tube will have considerable lost motion at its forward end because of the loose-fitting thread in the retainer and the looseness of the retainer on the gun. This is desirable to prevent seizing after extensive firing.

16. Make the necessary alignments and adjustments in accordance with tactical requirements as to direction of fire, and safety all adjustments.

(f) GUN ADJUSTMENTS.

1. HEADSPACE ADJUSTMENT. (Using gage Ordnance Drawing No. A-351217.)

a. Cock gun by fully retracting the recoiling parts and allowing them to return to battery position.

b. Retract the bolt approximately 1/16 inch. (This puts the forward locking surfaces of the breech lock and the bolt recess in contact, which is the position they will assume at the time of firing.)

c. Check the headspace for "tightness" by inserting the "GO" end of the headspace gage in the T-slot between the face of the bolt and the end of the barrel. If the gage "goes" readily, check the headspace for looseness in accordance with step d, following. If the gage does not "go" without being forced, the headspace is too tight. Correct by unscrewing the barrel one notch at a time, checking with the gage each time, until the gage enters easily.

CAUTION

Never release the firing pin with the gage in place, as to do so will damage the firing pin.

d. Check the headspace for "looseness" by trying the NO-GO end of the gage in the T-slot between the face of the bolt and the end of the barrel. If the gage does not enter, the headspace is correct. If the NO-GO end of the gage "goes" the headspace is too loose. Correct it by screwing the barrel into the barrel extension ONE notch at a time, checking with the gage each time until the NO-GO end of the gage will not enter.

e. Remove the gage and release the firing pin.

Note

This gage may be inserted either from the top or the bottom of the gun. In the event that the gage is inserted from the bottom of the gun, the slack between the bolt and the breech lock may be taken up by inserting a screwdriver between the bolt and the barrel. The width of the gage is such as to permit this.

2. SOLENOID ADJUSTMENT. (Type G-9.)

a. Securely assemble solenoid to the gun.

b. Cock the gun by fully retracting the recoiling parts and allowing them to return to battery position. Turn the solenoid adjustment to the right (clockwise) until the firing pin will not release with the bolt in battery.

c. Turn adjustment one notch at a time to the left (counter-clockwise) until position is found at which the firing pin is just released. The gun must be charged each time the solenoid is operated.

d. Turn adjustment five additional notches to the left (counter-clockwise).

e. After adjusting solenoids in accordance with the above instructions, the adjustment must be checked by means of the proper FIRE and NO-FIRE gage.

(1) With the gun charged, insert the FIRE gage between the barrel extension and trunnion block. The firing pin shall be released each time the solenoid is operated.

(2) With the gun charged, insert the NO-FIRE gage between the barrel extension and the trunnion block. When the solenoid is operated, the firing pin must not release.

(3) In the event that the firing pin does release with the NO-FIRE gage in place, the following corrective action must be taken:—Turn the adjustment cap one to two notches in a clockwise direction and recheck with both the FIRE and NO-FIRE gage.

3. OIL BUFFER.

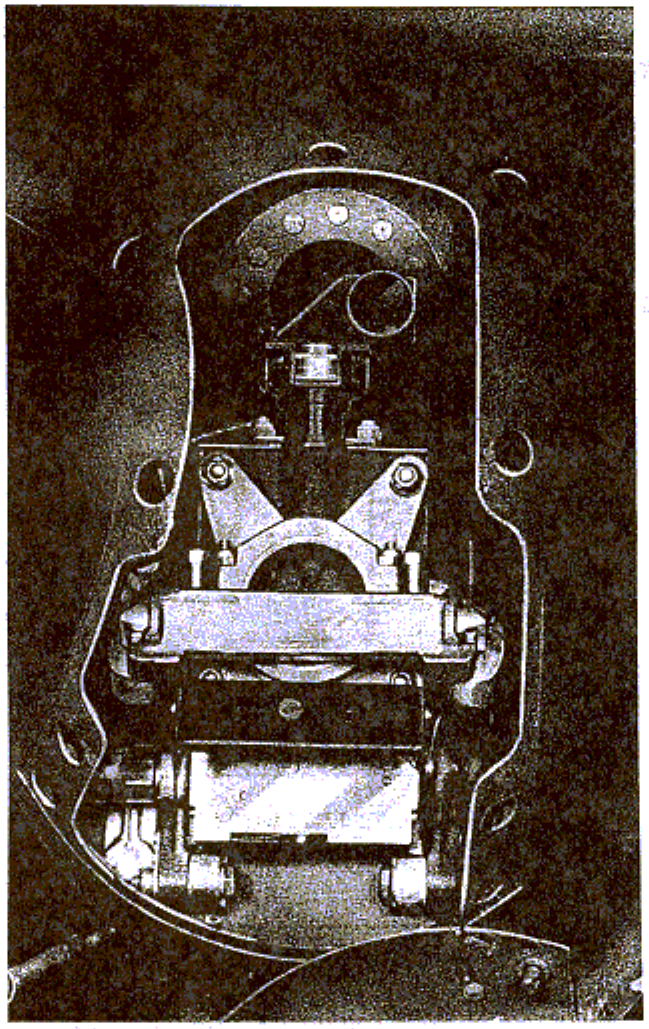
a. Rotate oil buffer counter-clockwise until it ceases to click.

b. Turn oil buffer clockwise until the first click is felt.

c. Turn oil buffer clockwise two additional clicks. This point is the best operating condition at highest cyclic rate.

(g) AMMUNITION BOXES.

The ammunition box installation consists of two single and two double ammunition boxes in each wing panel. The normal capacity is 235 rounds per gun. The two leading outboard compartments serve the center gun. The two trailing outboard compartments serve the inboard gun and the two inboard boxes serve the outboard gun. The ammunition boxes



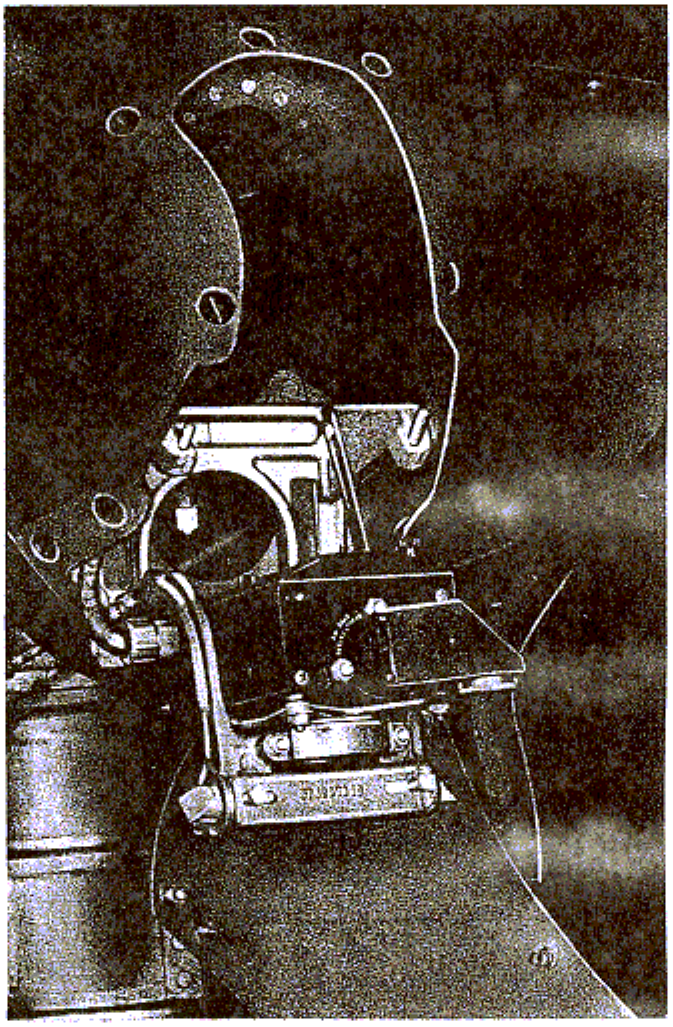


Figure 287—Gun Camera Installed

are accessible through doors on the top surface of the wing. The feed chute to the center gun must be removed before the two inboard ammunition boxes can be removed.

(2) GUN CAMERA.

(a) DESCRIPTION.—The camera mounted in the leading edge of the right landing gear fairing is government furnished G.S.A.P. type N-2.

(b) REMOVAL.—Unbutton the Dzus fasteners in the leading edge of the landing gear fairing. Squeeze together the two projecting knobs on the swinging mount and tilt the camera forward. This procedure will give access to the electrical conduit plug which may then be unscrewed from the camera. Remove the four bolts attaching the camera to the mounting plate.

(c) ADJUSTMENT.—Adjustment of the camera may be made only while the gun is being sighted. To adjust, insert the optical camera aligner in place of the film magazine. Loosen the two screws which tighten the collar assembly to the adapter ball and adjust the camera to bring the target into the reticle of the optical aligner. Tighten the two screws and check the image of the target in the aligner.

(d) LUBRICATION.—Lubricate camera and over-run control (AF43-23952 and up) at regular inspection intervals with stainless, low viscosity oil. All bearings, gear teeth, gear shafts, and moving parts should receive a light coat of oil. Do not lubricate excessively.

(3) GUN SIGHT.

(a) GENERAL.—The gun sight, type N-3B, is supported by a casting mounted on the forward armor plate at station 2A. The sight is above the instrument panel on the centerline of the airplane. It may be removed without disturbing the setting by removing the nut attaching the yoke assembly to the base assembly.

(b) SIGHT ADJUSTMENT.—The sight assembly may be adjusted in a rotational, horizontal, or vertical direction. Rotational adjustment may be accomplished by means of two adjustment bolts on the top side of the connection between the yoke assembly and base assembly, forward of the instrument

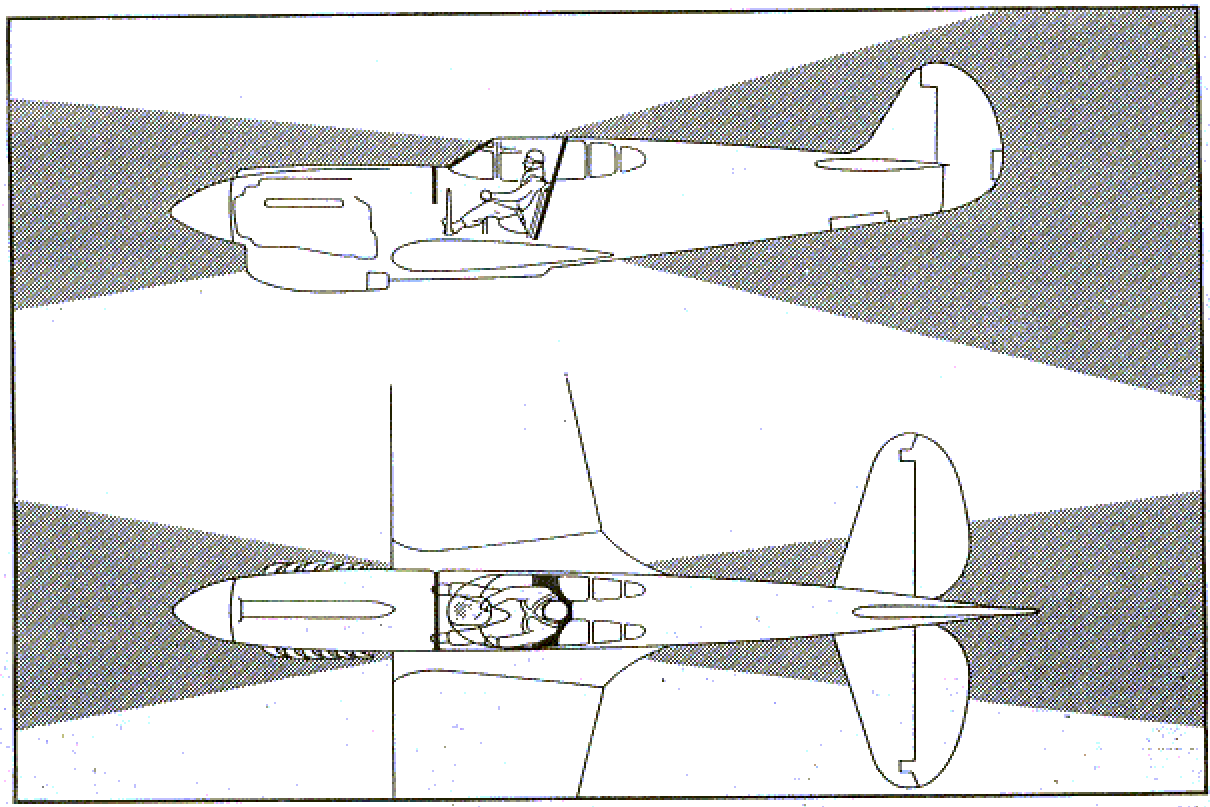


Figure 288—Angles of Armor Protection (AF42-104429 through AF42-104828)

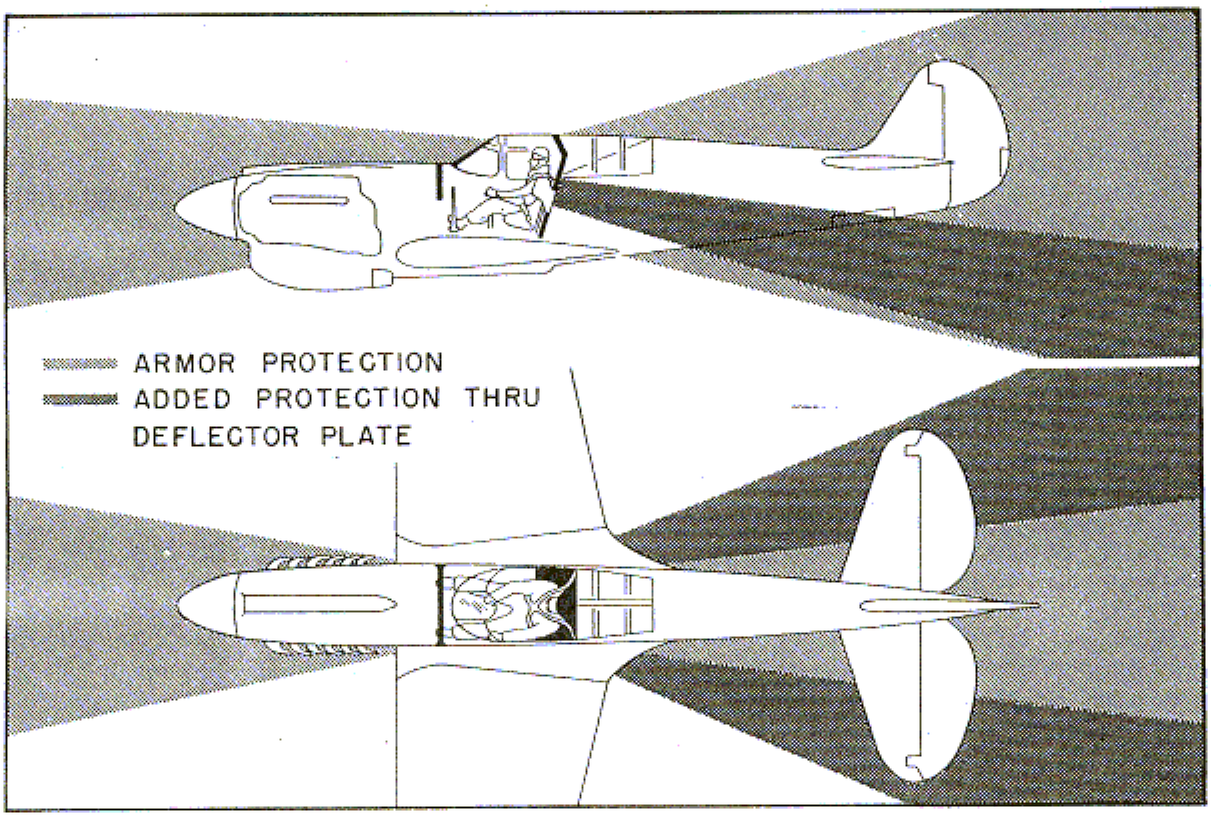


Figure 289—Angles of Armor Protection (AF42-104829 and Subsequent)

panel. One bolt and three screws, 90 degrees apart, beneath the sight assembly, regulate the horizontal and vertical adjustment. The top bolt and bottom screw control the vertical adjustment, and the right and left screws the horizontal adjustment.

(c) LENS ADJUSTMENT.—The lens may be adjusted by means of a knob on the right side of the sight by loosening the set screw and turning the knob. When the proper lens adjustment is attained, be sure to lock the adjusting knob with the set screw. The sight should be so adjusted that the reticle image, when viewed as reflected on the mirror and superimposed on a target approximately 500 yards distant, does not change in relation to the target as the head is moved over the field of vision.

(4) GUNFIRE PROTECTION.

(a) For airplanes AF42-104429 through AF42-104828, the pilot is protected from enemy gunfire originating within the shaded area shown in figure 288. The protection is afforded by a 1-½ inch thick bullet resistant plate glass panel in the windshield assembly, a ⅜ inch hard homogeneous armor plate conforming to Specification AN-O.S. No. 1 which is installed forward of the instrument panel, and a 5/16-inch face-hardened armor plate conforming to Ordnance Specification AXS-490 which is installed on the bulkhead at station 5, aft of the pilot's seat. A piece of 5/16-inch head armor, Ordnance Specification AXS-490, is bolted to the front side of the station 5 armor plate for additional gunfire protection.

(b) For AF42-104829 and subsequent airplanes, the pilot is protected from enemy gunfire originating within the shaded area shown in figure 289. The bullet resistant plate glass panel in the windshield assembly and the front armor plate at station 2A is identical to those installations in previous models of the P-40N series airplanes.

The armor plate at station 5 is 5/16-inch hard homogeneous armor plate conforming to Specification AN-O.S. No. 1. A piece of 5/16-inch head armor of the same material is welded to the upper part of the armor plate assembly, giving additional protection to the pilot. Side deflector plates of ¼-inch 24ST alclad sheet are bolted to each side of the armor plate and provide protection for the pilot's legs and arms against rear quarter attack. The side plates will deflect bullets which strike the plate at angles up to 15 degrees. (See figure 290.)

(5) BOMBING EQUIPMENT.

This airplane is equipped to carry a belly bomb as an alternate load in place of the belly fuel tank. Sway-brace locations and feet-attaching angles with short and long legs make possible the loading and bracing of 100-pound, 300-pound, 500-pound, and 600-pound bombs. Bomb loads are released by pulling up on the type A-3 tank-bomb release handle. The arming handle for the bomb shackle is located to the left of the pilot's seat. The release handle is in the same location.

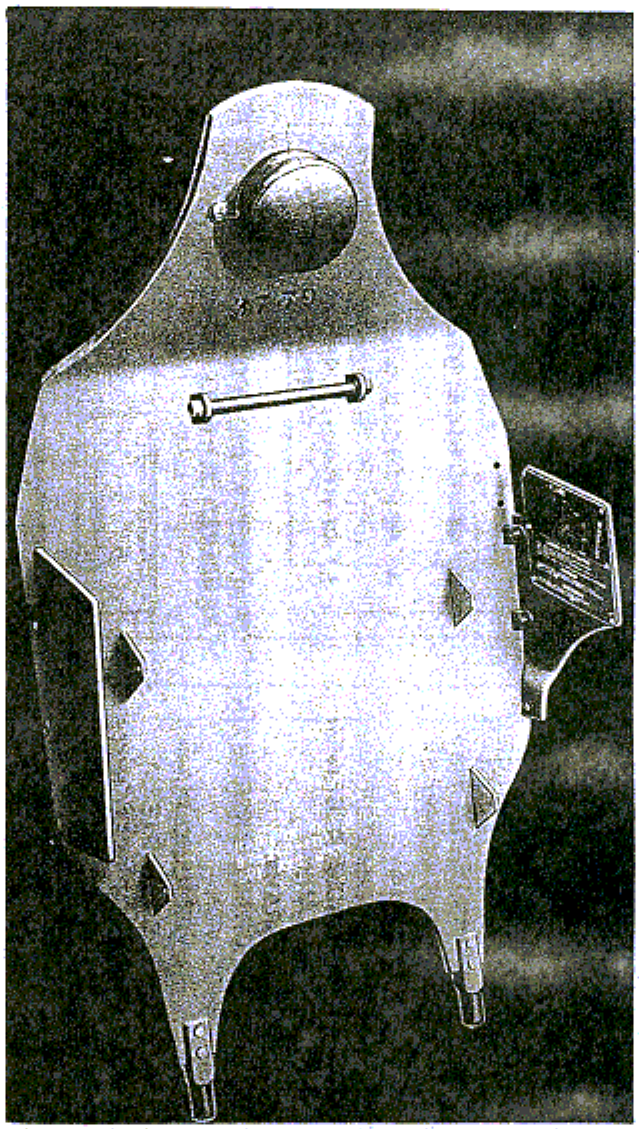


Figure 290—Station 5 Armor Plate (AF42-104829 and Subsequent)

g. FURNISHINGS.

(1) PILOT'S SEAT.—On airplanes AF42-104429 through AF42-104828, the pilot's seat installation is supported by two fittings on the cockpit floor and is adjustable for height. The adjustment control handle is located on the right side of the seat. On these airplanes the seat incorporates a non-skid type pad to prevent the parachute from slipping forward. On airplane AF42-104829 and subsequent, the adjustment is made on the ground by removing four bolts attaching the seat to the armor plate and raising or lowering seat as desired. The bolts are then replaced. (See figures 292, 293, and 294.)

(2) SAFETY BELT AND SHOULDER HARNESS.—A type B-11 adjustable safety belt is attached to the seat. On airplanes AF42-104429 through AF42-104828, a type 41G8725 shoulder harness is bolted to

1. BATTERY (SEE NOTE 1)
2. OIL TANK
3. COOLANT EXPANSION TANK
4. RUDDER PEDALS
5. HYDRAULIC HAND PUMP
6. COWL SHUTTERS CONTROL HANDLE
7. CONTROL STICK
8. CONTACTOR
9. PYROTECHNIC PISTOL
*10. RADIO CONTROLS
11. TRIM TAB CONTROLS
12. FIRST AID KIT
13. MAP CASE
14. PILOT'S SEAT
15. FUEL TANK
16. ARMOR PLATE
*17. SCR522-A TRANSMITTER-RECEIVER
18. OXYGEN CYLINDER- TWO TYPE D-2 (SEE NOTE 2)
*19. SCR522-A DYNAMOTOR
20. FUSELAGE ACCESS DOOR
21. DUFFEL BAG
*22. SCR274-N RADIO TRANSMITTER
*23. SCR522-A ANTENNA MAST
*24. MN26-A RADIO COMPASS
*25. LOOP ANTENNA
*26. SCR274-N DYNAMOTOR
*27. SCR274-N RADIO RECEIVER
28. HYDRAULIC TANK
29. STARTER CRANK
30. STARTER CRANK EXTENSION
31. MOTOR-DRIVEN HYDRAULIC PUMP
32. BATTERY (SEE NOTE 3)
33. EMERGENCY KIT (SEE NOTE 4)
34. OXYGEN CYLINDER— ONE TYPE F-1 (SEE NOTE 5)
35. TAIL WHEEL

NOTES:—
1. AF42-106029 AND SUBSEQUENT
2. AF42-105029 AND SUBSEQUENT
3. AF42-104429 THRU AF42-106028
4. AF42-105929 AND SUBSEQUENT
5. AF42-104429 THRU AF42-105028

* DENOTES RADIO EQUIPMENT DEPENDENT ON ALLOCATION.

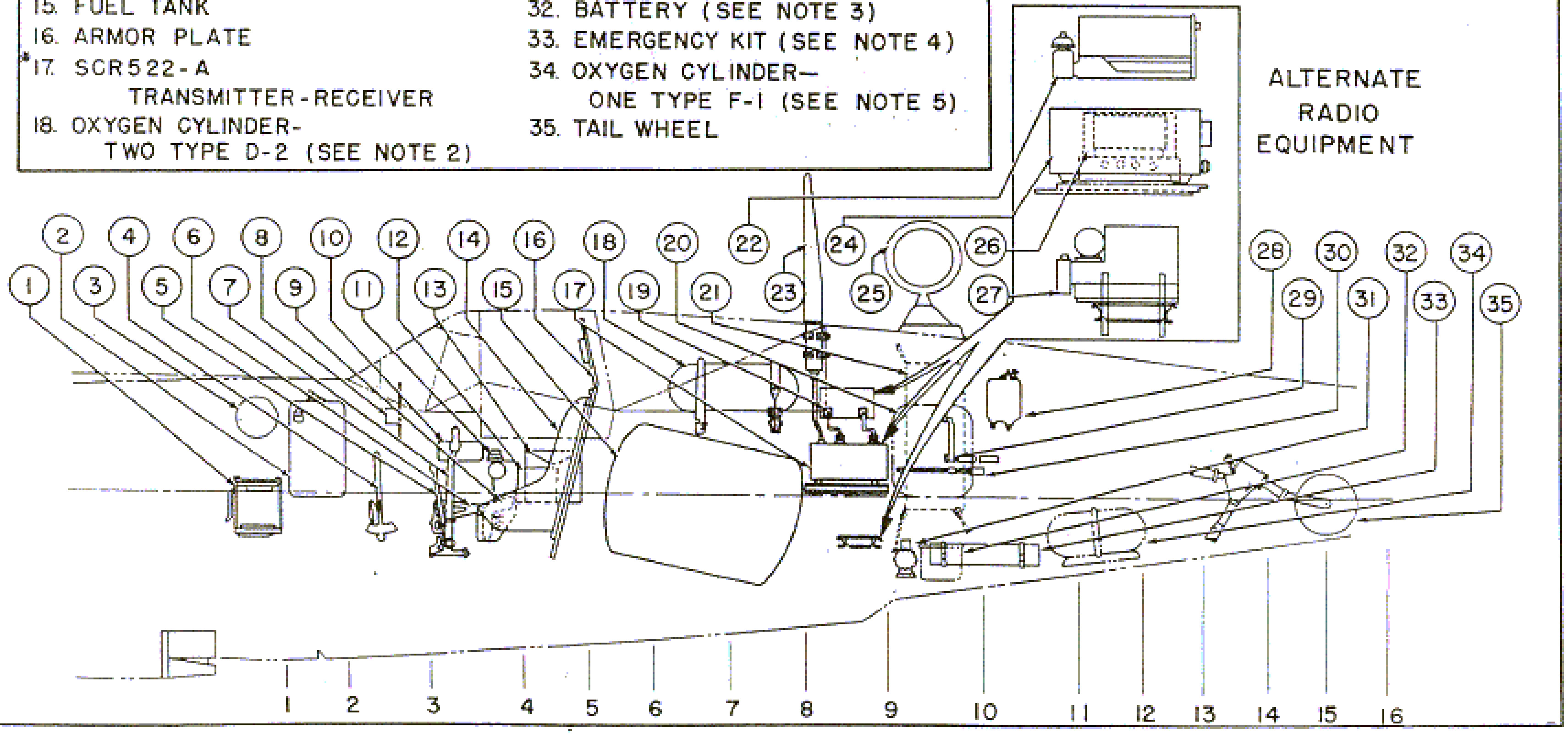


Figure 291—Fuselage Contents

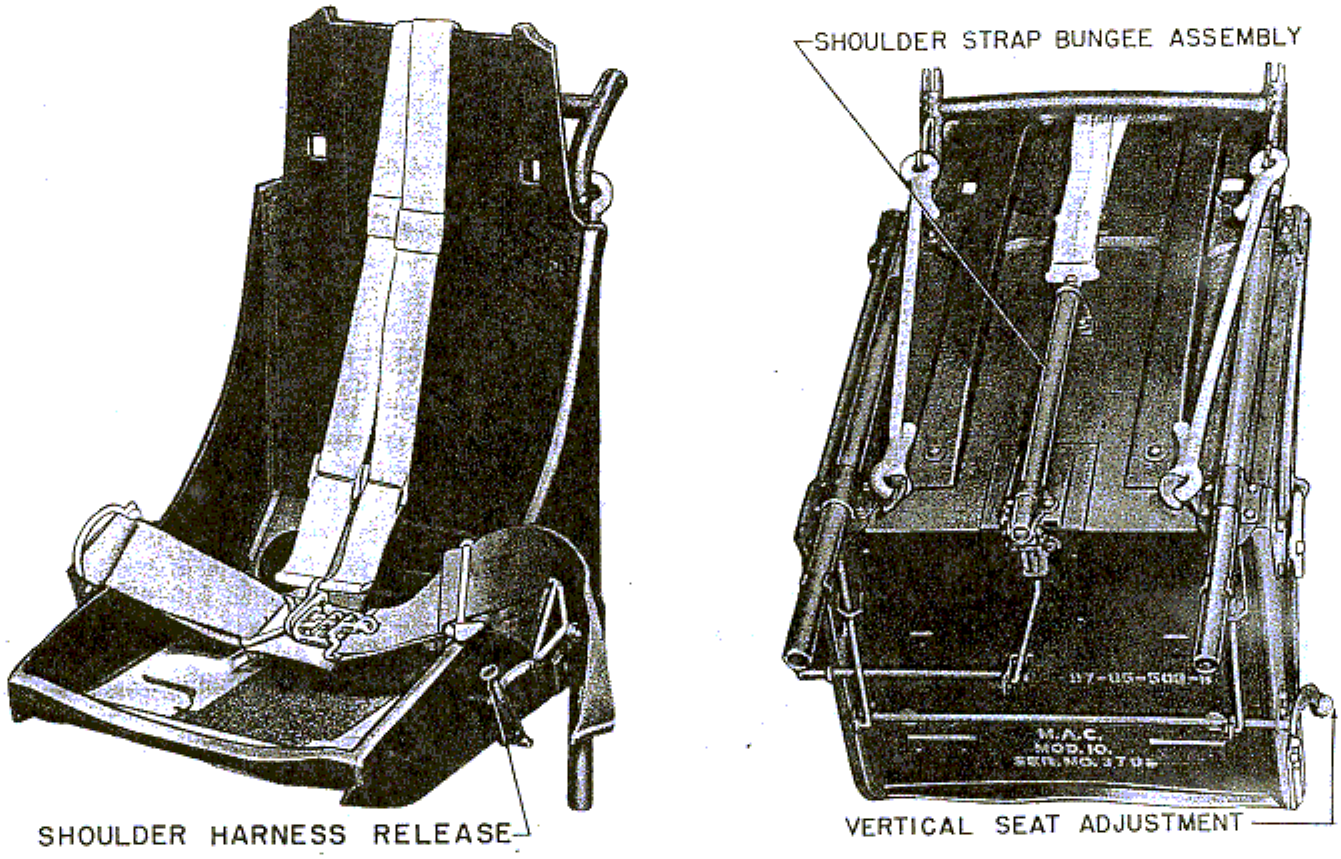


Figure 292—Pilot's Seat—Front and Rear Views (AF42-104429 through AF42-104828)

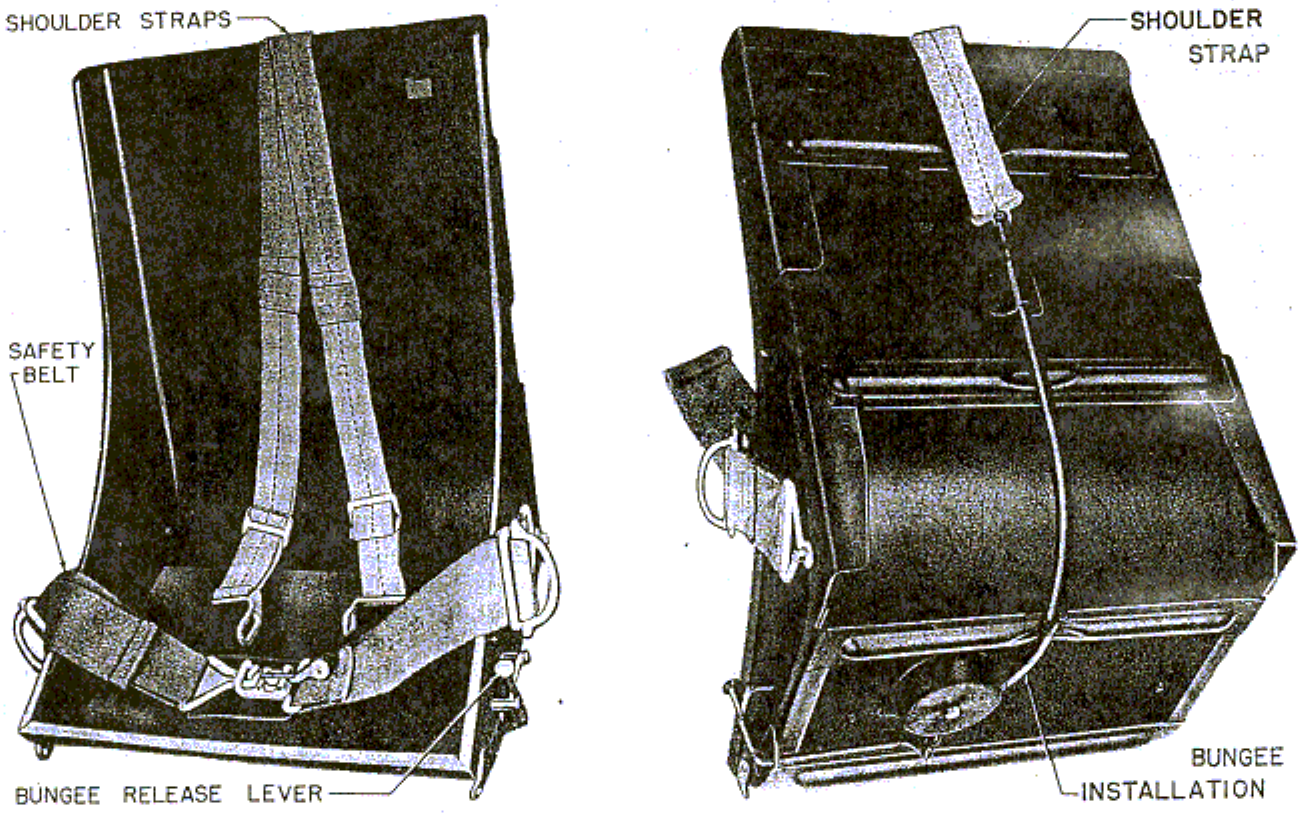


Figure 293—Pilot's Seat—Front and Rear Views (AF42-104829 and Subsequent)

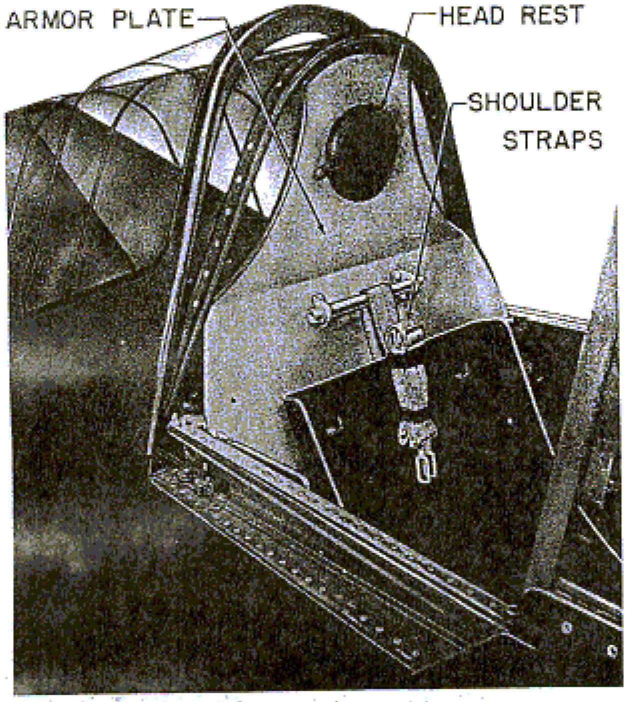


Figure 294—Pilot's Seat Installed

the bungee assembly which controls the movements of the shoulder strap. On these airplanes the release and locking control assembly handle for the shoulder straps is located on the left of the pilot's seat. This control lever will release the locking pin in the bungee assembly and permit freedom of forward motion with only the bungee spring acting as a retaining force. To release the locking pin, push the control button down and pull the handle back until it is locked in its aft position. To lock the shoulder straps, return the bungee spring to its retracted position and pull forward until it is again locked in the forward position. On airplanes AF42-104829 and subsequent, a type 42-G4027 shoulder strap is bolted to the cable back of the seat. The free ends are fastened to the safety belt and can be adjusted to fit the pilot.

(3) DUFFLE BAG.—The duffle bag is located through the access door on the left side of the fuselage between stations 9 and 10. On crated airplanes, it is shipped as loose equipment.

(4) CRANK AND EXTENSION.—On airplanes AF42-104429 through AF42-105428, the starter crank and crank extension are located on the right side of the fuselage directly opposite the access door. On airplane AF42-105429 and subsequent, they are stowed in one piece on the left side of the fuselage forward of the access door.

(5) PARKING HARNESS.—The parking harness (part No. 87-64-570) is enclosed in a stowage bag below the pilot's head rest on airplane AF42-104429 through AF42-104828. On these airplanes, the seat may be raised to remove any slack from the harness. On airplanes AF42-104829 and subsequent, the parking harness (part No. 87-530-1010) is stowed in the duffle bag. This harness may be adjusted to remove slack by tightening turnbuckles on the harness.

(6) MAP CASE.—The map case is located in the cockpit on the right side of the pilot's seat.

(7) HEAD REST.—The pilot's head rest is bolted to the armor plate at station 5 bulkhead just above the parking harness stowage on airplanes AF42-104429 through AF42-104828, but on airplanes AF42-104829 and subsequent, the pilot's head rest is fastened by "safety pins" to plugs welded to the armor plate at station 5 bulkhead. (See figure 294.)

(8) STATIC GROUND.—A static ground is attached to the underside of the fuselage, forward of the tail wheel doors.

(9) REAR VIEW MIRROR.—A rear view mirror is held by clips fastened to a bracket installed inside the cockpit on the upper windshield section at the center line.

(10) ANTI-GLARE SHIELD. — An anti-glare shield is attached to the fuselage and gun sight mount assembly.

(11) FIRST AID KIT.—Provisions for attaching the first aid kit to the side of the map case is made on airplanes AF42-104429 through AF42-104828. On airplanes AF42-104829 and subsequent, the first aid kit is stowed in the duffle bag.

b. AIR CONDITIONING.

(1) COCKPIT HEATING.

(a) DESCRIPTION.—This airplane is equipped with a ventilation system in which hot and cold air is fed from two mixing chambers into the right and left sides of the cockpit at the floor line. An auxiliary hot air line is held by a clip beside the pilot's seat. (See figure 295.)

Hot air is obtained from the coolant-radiator and oil-cooler air exit duct, and conveyed through two ducts into adjoining mixing chambers attached to the firewall. Cold air, received through two openings, one in the leading edge of each wing panel, is conveyed into its companion mixing chamber from the fresh air intake duct formed by the sealing of web 1, and rib 27 in the nose-section of the wing.

A flap valve located in each mixing chamber at the junction of the hot and cold air intake ducts, governs the flow of hot and cold air passing directly into the cockpit. This valve is regulated by the cockpit heat-control handle located below the instrument panel to the right of the main switch box (figure 296). Pushing the control handle all the way *in,* causes the flap valve to shut the hot air intake duct, permitting the flow of only *cold* air. Pulling the control handle all the way *out,* causes the flap valve to close the cold air intake duct, allowing the flow of only *hot* air. Any desired mixtures of hot and cold air can be obtained through adjustment of the control to an intermediate position. The control can be locked in any position by turning the handle clockwise.

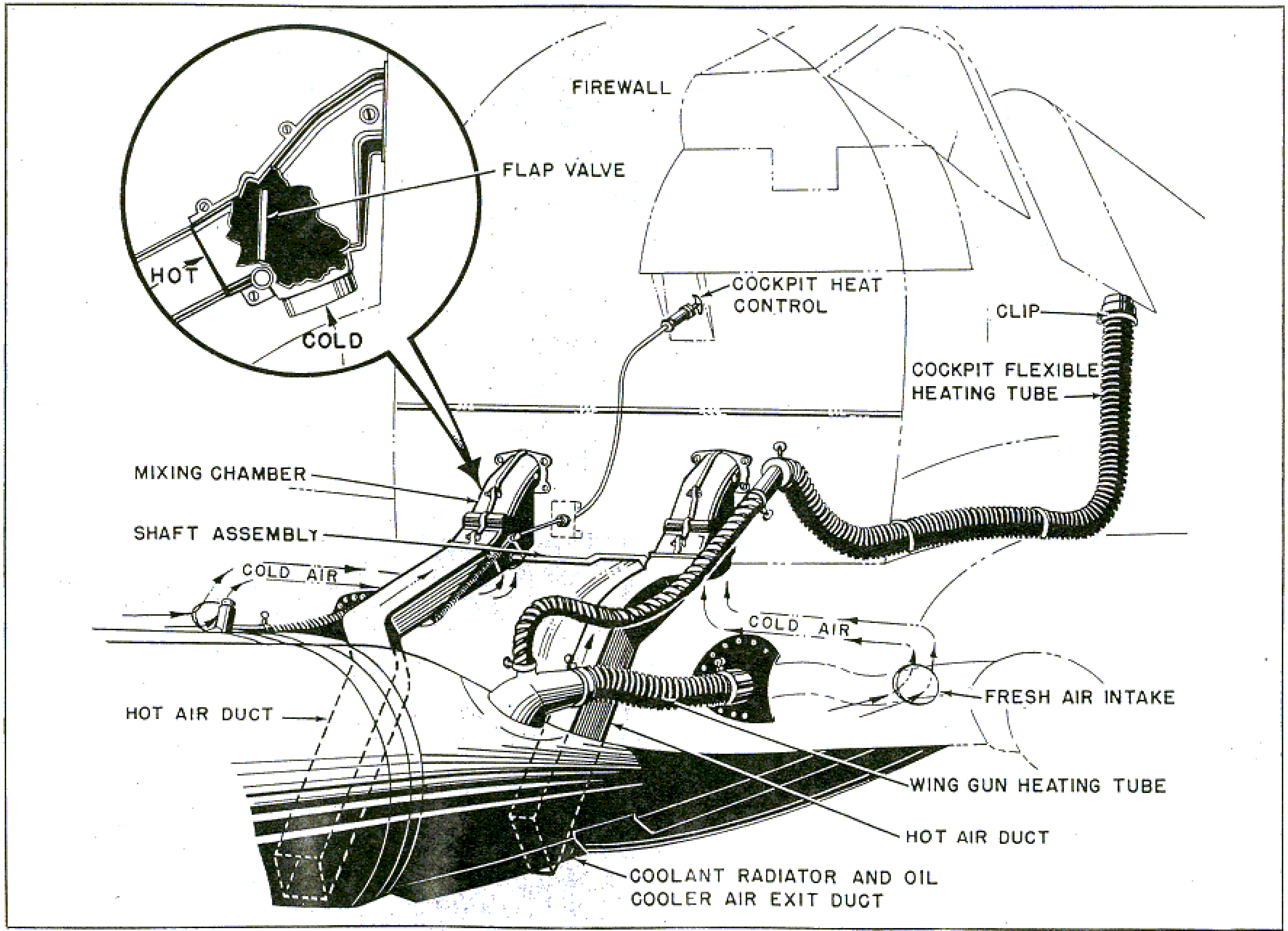


Figure 295—Heating and Ventilating System

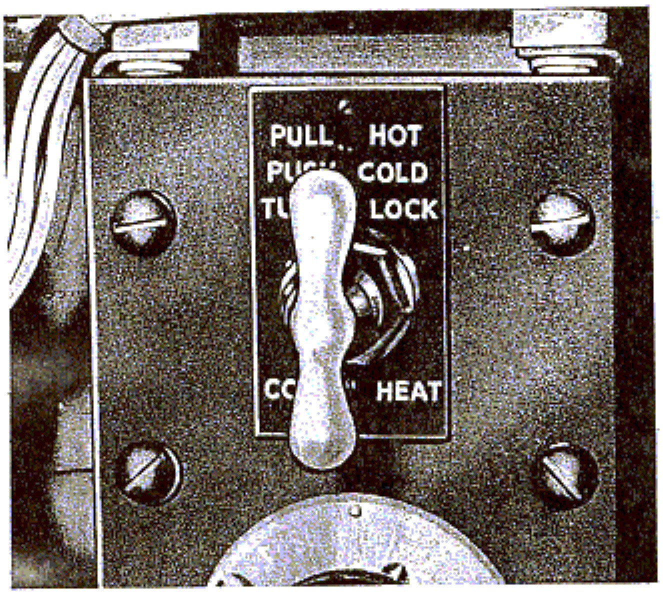


Figure 296—Cockpit Heat Control

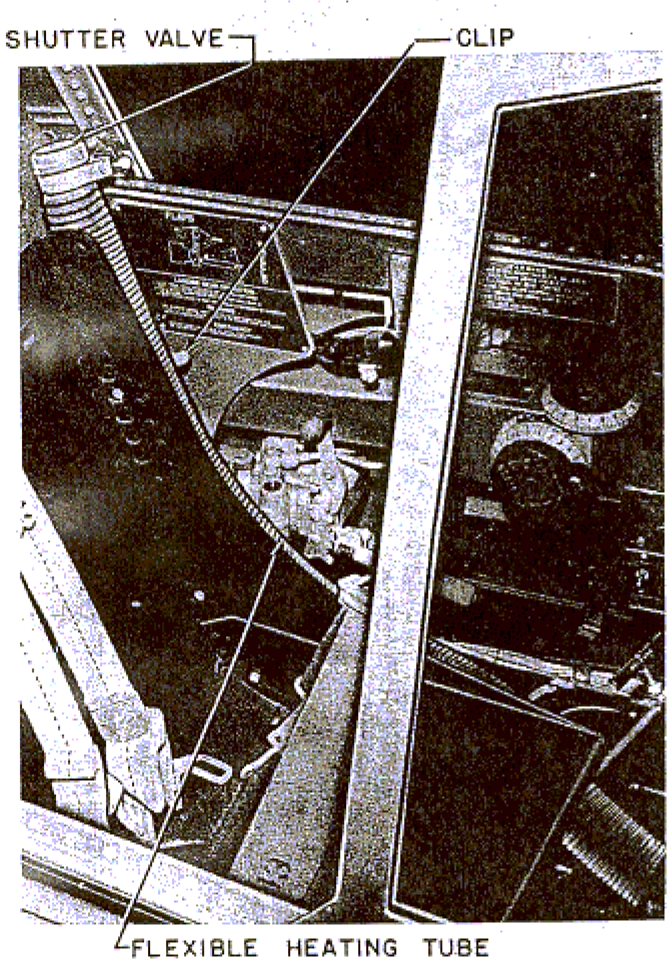


Figure 297—Cockpit Flexible Heating Tube

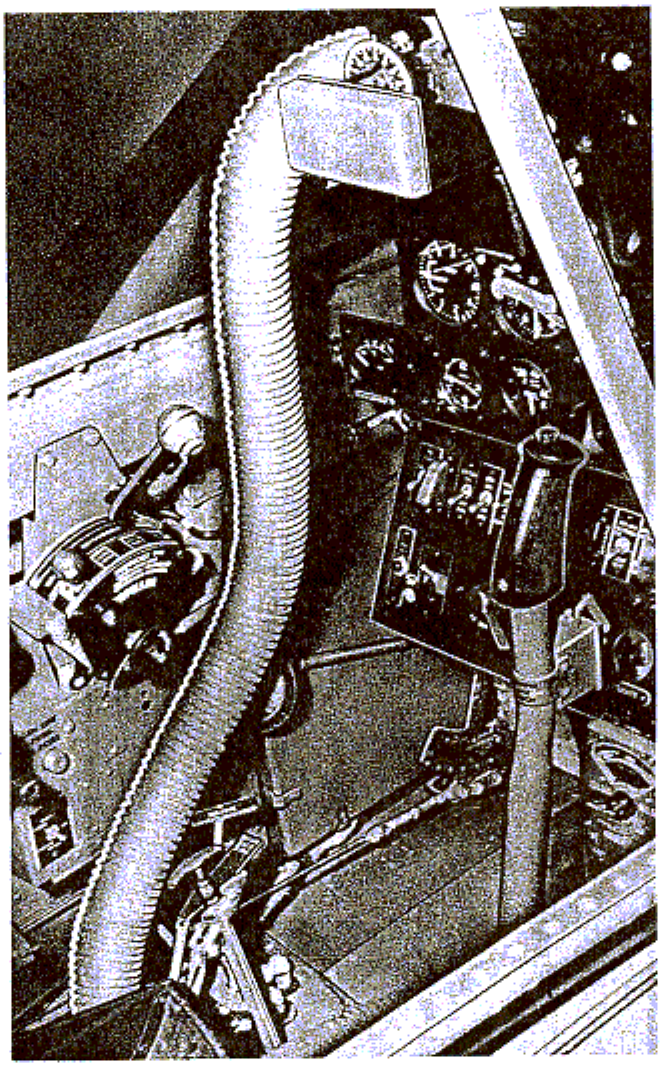


Figure 298—Windshield Defrosting Tube

When additional heat is required, hot air conveyed through a 1-½ inch flexible duct from the coolant-radiator and oil-cooler air exit duct to the adapter at the firewall, is released through a two-inch flexible duct which extends aft, from the adapter at the firewall, along the left side of the cockpit. The flexible duct is held by a clip beside the pilot's seat and may be moved at will to any desired position. A shutter attached to the cockpit end of the duct is the only device controlling the flow of air from the duct into the cockpit. (See figure 297.)

(b) TO REMOVE MIXING CHAMBER. *(See figure 295.)*

1. Remove engine side cowling. (See section IV, paragraph 5, *b*.)

2. Remove front wing fillets. (See section IV, paragraph 1, *e*.)

3. To remove left mixing chamber it is necessary to remove battery and battery support on those airplanes which have their battery located in the engine section.

4. Remove the two set screws from the mixing chamber, one from each side, so that the hot air duct may be pulled loose from the mixing chamber.

5. Remove the four screws which fasten the mixing chamber to the firewall.

6. Pry the mixing chamber up until the cold air opening is free of the wing panel.

7. Pull the mixing chamber outboard until the shaft of the flap valve is pulled loose from the slotted end of the shaft assembly. (See figure 295.)

8. Remove mixing chamber from airplane.

(c) TO DISASSEMBLE MIXING CHAMBER. Remove four bolts and the mixing chamber will be halved thus exposing the flap valve.

(d) TO REPAIR MIXING CHAMBER.—The mixing chamber is very simply constructed, so that any damage to it will necessitate the installation of a new part.

(e) TO INSTALL MIXING CHAMBER.

1. Place the mixing chamber so that the cold air opening fits in the opening in the wing panel.

2. Press the end of the shaft of the flap valve into the slotted end of the shaft assembly.

3. Fasten the mixing chamber to the firewall with four screws.

4. Fasten the hot air duct to the mixing chamber with two set screws, one for each side.

5. Replace battery support and battery on those airplanes which have their battery located in the engine section.

6. Replace engine side cowling. (See section IV, paragraph 5, *b*.)

7. Replace front wing fillets. (See section IV, paragraph 1, *e*.)

(2) WINDSHIELD DEFROSTING.—The flexible duct used for auxiliary heating may also be employed for windshield defrosting. (See figure 298.) The duct is held in a set position near the windshield by a clip attached to the anti-glare shield. The windshield then receives the full effect of the hot air released from the duct.

(3) WING GUN HEATING.—The wing guns in each panel are heated by a continuous unchecked flow of hot air through a flexible duct, one extending from each side of the coolant-radiator and oil-cooler air exit duct, into an opening in the leading edge of each wing panel. The ducts continue through the nose section of the wing panels to the gun installations.

SECTION V
MILITARY LOAD INSTALLATION

1. EQUIPMENT.

a. OXYGEN EQUIPMENT.

(1) DESCRIPTION.—The airplane is equipped with a low pressure demand oxygen system.

(a) OXYGEN CYLINDERS.—One type F-1 oxygen cylinder is installed in airplanes AF42-104429 through AF42-105028, and two type D-2 oxygen cylinders are installed in airplanes AF42-105029 and subsequent.

1. The type F-1 oxygen cylinder has a volume of 1000 cubic inches. The cylinder rests on rubber padding in a cradle installation mounted on the center line at the bottom of the fuselage. The cylinder is anchored in the cradle by a rubber-lined strap. It may be removed through the fuselage access door by disconnecting the oxygen and filler lines at the check valve forward of the cylinder and releasing the retaining strap by means of the turnbuckle.

2. The type D-2 oxygen cylinders, each has a volume of 500 cubic inches. The two oxygen cylinders rest on rubber padding in a cradle installation mounted on a shelf in the upper part of the fuselage between stations 6 and 8. The cylinders are anchored in the cradle by a rubber-lined strap. They may be removed, one or both through the fuselage access door by disconnecting the two oxygen supply and the filler lines at the check valves on the aft end of the cylinders and releasing the retaining straps.

Note

The system of check valves provides equal drain from both cylinders, and prevents exhaustion of the entire oxygen supply if one of the cylinders is punctured. The pressure gage will indicate the pressure of the highest charged cylinder if both cylinders are not at equal pressure.

(b) OXYGEN REGULATOR. — The oxygen regulator is attached to the right cockpit wall at station 4.

(2) FILLING THE OXYGEN CYLINDERS.—Instructions for filling the oxygen cylinders are given in section III, paragraph 2, *g*.

b. PYROTECHNIC EQUIPMENT.

(1) A type AN-M8 Very Pistol is provided for signaling purposes. This pistol is carried in a bracket below the front edge of the pilot's seat. When firing this pistol, the following directions should be adhered to as there is a large recoil and this recoil must be absorbed by the pilot's wrist and forearm.

(2) The arm holding the pistol should be bent at the elbow in such a manner that the forearm lies across the chest with the pistol pointing upward at an angle of approximately 45 degrees. The top of the pistol is rotated so that it is lying on its side with the top away from the chest. When fired, the recoil is absorbed by the bent arm and the pistol is pushed away from the body.

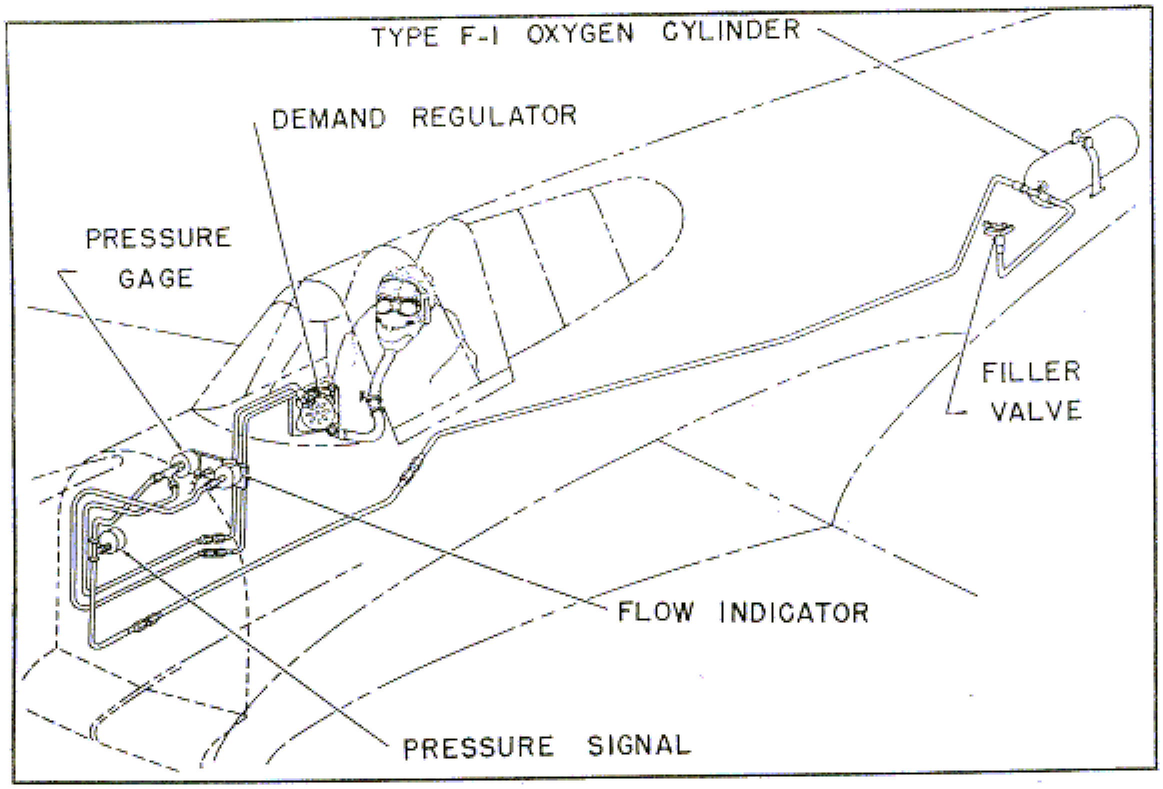


Figure 299—Oxygen System (AF42-104429 through AF42-105028)

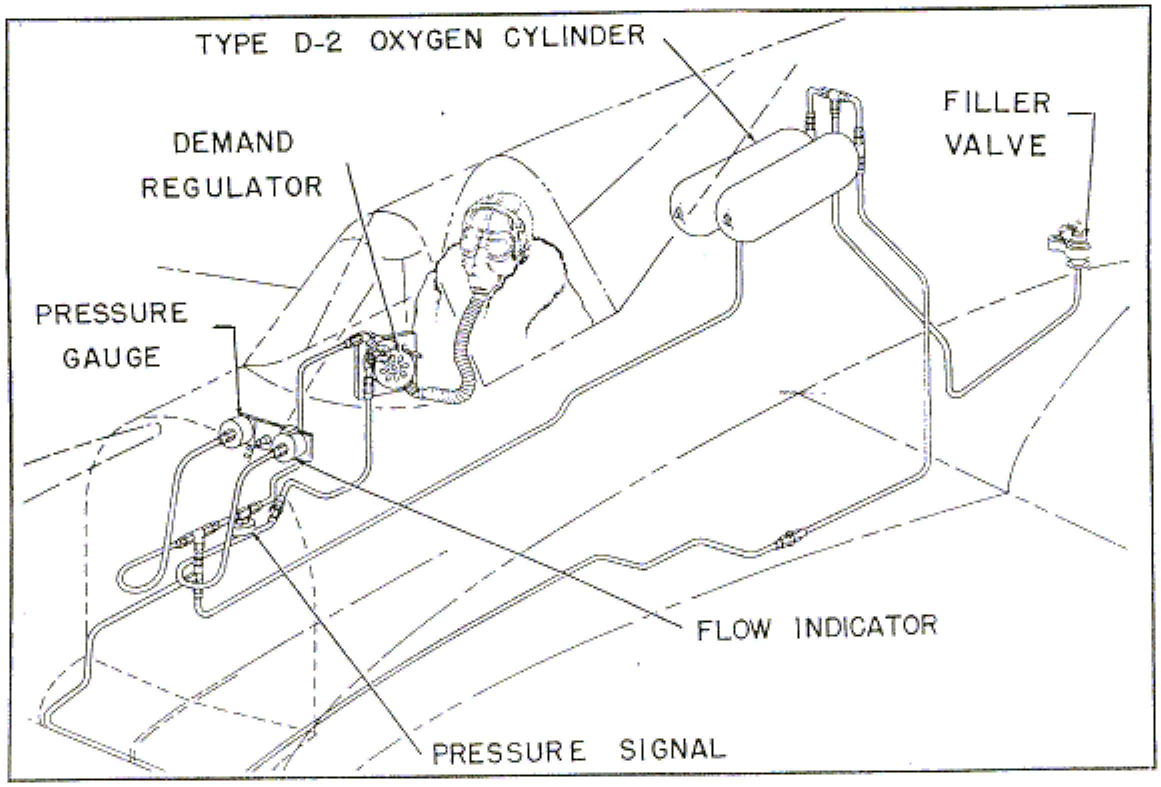


Figure 300—Oxygen System (AF42-105029 and Subsequent)

Note

The recoil force of the pistol is slightly greater than that of the .45 caliber service pistol.

(3) To load the pistol, simply push up on the breech unlocking lever and the pistol will break or open similar to opening a breech for an ordinary double barreled shotgun. To unload, reverse the procedure and pull out fired cartridge. The top forward finger grip is merely to pull the pistol out of the mount.

CAUTION

The cartridges are colored, make sure that the pistol is loaded with the correct cartridge for the signal intended.

2. ARMAMENT.

a. GUNNERY EQUIPMENT.—(See section IV, paragraph 7, *f*. (1).)

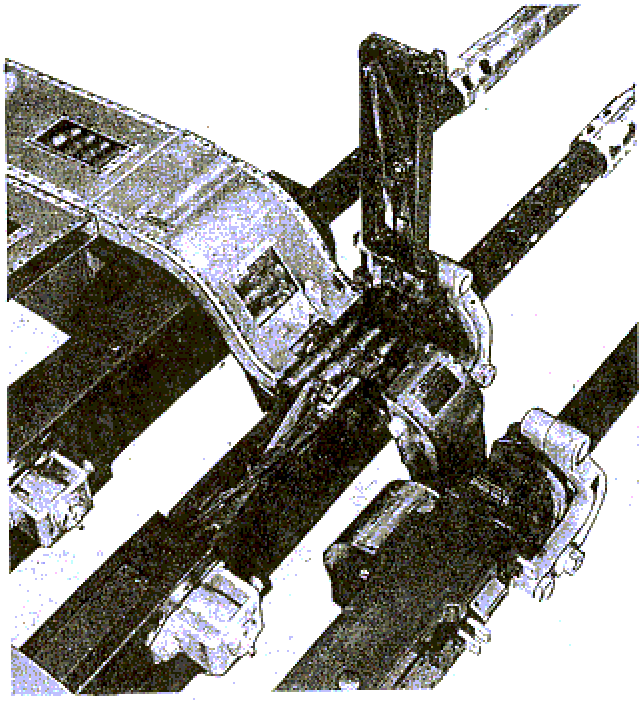


Figure 301—Ammunition Ready for Charging

(1) LOADING THE AMMUNITION BOXES.—If the guns are to be fired, remove the ammunition boxes and load them in accordance with the instruction plate on the box cover using a screwdriver inserted from the underside between the gun and feed chute to boost the first round over the belt-holding pawl. Connect the links between boxes and feed the ammunition over the feed rollers and into the feedways of the guns.

(2) CHARGING GUNS.—Charge each gun with the ground charger stowed on the gun bay access door in accordance with the instruction plate on the door. The first round will then be held by the bolt. Charge the guns again to fully load them. Charge the guns a third time, ejecting one cartridge in order to make certain there is a shell in the firing chamber.

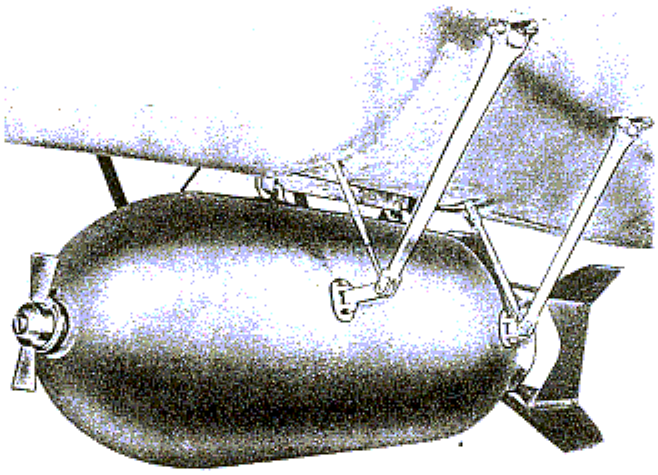


Figure 302—500-Pound Bomb Loaded

b. BOMBING EQUIPMENT.—(See section IV, paragraph 7, *f*, (5).)

(1) TO LOAD THE 500 OR 600-POUND BOMB AND DEPTH CHARGE.

(a) Unbutton the front fuel-drain access door in the keel fairing at the left of the shackle and insert a hand into the fairing. Pull the forward lever on the shackle back to unlatch the carrying hooks.

(b) Be sure that the front and rear sway-brace hinge fittings are bolted to the wing at the BLUE location (inboard). Remove the rubber pads from the sway-brace feet.

(c) Attach the front sway-brace feet at the long leg of the fitting and the back feet at the short leg. Be sure that the long barrels are installed on the front and rear sway-brace turnbuckles.

(d) Raise the bomb to the shackle and engage the bomb lugs in the carrying hooks. Raise the bomb until it has closed the carrying hooks. Insert a hand through the fuel drain access door to pull the release lever back approximately one inch to lock the carrying hooks.

(e) Adjust the sway braces at the barrels to contact the bomb surfaces evenly and positively at all sway-brace feet. Do not tighten sway bracing excessively or the shackle will not function. Lockwire the turnbuckle barrels.

(f) Arm the bomb by inserting a screwdriver into the opening aft of the arming slot on the shackle and pushing the arming hook back. Slide the loop of the arming wire into the slot on the shackle and release the arming hook.

(2) TO LOAD THE 300-POUND BOMB. (See figure 303.)

(a) Move the front sway-braces from the BLUE location to the RED location (outboard) and be sure that all feet are attached at the long leg of the adapter fittings. Install rubber pads on all feet and be sure that the short barrels are installed on the front sway-brace turnbuckles, and long barrels on the rear turnbuckles.

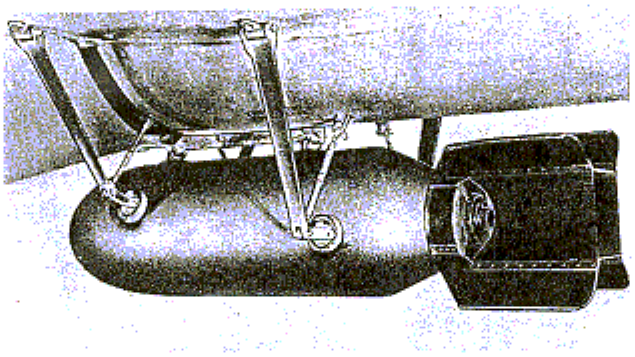


Figure 303—300-Pound Bomb Loaded

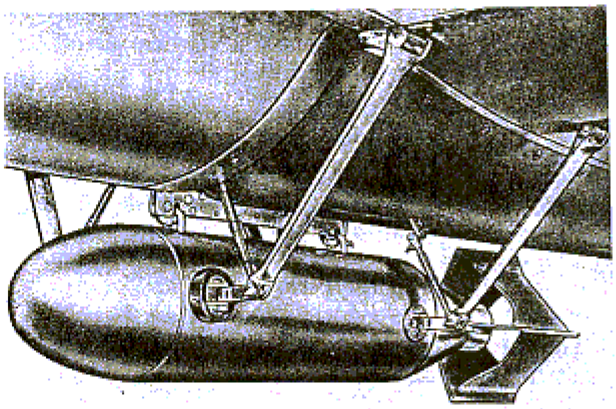


Figure 304—100-Pound Bomb Loaded

(*b*) Proceed with the loading as outlined for the 500-pound bomb.

(3) TO LOAD THE 100-POUND BOMB.

(*a*) Attach the front sway braces to the wing at the BLUE location (inboard) and the rear sway braces to the wing at the GREEN location (center). (See figure 304.)

(*b*) Install the special eye bolts on all turnbuckle attachment supports.

(*c*) Install short barrels on all four turnbuckles and attach the inboard clevis end of each turnbuckle to the special eye bolts.

(*d*) Attach all sway-brace feet at the long leg and install the rubber pads on the front feet only.

(*e*) Unbutton the front fuel-drain access door in the keel fairing, insert a hand, and actuate the release lever on the shackle to unlatch the carrying hooks.

(*f*) Proceed with the bomb loading as outlined for the 500-pound bomb.

(4) TO UNLOAD THE BOMB.

(*a*) Place the arming handle in the "SAFE" position and open the front fuel-drain access door.

(*b*) Attach the bomb hoist to the bomb and insert a hand through the access door. Pull back the release lever as far as possible to release the carrying hooks.

SECTION VI
MATERIALS OF CONSTRUCTION

Following is a list of the steel parts together with the tensile strength of each part that is used in the model P-40N airplanes.

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Actuator—Tail Wheel Retracting Strut Piston	75-37-024	87-37-005	AN-QQ-S-756	150,000
Adapter—Wing Gun Rear Mount—Inboard	87-69-548	87-69-500	AN-QQ-S-756	150,000
Adapter—Wing Gun Rear Mount—Outboard	87-69-546	87-69-500	AN-QQ-S-756	150,000
Arm—Aileron Control	75-05-020	75-05-018	57-107-18	120,000
Arm—Landing Gear Retracting Mechanism	87-31-529	87-31-521	AN-QQ-S-752	150,000
Arm—Gun Mount Toggle Adapter	87-69-746-2	87-69-701	AN-QQ-S-752	150,000
Arm—Gun Mount Toggle Adapter	87-69-746-5	87-69-701	AN-QQ-S-752	150,000
Axle—Landing Gear Wheel	87-310-1015	87-310-1017	AN-QQ-S-752	180,000
Axle—Landing Gear Wheel	87-31-528-1	87-31-520	AN-QQ-S-752	180,000
Ball—Elevator Control Connecting Rod	48825	87-64-509	AN-QQ-S-771	
Ball—Hydraulic Hand Pump Piston End	87-33-528	85-33-504	AN-QQ-S-689	180,000

Name	Part No.	Next Assembly	Specification	Tensile St. Lb/sq in.
Barrel—Flap Control Tube—Turnbuckle	75-64-061	87-03-809	AN-QQ-S-689	125,000
Barrel—Landing Gear Fairing Turnbuckle	87-34-037	87-34-501	AN-QQ-S-752	125,000
Bar—Seat Safety Belt Lock Catch Assembly	87-65-514-1	87-65-504	AN-QQ-S-752	65,000
Bar—Seat Safety Belt Operating Plunger	87-65-521-3	87-65-529	AN-QQ-S-752	65,000
Bearing—Elevator Control Connecting Rod	48824	87-64-509	AN-QQ-S-771	
Bearing—Tail Wheel Post Lower—Inner	87-37-536	87-37-901	AN-QQ-S-646	
Bellcrank—Cylinder Brake Control	87-32-519	87-32-501	AN-QQ-S-756	125,000
Blast Tube—.50 Calibre Fixed Gun	87-69-766-1	87-69-771	AN-WW-T-861	80,000
Blast Tube—.50 Calibre Fixed Gun	87-69-766-2	87-69-771	AN-WW-T-861	80,000
Blast Tube—.50 Caliber Fixed Gun	87-69-766-3	87-69-771	AN-WW-T-861	80,000
Block—Elevator Hinge	87-13-519-1	87-13-901	AN-QQ-S-752	125,000
Block—Inboard Wing Gun—Supporting Feed Chute	87-69-533	87-69-500	AN-QQ-S-752	65,000
Block—Landing Gear Side Strut Hinge	87-31-534	87-31-527	AN-QQ-S-752	150,000
Block—Pedal Adjustment Mechanism	58239	75-63-001	AN-QQ-S-752	95,000
Body—Hydraulic Hand Pump	87-33-067	87-33-501	AN-QQ-S-752	120,000
Bolt	65640	87-15-501	AN-QQ-S-689	125,000
Bolt—Aileron Control Arm	75-05-024	87-05-014	AN-QQ-S-689	125,000
Bolt—Bellcrank Flap Control	75-03-317	87-03-901	AN-QQ-S-689	125,000
Bolt—Cabin Control Handle Retaining	87-25-590	87-25-571	AN-QQ-S-689	125,000
Bolt—Cabin Control Pulley	87-25-611	87-25-570	AN-QQ-S-689	90,000
Bolt—Cabin Pulley Rear	87-25-642	87-25-570	AN-QQ-S-689	65,000
Body—Hydraulic Check Valve	87-33-079	87-33-071	AN-QQ-S-689	65,000
Bolt—Elevator Tail Erection	75-15-013	87-15-501	AN-QQ-S-752	125,000
Bolt—Engine Bearer to F'Wall	87-22-034-6	87-22-501	AN-QQ-S-689	125,000
Bolt—Engine Bearer to F'Wall	87-22-034-7	87-22-501	AN-QQ-S-689	125,000
Bolt—Engine Mount Attaching	87-21-598-1	87-21-501	AN-QQ-S-689	150,000
Bolt—Engine Mount Attaching	87-21-598-2	87-21-501	AN-QQ-S-689	150,000
Bolt—Engine Mount Housing to Engine Attaching	87-41-514	87-41-501	AN-QQ-S-689	150,000
Bolt—Engine Mounting Vibration Absorber Housing	87-22-532	87-22-501	AN-QQ-S-689	125,000
Bolt Eye—1/4-inch Pin	87-50-044	87-50-702	AN-QQ-S-689	125,000
Bolt—King Pin Wing to Fuselage	87-21-624	87-511	10074	150,000
Bolt—Landing Gear Inner Strut Hinge	75-31-061	87-31-801	57-107-18	120,000
Bolt—Landing Gear Oleo Strut Scissors	87-31-937	87-31-910	57-107-18	120,000
Bolt—Landing Gear Oleo Strut—Scissors Joint	87-31-939	87-31-910	57-107-18	120,000
Bolt—Landing Gear Retracting Cylinder End	75-31-065	87-31-001	57-107-18	120,000
Bolt—Landing Gear Retracting Mechanism Arm	75-31-066	87-31-001	57-107-18	120,000
Bolt—Landing Gear Retracting Mechanism Links	75-31-064	87-31-501	57-107-18	120,000
Bolt—Landing Gear Side Strut	75-31-062	87-31-501	57-107-18	120,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Bolt—Oil Tank Strap	85-46-011	87-50-702	AN-QQ-S-689	125,000
Bolt—Optical Sight Support	87-69-618	87-69-616	AN-QQ-S-771	75,000
Bolt—Optical Sight Yoke	87-69-958	87-69-954	AN-QQ-S-771	100,000
Bolt—Pedal Stop	75-64-037	87-64-501	AN-QQ-S-752	125,000
Bolt—Release Handle—Locking Bar	87-25-592	87-25-506	AN-QQ-S-689	65,000
Bolt—Six Gun Installation—Wing .50 Calibre	87-69-762	87-69-701	AN-QQ-S-646	125,000
Bolt—Special	87-22-717	87-710-1000	AN-S-9	125,000
Bolt—Wing Gun Adapter	87-69-560	87-69-500	AN-QQ-S-752	125,000
Bushing—Adapter—Auxiliary Wing Fuel Tank	87-45-523-2	87-45-565	AN-QQ-S-646	55,000
Bushing—Aileron Control Arm	87-05-011-1	87-05-014	AN-QQ-S-752	125,000
Bushing—Aileron Control Cable	75-64-055	87-64-047	AN-QQ-S-752	65,000
Bushing—Cabin Release Mechanism	87-25-619	87-25-621	AN-WW-T-850	95,000
Bushing—Engine Vibration Absorber Unit Housing	87-22-528	87-22-525	AN-QQ-S-752	90,000
Bracket—Gun Trunnion Front	80909	87-69-537	AN-QQ-S-756	125,000
Bushing—Hydraulic Tank Reducer	87-33-089	87-33-018	AN-QQ-S-689	150,000
Bushing—Landing Gear Fairing	87-34-537	87-34-501	AN-WW-T-850	
Bushing—Landing Gear Fairing	87-34-538	87-34-501	AN-WW-T-850	
Bushing—Landing Gear Hydraulic Arm	75-31-060	87-31-020	AN-QQ-S-752	150,000
Bracket—Landing Gear Fairing Door Holding Strut	87-34-021	87-34-056	AN-QQ-S-752	65,000
Bushing—Tail Wheel—Station 13 Fuselage	75-21-167	75-21-057	AN-QQ-5-752	150,000
Bushing—Wing Gun—Rear Mount	87-69-561	87-69-500	AN-QQ-5-752	65,000
Bushing—Wing Gun—Rear Support	87-69-553	87-69-918	AN-QQ-S-646	
Button—.50 Calibre Ammunition Box	87-69-827	87-69-903	AN-QQ-S-771	100,000
Button—Flush Door Fastener	75-03-376-8	75-03-374	AN-QQ-S-752	90,000
Button—Wing Gun Adapter—Front	87-69-596	87-69-916	AN-QQ-S-752	65,000
Cable End	87-81-027	87-81-001	AN-QQ-S-689	125,000
Cam—Gun Mount Adapter Toggle	87-69-746-3	87-69-918	AN-QQ-S-752	150,000
Cam—Poppet Valve	75-33-106	87-33-034	AN-QQ-S-646	90,000
Cap—Landing Gear Oleo Strut	75-31-011	87-31-006	AN-QQ-S-752	150,000
Cap—Landing Gear Oleo Strut Inner Fitting	75-31-013	87-31-538	AN-QQ-S-756	150,000
Cap Forging—Landing Gear Oleo Strut	75-31-460	75-31-047	AN-QQ-S-756	65,000
Cap—Tail Wheel Post Bearing Housing	87-37-932	87-37-901	AN-QQ-S-752	150,000
Cap—Tail Wheel Retracting Strut Cylinder	75-37-019	87-37-505	AN-QQ-S-689	125,000
Clevis Bolt—Elevator Control—Rear Horn	75-64-112	87-64-501	AN-QQ-S-689	125,000
Clevis End—Heat and Vent Control	87-81-028	87-81-209	AN-QQ-S-689	125,000
Clevis—Fletner Control Turnbuckle Assembly	75-64-110-1	87-64-052	AN-S-9	125,000
Clevis—Strut End—Control Stick Stop	75-64-104	81-62-001	AN-QQ-S-689	125,000
Clevis—Tail Wheel Door Operating	87-37-024	87-37-901	AN-QQ-S-684	65,000
Collar—.50 Calibre Blast Tube	87-69-765	87-69-771	AN-WW-T-858	75,000
Collar—Carburetor Air Filter Door Shaft	87-730-1014	87-730-1013	Comm. St. Bar	80,000
Collar—Carburetor Air Intake Lever	87-51-763-2	87-51-764	AN-WW-T-850	150,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Collar—Carburetor Air Thermometer Bulb	87-29-846-2	87-29-735	AN-QQ-S-752	
Collar—Door Hinge Rod Retaining	87-29-753	87-29-735	AN-WW-T-850	95,000
Collar—Engine Mount Vibration Absorber Unit	87-22-529	87-22-522	AN-QQ-S-752	90,000
Collar—Rudder Lower Hinge	75-14-016-1	87-14-511	AN-WW-T-850	100,000
Collar—Rudder Torque Tube	75-14-032-4	75-14-511	AN-WW-T-850	100,000
Collar—Seat Safety Belt Plunger Lock Pin	87-65-531	87-65-533	AN-WW-T-850	65,000
Collar—Seat Safety Belt Torque Tube	87-65-526	87-65-504	AN-WW-T-850	65,000
Collar—Starter Shaft Assembly Crank-Extension	87-43-519-2	87-43-501	AN-WW-T-850	90,000
Counter Weight—Anti-Spill Valve	75-33-067	75-33-070	AN-QQ-S-646	55,000
Counter Weight—Rudder	87-14-606-9	87-15-503	AN-QQ-S-646	
Coupling—Engine Control Connector	200540	200536	46523	125,000
Coupling—Engine Control Connector	200537	87-52-710	AN-QQ-S-752	125,000
Cylinder—Flap Actuating Mechanism	75-64-071	87-64-004	AN-QQ-S-756	125,000
Cylinder—Landing Gear Fairing Door Spring Strut	87-34-018-1	87-34-016	AN-WW-T-850	100,000
Cylinder—Landing Gear Oleo	87-31-915	87-31-916	AN-QQ-S-756	65,000
Cylinder—Landing Gear Retracting Strut	75-33-014	75-33-010	AN-QQ-S-756	180,000
Cylinder—Tail Wheel Oleo	87-37-013	87-37-810	AN-QQ-S-756	150,000
Cylinder—Tail Wheel Retracting Strut	87-37-920	87-37-905	AN-QQ-S-756	150,000
Disk—Anti-Spill Valve	75-33-071	75-33-066	AN-QQ-S-771	90,000
Dowel—Spinner Locating	87-42-528	87-42-502	Comm. St. Rod	80,000
Drift Pin—.50 Calibre Wing Gun	87-69-738	87-69-701	AN-QQ-S-752	
End—Elevator Control—Jack Shaft	75-64-039	75-64-010	AN-QQ-S-689	125,000
End—Fletner Control Turnbuckle Assembly	75-64-110-2	87-64-052	AN-QQ-S-689	125,000
End—Fletner Control Turnbuckle Assembly	75-64-110-3	87-64-052	AN-QQ-S-689	125,000
End—Landing Gear Oleo Lower Strut Plunger	87-31-515	87-31-512	AN-QQ-S-752	125,000
End—Landing Gear Retracting Cylinder Piston	75-33-015	75-33-010	AN-QQ-S-756	150,000
End—Seat Support—Tube	75-64-004	87-65-503	AN-QQ-S-684	90,000
End—Upper Landing Gear Oleo Strut Plunger	87-31-014	87-31-012	AN-QQ-S-752	125,000
Extension—Landing Gear Retracting Mechanical Fitting Lubricator	75-33-016-2	87-33-502	AN-QQ-S-689	62,000
Extension—Tail Wheel Knuckle	85-37-022	87-37-550	AN-QQ-S-756	180,000
Eye Bolt—Battery Box	87320-1	87240	AN-S-9	125,000
Eye Bolt—Carburetor to Duct Seal	87-51-735	87-51-734	AN-QQ-S-689	65,000
Eye Bolt—Landing Gear Fairing	87-34-036	87-34-501	AN-QQ-S-689	125,000
Eye Bolt—Rudder Pedal	75-63-004	75-63-001	AN-QQ-S-689	125,000
Eye Bolt—Steerable Tail Wheel Control	75-37-075	75-37-076	AN-QQ-S-689	125,000
Eye Bolt	87-64-053	87-21-105	AN-QQ-S-689	125,000
Ferrule—Ground Charger—Long	87-69-991	87-69-986	AN-QQ-S-752	55,000
Ferrule—Ground Charger—Short	87-69-992	87-69-986	AN-QQ-S-752	55,000
Filler—Propeller Control Support—Front	87-52-520-4	87-52-504	AN-WW-T-850	65,000
Fitting—Anti-Spill Valve	75-33-072	75-33-066	AN-QQ-S-646	55,000
Fitting—Cabin Support—Front	87-25-515	87-25-501	AN-QQ-S-752	125,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Fitting—Cabin Support—Rear	87-25-516	87-25-501	AN-QQ-S-752	125,000
Fitting—Engine Mount Bearer Tube	87-22-516	87-22-531	AN-QQ-S-756	150,000
Fitting—Engine Mount at Firewall—Upper	87-22-514	87-22-512	AN-QQ-S-752	65,000
Fitting—Expanding Ring	87-50-072	87-46-571	AN-QQ-S-689	65,000
Fitting—Fuselage Station 1—Lower	87-21-593	87-21-502	AN-QQ-S-756	150,000
Fitting—Fuselage Station 1—Upper	87-21-591	87-21-502	AN-QQ-S-756	150,000
Fitting—Landing Gear Axle	87-310-1013	87-310-1014	AN-QQ-S-752	90,000
Fitting—Landing Gear Hinge—Inboard	87-31-940	81-31-918	AN-QQ-S-752	150,000
Fitting—Landing Gear Inner Strut Hinge	75-31-012	87-31-006	AN-QQ-S-756	150,000
Fitting—Landing Gear Oleo Strut Axle	87-31-012	87-31-037	AN-QQ-S-752	150,000
Fitting—Landing Gear Outboard Hinge	87-31-533	87-31-517	AN-QQ-S-752	150,000
Fitting—Landing Gear Tow Ring and Jack Pad	87-31-507	87-31-520	AN-QQ-S-756	150,000
Fitting—Landing Gear to Wing—Inboard	87-31-922		AN-QQ-S-756	150,000
Fitting—Landing Gear to Wing—Outboard	87-31-033	87-31-006	AN-QQ-S-684	150,000
Fitting—Landing Gear to Wing Web 1	75-31-019	87-31-006	AN-QQ-S-756	150,000
Fitting—Link Assembly	87-64-911	75-64-066	AN-QQ-S-689	125,000
Fitting—Panel Jack Pad	75-03-048	75-03-124	AN-QQ-S-752	150,000
Fitting—Solderless Steel—Special	87-33-718	87-33-539	AN-QQ-S-689	150,000
Fitting—Sway Brace Installation	87-70-912	87-45-508	AN-QQ-S-752	125,000
Fitting—Tail Wheel Front Retracting Drag Truss	87-37-526	87-37-525	AN-QQ-S-752	65,000
Fitting—Tube to Engine Bearer	87-22-513	87-22-512	AN-QQ-S-752	65,000
Flange—Rudder Hinge—Reamed	59039	87-14-601	AN-QQ-S-752	90,000
Flange—Rudder Hinge—Tapped	59016	87-14-601	AN-QQ-S-752	90,000
Follower—Poppet Valve	75-33-112	87-33-513	57-107-18	120,000
Follower—Tail Wheel Retracting Strut	75-37-080	87-37-505	AN-QQ-S-752	125,000
Fork—Landing Gear Fairing Door Lock	87-34-529	87-34-801	AN-QQ-S-752	65,000
Fork—Landing Gear Fairing—Turnbuckle	87-34-035	87-34-501	AN-QQ-S-752	125,000
Gear—Fuel Cock Control	75-44-038	87-44-514	AN-QQ-S-752	125,000
Gear—Landing Gear Oleo Strut Aligning	87-31-936	87-31-910	S.A.E. 3645	200,000
Guide—Tail Wheel Retracting Strut Piston	87-37-016	87-37-905	AN-WW-T-850	90,000
Handle—Ground Charger	87-69-989	87-69-986	AN-WW-T-850	95,000
Hook—Ground Charger Pulley Bracket	87-69-994	87-69-988	AN-QQ-S-752	125,000
Horn—Rudder	75-14-011	75-14-033	AN-QQ-S-752	65,000
Horn—Tail Wheel Steerable	87-37-524	87-37-522	AN-QQ-S-756	As Received
Housing—Cabin Release Mechanism	87-25-620	87-25-621	AN-QQ-S-689	125,000
Housing—Cabin Release Mechanism	87-251-1017	87-251-1018	AN-S-9	125,000
Housing—Poppet Valve	75-33-103	87-33-022	AN-QQ-S-752	125,000
Knob—Gun Camera Support	87-69-975	87-69-979	AN-QQ-S-689	125,000
Knuckle—Tail Wheel Smooth Contour	87-37-541	87-37-550	AN-QQ-S-756	180,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb./sq in.*
Latch—Cabin Release Mechanism	87-25-616	87-25-621	AN-QQ-S-752	125,000
Lever—Panel Release	87-25-521	87-25-501	AN-QQ-S-752	125,000
Lever—Heater Shaft	87-71-026-1	87-81-019	AN-QQ-S-689	65,000
Lever—Popper Valve Landing Gear Shaft	87-33-034	87-33-040	57-107-18	120,000
Link—Cable and Chain Tap	84907	87-64-052	AN-QQ-S-752	65,000
Link—Engine Cowl Flap Hinge	87-29-855	87-29-703	AN-QQ-S-752	150,000
Link—Landing Gear Oleo Strut Scissors	87-31-925	87-31-923	AN-QQ-S-756	65,000
Link—Landing Gear Retracting Mechanism—Lower	87-31-539	87-31-524	AN-QQ-S-756	150,000
Link—Landing Gear Retracting Mechanism—Upper	87-31-021	87-31-519	AN-QQ-S-756	150,000
Link—Universal—Control Stick Stop	75-64-105	75-64-004	AN-QQ-S-689	100,000
Loop—Adapter Assembly—Filler Cap Fuel Tank	87-45-527-3	87-45-565	AN-QQ-S-646	55,000
Locking Plate—Wing Gun Rear Mount	87-69-541	87-69-500	AN-QQ-S-752	125,000
Lock—Wing Gun Front Mount—Inboard	87-69-931	87-69-929	AN-QQ-S-752	90,000
Lock—Wing Gun Front Mount—Outboard	87-69-932	87-69-930	AN-QQ-S-752	90,000
Lock Pin—Windshield	87-26-917-11	87-26-503	AN-QQ-S-752	65,000
Lug—Tailwheel Retracting Strut	81-37-013-1	87-37-905	AN-QQ-S-756	125,000
Nipple—Flap Line—Special	75-33-115	87-33-501	AN-QQ-S-689	150,000
Nut—Elevator Control Connecting Rod	48823	87-64-509	AN-QQ-S-771	
Nut—Hydraulic Hand Pump	87-33-050	87-33-504	57-107-9	
Nut—Landing Gear	87-31-557	87-31-501	AN-QQ-S-689	125,000
Nut—Landing Gear Oleo Strut—Upper Trunnion	75-31-043	87-31-041	AN-QQ-S-689	125,000
Nut—Landing Gear Retracting Strut—Indicator	75-33-025-1	87-31-003	AN-QQ-S-689	90,000
Nut—Landing Gear Retracting Strut—Indicator	75-33-025-2	87-31-505	AN-QQ-S-689	125,000
Nut—Special	75-64-111	87-64-501	AN-QQ-S-689	125,000
Nut—Wing Gun—Front Mount	87-69-925	87-69-929	AN-QQ-S-689	125,000
Packing Ring—Hydraulic Hand Pump	87-33-063	87-33-504	AN-QQ-S-689	150,000
Pawl—Landing Gear Retracting Strut	75-33-021	87-31-005	57-107-18	120,000
Pedal—Rudder Adjustment Mechanism	58201	75-63-001	AN-QQ-S-685	
Pendulum—Anti-Spill Valve	75-33-068	75-33-070	AN-QQ-S-689	90,000
Pin—Baggage Compartment Door Hinge	87-21-736-3	87-21-526	Comm. St. Rod	62,000
Pin—Baggage Door Latch	75-21-045-1	87-21-212	AN-QQ-S-752	95,000
Pin—Cabin Assembly	87-25-501-8	87-21-904	AN-QQ-S-771	
Pin—Cabin Lock Bar	87-25-560-1	87-25-623	AN-QQ-S-752	180,000
Pin—Cabin Lock Bar	87-25-560-2	87-25-623	AN-QQ-S-752	180,000
Pin—Cabin Lock Control	87-25-629	87-25-571	AN-QQ-S-752	125,000
Pin—Cabin Release Mechanism	87-25-618	87-25-621	Comm. St. Rod	125,000
Pin—Clevis—Spring Type	38141	84450	AN-QQ-S-689	125,000
Pin—Cockpit Heat Control Valve	87-81-931	87-81-929	AN-QQ-S-646	
Pin—Elevator Counterbalance	87-13-913-5	87-13-901	AN-QQ-S-752	90,000
Pin—Elevator Counterbalance	87-13-913-6	87-13-901	AN-QQ-S-752	90,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Pin—Hinge—Inner Door Landing Gear Fairing	81-34-026-3	87-34-507	Comm. St. Rod	
Pin—Hydraulic Hand Pump	87-33-057	87-33-504	Comm. St. Rod	
Pin—Main Door Landing Gear Fairing Hinge	87-34-515	87-34-501	AN-QQ-S-646	55,000
Pin—Landing Gear Oleo Piston Bearing Lock	72016	76311	AN-QQ-S-752	
Pin—Landing Gear Oleo Piston Strut Metering	75-31-050	87-31-010	AN-QQ-S-689	
Pin—Landing Gear Retracting Strut	87-31-025	87-31-505	Comm. St. Rod	
Pin—Landing Gear Retracting Strut —Indicator	75-33-026-2	87-31-005	AN-QQ-S-689	125,000
Pin—Landing Gear Retracting Strut —Indicator	75-33-026-1	87-31-005	AN-QQ-S-689	125,000
Pin—Landing Gear Warning Switch Bell-crank	75-66-173	75-67-175	Comm. St. Rod	
Pin—Pedal Adjustment Mechanism	58220-1	75-63-001	AN-QQ-S-689	150,000
Pin—Radio Hold—Down	81-67-236	87-67-827	AN-QQ-S-625	65,000
Pin—Ratchet—Control Lever	87-29-043	87-29-030	57-107-18	120,000
Pin—Seat Safety Belt Plunger Lock	87-65-532	87-65-533	AN-QQ-S-752	65,000
Pin—Spinner Anti-Icing Slinger	87-42-532-9	87-42-532	Comm. St. Rod	19,000
Pin—Starter—Crankshaft	87-43-523-1	87-43-519	AN-QQ-S-752	180,000
Pin—Starter—Crankshaft	87-43-523-3	87-43-519	AN-QQ-S-752	180,000
Pin—Starter—Crankshaft	87-43-523-2	87-43-519	AN-QQ-S-752	180,000
Pin—Tail Wheel Knuckle Extension	85-37-023-1	87-37-814	AN-QQ-S-752	125,000
Pin—Tail Wheel Oleo Metering	87-37-516	87-38-510	AN-QQ-S-689	125,000
Pin—Wing Gun—Folding Rear Support	87-69-735-1	87-69-701	AN-QQ-S-689	125,000
Pinion—Landing Gear Oleo Strut Aligning	87-31-935	87-31-910	SAE 3245	200,000
Piston—Landing Gear Oleo Strut	87-31-914	87-31-912	AN-QQ-S-756	65,000
Piston—Hydraulic Hand Pump	87-33-048	87-33-504	AN-QQ-S-689	150,000
Piston—Landing Gear Retracting Strut	87-31-027	87-31-005	AN-QQ-S-756	180,000
Piston—Tail Wheel Oleo Strut	87-37-514	87-37-510	AN-QQ-S-756	150,000
Piston—Tail Wheel Retracting Strut	87-37-919	87-37-905	AN-S-12	150,000
Plate—Nut—Web 3—Tank Door	87-03-793	87-03-294	AN-QQ-S-684	125,000
Plate—Panel Inboard Trailing Edge	87-03-406	87-03-309	AN-QQ-S-752	125,000
Plug—Carburetor Air Control	87-460-1024	87-460-1011	AN-S-16	125,000
Plug—Flap Actuating Cylinder	75-64-073	87-64-004	AN-QQ-S-756	125,000
Plug—Fuel Cock Brace	75-44-506-2	87-44-801	AN-QQ-S-684	90,000
Plug—Hydraulic Hand Pump	87-33-052	87-33-504	57-107-9	
Plug—Starter Crankshaft Assembly	87-43-524-2	87-43-519	AN-QQ-S-646	150,000
Plunger—Gun Camera Support	87-69-976	87-67-979	AN-QQ-S-752	55,000
Plunger—Seat Safety Belt Operating	87-65-518	87-65-521	AN-QQ-S-752	125,000
Point—Jackpoint—Tail End	87-21-631-3	87-21-801	AN-QQ-S-684	62,000
Post—Landing Gear Hydraulic Control	87-33-032	87-33-090	AN-QQ-S-752	
Rack—Cowl Flap Control Support	87-29-028	87-29-020	57-107-18	120,000
Retainer—Blast Tube	87-69-764	87-69-701	AN-WW-T-858(347)	75,000
Retainer—Spring—Hydraulic Hand Pump	87-33-055	87-33-504	57-107-9	
Retainer—Packing Hydraulic Hand Pump	87-33-062	87-33-504	AN-QQ-S-689	125,000
Retainer—Poppet Valve	87-33-021-1	87-33-023	AN-QQ-S-752	65,000
Retainer—Poppet Valve	87-33-021-2	87-33-023	AN-QQ-S-752	65,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Ring—Air Duct to Oil Cooler	87-46-509-1	87-46-571	AN-QQ-S-752	90,000
Ring—Air Duct to Radiator	87-50-549-1	87-50-047	AN-QQ-S-752	90,000
Ring—Bushing Adapter-Auxiliary Wing Fuel Tank	87-45-523-1	87-45-565	AN-QQ-S-646	55,000
Ring—Landing Gear Oleo Strut Piston	75-31-048	75-31-010	AN-QQ-S-752	90,000
Rivet—Tail Wheel Retracting Strut	87-37-905-5	87-37-901	AN-QQ-S-646	
Ring—Wing Hoisting	87-88-521	87-88-509	AN-QQ-S-684	125,000
Rod—Aileron Balance Rod	87-05-514-3	87-05-501	AN-QQ-S-646	As Received
Rod—Carburetor Mixture	87-52-727-1	87-52-702	AN-QQ-S-689	65,000
Rod End—Aileron Tab Actuator	84-05-552	87-14-558	AN-QQ-S-752	100,000
Rod End—Cowl Flap Control	87-29-039	87-29-031	AN-QQ-S-752	65,000
Rod End—Flap Control	87-64-025	87-64-040	AN-QQ-S-752	125,000
Rod End—Oil Cooler Scoop—Controls	75-28-135	75-28-069	AN-QQ-S-752	100,000
Rod—Extension—Breeze—Elevator	87-13-040-1	87-13-501	AN-QQ-S-689	125,000
Rod—Handle Control	87-32-515-1	87-32-501	AN-QQ-S-752	
Rod—Landing Gear Oleo Strut Assembly	87-31-910-1	87-31-901	Comm. St. Rod	
Rod—Spring Strut—Landing Gear Fairing Door	87-34-017	87-34-016	AN-QQ-S-689	100,000
Scoop—Carburetor Air Leading Edge—Engine Section Top	87-29-511	87-29-713	11319	30,000
Screw—Drum Support	87-64-038	87-64-034	AN-QQ-S-689	125,000
Screw—Expanding Ring	87-50-071	87-46-571	AN-QQ-S-689	125,000
Screw—Landing Gear Oleo Strut	95593	87-31-910	Steel Bar	125,000
Screw—Retract Motor Switch	87-66-174	87-66-082	AN-QQ-S-646	
Screw—Pedal Adjustment Mechanism	58234-2	76582	AN-QQ-S-689	95,000
Segment—Hydraulic Landing Gear Control	87-33-031	87-33-022	57-107-18	120,000
Set—Hydraulic Bleeder Valve	200430	87-33-066	AN-WW-T-850	65,000
Shaft—Arming Control—500 lb. Bomb	87-70-562	87-70-561	AN-WW-T-861	100,000
Shaft—Auxiliary Cowl Flap Control	87-29-022	87-29-520	AN-WW-T-850	180,000
Shaft—Cabin Control Drive	87-25-575	87-25-571	AN-QQ-S-752	125,000
Shaft—Carburetor Air Duct	87-51-761	87-51-764	AN-S-9	125,000
Shaft—Carburetor Air Duct Hot Air Door	87-29-762	87-29-732	AN-QQ-S-689	125,000
Shaft—Carburetor Aid Scoop Cold Air Door	87-29-736	87-29-734	AN-QQ-S-689	125,000
Shaft—Fuel Cock Control—Lower	75-44-039	87-44-514	AN-QQ-S-689	125,000
Shaft—Elevator Control Jackshaft	87-64-036	87-64-003	AN-QQ-S-689	125,000
Shaft—Flap Actuating Mechanism	87-64-057	87-64-072	AN-QQ-S-756	125,000
Shaft—Fuel Cock Gear Box—Upper	75-44-076	87-44-514	AN-QQ-S-689	125,000
Shaft—Poppet Valve—Cam	75-33-429	87-33-040	57-107-18	120,000
Shaft—Starter Crank	87-43-524-1	87-43-519	AN-WW-T-850	150,000
Shank—Wing Gun—Folding Rear Support	87-69-735-2	87-69-701	AN-QQ-S-689	125,000
Sleeve—Engine Control Connector	200538	87-52-710	AN-WW-T-850	125,000
Sleeve—Fuel Cock Control	75-44-077	87-44-834	AN-WW-T-850	100,000
Sleeve—Landing Gear Oleo Strut Piston	75-31-045	87-31-010	AN-WW-T-850	90,000
Sleeve—Starter Crankshaft Assembly	87-43-522-1	87-43-519	AN-WW-T-850	146,000
Spacer	75-64-088	87-64-006	AN-WW-T-850	

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb sq in.*
Spacer	75-03-184	75-03-176	AN-WW-T-850	95,000
Spacer	75-63-012	75-63-001	AN-WW-T-850	90,000
Spacer—Bell Crank	87-25-605	87-25-501	AN-WW-T-850	95,000
Spacer—Brake Control Cylinder Bellcrank	87-32-525	87-32-501	AN-WW-T-850	95,000
Spacer—Cabin Assembly	87-25-639	87-25-501	AN-WW-T-850	95,000
Spacer—Cabin Control	87-25-111	87-25-107	AN-WW-T-850	
Spacer—Cabin Release Mechanism	87-25-614	87-25-501	AN-WW-T-850	95,000
Spacer—Carburetor to Duct Seal Plate Assembly	87-51-734-3	87-41-501	AN-WW-T-850	62,000
Spacer—Cowl Flap Control	87-29-032	87-29-030	AN-WW-T-850	90,000
Spacer—Elevator Horn	58191	75-64-038	AN-WW-T-850	95,000
Spacer—Exhaust Stack-Flame Dampener	87-48-525-8	87-48-525	AN-QQ-S-771	
Spacer—Guide Pulley Cable	87-64-062	87-64-046	AN-WW-T-850	95,000
Spacer—Landing Gear Axle	87-310-1016	87-310-1017	AN-QQ-S-646	55,000
Spacer—Oil Cooler Support	87-46-575-2	87-46-702	AN-QQ-S-752	100,000
Spacer—Rear Vision Mirror	87-88-620	87-88-609	AN-WW-T-850	
Spacer—Tail Wheel	87-37-035	87-37-901	AN-QQ-A-362	As Received
Spindle—Hydraulic Check Valve	201345	201344	AN-QQ-S-646	55,000
Spring—Landing Gear Retracting Strut	75-33-463	87-31-005	AN-QQ-S-752	180,000
Sprocket—Tab Control—Rudder	75,64-078	87-64-006	AN-QQ-S-752	65,000
Stop—Engine Mount Vibration Absorber—Upper (Front)	87-22-542-2	87-22-501	AN-QQ-S-752	100,000
Stop—Engine Mount Vibration Absorber—Upper (Front)	87-22-542-1	87-22-501	AN-QQ-S-752	100,000
Stop—Engine Mount Vibration Absorber—Upper	87-22-533-1	87-22-501	AN-QQ-S-752	100,000
Stop—Engine Mount Vibration Absorber—Upper	87-22-533-2	87-22-501	AN-QQ-S-752	100,000
Stop—Hydraulic Check Valve	87-33-080	87-33-071	AN-QQ-689	65,000
Stop—Landing Gear Control—Hydraulic	87-33-030	87-33-090	57107-18	120,000
Strut—Landing Gear Oleo Side	87-31-530	87-31-532	AN-QQ-S-756	180,000
Stud—Battery Box	87321	87-66-510	AN-QQ-S-689	125,000
Stud—Blast Tube Retainer	87-69-763	87-69-701	AN-QQ-S-771	75,000
Stud—Cabin Control Pivot	87-25-628	87-25-571	AN-QQ-S-689	65,000
Stud—Cowl Attachment	87-29-139	87-29-002	AN-QQ-S-689	As Received
Stud—Landing Gear Oleo Strut—Lower Trunnion	75-31-032	87-31-007	AN-QQ-S-689	125,000
Stud—Landing Gear Hinge Fitting	87-31-558	87-31-548	AN-QQ-S-689	150,000
Stud—Landing Gear Retracting Cylinder Support	75-33-018-1	87-33-542	AN-QQ-S-689	125,000
Stud—Landing Gear Retracting Cylinder Support	87-33-518	87-33-542	AN-QQ-S-689	125,000
Stud—Oil Tank Heating Ring	87-66-767	87-46-934	AN-QQ-S-646	As Received
Stud—Oil Tank Support—Front	87-430-1017	87-430-1000	AN-S-9	125,000
Stud—Oil Tank Support—Rear	87-430-1018	87-430-1000	AN-S-9	125,000
Stud—Propeller Control Support	87-52-520-2	87-52-504	AN-QQ-S-752	65,000
Stud—Rudder Hinge—Center	75-21-156	87-21-214	AN-QQ-S-689	125,000
Stud—Tail Wheel Retracting Strut	75-37-025	87-37-005	AN-QQ-S-756	150,000
Stud—Spinner Supporting	87-42-526	87-42-502	AN-QQ-S-689	125,000
Stud—Stabilizer Attachment Fitting	75-11-011	87-11-515	AN-QQ-S-766	150,000
Stud—Wing Gun—Front Mount	87-69-926-1	87-69-929	AN-S-9	125,000
Stud—Wing Gun—Front Mount	87-69-926-2	87-69-929	AN-7-9	125,000

Name	Part No.	Next Assembly	Specification	Tensile St. Lb sq in.
Support—Engine Mount Vibration Absorber Housing	87-22-526	87-22-527	AN-QQ-S-756	65,000
Support—Landing Gear Retracting Strut	87-33-542-1	87-33-502	AN-QQ-S-756	150,000
Support—Wing Gun—Rear	87-69-540	87-69-500	AN-QQ-S-572	125,000
Tab—Aileron Balance Rod	87-05-514-2	87-05-501	AN-QQ-S-685	As Received
Tank—Hydraulic Reservoir	87-33-011	87-33-018	AN-QQ-M-561	32,000
Terminal—Swaged Type	87-25-626	87-25-503	AN-QQ-S-684	80,000
Thread—Cabin Control Cable	87-25-912	87-25-572	AN-QQ-S-752	90,000
Tie Rod—Radiator and Oil Cooler Support	87-50-021	87-50-702	AN-QQ-S-689	
Torque Shaft—Cowl Flap Control	87-29-528	87-29-520	AN-WW-T-850	150,000
Trigger—Cabin Release Mechanism	87-25-615	87-25-621	AN-QQ-S-752	125,000
Trunnion—Flap Control	75-08-013	87-08-501	AN-QQ-S-689	125,000
Trunnion—Landing Gear Oleo	87-31-549	87-31-525	AN-QQ-S-756	As Received
Trunnion—Landing Gear Oleo Strut—Upper	75-31-027	75-31-039	AN-QQ-S-756	180,000
Tube—Air Duct to Oil Cooler Ring Assembly	87-46-509-2	87-46-571	AN-WW-T-850	90,000
Tube—Air Duct to Radiator Ring Assembly	87-50-549-2	87-50-047	AN-WW-T-850	90,000
Tube—Arming Control Lock—500 Lb. Bomb	87-70-564-2	87-70-559	AN-WW-T-850	150,000
Tube—Carburetor Air Controls	87-460-1018-1	87-460-1011	AN-T-15	90,000
Tube—Carburetor Air Control—Filter	87-460-1020-2	87-730-1013	AN-T-15	95,000
Tube—Carburetor Hot Air Rod Assembly	87-52-710-8	87-52-508	AN-WW-T-850	
Tube—Carburetor Air Control Rod Assembly	87-460-1027-2	87-460-1002	AN-T-15	95,000
Tube—Carburetor Air Control Rod Assembly	87-460-1028-2	87-460-1002	AN-T-15	95,000
Tube—Cowl Flap Control Rod Assembly	87-29-031-2	87-29-520	AN-WW-T-850	
Tube—Crank Extension Support	87-43-512-13	87-43-501	AN-WW-T-850	95,000
Tube—Crank Extension Support	87-43-512-11	87-43-501	57-189-2	95,000
Tube—Crank Extension Support	87-43-512-9	87-43-501	AN-WW-T-850	95,000
Tube—Crank Extension Support	87-43-512-8	87-43-501	AN-WW-T-850	95,000
Tube—Crank Extension Support	87-43-512-7	87-43-501	AN-WW-T-850	95,000
Tube—Crank Extension Support	87-43-512-6	87-43-501	AN-WW-T-850	95,000
Tube—Flap Visual Indicator	87-03-791-2	87-03-826	AN-T-3	85,000
Tube—Elevator Push Pull	87-64-572	87-64-509	AN-WW-T-850	125,000
Tube—Elevator Control—Jackshaft	87-64-541	87-64-902	AN-WW-T-850	90,000
Tube—Engine Bearer	87-22-515-1	87-22-531	AN-WW-T-850	150,000
Tube—Engine Mount Bearer	87-22-512-1	87-22-501	AN-WW-T-850	150,000
Tube—Engine Mount Lower Diagonal	87-22-518-1	87-22-501	AN-WW-T-850	95,000
Tube—Flap Visual Indicator	87-03-792-2	87-03-826	AN-T-3	85,000
Tube—Fuel Cock Brace	75-44-506-1	87-44-801	AN-WW-T-850	90,000
Tube—Fuel Cock Control Assembly	87-44-534-2	87-44-508	AN-WW-T-850	100,000
Tube End—Landing Gear Fairing Door—Spring Strut	87-34-019	87-34-016	AN-QQ-S-752	100,000
Tube—Fuel Cock Control Assembly	87-44-534-5	87-44-508	AN-WW-T-850	100,000
Tube—Fuel Cock Control Assembly	87-44-534-3	87-44-508	AN-WW-T-850	100,000

Name	*Part No.*	*Next Assembly*	*Specification*	*Tensile St. Lb/sq in.*
Tube—Landing Gear Oleo Strut Plunger	87-31-532	87-31-512	AN-WW-T-850	125,000
Tube—Landing Gear Retracting Strut Indicator Rocker	75-33-029-2	87-33-005	AN-WW-T-850	125,000
Tube—Lift Tube Support	87-21-559-3	87-21-501	AN-WW-T-850	65,000
Tube—Pilot's Shoulder Strap Roller Assembly	87-561-1014-1	87-215-1001	AN-T-15	90,000
Tube—Pilot's Shoulder Strap Support	87-561-1013-2	87-210-1011	AN-T-15	100,000
Tube—Pilot Tube Support	75-66-604-2	75-66-053	AN-WW-T-850	90,000
Tube—Propeller Bellcrank Rod Assembly	87-52-724-2	87-52-702	AN-WW-T-850	95,000
Tube—Propeller Control Rod Assembly	87-52-516-2	87-52-501	AN-WW-T-850	95,000
Tube—Propeller Control Support—Front	87-52-520-3	87-52-501	AN-WW-T-850	65,000
Tube—Roller Attachment	87-25-525	87-25-623	AN-WW-T-850	90,000
Tube—Rudder Pedal	58520	87-63-501	AN-WW-T-850	95,000
Tube—Rudder Run-Around Cable Pulley Bracket	75-64-093-2	87-64-501	AN-WW-T-850	90,000
Tube—Seat Safety Belt Torque	87-65-528-2	87-65-504	AN-WW-T-850	65,000
Tube—Seat Support	87-65-503-8	87-88-901	AN-WW-T-850	150,000
Tube—Seat Support	87-65-503-5	87-88-901	AN-WW-T-850	150,000
Tube—Seat Support	87-65-503-4	87-88-901	AN-WW-T-850	150,000
Tube—Seat Safety Belt Lock	87-65-514-2	87-65-504	AN-WW-T-850	65,000
Tube Seat Safety Belt Lock Spring Housing	87-65-527	87-65-528	AN-WW-T-850	65,000
Tube—Seat Safety Belt Operating Plunger	87-65-521-2	87-65-529	AN-WW-T-850	65,000
Tube—Stick Control	75-62-019	87-62-501	AN-WW-T-850	100,000
Tube—Torque—Rudder	75-14-033-1	74-14-511	AN-WW-T-850	100,000
Tube—Torque—Rudder	75-14-032-1	75-14-511	AN-WW-T-850	100,000
Tube—Torque—Rudder	75-14-028-1	75-14-511	AN-WW-T-850	100,000
Tube—Torque—Rudder	75-14-027-6	75-14-511	AN-WW-T-850	100,000
Universal—Tail Wheel—Door Oper. Single	75-37-045	87-34-801	AN-QQ-S-752	90,000
Universal—Tail Wheel Oleo—Lower Joint	85-37-015	87-37-901	AN-QQ-S-756	150,000
Valve—Hydraulic Hand Pump	87-33-049	87-33-504	AN-QQ-S-762	
Valve—Poppet	87-33-019	87-33-023	57-107-18	120,000
Washer—Aileron Control Arm—Bushing	87-05-012	87-05-014	AN-QQ-S-752	65,000
Washer—Cabin Assembly	87-25-604	87-25-501	Comm. St.	45,000
Washer—Engine Mount Attachment	87-21-599	87-21-501	AN-QQ-S-689	
Washer—Landing Gear Retracting Arm	87-31-022	87-31-020	AN-QQ-S-752	55,000
Washer—Optical Sight Support	87-69-611	87-69-590	AN-QQ-S-771	75,000
Washer—Poppet Valve	87-33-020	87-33-023	AN-QQ-S-752	150,000
Washer—Poppet Valve	75-33-113-	87-33-022	AN-QQ-S-752	150,000
Washer—Tail Wheel Recoil	75-37-061	87-37-810	AN-QQ-S-646	55,000
Washer—Tail Wheel Retracting Strut	75-37-026	75-37-005	AN-QQ-S-756	150,000

SECTION VII
FINISH SPECIFICATIONS

This specification covers the requirements for finishing the P-40N fighter airplane. It consolidates the general requirements of U. S. Army Specification 3-100-H and Curtiss Finish Specification S-627.

1. APPLICABLE SPECIFICATIONS.

The current issue of the following Specifications shall form a part of this specification, unless otherwise noted herein:

Army-Navy Aeronautical	
AN-QQ-A-696	Anodic - Films; Corrosion Protective (for) Aluminum Alloys
AN-C-52	Compound; Exterior Surface, Corrosion Preventive
AN-C-53	Compound, Anti - Seize; White-Lead Base, for Threaded Fittings
AN-D-8	Dope; Cellulose Nitrate Pigmented Camouflage
AN-TT-D-514	Dope; Cellulose Nitrate, Clear
AN-E-7	Enamel; Camouflage, Quick Drying
AN-L-21	Lacquer; Camouflage
AN-M-12	Magnesium Alloy; Process for Corrosion — Protection of
AN-P-32	Plating; Zinc
AN-QQ-P-421	Plating; Cadmium
AN-TT-P-656	Primer; Zinc Chromate
AN-TT-T-256	Thinner; Cellulose - Nitrate-Dope - and - Lacquer
Army Air Forces	
3586	Fluid; Hydraulic
24114	Camouflage Finishes for Aircraft
U. S. Army	
57-0-2	High Grade Rust - Proofing Process
98-20007	Cleaning of Aircraft Metal Surfaces Prior to Application of Initial Protective Coating
98-24105	Marking for Airplane and Airplane Parts
Navy Aeronautical	
M-542	Tinting Paste; Zinc Chromate Primer

2. MATERIALS.

a. Materials shall be as specified herein.

b. Cockpit green: The finish referred to herein as "cockpit green" shall be compounded using the following materials:

Zinc Chromate Primer—AN-TT-P-656
Tinting Paste —M-542

Color shall conform to ANA Bulletin No. 157, Color No. 601, "Interior Green".

3. GENERAL REQUIREMENTS.

a. CLEANING.—All surfaces shall be cleaned in accordance with Specification 98-20007 prior to application of initial protective coatings and shall be dry at the time of application of paint-type protective coatings.

b. APPLICATION OF PAINT COATINGS.—The initial paint coating shall be applied immediately after cleaning, plating, or chemical treatment.

c. PAINT COATINGS.

(1) All aluminum alloys shall receive a basic finish of at least one coat of zinc chromate primer, Specification AN-TT-P-656, unless otherwise specified.

(2) The final finish on exterior surfaces shall consist of one coat of camouflage enamel, Specification AN-E-7. The final finish coat on interior surfaces (where required) shall consist of one coat of cockpit green.

d. THINNING.—Paint materials may be thinned as required, to obtain proper application properties.

4. DETAIL REQUIREMENTS.

a. CADMIUM PLATING.—All parts of steel, brass, bronze, or copper shall be cadmium plated, Specification AN-QQ-P-421, unless otherwise specified herein, or noted below:

(1) Parts made of corrosion resistant steel.

(2) Large welded structures, such as engine mounts, which are too large for available plating equipment.

(3) Parts which are welded to unplated structures.

(4) Armor plate.

(5) Cable and parts fabricated from wire, except springs and tie rods, unless specifically called for on drawings. Steel springs shall be plated and then baked for three hours at 204°C (400°F) to eliminate embrittlement. Steel springs need not be painted unless they are mounted on the exterior of the airplane. Brass or bronze springs need not be plated or painted unless they are to be assembled to dissimilar metals. Small springs shall not be cleaned by sand blasting.

(6) Members or portions of members which act as bearings or journals.

(7) Parts which are enclosed in grease or oil filled housings.

(8) Lines and fittings made of copper base alloys.

(9) Hardened steel chains (roller).

b. ZINC PLATING.—A plating of zinc (Specification AN-P-32) may be used in lieu of cadmium (Specification AN-QQ-P-421) where permitted by current directives.

c. PHOSPHATE TREATMENT.—Steel parts may be finished with phosphate treatment (Specification 57-0-2, Phosphate Type) in lieu of cadmium or zinc plating where permitted by current directives.

d. CHEMICAL TREATMENT OF ALUMINUM ALLOYS.—In order to obtain maximum protection, as much forming, drilling and cutting as is practicable shall be performed on parts prior to chemical treatment. With the exception of parts assembled by welding and those which are not under stress, all parts shall be treated in detail prior to assembly.

(1) ANODIC TREATMENT OR ALKALINE DICHROMATE TREATMENT (Alrok).

(a) All fuel and oil tanks except those fabricated of 52S or Alclad.

(b) All castings and forgings unless the alloy is unsuitable.

(c) All interior and exterior parts except those fabricated from the following alloys: 2S, 3S, 52S, 53S, 61S, and Alclad.

(2) CHROMIC ACID DIP OR ALCOHOLIC PHOSPHORIC ACID CLEANER.

(a) All parts fabricated from the following alloys: 2S, 3S, 52S, 53S, 61S, and Alclad.

(3) CHROMIC ACID DIP.

(a) Castings and forgings containing non-aluminum metal inserts.

(4) ALKALINE DICHROMATE TREATMENT (Alrok).

(a) Die castings except junction boxes.

Note

Anodic treatment shall be in accordance with Specification AN-QQ-A-696. Alkaline dichromate treatment (Alrok), chromic acid dip, and alcoholic phosphoric acid cleaner shall be in accordance with U. S. Army Specification 98-20007.

e. CHEMICAL TREATMENT OF MAGNESIUM. Magnesium and magnesium base alloys shall be treated as follows: all castings—dichromate process to Specification AN-M-12; all sheet, tubing, bar stock, and extrusions—chrome pickle treatment to Specification AN-M-12.

f. DOPE PROOF FINISH.—Metal parts which contact doped fabric surfaces shall be finished with one coat of zinc chromate primer, and allowed to dry before being placed in contact with doped fabric surface.

g. OPEN ENDED TUBULAR AND HOLLOW PARTS.—The interior surfaces of all hollow and tubular parts or members except stainless steel parts, portion of parts or members that act as bearings, or journals, instruments, oil, vent lines, or air ducts, which are open ended shall be given a coat of zinc chromate primer. The coating shall be applied by filling and draining or by dipping. Aluminum alloy conduit tubing and boxes shall not be finished inside.

h. CLOSED OR SEALED METAL TUBULAR AND HOLLOW PARTS.—With the exception of parts hermetically sealed by flash welding, the interior surfaces of all closed or sealed steel parts or members and of parts which are plated and which contain crevices or pockets where the plating solution might be held, shall be protected by a coating of raw linseed oil. The liquid shall be at a temperature of not less than 71.11°C (160°F) during application and shall be allowed to remain on the surface for at least two minutes. The liquid shall be applied by forcing it into the hollow members under pressure or by immersing the part in a bath of the liquid. Steel tubing 3/8 inch diameter or smaller need not be oiled. Parts which are immersed shall remain in the bath until all bubbling has ceased and shall be manipulated so as to insure the absence of air pockets. The members shall be thoroughly drained after treatment and wiped free of oil on all exterior surfaces. All accessible holes drilled in the members shall be closed with Parker self-tapping screws or equivalent. Solder shall not be used to close the holes. No protective coating is required on the interior surfaces of closed aluminum alloy members.

i. FINISH FOR INTERIOR PARTS AND SURFACES.—The minimum finish for interior parts and surfaces shall be as follows:

(1) The interior of fuselage shall be finished with one coat of zinc chromate primer.

(2) Wings, control surfaces, engine mounts and fuselage, excepting compartments for personnel, shall be finished with one coat of zinc chromate primer.

(3) Cockpits shall be finished with one coat primer and one coat of non-specular cockpit green as noted in paragraph 2. *b.* of this section. Cockpit area includes area aft of firewall and forward of armor plate.

(4) Cargo and luggage compartments, where applicable, shall be finished with one coat of primer. Where canvas construction is used, no finish is required.

(5) A coating of zinc chromate primer may be applied to aluminum coated aluminum alloy (Alclad), in heat treated condition, before fabrication. This coating shall be used as the primer coat for interior surfaces.

If zinc chromate primer is used prior to assembly, all areas that have been abraded by fabrication operations sufficiently to materially affect the protective qualities of the coating or the appearance of subsequent finishes shall be removed and treated in accordance with Army Specification 98-20007, section V, 5., *b.*, (2) after which they shall be re-coated with one coat of zinc chromate primer.

(6) The exterior surfaces of metal oil tanks shall be finished with one coat of primer.

(7) The interior surfaces of aluminum alloy spot-welded assemblies shall be treated in accordance with

U. S. Army Specification 98-20007, section V, 5., *b.,* (2) and given one coat of primer after assembly.

(8) Magnesium parts shall be given two coats of primer prior to assembly.

(9) Armor plate parts shall be free of grease, dirt, or metallic coatings before the application of finishes. Metallic coatings shall be removed by grit blasting from an area at least one inch removed from the area covered by attached fittings. All armor plate parts shall be finished with one coat of primer and one coat of cockpit green prior to assembly. Armor plate shall not be immersed in acid solution for any reason.

j. FINISH FOR EXTERIOR (EXPOSED) SURFACES.

(1) All metal exterior surfaces including wings, fuselage, control surfaces, wheel and engine cowling shall be finished in accordance with the following paragraphs, and U. S. Army Specification 98-24113 and AAF Specification 24114.

(2) External aluminum-coated aluminum alloy surfaces, such as wings, fuselage, and empennage shall be given one coat of camouflage enamel to AAF Specification 14109. The color to be in accordance with AAF Specification 24114. Before application of this coating, the surface shall be prepared for painting in accordance with paragraph 4, *d,* (3), this section, relating to surface treatment.

(3) On fabric covered surfaces, the doping scheme and finish shall be in accordance with the following paragraphs:

Three coats of clear nitrate dope, Specification AN-TT-D-514 shall be applied by brushing to fabric surfaces in a manner to produce proper tautness. These coats shall be applied without thinning.

Apply at least one spray coat of clear nitrate dope, Specification AN-TT-D-514, thinned as required for spray application. The final dope coating shall be at least two spray coats of dark olive drab or neutral gray, color No. 613 or No. 602, as required. The color scheme shall be applied in a manner similar to that described in AAF Specification 24114, paragraph E-lb (3) and E-lb (4).

The dope used for the final spray coat shall contain at least one-third thinner and shall be applied sufficiently heavy to wet all previous coats and is for the purpose of flowing out the roughness of the undercoats.

(a) Engine and cockpit fabric covers shall be finished with one lap of camouflage finish to match the pattern specified in the drawing applicable to the airplane's external finish.

Note

The line between the two camouflage colors shall be blended as uniformly and evenly as may be accomplished with the use of a spray gun.

(b) Insignia shall be applied in accordance with the requirements of AAF Specification 24114.

k. FINISH OF CABLES AND WIRES.

(1) CABLES.—Control cables shall not be painted. Corrosion-resistant steel cable may be given a light coat of oil or grease for lubrication. Steel cable shall be coated with white lead and tallow, or with rust preventative compound conforming to Specification AN-C-52.

(2) SPRINGS.—Bronze and cadmium plated steel springs need not be painted but steel springs shall be coated with rust preventative compound unless they are enclosed in lubricated housings.

(3) CHAINS.—Plated and unplated steel chains shall be coated with rust preventative compound.

l. ENGINE COMPARTMENTS.

(1) ALUMINUM OR ALUMINUM ALLOY COWLING.—The interior surface of aluminum or aluminum alloy cowling need not be painted.

(2) FIREWALL.—No paint coating shall be applied to either side of the firewall.

(3) ENGINE COMPARTMENT FITTINGS AND ACCESSORIES.—Paint coatings shall not be applied to fittings or accessories unless specifically called for herein or in the specifications or drawings. Brass, corrosion-resistant steel, and cadmium plated steel parts in the engine compartment need not be painted unless specifically required on the drawing.

m. RUBBER.—Rubber and rubber-like surfaces shall not be painted or greased.

n. JOINTS AND SEAMS.—With the exceptions noted herein, the overlapping portions (surfaces in contact) of all-metal joints and seams, shall receive at least two coats of primer or other similar corrosion inhibiting and insulating material between the faying surfaces. Magnesium parts shall receive two coats of primer prior to assembly.

(1) All parts joined by welding, brazing or soldering.

(2) Aluminum and aluminum alloy parts which are anodized after assembly.

(3) Contact parts of attachment fittings which act as connections between the various units of the airplane, such as attachment of wings to the fuselage, engine control brackets and other accessories.

(4) Terminals for electrical, radio or bonding connections.

(5) Parts made of phenol fibre or other nonmetallic materials.

(6) Aluminum and aluminum alloy parts which are spot welded during assembly.

o. WEARING SURFACES, OIL HOLES, ETC.—Care should be exercised to prevent the application of paint materials to wearing surfaces, threads and oil holes.

p. DISSIMILAR METALS.—Dissimilar metal contact, especially those between aluminum alloys and the alloys of copper or nickel, shall be avoided wherever practicable. Copper alloys and steel parts in contact with aluminum alloys shall be cadmium plated and then insulated as specified in paragraph 4, *n*. This requirement (for painting) shall be waived for nuts and bolts in the engine compartment.

q. HYDRAULIC SYSTEM AND OLEO STRUTS.—Protective coatings are not required on the internal parts of hydraulic mechanisms operating in hydraulic fluid, AAF Specification 3586 unamended grade B, which are at all times immersed in the oil. Such parts, when not installed and immersed in oil shall be coated with rust preventative compound, Specification AN-C-52. No organic finish shall be applied to the external surfaces of hydraulic system parts and oleo struts.

r. INSTRUMENT PANEL.—The instrument panel shall be finished all over with one coat of primer and two coats of dull black instrument lacquer.

s. FUEL, OIL, AND INSTRUMENT LINES.—Brass or copper lines and fittings shall not be plated. No finish other than color strips in accordance with U. S. Army Specification 98-24105 shall be applied.

t. ELECTRICAL SYSTEM.—The exterior of aluminum alloy connector boxes, conduit, conduit fittings, etc., shall receive no finish. The bond connections especially shall be kept free of finishing materials.

u. LUBRICATION OF THREADED PARTS.—All threads shall be treated with a lubricant conforming to Specification AN-C-53 prior to assembly. This material may be generally used except for purposes where another compound is specifically required. No thread lubricant other than hydraulic fluid of the type used in the system shall be used on straight threads of hydraulic system.

v. FINISH OF OLEO STRUTS AND HYDRAULIC SYSTEMS AND HYDRAULIC SYSTEM PARTS.—No organic finish shall be applied to the exterior of oleo struts and hydraulic system parts.

w. MARKING OF LINES.—Fuel, oil, and hydraulic vacuum and instrument lines shall be marked in accordance with U. S. Army Specification 98-24105 with a colored tape over which a coating of clear lacquer is applied to seal the edges.

x. IRREGULARITIES OF WING SURFACE.—All irregularities of the wing surfaces resulting from riveting skin laps or joints and other fabricating operations shall be suitably smoothed out to match the adjacent surfaces, prior to the application of final finishes.

y. MARKING OF SELF-SEALING FUEL CELL ACCESS DOORS.—The word "outside" shall be applied to the outside of all access doors.

z. STEEL AUXILIARY FUEL TANKS.—Interior and exterior surfaces of steel tanks shall be cleaned free of all scale, rust, grease and oil, etc., by light sand blasting or by use of hot alkali cleaner before final assembly. Immediately after fabrication, the interiors shall be given two thin slush coats of clear slushing compound (Pierce and Stevens No. 4215E, or equivalent), with eight hours drying time at room temperature between coats. Exteriors shall be finished with one coat of zinc chromate primer and one coat of gray enamel (Specification AN-E-7.)

SECTION VIII
TUBING CHARTS

TUBING CHART FOR COOLING SYSTEM

(See Figure 305)

Ref.	*Part No.*	*OD*	*Wall*	*Length*	*Material*	*Fittings*
1	87-440-1000-16	1-3/4	.049	36	52SO AL.AL	884-28-20 QS-100M-28
2	87-440-1000-55	1/2	.042	39-3/4	52SO AL.AL	AC895-3 AN842-8D AN884-8-12 AN746-7 87-50-069 AN842-8
3	87-440-1000-44	1/2	.042	8	52SO AL.AL	884-8-12 AN746-7 87-44-1000-49
4	87-440-1000-42	1-3/4	.049	36	52SO AL.AL	884-28-20 QS-100M-28
5	87-440-1000-37	1/2	.042	71	52SO AL.AL	884-8-12 AN746-7
6	87-440-1000-9	5/8	.042	14	52SO AL.AL	AN842-10 884-10-11 QS-100M-12

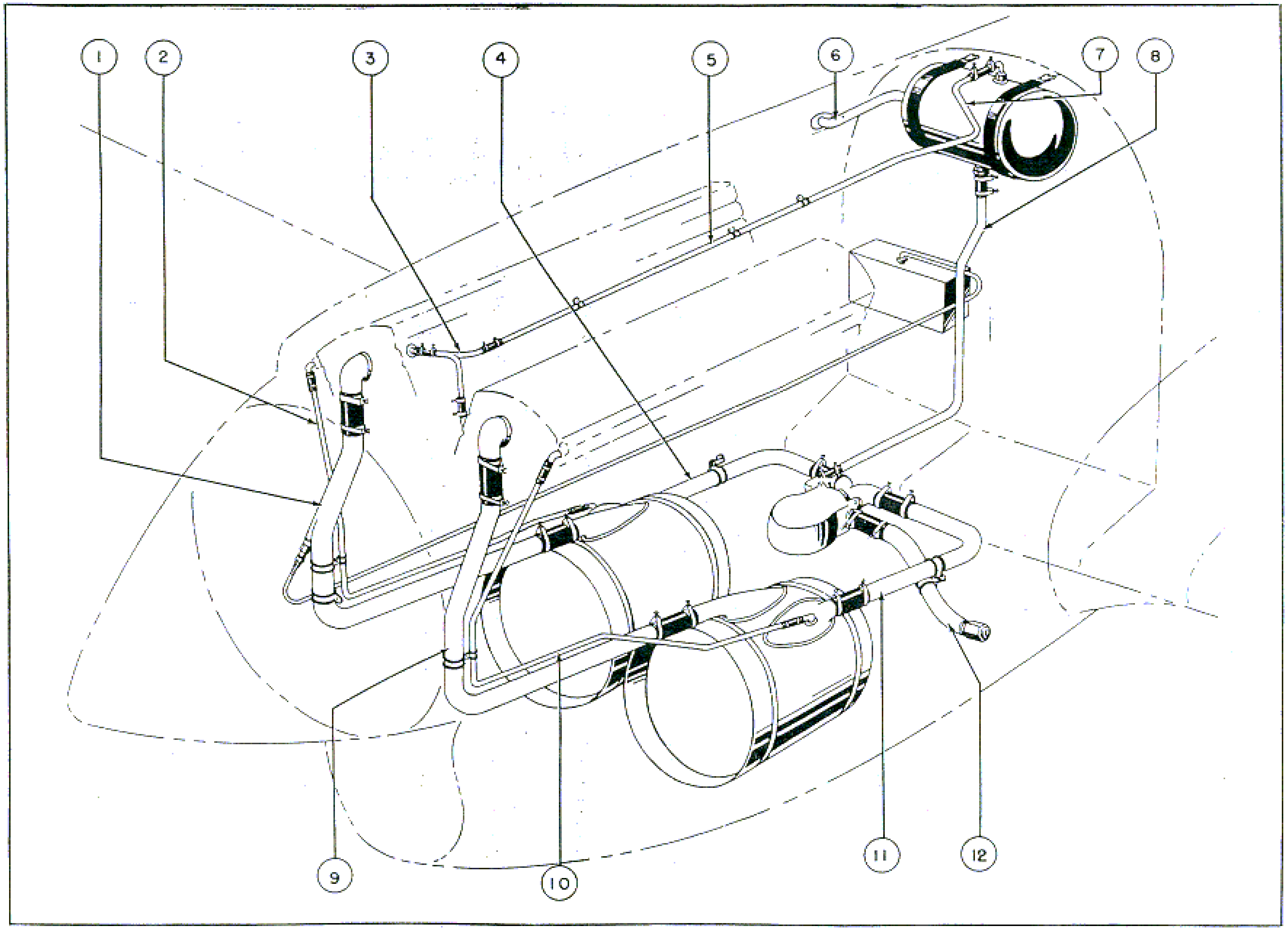


Figure 305—Cooling System Tubing Diagram

TUBING CHART FOR COOLING SYSTEM *(Cont'd)*

Ref.	Part No.	OD	Wall	Length	Material	Fittings
7	87-440-1000-51	10	.049	34-1/2	52SO AL.AL	884-16-17 QS-100M-16 AN840-16D 884-16-16 87-440-1000-48
8	87-440-1000-20	1-3/4	.049	36	52SO AL.AL	884-28-20 QS-100M-28
9	87-440-1000-53	1/2	.042	43-5/8	52SO AL.AL	AC895-3 AN842-8D AN884-8-12 AN746-7 87-50-069 AN842-8
10	87-440-1000-7	1-3/4	.049	28	52SO AL.AL	884-28-20 QS-100M-28
11	87-440-1000-27	1	.049	10	52SO AL.AL	AN840-16 884-16-16 QS-100M-16 87-50-068 907-12 AN900-12

TUBING CHART FOR FUEL SYSTEM

(See Figure 306)

Ref.	Part No.	OD	Wall	Length	Material	Fittings
1	87-420-1006-60	1/4	.032	38	Copper	AN884-4-12 AN746-5 AN914-1 AN840-4D
2	87-420-1006-58	1/4	.032	16-1/4	Copper	37A3528 AN842-4D AN884-4D AN746-5
3	87-420-1006-63	1/4	.035	15	52SO AL.AL	AN842-4 AN884-4-12 AN746-5
4	87-420-1006-59	1/4	.032	20-1/4	Copper	37A3528 AN842-4D AN844-4D AN746-5
5	87-420-1006-76	1/4	.032	18-1/2	Copper	811-CT-4
6	87-420-1006-78	1/4	.032	20	52SO AL.AL	811-CT-4
7	87-420-1006-25	1/4	.035	61	52SO AL.AL	AN884-4-12 AN746-5 AN884-4-10
8	87-420-1006-81	Vent Assembly				AN884-8-12 AN746-7
9	87-420-1006-64	1/4	.035	20-1/2	52SO AL.AL	AN884-4-16 AN746-5
10	87-420-1006-11	1/2	.042	5	52SO AL.AL	AN884-8-10 AN746-7
11	87-420-1006-14	1/2	.042	79	52SO AL.AL	AN884-8-10 AN746-7
12	87-420-1006-13	1/2	.042	43	52SO AL.AL	AN884-8-10 AN746-7

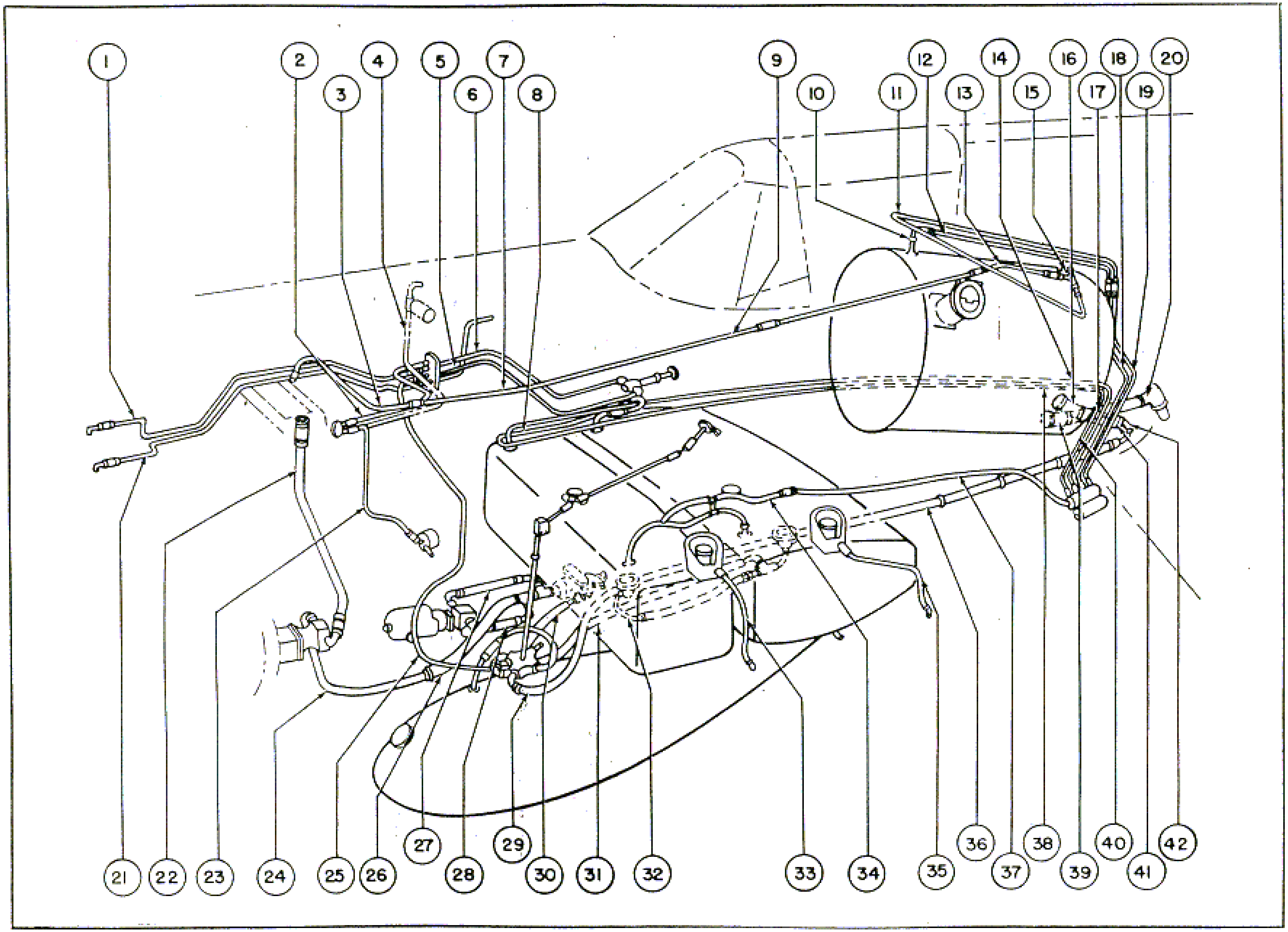


Figure 306—Fuel System Tubing Diagram

TUBING CHART FOR FUEL SYSTEM *(Cont'd)*

Ref.	*Part No.*	*OD*	*Wall*	*Length*	*Material*	*Fittings*
13	87-420-1006-65	1/4	.035	24	52SO AL.AL	AN884-4-10 AN746-5
14	87-420-1006-30	1/2	.042	79-1/2	52SO AL.AL	AN884-8-10 AN746-5
15	87-420-1006-11	1/2	.042	5	52SO AL.AL	AN746-7 AN884-8-10
16	87-420-1006-24	3/4	.049	4-1/2	52SO AL.AL	
17	87-420-1006-28	1/2	.042	38	52SO AL.AL	AN931-16-22 AN884-8-10 AN746-7
18	87-420-1006-2	1/2	.042	42	52SO AL.AL	AN884-8-10 AN746-7 AN931-16-22
19	87-420-1006-4	1/2	.042	42	52SO AL.AL	AN884-8-10 AN746-7 AN931-16-22
20	87-45-935-1.00-12	1	(ID)	12	Synthetic Rubber	AN844-16 QS-100-M16
21	87-420-1006-61	1/4	.032	40	Copper	AN914-1 AN840-4D AN884-4-12 AN746-5
22	87-420-1006-90	3/4	.049	22-1/2	52SO AL.AL	AN842-12 AN884-12-14 QS-100-MIZ
23	87-420-1006-62	1/4	.032	13-3/4	Copper	AN884-4-12 AN746-5
24	87-420-1006-21	3/4	.049	22	52SO AL.AL	AN844-12 AN884-12-14 QS-100-M12
25	87-420-1006-80	1/4	.032	48	Copper	AN884-4-12 AN746-5
26	87-44-935	3/4	(ID)	13-1/2	Synthetic Rubber	QS-100-M16 (2)
27	87-44-935	3/4	(ID)	10-1/4	Synthetic Rubber	QS-100-M16 (2)
28	87-44-935	3/4	(ID)	4	Synthetic Rubber	QS-100-M16 (2)
29	87-420-1006-20	3/4	.049	12-3/4	52SO AL.AL	QS-100-M12 AN884-12-12
30	87-44-935	3/4	(ID)	17-3/4	Synthetic Rubber	QS-100-M16 (2)
31	87-44-935	3/4	(ID)	57-1/2	Synthetic Rubber	QS-100-M16 (2)
32	87-420-1006-54	3/4	.049	10-3/4	52SO AL.AL	QS-100-M16
33	87-420-1006-33	1/4	.035	20	52SO AL.AL	AN931-4-7 AN746-5
34	87-420-1006-86	Vent Assembly				AN884-4-16 AN746-5
35	87-420-1006-15	1/4	.035	32	52SO AL.AL	AN931-5-9 AN931-4-7 AN746-5
36	87-44-935	3/4	(ID)	115	Synthetic Rubber	QS-100-M16 (2)
37	87-420-1006-9	1/4	.035	76-3/4	52SO AL.AL	AN884-4-10 AN746-5
38	87-420-1006-12	1/2	.042	74-1/2	52SO AL.AL	AN884-8-12 AN746-7 AN884-8-10 AN746-7

TUBING CHART FOR FUEL SYSTEM *(Cont'd)*

Ref.	*Part No.*	*OD*	*Wall*	*Length*	*Material*	*Fittings*
39	87-420-1006-22	1	.049	4-1/2	52SO AL.AL	QS-100-M16
40	87-420-1006-6	1/2	.042	38	52SO AL.AL	AN931-16-22 AN884-8-10 AN746-7
41	87-44-935	3/4 (ID)		9-1/2	Synthetic Rubber	QS-100-M16 (2)
42	87-420-1006-23	3/4	.049	8-1/2	52SO	AN931-16-22

TUBING CHART FOR HYDRAULIC SYSTEM

(See Figure 307)

Ref.	*Part No.*	*OD*	*Wall*	*Length*	*Material*	*Fittings*
1	87-33-902-54	5/16	.035	10-1/4	Cu. Si. Br. (Everdur)	75-33-115 75-33-101-FT-5-2330 75-33-101-FT-6-2330 75-33-101-CT-5-2330
2	87-33-902-52	5/16	.035	8-1/2	Cu. Si. Br.	75-33-101-CT-5-2330 75-33-115 75-33-101-FT-5-2330 75-33-101-FT-6-2330
3	87-33-902-34	3/8	.035	7-3/4	Cu. Si. Br.	75-33-101-CT-6-2330 75-33-115 75-33-101-FT-5-2330 75-33-101-FT-6-2330
4	87-33-902-198	3/8	.035	48	Cu. Si. Br.	75-33-101-CCT-6-2330 75-33-101-DT-6-2330
5	87-33-902-192	3/8	.035	50	Cu. Si. Br.	75-33-101-CCT-6-2330 75-33-101-DT-6-2330
6	87-33-902-84	3/8	.035	14	Cu. Si. Br.	73-33-101-CT-6-2330 75-33-101-ET-6-2330
7	87-33-902-66	3/8	.035	10	Cu. Si. Br.	75-33-101-JT-6-2330 75-33-101-CT-45-6-2330
8	87-33-902-64	3/8	.035	10	Cu. Si. Br.	75-33-101-JT-6-2330 75-33-101-CT-45-6-2330
9	87-33-902-50	3/8	.035	61-1/2	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-FT-6-2330
10	87-33-902-48	3/8	.035	64	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-CT-6-2330
11	87-33-902-32	3/8	.035	14-1/4	Cu. Si. Br.	75-33-101-HT-6-2330
12	87-33-902-30	3/8	.035	18-1/8	Cu. Si. Br.	75-33-101-HT-6-2330
13	87-33-902-76	3/8	.035	7-3/4	Cu. Si. Br.	75-33-101-JT-6-2330
14	87-33-902-88	3/8	.035	46	Cu. Si. Br.	75-33-101-HT-4-2330
15	87-33-902-18	3/8	.035	46-3/4	Cu. Si. Br.	75-33-101-HT-6-2330
16	87-33-902-112	3/8	.035	34	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-CT-45-6-2330
17	87-33-902-14	3/8	.035	55-1/8	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-FT-6-2330
18	87-33-902-16	3/8	.035	54-1/8	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-FT-6-2330
19	87-33-902-80	3/8	.035	66-7/8	Cu. Si. Br.	75-33-101-CT-6-2330 75-33-101-HT-6-2330
20	87-33-902-78	3/8	.035	45-1/4	Cu. Si. Br.	75-33-101-FT-6-2330 75-33-101-HT-6-2330
21	87-33-902-210	3/8	.035	29	Cu. Si. Br.	75-33-101-T-6-2330

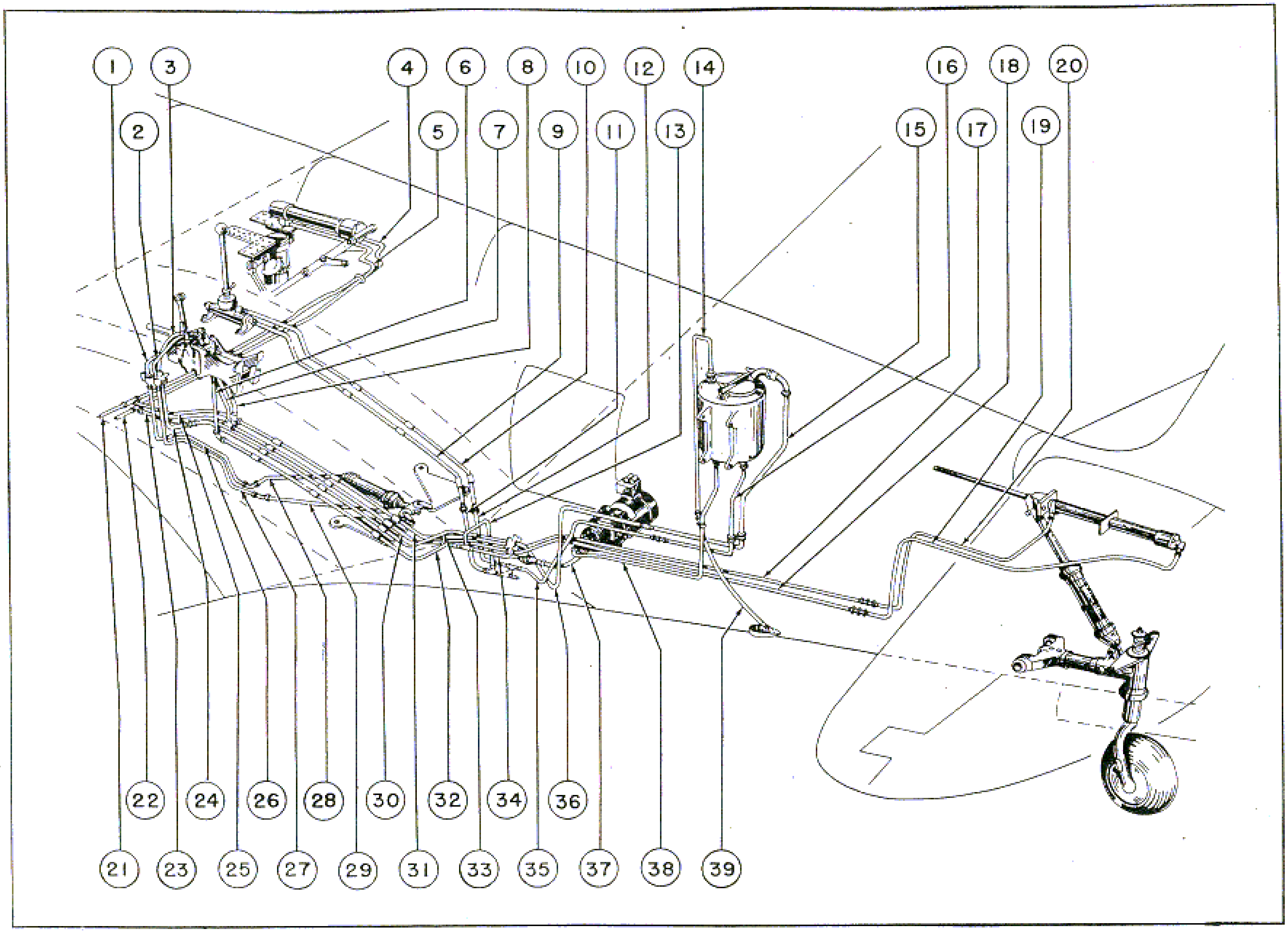


Figure 307—Hydraulic System Tubing Diagram

TUBING CHART FOR HYDRAULIC SYSTEM *(Cont'd)*

Ref.	*Part No.*	*OD*	*Wall*	*Length*	*Material*	*Fittings*
22	87-33-902-208	3/8	.035	32	Cu. Si. Br.	75-33-101-CCT-6-2330
23	87-33-902-36	3/8	.035	16-1/4	Cu. Si. Br.	75-33-101-JT-6-2330 75-33-101-CCT-6-2330
24	87-33-902-94	3/8	.035	11	Cu. Si. Br.	75-33-101-HT-6-2330
25	87-33-902-202	3/8	.035	44	Cu. Si. Br.	75-33-101-DT-6-2330 75-33-101JT-6-2330
26	87-33-902-68	5/16	.035	10-3/8	Cu. Si. Br.	75-33-101-FT-5-2330 75-33-CT-6-2330
27	87-33-902-70	5/16	.035	11-1/2	Cu. Si. Br.	75-33-101-FT-5-2330 75-33-CT-6-2330
28	87-33-902-60	5/16	.035	17	Cu. Si. Br.	75-33-101-CT-45-5-2330 75-33-101-ET-5-2330
29	87-33-902-62	5/16	.035	21-1/2	Cu. Si. Br.	75-33-101-FT-5-2330 75-33-101-ET-5-2330
30	87-33-902-26	3/8	.035	61-5/8	Cu. Si. Br.	75-33-101-FT-6-2330 75-33-101-JT-6-2330
31	87-33-902-28	3/8	.035	62	Cu. Si. Br.	75-33-101-FT-6-2330 75-33-101-JT-6-2330
32	87-33-902-24	3/8	.035	54	Cu. Si. Br.	75-33-101-ET-6-2330 75-33-101-JT-6-2330
33	87-33-902-22	3/8	.035	74-1/2	Cu. Si. Br.	75-33-101-FT-5-2330 75-33-101-FT-6-2330
34	87-33-902-72	3/8	.035	12	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-JT-6-2330
35	87-33-902-86	3/8	.035	80	Cu. Si. Br.	75-33-101-CT-45-6-2330 75-33-HT-6-2330
36	87-33-902-20	3/8	.035	40	Cu. Si. Br.	75-33-101-HT-6-2330 75-33-101-CT-45-6-2330
37	87-33-902-12	3/8	.035	10	Cu. Si. Br.	75-33-101-CT-45-6-2330 75-33-101-FT-6-2330
38	87-33-902-10	1/2	.035	44	Cu. Si. Br.	75-33-101-CT-45-8-2330 75-33-101-CT-45-8-2330
39	87-33-902-166	1/4	.035	16	Cu. Si. Br.	75-33-101-HT-4-2330 AN823-4

Anti-seize thread lubricant AN-C-53 is recommended for application to fittings in assembling the hydraulic tubing. Apply AN-C-53 so that none can possibly enter the fluid system. Apply sparingly to threads and external surfaces of the tube flares only.

CAUTION

Seal all ports and openings immediately upon disconnecting lines to prevent dirt entering the system.

The following torque values shall be used on tube fittings installed in the hydraulic system of the P-40N airplane when they are assembled with AN-C-53 anti-seize.

TORQUES FOR TAPER THREADS

Nominal Pipe	*Torques—Inch-Pounds*		
Size—Inches	*Minimum*	*Best*	*Maximum*
1/4	70	150	250
3/8	75	275	315
1/2	90	550	840
3/4	90	750	1400

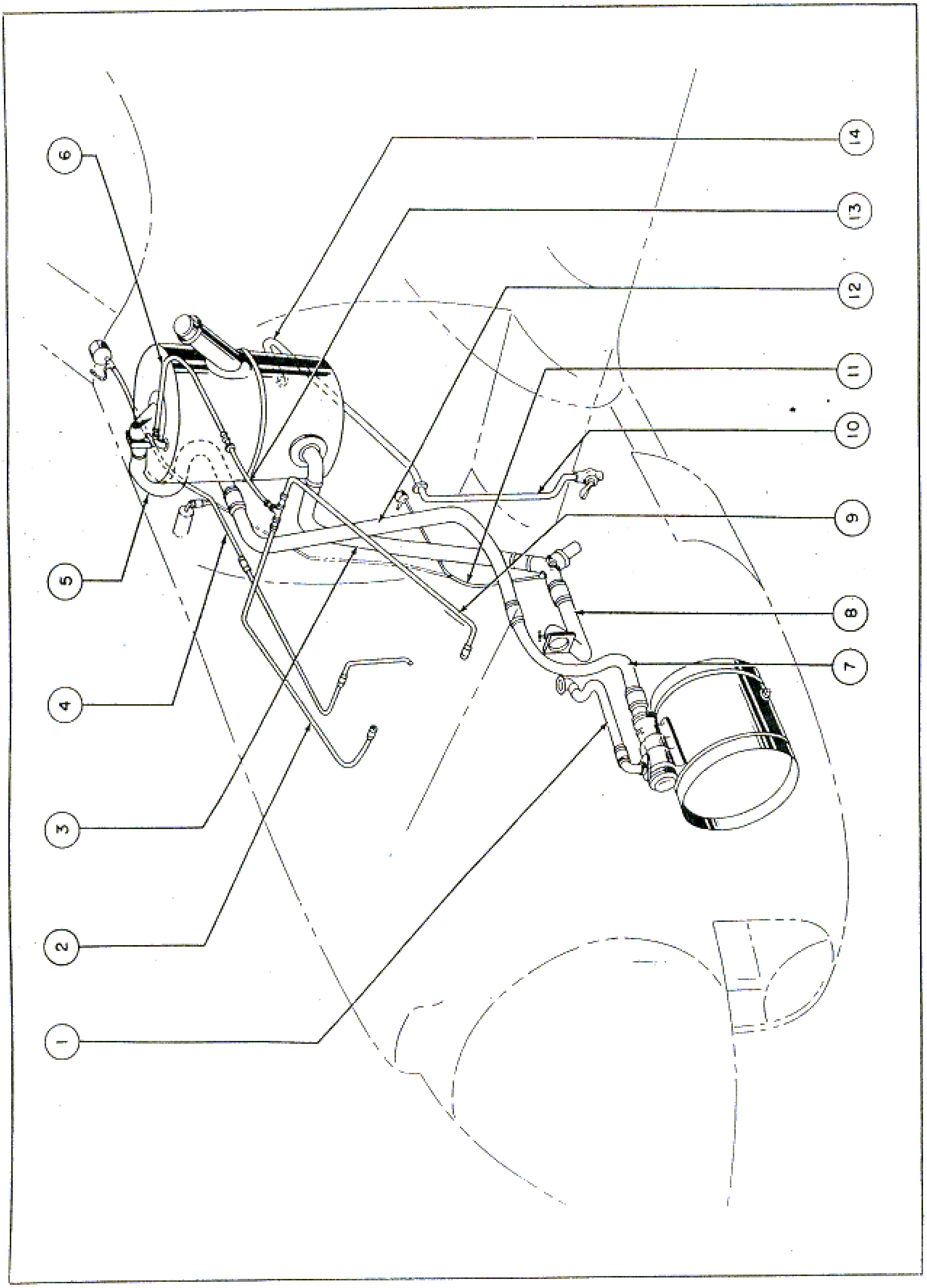


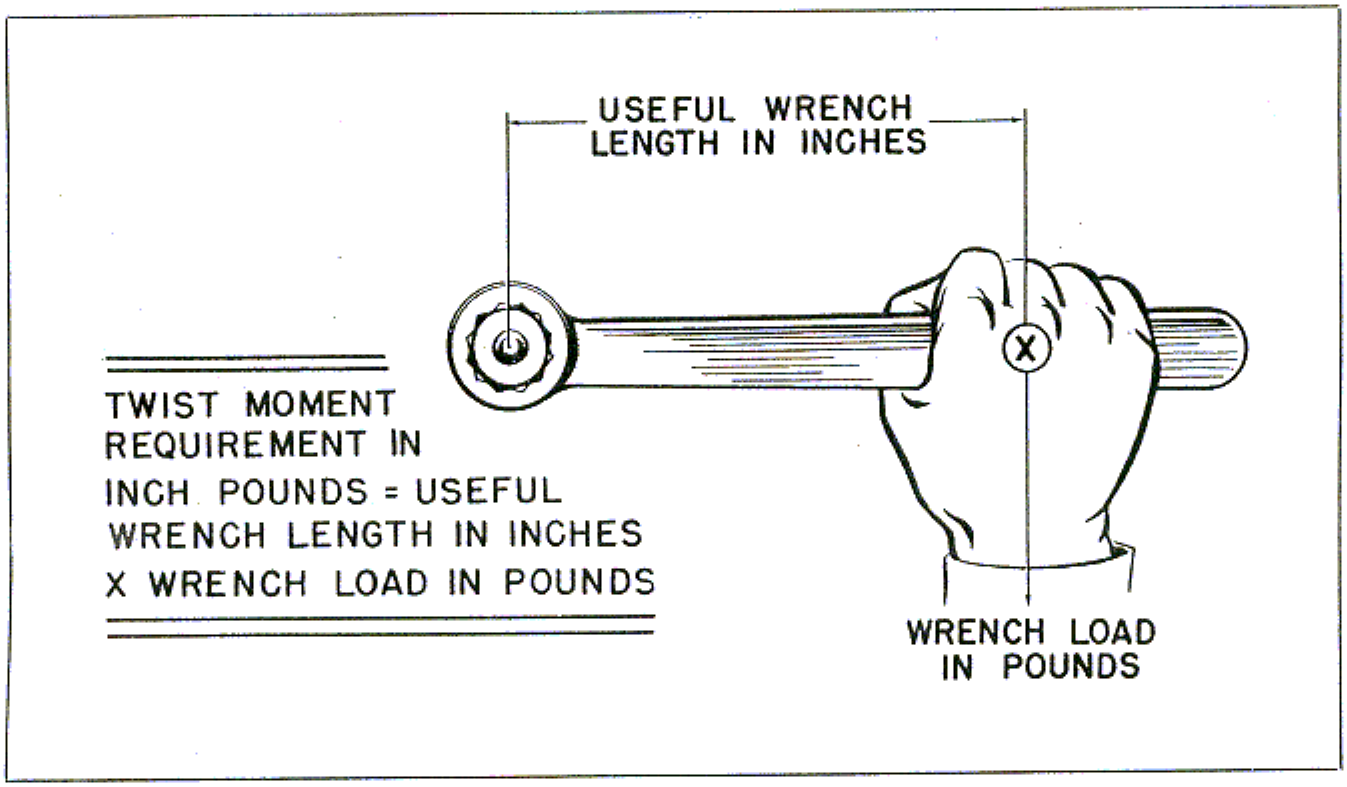
Figure 308—Lubrication System Tubing Diagram

TUBING CHART FOR LUBRICATION SYSTEM

(See Figure 308)

Ref.	Part No.	OD	Wall	Length	Material	Fittings
1	87-429-1002-43	1-1/2	.049	20	52SO AL.AL	AC878-24-14 QS-100M-24 87-429-1017 87-46-544
2	87-429-1002-40	1/2	.042	30-1/2	52SO AL.AL	AC878-8-12 AN746-7 AN840-8 AC878-8-9
3	87-429-1002-2	2	.065	24	52SO AL.AL	87-46-545 87-432-1003 QS-100M-32
4	87-429-1002-17	1/4	.032	26	Copper	AN884-4-12 AN746-5 AC878-424 AN746-5 AN915-1 87-429-1021
5	87-429-1002-46	1-1/2	.049	5	52SO AL.AL	AC878-24-14 QS-100M-24 840-24D
6	87-429-1002-41	3/4	.049	15	52SO AL.AL	AN842-12 AC878-12-14 QS-100M-12
7	87-429-1002-35	1-1/2	.049	27	52SO AL.AL	AC878-24-14 QS-100M-24
8	87-429-1002-6	2	.065	8	52SO AL.AL	87-452-1002 AN771-1 87-46-712 QS-100M-32 AC878-32-14
9	87-429-1002-39	1/2	.042	16	52SO AL.AL	AC878-8-9 AN746-7 AC878-8-12 AN912-8 AN844-8D 87-46-543
10	87-429-1002-49	1	.049	31	52SO AL.AL	AC878-16-12 QS-100M-16
11	87-429-1002-18	1/4	.032	15-7/8	Copper	AN844-4D AC878-4-14 AN746-5 AN842-4
12	87-429-1002-60	1 1/2	.049	31	52SO AL.AL	AC878-24-14 QS-100M-24
13	87-429-1002-44	3/4	.049	16	52SO AL.AL	AC878-12-14 QS-100M-12 87-46-543
14	87-429-1002-12	1	.049	33	52SO AL.AL	AC878-16-12 QS-100M-16

SECTION IX
CHARTS AND TABLES



WRENCH LOAD DATA

Bolt Diameter	*No. 10*	*1/4*	*5/16*	*3/8*	*7/16*	*1/2*
Wrench Loads in Pounds	20 to 25	25 to 35	30 to 40	60	60	60
Useful Wrench Length in Inches	1-3/4 to 2	2 to 2-1/2	3-1/2 to 4	5 to 6	6 to 7-1/2	6 to 7-1/2
Number of Fingers on Wrench	2*	3*	4*	Hand	Hand	Hand
Twist Moment Requirement in Inch Pounds	35 to 55	55 to 90	90 to 150	250 to 350	300 to 500	300 to 500

This table applies to steel bolts heat treated to a tensile strength of 125,000 pounds per square inch.
* Fingers should be placed on wrench starting at and as close to bolt as possible.

CABLE CHART

Part No.	Assembly Title	No. Req'd	Dia.	Length (Inches)	End Fitting Attachment	End Fitting Type	and Part No.
85731	Rudder Control Cable	1	5/32	60,000	Spliced and Wrapped	Bushing	AN111-5
85731	Rudder Control Cable	2	5/32	133.375	Spliced and Wrapped	Bushing	AN111-5
85731	Rudder Control Cable	2	5/32	118.625	Spliced and Wrapped	Bushing	AN111-5
85731	Rudder Control Cable	2	5/32	19.093	Spliced and Wrapped	Bushing	AN111-5
85731	Steerable Tail Wheel Cable	2	5/32	55.500	Spliced and Wrapped	Bushing	AN111-5
85731	Steerable Tail Wheel Cable	2	5/32	30.500	Spliced and Wrapped	Bushing	AN111-5
85731	Elevator Control Cable	2	5/32	59.875	Spliced and Wrapped	Bushing	AN111-5
85731	Elevator Control Cable	4	5/32	99.875	Spliced and Wrapped	Bushing	AN111-5
85731	Elevator Control Cable	2	5/32	62.125	Spliced and Wrapped	Bushing	AN111-5
87-64-052-5	Rudder Tab Control Cable	1	1/16	109.375	Soldered	Link	84907
87-64-052-9	Rudder Tab Control Cable	1	1/16	109.000	Soldered	Link	84907
87-64-052-6	Elevator Tab Control Cable	1	1/16	110.500	Soldered	Link	84907
87-64-052-10	Elevator Tab Control Cable	1	1/16	108.250	Soldered	Link	84907
87-64-047-1	Aileron Control Cable	1	5/32	24.000	Spliced and Wrapped	Bushing	AN111-5
87-64-047-2	Aileron Control Cable	1	5/32	115.688	Spliced and Wrapped	Bushing	AN111-5
75-64-056-1	Aileron Control Cable	1	5/32	111.000	Spliced and Wrapped	Bushing	AN111-5
75-64-056-3	Aileron Control Cable	1	5/32	121.938	Spliced and Wrapped	Bushing	AN111-5
75-64-056-5	Aileron Control Cable	1	5/32	27.500	Spliced and Wrapped	Bushing	AN111-5
75-64-056-7	Aileron Control Cable	1	5/32	20.750	Spliced and Wrapped	Bushing	AN111-5
87-25-503-2	Cabin Release Cable	1	1/16	53.563	Sweat Soldered	Terminal	87-25-626 200505
87-69-986-1	Ground Charger Cable	1	3/32	21.250	Frayed and Soldered	Ferrule	87-69-991 87-69-992
87-530-1010-1	Parking Harness Cable	1	1/8	10.250	Swaged	Terminal	AN666-4 L. H.
87-530-1010-2	Parking Harness Cable	1	1/8	29.880	Soldered	Thimble	AN100-4
75-70-448-1	Bomb Control Cable	1	1/16	8.000	Sweat Soldered Soldered	Nipple Turnbuckle	070713 049324
75-70-448-2	Bomb Control Cable	1	1/16	9.000	Sweat Soldered	Nipple	070713

CABLE CHART *(Cont'd)*

Part No.	*Assembly Title*	*No. Req'd*	*Dia.*	*Length (Inches)*	*End Fitting Attachment*	*End Fitting Type and Part No.*	
75-70-448-3	Bomb Control Cable	1	1/16	10.000	Sweat Soldered Sweat Soldered	Nipple Clevis	070713 066135
75-70-448-4	Bomb Control Cable	1	1/16	11.000	Sweat Soldered Served and Soldered	Nipple Bushing	070713 81435
75-70-448-5	Bomb Control Cable	1	1/16	12.000	Sweat Soldered Served and Soldered	Clevis Bushing	066135 81435
75-70-448-6	Bomb Control Cable	1	1/16	13.000	Soldered Sweat Soldered	Turnbuckle Clevis	049324 066135
75-70-448-7	Bomb Control Cable	1	1/16	14.000	Sweat Soldered Sweat Soldered	Nipple Handle	070713 75-70-514
87-32-528-1	Upper Parking Brake Cable	1	1/16	32.750	Sweat Soldered Sweat Soldered	Clevis Turnbuckle	066135 75-64-110-7
87-32-528-3	Lower Parking Brake Cable	1	1/16	14.250	Sweat Soldered Sweat Soldered	Clevis Turnbuckle	066135 75-64-110-7
87-45-544-1	Belly Tank Release Cable	1	1/16	7.063	Sweat Soldered Frayed and Soldered	Nipple Handle	070713 0159268
87-43-521-2	Starter Cable	1	1/16	25.000	Wrapped—Spec. 98-25513-F Soldered	Thimble Rod	AN100-3 74226-1
87-25-572-1	Cabin Control Cable	1	1/16	179.750	Sweat Soldered Sweat Soldered	Turnbuckle Thread	75-64-110-3 87-25-912
87-25-572-2	Cabin Control Cable	1	1/16	135.125	Sweat Soldered	Thread	87-25-912

SECTION X
SERVICE INSPECTION

INDEX TO COLUMN NUMBERS

The inspections outlined in this section are arranged to correspond with the columns on AAF Form No. 41-B, the corresponding column numbers being found to the left of the pertinent paragraphs. The following index is provided for convenience in locating inspections specified for the various components of the airplane:

Column

10 Preflight Inspection
11 Bombing
12 Gunnery
15 Communications
19 Daily Inspections—Power Plant
20 Engine Controls
21 Engine Instruments
22 Ignition and Electrical
23 Fuel System
24 Oil System
25 Cooling System
26 Valves
27 Manifolds and Supercharger
28 Propellers and Accessories
29 General—Power Plant
30 Daily Inspections—Airplane
31 Cockpit
32 Flight Control Mechanism
33 Movable Surfaces
34 Fixed Surfaces
35 Fuel Tanks
36 Tail Wheel Gear
37 Landing Gear
38 Wheels and Brakes
39 Hydraulic System
40 Fuselage
41 Oxygen Equipment
43 General—Airplane
44 Navigation Instruments
46 Battery

Results of these inspections will be recorded on AAF Form No. 41-B maintained for each airplane.

PREFLIGHT INSPECTION

Any Defects Noted During This Inspection Will Be Entered Under Appropriate Column Number On Inspection Form.

Col 10

GENERAL.—A preflight inspection must be made prior to the first flight of each day and at least once every seven days. This requirement does not include airplanes in "storage" status or in the engineering shops for repairs. Every effort should be directed toward minimizing the inspection time required without sacrificing full coverage of the listed items. If the daily inspection is performed a short time before flight, the majority of the inspections and checks listed below should be made at the time of daily inspection thus minimizing the time required for the preflight inspection. Preflight inspections are normally performed by a crew chief and at least two assistants. The procedure may be speeded up by the addition of more personnel to the crew, each qualified man being assigned a particular section of the airplane.

WARNING

Do not tow the airplane unless a member of the ground crew is in the cockpit to operate the brakes. Be sure the landing gear control handle is in the "OFF" position.

BEFORE STARTING ENGINE

Col 10

FLIGHT DATA

Examine the airplane flight report for completness. If it is incomplete, make the necessary entries to complete it. Note whether routine inspections are due. If they are due and cannot be made, see that the proper symbols are entered to indicate the omission of the inspections. See that the proper operating data are stowed in the airplane.

STATIC GROUND

Check condition of static ground forward of tail wheel doors.

WHEEL CHOCKS

See that wheel chocks are in proper position.

FUEL AND OIL SYSTEMS

Check the quantities of fuel and oil in the tanks; fill if necessary, and enter the quantites on the Airplane Flight Report, Form No. 1-A. See that tank caps are secured after filling the tanks.

Col 10

Note

This check must be made on the day the airplane is to be flown, prior to the first flight of the day. Checks made on a previous day cannot be considered part of the preflight inspection.

Drain all accessible fuel strainers (including tank drains). Inspect all drain cocks and plugs for proper safety.

Visually inspect for leaks the structure surrounding the cells of the self-sealing fuel tanks and all fittings attached to the cells which are visible through quick-opening access doors in the keel fairing.

Note

Self-sealing fuel tank drains must be secured by a wrench applied to the shoulder of the drain while operating the drain cock, to prevent torque from being transmitted to the fuel tank, which would cause the fitting to tear loose. Extreme care must be exercised by all personnel handling fuel tanks, to prevent damage to the fittings.

Rotate the fuel cock control handle one complete revolution and note whether binding occurs at any point. Should binding exist, the control linkage will be checked for correct alignment.

Note

Always set fuel cocks by "Click and Feel."

Check fuel systems which have been treated for use of Aromatic fuels for correct and discernible identification marking.

See that wing tank scupper drains are clear.

Check all oil system drain plugs and drain cocks for leakage and for proper safetying.

Inspect oil cooler for security of mounting and evidence of clogging. Inspect for proper blanketing according to weather conditions and existing orders.

During cold weather operation below 0°C (32°F) drain the oil pressure gage line and refill with hydraulic fluid, Specification AN-VV-O-366.

CARBURETOR AIR FILTER

Inspect carburetor air filter for contamination. If there is evidence of dirt collecting, clean the filter.

COOLING SYSTEM

See that coolant expansion tank is filled to proper level, and replace and safety wire the tank filler cap. If it is necessary to add coolant liquid, refer to section III, paragraph 2. *g*. (3).

Inspect all lines, connections and clamps for any damage. Make sure they are tight.

Col 10

LANDING GEAR

Inspect landing gear and fairings for damage and for obvious defects. Check for proper tire and shock strut inflation. (Inflate tires to inflation mark.)

Inspect for distorted rim flanges and rims, security of retaining nuts, bolts, and cotter pins.

HYDRAULIC SYSTEM

Check the level of the fluid in the hydraulic reserve tank. Fill, if necessary, with hydraulic fluid, AAF Specification 3586.

PROPELLER

Make sure ignition switch is off, and then inspect propeller blades for nicks, scratches, looseness, and other obvious defects.

See that the propeller is properly installed and that all exposed screws, pins, bolts, etc., are tight and safetied.

Check, that blades follow in the same plane of rotation so that there is not over 1 8-inch variance from that plane.

PITOT-STATIC TUBE

Remove the protection cover and check tube openings for freedom from obstructions. Test heating unit. Drain air-speed lines.

SURFACES

Inspect wings, ailerons, fuselage, stabilizers, elevators, and rudder against damage or obvious defects.

Check all screws which attach wing tank doors to bottom surface of wing.

FUSELAGE

Inspect fuselage (outside) for—loose or wrinkled skin, sheared or loose rivets, faulty doors, holes, breaks and loose cowling. Inspect fuselage (inside) for—any loose equipment, corrosion due to faulty battery, any damaged or defective bulkheads, stringers and all parts of interior construction.

TAIL WHEEL

Inspect tail wheel for condition of tire and for proper inflation of tire and shock strut. (Tire should be inflated to inflation mark.) Inspect tail wheel doors and linkage for general condition.

COWLING

Check cowling and all inspection doors and covers for security.

OXYGEN SYSTEM

Check oxygen equipment for condition, completeness, sufficient pressure, and proper functioning.

CAUTION

The Low Pressure oxygen cylinders installed on aircraft operating in combat zones will be charged not to exceed 450 pounds per square inch.

ELECTRICAL SYSTEM

Exposed electrical contact point, commutators, etc., shall be cleaned of dust.

Col 10

COCKPIT

Windshield and cockpit canopy must be clean.

The sliding canopy must function properly.

Make sure that the cabin release mechanism is lock-wired. If lock wires are not installed, the canopy may be ripped off by the slip stream, causing serious damage to the airplane.

Verify that canopy emergency release is properly safetied.

INSTRUMENTS

Set clock to Operations Office time.

Set altimeter to station altitude, or as directed by pilot.

Inspect coolant thermometer fastenings for anchorage. Be sure that bulb will not work loose.

Set rate-of-climb indicator at zero, and tap instrument to insure that hand is properly set.

Air-Speed indicator pointer must indicate "zero," or value of wind velocity component, in direction airplane is headed.

Check compass for discoloration of liquid and for evidence of bubbles.

Check instruments for broken or loose cover glasses and other visible defects. Particular attention should be given to cover glasses that may have been marked to indicate proper operating limits.

Clean all instrument cover glasses with a clean cloth. Special care should be exercised with the individually lighted instruments, as scratches, finger prints, etc., on the cover glasses disturb the lighting.

Check the shockproof instrument board for flexibility.

Inspect lamps; replace those found defective.

Note

> In sub-zero weather, malfunctioning of all instruments may be avoided by pre-heating the instrument panel. A standard radiant heater attached to an external source of power can be used for this purpose.

MISCELLANEOUS EQUIPMENT

Check the following:

MAP CASE.—A map case is installed on the right side of the cockpit adjacent to the pilot's seat.

FIRST AID KIT.—On airplanes AF42-104429 through AF42-104828, provision is made for attaching the first aid kit to the map case. On airplanes AF42-104829 and subsequent, the first aid kit is stowed in the duffle bag. If seal is broken on the First Aid Kit, report the condition.

PARKING HARNESS.—On airplanes AF42-104429 through AF42-104828, the parking harness is stowed in the parking harness bag located immediately below the pilot's head rest. On airplanes AF42-104829 and subsequent, the parking harness is stowed in the duffle bag.

Col 10

DUFFLE BAG.—The duffle bag is located in the stowage compartment.

SPECIAL TOOLS AND EQUIPMENT.—These are carried in a special tool pocket attached to the duffle bag.

MOORING KIT.—The mooring kit is carried in two special pockets attached to the duffle bag.

STARTER CRANK AND CRANK EXTENSION.—On airplanes AF42-104429 through AF42-105428, the starter crank and crank extension are located on the right side of the fuselage directly opposite the access door. On airplane AF42-105429 and subsequent, they are stowed in one piece on the left side of the fuselage forward of the access door.

Security of baggage door latch.

NIGHT-FLYING EQUIPMENT

Check lighting of all landing, running, and spotlight lamps. Replace any defective lamps or fuses.

FLIGHT CONTROLS

See that the flight controls are unlocked.

See that flight controls operate freely, and that there is nothing in the cockpit that will interfere with the controls.

Before starting engine, check proper functioning of wing flap system. If flaps operate briskly after airplane has been idle for twenty-four hours or more, the system is in proper operating condition.

See that all trim tabs are in proper position.

Check operation of brake and parking brake controls (there must be sufficient slack in parking brake control cables to allow full application of brakes without locking parking brake.) Brakes must hold airplane at full throttle.

BATTERY

Take hydrometer readings of the battery, if any cell is too high or too low, turn battery in for check.

Add distilled water as necessary.

Inspect battery leads, and check to see that vents are open.

BOMBING

Inspect bomb racks and controls for proper operation.

See that the sway brace feet on each side of each bomb contact the bomb and prevent any side motion.

Do not tighten the sway brace turnbuckles excessively.

BELLY BOMBS: Inspect the sway braces for proper tension and for correct position. See that turnbuckles are safety wired. Inspect the bomb shackle for security of mounting and for proper operation.

Col 10

WARNING

See that the feet of the sway braces do not contact the bomb below its center line or the bomb will not release.

GUNNERY

Clean gun sight reflector glass and the dust shield assembly over the main lens.

Determine that the reflector is held securely in its support.

See that gun sight body is held firmly in its mount, and that no shake or wobble is present. Check electrical connections for contact, and determine whether both lamp filaments will burn. Loss of one filament is shown by a reduction in reticle brilliance. If the lamp is burned out, replace it with an RP 11, 21-21CP, double-contact, candelabra base, inside-frosted lamp of voltage corresponding to that of the airplane power supply. The lamp may be checked in the sight without removing it, by using an ohmmeter to measure the resistance of a filament when cold. The resistances are measured at the sight connections.

Lamp voltage rating	*One filament*	*Two filaments*
24-28 volts	*.4 ohm x 10*	*.2 ohm x 10*

Determine whether the rheostat functions smoothly, to control the intensity of light satisfactorily.

See that the reticle pattern is reflected properly by the sight reflector.

Check reflector for cracks and or chips.

Check alignment of sight-to-flight line and harmonization of guns to sight line.

Start proofing

Make certain that guns are clean, oiled, and in operating condition.

Check for correct headspace adjustment.

Check for correct timing.

Note

Use the new headspace and timing gage assembly, Ordnance Part No. A-351217.

Check the feed and ejection chutes for misalignment and defects.

Make certain ammuntion boxes are loaded before all gunnery missions.

Col 10

Check ammunition belt for freedom of movement through chutes, over rollers, and in boxes. Check to see that guns are loaded and fully charged. Do this by hand charging until a live round is ejected from each gun.

Check gun sight for burnt-out lamp and for parallax in sighting.

CAUTION

Care must be exercised by all personnel working on the airplane after the guns are fully charged in order to prevent accidental firing of the guns. To guard against this, the safety firing switch as well as the gun circuit breakers, located on the instrument panel, should be in the "Off" position.

Note

Except when on gunnery missions, the blast tube openings shall be covered over and sealed with masking tape to keep dirt and moisture out. Transparent scotch acetate tape will be used to cover the ejection chute openings in the underside of the wing.

BLAST TUBES

Check for security of attachment, and for alignment. Be sure blast tubes are not tight on retainers. Back off approximately 1/2 turn from tight position.

COMMUNICATIONS

Visually inspect all radio equipment for general condition. Make operating check of all units. (Tests of radio compasses will be conducted at a distance from hangars.) Inspect fixed antenna system for condition, and see that the lines are taut. Do not use pliers on any part of the antenna wires. Clean dirt and carbon from insulators.

Note

Installed radio transmitters will not be operated (dynamotor running) if any point of the antenna system is nearer than one foot to any other object.

DURING ENGINE WARM-UP

Col 10

WARNING

If fuel has been spilled during refueling operations, move the airplane a safe distance from that location before starting the engine.

Warm-up test periods should be as brief as possible, to prevent excessive wear on moving parts.

Col 10

Before starting the engine, pull propeller through several revolutions by hand, to clear the combustion chambers.

WARNING

Be sure the ignition switch is "OFF" before attempting to rotate the propeller by hand.

Col 10

Do not run engine at high speeds with control surfaces locked.

PROPELLER AND ACCESSORIES

Check propeller operation for full range and free operation of controls.

Note

Do NOT operate the propeller blade pitch angle changing controls unnecessarily when the engine is not running.

ENGINE INSTRUMENTS

Check engine instruments for proper operation and excessive pointer oscillation, and note whether the pointer indications are consistent with the stage of warm-up.

Check engine gage unit for pointer tolerances at "ZERO". (Tolerance for fuel pressure gage, ±.2 pound for oil pressure gage, ±5.0 pounds; for thermometer, ±3.0 degrees of existing room temperature.)

Check manifold pressure gage by gunning the engine. Needle should move freely to the left. Check with a barometer, if practicable. Check all connections for leaks.

IGNITION AND ELECTRICAL EQUIPMENT

With the engine running at about one-third throttle, turn the ignition switch momentarily to the "OFF" position. If the engine does not entirely cease firing, defective functioning of the switch or connections (likely the ground connection) is indicated. For the test, the engine must not be excessively hot, and the period during which the switch is off must be brief, so that the engine does not slow down too much.

DANGER

If the engine does not cease firing when the switch is placed in the "OFF" position, it will be necessary to stop the engine by moving the mixture control to "IDLE CUT-OFF.'

Col 10

WARNING

AFTER THE ENGINE STOPS, DO NOT TOUCH THE PROPELLER UNTIL THE DIFFICULTY HAS BEEN FOUND AND CORRECTED AS THE ENGINE MAY START OR "KICK OVER," CAUSING SERIOUS INJURY OR DEATH.

With the generator line switch "ON" and the engine running at cruising speed, and an electrical load applied, note if the ammeter indicates "CHARGE."

Note

Operate the motor-driven hydraulic pump to obtain electrical load. With no electrical load (and battery fully charged), the ammeter reading should return to zero.

FUEL SYSTEM

Test the functioning of the engine on each fuel tank, obtaining the required fuel pressure on each tank. Check that the gage registers the amount of fuel in tanks.

Note

Always set fuel selector valve by "click-and-feel" method.

The fuel selector valve must turn readily when shifting from one tank to another.

With fuel "ON" and pressure built up, inspect carburetor and fuel line connections against leakage (particularly at drain plugs, passage plugs and parting surface of body castings) and for security of mounting and proper safetying.

NAVIGATION INSTRUMENTS

With the engine running at 1,000 rpm or more, note reading on suction gage. Reading should be 3.75 to 4.25 in. Hg.

With the flight and turn indicators uncaged, and the gyro operating under rated suction, the horizon bar and card should settle to indicate the attitude of the airplane sitting on the ground, within two minutes after suction is turned on.

AFTER - FLIGHT INSPECTION

Any Defects Noted During This Inspection Will Be Entered Under Appropriate Column Number On Inspection Form.

Col 10

Note

If the airplane is to remain outside over-night, or if an engine start is anticipated in temperatures below −1°C (30°F), before stopping the engine, use the oil dilution system.

LANDING GEAR

After an abnormal or unusually hard landing is known to have been made, the upper and the lower retracting links on the main landing gear will be inspected. Defective upper or lower retracting links will be replaced immediately by new links obtained from class 01-C stock.

Col 10

OXYGEN EQUIPMENT

At completion of a flight involving the use of oxygen, mouthpieces or masks will be sterilized. (If no standard facilities are available, consult the medical officer.) Valves on oxygen cylinders will be turned off immediately. Check contents of cylinders as indicated by pressure.

Col 10

FUEL AND OIL SYSTEMS

All fuel and oil tanks will be serviced to the normal supply, and the quantities entered on Form No. 1-A, at completion of the day's flying.

PROPELLERS AND ACCESSORIES

At end of day's flying, clean propeller, inspect it, and coat it with clean engine lubricating oil.

Note

Coating the metallic propeller blades and hubs with engine oil protects the exposed surfaces of the propeller from corrosion. The oil also seeps into cracks that exist in the blade or hub, making otherwise obscure cracks stand out, and thus facilitating inspection.

Propellers installed on aircraft operating near salt water will be flushed off with fresh water, dried, and coated by spraying lightly with engine lubricating oil. Excess oil will be wiped off.

POWER PLANT—GENERAL

Sufficient cowling will be removed in order to check for fuel and oil leaks within the engine section, and for failures of wires, lines, connections, attachments of exhaust stacks, etc.

Col 10

BOMBING

Inspect bomb racks for any remaining bombs. Inspect bomb rack controls for proper positioning.

GUNNERY

Remove ammuntion from all guns and ammunition boxes. Check all ejection chutes for jams and for alignment with gun. Remove mechanism from all guns, and check parts for wear, burrs, breakage, or other defects. Clean and lubricate guns, and reassemble. Check head space, and test firing mechanism.

The guns will be cleaned as soon as possible after firing.

After flight, the installation will be inspected for loose gun mounts, broken, worn, or defective parts, gun stoppages and their possible causes and remedies for same.

PITOT-STATIC TUBE

See that air-speed protection cover is installed.

SURFACE CONTROLS

Attach the parking harness.

DAILY INSPECTION

To Be Performed At Any Time During the Day. Any Defects Noted During This Inspection Will Be Entered Under Appropriate Column Number On Inspection Form.

POWER PLANT

Col 19

PROPELLER

Carefully inspect exterior of all parts against cracks or other failures, misalignment, or other damage, giving particular attention to leading and trailing edges and tip portions of the blades. A propeller involved in any accident will not be used before it is first disassembled and the parts carefully inspected for damage and misalignment.

WARNING

Do not turn propeller by hand without first insuring that the ignition switch is off.

COWLING

Inspect the engine cowling and exposed portion of the mounting brackets for security of attachment, cracks, deformations, and general condition of the fasteners.

ENGINE

Determine whether engine is due for overhaul. Inspect exposed portions of the engine mount and mounting brackets for general condition and security of attachment to the fuselage.

Inspect oil, fuel and battery vent and overflow lines for security of anchorage, clogging, breaks or kinks and to see that drain lines extend below cowling. Inspect the Generator, Generator Voltage Regulator and the Motor-Driven Hydraulic

Col 19

Pumps for: loose connections; worn or binding or short brushes; pitted or scored commutator or contacts. Replace any defective wiring.

Check the generator engine oil seal for evidence of leakage.

Inspect generator, switches, coils, solenoids, starter and magnetos for cracked housings or flanges, security of mounting, tightness of housing bolts, safetying, etc.

SPARK PLUGS AND ADAPTERS.—Inspect carefully for signs of gas and oil leakage.

Inspect spark plugs to see that elbows all point down and are in a vertical position.

WIRING HARNESS LEADS.—Inspect leads on exhaust side of cylinders for burning due to exhaust leakage.

ENGINE CONTROL LINKAGE.—Inspect all engine and engine accessory control rods, levers, shafts, and connections for freedom of movement, excessive free play, security of attachment, and presence and condition of all locking devices.

OIL THROWING AND LEAKAGE.—Inspect engine for evidence of oil throwing, and all oil lines and connections for leakage, chafing and security.

COOLING SYSTEM.—Check the poppet type relief valve in the filler unit on the coolant expansion tank for freedom of motion.

Col 19 Check radiators, expansion tank and hose connections for leaks.

Drain plugs must be safetied. Coolant pump leakage must not exceed 3 drops per minute.

EXHAUST MANIFOLDS. — Inspect exhaust manifolds for "blown" flange gaskets and warped or broken flanges, loose or damaged studs, and loose or missing nuts.

CARBURETOR.—Inspect carburetor and fuel line connections for fuel leakage, paying particular attention to drain plugs, passage plugs, and parting surfaces between regulator castings.

Col 19 Inspect throttle and mixture control connections. Be sure they are tight and properly safetied. Inspect all safety wiring on carburetor.

CUNO OIL FILTER-SPECIAL—TEN HOURS

Check the turning mechanism of the automatically operated filter for proper operation by installing the manual turning nut, marking its position, and noting if it has moved after the engine has been idled for approximately five minutes. Non-movement of the nut denotes a defective unit, which should be replaced.

AIRPLANE

Col 30

LANDING GEAR AND TAIL WHEEL

Visually inspect condition of landing and tail wheel gear, struts, braces, and fittings.
Check shock struts for proper inflation and for evidence of leakage.
Check doors, fairings, and linkage for condition, security of attachments, and proper adjustment.
Check wheels for bent or distorted rims and for security of retaining bolts and nuts.
Check tail wheel for freedom from foreign matter.
Check tires for general condition and against cuts, pulling away from rims, and evidence of interference or chafing against other parts.
Check all units for proper safetying.

SURFACES

Inspect wings, fuselage, and horizontal and vertical stabilizers for general condition, distortion, pulled rivets, or other evidence of failure; security of attachment, etc.
Check the screws which attach the wing tips to the wing panels.

Col 30 Inspect flight control surfaces (flaps, ailerons, rudder, and elevators) for general condition.
Inspect fairing for security of attachment and against cracks, dents, etc. Check doors for proper operation and condition of fasteners.

VACUUM LINES

Inspect vacuum lines for tighness of joints, security of anchorage, and general condition.

HYDRAULIC SYSTEM

Check all hydraulic units for leakage.

SAFETY BELT

Inspect fabric and leather parts for cuts or fraying; latching devices for condition and operation; fittings and attachment parts for condition and security of fastening. Check for date of last weight test.

SPECIAL FIVE-DAY INSPECTION

The guns will be inspected for rust and corrosion at least every five days, and cleaned and reoiled, if necessary. In any event, the bore will be dry swabbed, inspected, and reoiled every five days.

PERIODIC INSPECTION

Regular Preflight And Daily Inspections Will Be Performed In Addition To The Periodic Inspections Specified Below.

Col 11

BOMBING

50-Hour

Inspect structure, installation, fittings, releasing and arming mechanisms.
Clean racks with kerosene, Federal Specification VV-K-211.
Clean entire control system.

Col 12

GUNNERY

25-Hour

The gun mounts will be inspected for worn, broken, or defective parts, including self-locking stop nuts, worn threads, etc.
The guns and gun sight will be checked for proper alignment in relationship with each other and also with relationship to the line of flight of the airplane. This is accomplished with the aid of the fixture kit for aligning the guns or the type J-2 boresighting kit.

Col 12

50-Hour

Perform maintenance inspection on all gunnery equipment (not to exceed 30 days between inspections whether equipment has been used or not).
Gun Sight: Check for alignment with flight line; and reflector for cracks or chips.
Guns and Mounts: Make complete inspection of gun mounts, thoroughly clean and inspect solenoids and other related accessories for security of attachment and operation. Adjust setting of guns with respect to flight line.

Col 15

COMMUNICATIONS

100-Hour

Remove and inspect all radio set boxes, clean with compressed air. Check all tubes and replace any found defective (serviceable tubes will be replaced in same sockets from which removed). Replace all fixed antenna wires and inspect trailing antenna wires, replacing if necessary. Check cords, plugs and flexible conduit for loose connections, corrosion, bonding, etc. Reinstall and safety radio set boxes. (Accomplish this inspection at least once every three months regardless of flying hours.) Installed dynamotors will be turned in for major overhaul at least once each year.

Col 20

ENGINE CONTROLS

25-Hour

Inspect entire control installation from levers in cockpit through all linkage; support brackets. Inspect for full and free movement and lost motion. See that all levers are adjusted to prevent creeping.

50-Hour

Thoroughly clean all control cables where they pass over pulleys, through fairleads or other points of contact.

In areas where atmospheric conditions are conducive to forming corrosion, coat the cables with rust preventive compound, Specification AN-C-52.

Lubricate throttle and mixture control fire wall guides with grease, Specification AN-G-3.

Col 21

ENGINE INSTRUMENTS

25-Hour

Inspect the manifold pressure regulator for security.

50-Hour

Manifold Pressure Gage: Check reading of instrument with Station Barometer. If it differs more than 0.4 inch of mercury, replace and turn in defective instrument for bench check.

Tachometer: Inspect leads for security, flexibility, anchorage and shielding.

Engine Gage: Inspect pointers for tolerance at zero. SPECIAL: Inspect oil line to see that it is filled with a light grade oil during operation in excessively cold weather.

Hydraulic Pressure Gage: Inspect gage for reading consistent with requirements.

100-Hour

Remove manifold pressure gage and check for scale error and case leaks.

Col 22

IGNITION AND ELECTRICAL

25-Hour

Check ignition shielding conduit anchorages for security and flexible conduit nuts for tightness. Inspect spark plug cable connector insulators for

Col 22

cracks, burns and all defects. Check cable contact spring retainer assembly for freedom of movement and determine that springs are not broken. Check elbow terminals and shielding nuts of shielded installations, for security.

CAUTION

> When checking the elbow assembly of shielded plugs EXTREME CARE must be exercised to prevent rotation of the barrel with respect to the shell, since this will change the gap setting.

Inspect the three threaded connectors in each distributor drive housing for looseness. The three connectors are the two distributor head housing to ignition cable tube connectors and one ignition cable cross tube connector. If there is any looseness, remove the loose connector from the housing and install a new connector.

CAUTION

> It is important that the above inspection be carried out periodically because, once the connector has started to work loose at its threaded fitting in the distributor housing, continued engine operation may damage the housing beyond repair. A new connector should be installed at the slightest indication of looseness.

MAGNETOS

Remove breaker cover and inspect cam and breaker cap for excessive amount of lubricant. If any excess, remove breaker assembly and clean with gasoline, allowing to dry thoroughly, then apply three or four drops of oil, lubricating, aircraft engine, grade 1100, Specification AN-VV-O-446. After application of oil, the felt should be soft and contain just enough lubricant so that oil can be brought to the surface when felt is squeezed. Do not give it all it can hold and do not permit oil to drip from the felt lubricators nor to touch the breaker contacts. No additional lubrication of the breaker should be required between engine overhaul periods unless subsequent cleaning is necessary.

Note

> Under no circumstances will any other type of grease or lubricant other than that specified, be applied to breaker mechanism.

SPARK PLUGS

Spark plugs should be removed and the gap clearance reset to .012 inch, + .002 inch, − .001 inch. Reinstall plugs with gaskets (new, where necessary), then check the elbow terminal and shielding nuts for security. In the latter operation, the barrel must not be loosened for rotated with respect to the shell, since this will change the gap setting.

Col 22 In measuring gap, use hard steel wire of suitable diameter, inserted parallel to center electrode. Do not use flat-feeler half round, crow bar or wedge type gap gages.

For gap setting, use AC tool No. 1558087 with the correct size bushing. Adjust the gap carefully and precisely. Do not attempt to use any other method.

CAUTION

Never regap with wire gage in gap because the pressure resulting on the center electrode will crack or break the insulator. For the same reason, do not use the center electrode as a pry to increase the clearance between the shell and center electrodes.

If the gap has been closed below the low limit during regapping, the plugs can still be used if the gap clearance is not less than .008 inch. If less than .008 inch the plugs must not be used, but must be returned to the control depot for their handling. Do not try to widen the gap. The shell threads of the plugs should then be lightly lubricated with a small amount of spark plug thread lubricant Specification AN-VV-C-566, with the lubricant thoroughly stirred prior to use. Make certain to remove any lubricant from the firing end of the plug, which may have been accidentally deposited there.

Install the spark plug with a good spark plug copper gasket on the plug, making certain that there is no old gasket sticking to the cylinder head. The new gasket should be free of deep ridges or nicks and should not be excessively flared out nor flattened to insure leakproof compression.

Start the plug into the spark plug hole by hand, making certain that it turns freely before using the wrench. Then, with a torque wrench having not more than a 10-inch leverage, tighten plugs with a maximum of 480 inch pounds. Pressure greater than this should be avoided since cracked or distorted shells are apt to result.

CAUTION

Do not install or tighten spark plugs in a hot engine, as thread seizure with subsequent damage to the spark plug shell and cylinder bushing may result.

When connecting elbow terminals to plugs do not tighten the terminal and shielding nut excessively but only sufficiently for a snug fit, as the elbow terminal and plug may be damaged. It may also be found, when unscrewing tightly installed elbow nuts from spark plugs, that the barrel will tend to loosen and unscrew from the shell. If the barrel is turned at any time as above, the plug should not be used until gap is checked. All plugs should be inspected at the time of

Col 22 installation for evidence of damage to the threads or terminal. Those which are damaged either on the threads or the entrance to the terminal well will be replaced.

50-Hour

Generators: Inspect for security of mounting, excessive arcing, dirty or loose connections, conditions of terminals, worn or binding brushes, and installation of safety wire.

Generator Control Panel: Inspect for security of mounting, excessive arcing, cleanliness, condition of contact points, proper safetying, etc. Inspect terminals, cables and connections for condition and security of attachment. Check condition of vibration absorption mounts. Check voltage regulator element for proper setting.

Electrical Wiring: Inspect all electrical wiring for proper anchorage of conduit nuts, bonding, leads, and terminal box covers, condition of connections, terminals, exposed ends and contacts.

Switches and Solenoids: Inspect for security of mounting and security of all electrical leads, particularly magneto ground connections.

100-Hour

All spark plugs will be removed and replaced with new or reconditioned plugs of the approved type. Replaced plugs will be treated immediately after removal by immersing the shells only in rust preventive compound, Specification AN-VV-O-576, or in hot engine oil, Specification AN-VV-O-446.

Whenever a spark plug is removed from the engine, the spark plug ports in the cylinder heads should be inspected for foreign particles. The high operating temperature, in the cylinder combustion chambers, sometimes causes the residue from the fuel and oil to fuse together, forming residual deposits around the ports. These may eventually bridge the spark plug electrodes, causing the spark plug to become short circuited. If a deposit is found it should be carefully removed. Care must be used to avoid damaging the spark plug insert or other engine parts. A sharp wooden stick is sufficient to remove such deposits. Check the wiring harness cables using the high voltage tester.

If contact breaker arm cam rubbing block extends less than 1/16 inch beyond arm, replace the entire breaker arm assembly. Install new cam lubricating pad and clip assembly.

Col 23

FUEL SYSTEM

25-Hour

Relief Valves: Clear relief valve cover plug by inserting a drill or wire into the vent opening. Inspect valves for leaks and proper operation.

Fuel Pumps: Check pumps for security of mounting, leaks, and proper operation.

Fuel Strainers: Remove and clean all fuel

Col 23 strainer screens (including carburetor screen). Inspect for breaks and tears. Clean strainer bodies. Replace screens, plugs and drain valves and resafety.

Note

> Fuel supply line does not have to be disconnected in order to clean strainer.

Check carburetor air scoop flange nuts for tightness.

Carburetor: Check attachment bolts for tightness.

Inspect the carburetor air heater valves for wear and excessive play. Replace all defective parts. Inspect fuel primer for leaks, security of mounting and proper operation.

Fuel Lines: With fuel "ON" and pressure built up, inspect self-sealing fuel lines and connections for leaks, evidence of deterioration, cracks, security of anchorage, chafing, tightness and condition of hose connections and hose clamps.

Inspect all fuel overflow or drain lines for security of mounting, kinks, breaks, or stoppage. Check to see that lines extend beyond cowling.

Fuel Tanks: Check tanks for evidence of leaks. Inspect self-sealing tanks against evidence of deterioration.

Lubricate throttle shaft bushings, using oil, Specification AN-O-6.

50-Hour

Drain the carburetor regulator unit, air chamber, and fuel chambers and fuel control unit through plugs in bottom. Remove and clean air intake screens. Clean the air scoops, if necessary.

Inspect fuel booster pump for security of mounting, proper operation and general condition.

Fuel Cock Control: Inspect for conditions that would cause binding or excessive backlash, general condition of universal joints, cockstem, yokes, yoke pins, yoke driven lugs, and dial and handle assemblies, rivets, taper pins, gear boxes, spindles, shafts and cable. Check for interference with other parts.

CAUTION

> Whenever fuel cock controls are disconnected or assemblies are removed or replaced the reassembled parts must be checked to insure the valve ports open to the tank positions indicated by the control-handle pointer.

Grease mechanism of mixture control latch, using grease, Federal Specification VV-G-681-Medium.

100-Hour

Fill the seal chamber of the engine driven fuel pump approximately half full with grease, lubricating, cup, medium, Federal Specification VV-

Col 23 G-681. Apply thorough Alemite or Zerk fitting on one of the 1/8 inch pipe tapped connections next to the engine pad.

Replace carburetor automatic altitude mixture control unit.

Remove and clean the priming jets on the side induction manifolds and the jets and filter in the supercharger elbow.

Check the flow of fuel from priming pump. Check the complete priming system for leaks.

Col 24

OIL SYSTEM

25-Hour

Oil Lines: Inspect for leaks (particularly at connections and passage through fire wall or other structure), security of attachment, dents, cracks, chafing, etc., hose connections and hose clamps for general condition and proper location of clamps.

Remove and clean the oil filter cartridge. Check cartridge rotation. Check that all cleaner blades are straight and flat. Check that all discs are flat, evenly spaced and free from burrs or nicks. Oil Cooler: Inspect for security of mounting, general condition, and for evidence for clogging in air passages.

Inspect all tanks and protection of tanks.
Inspect all piping for any imperfections.

50-Hour

Remove the oil drain plugs and inspect for accumulations of sediment. Clean, reinstall, and safety drain plugs.

Oil Tank: Inspect oil tank for security of mounting, signs of leakage, condition and location of padding, proper tension of supporting straps and for proper anchorage of lines leading from tank. Inspect the oil dilution control linkage to insure that the linkage does not bind at any point and is adjusted so the dilution valve will close completely.

Oil Pump: Clean and tighten all loose connections.

100-Hour

Remove the filter and disassemble sump from head and cartridge. Clean the cartridge and check rotation (no hard spots or points of catching). Check that all cleaner blades are straight and flat. Check that all discs are flat, evenly spaced, and free from burrs or nicks.

CAUTION

> Great care must be exercised to prevent damage to the filter cartridge. Bent or misaligned blades and discs are causes for overhaul or rejection.

Clean oil filters by flushing with kerosene or an equal mixture of carbon tetrachloride and benzol.

Col 25

COOLING SYSTEM

25-Hour

Inspect radiators and expansion tanks for evidence of leaks and proper quantity of coolant. Remove ball check valve from filler unit on expansion tank and inspect ball for freedom of motion. Check relief valve opening at proper pressure.

Inspect radiator mounting, supports and mounting brackets for breakage and security.

Inspect lines for evidence of leaks, security of anchorage and wear, hose connections for condition and tightness, condition and location of clamps at air duct seals.

Inspect entire engine cowl flap control assembly for free and full movement, opening and shutting of flaps, lost motion and loose or missing bolts, nuts, screws, etc. Lubricate in accordance with lubrication diagram (figure 39).

Make sure that drain holes are open to drain any coolant that may leak past the cylinder liner lower coolant seals.

50-Hour

Inspect coolant pump for evidence of leaks. The coolant pump has a spring loaded type packing which will not require manual tightening. If leakage is excessive do not attempt to replace packing or any part of the pump. Replace the entire pump as a unit.

100-Hour

Inspect radiator for being clogged with foreign matter.

Drain and refill the coolant system using ethylene glycol conforming to Specification AN-E-2. Safety drain plug and filler cap.

Col 26

VALVES

50-Hour

At each 50-hour period the following inspection of the valve mechanism will be performed.

Check condition of cylinder head cover gasket.

Check for damaged valve springs, retainers, keepers, etc.

Check valve clearances as follows:

When adjusting valves make sure that the engine is thoroughly cool 10 C to 50 C (50 F to 122 F.) In order to check the valve clearances, first remove the cylinder head covers and rotate the propeller shaft so that the cam roller is on the base circle or heel of the cam for the particular valve being checked. Then use feeler gage between the valve stem tip and the valve adjusting screw ball end. The proper valve clearance when cold is .015 inch for the intake valves and .020 inch for the exhaust valves. If adjustment is necessary, loosen the lock nut and back off or turn down the valve adjusting screw. When retightening the lock nut, be careful not to turn the adjusting screw.

Col 26

CAUTION

Adjusting screw lock nuts must be drawn tight. Tighten by hand, but do not strike wrench with any object.

After tightening the locknut, the clearance should again be checked. All clearances which are found to be below the proper amount (.015 inch for intake valves; .020 inch for exhaust valves) should be reset to proper clearances. Reset any intake if clearance exceeds .017 inch, and reset any exhaust valve if clearance exceeds .022 inch.

When checking valve clearances, if any are found to have opened to .025 inch or more for the exhaust and .020 inch for the intake, it is well to remove the adjusting screws and examine the ball ends for abnormal wear or breaks. Otherwise the adjusting screws need not be removed between overhauls.

Col 27

MANIFOLDS AND SUPERCHARGER

25-Hour

Check outboard face of exhaust shrouds for proper clearance from flange on cowling.

Check bolts through shroud for clearance on exhaust stacks.

Automatic Manifold Pressure Regulator.

Inspect oil supply line, oil drain line, and air line, for leaks, security of anchorage, wear, dents or cracks, condition and location of clamps at rubber connections.

Oil all linkages with light lubricating oil.

Inspect all safety wiring.

50-Hour

Inspect intakes and exhaust system for damaged manifolds, loose stacks and retaining lugs, broken or loose studs, bolts and blown gaskets. Inspect exhaust shrouds for cracks and condition of spot welds.

Col 28

PROPELLERS AND ACCESSORIES

25-Hour

Inspect the clearance of the propeller brake. Clearance will be checked by inserting a thickness gage between the floating brake plate and the inner ring of the solenoid housing. This clearance should be .015 to .020 inch. To adjust clearance, do not remove nut on the motor shaft as the brake clearance cannot be adjusted from this point. Adjustment is accomplished by unscrewing end plate assembly and removing or adding the necessary number of laminated shims under the fixed friction plate to secure the desired clearance. Ascertain that end plate assembly is tight and secured after adjustment.

50-Hour

Using a magnifying glass, carefully examine exterior of all parts of propeller for cracks, nicks, bends and similar defects. Check for deterioration of markings and for proper safetying.

Col 28 Check propeller hub retaining nut for looseness. Remove brush holder from housing and check for proper contact. If brushes protrude 3/8 inch or less, they will be replaced. Clean brush holder, housing, brushes and slip ring with cleaning fluid (not to contain carbon tetrachloride) and dry with compressed air. Check brush springs for smooth action. Check magnetic brake for proper operation, looseness of brake disc and condition of lining.

Check governor for security of mounting; contact points for clearance and pitting. Inspect governor controls and electrical connections for security and conditions. Inspect governor drive shaft and adapter for excessive wear.

Check propeller relay for broken terminals; contact points for smoothness, proper alignment (middle contact should rest squarely against fixed contacts), and for free action of arm. Contact points will not be filed or stoned as no serious pitting will result with this type of point. Check to see that contact points touch before armature strikes relay coil. Check for gap of .015 inch to .025 inch between armature and relay coil when movable contact is lightly touching either of fixed contacts.

Lubricate propeller as follows:

Lubricate the hub with grease, Specification AN-G-4, Grade AA, using a pressure gun on the Zerk fitting located on the speed reducer housing just forward of the front hub face until hub is full, as indicated by a flow of grease from the relief fitting. The following lubricants conform with Specification AN-G-4, Grade AA, and can be used for this lubrication:

Texaco Propeller Lubricant No. 1.
Mobile Grease Zero
Aero Shell Grease No. 3

Check the oil level in the speed reducer by removing the filler plug located near the front of the housing and rotating the propeller until the plug opening is approximately 20 degrees below the horizontal when the airplane is at a ground angle of approximately 12 degrees and 8 degrees below the horizontal when the airplane is levelled. The oil in the speed reducer should then be at the plug opening. If not, fill the gear assembly at this point using oil, Specification AN-O-4, with which the following commercial products conform:

Curtiss Speed Reducer Oil No. 2
Gargoyle Aircraft Instrument Oil
Aero Shell Fluid No. 6

Col 29

GENERAL—POWER PLANT

25-Hour

Make a thorough inspection of entire engine and mountings. Check engine cowl spinner bulkhead mounting for defects and security of attachment. Check engine mounting lugs for tightness of bolts and condition of rubber bushings.

Col 29

CAUTION

Do not over-tighten mounting bolts.

Clean and inspect distributor drive housing vent screens.

50-Hour

Make thorough inspection of entire engine for cracks. Check stud nuts cylinder head to coolant jackets and crank case for coolant jacket for looseness. Check for coolant leak at cylinder head gasket.

Check all clamps, bondings, taping, and safetying of all lines, and all rods within the engine section.

Check engine cowl spinner bulkhead mountings.

Inspect engine mount for cracks (particularly at welds), tightness of mounting to fuselage, engine mounting lugs for tightness of bolts, proper protective coating, condition of rubber shock absorbing unit attaching bolts, condition of stops above and below the units.

Inspect condition of Fabreeka snubbers between engine support fittings and the engine mount supports.

Check the front mounting bolts for tightness. Nuts should be tightened to 240 to 264 inch pounds torque. Rear mounting bolt nuts should be tightened to a torque of 120 to 144 inch pounds.

CAUTION

Do not over-tighten mounting bolts.

Engine Change

Cylinder Hold-Down Nuts: At the end of the first five hours flying time of a new or newly overhauled engine, the cylinder hold-down nuts should be inspected for tightness. No further checking of these nuts will be necessary until the next overhaul. In general the nuts will usually be somewhat loose because of settling of the cylinder blocks and compression of gasket paste on the cylinder barrel bearing plates. The nuts are tightened as follows: Turn the nut so that it just makes contact with the boss, but does not load the stud. Then tighten it by turning through an angle of 90 to 110 degrees. Cotter each nut after final tightening. In doing this, only one nut on a block should be tightened at a time to avoid possibility of breaking the crankcase cylinder block seal.

Note

It should be held in mind when tightening the cylinder head stud nuts by angular displacement that the washer must be pulled down sufficiently to compress the shoulder of the rubber packing sleeve and permit the washer to make contact with the cylinder head boss before the 90 and 110 degrees tightening angle is made. Washers with 1/64 chamfer on bottom inner diameter must be used.

Col 29

CAUTION

Engine must be cold when hold-down nuts are tightened.

Col 31

COCKPIT

50-Hour

Seat: Inspect for security of attachment (including supports and brackets), breaks or cracks in the seat which could foul parachute or clothing. Inspect the shoulder strap control mechanism from the lever on the left of the pilot's seat to the releasing mechanism on the back of the seat. Inspect windshield and cockpit enclosure for condition of frame and security of attachment, breaks, or cracks in glass or transparent sheet, condition and operation of mechanism of sliding enclosure including emergency release. Lubricate working parts with oil, grade 1080, Specification AN-VV-O-446. Check condition of rubber stops at aft end of cockpit enclosure track and rubber seals on enclosure.

Check to determine that canopy release mechanism is engaged with all lugs of canopy carriage, with special attention given to rear lugs. Check that locking wires (.032 brass or equivalent) are installed securing canopy release mechanism to roller assembly. Inspect canopy release mechanism to insure safe operation of the canopy.

Check for condition and proper operation of ventilator and hot air control. Inspect mixing chamber casting for cracks and leaks.

100-Hour

Inspect microphone connector cords, fiexible oxygen tubes, etc., for proper anchorage to insure against fouling controls. Clean cockpit.

Col 32

FLIGHT CONTROL MECHANISM

25-Hour

At first 25 (and subsequent 100) hour inspections check tension of controls.

Lubricate control mechanism in accordance with lubrication diagram. (See figure 39.)

Make inspection of flight control mechanism as follows:

Inspect cable for frayed wires. (Not more than 6 broken wires per inch.)

Inspect for broken, loose or misaligned pulleys.

Inspect rods for freedom of movement and for condition of bearings and sliding surfaces.

Inspect guides for general condition, proper alignment and security of mounting.

Inspect brackets for security of attachment, cracks or other defects.

50-Hour

Thoroughly clean all control cables where they pass over pulleys, through fairleads or other points of contact. In areas where atmospheric conditions are conducive to forming corrosion, coat the cables with corrosion preventive compound, Specification AN-C-52.

Col 32 Inspect rudder pedal assembly for proper functioning of the parts; lost motion or binding. Check for proper setting of the rudder pedals and the rudder when in neutral position and check that rudder doesn't interfere with the elevators when in extreme positions.

Inspect stick control for condition and proper functioning of the parts. Check for lost motion or binding.

Check tab mechanism for proper functioning.

100-Hour

Check flight control cables for tension.

Col 33

MOVABLE SURFACES

25-Hour

Inspect elevators, rudders and tabs for free and full movement, warping, loose rivets, conditions of covering, hinges and horns for security of attachment, bends, breaks and proper safetying. Lubricate wing flap hinges with oil, grade 1080 Specification AN-VV-O-446.

Inspect ailerons for cracks and general condition.

Col 34

FIXED SURFACES

25-Hour

Make a thorough inspection of horizontal and vertical stabilizers and fairings for cracks, loose rivets, screws, and general condition. Inspect mounting of navigation lights in vertical stabilizer.

Make thorough inspection of wings, and fairings for cracks, loose rivets, loose screws and general condition, corrosion, etc.

50-Hour

Make a thorough inspection of wings for loose rivets, loose screws, and general condition; check for corrosion. Inspect joint at centerline of airplane and wing to fuselage joints for security of attachment, cracks, elongated holes and condition of sealing compound around lights. Lubricate wing flaps hinges with oil, grade 1080, Specification AN-VV-O-446.

Col 35

FUEL TANKS

50-Hour

WARNING

Before inspecting fuel tanks, allow fumes to dissipate from tanks for at least ten minutes after removing access doors. If repairs are to be made, drain the tanks and dry the interior by directing a blast of air into the interior of the tank for several hours, preferably overnight.

Inspect for security of mounting, signs of leakage, condition of padding, proper location of padding between tank and straps and mounts, proper tension of support straps, and proper anchorage of fuel lines leading from the tanks.

100-Hour

Drain the fuel tanks and remove the hand hole covers. Clean the interior of the fuel tanks. Remove finger strainer from sump and clean.

Col 35

300-Hour

Drain the fuel tanks and remove all access covers and make thorough inspection. Examine compartment structure and fittings for corrosion and damage. Replace hand hole covers, and test tank for leaks.

Col 36

TAIL WHEEL GEAR

25-Hour

Inspect struts, braces and fittings for cracks, bends, security and condition of attachment fittings, elongated bolt holes. Check for loose, missing or unsafetied bolts, nuts or cotter pins. Inspect doors for security and condition.

Lubricate in accordance with lubrication diagram figure 39.

Check shock strut for fluid level and proper inflation.

Lubricate linkage on doors with oil, grade 1080, Specification AN-VV-O-446. Check operation of swivel release mechanism.

50-Hour

Inspect the tail wheel doors for proper closing when the wheel is retracted.

Inspect tail wheel swivel for proper operation.

Col 37

LANDING GEAR

25-Hour

Inspect struts, braces and fittings for cracks, bends, security and condition of attachment fittings, elongated bolt holes. Check for loose, missing or unsafetied bolts, nuts or cotter pins. Inspect fairings for security and condition.

Lubricate in accordance with lubrication diagram, figure 39.

Check shock struts for fluid level and proper inflation.

Lubricate linkage on movable fairings with oil, grade 1080, Specification AN-VV-O-446.

50-Hour

Check control and functioning of retracting and lowering mechanism by operating independently with both the motor driven pump and the emergency hand pump. Check operation and condition of mechanical locks and signal system.

Inspect landing gear operating cylinders for proper landing and travel.

Check for proper fluid level of shock absorber struts.

Inspect entire installation for proper operation.

Col 38

WHEELS AND BRAKES

25-Hour

With parking brake set, inspect entire hook-up from master brake cylinders to wheel cylinders for leaks, condition of attaching clips and flexible connections. Inspect brakes for entrapped air (soft spongy feel to brake action), and for leakage at brake cylinder sleeve. Check clearance between brake lining and brake drum (should be .008 inch).

Col 38

CAUTION

Do not apply brakes with wheels removed.

Check the fluid level in the master brake cylinder unit on each rudder pedal with the brakes released. Fill the system with hydraulic fluid, AAF Specification 3586.

50-Hour

Wheels: Inspect for evidence of corrosion of the visible portion of the wheel rim and for evidence of damage to wheel rim edges.

Tires: Inspect for tread wear exposing fabric carcass; replace if this defect is found. Inspect for external cuts, breaks, blisters or other visible damage.

100-Hour

Remove wheels and check entire brake assembly for corrosion and broken or distorted parts. Inspect linings for cracks, wear, evidence of grease or oil and loose rivets. Inspect drums for scoring. Inspect the wheel bearings for general condition. Inspect the wheels for cracked or distorted rim flanges and ribs. Replace wheels and adjust brakes. Check wheels for end play and free running.

Remove, inspect, and lubricate tail wheel roller bearings. Use grease, Specification AN-G-3.

Col 39

HYDRAULIC SYSTEM

25-Hour

Hydraulic Lines: Inspect all lines and connections for any imperfections.

Valves: Inspect valves for general condition.

Hand Pump: Check hand-operated hydraulic pump for proper condition and functioning.

Motor-Driven Pump: Inspect pump for security of mounting and proper operation. Inspect and clean motor terminals.

Struts: Check retracting and actuating struts for functioning. Lubricate tail wheel retracting strut guide with oil, Specification AN-O-6.

Fluid Reservoir: Check the fluid level. Fill with fluid, hydraulic, Specification 3586. Clean strainer in top of reserve tank in alcohol.

50-Hour

Hydraulic Lines: Inspect all lines and connections for leaks, kinks, dents, or cracks, security of anchorage, wear due to chafing or vibration, etc.

Valves: Inspect cams and followers in hydraulic control valve for condition, check for clearance of from .005 inch to .015 inch and for minimum poppet valve travel of .004 inch. Test relief valves in accordance with Section IV, 7. *c.* (1) (g).

Pump, Motor-Driven Hydraulic: Check tightness of attaching nuts and inlet and discharge fittings.

Col 40

FUSELAGE

25-Hour

Inspect for general condition, corrosion, pulled rivets, rupture or distortion indicating failure, etc.

50-Hour

Inspect all accessible parts of interior and exterior of fuselage for general condition of skin, cracks in structural members, loose bolts, rivets, etc., and condition of protective coating. Inspect for proper attachment of inspection doors, fairing and cowling.

Inspect armor plate for any dissimilar metal contacts and evidence of corrosion.

Col 43

GENERAL—AIRPLANE

25-Hour

Lubricate the heating system and the ventilator with oil, Specification AN-O-6.

Remove the air filter inlet screen and clean.

50-Hour

Heating and Ventilating: Lubricate the heating system and ventilator with oil, Specification AN-O-6.

Check for condition and proper operation of ventilator and hot air control. Inspect mixing chamber castings for cracks and leaks.

Check contents of aircraft data case for completeness and for security of cover fastenings to avoid spilling contents during maneuvers.

Col 44

NAVIGATION INSTRUMENTS

50-Hour

Inspect all instruments for chipped or discolored luminous markings, correct the discernible operation markings, security of mounting and tightness of connections. Check electrical instruments for condition of insulation. Check pressure gage lines and connections for leaks.

Check instrument panels for defective shock mounting; bonding on panels, lines and instruments.

Magnetic Compass: Note if compass is to be swung. Inspect for discoloration of liquid, unbalanced card, etc.

Altimeter: Set pointer at "ZERO". Check reading of setting markers against Station Barometer. If a difference exists adjust.

Air-Speed Lines: Inspect for security of mounting and tightness of connections. Drain airspeed lines. Check air-speed tube for security of mounting and for general condition. Clean holes in air-speed head with soft copper wire. Check electrical heating element.

Air Thermometer: Inspect indicator and leads for short circuit to ground and between leads. Check for reading consistent with atmospheric or hanger temperature.

100-Hour

Compensate the compass and record readings on AAF Form No. 57 at the end of each 100 hours

Col 44

of flying time, at each change of engines, guns, armor plate or electrical equipment likely to affect the compass, or at least once during each three-month period.

Ground swinging of the airplane may be accomplished by means of a compass base or a swinging compass. The swinging compass is a standard aircraft compass, Pioneer Type B-16, which has had its compensating assembly removed and a swinging compass sight, Stock No. 7800-725200, attached in its place. The magnetic heading of an aircraft is determined with the swinging compass by standing at least 50 feet from the airplane. The observer aligns himself with the airplane's longitudinal axis by reference to a radio mast and fin, row of central fuselage rivets, or any suitable line or pair of objects on the airplane, and with the swinging compass held in cupped hands, the observer looks both through and over the lens of the attached sight (through it at the hair line, and over it at the object sighted upon) and aligns the two by rotating the compass. The reading obtained is the magnetic heading of the aircraft if the observer is behind the aircraft. If the observer is in front of the aircraft, the magnetic heading is obtained by adding or subtracting 180 degrees from the reading obtained from the swinging compass. Having selected a suitable area for swinging, adjust the compensator on the aircraft for zero effect. Head the airplane EAST, within five degrees by its own compass. Allow the aircraft compass sufficient time to settle, then read. Record reading in its proper space in the second column of card, AAF Form No. 57. Determine the magnetic heading of the aircraft with the swinging compass and record in the proper space in the first column of the card. Then with the engine running at sufficient rpm to show the maximum charge on the ammeter, recheck the compass reading.

Note

> An electrical load must be applied before the ammeter will indicate any change.

Head the airplane SOUTH and repeat the above process. If no change is noted in the compass indication as a result of running the engine, it will not be necessary to keep it running during the rest of the swing. If a change in the reading results, the engine must be kept running during the swing of the airplane and the compass readings thus obtained entered on the card. Continue the swing on the other two cardinal headings WEST and NORTH in that order. A card having the first two columns completed is shown in figure 309.

	Compensating Swing			Residual Swing		Aircraft Comp.	Date	
	Actual Head. (M)	Aircraft Comp.	Dev'n	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	005	001					000	
NE 045							045	
E 090	087	090					090	
SE 135							135	
S 180	176	180½					180	
SW 225							225	
W 270	265	273					270	
NW315							315	
	(1)	(2)	(1)−(2)	(3)	(4)	(3)−(4)		(4)−(3)

If swinging compass used ahead of aircraft add or subtract 180 degrees.

Coeff. C = $\frac{N-S}{2} = \frac{(\quad)-(\quad)}{2} =$

Coeff. B = $\frac{E-W}{2} = \frac{(\quad)-(\quad)}{2} =$

Coeff. A = $\frac{N+E+S+W}{4} = \frac{(\quad)+(\quad)+(\quad)+(\quad)}{4} =$

Figure 309—Compass Compensating Card No. 1

Col 44 Calculate the deviation and its sign for each heading. The deviation and its sign are determined by subtracting the aircraft compass reading from the actual heading, that is, the deviation and its sign indicate the quantity that must be added or subtracted to the aircraft compass reading to make its value the same as the actual heading. If the quantity must be added, the sign is plus (+); if subtracted, it is minus (−). The deviations and their signs are entered in the column label "Dev'n" as illustrated in figure 310.

	Compensating Swing			Residual Swing		Aircraft Comp.	Date	
	Actual Head (M)	Aircraft Comp.	Dev'n	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	005	001	+4				000	
NE 045							045	
E 090	087	090	−3				090	
SE 135							135	
S 180	176	180½	−4½				180	
SW 225							225	
W 270	265	273	−8				270	
NW315							315	
	(1)	(2)	(1)−(2)	(3)	(4)	(3)−(4)		(4)−(3)

If swinging compass used ahead of aircraft add or subtract 180 degrees.

Coeff. C = $\frac{N-S}{2} = \frac{(\quad)-(\quad)}{2} =$

Coeff. B = $\frac{E-W}{2} = \frac{(\quad)-(\quad)}{2} =$

Coeff. A = $\frac{N+E+S+W}{4} = \frac{(\quad)+(\quad)+(\quad)+(\quad)}{4} =$

Figure 310—Compass Compensating Card No. 2

Using the recorded deviations, calculate coefficients A, B, and C according to the formulae on

	Compensating Swing			Residual Swing		Aircraft Comp.	Date	
	Actual Head (M)	Aircraft Comp.	Dev'n	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	005	001	+4				000	
NE 045							045	
E 090	087	090	−3				090	
SE 135							135	
S 180	176	180½	−4½				180	
SW 225							225	
W 270	265	273	−8				270	
NW315							315	
	(1)	(2)	(1)−(2)	(3)	(4)	(3)−(4)		(4)−(3)

If swinging compass used ahead of aircraft add or subtract 180 degrees.

Coeff. C = $\frac{N-S}{2} = \frac{(+4)-(-4\frac{1}{2})}{2} = +\frac{8\frac{1}{2}}{2} = +4\frac{1}{4}$ OR $+4$

Coeff. B = $\frac{E-W}{2} = \frac{(-3)-(-8)}{2} = +\frac{5}{2} = +2\frac{1}{2}$

Coeff. A = $\frac{N+E+S+W}{4} = \frac{(+4)+(-3)+(-4\frac{1}{2})+(-8)}{4} = -\frac{11\frac{1}{2}}{4} = -3$

Figure 311—Compass Compensating Card No. 3

Col 44 the latter part of the form as shown in figure 311. All additions and subtractions are algebraic.

Note

Coefficient C is the deviation on NORTH minus algebraically the deviation on SOUTH, divided by 2, that is, the sign of the deviation on SOUTH heading is made opposite to that recorded, and if the signs of both deviations are the same, the two quantities are added, the sum divided by 2 and the result is given that same sign. If the sign of the two deviations are opposite, the smaller quantity is subtracted from the larger, the result divided by 2 and given the sign of the larger number. Coefficient B is the deviation on EAST minus algebraically the deviation on WEST, divided by 2, that is, the sign of the deviation on WEST is made opposite to that recorded. If the signs of both deviations are then the same, the two quantities are added, the sum divided by 2 and the result given the same sign. If the signs of the two deviations are opposite, the smaller quantity is subtracted from the larger, the result divided by 2 and given the sign of the larger number. Coefficient A is the sum of the deviations on NORTH, EAST, SOUTH and WEST divided by 4, that is, all the plus (+) recorded deviations area added and all the minus (−) deviations are added, the smaller quantity subtracted from the larger, the result divided by 4 and given the sign of the larger number.

Col 44 With the aircraft's heading on magnetic NORTH within five degrees by its own compass, determine what the instrument should indicate when compensated by adding coefficient C algebraically to the compass reading, that is, add or subtract coefficient C from the compass reading on that heading as indicated by the sign of the coefficient. Adjust the North-South compensating screw (using nonmagnetic screwdriver) to make the compass indicate the compensated value. For example, the aircraft compass reads one degree and coefficient C is + four degrees. To correct for coefficient C, the compass should be made to read one degree plus four degrees or five degrees by rotating the North-South compensator screw.

With the aircraft heading on magnetic EAST within five degrees by its own compass, add coefficient B algebraically to the compass reading. Determine what the instrument should indicate when compensated by adding coefficient B algebraically to the compass reading, that is, add or subtract coefficient B as indicated by its sign to the compass reading on the EAST heading. Make the compass indicate the compensated value by adjusting the East-West compensating crew (use nonmagnetic screwdriver). For example, the aircraft compass reads 90 degrees and coefficient B is +2-1/2 degrees. To correct for coefficient B, the compass should be made to read 90 degrees plus 2-1/2 degrees or 92 1/2 degrees by rotating the East-West compensating screw.

With the aircraft on any heading, determine what the instrument should read when corrected for coefficient A by adding coefficient A algebraically to the reading of the compass on that heading, that is, add or subtract the value of coefficient A as indicated by its sign to the compass reading. Make the compass indicate the corrected value by rotating the compass bowl bodily. (When the pilot's compass is mounted on an instrument board the correction for coefficient A may be omitted.) For example, the compass reads 92-1/2 degrees after the correction for coefficient B and coefficient A is minus three degrees. To correct for coefficient A, make the compass read 92-1/2 degrees minus three degrees or 89-1/2 degrees by rotating the compass bowl counterclockwise three degrees. The correction of the three coefficients A, B, and C completes the compensation of the compass.

Securely fasten the compass and swing for residual errors. The residual errors result from causes other than those which give rise to coefficients A, B and C, and no provision is made to compensate for these errors. The residual swing is accomplished in the same manner as the swing before compensation was performed except that

Col 44 eight headings are used instead of four. The aircraft is placed on the cardinal and quadrantal magnetic headings (EAST, SOUTHEAST, SOUTH, SOUTHWEST, WEST, NORTHWEST, NORTH, NORTHEAST) and the magnetic headings and the corresponding compass readings are entered in their proper spaces on the card. The card will appear as shown in figure 312 after the data from the residual swing are entered.

	Compensating Swing			Residual Swing		Aircraft Comp.	Date	
	Actual Head (M)	Aircraft Comp.	Dev's	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	005	001	+4	002½	001		000	
NE 045				040	043		045	
E 090	087	090	−3	095	094		090	
SE 135				136	134		135	
S 180	176	180½	−4½	185	184		180	
SW 225				222	225		225	
W 270	265	273	−8	275	276		270	
NW315				317	316		315	
	(1)	(2)	(1)−(2)	(3)	(4)	(3)−(4)		(4)−(3)

If swinging compass used ahead of aircraft add or subtract 180 degrees.

$$\text{Coeff. } C = \frac{N-S}{2} = \frac{(+4)-(-4\frac{1}{2})}{2} = +\frac{8\frac{1}{2}}{2} = +4\tfrac{1}{4} \text{ OR } +4$$

$$\text{Coeff. } B = \frac{E-W}{2} = \frac{(-3)-(-8)}{2} = +\frac{5}{2} = +2\tfrac{1}{2}$$

$$\text{Coeff. } A = \frac{N+E+S+W}{4} = \frac{(+4)+(-3)+(-4\frac{1}{2})+(-8)}{4} = -\frac{11\frac{1}{2}}{4} = -3$$

Figure 312—Compass Compensating Card No. 4

Complete AAF Form No. 57 by filling in the remaining two columns from data obtained in the residual swing. The entries for the left-hand column (C to M) are obtained by subtracting column 4 from column 3 for each heading. The C to M column indicates that the tabulated corrections are to be added or subtracted to the compass reading to obtain the magnetic heading. The entries for the right-hand column (M to C) are obtained by subtracting column 3 from column 4 for each heading. The completed column labeled M to C indicates that the corrections are added or subtracted to the magnetic heading to obtain the compass reading. For example, using the card shown in figure 313, if the compass heading is 225 degrees subtract three degrees (C to M column) to determine the corresponding magnetic heading, 222 degrees. If the magnetic heading is 45 degrees add three degrees (M to C column) to determine the corresponding compass reading, 48 degrees C. Complete the correction card, adding the information required in the blanks on the rear of the card. Detach the com-

	Compensating Swing			Residual Swing		Aircraft Comp.	Date	
	Actual Head (M)	Aircraft Comp.	Dev'n	Actual Head (M)	Aircraft Comp.	C to M		M to C
N 000	005	001	+4	002½	001	+1½	000	−1½
NE 045				040	043	−3	045	+3
E 090	087	090	−3	095	094	+1	090	−1
SE 135				136	134	+2	135	−2
S 180	176	180½	−4½	185	184	+1	180	−1
SW 225				222	225	−3	225	+3
W 270	265	273	−8	275	276	−1	270	+1
NW315				317	316	+1	315	−1
	(1)	(2)	(1)−(2)	(3)	(4)	(3)−(4)		(4)−(3)

If swinging compass used ahead of aircraft add or subtract 180 degrees.

Coeff. $C = \frac{N-S}{2} = \frac{(+4)-(-4\frac{1}{2})}{2} = +\frac{8\frac{1}{2}}{2} = +4\frac{1}{4}$ OR $+4$

Coeff. $B = \frac{E-W}{2} = \frac{(-3)-(-8)}{2} = +\frac{5}{2} = +2\frac{1}{2}$

Coeff. $A = \frac{N+E+S+W}{4} = \frac{(+4)+(-3)+(-4\frac{1}{2})+(-8)}{4} = -\frac{11\frac{1}{2}}{4} = -3$

16—29598-1

Figure 313—Compass Compensating Card No. 5

Col 44 pass card and insert it in the compass card holder in the aircraft. Place the remainder of the form in a permanent file.

To swing the airplane on a prepared base, the aircraft is turned to the desired heading as determined by the base. These magnetic headings are entered in the column, Actual Head (M). In

Col 44 every respect, the compensation and swinging are the same as when using the swinging compass method.

Col 46

BATTERY

25-Hour

Inspect the felt pad in the battery vent sump for proper condition. Saturate, if necessary, with solution of sodium bicarbonate and water.

APPENDIX I
U. S. A. - BRITISH GLOSSARY OF NOMENCLATURE

U. S. A.	*British*
Accumulator (hydraulic)	Should not be confused with electrical accumulator or battery
Antifriction bearings	Ball and roller bearings
Battery (electrical)	Electrical accumulator
Blade connecting rod	Plain connecting rod
Block test	Bench test under engine's own power
Box-end wrench	Circular-ended wrench (for hexagon)
Cap screw	Setscrew or screw
Check valve (hydraulic)	Non-return valve
Clevis	Fork joint or knuckle joint
Closed spanner—wrench with internal lugs or surface lugs	Ring spanner
Cotter pin	Split pin
Cylinder (hydraulic)	Jack
Dump valve	Jettison valve
Fillister head screw	Cheese headscrew
Flathead screw	Countersunk head screw
Flight indicator	Artificial horizon
Gall	To fret or score
Gasoline (gas)	Petrol
Gross weight	All up weight
Ground (electrical)	Earth
Green run	Endurance test
Gyro horizon	Artificial horizon
Kerosene	Paraffin
Knuckle pin (used on radial engines)	Wrist pin or anchor pin
Lock washer	Spring washer
Manifold pressure	Boost
Oil pan	Sump
Pad	Sometimes used for raised machined surface for mounting accessories, etc.
Palnut	Type of lock nut
Panel, wing—Center of inboard panel	Center section
Outboard panel	Outer plane
Piston pin	Gudgeon pin
Propeller	Airscrew
Recticule (gun sight, etc.)	Graticule
Round-head screw	Cup head screw
Screen	Filter
Setscrew	Grub screw
Ship	Aircraft
Slushing compound	Corrosion inhibitor
Socket wrench	Box spanner
Spanner	C-spanner
Spanner wrench	Ring spanner
Stabilizer—	
Horizontal	Tail plane
Vertical	Fin
Stack	Manifold (inlet or exhaust)
Sylphon	Aneroid
Tachometer	Engine speed indicator
Tag	Label
Test club	Test fan
Tube (radio)	Valve
Turn indicator	Direction indicator
Valve (fuel or oil)	Cock
Weight empty	Tare

ALPHABETICAL INDEX